

THE UPGRADE OF HUGUENOT TUNNEL

Huguenot Tunnel Design Process

*Tiago Massingue*¹, and *Roger Dickson*²

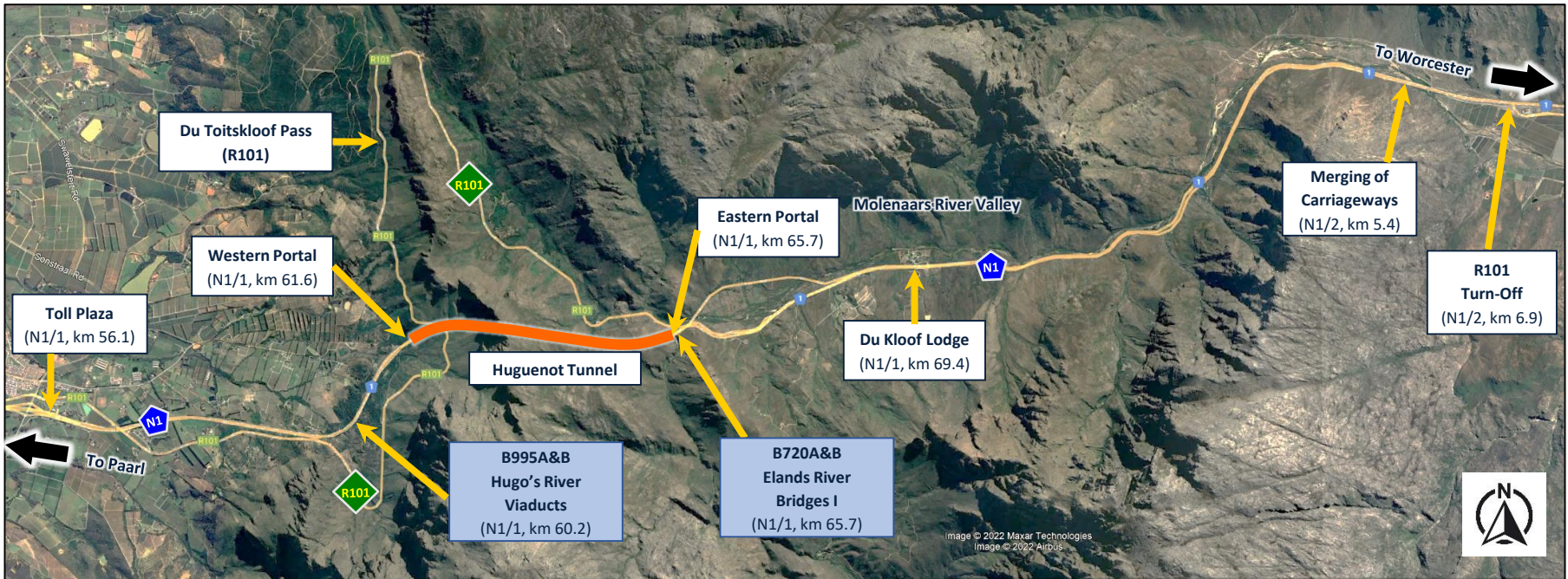
¹ The South African National Roads Agency SOC Ltd, Cape Town, South Africa, Project Engineer,
BEng Civil & Structural Engineering, MBA, PIARC T4.4 Tunnels

² SMEC (Pty) Ltd, Functional General Manager, Structures, BSc Civil Engineering, Professional Engineer

THE COMMISSIONING OF THE HUGUENOT TUNNEL NORTH BORE AND THE UPGRADING OF THE HUGUENOT TUNNEL SOUTH BORE ON NATIONAL ROUTE 1 SECTION 1 (KM 60.0) TO KM 66.0) WESTERN AND EASTERN PORTALS



Huguenot Tunnel



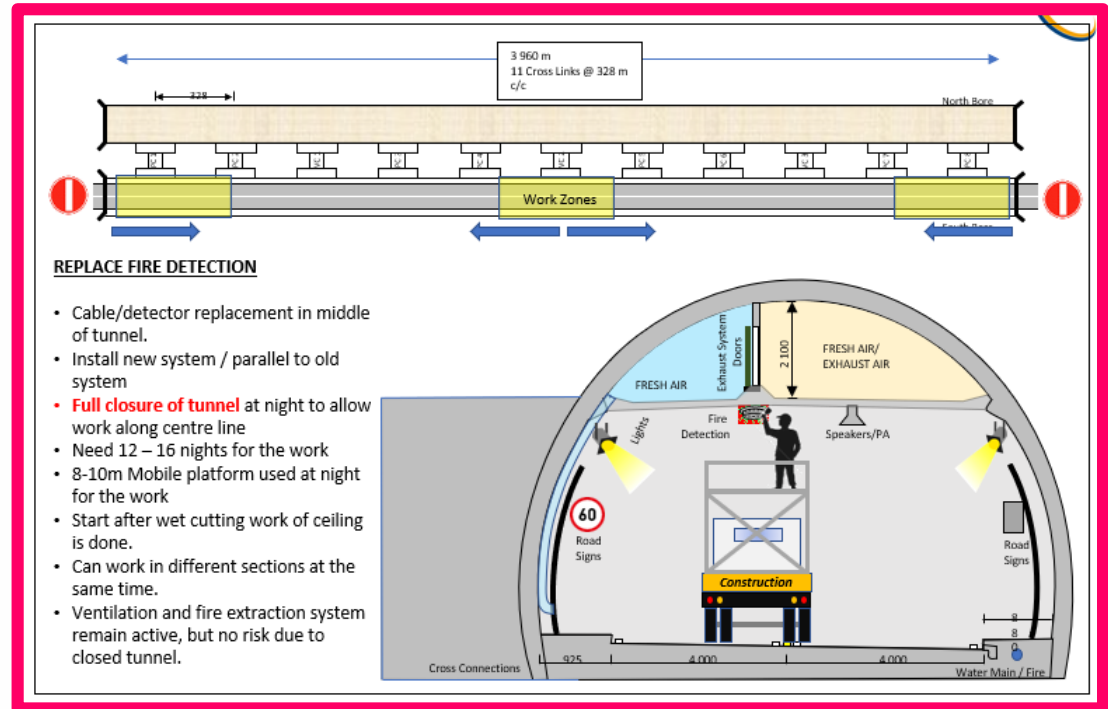
THE HUGUENOT TUNNEL SOUTH BORE

- Tunnel opened in March 1988
- Bi-directional tunnel
- 34 years of use,
- More than 110 million vehicles,
- Light Vehicles : 90.2 million,
- Heavy Vehicles: 18.8 million,
- Traffic growth rate: 3% annual
- 18% percentage of heavies
- North bore excavated,



