Colton Junction OLE Tangential Wiring

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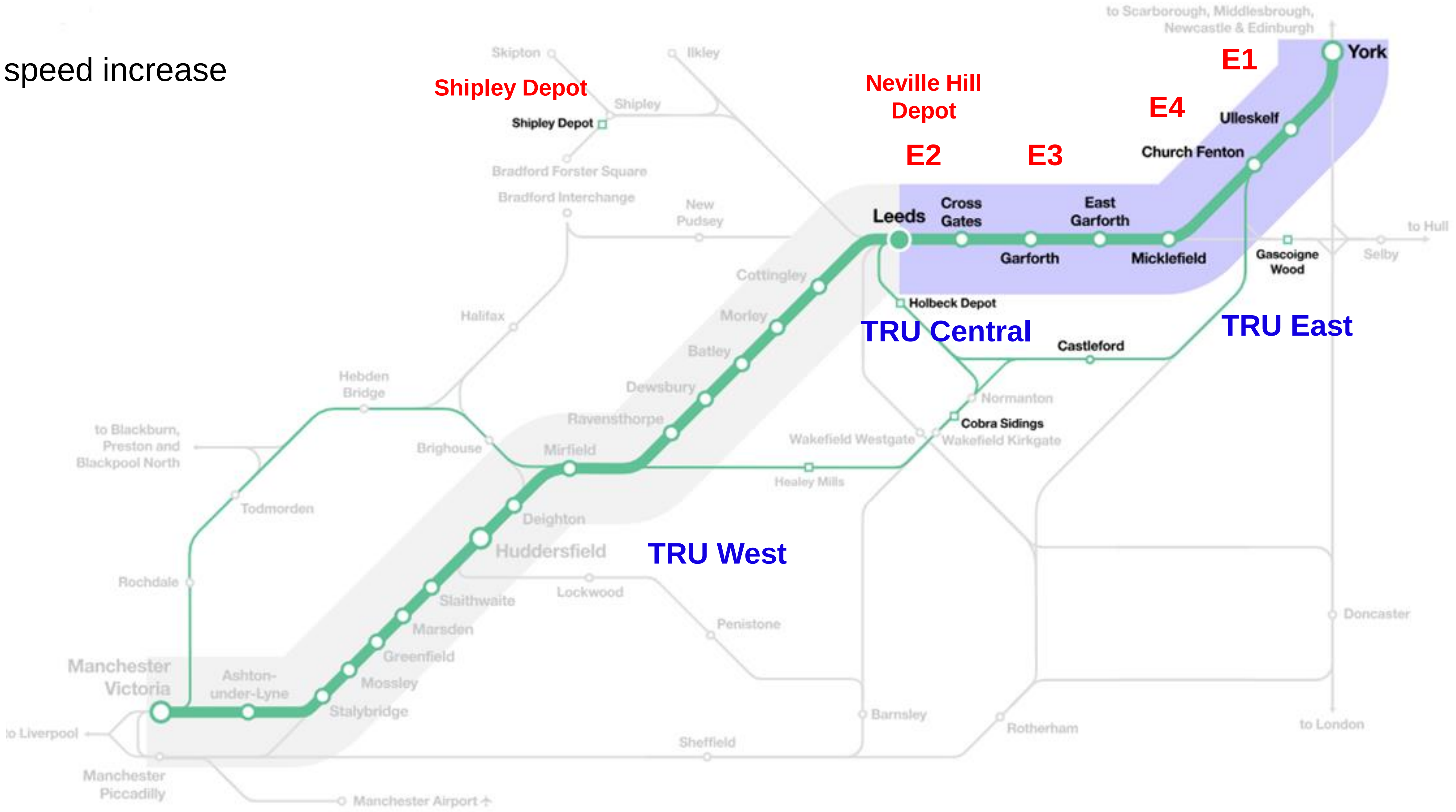
TRANSPENNINE ROUTE UPGRADE

ON TRACK TO BETTER

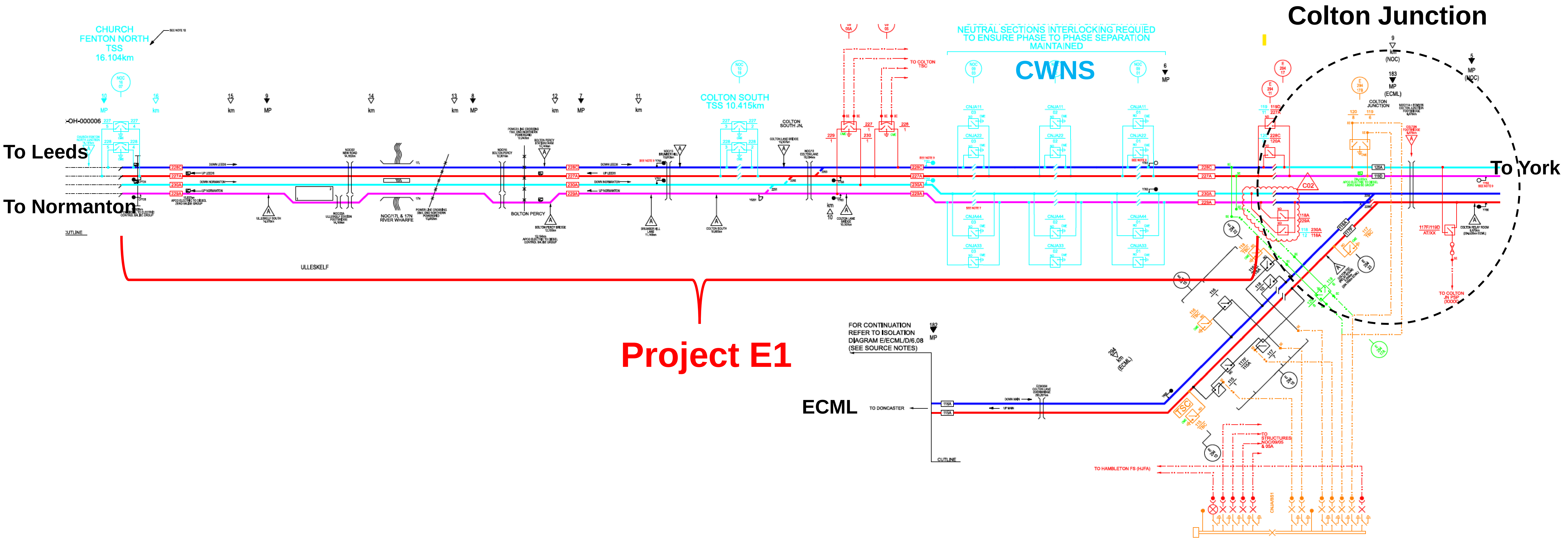
TRU Alliance Overview – Projects E1234

- 25kV A.C. Electrification between Colton Junction and Leeds
- Line speed increase to 125mph through to York
- Resignalling to improve capacity and allow for line speed increase
- Closure of 5No. Level Crossings
- Overbridge and Underbridge reconstructions
- Culvert and drainage interventions
- New electrified depot at Shipley



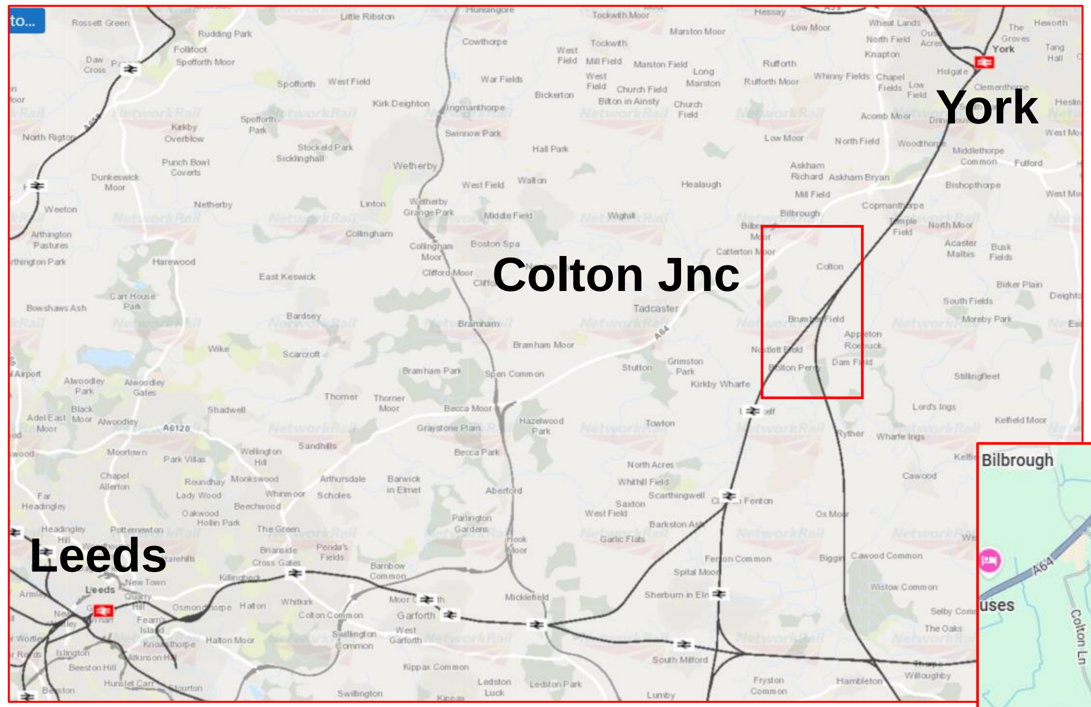
Project E1 Electrification Overview

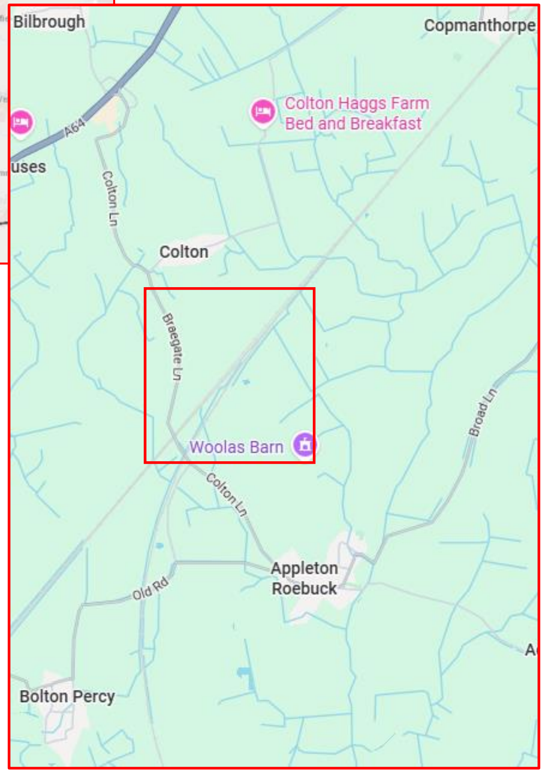
- 32 STK of new OLE between Colton Junction & Church Fenton - Siemens equipment
- OLE fed from the Colton Junction MPTSC, via Hambleton Feeder Station
- Future sectioning sites and CWNS shown in cyan, required for E234 commissioning



Colton Junction – Where?

- South-West of York off the ECML
- Key to complete the overall TRU West to East upgrade works





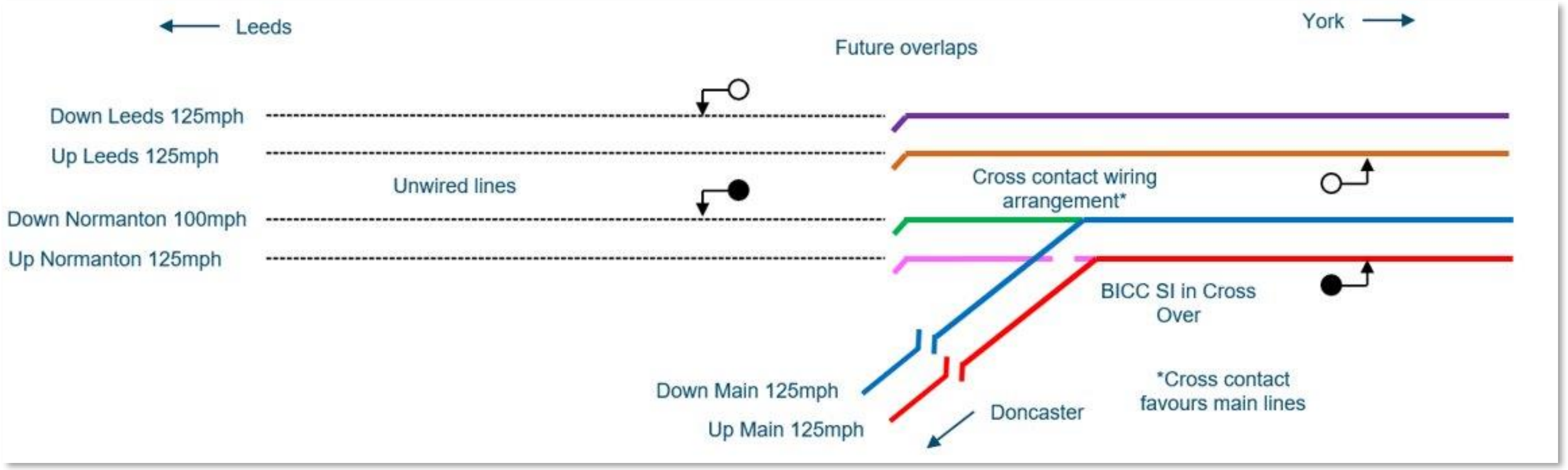
(Final OLE arrangement pictured above)

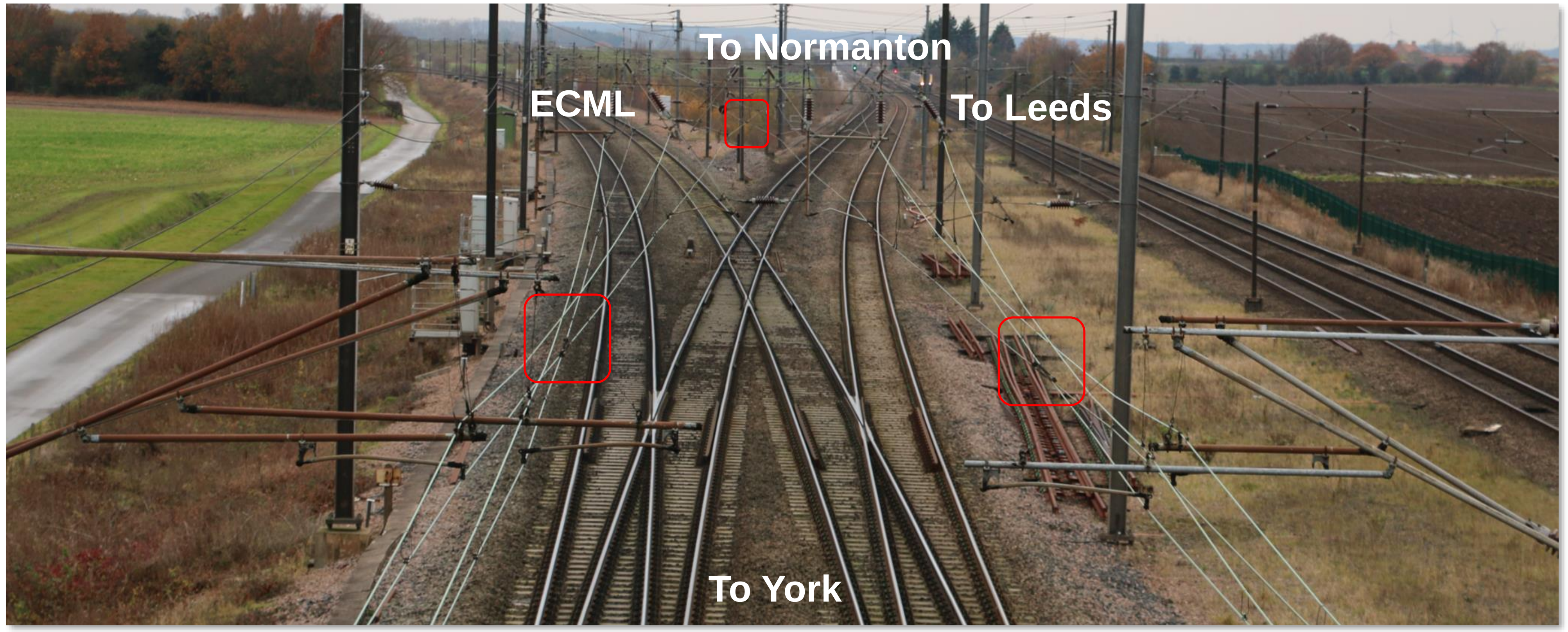
- It's an equal-split 125mph high-speed double junction
- It's where the Selby diversion off ECML joins the York to Normanton lines
- The ECML was electrified with BR standard Mk3B OLE in 1989
- *Probably* the highest speed double junction in the UK - ***a one-off***

Colton Junction Existing Arrangement

- Wired with short 'overrun' protection and provision for future extension to Leeds – **<u>headspan construction</u>**
- All turnouts and switched diamond crossed with cross contact bars
- Electrical sectioning via section insulator, never seen a pantograph as overrun only – APCO protected
- Section insulators can be hard spots — not suitable for 125mph mainlines
- S.I.'s require more frequent maintenance than insulated overlaps – limited junction access

Can we just extend the wiring?

