



William Robert

Vice President and Partner,
Spy Pond Partners LLC

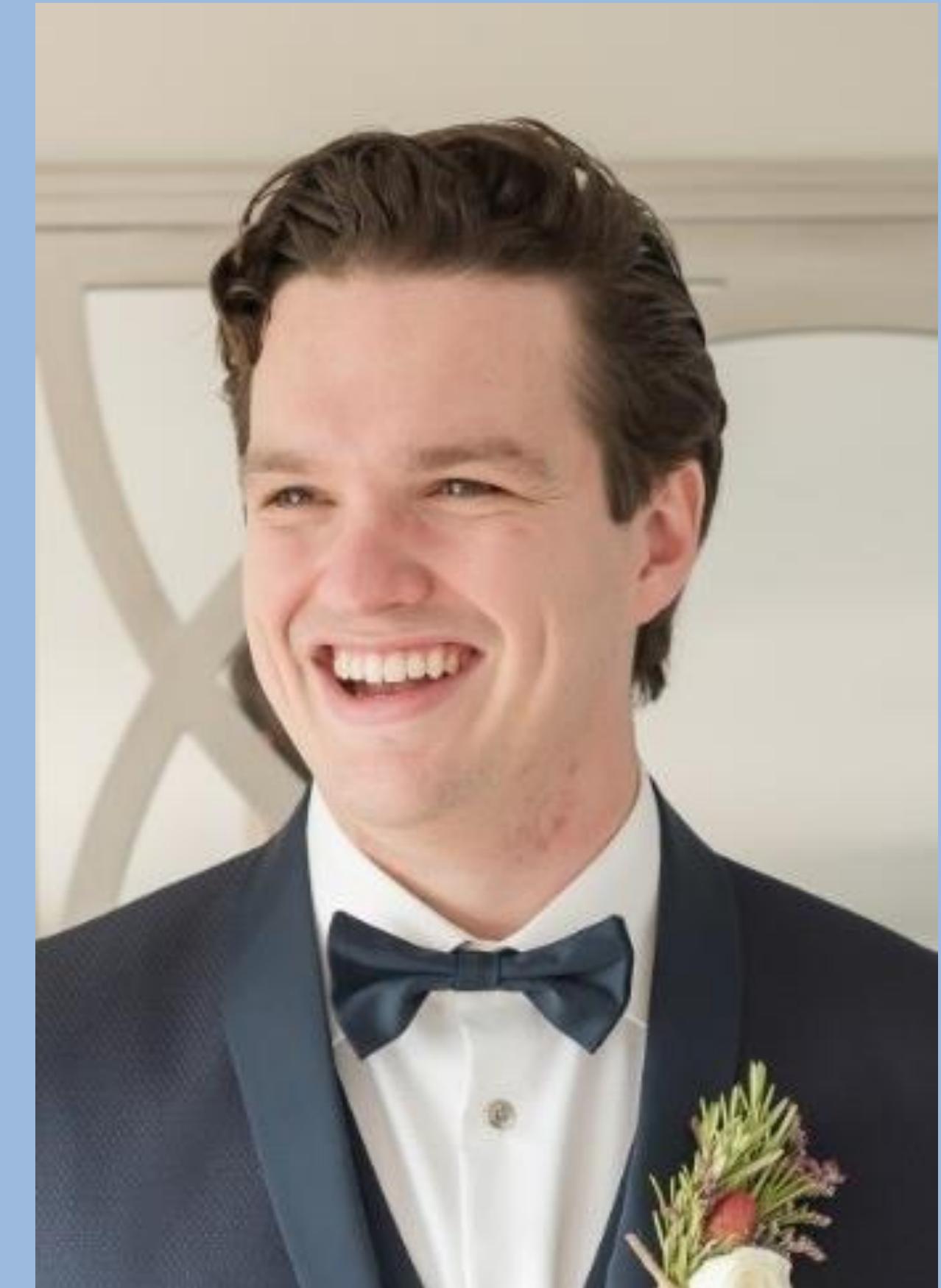




Wes Thomas

Director, Digital Service Delivery,
Loram

SEATTLE, WA



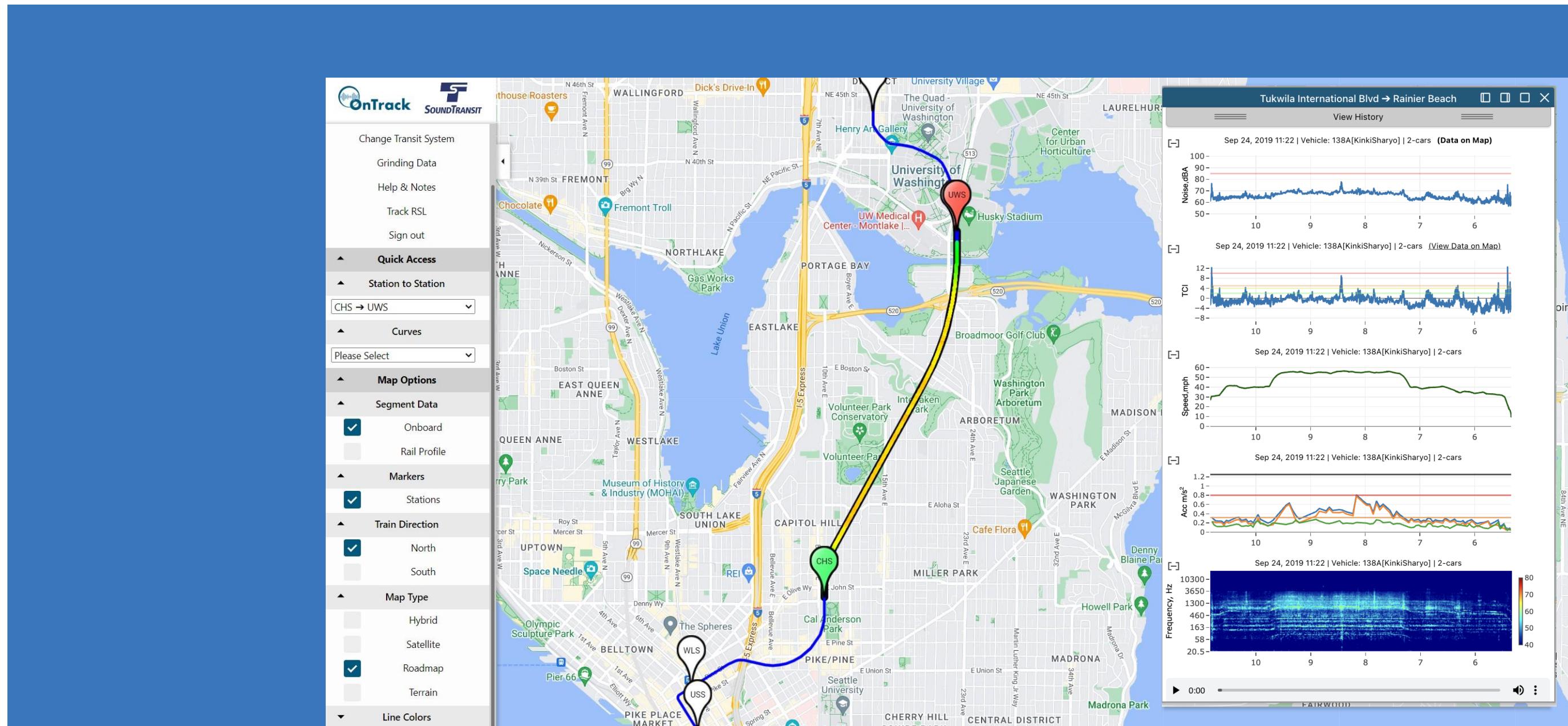


RAIL TRANSIT SEMINAR



Use of OnTrack to Support Track Maintenance Decisions for Sound Transit

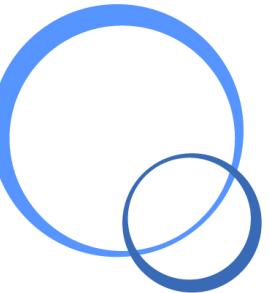
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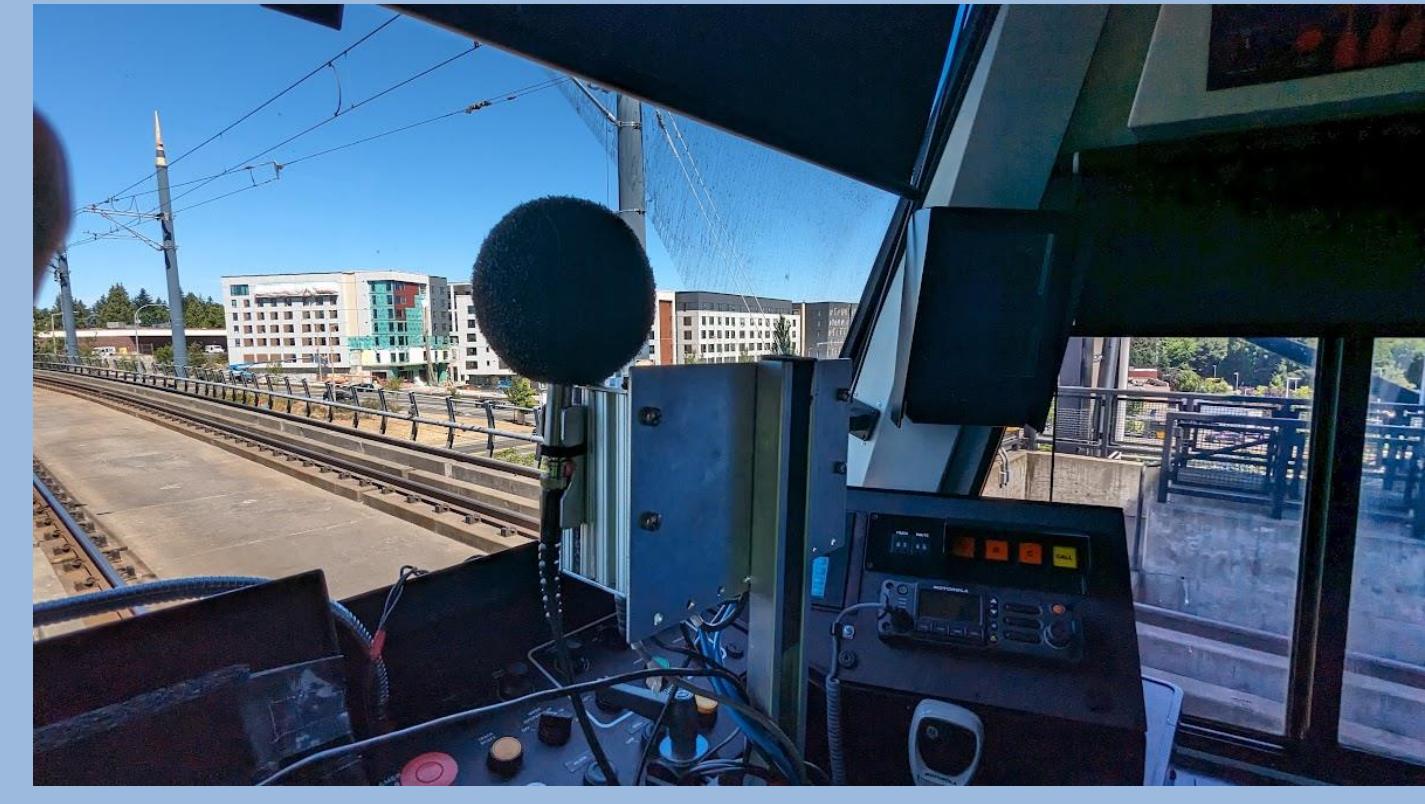
Outline

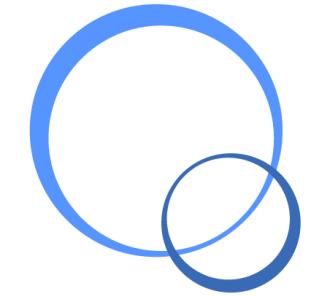
OnTrack overview

Implementation of OnTrack at Sound Transit

Current activities

Future directions

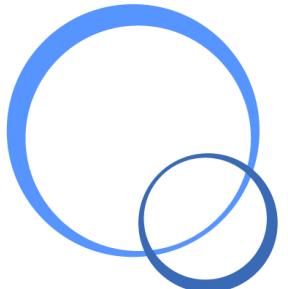




What is OnTrack?

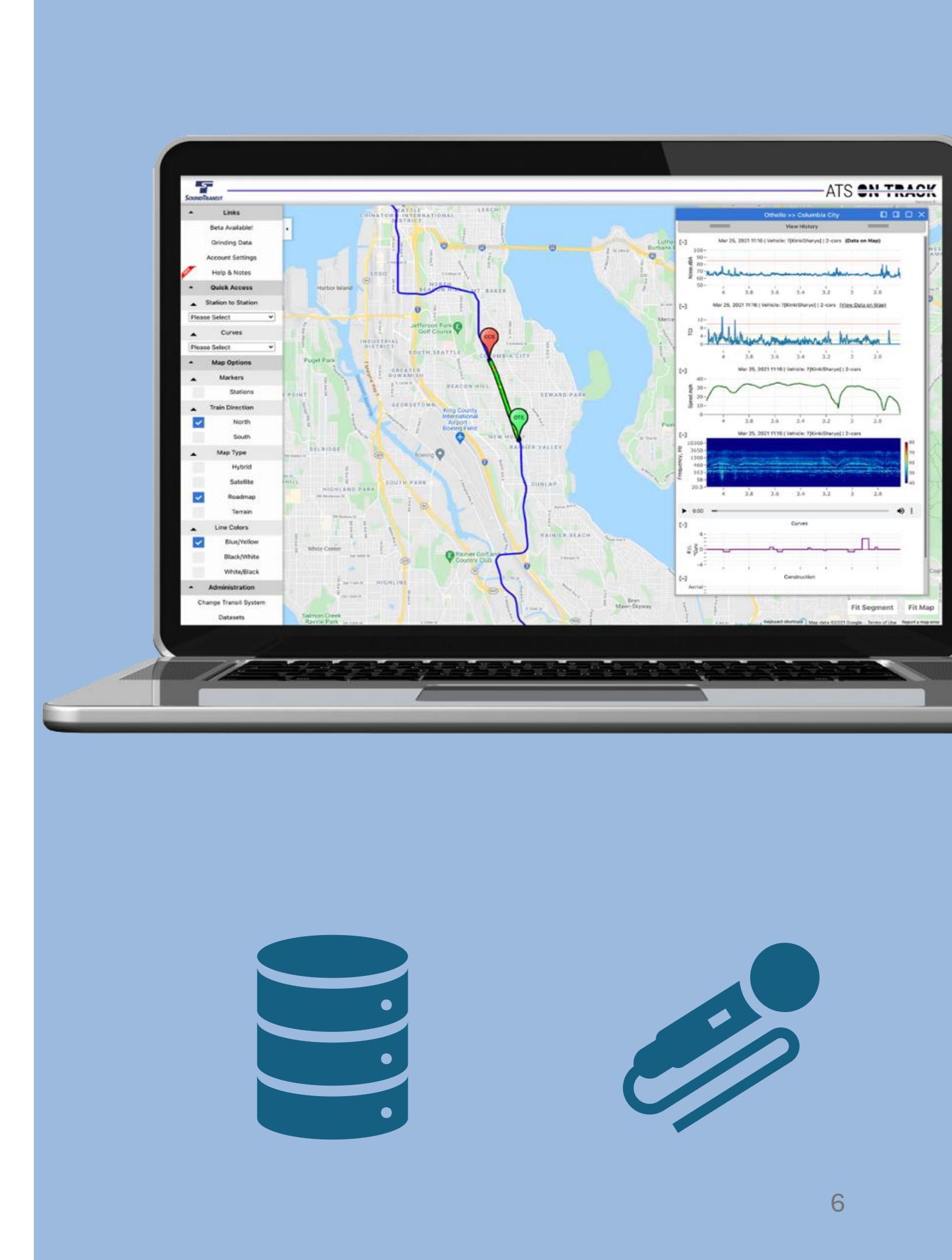
- Helps transit agencies:
- Monitor rail noise and vibration changes
- Identify locations with excessive noise caused by
 - Rail corrugation
 - Wheel squeal
 - Track defects
 - Other issues
- Identify rail grinding priorities
- Improve predictions of track remaining service life

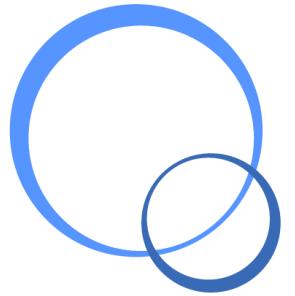
The right half of the slide features a dark blue background with the OnTrack logo on the left. The logo includes a teal circle with a white sound wave pattern and the word "OnTrack" in a teal, sans-serif font. To the right of the logo, the text "is a software and measurement system for tracking onboard noise and vibration measurements" is written in white, sans-serif font, with each sentence on a new line.



