

14600 South Railroad Crossing

Track Monitoring Plan & Contingency Plan

Prepared by:

RLW Construction & Petrucco

Track Monitoring Plan

UPRR Response to 30% plans

This track monitoring plan is designed to comply with UPRR review comments specific to the 30% review of the 14600 South Railroad Undercrossing project located in Bluffdale, UT. UP MP 725.66, Provo Sub.

The 30% comment is repeated here:

“Please revise the plan notes to require that a track monitoring program shall be submitted for UPRR Structures review and approval, as outlined in Section 2.6 of the UPRR/BNSF Guidelines for Temporary Shoring and the UPRR criteria for Track, Shoring & Existing Structure Monitoring. Also incorporate these monitoring requirements in the design plan notes. These requirements are being transmitted with this review.”

The following figures are the UPRR monitoring requirements referenced in the comment. The requirements will be included in the design plan notes.

2.6 TRACK, GROUND & SHORING MONITORING:

The Contractor must monitor the track, ground and shoring for movement to ensure proper performance of the shoring system and the safe operation of trains. Record top of rail elevations and track alignment for the duration of the project. After the project is complete additional track and ground monitoring may be required as deemed necessary by the Railroad.

- a. Track & Ground Monitoring requirements: In addition to [Table 2](#):
 - For UPRR, see the [Union Pacific Railroad Guidelines for Track & Ground Monitoring](#).
 - For BNSF, subject to direction of the BNSF project engineer for the project
- ii. Deflection Limits ([Table 2](#)), [Section 3.8k](#), for both track and shoring deflection limits.
 - Displacements exceeding the limits defined in [Table 2](#) must be immediately reported to the Railroad. All work on the project must stop and the Railroad may take any action necessary to ensure safe passage of trains. The Contractor must immediately submit a corrective action plan to the Railroad for review and approval. The Railroad must review and approve the proposed repair procedure. The repair must be inspected by the Railroad before any work on the project can proceed.
- b. Any damage to Railroad property such as track, signal equipment or structure could result in a train derailment. All damage must be reported immediately to the Railroad representative in charge of the project and to the Railroad Track Maintenance Representative.

UPRR & BNSF GUIDELINES FOR TEMPORARY SHORING, 12/7/2021

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Figure 1- UPRR & BNSF Guidelines

B. Track Monitoring

1. Track Deflection Limits
 - i. The top of rail shall not permanently deflect more than ¼ inch vertical or horizontal. This is not an "allowable" deflection. All estimated deflection should be eliminated to the greatest extent possible prior to construction.
2. Targets
 - i. Track monitoring shall not require track access other than to place the track monitoring targets.
 - ii. Monitoring targets should be placed such that monitoring is possible when a train is present. However, monitoring during the passing of a train is not required as the train will temporarily deflect the track.
 - iii. Adhesive backed reflective targets may be attached to the side of the rail temporarily. Targets should be removed once monitoring phase is complete.
 - iv. Note, there are normal and temporary vertical track deflections caused by the passage of a train which should be noted and established prior to construction.
3. Monitoring Plan
 - i. If the top of rail does deflect more than 1/4 inch, either vertical or horizontal, all operations shall stop until the matter is resolved.
 - ii. Provide established contingency plan, See Section 2.D, in the event of ground loss and/or the rail deviates ¼ inch vertical or horizontal.
 - iii. Establish a bench mark in the vicinity of the construction. Establish locations for shooting elevations on the top of rail at each area of construction.
 - a. Example locations for shooting rail elevations would be at:
 - At the centerline of an under track crossing.
 - At both outside edges of the crossing. ie. For a wide excavation.
 - At multiple locations from the crossing/excavation edge but no less than 10, 20, 30, 40 and 50 feet from the crossing.
 - iv. Monitoring shall be continuous and recorded in a field log book dedicated for this purpose. Copies of these field log entries can be made available to all concerned parties upon request at any time during construction.

C. Ground Monitoring

1. Provide means for monitoring ground settlement. Submit monitoring plan for Railroad review.
2. Ground monitoring points should be in alignment above the proposed construction activities.

D. Contingency Plans

1. The Contractor shall supply Contingency Plan(s), which anticipate reaching the Threshold and Shutdown values, for all construction activities which may result in horizontal and/or vertical track deflection.
 - i. Track monitoring values:
 - a. Threshold value = 1/8 inch permanent vertical or horizontal deflection
 - b. Shutdown value = 1/4 inch permanent vertical or horizontal deflection
2. The Contingency Plans shall provide means and methods, with options if necessary.
3. The Contractor should anticipate the need to implement each Contingency Plan with required materials, equipment and personnel.
 - i. Once the Threshold value is met, the contractor shall determine the appropriate Contingency Plan(s) and immediately discuss this plan with, and receive approval confirmation from, the Railroad or authorized Railroad representative.
 - ii. Once the Shutdown value is met all project work shall stop and the chosen Contingency Plan shall commence.
 - a. The Railroad may choose to allow and/or require the immediate implementation of specific approved Contingency Plans, submitted by the Contractor, once the Shutdown value is met.

Figure 2- UPRR Specific Requirements

UPRR Minimum Criteria for Track, Shoring & Existing Structure Monitoring:

1. Monitoring Program;

Track, shoring and existing structures shall be monitored for settlement and/or displacement during an adjacent excavation, pile driving or other activity as dictated by the Railroad. A detailed monitoring plan shall be submitted for review by the Railroad prior to the start of any work. The monitoring plan shall comply with the following minimum requirements, however more stringent criteria may be required by the Railroad on a case by case basis:

a. Track, Shoring & Existing Structure Deflection/Settlement Limits

- i. The top of rail shall not permanently deflect more than 1/4 inch vertical or horizontal.
- ii. Any point of the shoring shall not deflect more than 3/8" for shoring located at 18' from CL of track or closer.
- iii. Any point of the shoring shall not deflect more than 1/2" for shoring located more than 18' from CL of track, unless the shoring is supporting a cut entirely located in Zone B.
- iv. Any point of existing substructure supporting Railroad Track(s) shall not permanently deflect more than 3/8 inch vertical or horizontal.

b. Targets

- i. Each track shall have monitoring targets at each rail.
- ii. Track monitoring shall not require track access other than to place the track monitoring targets.
- iii. Monitoring targets should be placed such that monitoring is possible when a train is present. However, monitoring during the passing of a train is not required as the train will temporarily deflect the track.
- iv. Adhesive backed reflective targets may be attached to the side of the rails temporarily. Targets should be removed once monitoring phase is complete.
- v. Each shoring system shall have monitoring targets at the top of the shoring and, if a braced system, at points of bracing.
- vi. Monitor any existing substructures supporting Railroad Track(s) within the vicinity of the work with a minimum of 4 monitoring targets per existing substructure element.
- vii. The distance between monitoring points on rail and shoring shall be spaced no more than 10 feet apart, and rail monitoring points must extend at least 20 feet beyond end of shoring system(s).
- viii. A plan view shall be developed for Railroad review showing the location of all monitoring points.

c. Execution:

- i. If shutdown values are reached, all construction operations shall stop until the matter is resolved.
- ii. Provide an established contingency plan to the Railroad.
- iii. Establish a bench mark in the vicinity of the construction. Establish locations for shooting elevations on the targets at each area of construction.
 - 1). Survey equipment and control used for monitoring shall be accurate to 0.01'. GPS quality is not acceptable.
- iv. Monitoring survey data shall be processed in to an easy to interpret digital format and be submitted to the Railroad upon request. The document shall be formatted to keep all prior survey results in one, easy to reference location.
- vi. Monitoring shall commence once any construction activity is within Zone A.
- vii. During construction and use of the shoring, monitoring may need to be performed continuously. However, during construction and use of the shoring, monitoring shall never be performed less than least three times a day.
- viii. Monitoring shall continue after final backfill is complete, at a minimum once a day for 7 days or as required by the Railroad.