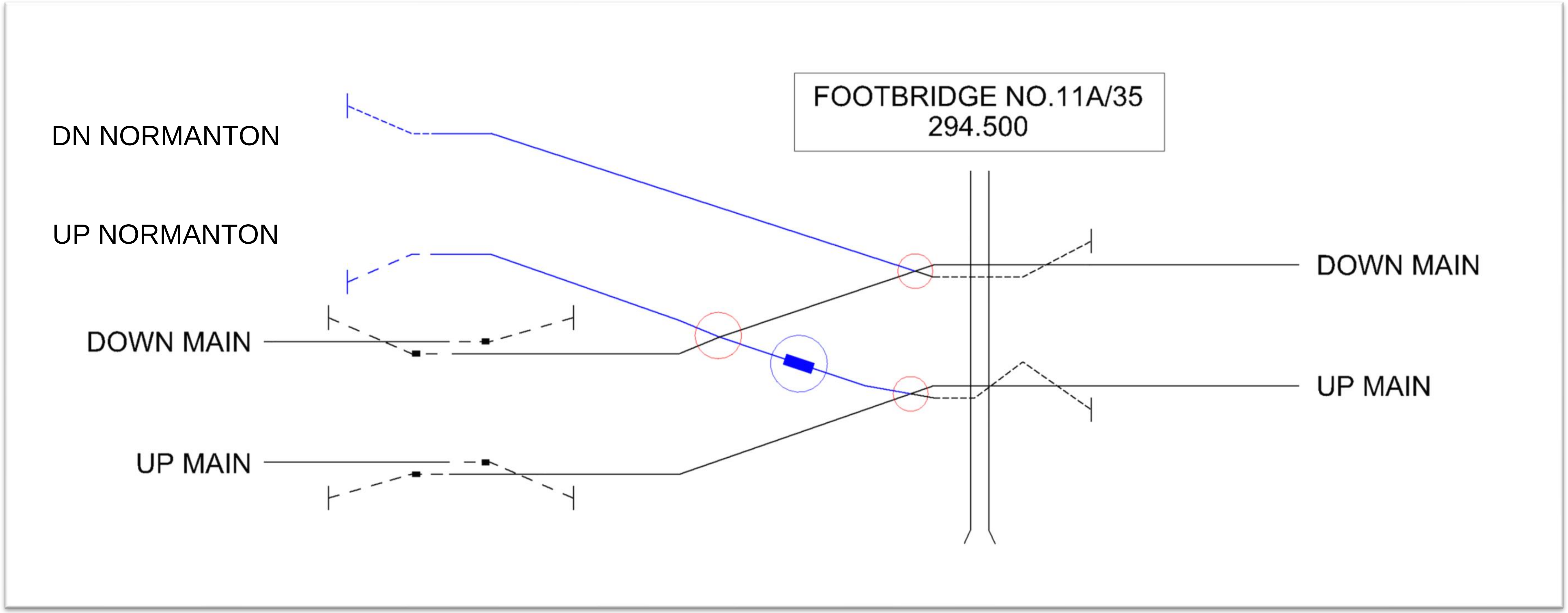




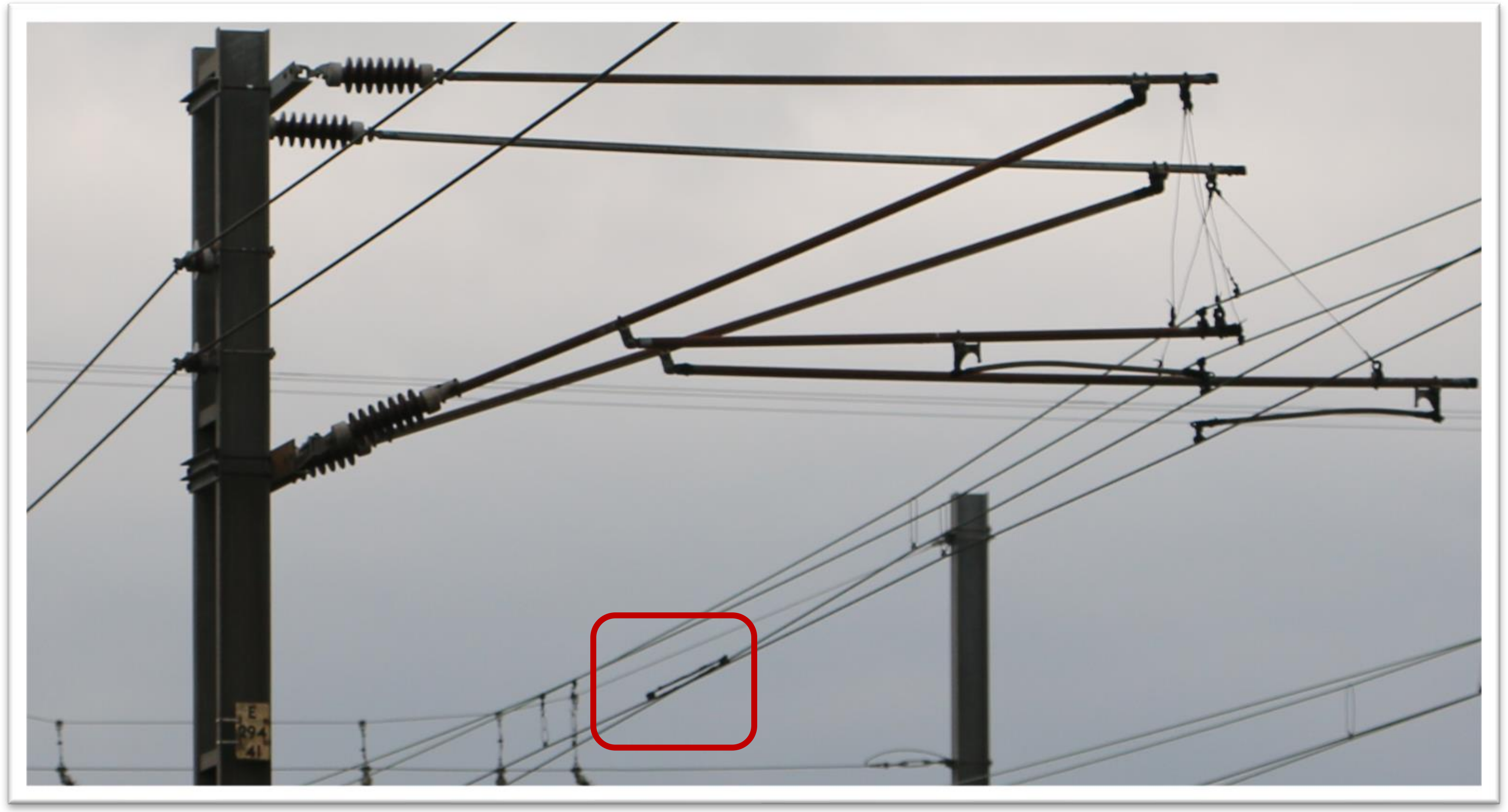
Existing Wiring Schematic

- 3 x cross contact bars
- Section insulator

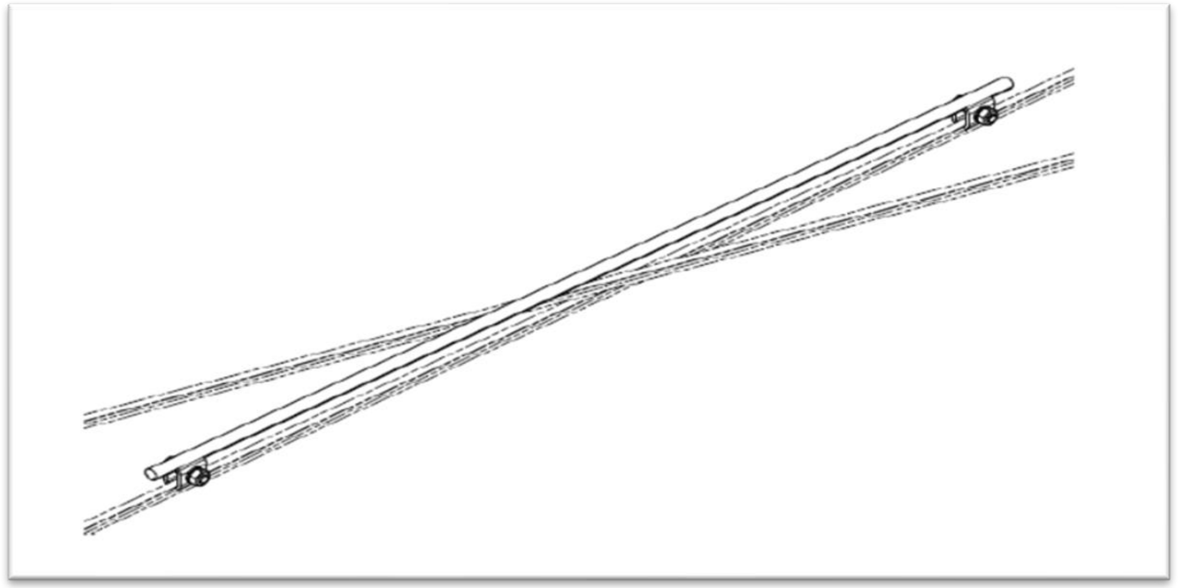
- Low footbridge restricting wire heights
- All routes 125mph – Dn Norm 100mph



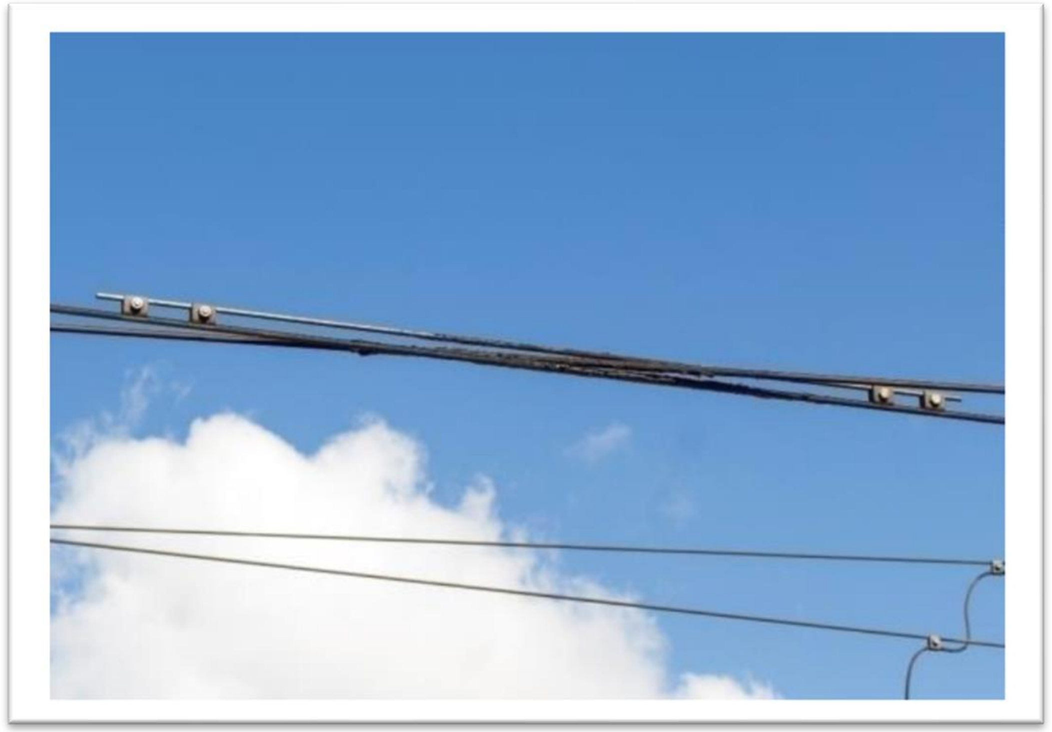
Crossed Contact OLE Wiring



- Main line always lower wire - higher speed route takes precedence
- Cross-contact bar connects main and crossover wires allowing them to lift together - managing “hook-over” risk
- Can cause **high pantograph forces** if poorly designed or maintained
- Become detached - potential **OLE de-wirement**
- Colton Junction all lines are high speed therefore no route can be biased



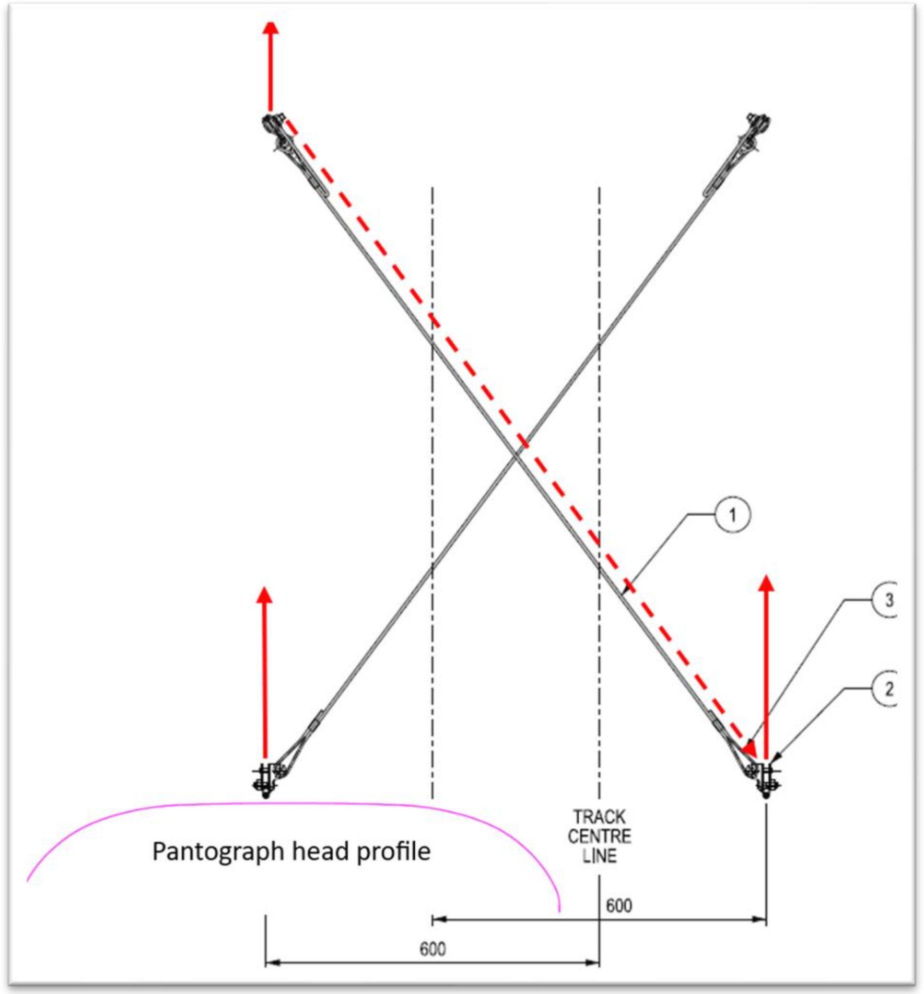
(Cross contact bar arrangement)

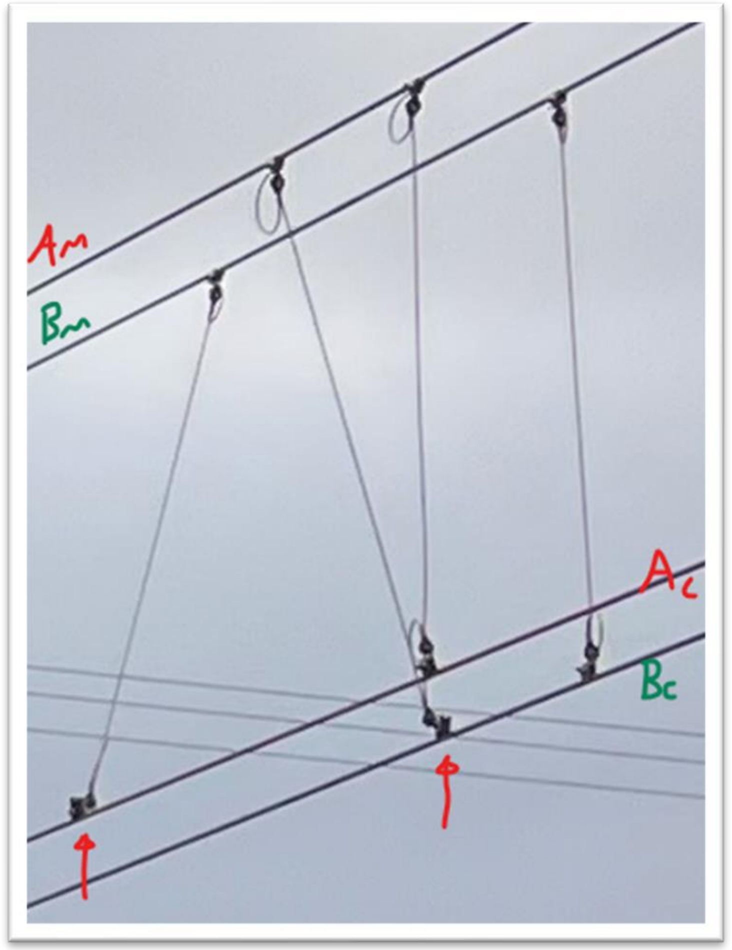


Tangential Wiring - Cross Droppers

- Modern wiring uses “tangential” alignment — wires do not cross
- Standard UK Master Series (UKMS) for turnouts and crossovers
- No cross-contact bar, hook-over managed by “cross droppers”
- As the Pantograph uplifts it’s wire the cross dropper lifts adjacent contact wire
- Higher speed mainline wire still biased 20mm lower
- Both wires land on the pantograph at the same height – lower forces

<u>Preferred arrangement</u>

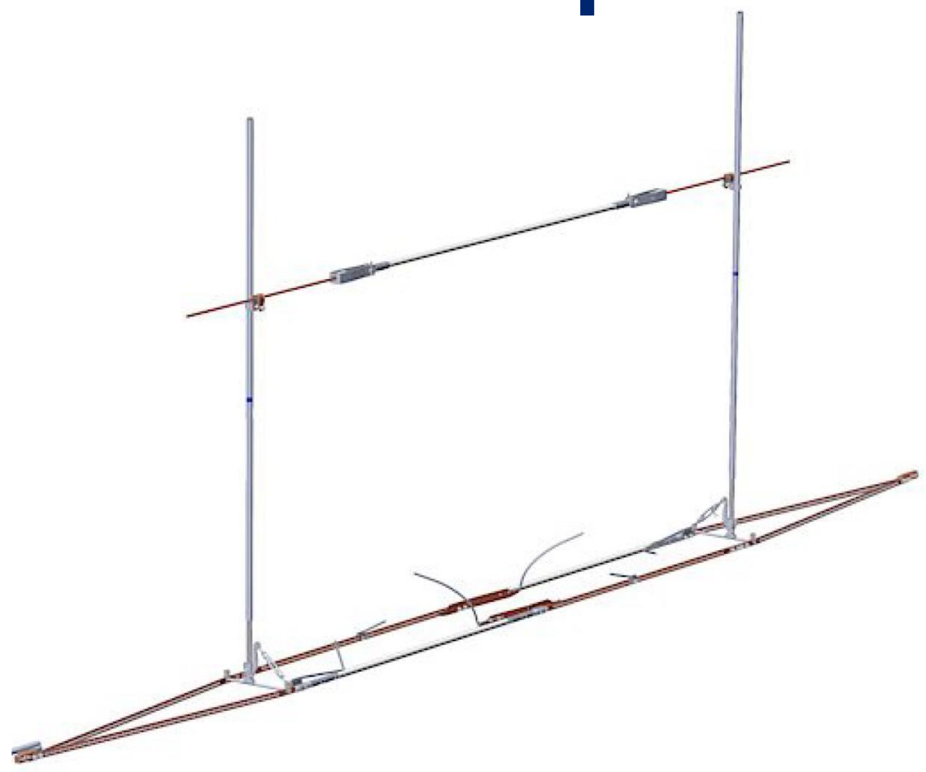




Section Insulator (S.I.) vs Insulated Overlap

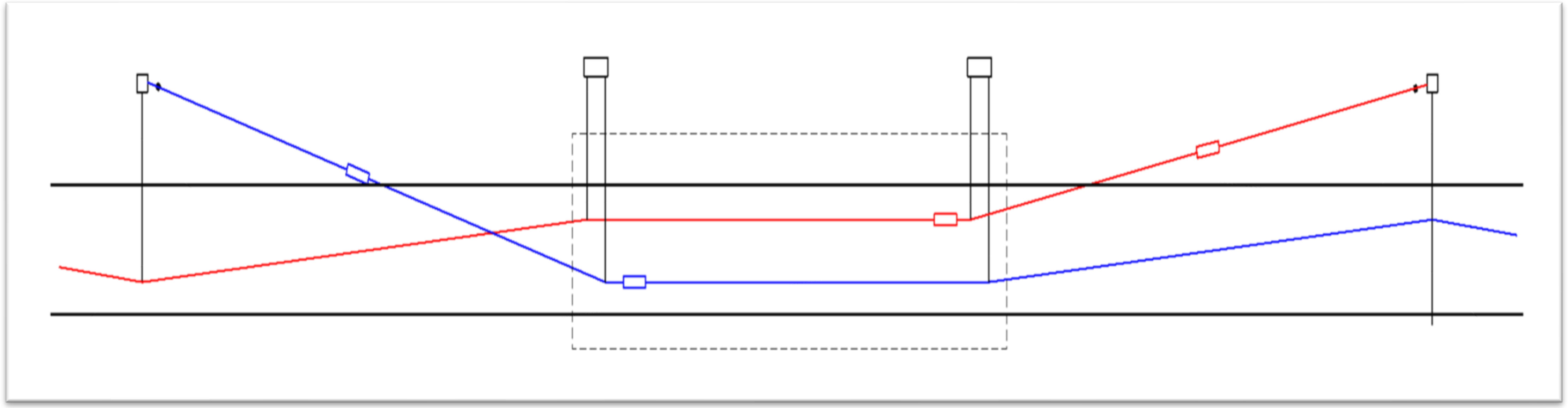
S.I.

