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UNDERGROUND CIRCULATION OF LOGISTICS AS A STRATEGY FOR LAND OPTIMIZATION AND LOGISTICS EFFICIENCY: A CASE STUDY OF DISTRICT LOGISTICS NETWORK IN JURONG INNOVATION DISTRICT, SINGAPORE

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Abstract: The District Logistics Network (DLN) in Jurong Innovation District (JID) exemplifies an innovative approach to underground logistics that optimizes land use and enhances freight movement efficiency. Situated 15 meters below ground, this 3.5-kilometre-long network, with an average width of 14 meters, accommodates prime movers with 40' containers and is designed for future integration with Automated Guided Vehicles (AGVs) or Autonomous Vehicles (AVs). By relocating prime movers' circulation to the subterranean level, the DLN unlocks surface land for higher-value activities, such as businesses, amenities, and parks, while creating a greener, more liveable urban-industrial environment. DLN significantly improves logistics efficiency by connecting directly to factories and companies' basement loading/unloading bays. This seamless underground system allows goods and cargo to be transported directly from the expressways to businesses without traversing internal surface roads. As a result, the estate experiences less congestion, faster delivery times, and smoother operations.

Safety is also enhanced by reducing heavy vehicles traffic on surface roads, which adjoin residential neighbourhoods in Bulim. The removal of heavy vehicles from surface circulation minimizes the risks to residents and other road users, contributing to a safer and more pedestrian-friendly environment. Additionally, the reduced surface road widths and underground circulation mitigate noise and air pollution, further enhancing the quality of life for the surrounding community. Despite adverse underground conditions, including soil cavities, limestone, and peaty clay, the project overcame these engineering challenges through innovative solutions, ensuring the successful implementation of this ambitious infrastructure. As Singapore's first subterranean district logistics network, the DLN sets a benchmark for integrating logistics and land optimization strategies. It demonstrates how underground circulation can contribute to sustainable urban development, improving both logistics efficiency and the liveability of industrial estates.

Keywords: Sustainability, Innovative Design, Logistics Efficiency, Underground Infrastructure, Land Optimization, Geotechnical Engineering, Urban Geology, Sustainable Urban Development

1. INTRODUCTION

1.1. Background on Logistics Flow and Handling in Singapore

As a land-scarce nation, Singapore relies extensively on underground spaces to optimize land use. In addition to underground train networks, Singapore had developed caverns for hydrocarbon storage (CTRL+SHIFT, 2023) and is in the midst of expanding deep tunnel sewerage system (Public Utilities Board Singapore, 2025) to free up surface land used for sewerage treatment.

Logistics movement in Singapore has thus far relied on Heavy Goods Vehicles (HGVs) that travel on surface roads - the HGVs begin their journeys from seaports or through the Malaysia-Singapore links and carry containers as long as 40' through the internal roads of industrial estates, before delivering them at the loading and unloading bays of each factory unit. However, this conventional process poses several inefficiencies for Singapore from a

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land intensification perspective. Firstly, HGVs require wider roads with bigger turning radii (Land Transport Authority Singapore, 2019), as well as expansive loading/unloading bays. In addition, each factory requires a warehouse of its own for the storage of raw materials and semi-finished goods for production. Lastly, the decentralised nature of freight traffic is prone to last mile congestion, which exacerbates environmental concerns such as air pollution (Robert de Souza, 2014).