Maintenance concluded works/South Bore

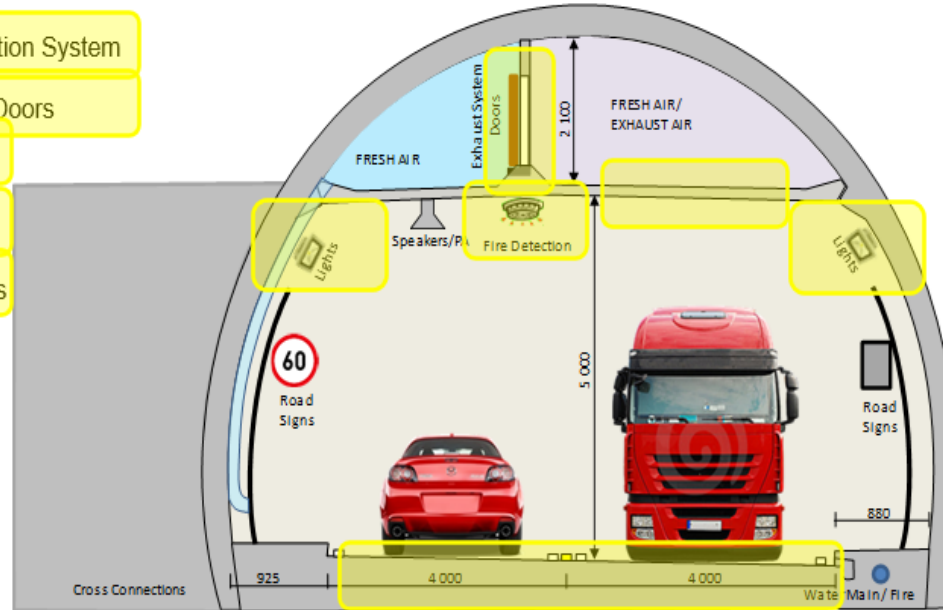
1. 11Kv line replacement between Tunnel and MCC
2. Installation of back-up generators at MCC and Portal Buildings
3. North-bore watermain replacement
4. South-bore watermain replacement
5. MCC watermain replacement
6. MCC Building redecoration and upgrade of ablution facilities
7. Replacement of VMS signs on the approaches and in the tunnel
8. Replacement of electronic signage in tunnel
9. Replacement of MCC fire detention and suppression systems
10. Replacement of tunnel fire detention systems
11. Installation of Tetra Emergency radio systems in tunnel
12. Replacement of Tunnel FM radio re-broadcasting System
13. Upgrade of Tunnel PA systems
14. 6.6 /11 KV Switchgear upgrade /replacement



Maintenance concluded works/South Bore

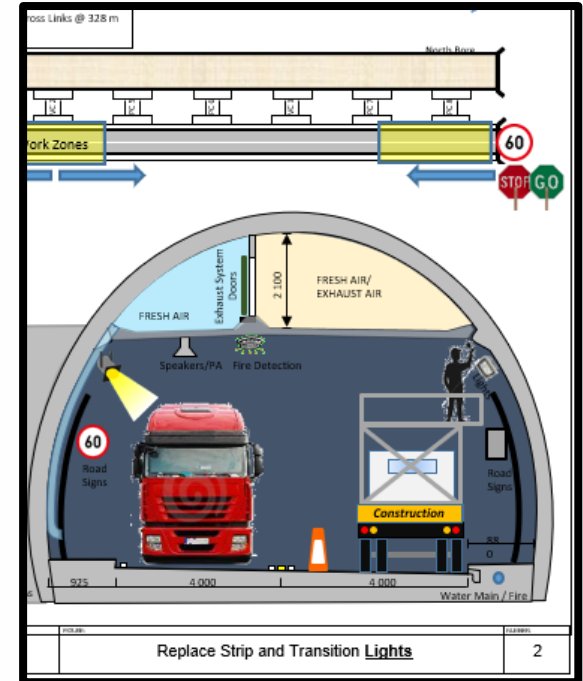
SYSTEMS IMPROVEMENT IMPACTING TUNNEL OPERATIONS

- Ventilation System: New Point Extraction System
- Ventilation System: Exhaust Bypass Doors
- Tunnel Lights
- Fire Detection System
- Resurfacing of pavement at entrances



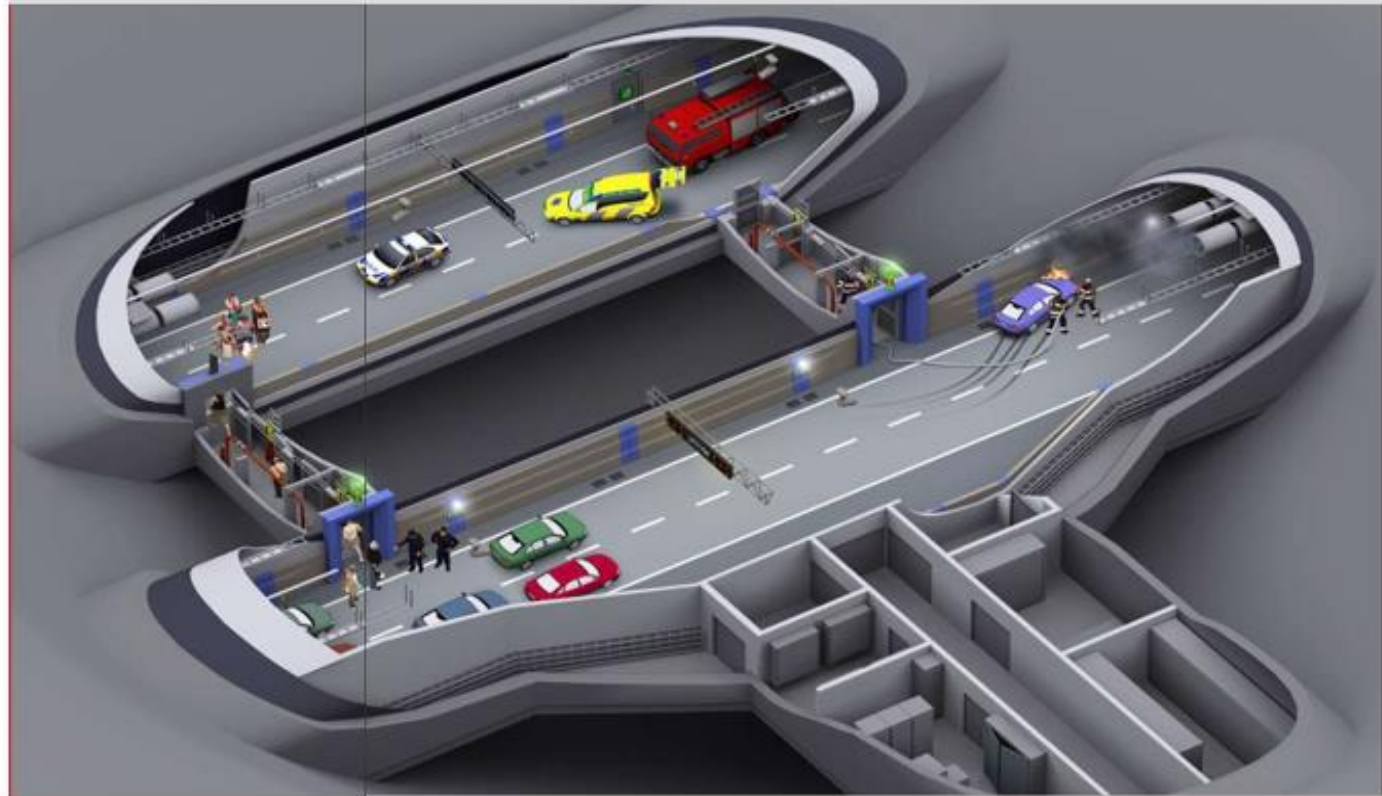
15. Replacement of CO/Visibility monitoring instrumentation
16. Toll Cash Vacuum Transport System
17. Lighting of N1: Toll Plaza to Viaduct
18. Tunnel Network Upgrades
19. Tunnel Ventilation System: Overhaul of spare universal fan
20. Toll lane AVC Fibre Optic Treadles
21. Toll collection system server upgrades
22. Additional CCTV at MCC area