- Higher forces – pantograph damage
- Increased maintenance frequency
- Known weak link – dewirement risk
- Not approved for 125mph
- However relatively short in length at 6m



Insulated Overlap

- Lower forces
- Reduced maintenance – normal wiring
- Approved for 125mph – normal wiring
- However much longer at +40m

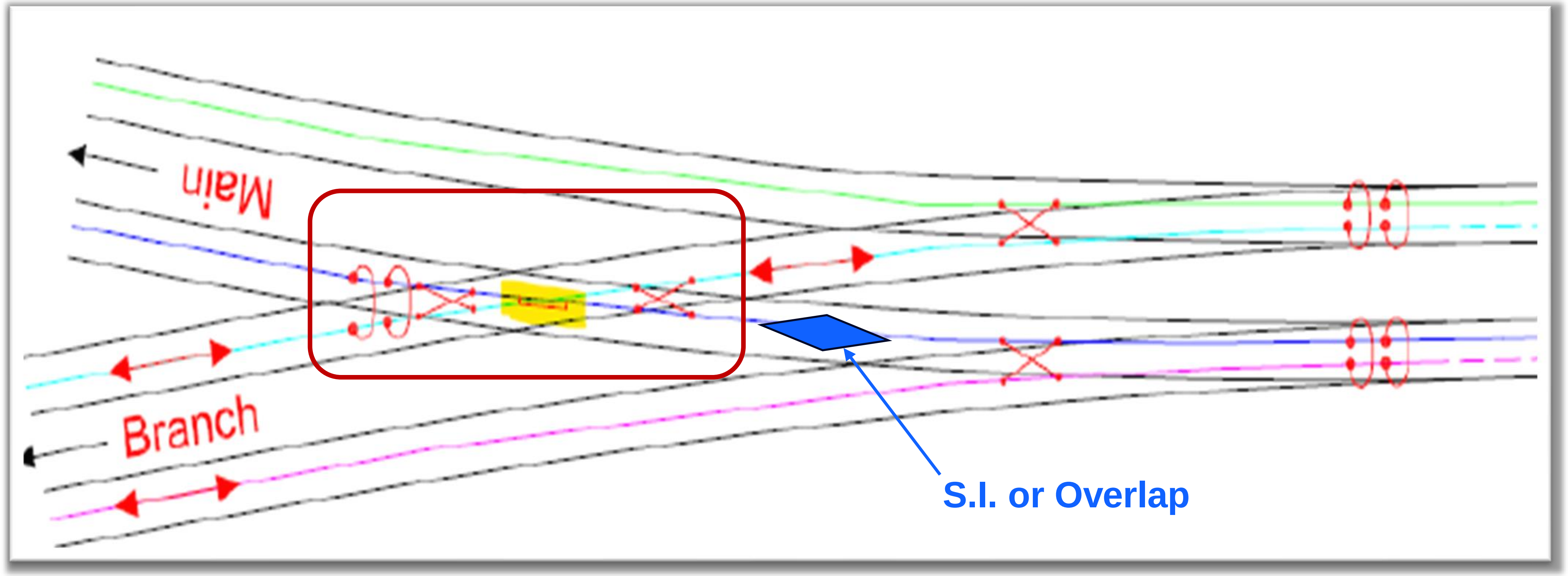


(standard insulated overlap wiring schematic)

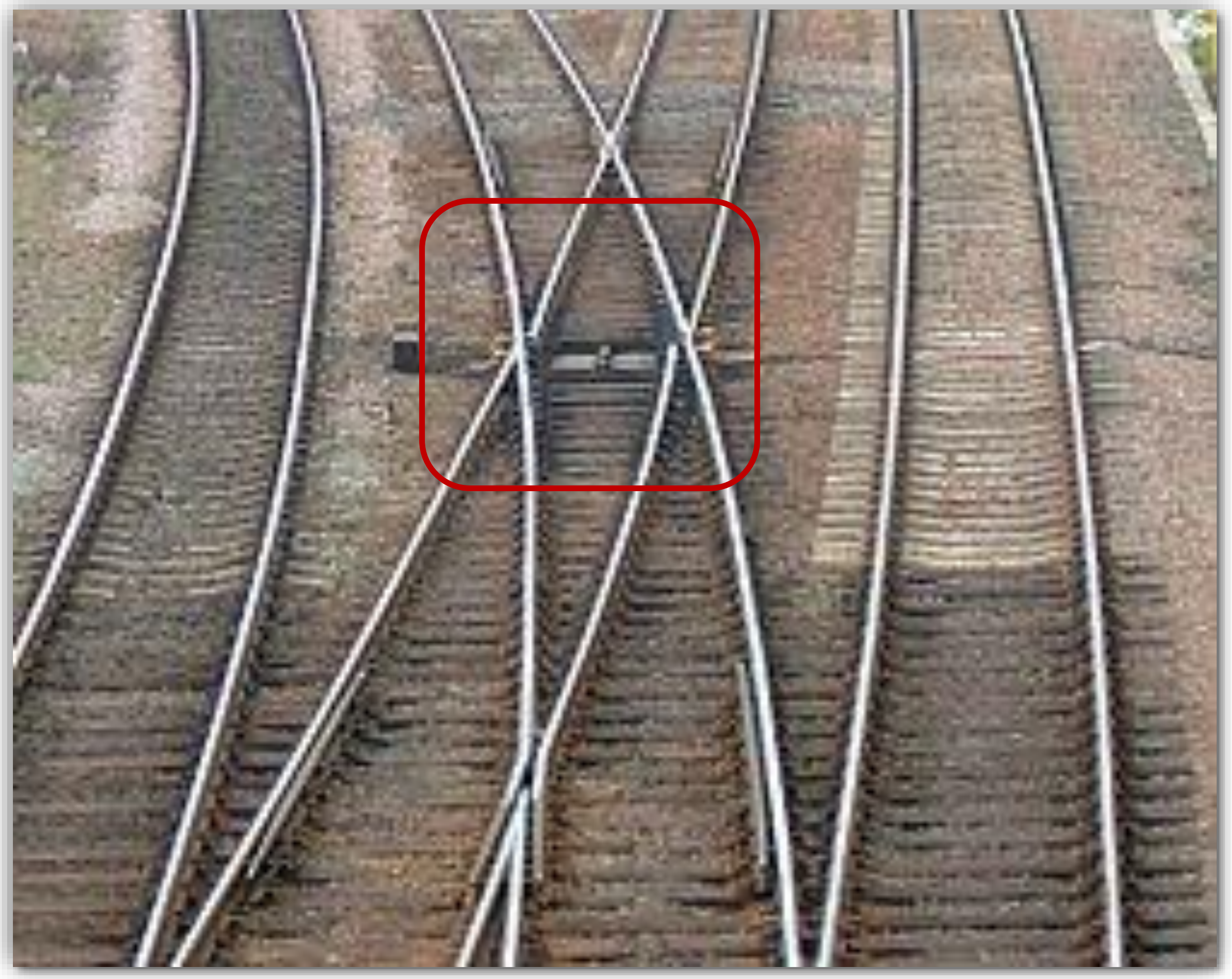
Available General Arrangement Drawings

- No standard UKMS arrangement for a high speed switch diamond
- Series 1 available, however cross contact bar - much lower speed
- Colton junction S&C physically longer

<u>Advantage for fitting an insulated overlap</u>



(Series 1 wiring schematic)

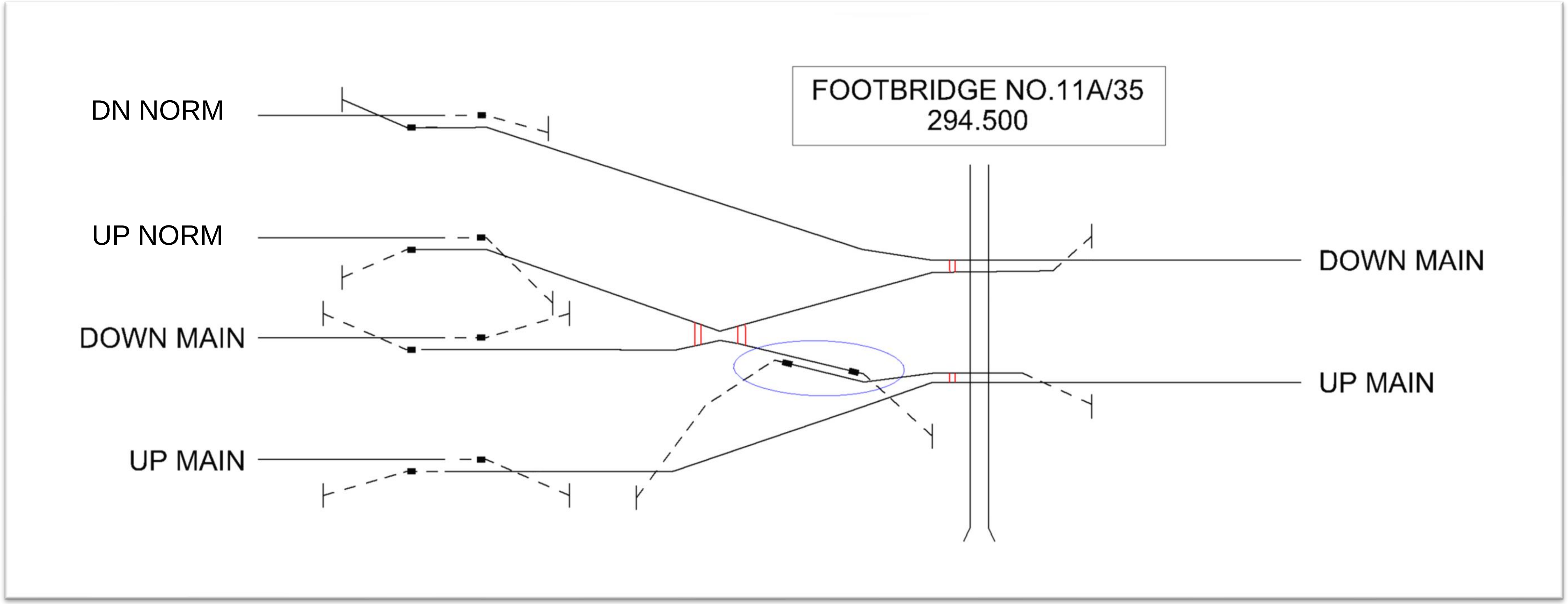


(Switch diamond crossing)

Proposed Wiring Schematic

- Based on UKMS crossover wiring principles
- Uncrossed tangential using cross droppers
- S.I. replaced with insulated overlap
- Wires at the same height as no route can be biased

Industry best practice tells us this should be the correct solution



Form A Requirements – Project Legacy

- Future proof critical ECML junction
- Replace headspans with portals – mechanically independent
- Renew aluminium catenary with copper
- Renew cantilevers with new Siemens type
- Ensure no contact wire splices in the junction – hard spot / high wear

- Approval in Principle accepted on this basis
- Still concern over forces
- Verify via ***dynamic modelling***

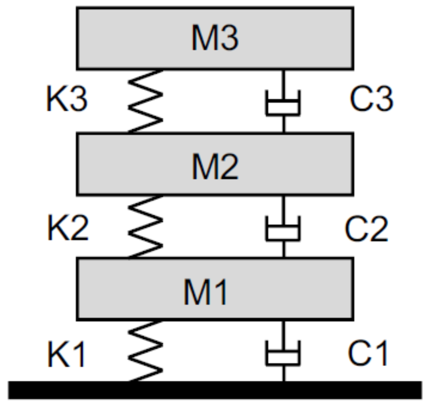
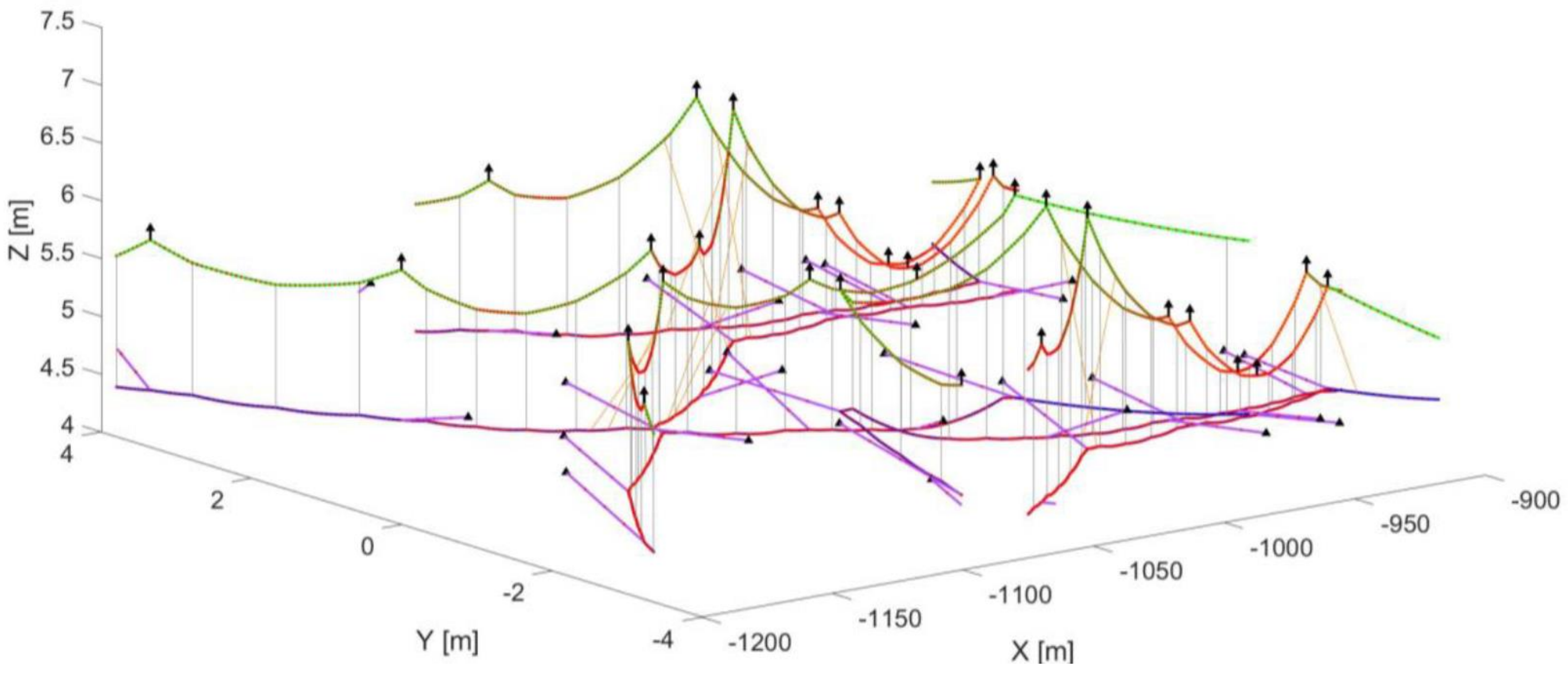


Figure 8: Three-stage lumped-mass pantograph model.

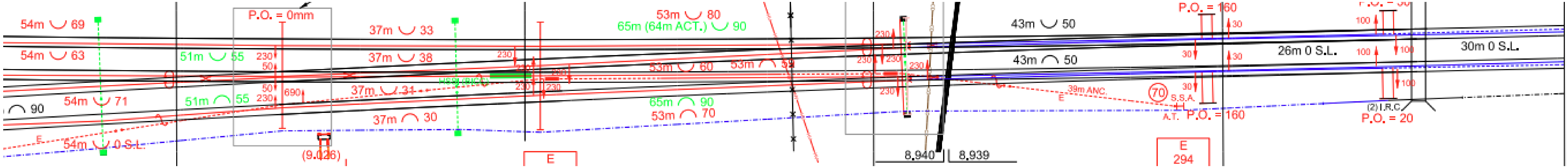


(Visualisation of wiring model)

University of HUDDERSFIELD
Inspiring global professionals

Form B OLE design.