OnTrack Components

- Measurement System
 - Portable
 - Installed in cab during revenue or non-revenue service
- Relational Database
 - Detailed and summary data for all measurements
 - Audio recordings support detailed analysis
- User Interface
 - Web-based system
 - Map interface for data access
 - Trend analysis and data review

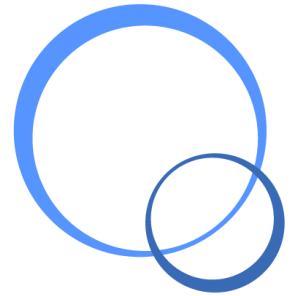




OnTrack Data

- Measurements performed periodically in a trailing cab
- Noise data
 - SPL by 1/12 octave band from 20 Hz to 20 kHz every 1/8 second
 - Overall A-weighted noise level
 - TCI: measured – expected noise level
- Vibration data
 - Collected using a triaxial accelerometer
 - Processed using based on ISO 2631-1 to obtain weighted RMS acceleration in the x, y, and z axes, as well as overall acceleration
- Position data
 - GPS location (except for tunnels)
 - Vehicle speed captured using the train speedometer
 - RFID tags at each station





OnTrack History

- Developed by ATS Consulting beginning in 2010
- Implemented for
 - Bay Area Rapid Transit (BART): 2010-current
 - Sound Transit: 2016-current
- New directions for OnTrack
 - Spy Pond Partners (SPP): took over development and support for OnTrack software in 2022
 - Cross Spectrum Acoustics (CSA): SPP's data collection partner

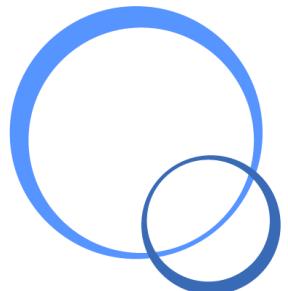


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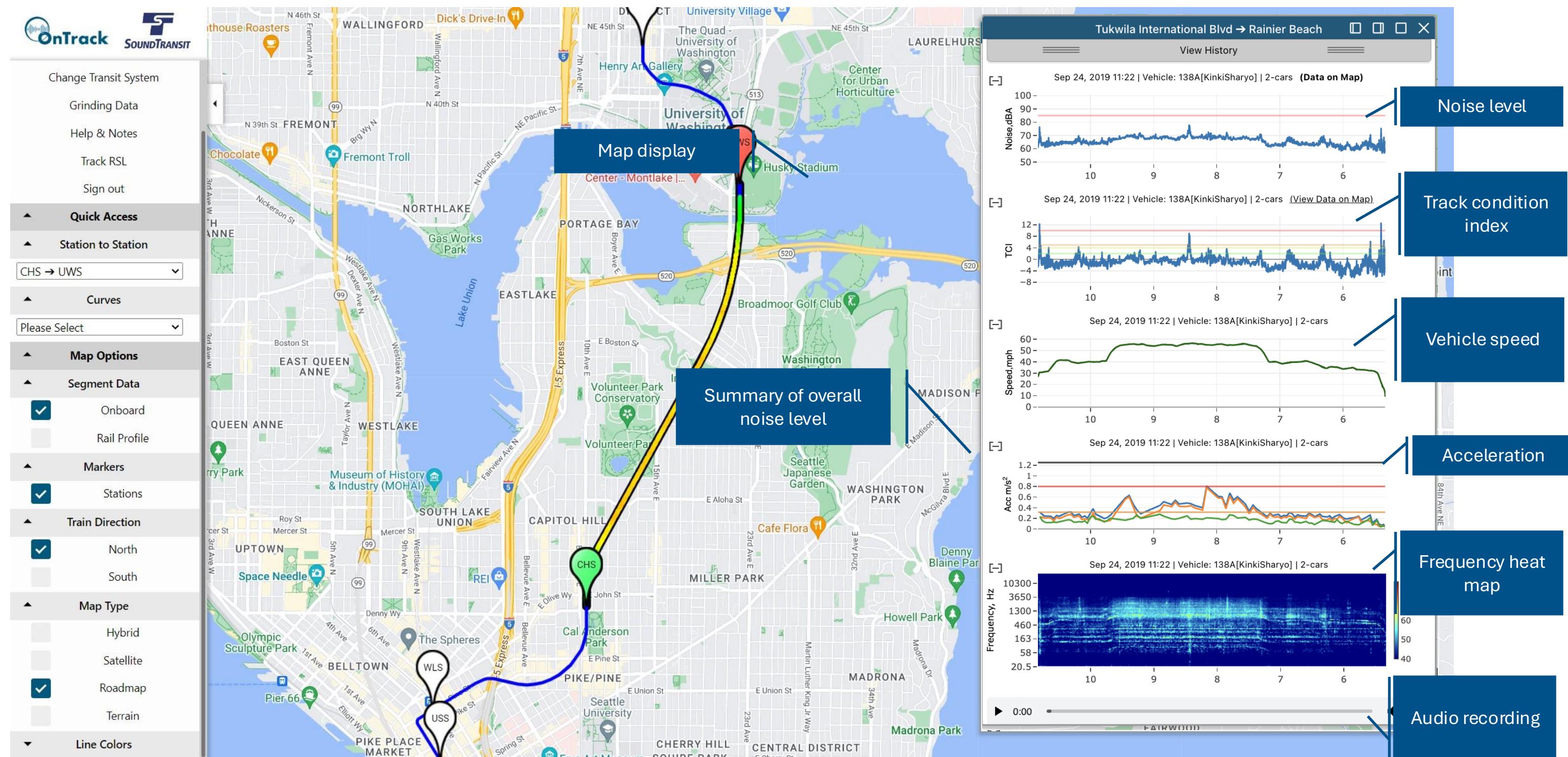