Night Work



OVERALL OBJECTIVE

UPGRADE THE TUNNEL FROM ONE TO TWO OPERATIONAL BORES



OVERALL OBJECTIVE



MAJOR ASPECTS OF DESIGN

Concrete Lining,

Drainage Works,

Road Works

Electrical Systems,

Ventilation Systems

Fire Fighting Systems

Tunnel Water Pipeline System,

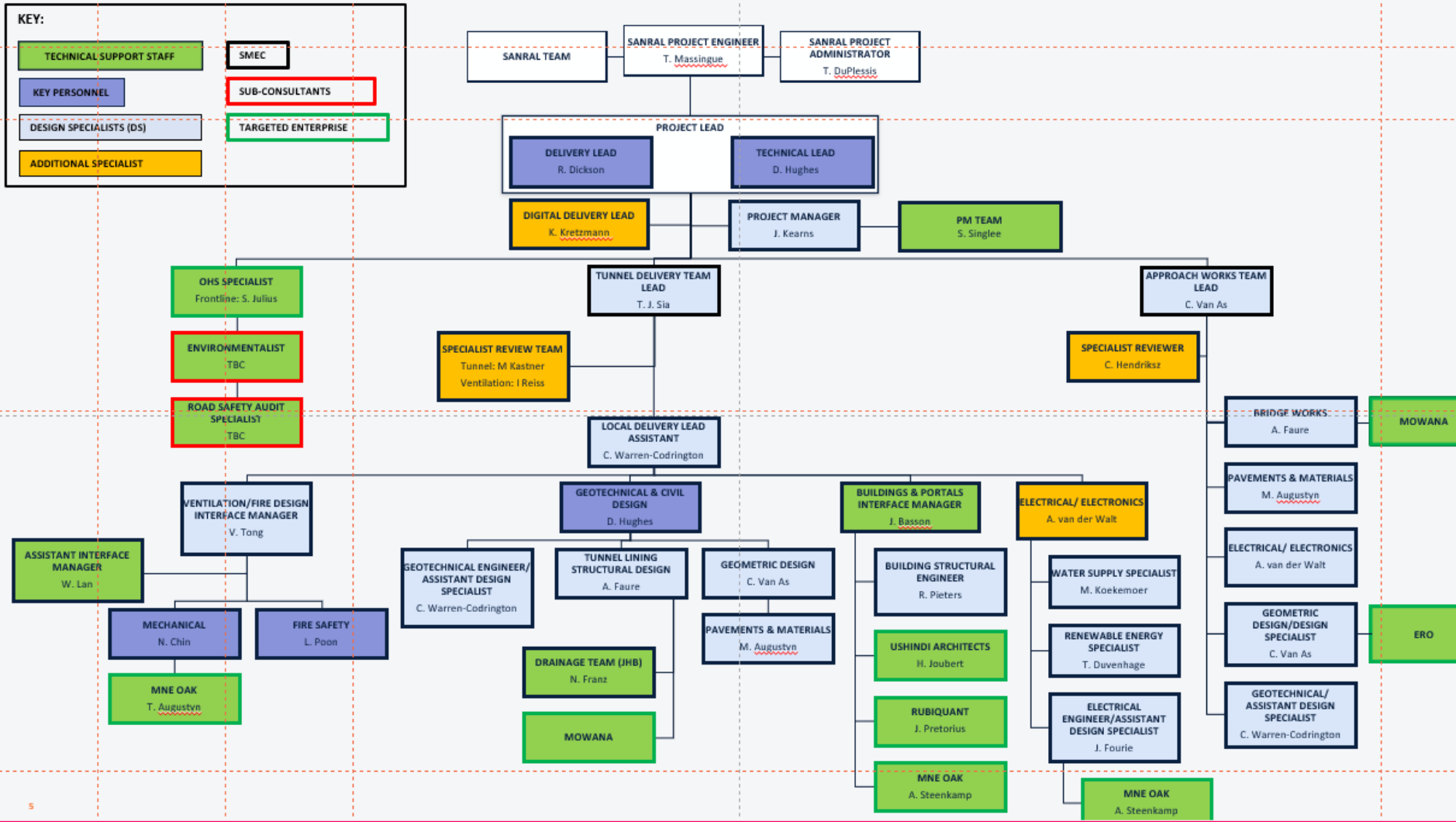
Traffic accommodation from the South Bore, (If feasible)

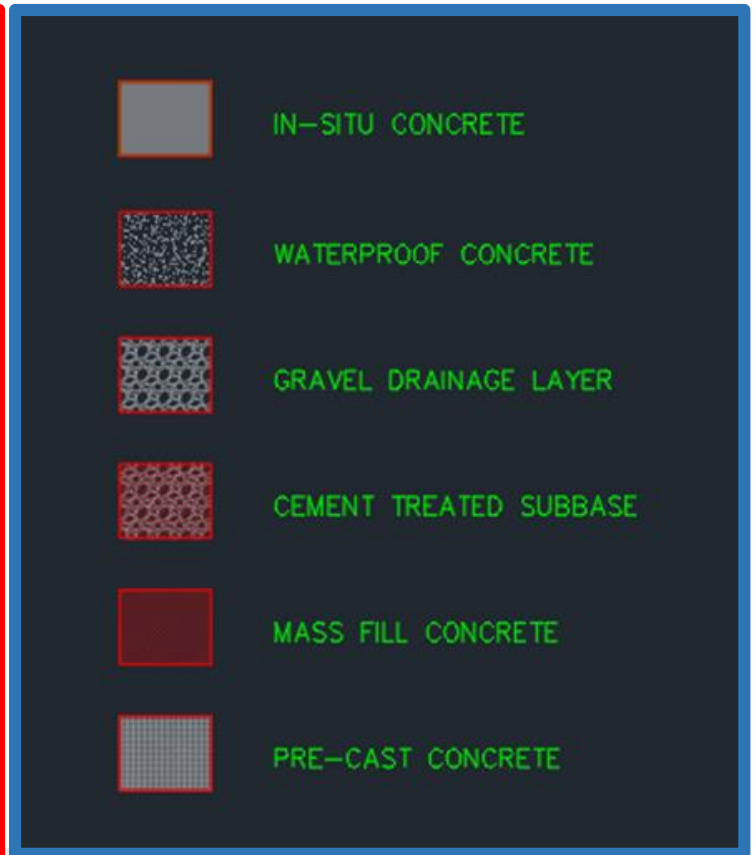
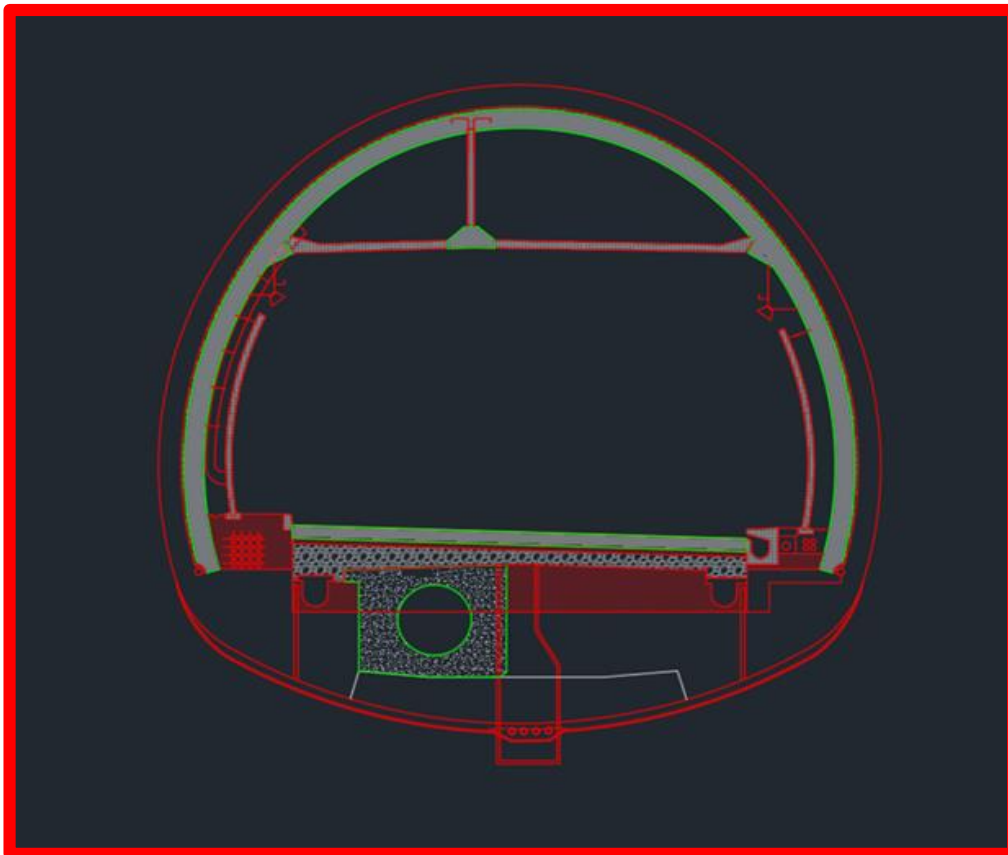
Provision and accommodation of services