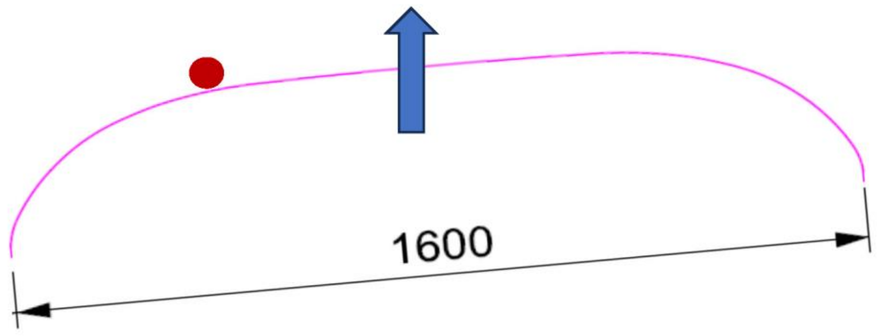
- Here was the Form B OLE layout design (B01 May.-2021):

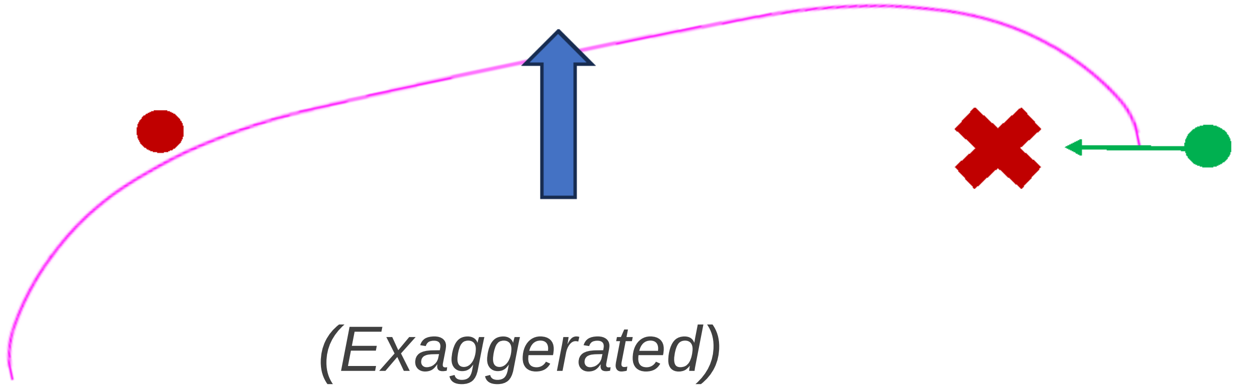


- Now with an insulated overlap in the Up Normanton and junction wideway requiring a new wire run 71A.
- So, the University of Huddersfield modelled this layout using their 3D PantoCat dynamic simulation tool.
- This required track model, all geometrical characteristics, OLE & dropper material properties as well as train vehicle types, formations, pantograph types & positions within set inputs to the model.
- 3 routes analysed (UM-UN, DM-DM, DN-DM)
- Stagger design refined to manage head roll

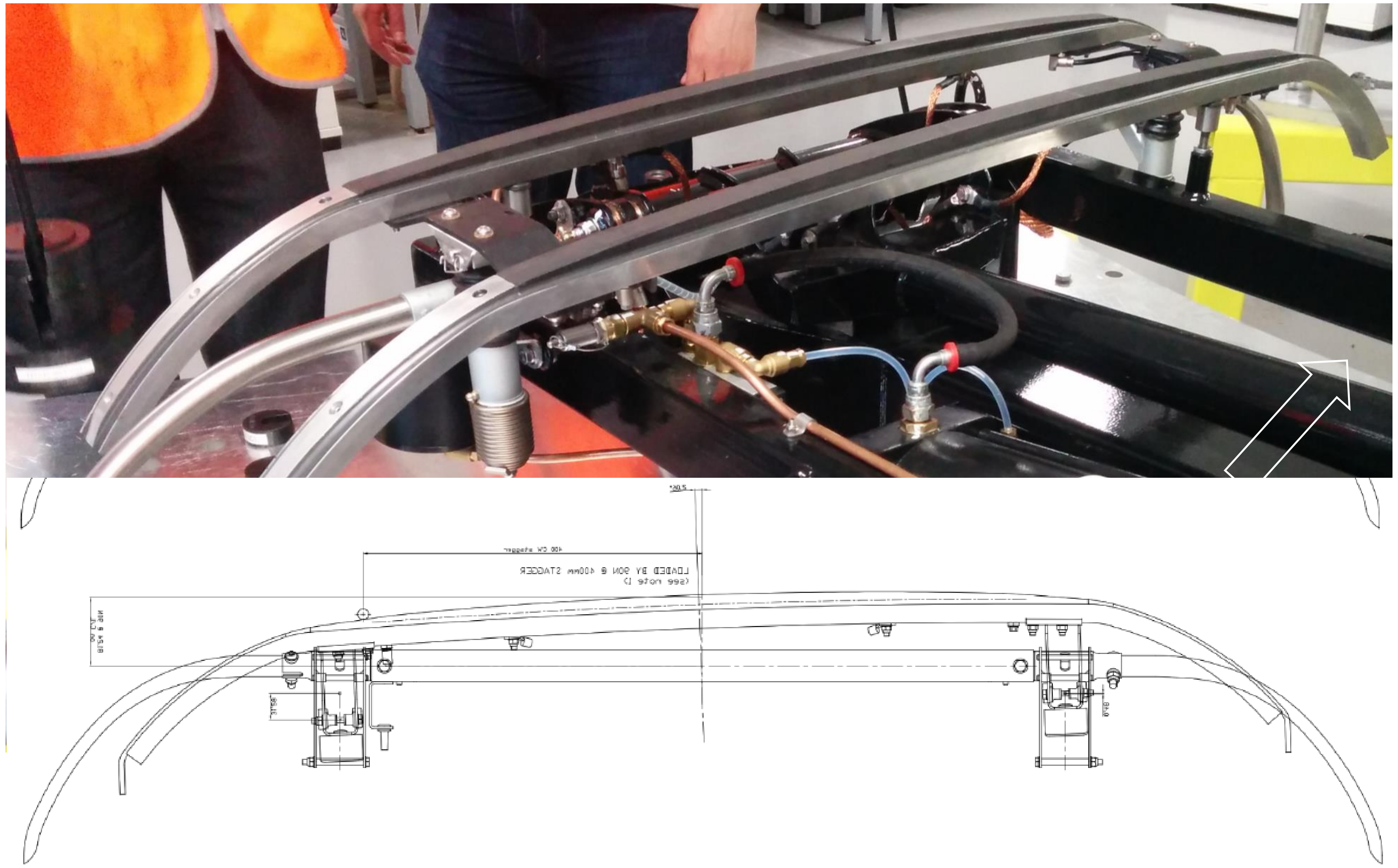
Stagger Theory.

- We need to understand pantograph head roll.
  - As the pantograph moves it exerts an upward force, both a static pre-force & aerodynamically.
  - The pantograph head is designed to 'roll' within limits (up to 60mm, BS EN 50367 s5.3.1).
  - Monitoring and controlling pantograph head roll is essential for ensuring reliable collection and preventing issues like dewirement and arcing.
  - So, if we have a left stagger we don't want the converging contact wire to be on the right and low.





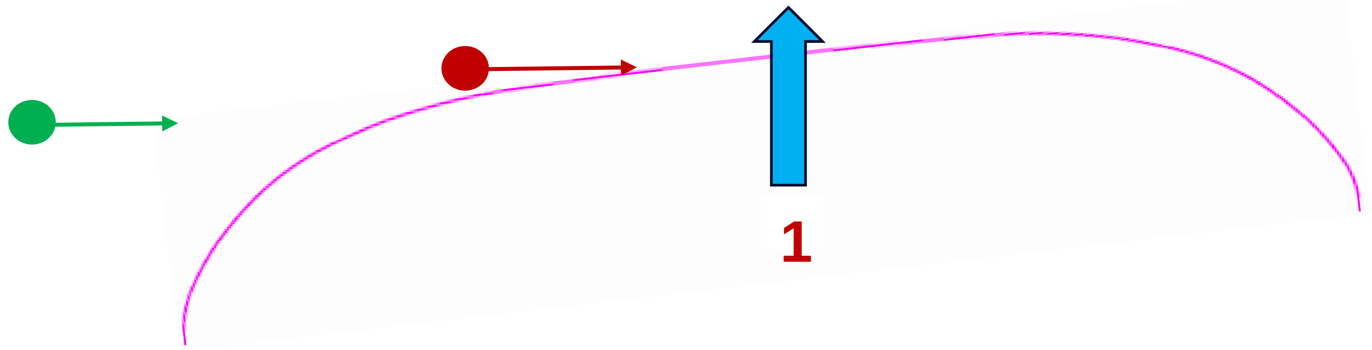
(Exaggerated)



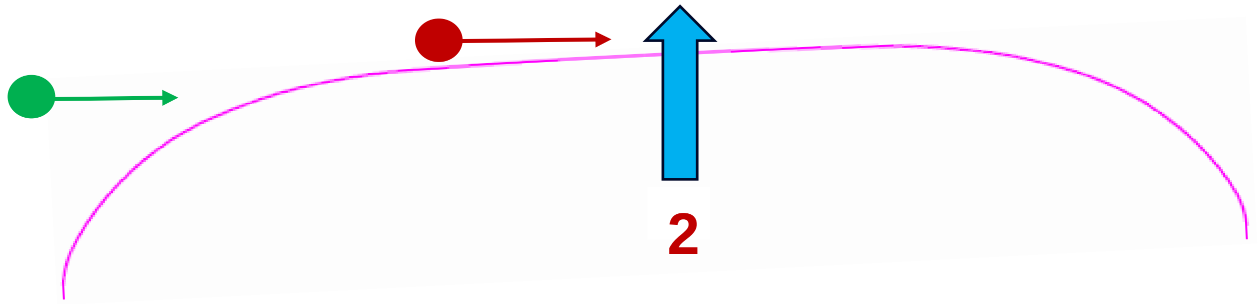
  - There is a hook-over risk; so, we need to design staggers such that we use head roll to our advantage.

Stagger Theory

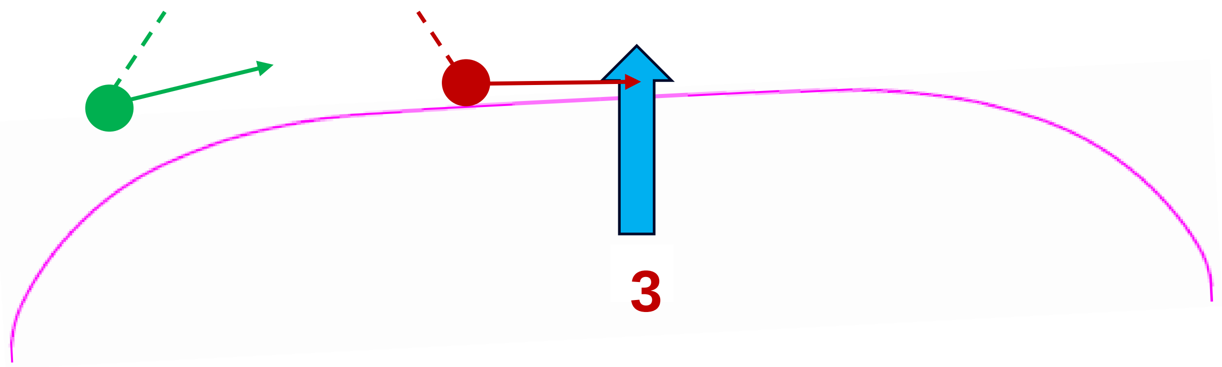
- Principle using stagger design to ‘roll’ the pantograph head to the converging contact wire.



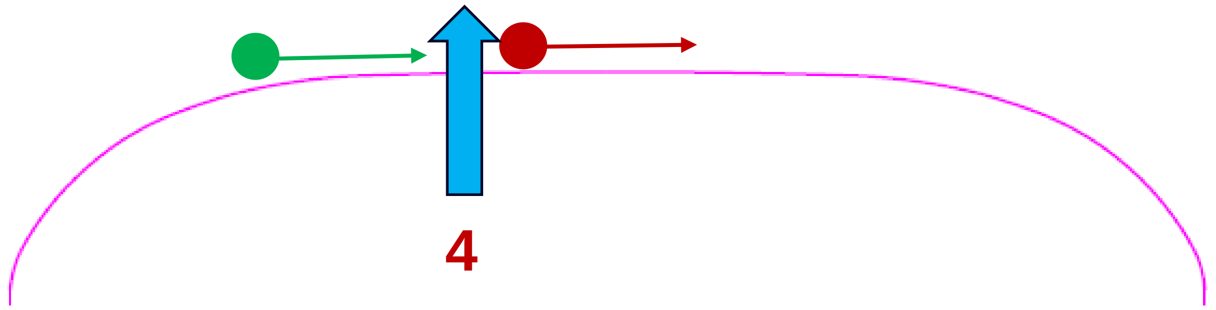
Max Uplift could be in the order of ~100mm



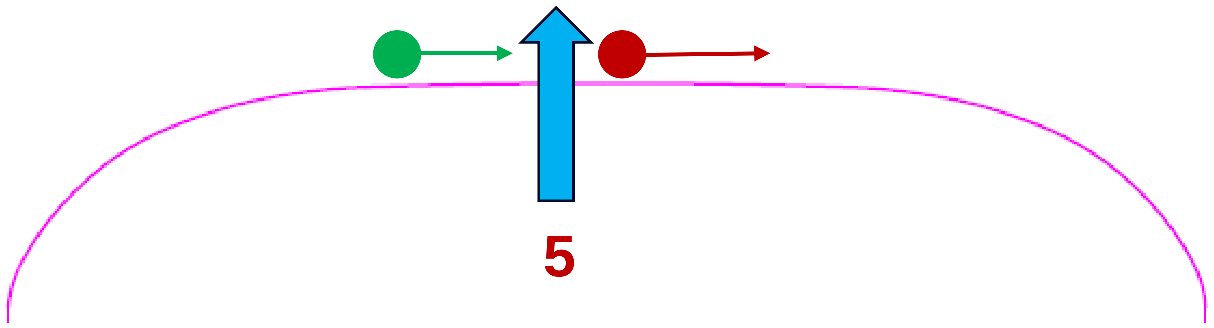
Cross-dropper lifts converging contact wire



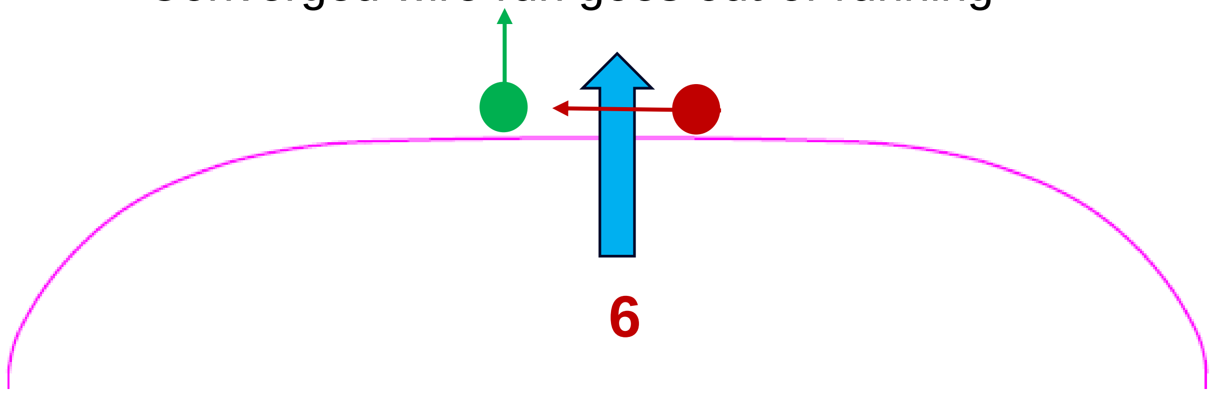
Pan. head & converging wire run meet on carbons



Pan. head stabilises



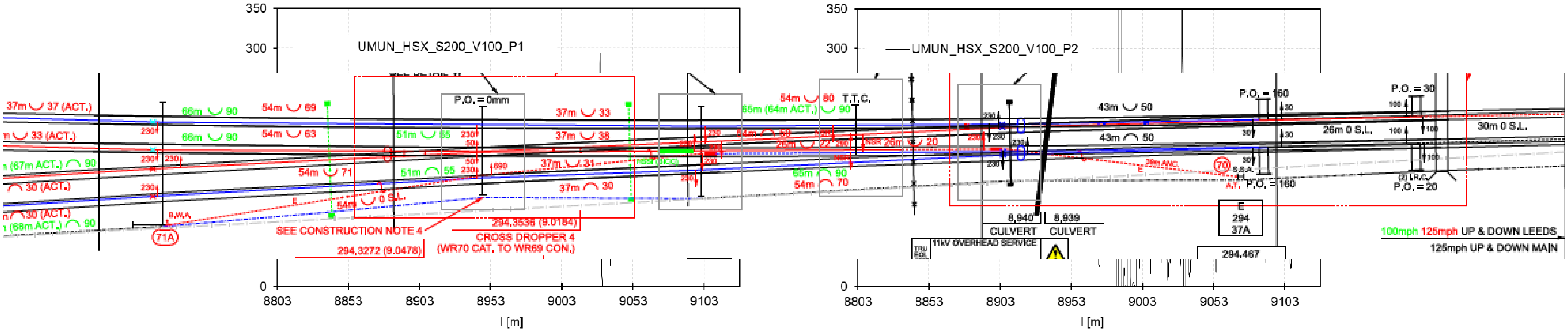
Converged wire run goes out-of-running



Modelling – Initial Scope

No. Pans.	Type	Spacing (m)	Speed (mph)
2	BW-HSX-250	200	125
			110
			100
	BW-HSP-Mk1 BW-HSP-Mk2 BW-HAS AMBR	53	100
		74	100
		86	100
		7.84	90
			80
Total configurations = 20			

Initial results

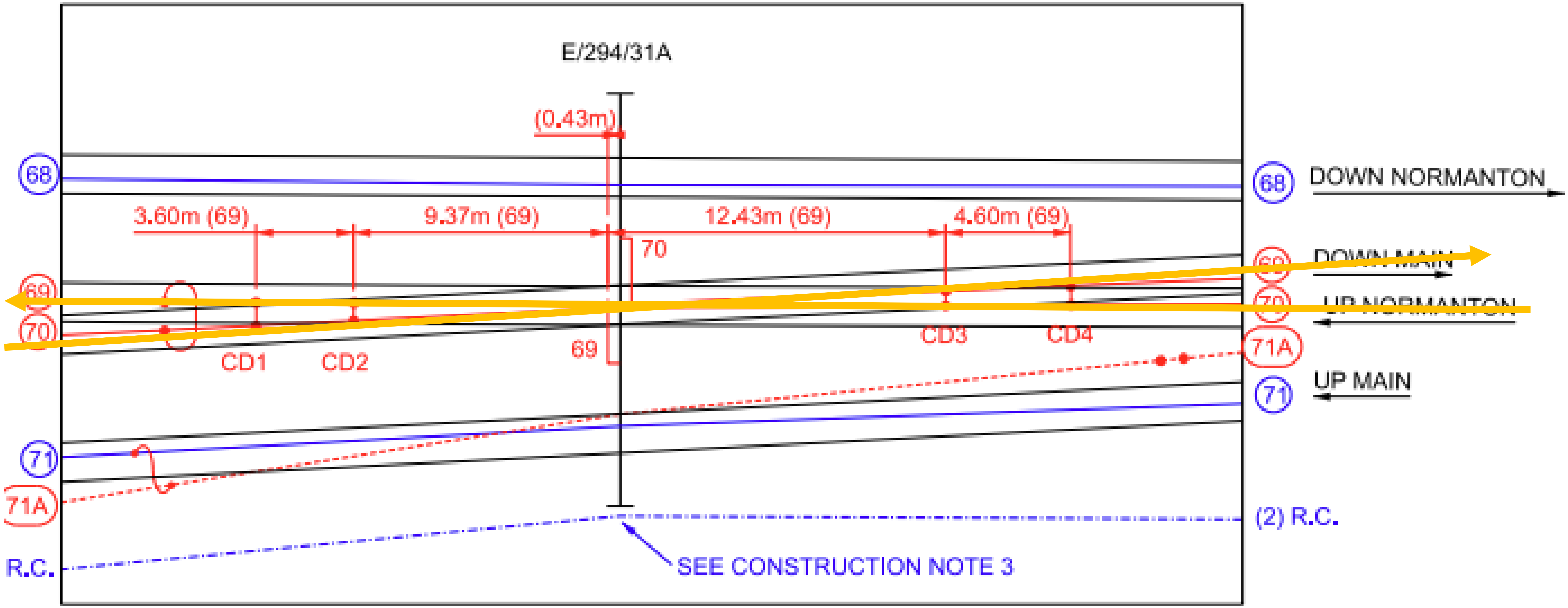


	F_{max}	F_{min}	Amp	F_m	σ	$σ/F_m$	S_{max}	S_{min}
UMUN_HSX_S200_V100_P1	294.129	-5.048	299.177	102.696	22.863	0.223	171.285	34.108
UMUN_HSX_S200_V100_P2	1384.506	-132.159	1516.665	102.435	78.664	0.768	338.427	-133.557