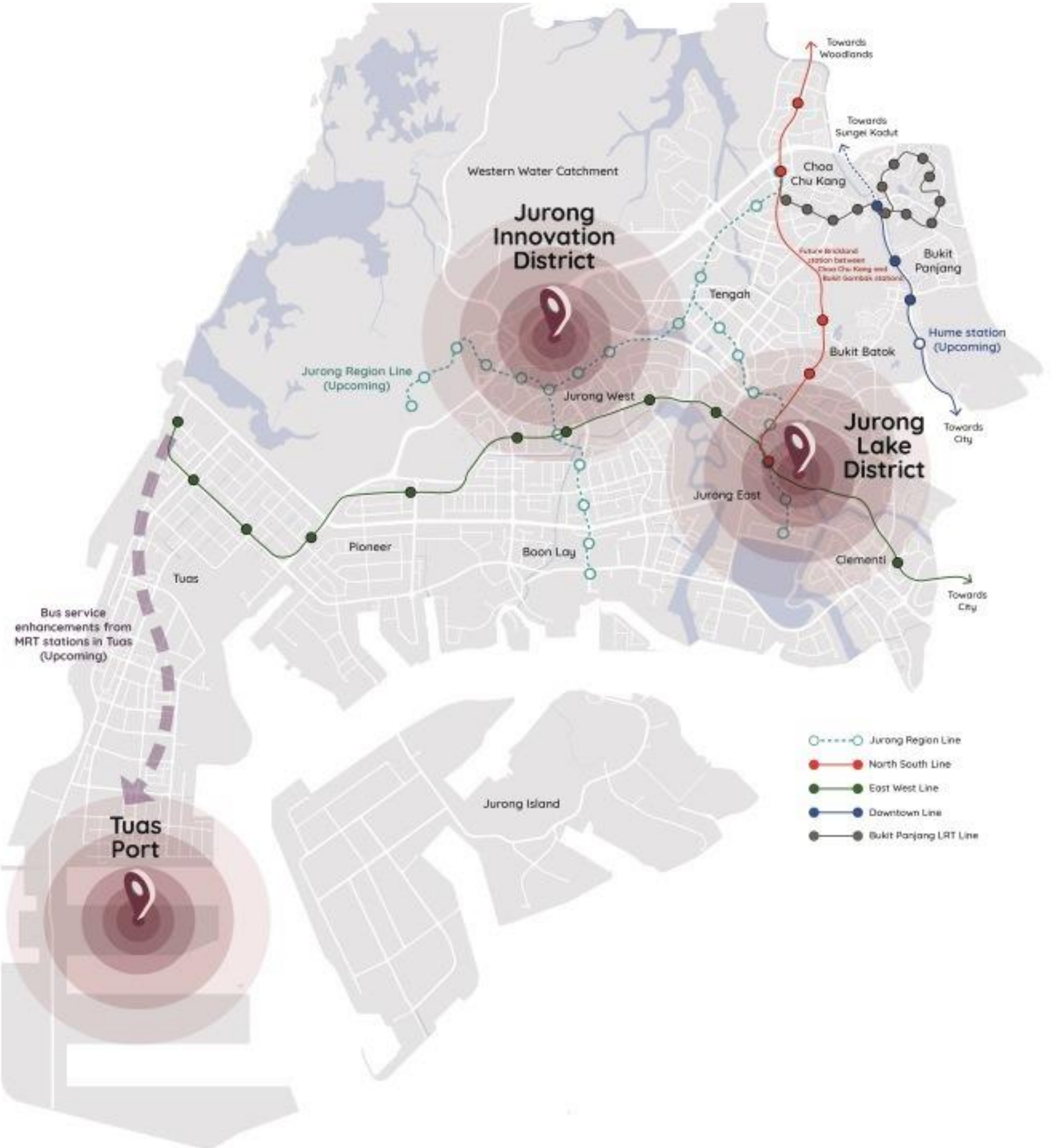


Figure 1. *Location Map of Jurong Innovation District (JID) (URA, n.d.)*

1.2. Overview of the District Logistics Network (DLN)

The District Logistics Network (DLN) at Jurong Innovation District (JID) comprises an underground road network, with the aim of alleviating the inefficiencies of conventional freight movement. All HGVs entering the estate will be directed to the underground road network which leads directly to the companies' doorstep via the basement Goods Receiving Area (GRA).

The DLN is designed with a width of 10.4m and a clear height of 5.5m to accommodate different types of AGVs or AVs in the future. At present, JTC is developing a 3.5-kilometre-long network at Bulim industrial precinct, one of the 5 precincts within JID - the first phase has been completed in January 2025, and the rest of the network by 2030.

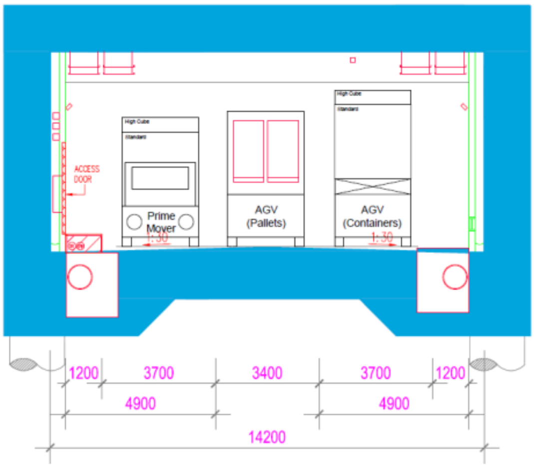
1.3. Vision and Purpose of the District Logistics Network

1.3.1. Vision of the DLN

The District Logistics Network (DLN) represents an innovative subterranean logistics infrastructure conceived to greatly improve freight movement efficiency while optimising land utilisation in Singapore's industrial landscape. The network's architectural framework embodies three fundamental design principles: operational versatility to accommodate both conventional manned vehicles and future AGVs or AVs, scalable infrastructure capable of serving varying throughput volumes across multi-tenanted and single-tenant facilities, and systematic redundancy to ensure operational resilience during vehicular incidents or mechanical failures. The infrastructure's 14.2metre width configuration supports dual 40-foot container traffic while incorporating future-ready provisions for AGV integration. This forward-looking design philosophy enables the progressive transition from manual operations to automated systems, ensuring the DLN's long-term viability as a cornerstone of Singapore's next-generation logistics ecosystem.

1.3.2. Width of the DLN

The width of the DLN was designed to accommodate two 40' trucks with enough room to bypass in the event of vehicular breakdown or similar, with futureproofing to support AGVs or AVs. This works out to be 14.2m wide for a 3-lane underground road as seen in Figure 2.