Compliance with EU/2004/54/EC



Team Composition : =/- 45 experts





CONCRETE LINING

VENTILATION DESIGN

Concrete Lining,

Drainage Works,

Road Works

Electrical Systems,

Ventilation Systems

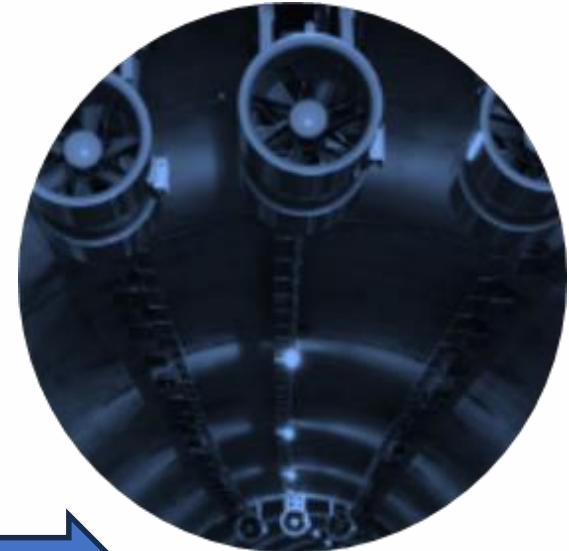
Fire Fighting Systems

Tunnel Water Pipeline System,

Traffic accommodation from the South Bore, (If feasible)

Provision and accommodation of services

Compliance with EU/2004/54/EC





IMPROVEMENTS FOR OPERATIONS CONTROL CENTER



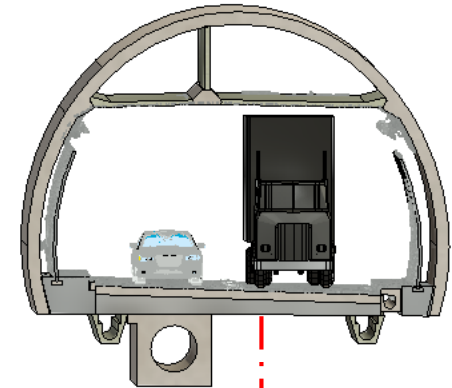
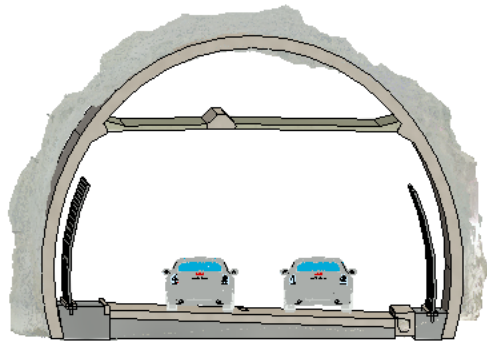
MOST IMPORTANTLY

Compliance with EU/2004/54/EC



Planned Tunnel Works

Dual Carriageway Now Required for N1 Tunnel and Approach Roads:



36 m offset betw. tunnel bores



Design Process

Identify key dependencies/ constraints:

1. North Bore as emergency route for South Bore required to remain;
2. South Bore tunnel is required to remain in operation/minimum of disruption;
3. North Bore already excavated for South Bore geometry and cross-section 36 m offset to north.
4. North Bore requirement: 2-lanes and vertical clearance per SANRAL requirements.
5. Design ventilation and smoke extraction systems for 100 MW fire load.
6. Assess and determine optimal ventilation configuration
7. Main ventilation configuration options evaluated, independent specialist review obtained;

Design Process

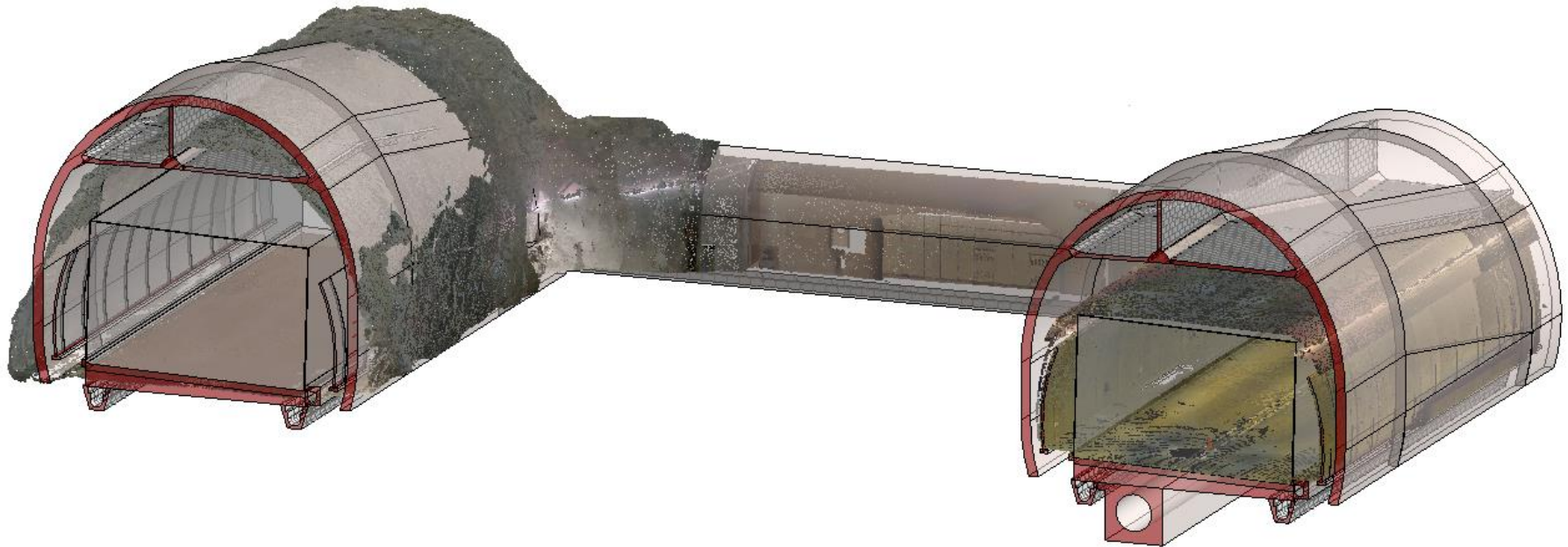
Identify key dependencies/ constraints:

8. Design intent established to equip North and South Bore with similar configuration;
9. Major electrical and electronic equipment designs proceed.
10. Geotechnical design evaluated to determine what constraints. A key consideration being soft ground zones (including fault zones).
11. Fire-fighting and fire suppression system informed water supply/pipework design layout.
12. Space-proving of tunnel geometry to accommodate all the above requirements/constraints.
13. Approach works design followed to enable bi-directional operation, and future dual carriageways.



Dual Tunnels with Ventilation Upgrade

Niches for jet fans incorporated



Key Design Element: Approach Roadworks

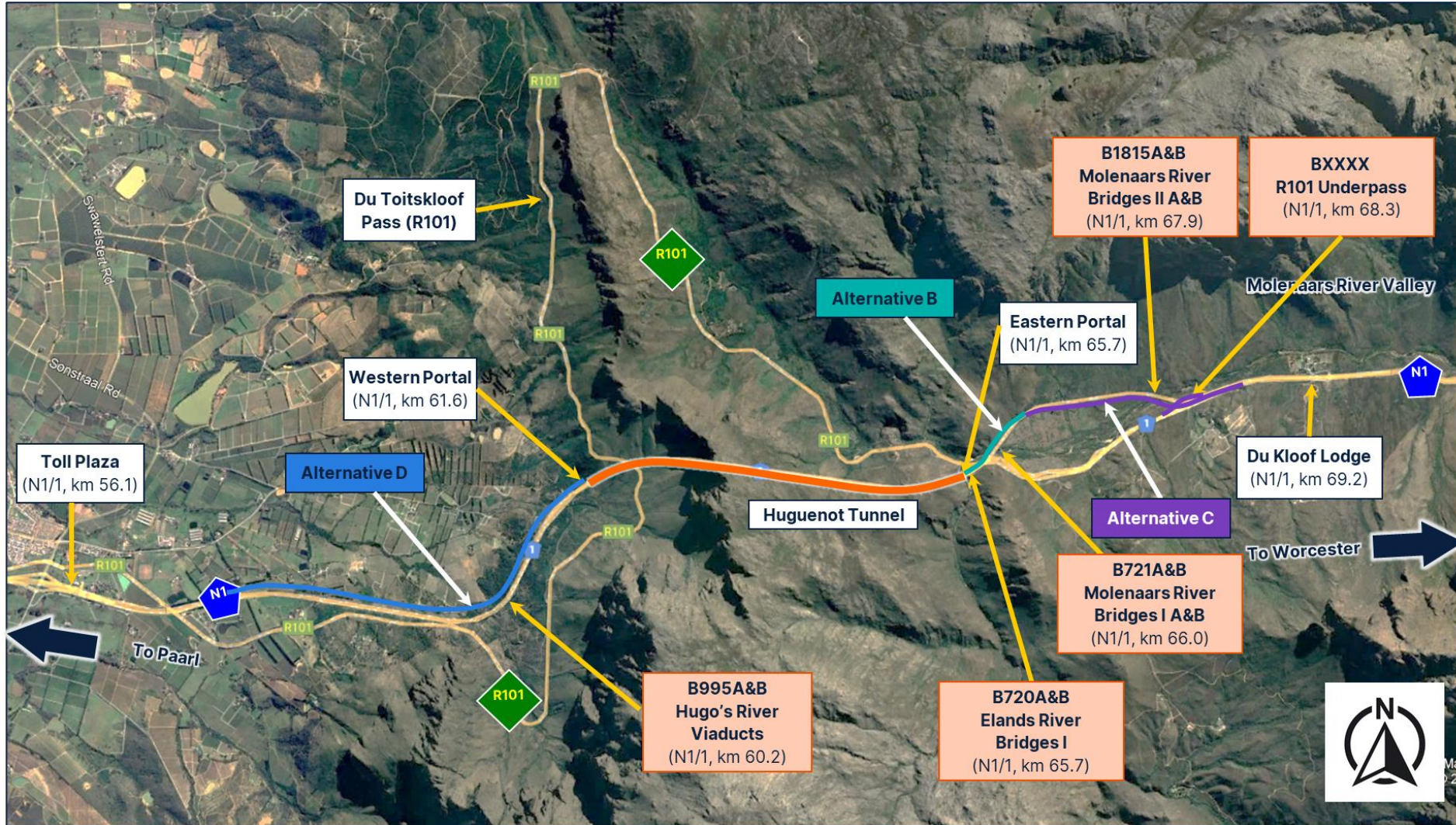
Roadworks Design Development Requirements:

1. Accommodate future dual carriageway approach roads
2. Must accommodate bi-directional traffic through tunnels during temporary tunnel closures during construction and maintenance.

Design development from constraints to solutions are outlined.



Road Alignment for Upgrade



Original Planned Tunnel Works

Planned works from the 1970's:

- Divided dual carriageways at both Western and Eastern approaches to the tunnel with at least two lanes per direction
- Two uni-directional tunnel bores (each having two traffic lanes)

Interim Scheme implemented in 1981 (adequate for at least 20 years):

- One bi-directional tunnel bore (South Bore), each one traffic lane per direction

Dual Carriageway Now Required for N1 Tunnel and Approach Roads:

- Required to improve capacity to accommodate increased traffic demand. Peak traffic volume exceeding limits of CD 352 and PIARC – 2019R02EN
- Required to maintain continuous dual carriageway to N1