2. Contingency Plans

a. The Contractor shall supply Contingency Plan(s), which anticipate reaching the Threshold and Shutdown values, for all construction activities which may result in horizontal and/or vertical track, shoring or existing structure deflection and/or settlement.

i. Track monitoring values:

1. Threshold value = 1/8 inch permanent vertical or horizontal deflection.
 2. Shutdown value = 1/4 inch permanent vertical or horizontal deflection.
- ii. Shoring Monitoring values:
1. Shutdown value = 3/8 inch permanent horizontal deflection for shoring located at 18' or closer to track CL.
 2. Shutdown value = 1/2 inch permanent horizontal deflection for shoring located further than 18' from track CL, unless the shoring is supporting a cut entirely located in Zone B.

iii. Existing Structure Monitoring values:

1. Shutdown value = 3/8 inch permanent vertical or horizontal deflection and/or settlement.

b. The Contingency Plans shall provide the Contractor's detailed means and methods, with options if necessary.

c. The Contractor shall anticipate the need to implement each Contingency Plan with required materials, equipment and personnel.

- i. Once the Threshold value is met, the Contractor shall determine the appropriate Contingency Plan(s) and immediately discuss this plan with, and receive confirmation from, the Railroad.
- ii. Once the Shutdown value is exceeded, all project work shall stop and the chosen Contingency Plan shall commence.
 1. The Railroad may choose to allow and/or require the immediate implementation of specific approved Contingency Plans, submitted by the Contractor, once the Shutdown value is exceeded.

Figure 3- Project Specific Requirements Attached to 30% UPRR Comments

Project Description

The project constructs a new RR undercrossing using a proprietary track support system (Petrucco Verona System) and then jacking two large (51' wide x 24'-6" high) concrete precast box culverts under the supported UPRR track.

Monitoring Locations/Targets

Benchmarks

Benchmarks will be established at fixed hard points in at least 4 locations within line of site of the limits of the Petrucco support system shoring.

Track Targets

Targets will be affixed to each rail at 10 feet on center per the specific UPRR requirements. We will set targets at 10 feet for 20 feet past the end of the Petrucco system per the requirements for shoring systems in the UPRR comments shown in Figure 3.

The proposed method of construction does not use any other shoring methods to support the tracks from adjacent excavations and no additional monitoring is required per the UPRR Track and Ground Monitoring Guidelines April 2021. The system is essentially a temporary bridge with many short spans supported by micro-pile foundations. Horizontal rigidity is provided by a horizontal truss that prevents any single support from moving laterally independently of the adjacent supports. As the pre-cast box is jacked under the ROW, track support is transferred from the micro-piles to the pre-cast box.

As there is no shoring supporting the track, the track targets will be the monitoring points to check track vertical and horizontal alignment. There are no targets required to monitor horizontal movements for shoring or walls because there are no temporary walls or shoring supporting the track in addition to the Petrucco system.

TMP -01 – shows benchmark and monitoring target Locations. A final version of TMP-01 will include more definitive benchmark and target locations based on the final design of the box structure and Petrucco system. Plan notes describing the monitoring requirements will be added.

Petrucco Twist Control system

Used during the box jacking phase, the Petrucco Twist Control system is a continuous checking system of the rail track twist and cross-level developed by Petrucco and a leading company in structure monitoring systems. The system is described in detail Exhibit A - Petrucco Twist and Cross-Level Control system and Contingency plan.

Monitoring

Methods:

During non -jacking activities, survey data will be provided by manual survey and an Automated Motorized Total Station (AMTS).

During the actual jacking of the box under the tracks we will provide continuous survey monitoring via the Petrucco Twist Control system described in detail in Exhibit A.

Results and Reporting

Data will be logged in a spreadsheet that will flag data that exceeds the threshold limit.

Data will be provided in a spreadsheet sent to UPRR or made available on a cloud-based platform to allow

data review at all times.

During the box jacking continuous monitoring activities, data is sent real time via the PTS to a cloud-based cell phone app that alerts the designated track superintendent when deflection thresholds are triggered. Results are immediately displayed on Petrucco's dedicated web platform. Web access will be granted to all stakeholders.

Description of Monitoring during each stage of Construction:

Track monitoring will begin before construction begins to verify the initial design survey track elevations and set the baseline for rail elevations and alignments.

Phase 1 – Work Outside Zone A

Construction activities outside the UPRR ROW will commence and continue for weeks or months before we begin installation of the Petrucco Verona System or any shoring within Zone A as defined in the UPRR BNSF Temporary Shoring Guide. During this period, we will monitor track elevations weekly. This includes monitoring track elevations during any periods of dewatering, if necessary, before excavation begins even if outside Zone A as defined in the UPRR BNSF Temporary Shoring Guide.

Phase 2 – Install Micro-piles Work Inside Zone A

The first construction activity within Zone A will be installation of micro-piles to support the Petrucco Verona System. The installation of micro-piles alone does not transfer loads from the RR to the micro-piles in this stage. The micro piles will be installed inside steel cans. At the completion of the micro-pile installation, the can will be partially filled with a concrete pile cap. The installation of the micro-piles, cans and concrete plinths will be performed outside of the 12-foot construction clearance envelope approved by UPRR for this project.

Work will be done under Form B track protection. Work will stop under direction of the EIC.

Planned production is two to four micro-piles per day depending on UPRR train frequency.

Frequency of Monitoring:

The track profile and alignment will be monitored once just prior to a micro-pile installation and once after each stage of each micro-pile installation.

The track profile and alignment will be checked once a day when work is not active.

Anticipated Impacts/Contingency Plan:

The micro-pile construction process does change the load path from the tracks to the ties and into the ballast, sub-ballast and grade. After this process, the track is not being supported by the micro-piles. The vibrations of micro-pile installation may impact the existing ground and cause minor changes in the ground surface. We will stop work if survey data exceeds thresholds and implement correction as described in Exhibit B - Contingency Plans.

Phase 3 - Install Petrucco Verona System

Installation of the Verona System will take place under a pre-planned track curfew. The curfew duration for the installation is a single 16 hour window.

Frequency of Monitoring:

Immediately before track curfew.

After re-setting of track

Three times a day until actual box jacking – Automated Theodolite

Anticipated Impacts/Contingency Plan:

The installation of the Verona System will be done under Form B protection in pre-planned curfews. After the Verona system is installed, the track will be supported both vertically and horizontally on the Verona system. We do not anticipate any changes in track geometry once track is re-set. If at any point while the track is being supported by the Verona System survey data exceeds thresholds, we will implement corrections as described in Exhibit B – Contingency Plans.

Phase 4 – Box Jacking - North Box & South Box

Phase 4 is anticipated to take many days. The jacking procedure will include pushing the precast box sections under the ROW approximately 3 ½ feet at a time, followed by a period of excavation within the box. During this time the loads will be transferred to the top of the box, and the micro-pile being cut as excavation progresses.

We will only jack and excavate in pre-determined UPRR curfews. Box jacking and excavation will be performed under Form B track protection. All box jacking and excavating within the jacked box will end no later than 1 hour before the end of the designated UPRR curfew. We can correct track displacements to within 1/8” of pre-jack position in 20 minutes. Jacking will take less than 1 hour. We will be able to stop work if we exceed the shutdown threshold and correct track work to within 1/8” of pre-slide position, allowing at least 1 hour after correction and before the track curfew ends. If at any time the EIC indicates that a train is less 1 hour from the job site we will stop work and verify the track is under the shutdown threshold to avoid the EIC needing to stop trains from entering the work zone.