Modelling Re-Scope

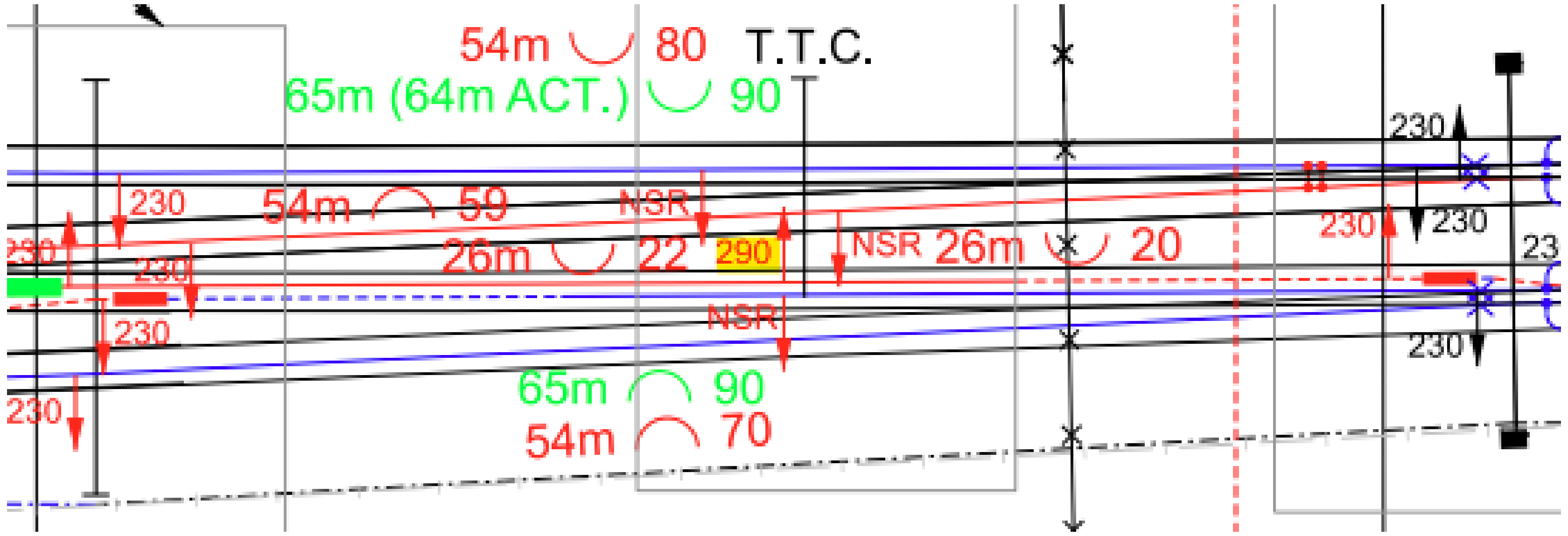
- Train configurations reviewed
  - NR/L2/ELP/27715/01 vs Sectional Appendix
- Wire lower through the junction
  - Creates a ‘softer’ system
  - No wire gradients
- A greater review of what the pan sees – system level thinking
  - ‘Half’ cross droppers
  - Wire hog
- Alternative sectioning
  - SI or none
- Wire damping – Second pantograph impacts
  - Overlap TTC

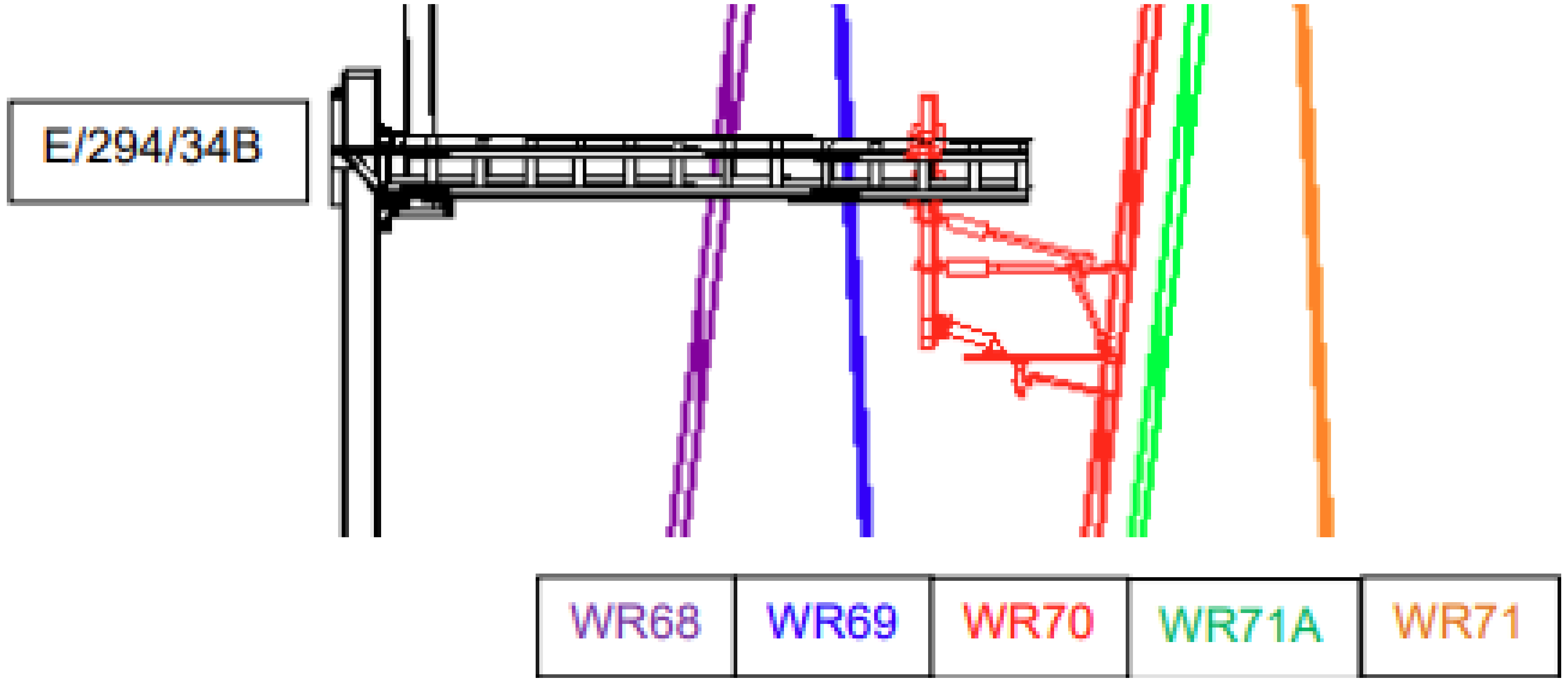
Switched Diamond Review – What the Pan sees



Wire Damping TTC

- Second pantograph always saw higher forces due to it interacting with a vibrating wire.
- This was seen mainly at the overlap, so we looked at how to dampen that wire





- Catenary takes load which reduced vibrations in contact and unloaded reg damped the uplift from the first pan

Modelling learning curve

- This is a bespoke use of modelling as normally only used for system design rather than detailed design
  - UKMS modelling analysed a ‘standard’ wire run. Which may include lots of the discrete features we looked at but not all happening in very quick succession.
  - UoH were used to modelling these discrete features but not multiwire interaction and therefore we had to work together on updating modelling for example, the full pantograph modelled rather than just the carbons.
- As a project our understanding of how modelling worked was lacking and therefore significant upskilling in our knowledge required.
- As ‘Allocation’ designers we had to develop the base understanding of system design.
  - E.G.: Where do cross droppers help.
  - Does UKMS GA’s possibly over subscribe them. Leading vs Trailing X/Over?

Modelling Configurations

Pantograph Configuration			Speed	Comments	Routes		
Units #	Spacing	Type	(mph)		DMDM	DNDM	UNUM
1	-	BW-HSX-250 BW-HSP-Mk1 BW-HSP-Mk2 BW-HSA AMBR	100	Single pantograph operation.	X	X	X
1	-	BW-HSX-250	105	Single pantograph operation at diferent speeds above 100 mph.	X		X
			110		X		X
			125		X		X
2	43	BW-HSX-250	80	2 x Class 800 (5 car) - pantograph raised on cars 5 & 6	X	X	X
2	55		80	2 x Class 397 multiple unit.	X	X	X
2	55		100		X	X	X
2	118		80		X	X	X
2	130		100	2 x Class 800 (5 car) - pantograph raised on cars 1 & 6 or 5 & 10	X	X	X
2	118	BW-HSX-250	100	2 x Class 397 multiple unit.	X	X	X
2			105		X		X
2			110		X		X
2	180	BW-HSX-250	100	2 x Class 397 multiple unit.	X	X	X
2			105		X		X
2			110		X		X
2			125		X		X
2	216	BW-HSX-250	100	2 x Class 800 (5 car) - pantograph raised on cars 1 & 10.	X	X	X
2			105		X		X
2			110		X		X
2			125		X		X
2	55.4	BW-HSP-Mk2	100	2 x Class 331 multiple unit.	X	X	X
2	71.4				X	X	X
2	87.4				X	X	X
2	94.75				X	X	X
2	110.8				X	X	X
2	134.1				X	X	X
3	94.75-55.3	BW-HSP-Mk2	80	3 x Class 331 multiple unit.	X		
3	55.3-94.75				X		

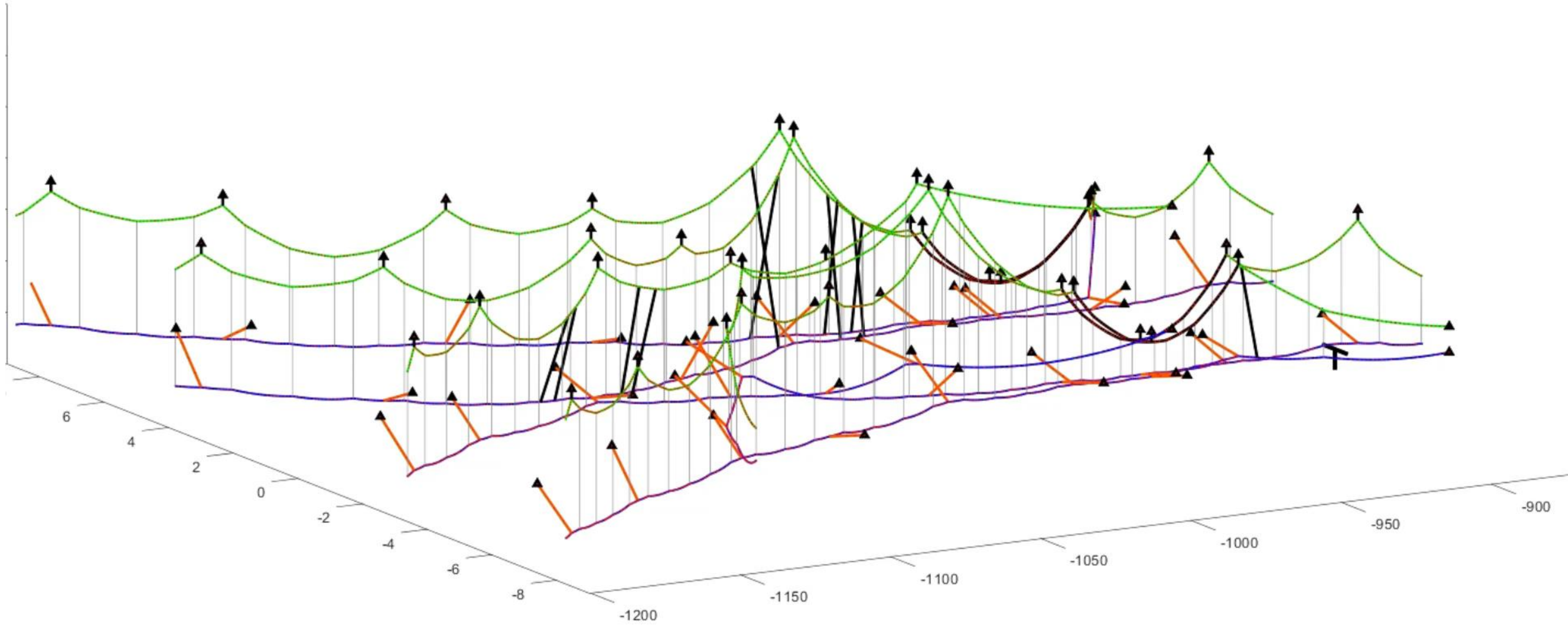
Design Variation	Model ID	Description
General	OGR	- Original OLE design
	NGR	- Level wire gradient design
Pre-Sag	NPS	- No pre-sag in the NGR design
	CPS	- No pre-sag in CD1 design
Diamond Wire Lift	H1G	- 10mm wire rise at the diamond on wire 69 without cross-droppers
	H2G	- 15mm wire rise at the diamond on wire 69 without cross-droppers
	H3G	- 20mm wire rise at the diamond on wire 69 without cross-droppers
	H4G	- 30mm wire rise at the diamond on wire 69 without cross-droppers
	H5G	- 40mm wire rise at the diamond on wire 69 without cross-droppers
	H6G	- 50mm wire rise at the diamond on wire 69 without cross-droppers
	H1C	- 15mm wire rise at the diamond on wire 69 with CD1 cross-droppers
	H2C	- 20mm wire rise at the diamond on wire 69 with CD1 cross-droppers
	H3C	- 30mm wire rise at the diamond on wire 69 with CD1 cross-droppers
	GCD	- 20mm steady arm rise at the diamond for wire 69 with CD1 cross-droppers
Cross Dropper	CD1	- Initial cross-dropper arrangement at Turnouts and Diamond
	CD2	- CD1 with added cross-dropper at Down Turnout + removed from Up Turnout
	CD3	- CD2 with a Down Turnout cross-dropper repositioned (position scheme 1)
	CD4	- CD2 with a Down Turnout cross-dropper repositioned (position scheme 2)
	DY1	- Mix of CD2 with CD3 (position scheme 1 - with half cross-droppers)
	DY2	- Mix of CD2 and CD3 (position scheme 2 - with full cross-droppers)
	CD5	- DY2 with fifth pair of cross-droppers at Down Turnout
Section Insulator	SN0	- No electrical sectioning between Up Normanton and Down Main
	SN1	- AF HI25 Section Insulator between Up Normanton and Down Main

This represents 69 configurations (Pan type/Spacing/Route) and 23 models of the OLE design

1597 simulations to carry out!

Results for Final Model

Case	Pantograph	Contact force								Contact loss		SP_{up} [mm]
		F_{max} [N]	F_{min} [N]	A [N]	F_m [N]	σ [N]	σ/F_m	S_{max} [N]	S_{min} [N]	$CL_{\%}$ [%]	$CL_{\#}$	
UMUN_HSX_S_V125_CD3	Single	170.0	28.3	141.7	108.5	21.8	0.201	173.8	43.1	0	0	67.4
UMUN_HSX_S_V110_CD3	Single	159.3	54.3	105.0	104.3	18.8	0.181	160.8	47.7	0	0	59.3
UMUN_HSX_S_V105_CD3	Single	164.6	59.0	105.6	102.5	18.5	0.181	158.1	46.9	0	0	48.9
UMUN_HSX_S_V100_CD3	Single	150.0	58.6	91.4	101.5	17.9	0.176	155.2	47.8	0	0	47.6
UMUN_HSX_D043_V080_CD3	Leading	141.5	62.4	79.1	97.5	13.0	0.133	136.4	58.6	0	0	54.6
	Trailing	152.3	40.0	112.3	97.3	17.5	0.180	149.8	44.9	0	0	
UMUN_HSX_D130_V100_CD3	Leading	150.9	57.4	93.5	101.5	17.9	0.176	155.2	47.9	0	0	55.5
	Trailing	164.7	38.5	126.2	101.3	22.2	0.219	167.9	34.7	0	0	
UMUN_HSX_D216_V125_CD3	Leading	170.0	36.0	134.0	108.5	21.9	0.202	174.1	42.9	0	0	81.9
	Trailing	188.8	-8.2	197.0	108.5	28.2	0.260	193.2	23.8	0	0	
UMUN_HSX_D216_V110_CD3	Leading	159.2	55.7	103.5	104.2	18.8	0.180	160.5	47.9	0	0	61.3
	Trailing	171.3	35.3	135.9	104.2	23.7	0.227	175.2	33.2	0	0	
UMUN_HSX_D216_V105_CD3	Leading	164.1	58.9	105.1	102.4	18.5	0.181	158.0	46.8	0	0	58.5
	Trailing	182.8	26.6	156.3	102.5	24.1	0.235	174.9	30.2	0	0	
UMUN_HSX_D216_V100_CD3	Leading	151.5	57.4	94.1	101.5	17.9	0.176	155.1	47.8	0	0	53.9
	Trailing	167.4	34.4	133.0	101.2	22.6	0.223	169.0	33.5	0	0	



Bringing this to life – can you build and maintain to this level

- Throughout the design and modelling phase we were careful to ensure we were focussed on how this would be implemented