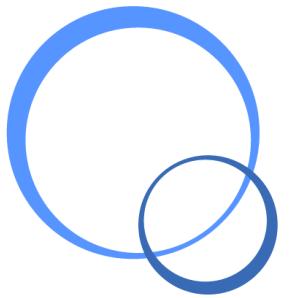
Cross-Spectrum Acoustics



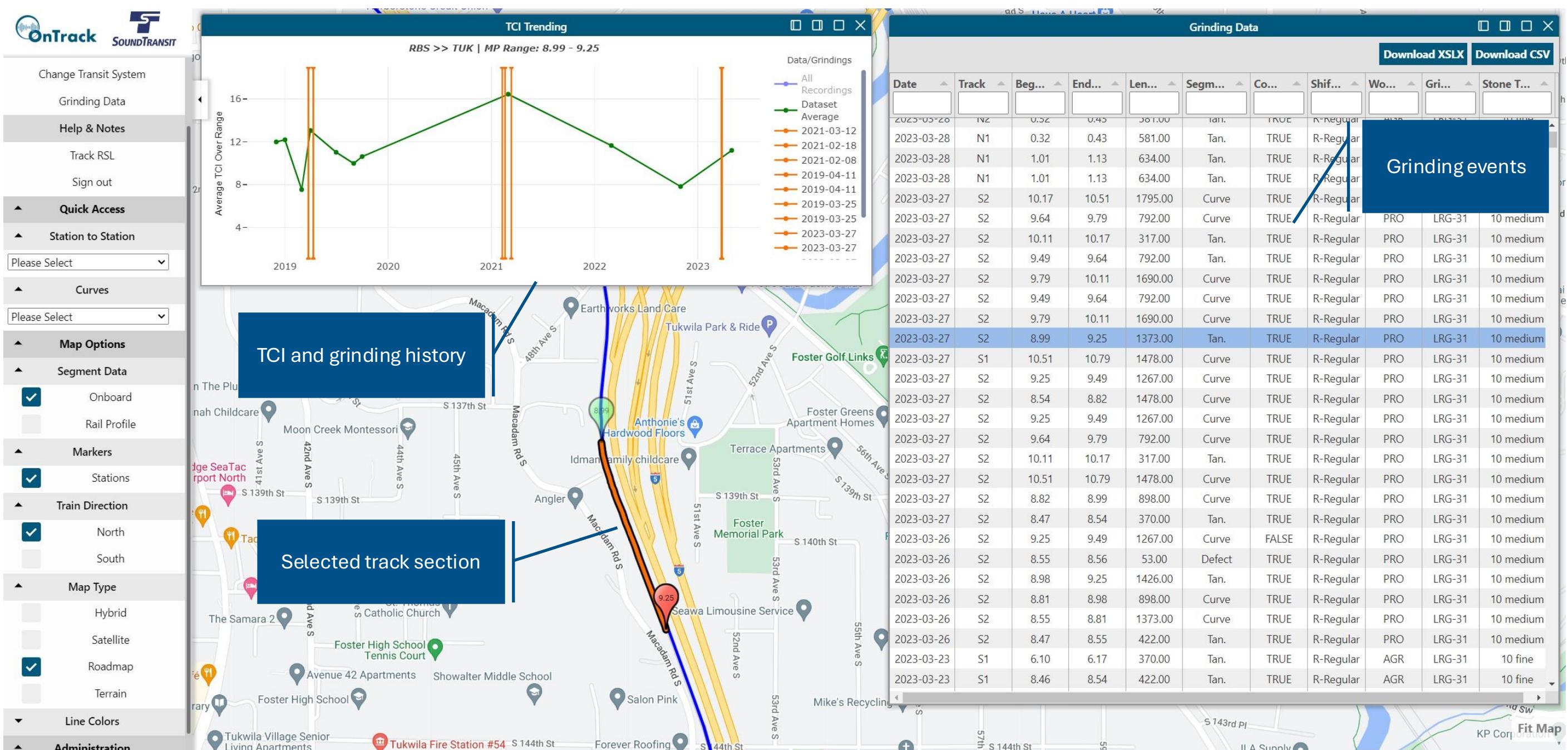


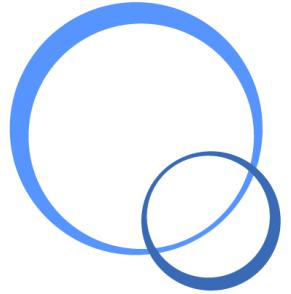
OnTrack Interface





OnTrack Interface: Trend Analysis

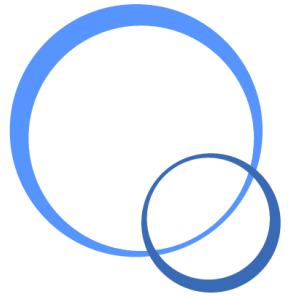




Implementation at Sound Transit: Overview

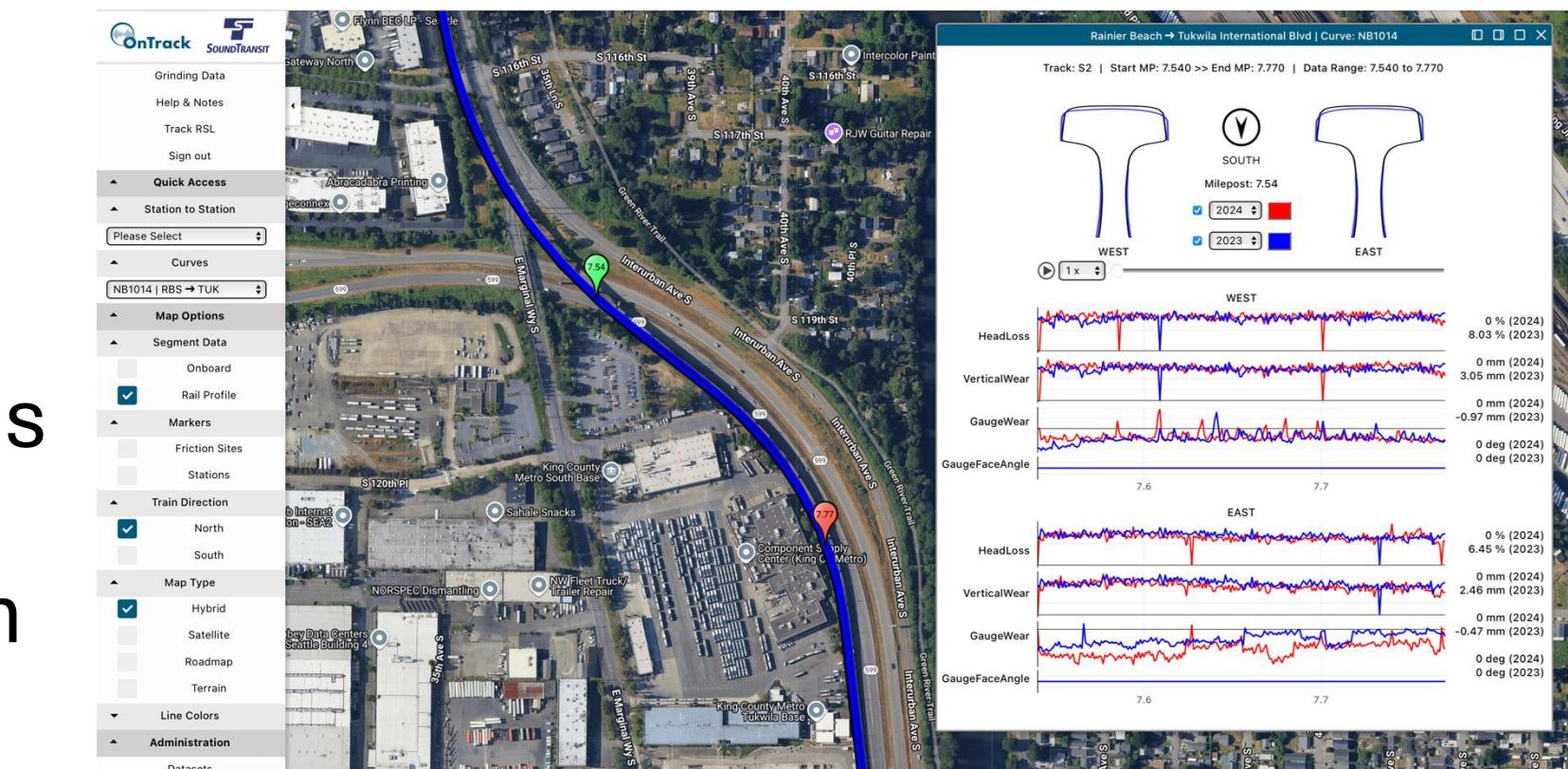
- System primarily used for
 - Monitoring trends
 - Reviewing effectiveness of grinding
- Implementation includes a Sound Transit-owned measurement kit
 - Measurements initially performed by consultants, now performed by Sound Transit staff
- Various features added for Sound Transit, with a focus on integration of different forms of data
 - Grinding history
 - Rail profile
 - Friction control sites
 - Vibration data