Frequency of Monitoring:

The track will be monitored before each jack operation and monitored continuously during box jacking and excavation using the Petrucco Twist Control system – See Exhibit A. Per UPRR requirements we will be monitoring jack forces as we jack the box.

Anticipated Impacts/Contingency Plans:

The installation of the Verona System will be done under Form B protection during pre-planned track curfews. Contingency plans anticipate measurable vertical and horizontal track deflections during the jacking process.

Vertical displacements are due to the top of the concrete box not being perfectly flat. As the box slides under the Verona support beams, the beam bearing elevations “float” up and down with variations in the smoothness of the box top and travel of the box on the soil. The “ski” shape of the bottom slab of the box section and surface preparation in front of the box mitigate vertical movements of the box. Construction practices that provide a smooth finished top slab analysis will be used to mitigate risk of vertical displacements. These include mix design selection, analysis of rebar placement, a shoring system that prevents deflections during concrete placement, placing with a roller screed or bid-well screed machine, wet curing, a 2” levelling placement, or post construction grinding.

Horizontal displacements are due to the friction force between the top of the box and the support beams as the box slides under the support beams. The horizontal truss component of the Verona System limits displacements by transferring the horizontal forces to micro-piles which have been designed to resist the horizontal forces and limit displacements. Further mitigation may include high load, low friction sliding pads used for sliding bridges.

After the Verona system is installed, the track will be supported both vertically and horizontally on the Verona system. If at any point while the track is being supported by the Verona System survey data exceeds

thresholds, the Petrucco Twist Control system will alert our team and we will make corrections as stated in the Contingency Plans.

Phase 5 - Remove Petrucco Verona System

Removal of the Verona System and re-setting final ballast track will take place under a pre-planned track curfew. The curfew duration for the removal and re-installation of permanent track is a single 16 hour window.

Frequency of Monitoring:

Immediately before track curfew.

After re-setting of track.

Anticipated Impacts/Contingency Plan:

The removal of the Verona System will be done under Form B protection in a pre-planned track curfew. After the Verona system is removed the track will be supported by the final subgrade and ballast. No track movement is anticipated after the track is set in its final position.

Phase 6 – Final Monitoring

We will continue to survey the track for an additional 7 days checking data at least 1 time a day per the project specific requirements.

Frequency of Monitoring:

1 time per day for 7 days

Anticipated Impacts/Contingency Plan:

At this point the track will be its final configuration supported by permanent ballast and the new concrete box structure. Remaining construction activities are outside the UPRR ROW and UPRR shoring or excavation limits and do not impact UPRR.

If at any point while the track survey data exceeds thresholds, we will implement corrections as described in Exhibit B – Contingency Plans.

Exhibit A – Petrucco Twist Control system

Petrucco USA

Petrucco Twist and Cross-Level Control system and Contingency plan

14600 South Railroad Crossing – Bluffdale City, Utah

EXHIBIT A: PART OF GENERAL TRACK
MONITORING PLAN & CONTINGENCY
PLAN DOCUMENT

Author	Date	Rev.	Notes
Diego Rodríguez	2024 May 07	00	System details update
Jim Deschenes (RLW)	2024 May 23	01	Updating Technical Language and Syntax more familiar to U.S. Engineers and provide consistency

1 PETRUCCO TWIST CONTROL SYSTEM

The complete monitoring system during jacking consists of:

- Visual control made on the track by trained specialists.
- Elevation control with a Track Gauge by trained specialists.
- Continuous control of the twist and the cross-level of the track with the Petrucco Twist Control system.
- Topographic survey of the track as described in the general monitoring plan.

The Petrucco Twist Control system is a continuous monitoring system of track twist and track cross-level developed by Petrucco in partnership with a structure monitoring and survey specialist. It was developed specifically to be used with Petrucco's Verona track support system.

The twist and cross-level of the track are constantly checked with the Petrucco Twist Control. It registers the twist and cross-level of the track approximately each second. The results are shown on a computer directly on site and are also displayed on a dedicated web platform (www.petrucco.tech) that can be easily accessed for any stakeholder involved with the project.

The system is able to send alert messages if the threshold limits are exceeded.

The Verona System is designed to keep the track in position during box jacking but also allows adjustments to keep the track in position. The movement of the jacked box below the Verona System is slow and controlled, and the movement can be stopped at any time. Any small modification of the track geometry can be easily checked and corrected by Petrucco technicians on site. Mitigation implementations and corrections only take a few minutes and only require hand tools.

The adjusting procedures last less than 10 minutes.

The following figures show key components of the Petrucco monitoring plan.



Figure 4 Petrucco Twist Control Sensor.

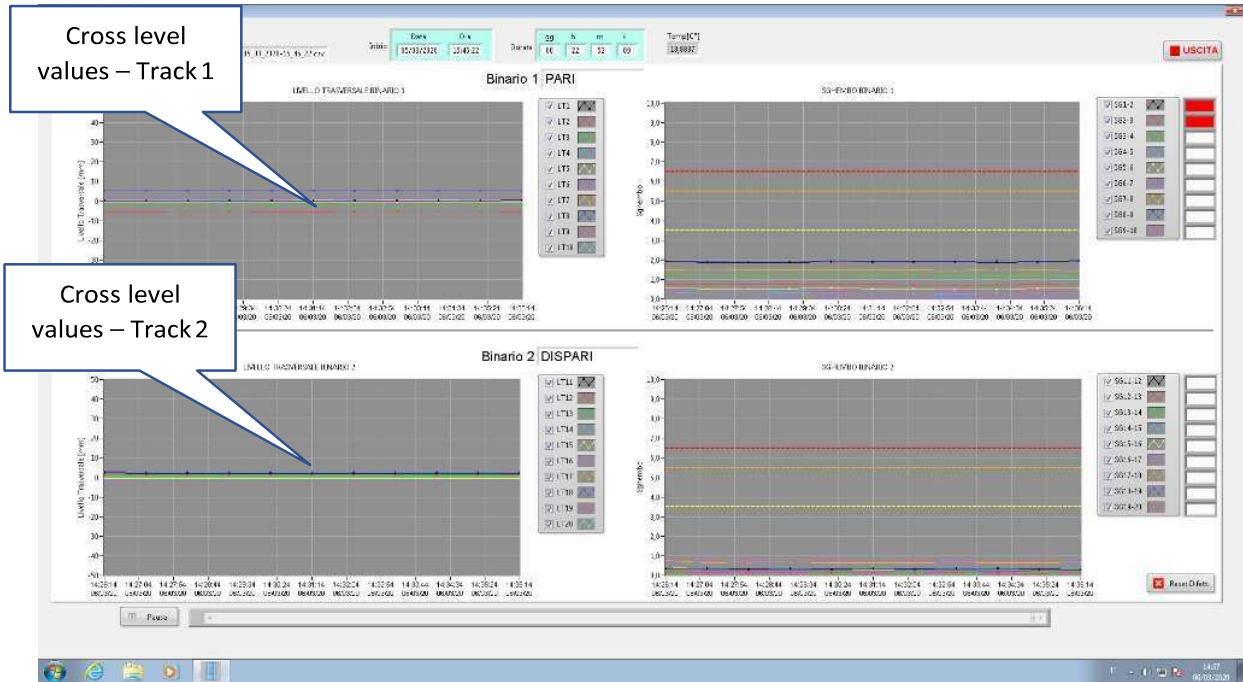


Figure 5 – Petrucco Twist Control output screen – Administrator page example from a double track system. The Bluffdale project will have only 1 track to monitor.



Figure 6 – Petrucco Twist Control Sensors installed on live double track corridor.