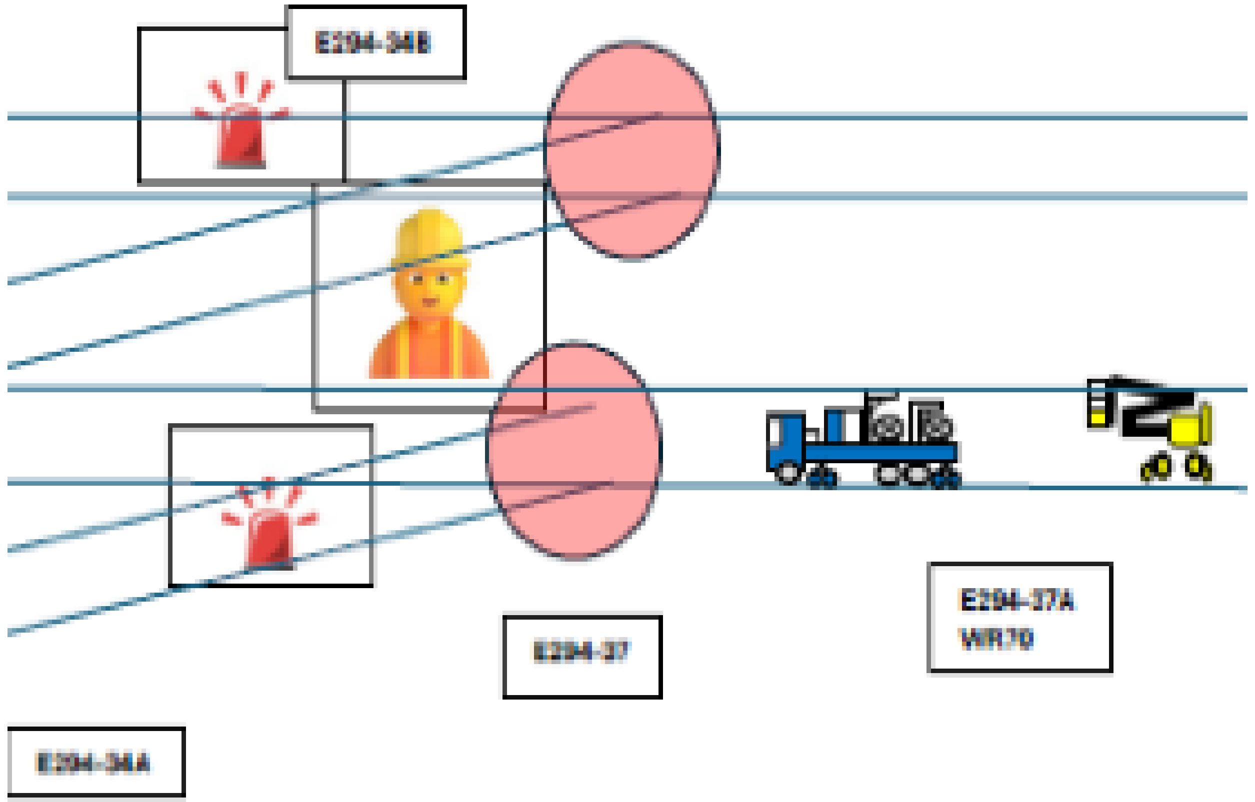
- Considerations:
  - Wire gradient rather than hog
  - Cross dropper positioning and tolerance
  - Dropper installation accuracy and tolerance
  - Increased survey data

STRUCTURE NUMBER:		ARM REACHING FROM LEFT OR RIGHT OF CW	CANT (mm)		STAGGER / OFFSET (mm)		CW HEIGHT (mm)	CW HEIGHT (mm)	Distance from low chainage registration (m)	COMMENTS	Contact wire height tollerance to be achieved at dropper			
			L	R	L	R								
STR	E/294/28A					230	4400		N/A		-			
d1							4400		5.30		±25mm			
d2							4366		15.90		±25mm			
d3							4357		26.50		±25mm			
d4							4374		37.10		±10mm			
d5							4420		47.70		±10mm			
STR	E/294/31A				50		4420		N/A	Diamond Crossover		Contact wire at this location must be a minimum of 20 and max 30mm higher than WR70		
d1							4420		6.17		±10mm			
d2							4373		18.50		±10mm			
d3							4400		30.83		±25mm			

71 CAT.
M, 29M
(9.0484) 294.3236
(WR70 CAT. TO WR69 CON.)

Construction Works - Challenges

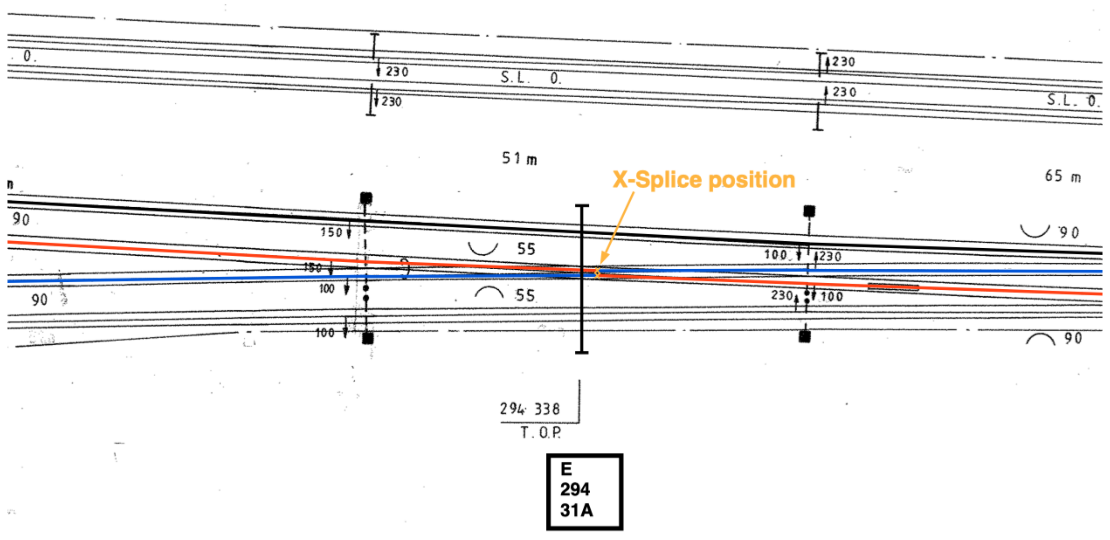
- Critical junction on ECML with potential for huge disruption.
- Complex staging and reconfiguration of junction wiring.
- Limited access
- Small footprint with risks to manage

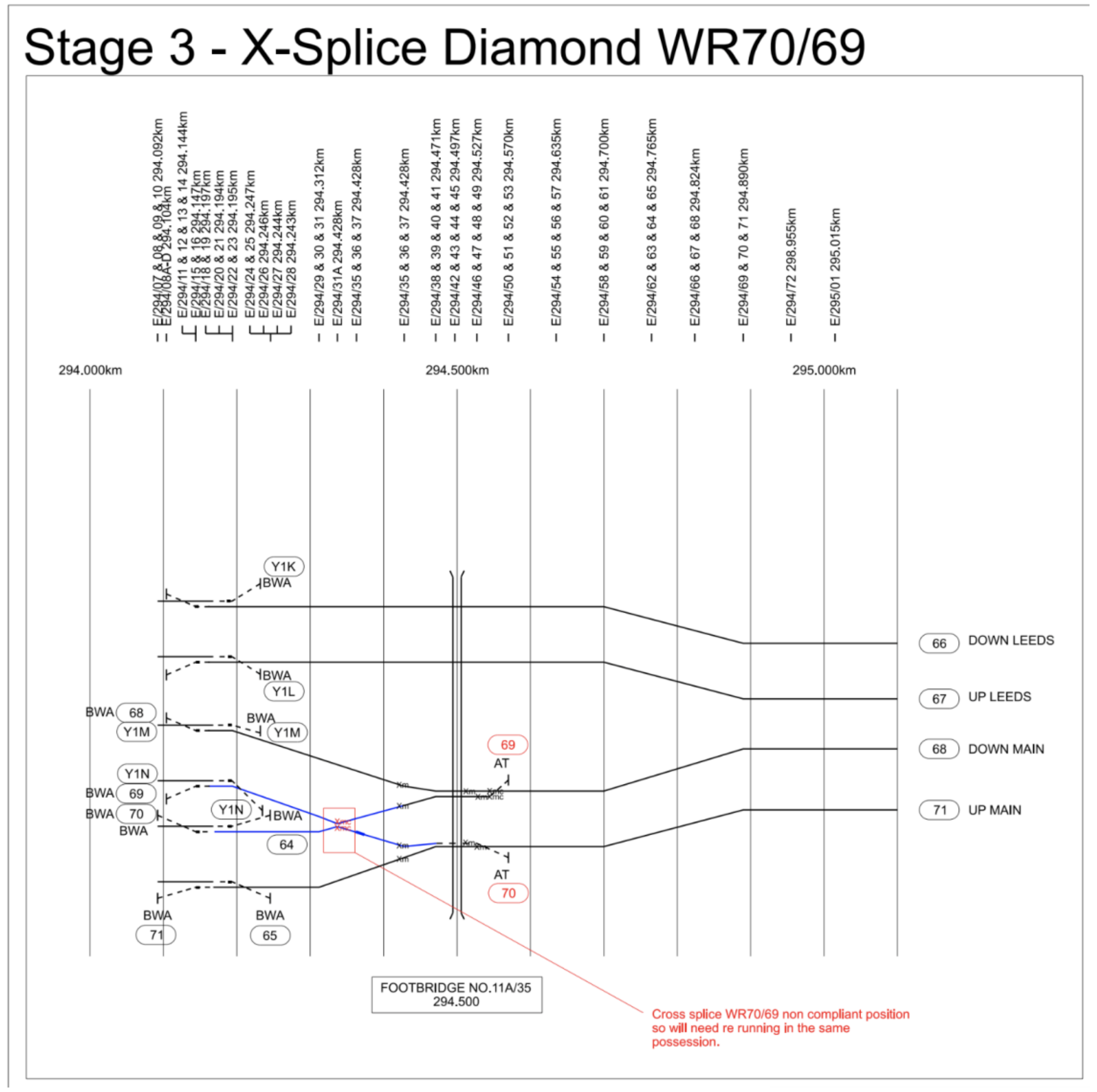


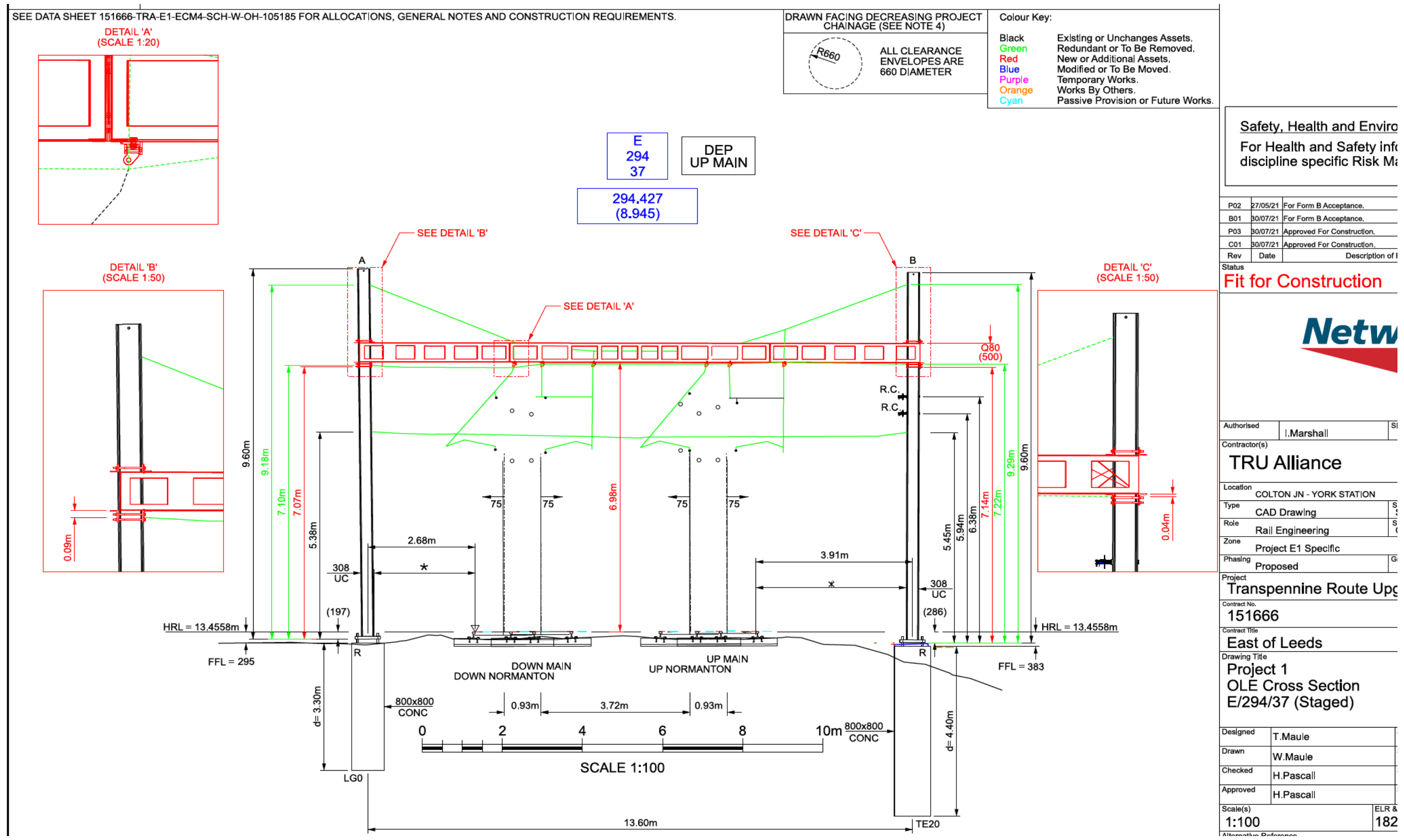
Construction Works – Finding a solution

Finding a solution

- Collaboration between (Design, Construction, PE's)
- Workshops to understand scope and access constraints
- Challenged scope
- Stage design for wiring
- Stage headspan conversion
- Designs updated to 'As Built' between disruptive possessions.



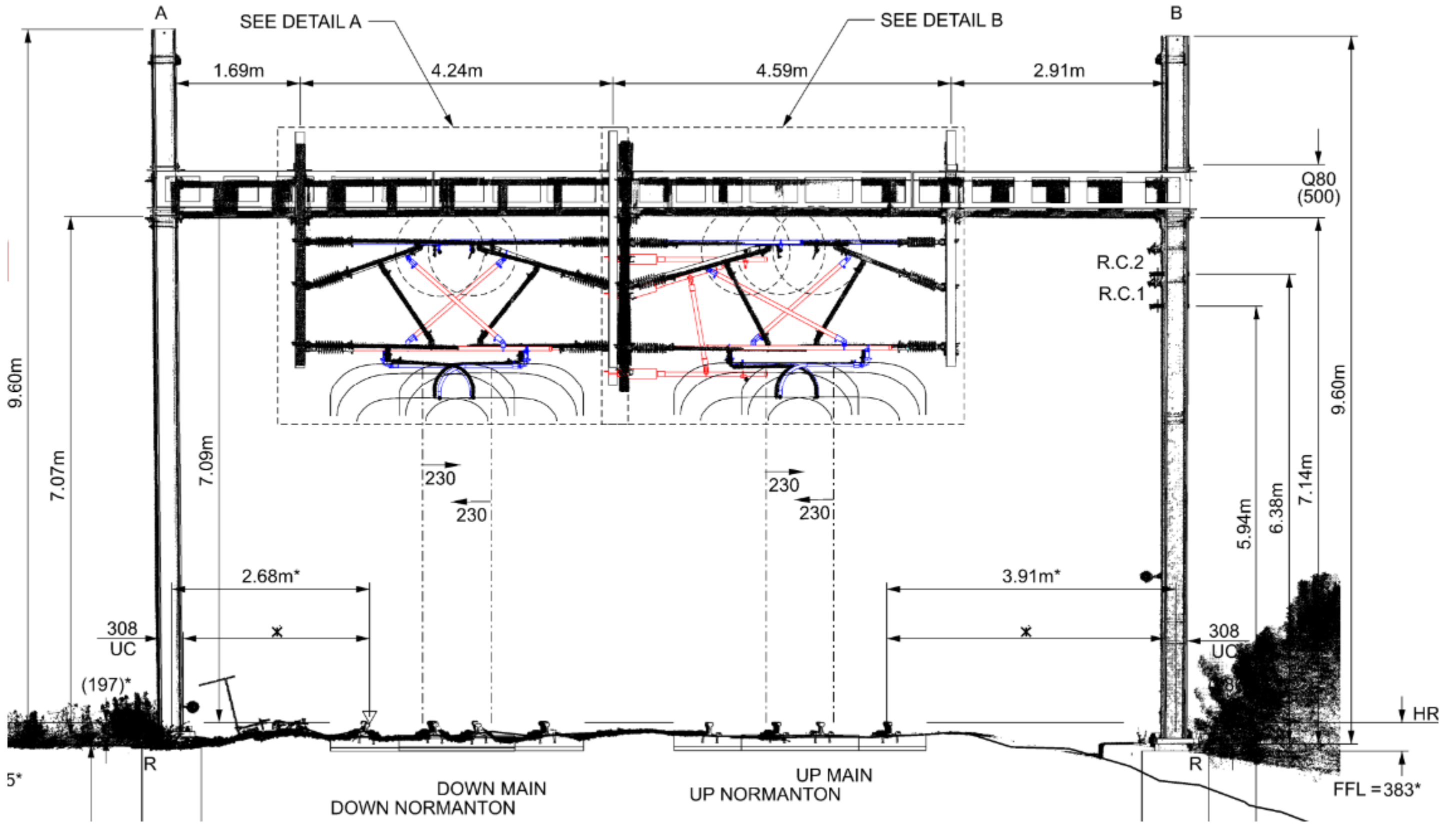




Construction Works – Delivery of works

<u>Xmas 2022</u>
Cancelled – Due to High contact forces requiring further design

<u>ROTR 2023</u>
- Portal installation
- TTC installation
- Headspan conversion
- Drop tube installations



<u>Week 35 2023 – 54 Hour Block</u>
- Lowering of all wire runs across the junction.
    - Headspan lowering
    - Lowering existing cantilever heights
- Adjust existing switch feeds
- X-Splice WR68/70
- Re-droppering
- X dropper installation
- New structure SPS installation
- Tangential wiring of two Turnouts completed
- Panning & Assurance of all wire runs

<u>Week 39 2023 - 54 Hour Block</u>
Cancelled – Project decision due to Predicted High Winds

Construction Works – Delivery of works

<u>ROTR 2024/25</u>
- Copper catenaries from O/Lap insulation to BWA – Normanton Lines
- Switch feeder support alterations – Normanton Lines
- Cantilever replacements and stagger changes Normanton Lines
- Adjust / replace drop tubes based on point cloud design check
- Dry fit and register all cantilevers at new structure locations and then remove and store
- Close any current referrals (snags)
- Install new RC SPS
- Install Fixed anchor SPS
- Install Anti fall BWA, lift weights.