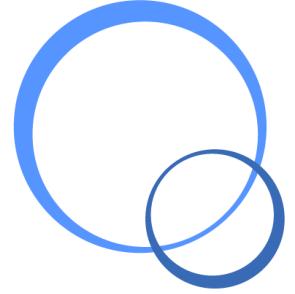




Implementation at Sound Transit: Rail Profile Data

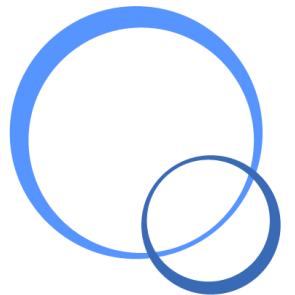
- Collected annually through a separate effort
- Includes
 - Vertical wear
 - Head loss
 - Gauge face wear
 - Gauge face angle
- Can view summary measures and the physical profile by direction, rail and location





Implementation at Sound Transit: Track Remaining Service Life (RSL)

- Of interest for forecasting future conditions and showing the impact of different maintenance strategies
- Initial estimate
 - Obtain head loss from most recent rail profile data
 - Predict future head loss based on
 - Degree of curvature
 - Assumed frequency of grinding
 - Classification of track as high, medium or low wear base on change in TCI (if measurements are available over time without intervening grinding events)
 - Calculate RSL as predicted years until the rail has reached the end of its useful life
- Refined estimate
 - Extract data from OnTrack to model in Loram Digital Twin (next presentation)



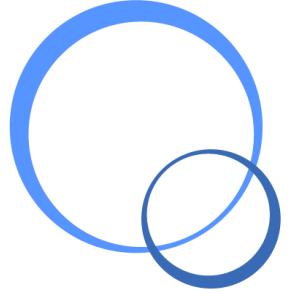
Implementation at Sound Transit: Example Track RSL Report

Track Remaining Service Life

Date: Oct 2023 ▾

Download XSLX Download CSV

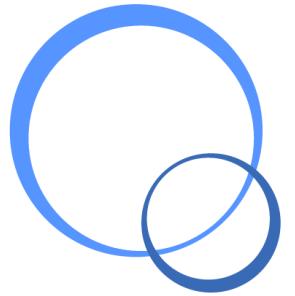
Segment	Curve	Begin Milepost	End Milepost	Remaining Servic... (years)
RBS → TUK	NB1002	6.150	6.380	13
CCS → MBS	SB1612	2.530	2.700	19
WLS → USS	NB1612	2.540	2.700	20
SEA → TUK	SB514	0.110	0.870	20
TUK → RBS	NB512	0.120	0.830	21
TUK → SEA	SB1004	6.670	6.920	22
TUK → SEA	NB1028b	9.990	10.080	22
ALS → SEA	SB704	1.400	1.490	22



Current Activities

- Measuring newly-opened portions of the system and adding these to OnTrack
- Improving the Sound Transit measurement kit to obtain speed data from an IMU
 - Will simplify measurement set up and processing
- Developing a reporting dashboard
 - Summary of measurement runs and trips performed
 - Summary of noise and vibration levels by station pair and curve/tangent section
 - Worst locations for noise and ride quality
 - Locations with largest changes
 - Trends at specified selected hotspot locations





Potential Future Directions

- Integration of vehicle event data
 - Initial work performed to extract braking event data from Sound Transit's event recorders
 - Integration of additional wayside noise and vibration measurement data
 - Further analysis and refinement of vibration data
 - Work being performed by other team members to analyze vibration data using different approaches
 - Improving support for maintenance decision-making as the system matures





Digital Twins to Support Track Maintenance Decisions for Sound Transit



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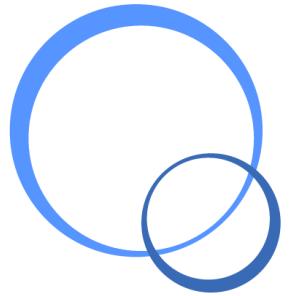


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Background – Challenges to Solve

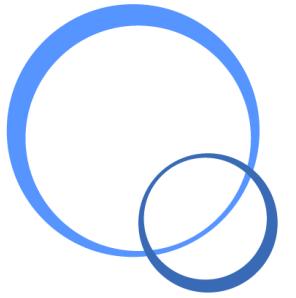
Noise, Vibration, and Gradual Preventive Grinding

Sound Transit experienced vibration, noise, and stud defects during periods before preventive grinding. These challenges have been improved with corrective work, but how can we optimize the frequency and schedule?

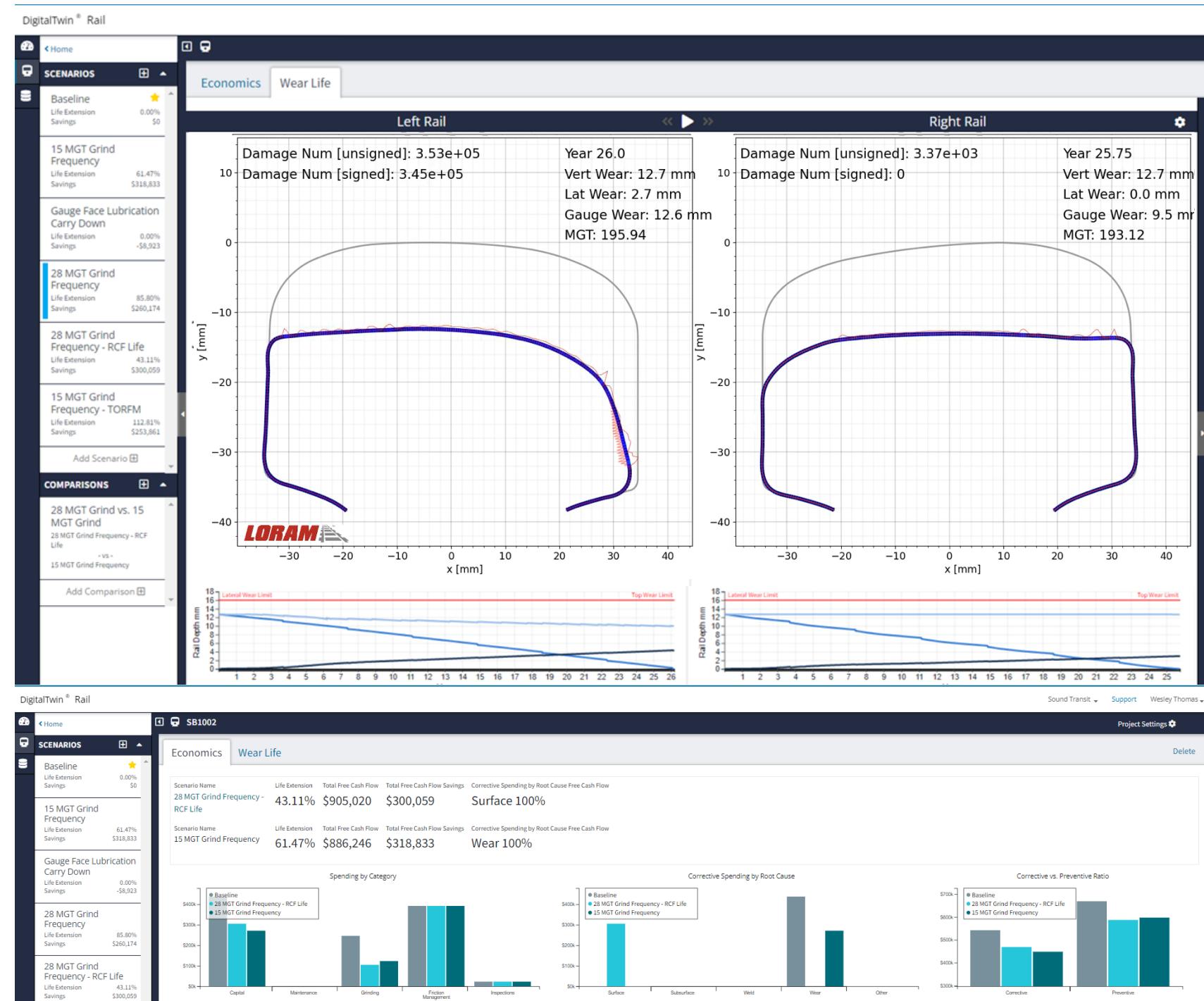
Life Extension from Network Build Focus to O&M Focus

Sound Transit has been rapidly expanding its network with significant funding. However, the capital investment will reduce and budgets will tighten. How do we help plan for the upcoming maintenance needs and be good stewards of taxpayer funding?