Eastern Approach Ex. Layout



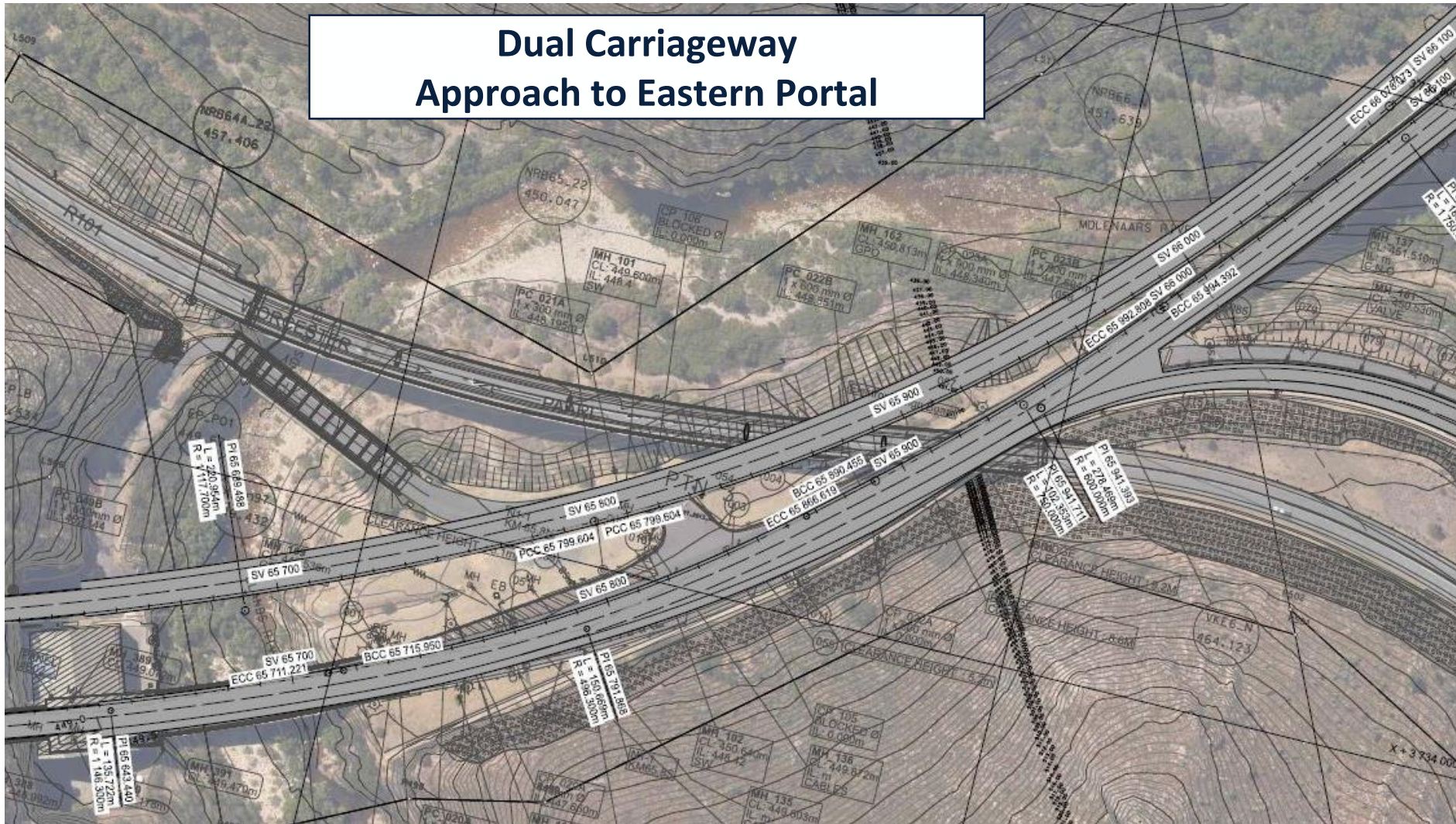
Eastern Approach Ex. Layout

- Existing single carriageway approach to South Bore Tunnel
- New carriageway to fit through existing bridge Piers 3 and 4



Eastern Approach Layout

Dual Carriageway Approach to Eastern Portal



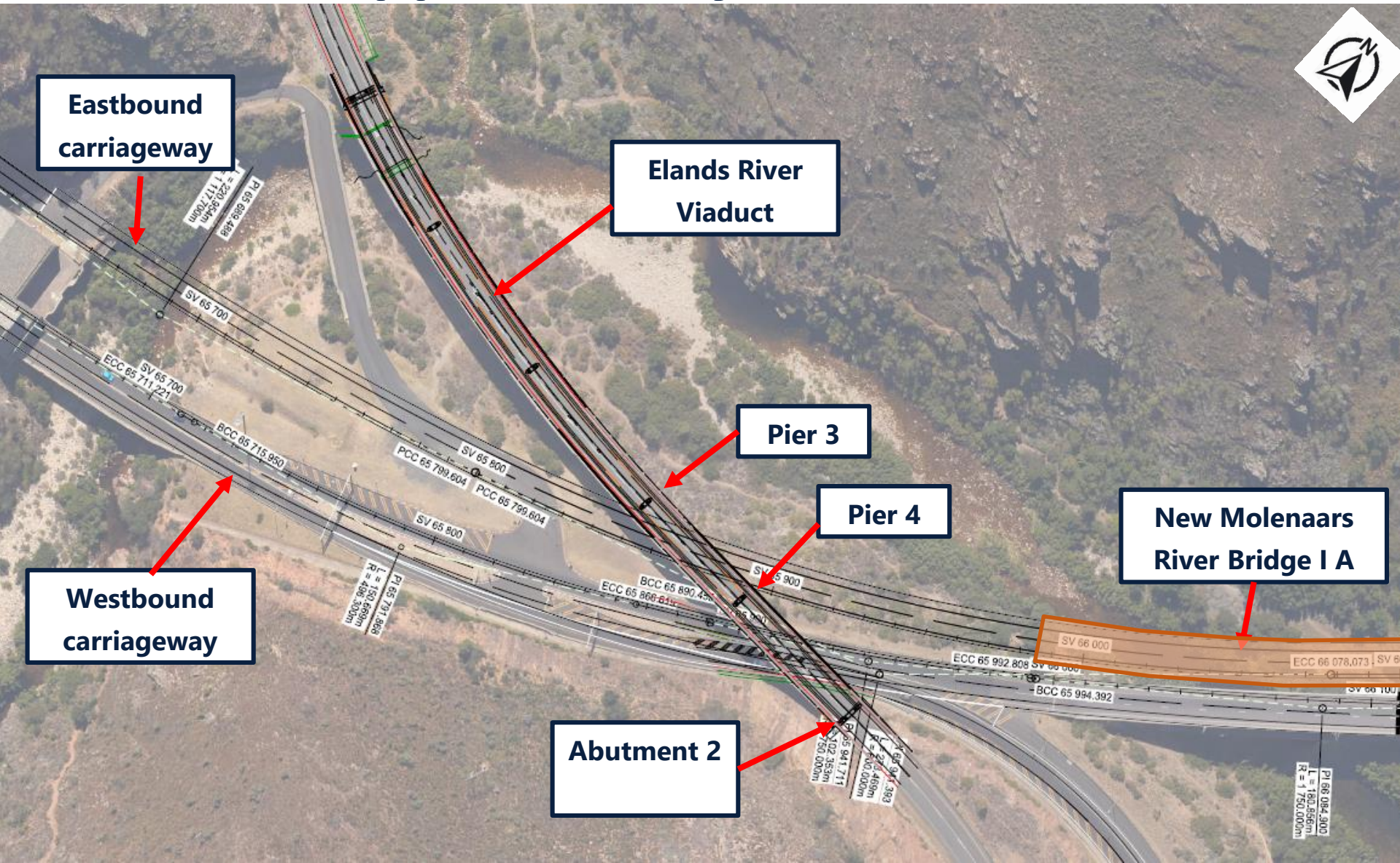
Eastern Approach

Maintaining dual carriageway to tunnel and approaches:

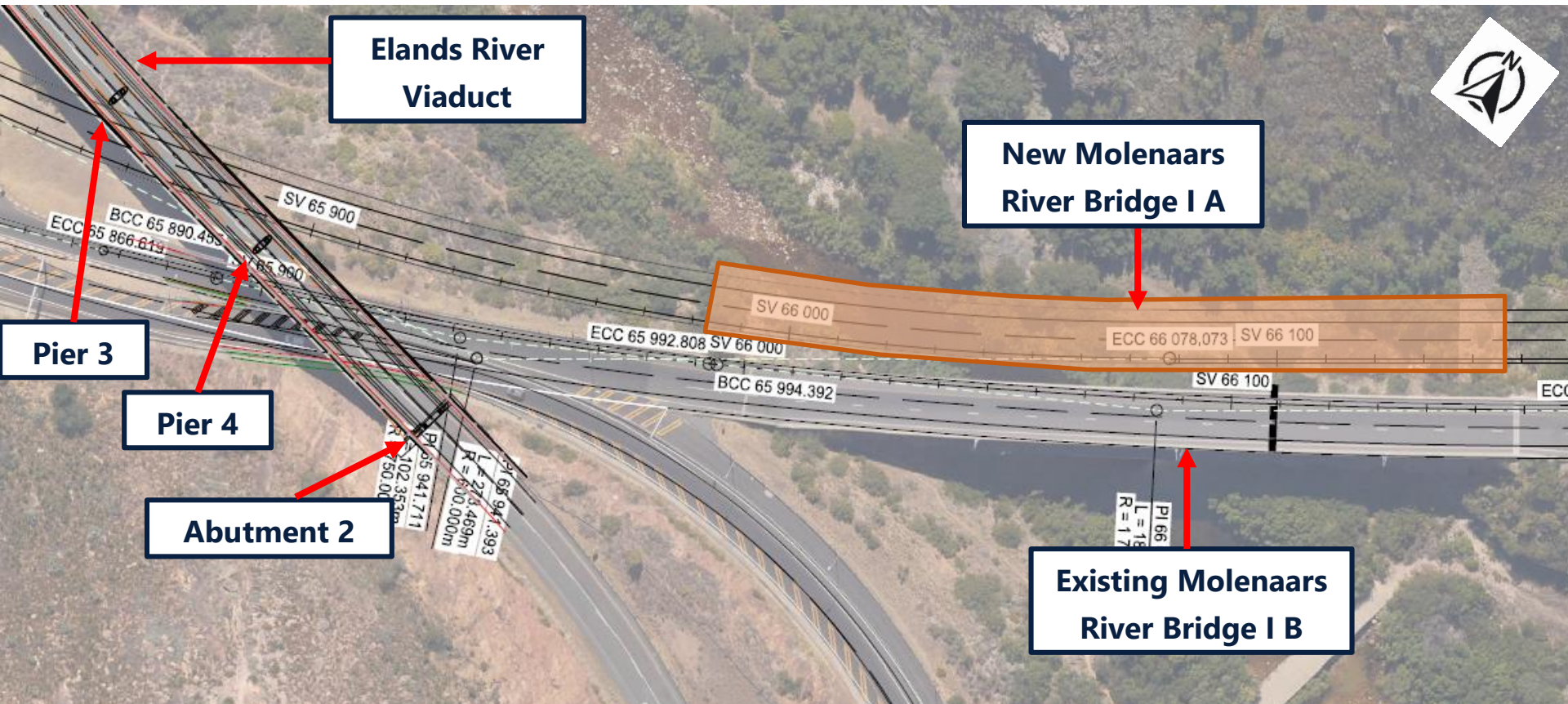
- Planned second Molenaars River bridge, adjacent to the existing Molenaars River bridge, solves the problem of the R101 Elands River Viaduct's pier; and provides an alignment of suitable design standard.
- The planned construction of a second (southbound) carriageway on the N1 parallel and adjacent to the existing northbound carriageway, from the Eastern Portal of the North Bore for approximately 3 km to the Du Kloof Resort.
- The planned reconfiguration of the links between the eastern end of the old Du Toits Kloof Pass (R101) and the N1.
 - Resolves complexity of providing a tie-in of the Northbound Carriageway to the existing Molenaars River Bridge



Eastern Approach Layout



Eastern Approach Layout



Elands River Viaduct

New Molenaars River Bridge I A

Pier 3

Pier 4

Abutment 2

Existing Molenaars River Bridge I B



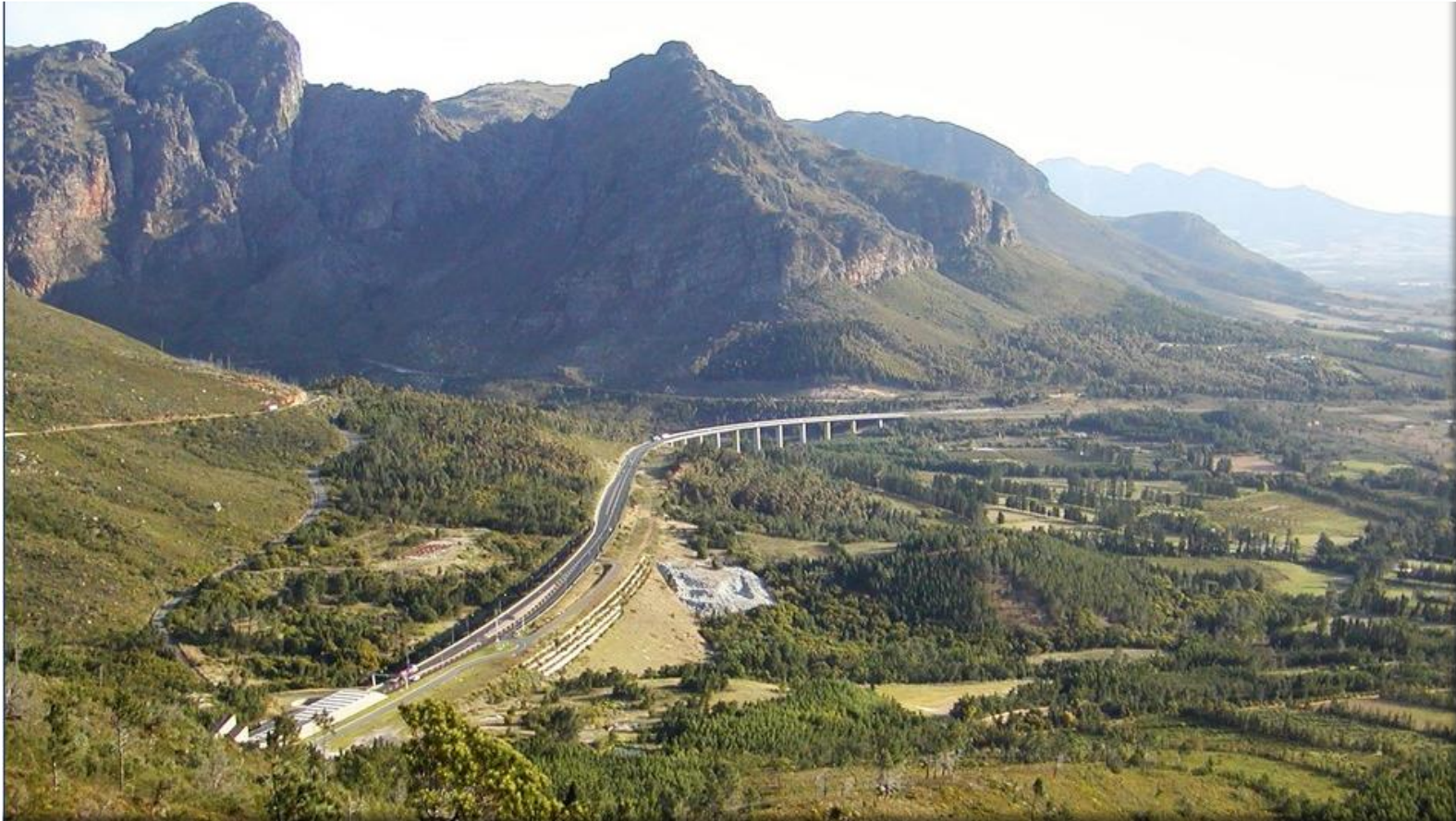
Eastern Approach

Planned Southbound Carriageway:

- Provides uniform cross-section for Class A1 Freeway from Eastern Portal to R101 / Rawsonville.
- Avoids Molenaars River flood plain.
- Provides easy connection to existing N1 carriageways from Worcester.
- Requires new SBC underpass structure for R101.
- Resolves short section of undivided carriageway (N1 / R101).
- R101 is completely separated from N1.
- Truck check facility remains as-is.