<u>Week 52 2025</u>
- SPS & Wiring Equipment Installation on new OLE Structures
- Transferal of Equipment from Redundant Structures to new OLE Structures
- Recover redundant Headspan material
- Cross-Splice Diamond X-Over WR69/70 to create Tangential running X-Over
- Form New Overlap WR70/71A
- Removal of Old Section Insulator
- Replacement of the contact and catenary wires in the Tangential running across Colton Junction.
- Replacement of AWAC Catenary for Wire Runs 68, 69, 70 & 71 with Cu BzII Catenary.
- Installation of all Along Track equipment (O/Lap Insulation, X-Droppers etc.)
- Panning, Registration & Assurance Works

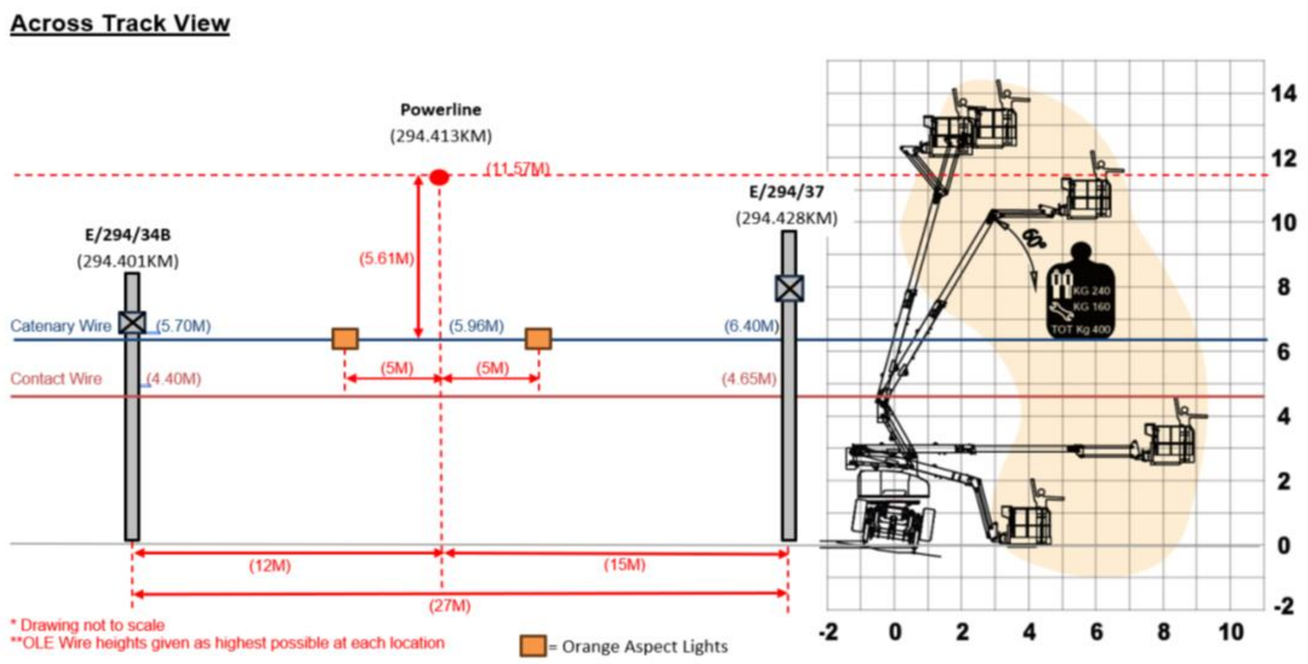
Colton Junction – Construction Planning

<u>Construction Planning</u>

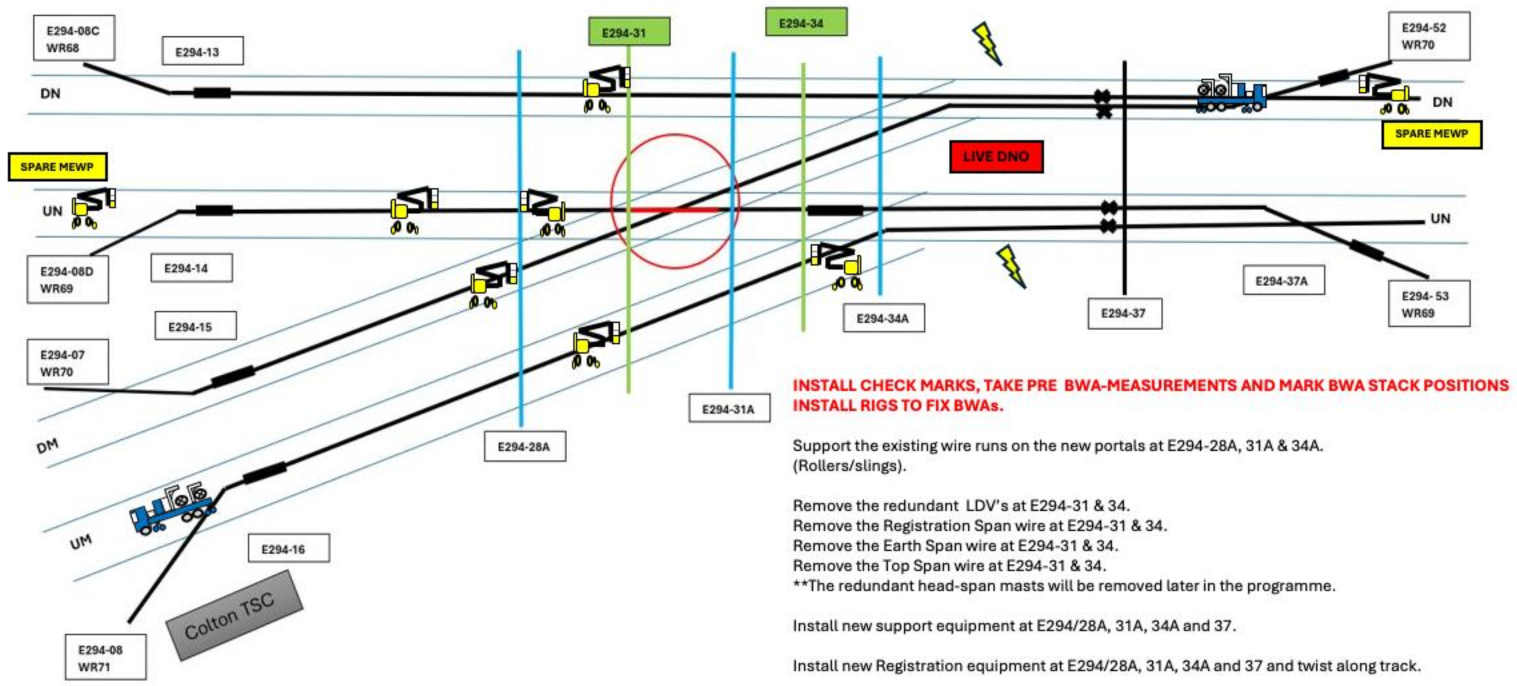
- Detailed Hr by Hr programme
- Weekly planning / progress meeting for Colton works only
- Presentation prepared for site staff
- Supervisor site walkthrough
- Townhall briefing for all staff

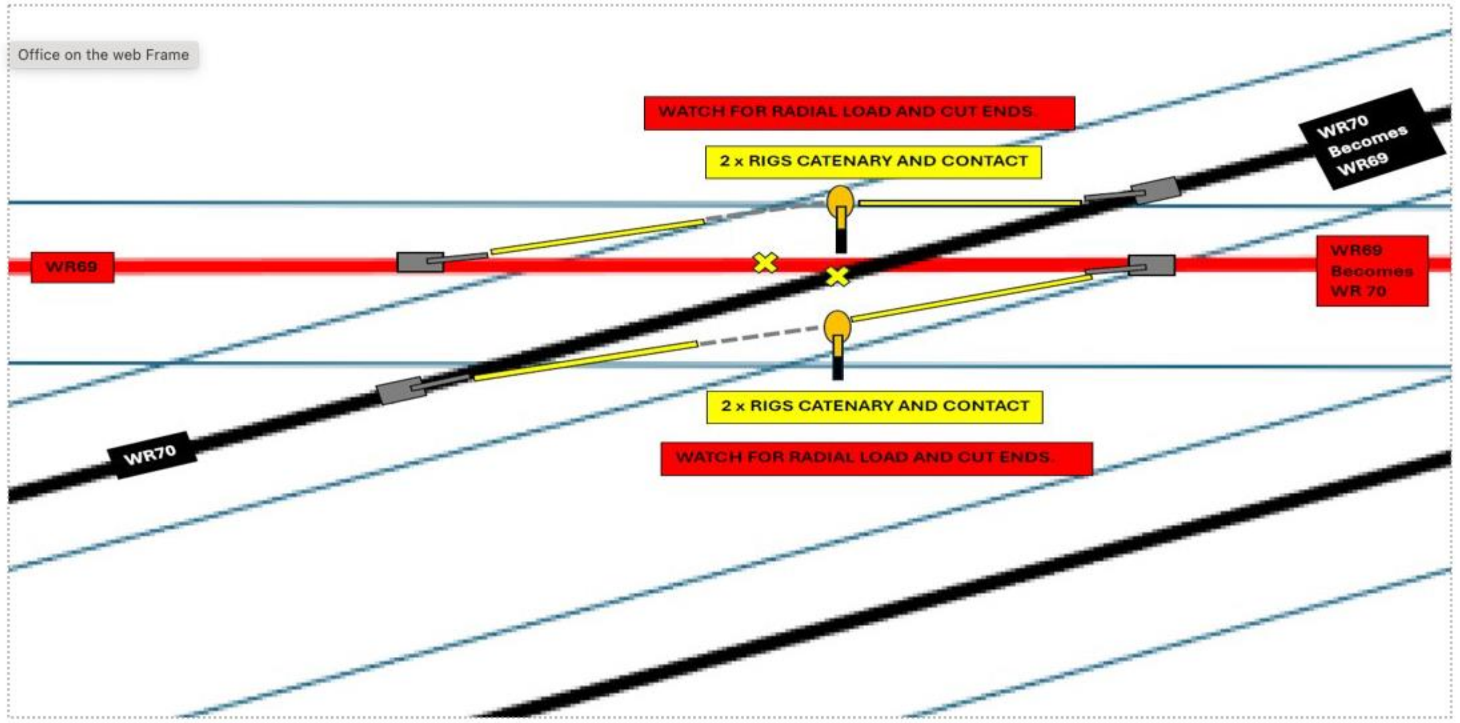
LIVE DNO Risk Assessment.

151666-TRA-00-CPN-W-CS-000010-P12



Head-span removal – New SPS





Colton Junction – Assurance

- On site control room.
- Right level of assurance
- Progressive assurance
  - Site design & PE support
- AMP 16 walkout
- Form E's pre-prepared and agreed

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Wire Run WR 70 D.M

TRANSPENNINE ROUTE UPGRADE ON TRACK TO BETTER

Reference:	151666-TRA-E1-000-CAL-W-OH-104194
Version:	B02
Date:	09/08/2024

151666 TRUe Project E1 **HEIGHT & STAGGER RECORD SHEET** **Copper Catenary**

IS HEIGHT AND STAGGER GAUGE CALIBRATED?	Yes
Checked & Approved by : OLE CRE	Signed : Date:

	(X) Pre-Height and Stagger
	(X) Post-Height and Stagger

CANT	High rail to be indicated as follows: Left Rail High (L) Right Rail High (R)
STAGGER	Stagger direction to be shown in left and right columns & Negative stagger shown as (-)

SURVEY COMPANY:	AREA SURVEYED:	TRACK:	OLE EQUIP TYPE:	DEGREES CELSIUS:	DATE:		Readings taken by:
TRU East Alliance		**DM**	**MK3B**	**Various - See Below**	**Various - See Below**		**Various - See Below**
DIRECTION OF SURVEY:	WIRE RUN NUMBER/S:	TYPE OF H&S GAUGE		H&S GAUGE NO:	SHEET NO:		Readings Recorded by:
Facing Increasing Chainage	**70**	**Abtus**		**Various - See Below**			**Various - See Below**

Design Value

Surveyed

STRUCTURE NUMBER:		ARM REACHING FROM LEFT OR RIGHT OF CW	CANT (mm) L	CANT (mm) R	STAGGER / OFFSET (mm) L	STAGGER / OFFSET (mm) R	CW HEIGHT (mm)	CW HEIGHT (mm)	Distance from low chainage registration (m)	COMMENTS	Contact wire height tollerance to be achieved at dropper			
STR	E/294/28A				230		4400		N/A		-			
d1							4400		5.50		±25mm			
d2							4360		16.50		±25mm			
d3							4345		27.50		±25mm			
d4							4360		38.50		±10mm			
d5							4400		49.50		±10mm			
STR	E/294/31A					50	4400		N/A	Diamond Crossover	±10mm	Set wire run 70 contact wire height prior to setting wire run 69 contact height.		
d1							4400		6.17		±10mm			
d2							4363		18.50		±10mm			
d3							4400		30.83		±25mm			
STR	E/294/34A				230		4400		N/A	Dropper QCS can be deferred to de-risk an overrun if required.	-			
d1							4400		5.50	Dropper QCS can be deferred to de-risk an overrun if required.	±25mm			
d2							4400		15.05	Dropper QCS can be deferred to de-risk an overrun if required.	±25mm			
d3							4400		24.60	Dropper QCS can be deferred to de-risk an overrun if required.	±25mm			
STR	E/294/34B				290		4400		N/A	Dropper QCS can be deferred to de-risk an overrun if required.	-			
d1							4525		36.75	Dropper QCS can be deferred to de-risk an overrun if required.	±25mm			
d2							4650		48.90	Dropper QCS can be deferred to de-risk an overrun if required. Overlap Insulation	N/A			
STR	E/294/37				230		4650		N/A	UN/UM Turnout				

TRANSPENNINE ROUTE UPGRADE EAST

Create new... +

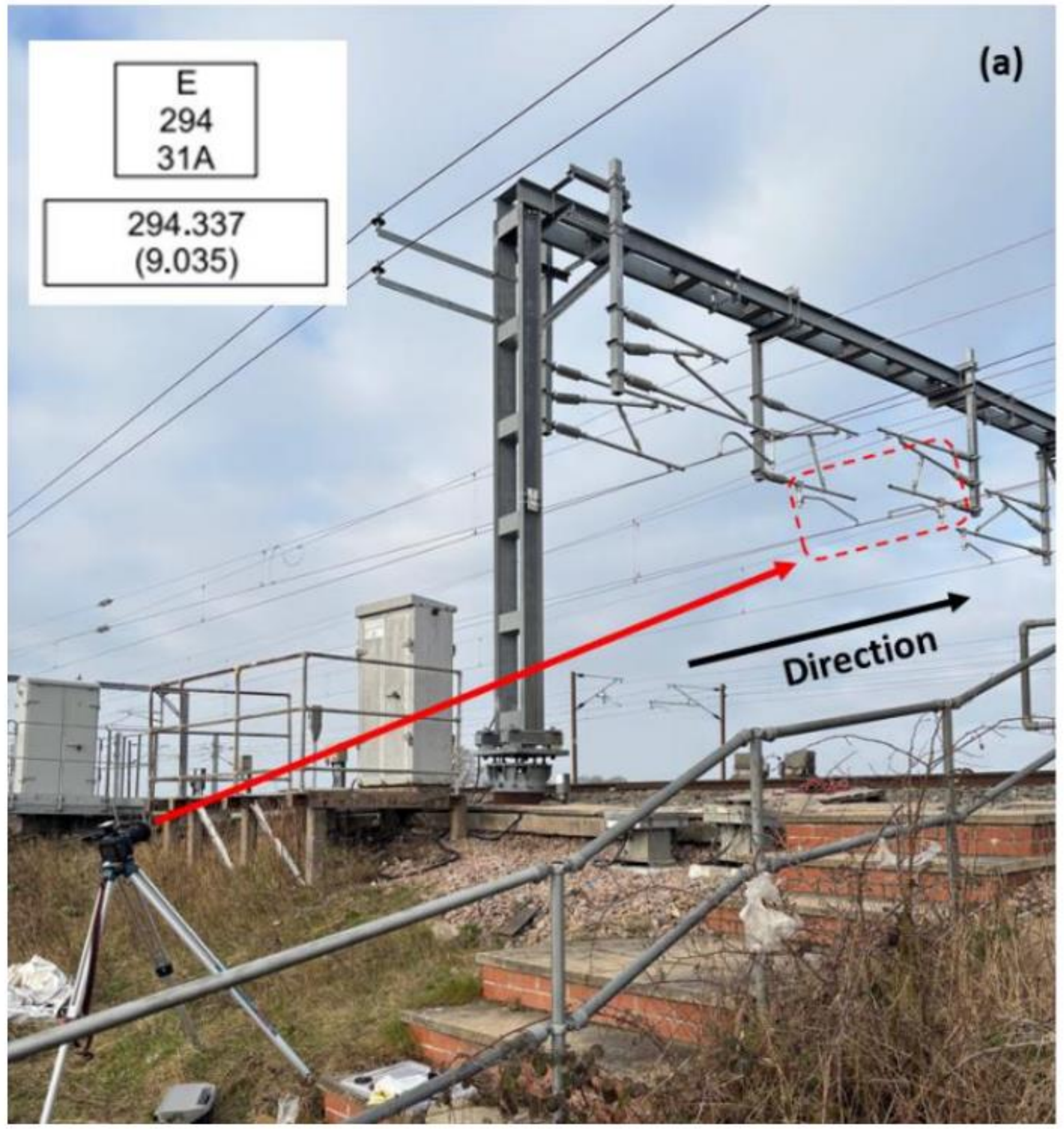
- dashboard
- Holbeck Depot
- East of Leeds E1
  - OLE Construction
    - all activities (329)
    - Foundation I... (329)
    - Foundation B... (329)
    - Transfer/Ada... (329)
    - Steel Installat... (329)
    - Earth Wire S... (329)
    - Catenary/Co... (329)
    - Tensorex Uni... (329)
    - Earth Wire In... (329)
    - Cantilever Fa... (329)
    - Catenary/Co... (329)
    - Catenary/Co... (329)
    - OBR Bonding (329)
    - Datum Plate I... (329)
    - Section Insul... (329)
    - Switching Ins... (329)
    - Neutral Secti... (329)
    - Panning (329)
  - OLE Modification E1
  - QA Referrals