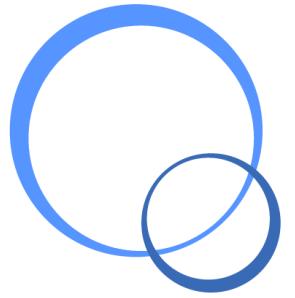
Year 1 – Grind Strategy in Digital Twin



Grind Plan

Grind frequency was inconsistent across network.

Recommended grind strategy for long-term scheduling



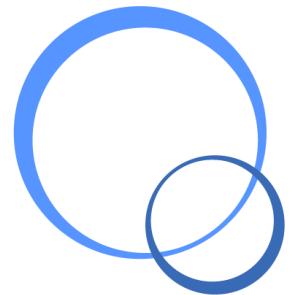
Year 1 – Rail Material to Address Studs



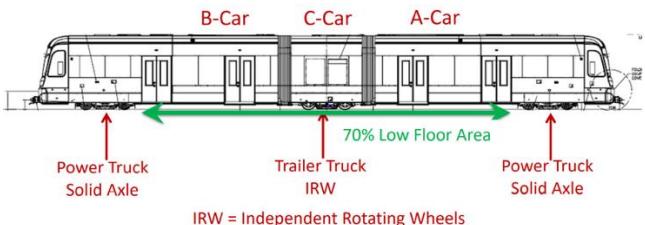
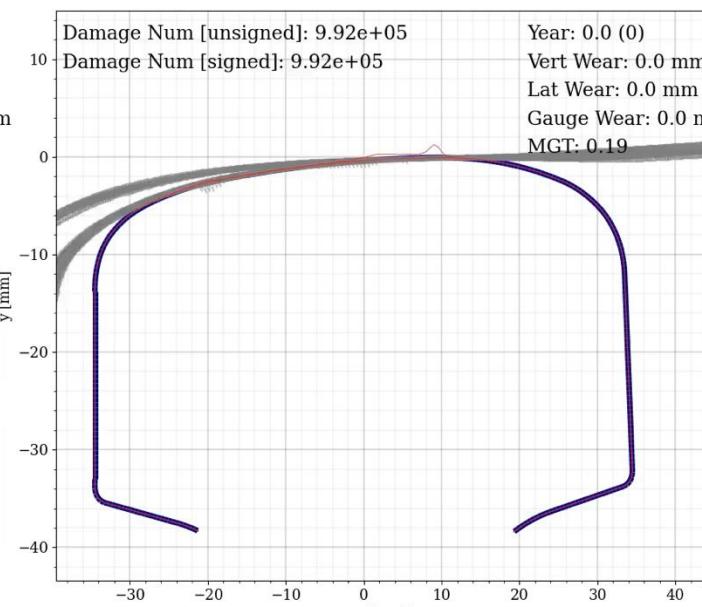
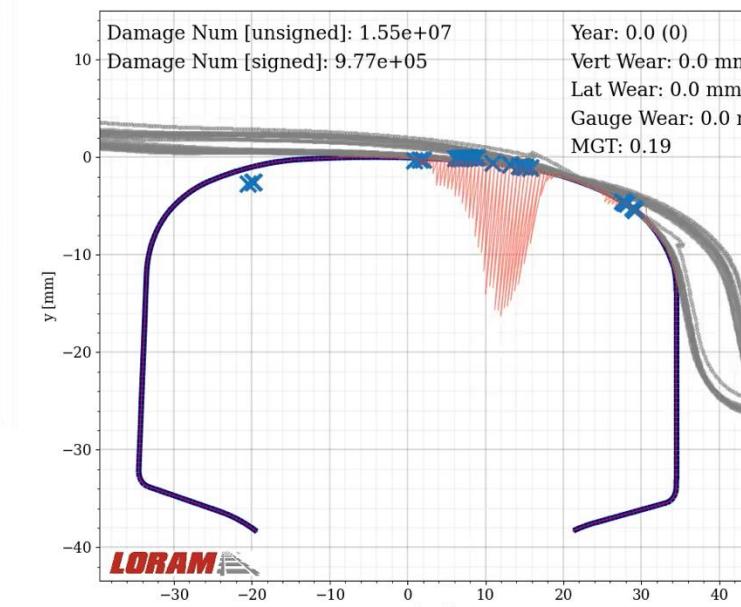
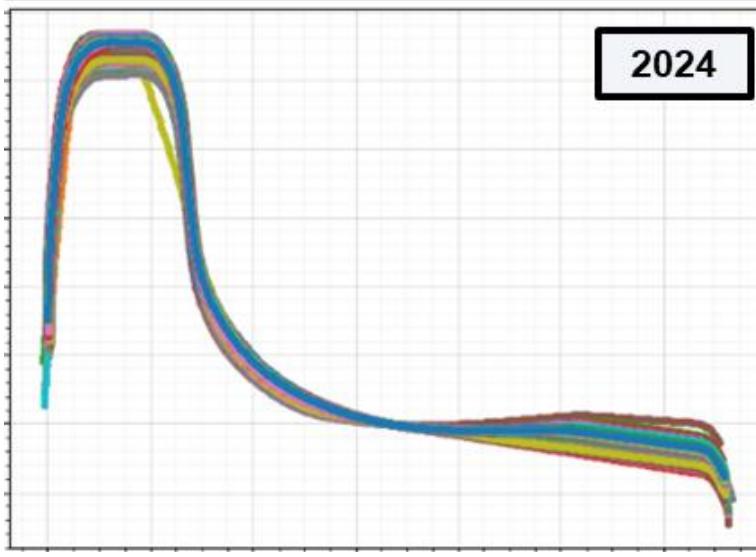
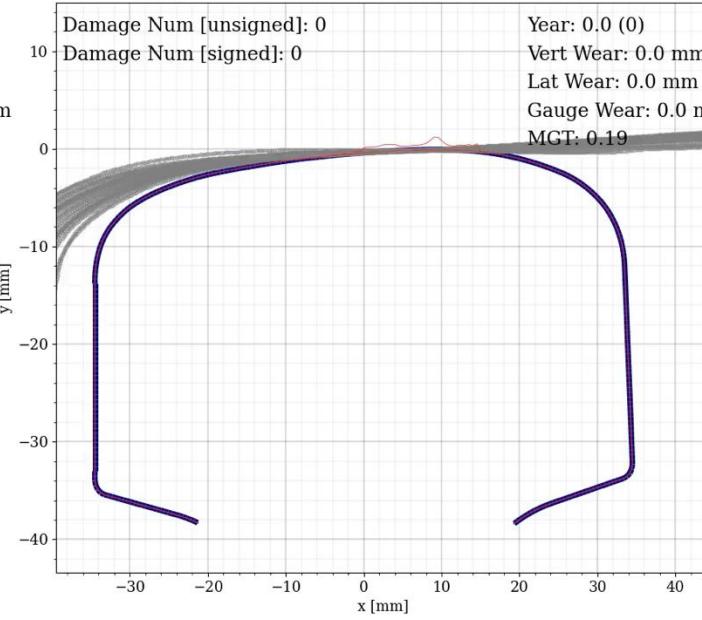
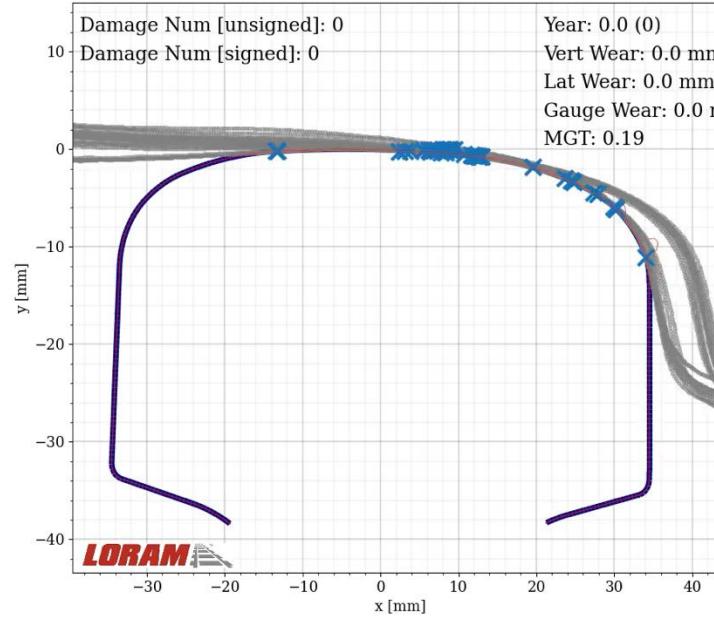
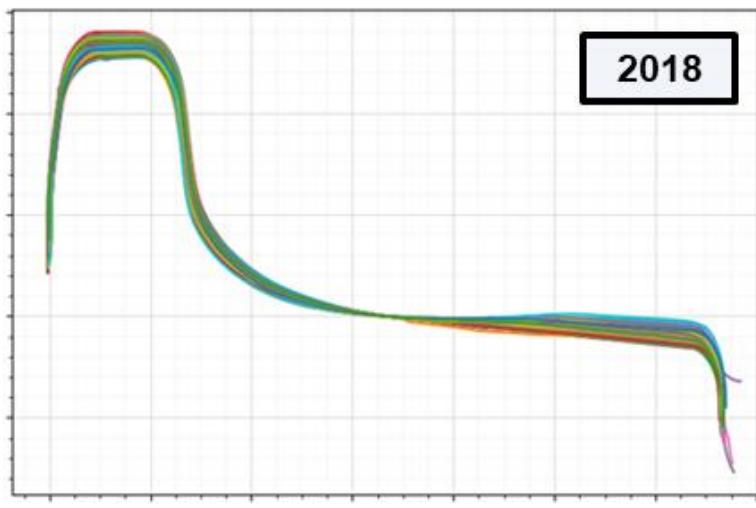
Stud Remedy