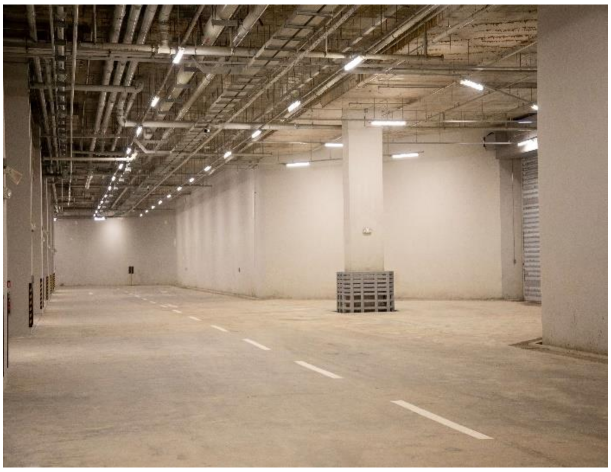


Figure 2. *(Left) Cross section of underground road with 3 lanes*

Figure 3. *(Right) Photo of the completed underground road*

1.3.3. Routing of the DLN

The routing of the DLN underground road would be implemented in two phases – the first phase has been completed in 2025, and the second phase is expected to be completed in 2030. Within the first phase of the DLN ("DLN Phase 1"), a ring-shaped network with one-way traffic flow was adopted to house the underground road at basement 2 level of Bulim Square, a four-tower industrial development with a gross floor area of approximately 160,000 m2 by JTC. Bulim Square is built and owned by JTC and is specifically designed to accommodate Small and Medium-sized Enterprises (SMEs), with factory units ranging from 120m^2 to 1200m^2. In doing so, tenants in Bulim Square could be directly served by the DLN.

A ring-shaped network also avoided a single point of failure if a localized section of the underground road had to be closed in Bulim 1. The ring network extended beyond Bulim to its adjacent industrial plots through 6 "finger" connections designed with knock-out panels to allow for future integration with the basement of future industrial buildings.

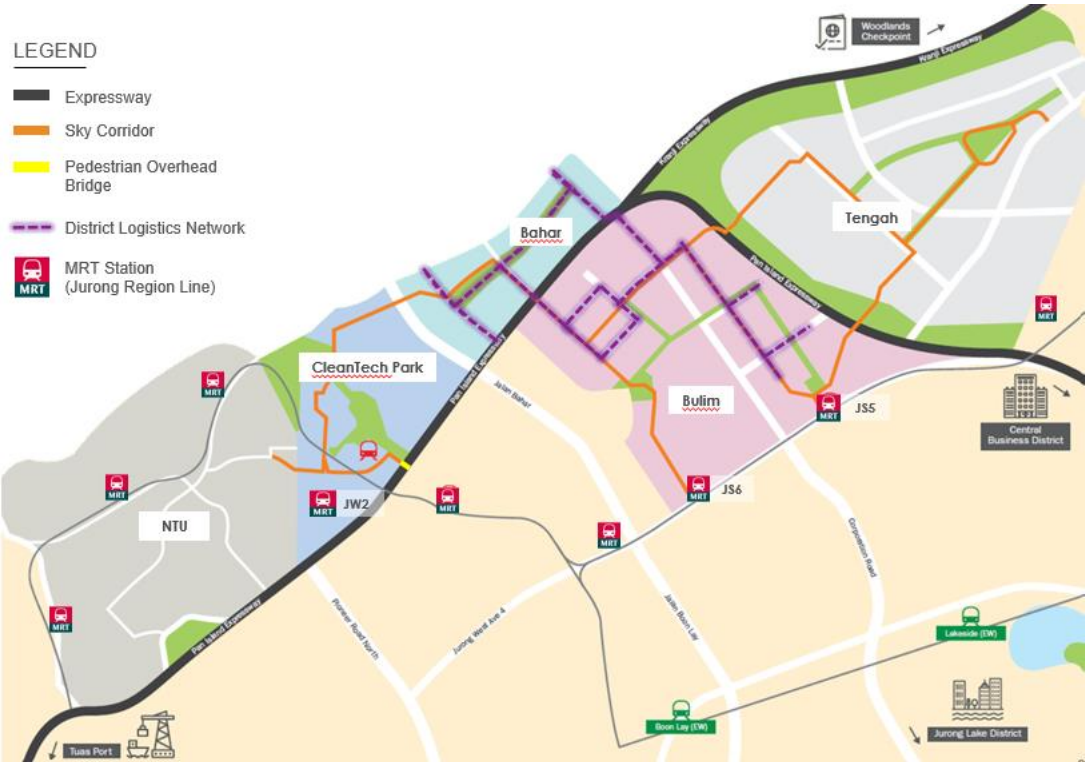


Figure 4. *General Alignment of District Logistics Network (DLN) in Phase 1*

2. PLANNING AND DESIGN OF THE DISTRICT LOGISTICS NETWORK

2.1. Key Benefits – Land Optimisation

The District Logistics Network (DLN) facilitates the relocation of logistics circulation and loading/unloading operations from surface level to basement facilities. This subterranean integration yields an estimated land savings of 2.46 hectares (refer to Appendix A.1), through two primary mechanisms: reduction of land required for surface roads, and reduction of loading/unloading bays.