2 MONITORING

The baseline reference will be established once the Verona System is installed, prior to the jacking activities. From that point, all measurements will be based on the baseline.

The Petrucco Twist Control system exceeds the minimum UPR Requirements for track monitoring during box jacking operations. The Petrucco Twist Control system was originally developed to monitor the “twist” in track alignments, the key geometry indicator used in Europe for track safety for both design and maintenance as shown in Figure 4 below. The system also provides a vertical measurement between each rail at approximately 10 foot (3 meter) intervals as shown in figure 5.

The system will provide profile and cross level data per the track surface tolerances prescribed in 49 CFR 213.55. Instead of discrete measurements at 31 feet or 62 feet as referenced in the CFR, the PTS will provide data at approximately 10 foot intervals (3 meters), and will be measured against the track tolerances prescribed in the UPRR memo provided with the UPRR review at the 30% design level.

As stated previously the PTS will provide measurement data at approximately 1 second intervals during box jacking. The app will be programmed to send alerts when thresholds are met.

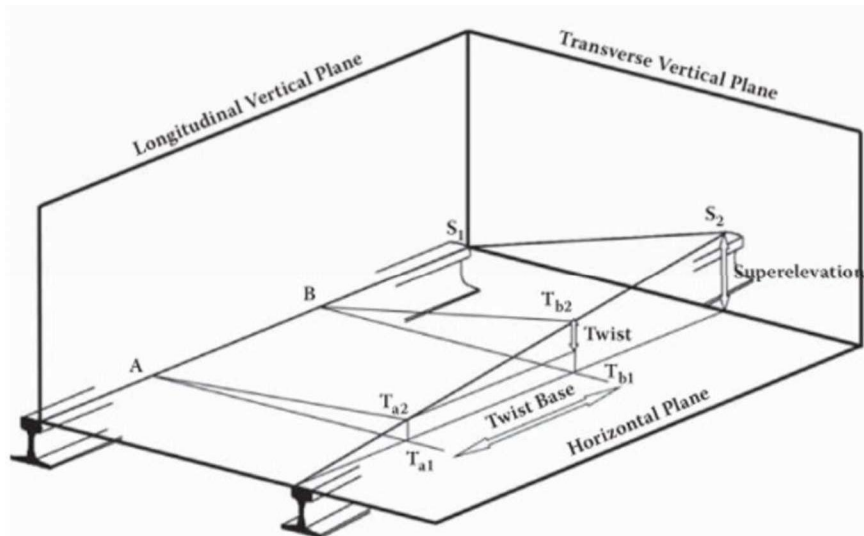


Figure 7 - Twist graphic definition, for clarification on original purpose of the Petrucco Twist Control system.

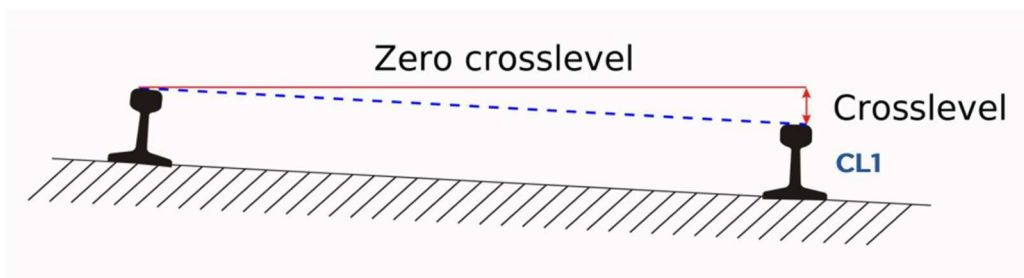


Figure 8 - Cross level representation.

2.1 Limitations:

The design speed recommended during construction is 50 mph. Full structural checks on the Verona system have been done for 60 mph. Petrucco does not have significant field experience deploying the Verona system at higher design speeds and therefore, it is highly recommended to limit the train speed to 50 mph work while the temporary rail bridge is in place.

To minimize risk, jacking activities are performed without trains on the system. Accordingly, daily jacking production will be organized around train curfews. The EIC Flagmen are anticipated to be on site to ensure coordination with train curfews.

2.2 Maintenance and mitigation actions plan:

Twist Control THRESHOLD	Cross level Values	Action Plan	URGENCY LEVE	STAFF	NOTIFICATION	DOCUMENT
THRESHOLD 1 MINOR DEFECTS	<1/8"	<u>Non immediate action is required.</u> Track monitoring will continue until threshold values are met.	MINOR	N/A	N/A	N/A
THRESHOLD 2 PRIORITARY DEFECTS	From 1/8" to 1/4"	<u>Priority action is required.</u> The EIC will be notified. Petrucco Crew will be in Stand By for corrective measures that take between 2 to 5 minutes once Petrucco crew enters the rail corridor. The EIC will be consulted with regards to the curfew duration. A decision will be made to continue jacking until the next threshold is met or to stop and wait for the next planned curfew to continue jacking or make corrections.	REGULAR	Petrucco Supervisor	EIC informed in person or radio/phone call	Maintenance template signed and saved in dedicated folder/log.
THRESHOLD 3 URGENT DEFECTS	>1/4"	<u>Priority action is required.</u> The EIC will be notified. Petrucco crews will mobilize and make corrections. Corrections are anticipated to take 10 Minutes. Trains allowed after EIC approval.	PRIORITARY	Petrucco Supervisor	EIC informed in person or radio/phone call Alerts will be sent to stakeholder's distribution list automatically by Petrucco app.	Maintenance template signed and distributed to stakeholder list during the shift.



Figure 9 - Flagman & two Petrucco representatives carrying maintenance operations on three active tracks, with both traffics goods and passengers.



Figure 10 - Manual tools needed for maintenance and geometric adjustments.

2.3 Production & Daily Maintenance Plan:

In addition to Petrucco Twist Control system continuous monitoring and monitoring of track targets set for non-jacking activities, daily visual inspections will be performed.

For purposes of production and total box jacking duration it was assumed jacking activities will proceed during train curfew windows of 2-4 hours, (minimum 2h / optimal 4h) between trains. Petrucco & UPRR will agree on maintenance procedure.

2.4 Maintenance Template:

The template below, or similar template developed with UPRR concurrence, will be used any time corrections are made. These forms will provide a maintenance log and means for the EIC to verify corrections have been made.

Element Description:	Criteria for approval:	Type of inspection:	Status					
Transverse Beams	Correct function and shape. Fit for the purpose and according with drawings.	Visual <input type="checkbox"/> Manual <input type="checkbox"/>	<input type="checkbox"/> Conform <input type="checkbox"/> No conform <input type="checkbox"/> Corrected					
Rollers	Correct function and shape. Fit for the purpose and according with drawings.	Visual <input type="checkbox"/> Manual <input type="checkbox"/>	<input type="checkbox"/> Conform <input type="checkbox"/> No conform <input type="checkbox"/> Corrected					
Temporary Bridge Modules	Correct function and shape. Fit for the purpose and according with drawings.	Visual <input type="checkbox"/> Manual <input type="checkbox"/>	<input type="checkbox"/> Conform <input type="checkbox"/> No conform <input type="checkbox"/> Corrected					
Shims	Correct function and shape. Fit for the purpose and according with drawings.	Visual <input type="checkbox"/> Manual <input type="checkbox"/>	<input type="checkbox"/> Conform <input type="checkbox"/> No conform <input type="checkbox"/> Corrected					
Track Geometry	All points should be within the allowable thresholds. If necessary, corrections are made to bring back the geometry within the thresholds.	Survey <input type="checkbox"/> PTC <input type="checkbox"/>	<input type="checkbox"/> Conform <input type="checkbox"/> No conform <input type="checkbox"/> Corrected					
RLW/Stacy Witbeck Shift Supervisor (If required) Print: _____		Signature: _____						
UPRR Supervisor/Inspector (If required) Print: _____		Signature: _____						
Additional Comments / Clarifications: <table border="1" style="width: 100%; height: 40px; border-collapse: collapse;"> <tr><td> </td></tr> <tr><td> </td></tr> <tr><td> </td></tr> <tr><td> </td></tr> <tr><td> </td></tr> </table>								