Stud defects were persistent before grinding

Did not recommend reduce rail hardness to prevent based on ROI

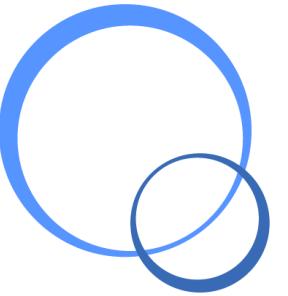


Year 2 – Verify with Actual Vehicles/Wheels

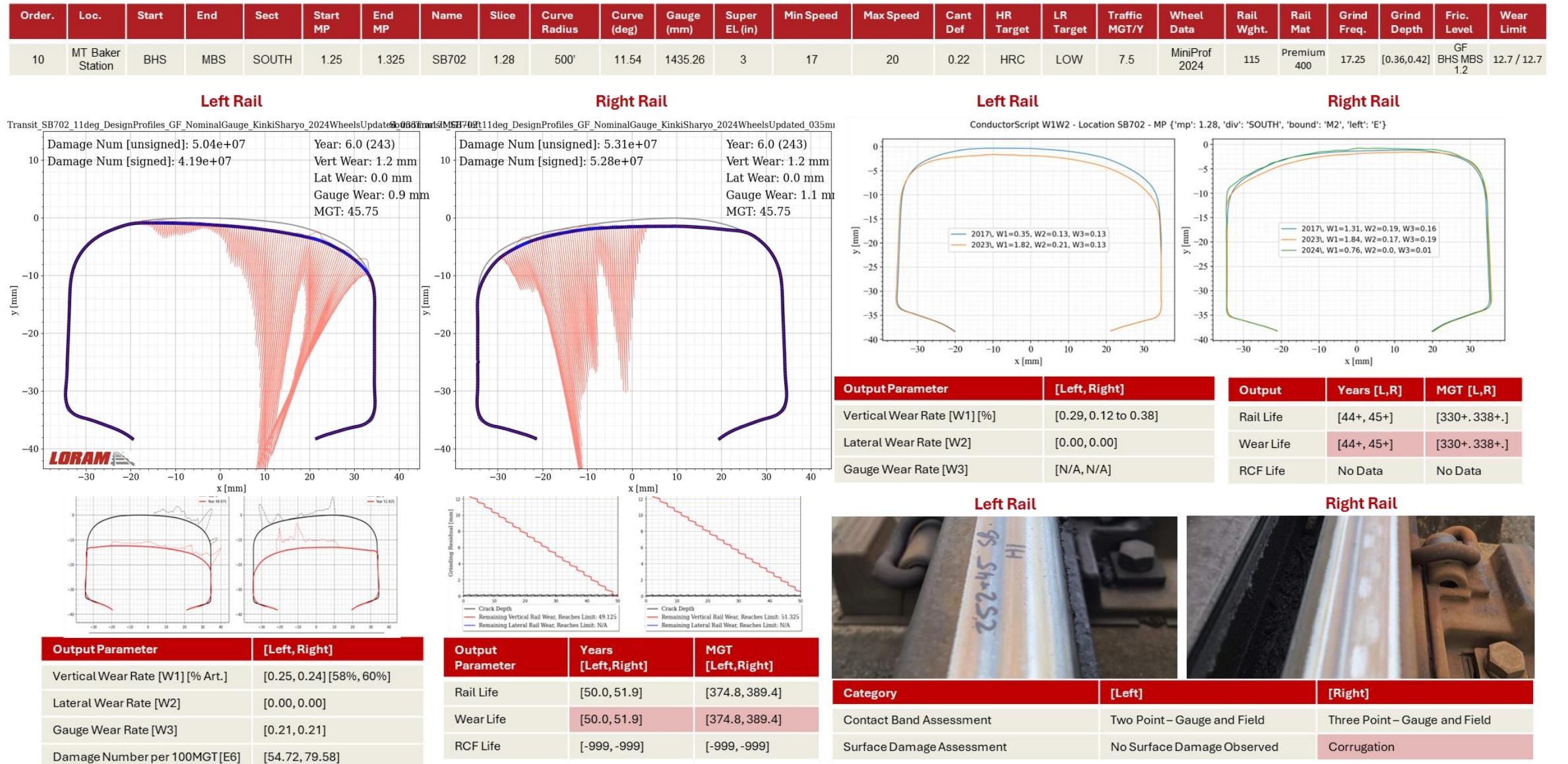


Wheel-Rail Interaction

Updates to the wheel profiles and vehicle model to represent Sound Transit rolling stock replicated wheel-rail interaction



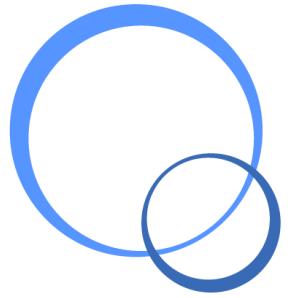
Year 2 – Verify with Actual Rail Condition