By channeling logistics traffic underground, the DLN enables surface roads to accommodate larger volumes of non-logistics traffic, which in turn increases plot ratios for surrounding buildings. This is particularly significant in the traffic-constrained Bulim area, where the DLN unlocks additional Gross Floor Area (GFA) development potential that would otherwise be limited by surface traffic capacity.

From a cost-benefit perspective, this configuration reduces land acquisition cost by approximately SGD 24.63 million, as developers need only purchase the requisite underground strata. Moreover, given Singapore's geographical constraints as a city-state with limited industrial land availability, the liberated surface area can be allocated to higher-value economic activities.

Furthermore, by relocating logistics traffic underground, the DLN enables a reduction in nuisance buffer (NEA, n.d.) traditionally required between industrial and nearby existing residential areas to mitigate noise and air pollution impacts. These nuisance buffers, which typically constrain industrial development, could potentially be narrowed[3] given the reduced industrial traffic and associated emissions at the surface level. This creates opportunities for more flexible land use planning and allows industrial areas to be situated closer to residential developments without compromising environmental quality standards or resident comfort.

[3] Subject to detailed Industrial Siting Consultation (ISC) with National Environment Agency (NEA)

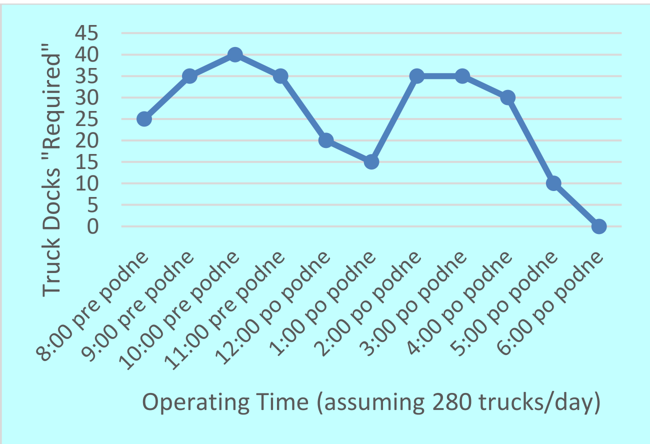
2.2. Key Benefits – Improved Logistics Efficiency

The District Logistics Network (DLN) has been conceptualised with several key objectives and design considerations. Primary among these are the optimisation of infrastructure utilisation through round-the-clock operations, maximising return on investment, and the incorporation of future-ready automation capabilities, particularly in facilitating sophisticated logistics interfaces between Distribution Centres and basement Goods Receiving Area (GRA). The network has been specifically engineered to provide Small and Medium-sized Enterprises (SMEs) with access to economies of scale in logistics operations, whilst ensuring connectivity, scalability, and flexibility for phased implementation. Importantly, the design adheres to Singapore's Land Transport Authority (LTA) regulations, ensuring that the network can be utilised by existing road vehicles immediately in its manual operational phase without any further retrofitting.

In DLN Phase 1, the provision of dedicated underground routes for manual Heavy Goods Vehicles (HGVs) fundamentally transforms logistics operations by separating them from surface traffic patterns in JID. This strategic separation not only minimises rush-hour congestion but also ensures consistent and predictable journey times for freight movement. Enhanced reliability in delivery schedules is particularly crucial for manufacturing operations that depend on precise just-in-time logistics. Furthermore, the optimised traffic flow significantly improves operational efficiency, as HGV operators can maintain consistent delivery schedules without the productivity losses typically associated with surface traffic delays. Singapore motorists lost 52 hours a year to rush hour traffic in 2024, according to technology firm TomTom's traffic index (Xiang, 2025), underscoring the broader benefits of such traffic segregation strategies.

The dedicated infrastructure network enables SMEs to plan for round-the-clock operations, marking a significant departure from conventional industrial estates where goods movements are typically restricted to "office" hours (8am~5pm, approximately 9 hours). With extended operating hours of up to 24 hours, productivity is projected to increase up to 2.5 times through more streamlined operations, significantly reducing human resource requirements for driving, loading, and unloading activities. The system's continuous operation capability allows companies to optimize their resource allocation, particularly in terms of receiving/dispatching docks and transport vehicles. Rather than dimensioning basement Goods Receiving Area (GRA) for peak handling capacity, companies can plan for consistent average volumes throughout the day, leading to more efficient resource utilization.

Building upon these productivity enhancements, the DLN has been designed with future automation capabilities in mind, enabling all logistics movements within the network to operate round the clock. This automation-ready infrastructure allows for "lights-out" operations, while the implementation of electrically driven automated vehicles positions the DLN as an environmentally sustainable logistics solution. The system's design enables significant reduction in common resources such as receiving/dispatching Truck docks, as facilities no longer need to be dimensioned for peak handling capacity but can be planned for consistent average volumes throughout the day. This represents a transformative advancement compared to traditional industrial estates, optimizing both operational efficiency and resource utilization while minimizing environmental impact.