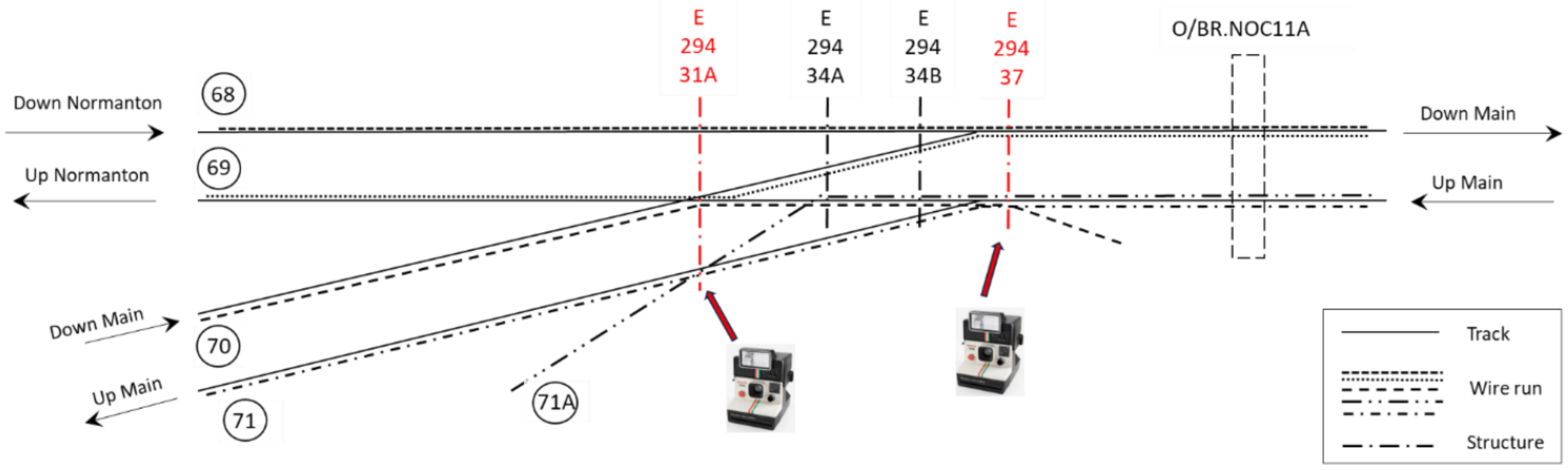
Panning Checklist

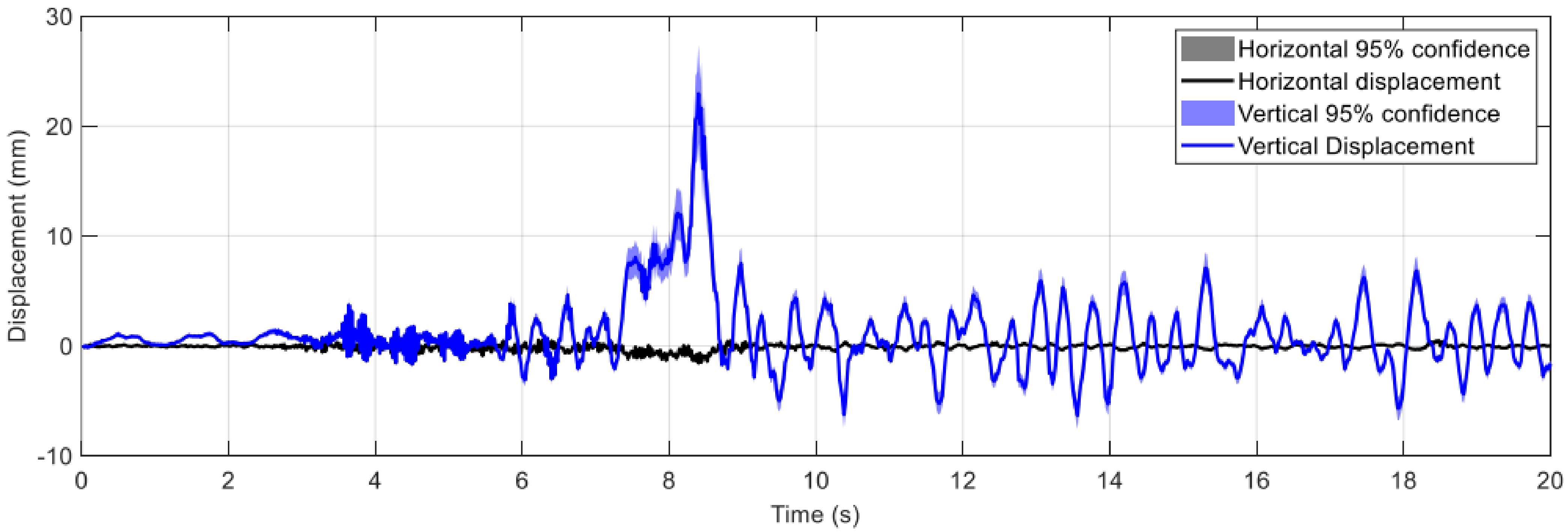
Code	Checklist	Design value	Response	"Engineer"	Date	Comments
A1.3.1	Pantograph run direction?	Continue to repeat pan runs until a full satisfactory pan has been completed	In both directions	David Leaming	23/03/2025 23:47:45 PM	enter Comments
A1.3.2	Observe the interface between the pantograph and items sitting below the contact wire such as incorrect fitted dropper clips, clamps or reg. arms ?	From E/294/31A to E/294/41	Pass	David Leaming	23/03/2025 23:47:45 PM	enter Comments
A1.3.3	Observe the interface between the pantograph and excessive staggers or wires running on pantograph horn ?	From E/294/31A to E/294/41	Pass	David Leaming	23/03/2025 23:47:45 PM	enter Comments
A1.3.4	Observe the interface between the pantograph and the registration arm types for correct permissible stagger ?	From E/294/31A to E/294/41	Pass	David Leaming	23/03/2025 23:47:45 PM	enter Comments
A1.3.5	Observe the free movement and natural return to static position of the registration arm after uplift ?	From E/294/31A to E/294/41	Pass	David Leaming	23/03/2025 23:47:45 PM	enter Comments
A1.3.6	Check contact wire for kinks and twists?	From E/294/31A to E/294/41	Pass	David Leaming	23/03/2025 23:47:45 PM	enter Comments
A1.3.7	"Are all structures and associated equipment clear of pantograph? See attached Generic Pantograph Gauge (sway allowance =200mm for tangent track and 230mm for curved track)"	> 200 mm / > 125 mm for bridges & tunnels - for maximum uplift	Pass	David Leaming	23/03/2025 23:47:45 PM	enter Comments
A1.3.8	All components fitted correctly and securely including jumpers, clamps, dropper clips, splices, insulations and	N/A	Pass	David Leaming	23/03/2025 23:47:45 PM	enter Comments

Colton Junction – Post Commissioning Monitoring

- Following the Wk52 Tangential Wiring Works a TSR of 90mph was implemented on the Dn Leeds Line for 1 week
- At possession hand back EMU services through the junction were monitored using Digital Image Correlation to determine the level of contact wire vertical displacement (uplift).
- Measured uplift was compared with simulated values from the UoH modelling which was within 5mm of predicted – TSR lifted and 125mph running implemented



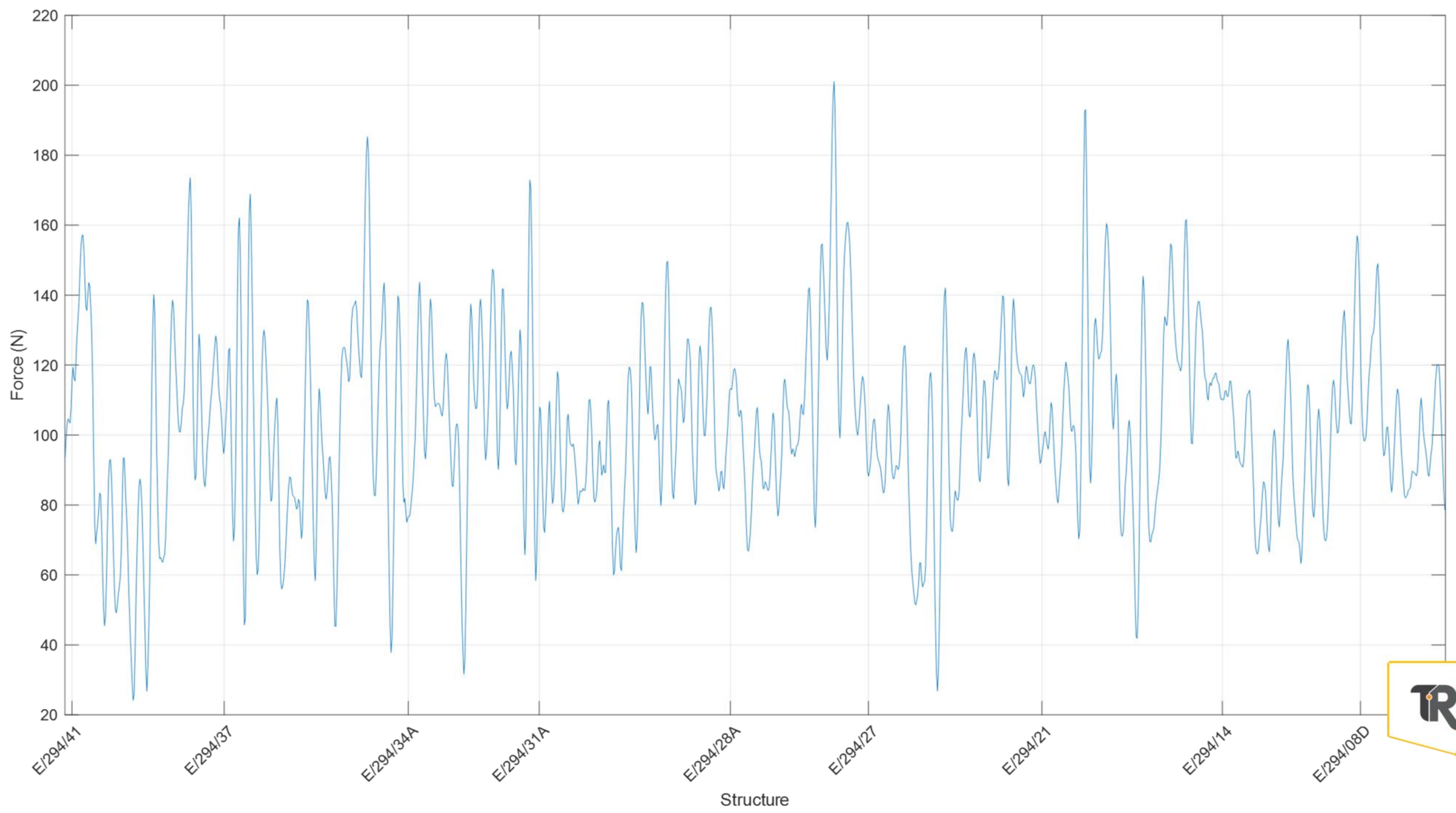




Colton Junction – Test Train Dynamic Assurance

- WK02 – Class 91 EMU with 2No. Class 43 DMUs & 3No. Mk 3 Coaches ran through the Junction at 125mph with an instrumented HS-X Pantograph

- Measured contact forces through the junction showed **F_{max} 201N**, predicted max through modelling was **189N**



F_{max} = 201N
F_{min} = 24N
F_{mean} = 103N
σ = 26N
Speed = 125 mph

MVP Examples on TRU East

- 72m Span Lengths were utilised – TRU E1 is mainly straight track
- Lateral Pile Testing to reduce pile lengths in high rock areas using ‘rock sockets’
- Use of foundation load cases to reduce design effort for OLE foundations reducing timescales from AiP to foundation installation to 4 months
- Review and analysis of 610mm pile steel boss and studs to allow an increase over the historical 181kNm limit – removing the need for pile caps & transfer plates.
- Use the application of NR/L2/ELP/27716 (VCCs) at Bridges – Business as Usual
- Regulation 14 in draft against ENE NTSN Clause 6.2.4.5, *“Assessment of dynamic behaviour and quality of current collect (integration into a subsystem)* Aim for no test trains or Assessment Body review of wire geometry

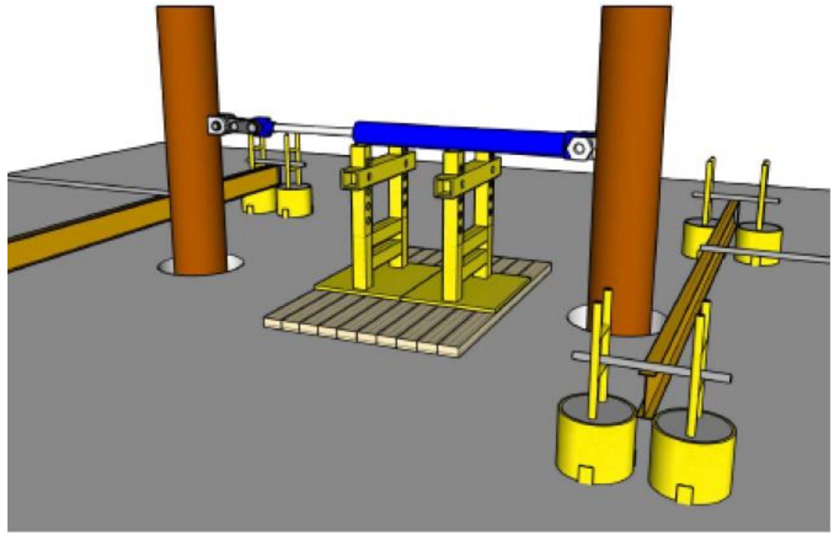


Figure 20: Huddlestone - Moment verses Displacement for TP1 (3 metre pile embedment)-

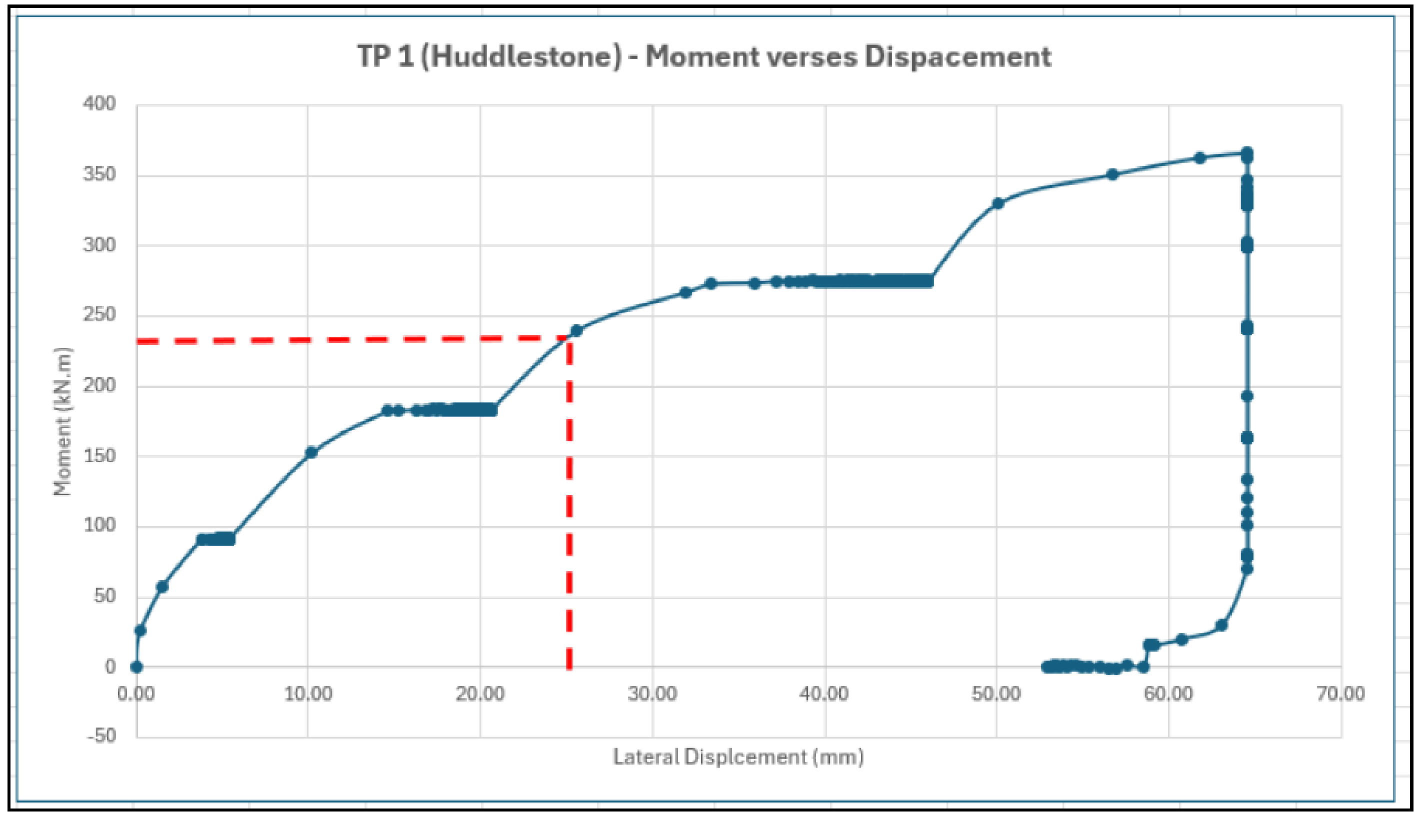
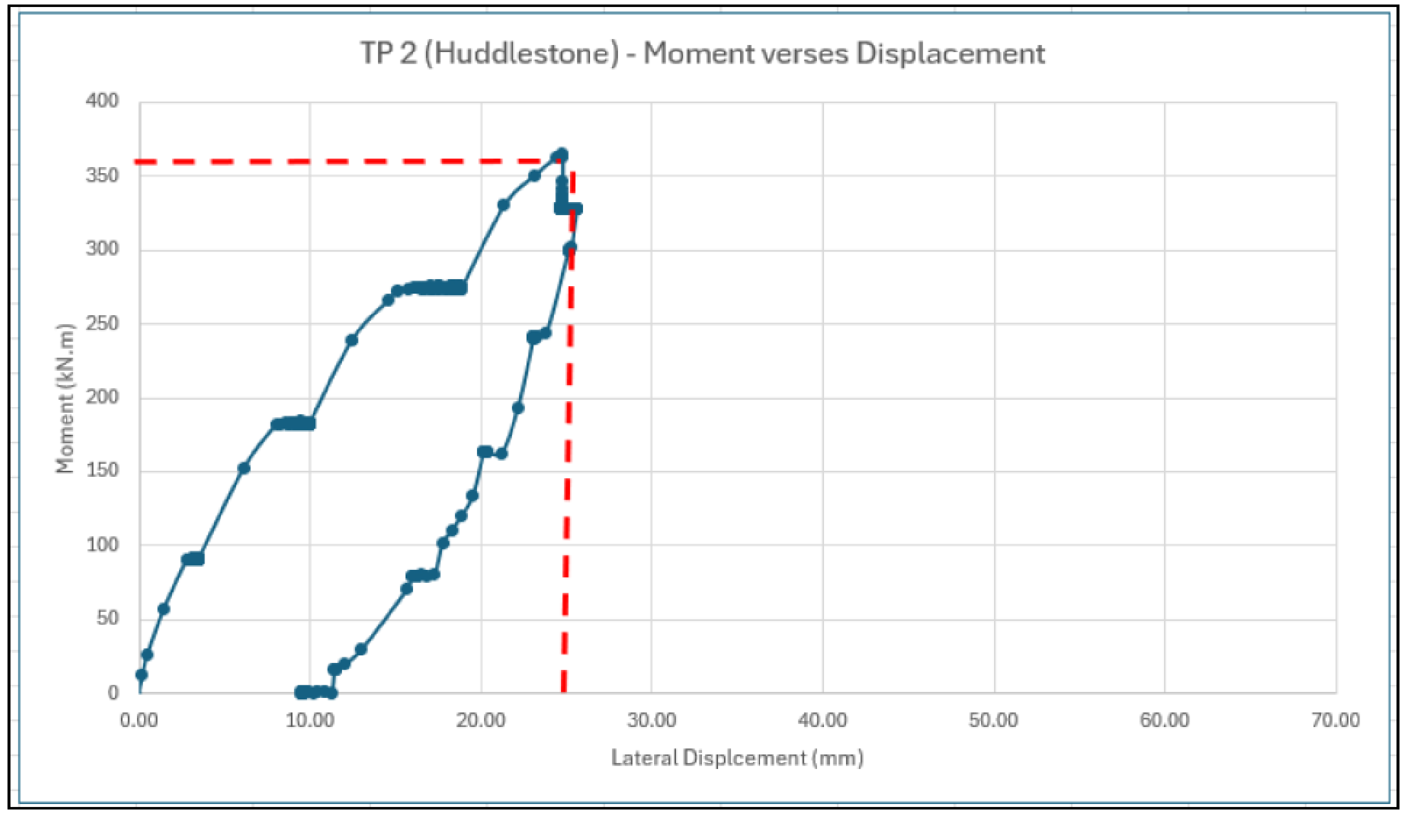


Figure 21: Huddlestone - Moment verses Displacement for TP2 (4 metre pile embedment)



Questions?