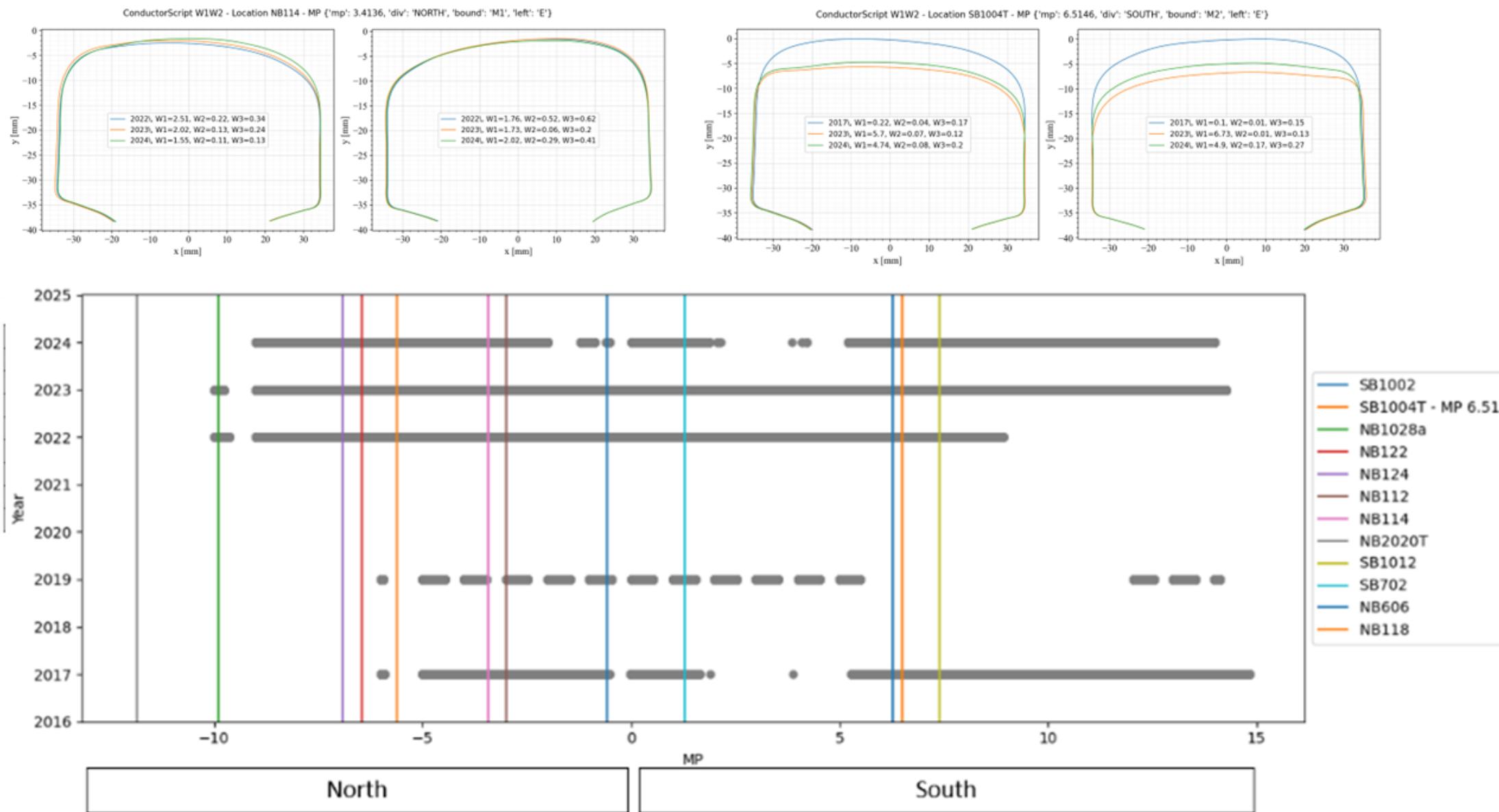
Rail Condition

Twelve virtual test sites were established on Sound Transit showing similar wheel-rail interaction, wear, and surface damage as observed





Challenge – Consistency of Rail Profile Data

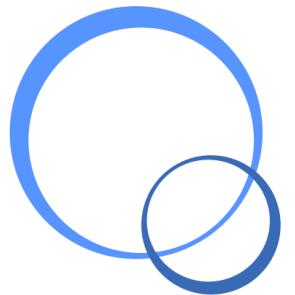


Rail Profile Data

Rail profiles stored for network

Quality and consistency improvements

Connect to OnTrack for RSL

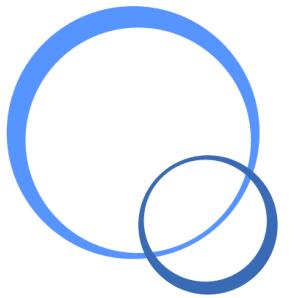


Challenge – Rail Surface Condition

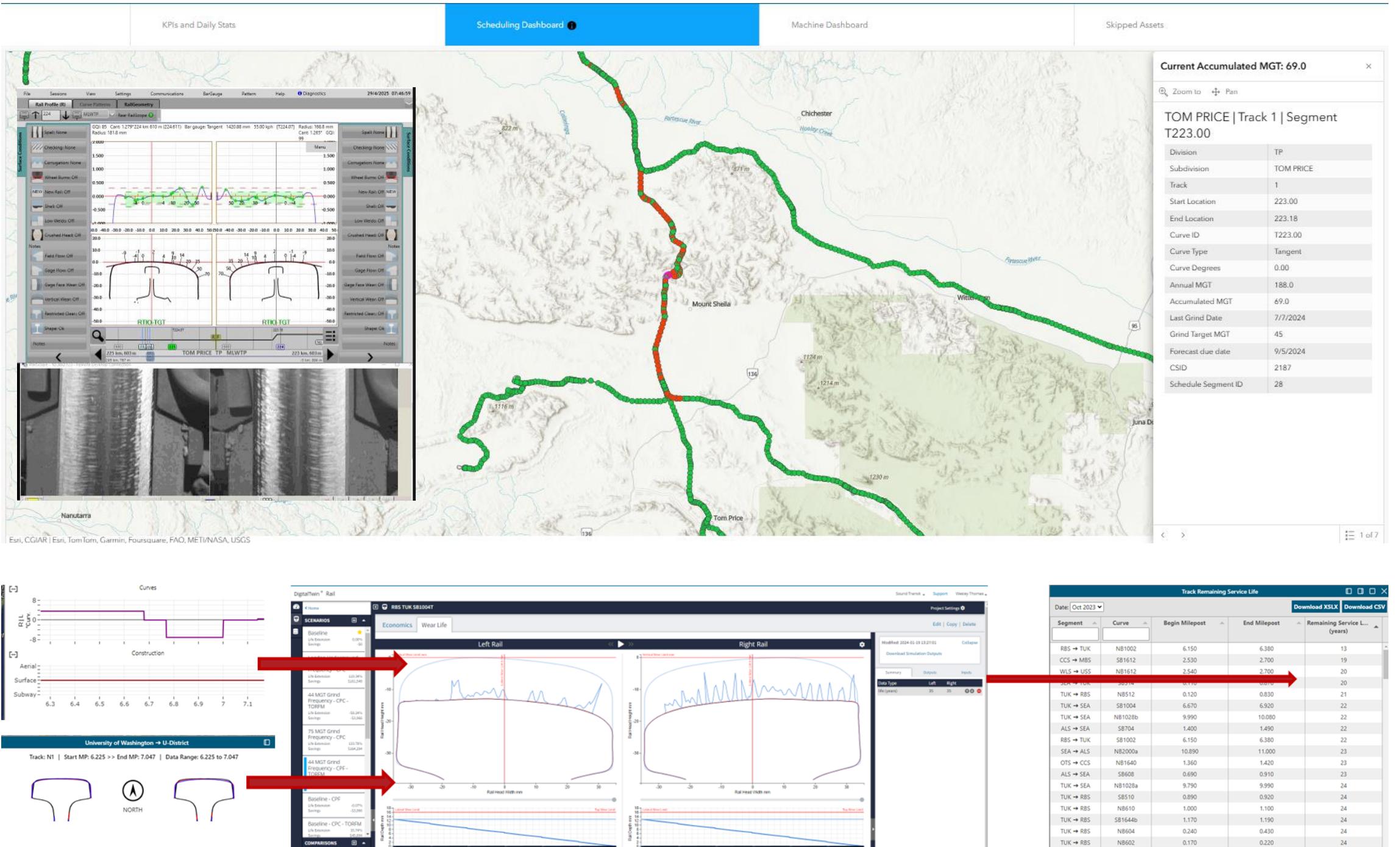


Rail Condition Data

Rail conditions limited to photos and Excel tracking manually or as export from EAM work orders.



Future - Implementing the Strategy



Tools to Implement
 Rail conditions limited to photos and Excel tracking manually or as export from EAM work orders.