3 Petrucco Twist Control Details

The Petrucco Twist Control system is composed of:

- Electronic levels:
 - o Wi-Fi sensors with Lo.Ra protocol.
 - o IP67 protection case.
 - o The sensors are equipped with Lithium batteries for a minimum duration of 12 months.
 - o A complete set of batteries will always be present on site.
 - o All sensors are tested for 48 hours at -20°C.
 - o Range of use: $\pm 2.5^\circ$.
 - o Sensibility of twist input: 0.33‰.
 - o Frequency radio ISM 868 MHz.
 - o Range of temperature: -30°C - +60°C.
- Lo.Ra gateway with n.2 directional antennas for a complete field covering.
- Router Wi-Fi for data transmission.

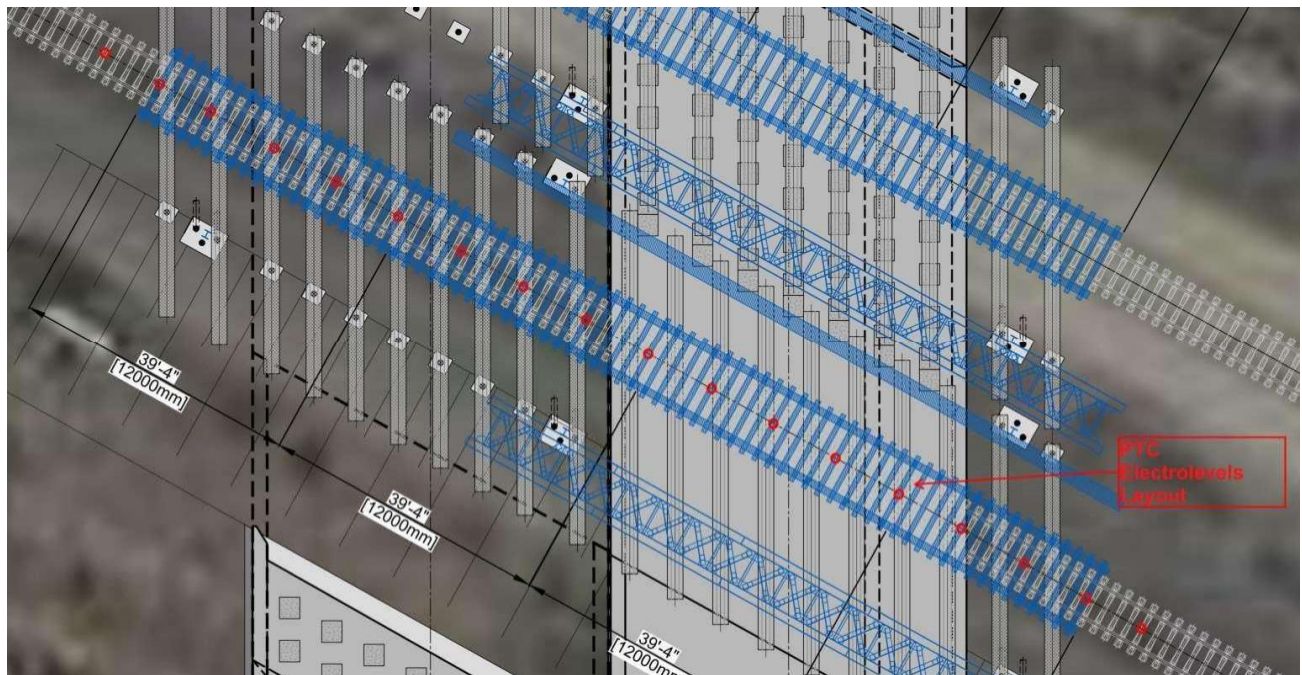


Figure 11 - Sensor positioning

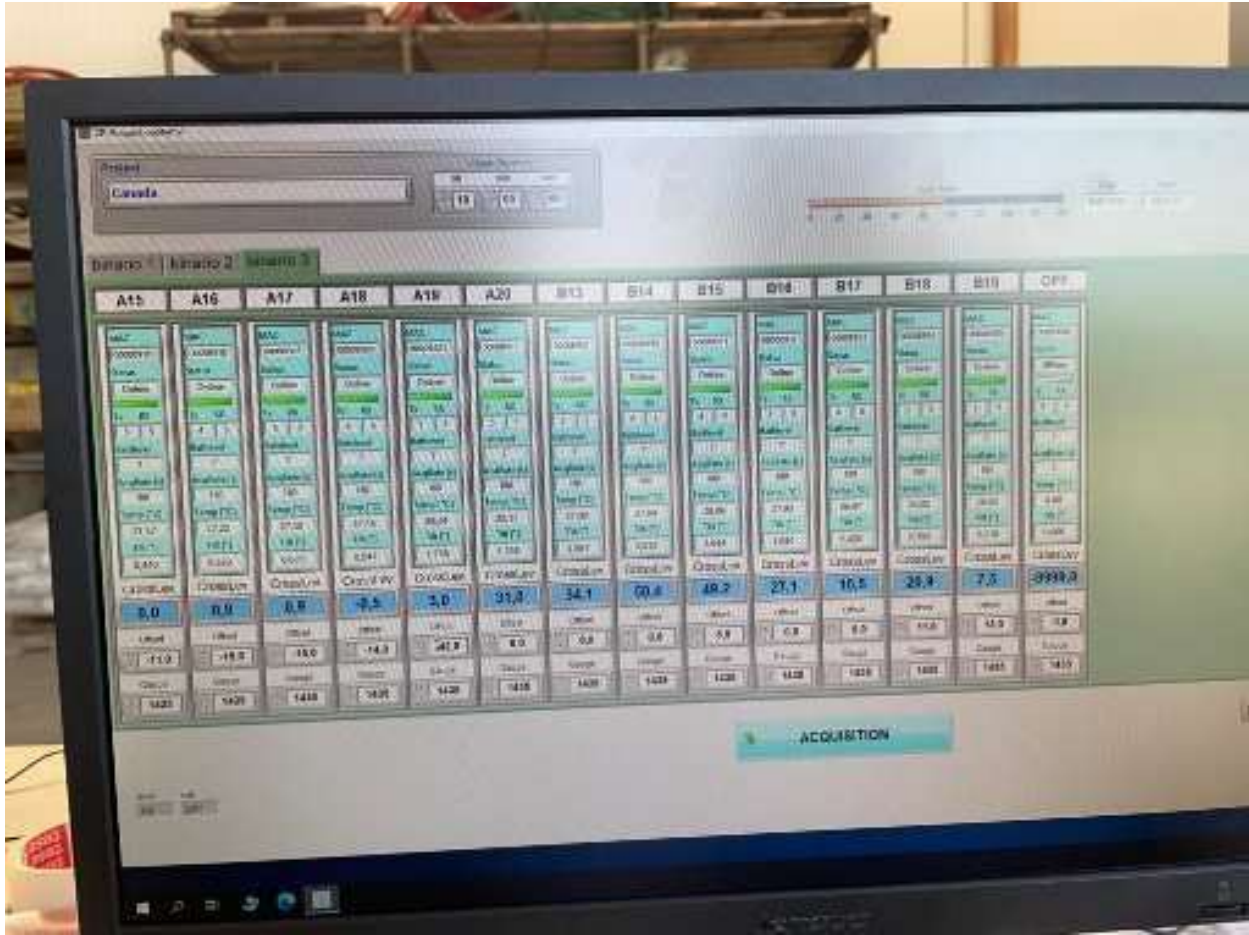


Figure 12 - Example of the Petrucco Twist Control software display.