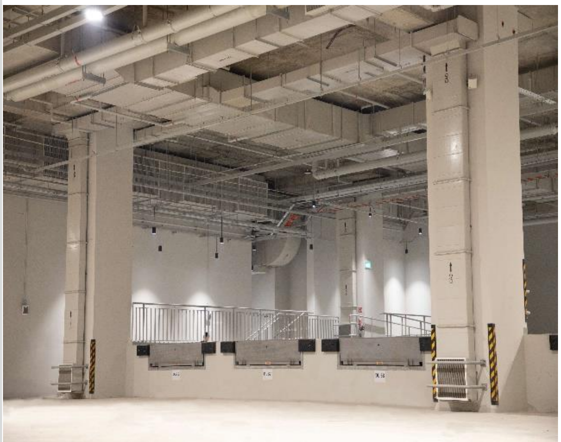


Figure 5. *(Left) Demand for Trunk Docks based on 8am to 5pm (9hrs) operations*

Figure 6. *(Right) Photo of the completed Trunk Docks*

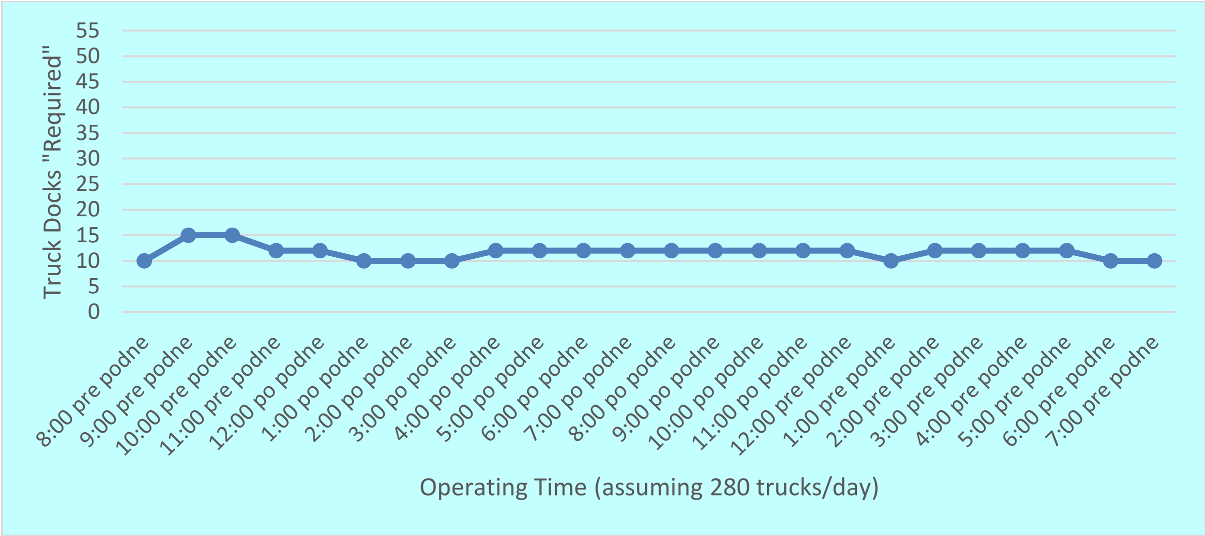


Figure 7. *Demand for Trunk Docks based on 24/7 (24hrs) operations*

3. ENGINEERING CHALLENGES ENCOUNTERED WITHIN THE DLN UNDERGROUND ROAD

3.1. Site and Existing Infrastructure Constraints

The project presented several engineering challenges due to its location and close proximity with existing residential and industrial developments. The presence of an operational bus depot and arterial road networks demanded traffic management protocols while maintaining operational continuity.

Figure 8. *(Left) Existing 5.5m wide drain serving surrounding catchment*

Figure 9. *(Right) Existing Bus Depot in close proximity*

The subsurface development was significantly constrained by the presence of existing sewers and 5.5m wide drains, alongside a common services space requirement at Basement 1 level. Alternative solutions which involved diversion for the 5.5m wide drains were evaluated but proved economically unfeasible due to the existing drains and sewers' gravitational alignment requirements.

To ensure these "live" services for drainage and sewerage are not affected during construction, the engineering team implemented temporary pile supports and a reinforced concrete (RC) beam to underpin the services, enabling top-down construction methodology in the DLN Core 1 area. This approach required precise engineering coordination, particularly where the Common Services Space (CSS) crosses beneath the existing drain. The solution encompassed:

- Structural assessment of existing H-pile and drain conditions
- Enhanced existing H-pile bracing systems
- Strategic localised drain diversions for soldier pile installation