Western Approach



Western Approach

Completion planned of N1 to Western Portal (Incl. 2nd Hugos River Viaduct):

- N1 comes through pinch point on existing tunnel approach to single carriageway.
- Proposed new Carriageway to the north of the existing Carriageway.
- Proposed three-lane facility to match existing Carriageway.
- Third lane (Outside Lanes) of each carriageway to function as crawler lane.
- Earthworks and structures constructed for future median divided dual carriageway



Hugos Viaduct:

Overturning Vehicles due to Wind

- Wind barriers required to viaduct



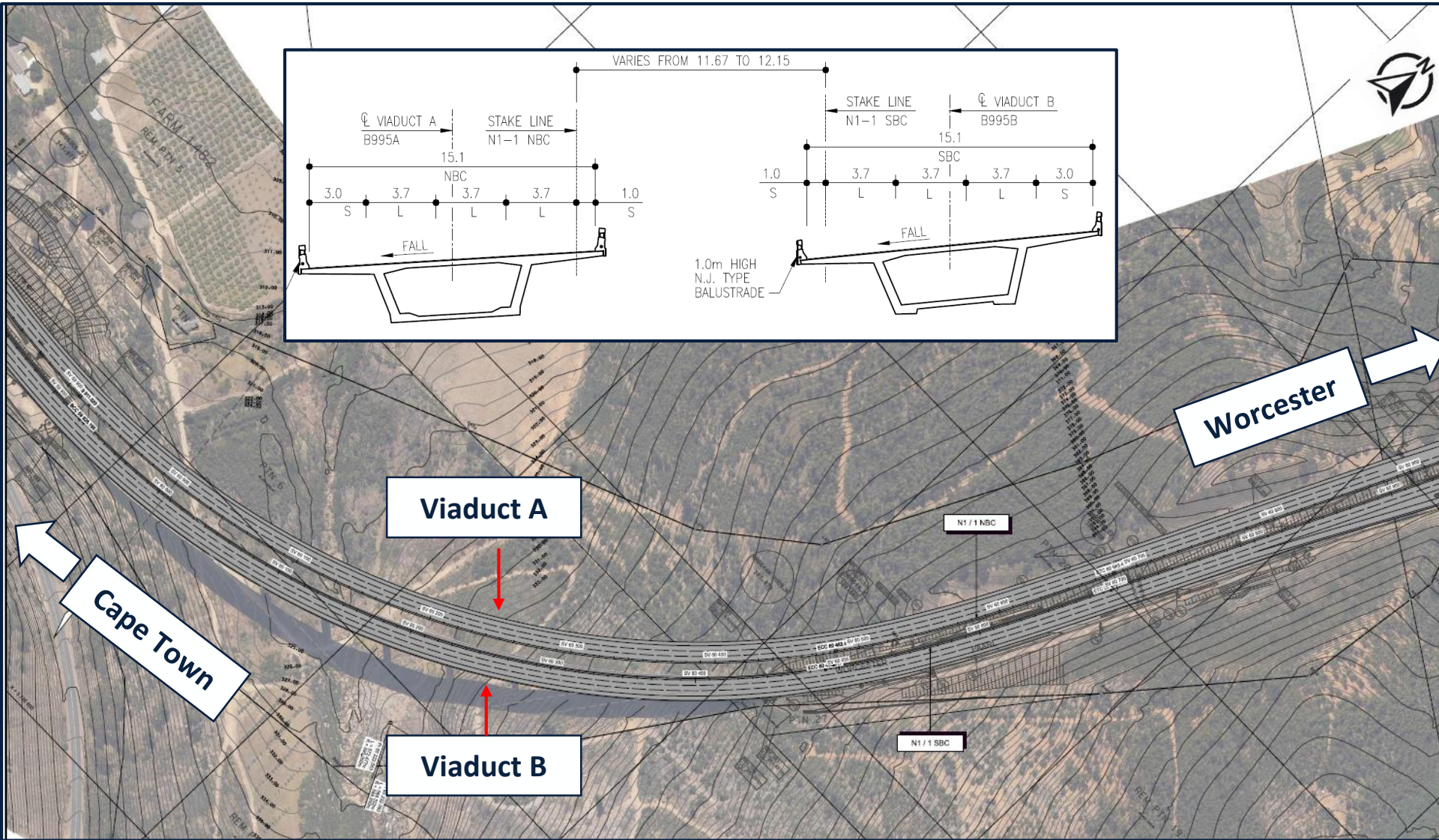
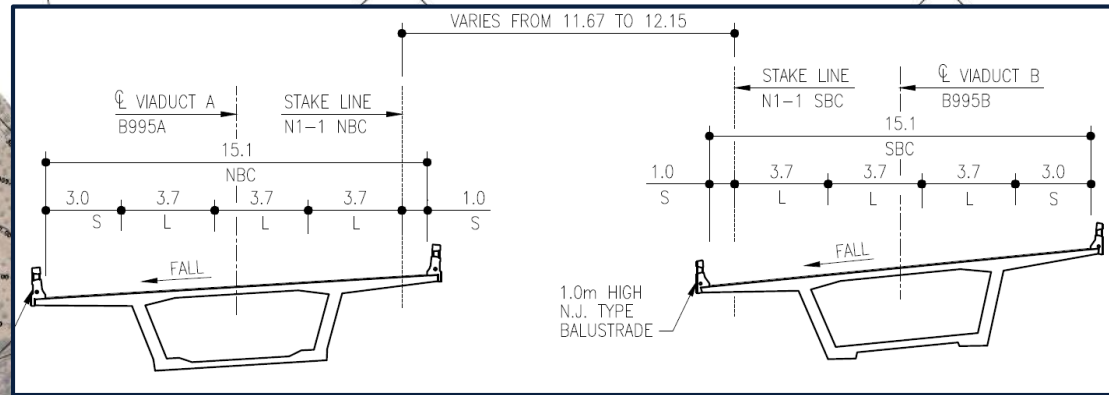
Single lane occupied

Second lane in process of being occupied

All lanes occupied



Western Approach Layout



Approach Roads to Tunnel Upgrade

Plan to provide continuous dual carriageway on N1 on approaches and through Huguenot Tunnel

- Will improve safety and capacity of approach roads.
- Allow continued use of Eastern Approach truck check stop.
- Ensure high mobility is maintained through national key point of Huguenot Tunnel.



Thank you