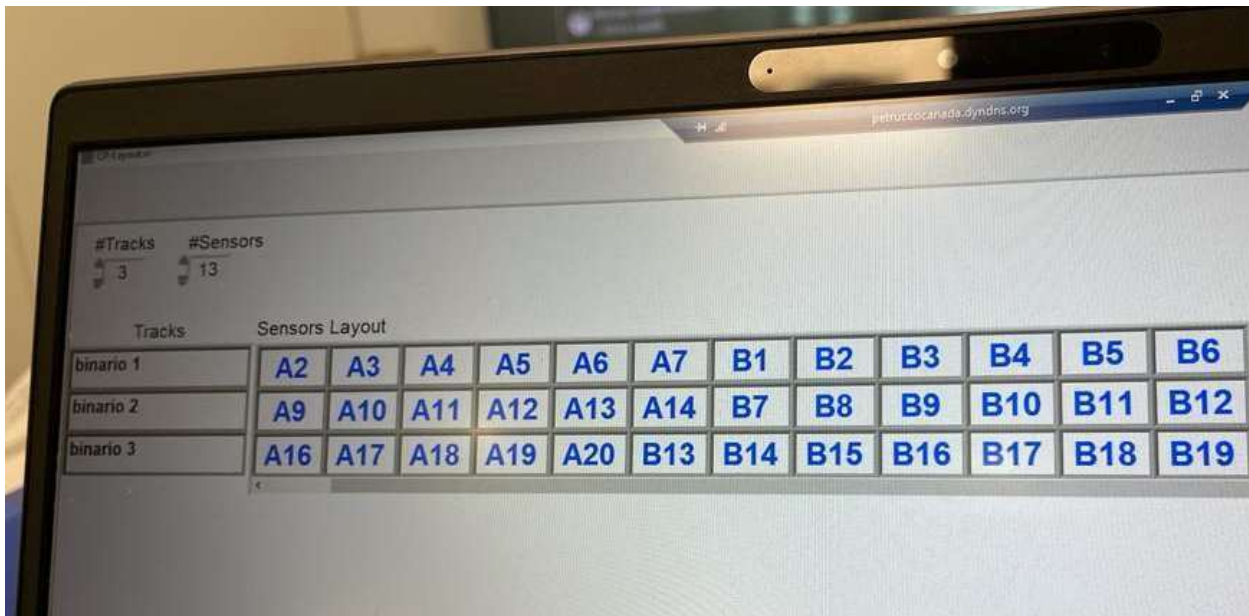


Figure 13 - Example of Petrucco Twist Control software display. Layout of sensors on each Track (3 Tracks Project as Port Credit).

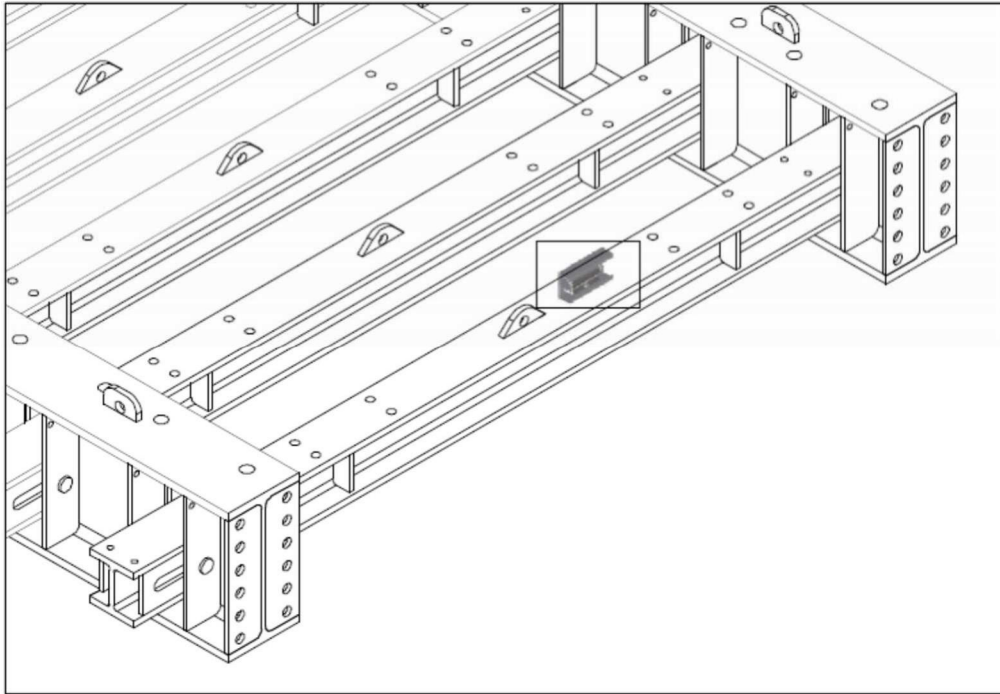


Figure 14 3D Electronic level position

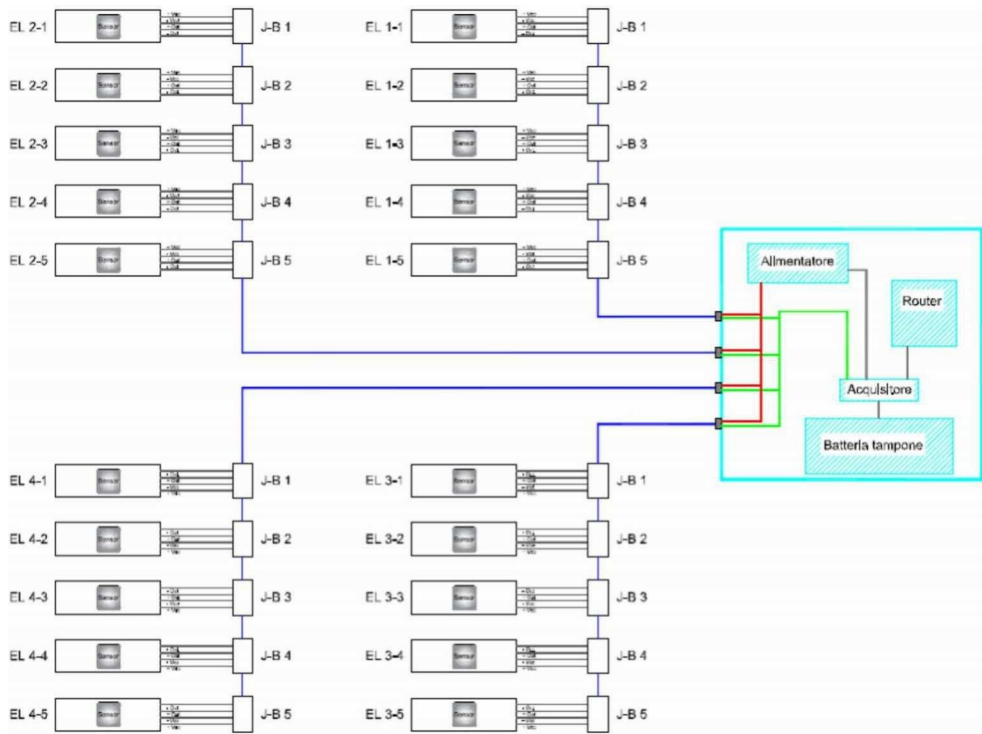


Figure 15 Sensors functional layout, the sensors will be wi-fi and not cabled.