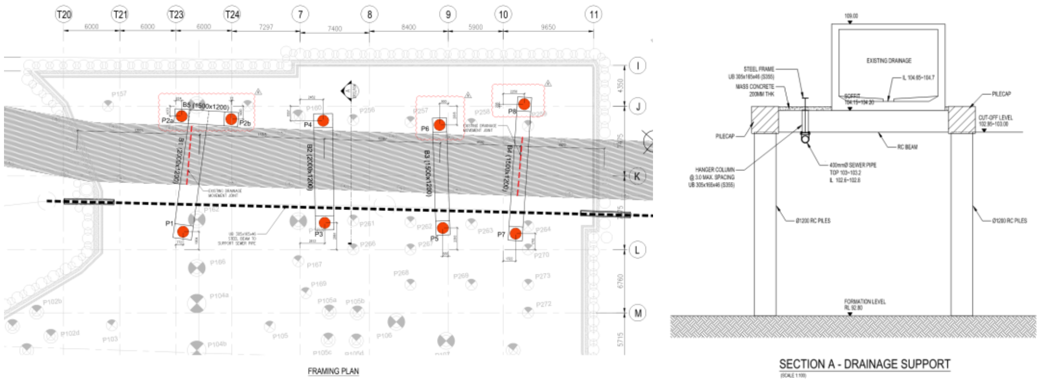


Figure 10. *Temporary support layout for 5.5m drain and sewer to facilitate DLN Core 1 Top-Down Construction*

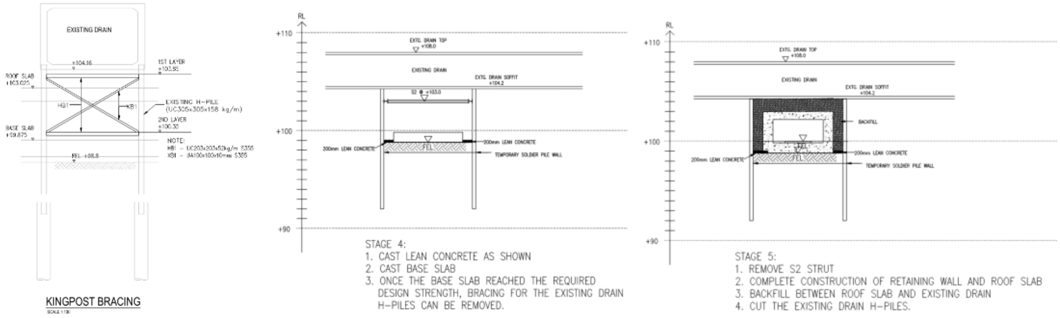


Figure 11. *Strengthening localise area of drain existing H-pile to facilitate the construction of under-crossing CSS*

3.2. Design Integration and Construction Methodology in conjunction with Bulim Square

To ensure an unobstructed transport network, the DLN tunnel was designed as a column-free structure, with some junctions spanning approximately 40 meters in both directions. An efficient structural framing system using waffle slabs and two-way beams was adopted to reduce material usage and allow space for services to pass through.

The structural design incorporated comprehensive loading considerations. The tunnel roof slab, spanning approximately 18-20m with maintenance corridor, was engineered to withstand a permanent load from 6m thick soil layer and an overburden traffic load of 25kN/m². These loading parameters necessitated a reinforced concrete tunnel roof slab depth ranging from 1.0-1.2m. The design additionally accounted for full water pressure conditions, including detailed analysis of tension pile requirements for uplift resistance.

The construction methodology for this project employed a hybrid approach, combining both open cut and top-down methods to optimise construction efficiency whilst minimising disruption to the surrounding infrastructure. In the vicinity of Bulim Square, open cut excavation was implemented due to the absence of immediate surface constraints, matching with Bulim Square bottom-up construction and the need for rapid construction progress with better construction quality control with waterproofing application.

However, for sections further from Bulim Square, a top-down construction sequence using Secant Bored Pile (SBP) with temporary soil nailing was adopted to maintain ground stability, minimum disturbance to existing sewer, drains, existing road networks, nearby bus depot operation and surface activities. Using ground anchors, with proper assessment of ground conditions, frees up space within the DLN footprint for construction activities, unlike the diagonal strut method, which restricts movement due to the struts.

This strategic combination was driven by several key considerations: firstly, the phasing requirements necessitated maintaining access to Bulim Square throughout construction; secondly, the top-down method provided inherent structural support in areas with deeper excavation depths; and thirdly, this arrangement allowed for concurrent surface and subsurface activities, thereby optimising the construction schedule.

Figure 12. *Key Cross Section showing the integration of District Logistics Network and Bulim Square*

3.3. Geotechnical Challenges – Adverse Ground conditions

The geotechnical characteristics of the DLN site present significant engineering challenges, predominantly comprising loose to medium gravelly silty sand extending to an average depth of 4 metres, which is subsequently underlain by the Jurong Formation[4]. The presence of karstic limestone formations, identified during comprehensive soil investigation, necessitated extensive subsurface characterisation prior to foundation works.

To mitigate risks associated with potential subsurface cavity voids, a systematic cavity mapping programme was implemented. The investigation methodology incorporated multiple probe drillings utilising 75mm diameter boreholes extending to depths of 65-75 metres. This extensive ground investigation exercise enabled the development of detailed three-dimensional subsurface models, critical for identifying and characterising subsurface features.