3.1 Web platform

Petrucco developed a dedicated web platform to allow stakeholders access to the data from the system from any device.

This website is available at www.petrucco.tech and is accessible with guest credentials that will be generated at prior to jacking operations.

The data will be available 24/7 with clear threshold limits.

Please note that data peaks will be visible during the passage of trains. Those peaks will not be considered as exceeding thresholds.

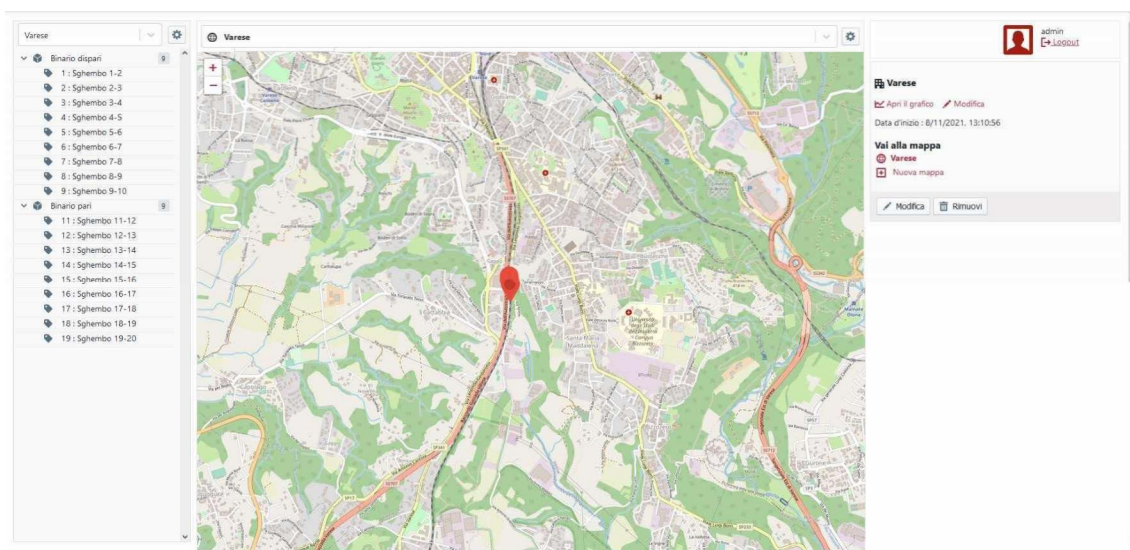


Figure 16 - Location of the site on the map

The site will be clearly located on the map, with the position and values of each sensor. Then a graphic will show, in real time, the data for each interval. In the image below the intervals are set to 3 m.

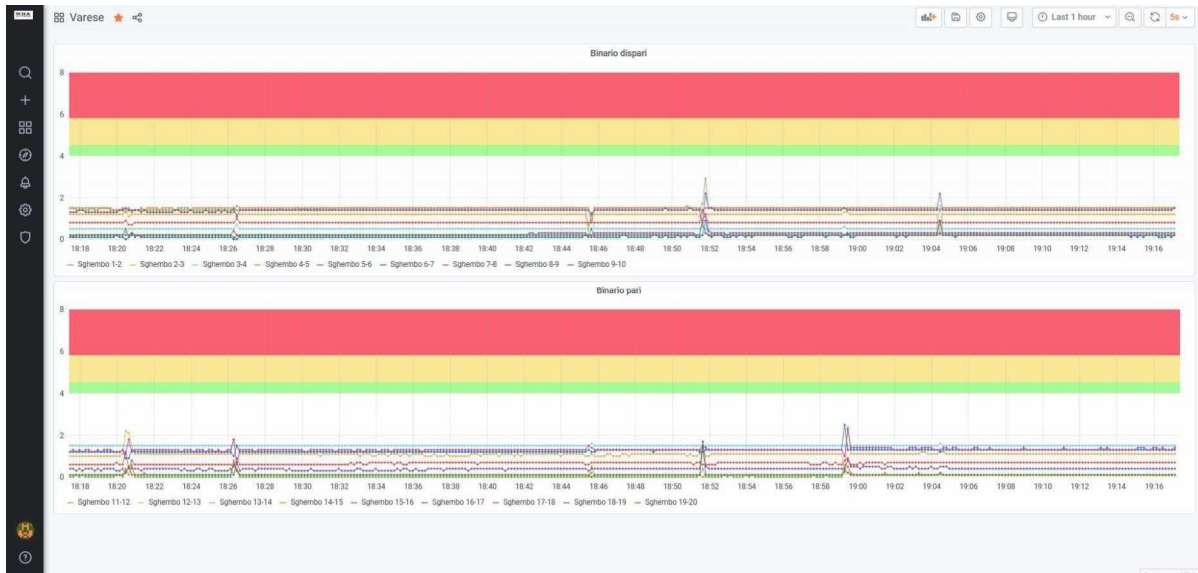


Figure 17 – Graphic page, the one on site will show three windows for the cross-level values

EXHIBIT B - CONTINGENCY PLANS

Phase 1						
Work outside RR ROW						
Action Level	Vertical	Horizontal	Action Plan	Staff	Notification	Documentation
TRACK – Monitor 1 times per day						
Threshold	1/8"	1/8"	Work is paused. RLW/SW will have steel shims and jacks on site at all times and prepare to stop work and correct alignment and profile. RLW will communicate with EIC as to timing of next train. If less than an hour before the next train, work will stop until the train passes.	TBD	TBD Notifies EIC	Spreadsheet (web based)
Shut Down	¼"	¼"	Stop Work. EIC notified that track correction will be performed. Track is shimmed or realigned by with hand actuated jacks. Trains allowed after EIC approval.	TBD	TBD Notifies EIC	Spreadsheet (web based)
SHORING – None						
Threshold	3/8"	3/8"	n/a			
Shut Down	½"	½"	n/a			