The geotechnical data obtained informed the development of specialised Earth Retaining or Stabilizing Structures (ERSS) techniques. The design approach incorporated:

- Detailed cavity risk assessment and classification
- Zone-specific pile installation methodologies
- Modified casting sequences tailored to varying cavity conditions
- Enhanced quality control protocols during foundation work

To address the challenging ground conditions, the engineering team implemented several engineering solutions. These included pre-treatment of identified cavity zones using specialised grouting techniques, along with custom-designed pile reinforcement configurations for zones with varying cavity risks. The team also installed real-time monitoring systems on surrounding existing infrastructure and buildings to detect anomalies during pile installation, whilst implementing adaptive pile design modifications based on encountered ground conditions.

The successful implementation of these measures demonstrated the effectiveness of integrated geotechnical solutions in managing complex subsurface conditions. The approach not only ensured structural integrity but also optimised construction efficiency while maintaining stringent safety standards.

[4]The Jurong Formation is a bedrock formation (primarily mudstone and sandstone, shale, siltstone, conglomerate and fossil-rich limestone) that dates to the Late Triassic (Gang, 2012)

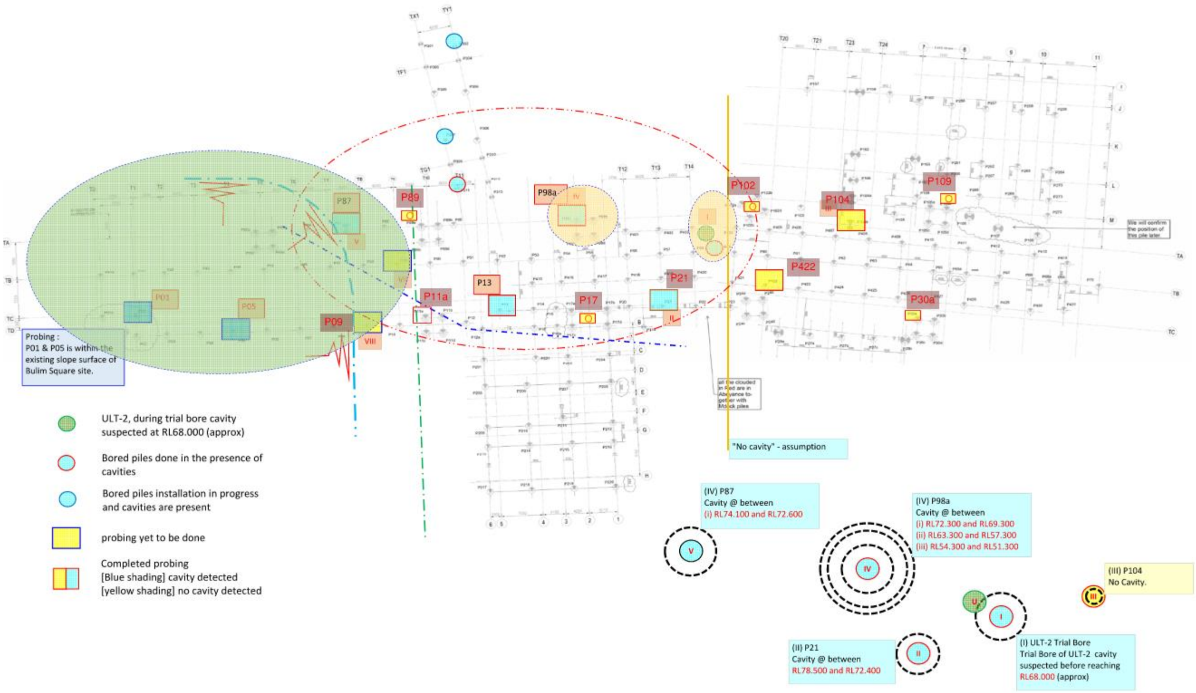


Figure 13. *Systematic Cavity Mapping to determine potential subsurface cavity voids*