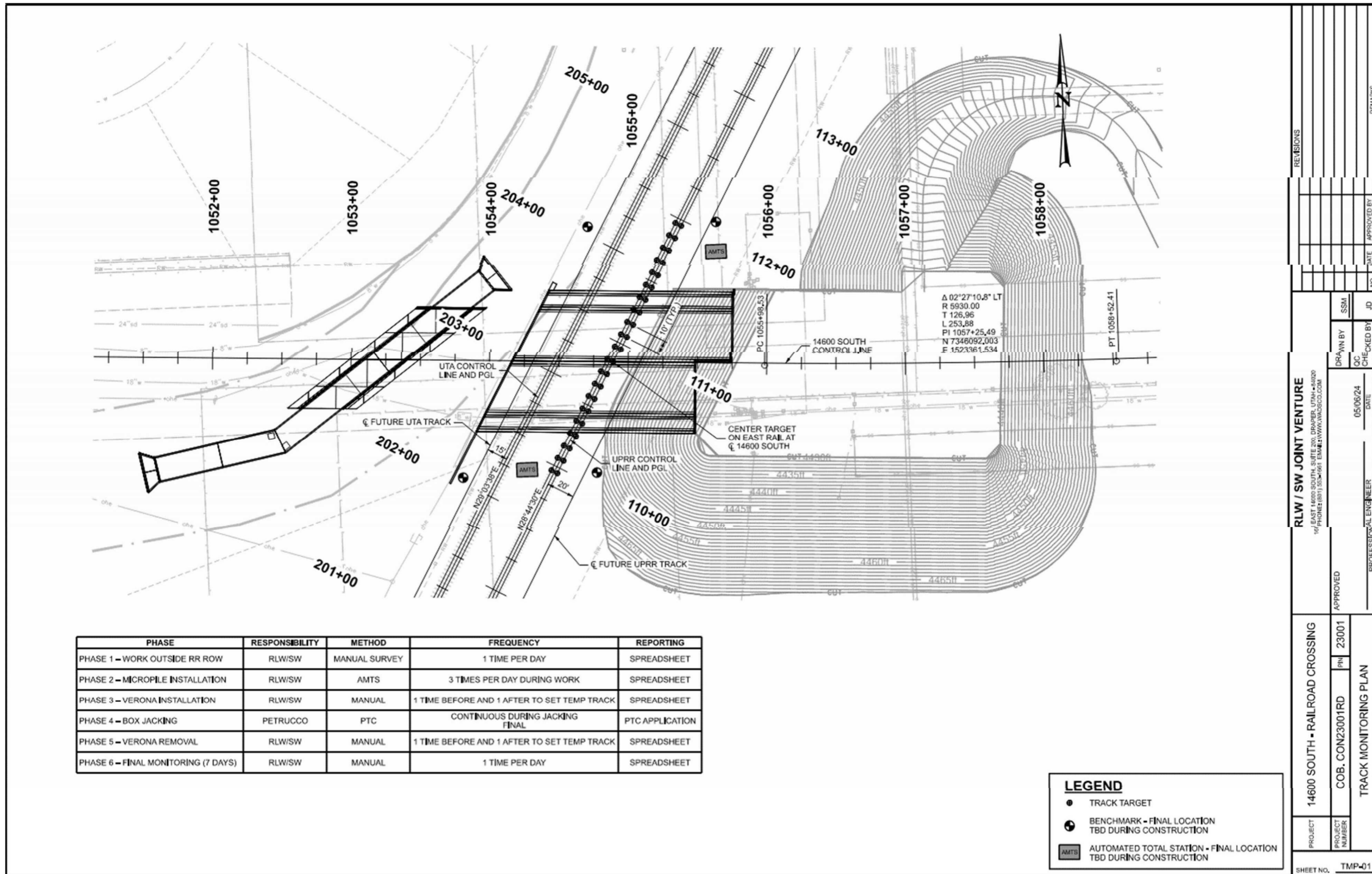
Phase 2						
Micro-pile Installation						
Action Level	Vertical	Horizontal	Action Plan	Staff	Notification	Documentation
TRACK – Monitor each day prior to work commencing and after micro-pile installation						
Threshold	1/8"	1/8"	Work is paused. RLW/SW will have steel shims and jacks on site at all times and prepare to stop work and correct alignment and profile. RLW will communicate with EIC as to timing of next train. If less than an hour before the next train, work will stop until the train passes. Track will be monitored as work progresses if displacement is not corrected, work will stop and track will be corrected before the shutdown threshold is reached.	TBD	TBD Notifies EIC	Spreadsheet (web based)
Shut Down	¼"	¼"	Stop Work. All Trains Stopped until alignment is corrected. EIC notified that track correction will be performed. Track is corrected. Trains allowed after EIC approval.	TBD	TBD Notifies EIC	Spreadsheet (web based)
SHORING – Track sits directly on existing grade, any vertical or horizontal changes will be directly measured in the track.						
Threshold	3/8"	3/8"	n/a			
Shut Down	½"	½"	n/a			

Phase 3 – In Pre-Planned Curfew						
Cut Track Install Verona Track Support – Re-Set Track						
TRACK – Monitor Before track is cut and after track is replaced						
Action Level	Vertical	Horizontal	Action Pan	Staff	Notification	Documentation
Threshold	1/8"	1/8"	n/a	TBD	TBD Notifies EIC	Spreadsheet
Shut Down	¼"	¼"	Re-set track within 1/8" of original position vertically and horizontally	TBD	TBD Notifies EIC	Spreadsheet
SHORING – None						
Threshold	1/8"	1/8"	n/a			
Shut Down	¼"	¼"	n/a			

Phase 4 – Jack During Planned Curfews						
Verona System Supports Track						
TRACK – Monitor 3 times per day						
Action Level	Vertical	Horizontal	Action Pan	Staff	Notification	Documentation
Threshold	1/8"	1/8"	See Petrucco Twist Control Document Section 2.2	TBD	Auto Alert via app. TBD notifies EIC	Petrucco Twist Control system
Shut Down	¼"	¼"	See Petrucco Twist Control Document Section 2.2	TBD	Auto Alert via app. TBD notifies EIC	Petrucco Twist Control system
SHORING – None						
Threshold	3/8"	3/8"	n/a			
Shut Down	½"	½"	n/a			

Phase 5						
Verona Removal						
TRACK – Monitor Before track is cut and after track is replaced						
Action Level	Vertical	Horizontal	Action Pan	Staff	Notification	Documentation
Threshold	n/a	n/a	n/a	TBD	TBD Notifies EIC	Spreadsheet
Shut Down	¼"	¼"	Re-set track within ¼" of original position vertically and horizontally	TBD	TBD Notifies EIC	Spreadsheet
SHORING - None						
Threshold	3/8"	3/8"				
Shut Down	½"	½"				

Phase 6						
Final Monitoring						
TRACK – Monitor 1 per day for 7 days						
Action Level	Vertical	Horizontal	Action Pan	Staff	Notification	Documentation
Threshold	1/8"	1/8"	EIC will be notified RLW/SW will have steel shims and jacks on site at all times and prepare to stop work and correct alignment and profile. Monitoring will continue.	TBD	TBD Notifies EIC	Spreadsheet
Shut Down	¼"	¼"	EIC notified that track correction will be performed. Track is corrected. Trains allowed after EIC approval.	TBD	TBD Notifies EIC	Spreadsheet
SHORING - None						
Threshold	3/8"	3/8"	n/a			
Shut Down	½"	½"	n/a			



PHASE	RESPONSIBILITY	METHOD	FREQUENCY	REPORTING
PHASE 1 – WORK OUTSIDE RR ROW	RLW/SW	MANUAL SURVEY	1 TIME PER DAY	SPREADSHEET
PHASE 2 – MICROPILE INSTALLATION	RLW/SW	AMTS	3 TIMES PER DAY DURING WORK	SPREADSHEET
PHASE 3 – VERONA INSTALLATION	RLW/SW	MANUAL	1 TIME BEFORE AND 1 AFTER TO SET TEMP TRACK	SPREADSHEET
PHASE 4 – BOX JACKING	PETRUCCO	PTC	CONTINUOUS DURING JACKING FINAL	PTC APPLICATION
PHASE 5 – VERONA REMOVAL	RLW/SW	MANUAL	1 TIME BEFORE AND 1 AFTER TO SET TEMP TRACK	SPREADSHEET
PHASE 6 – FINAL MONITORING (7 DAYS)	RLW/SW	MANUAL	1 TIME PER DAY	SPREADSHEET

LEGEND

- TRACK TARGET
- ⊕ BENCHMARK - FINAL LOCATION
TBD DURING CONSTRUCTION
- AMTS AUTOMATED TOTAL STATION - FINAL LOCATION
TBD DURING CONSTRUCTION

RLW / SW JOINT VENTURE		DRAWN BY: SSM	
14600 SOUTH - RAILROAD CROSSING		QC CHECKED BY: JD	
PROJECT NUMBER: COB. CON23001RD		DATE: 05/06/24	
TRACK MONITORING PLAN		PROFESSIONAL ENGINEER	
APPROVED		DATE	
PROJECT: 14600 SOUTH, SUITE 200, DRAPER, UTAH • 84020		REVISIONS	
101 PHOENIX BLVD, SUITE 100, DRAPER, UTAH • 84020		NO.	
WWW.WAECOR.COM		DATE	
SHEET NO. TMP-01		REMARKS	

MP-01 - Track Target and Bench Mark Location