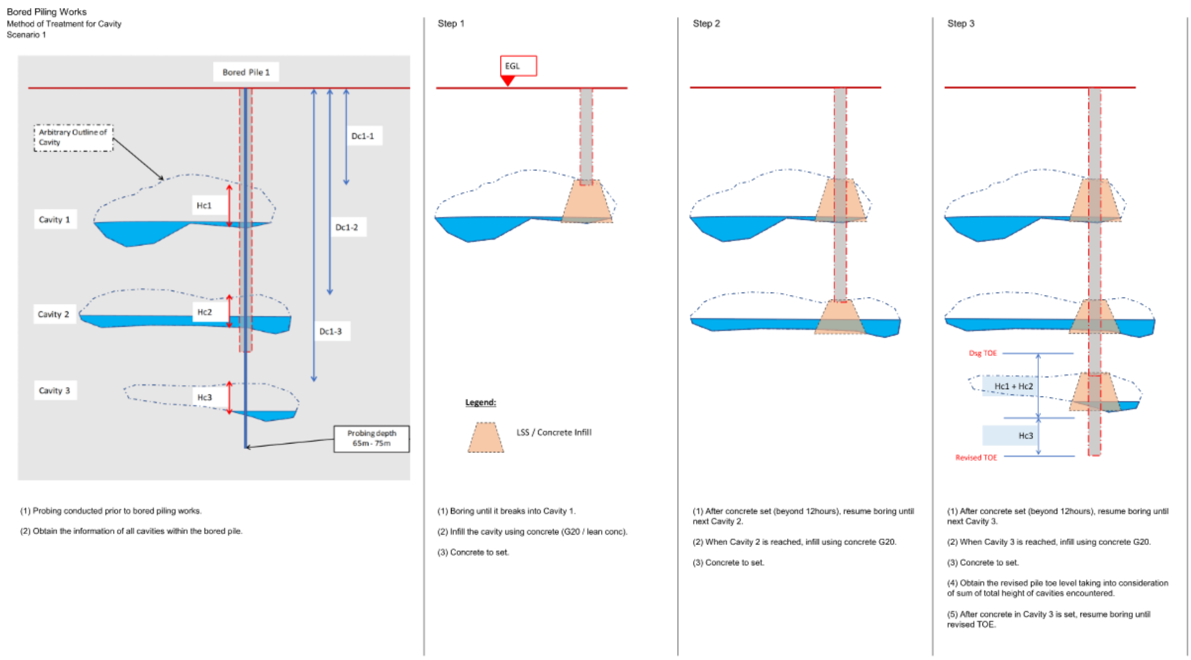


Figure 14. *Pre-treatment of identified cavity zones using specialised grouting techniques*

3.4. Design challenges as Innovative Infrastructure

The District Logistics Network (DLN) represents Singapore's first underground logistics infrastructure of its kind, necessitating innovative approaches to mechanical and electrical (M&E) provisions, particularly in ventilation and fire safety systems. This innovative infrastructure demanded exceptional engineering solutions that transcend conventional infrastructure requirements.

The mechanical ventilation system incorporates dual functionalities: environmental control during normal operations and smoke management during emergencies. During standard operations, the system maintains optimal air quality and temperature through strategic air exchange, while being prepared for immediate reconfiguration in emergency scenarios.

Classified as a “Building” under Singapore Civil Defence Force (SCDF) regulations, the DLN must comply with Fire Code 2018 requirements. However, this classification presented unique engineering challenges, as traditional building code compliance proved incompatible with the tunnel's operational demands. The primary constraint emerged from the Fire Code's prescribed smoke zone requirements, which traditionally mandate physical barriers, such as smoke curtain or fire shutter - a feature incompatible with the continuous vehicle movement essential to the DLN's operations.

To resolve this technical contradiction, a full Performance-based fire safety design approach was developed instead and approved through regulatory consultation. The smoke ventilation system in the DLN was designed to comply with NFPA 502 – Standard for Road Tunnels, supported by comprehensive Computational Fluid Dynamics (CFD) modelling to validate its effectiveness. This solution successfully demonstrates smoke containment within designated zones without physical barriers.

The DLN is designed to accommodate constant traffic flow throughout its network, where in the event of fire, Heavy Goods Vehicles (HGVs) may be located on both side of fire site. Under this scenario, several objectives regarding smoke control have to be met, such as effective smoke extraction and undisturbed smoke stratifications (Association, 2020). To achieve effective smoke control while considering DLN’s traffic layout and design, the smoke management strategy utilises sophisticated zonal control mechanisms which necessitate the implementation of Partial Transverse Ventilation with high-level or ceiling extraction points. This alternative design approach considers that conventional "push-pull" ventilation solutions or jet fans may inadvertently direct smoke towards HGVs in the affected zones. This design choice was validated through extensive simulation studies and risk assessments.

The ventilation system's architecture divides the DLN tunnel into virtual smoke zones, each spanning approximately 200 to 300 metres, which is in accordance with PIARC’s recommendation to limit the incident zone where smoke is prevented from propagating further (Operation, 2007). These virtual zones feature high-capacity reversible fans with variable frequency drives, enabling dynamic operational flexibility between supply and exhaust modes. During fire incidents, the system executes a coordinated response: the affected zone transitions to negative pressure exhaust mode, while the two adjacent zones operate in positive pressure supply mode, creating aerodynamic containment of smoke within the fire zone. This sophisticated approach ensures effective smoke management without compromising operational continuity, unlike physical smoke zones where activation of smoke barriers or smoke curtains will affect HGV movement.

The smoke management strategy encompasses multiple operational scenarios, each tailored to specific zones within the DLN. These scenarios have been extensively modelled and validated through computational analysis to ensure robust emergency response capabilities. The implemented solution addresses three critical scenarios, each corresponding to distinct spatial and ventilation characteristics:

Smoke Zone 1 (SZ-1):
- Features three strategically positioned 10m x 10m air wells
- Utilises passive ventilation principles through natural convection
- Demonstrates optimal smoke evacuation without mechanical intervention

Smoke Zone 2 (SZ-2) - Partial Transverse Ventilation:
- During fire incidents, implements a hybrid ventilation strategy
- Receives coordinated support from SZ-3, which provides 100% mechanical supply air
- Achieves complete smoke extraction through Air Well 3 via natural ventilation principles
- System design ensures maintained pressure differentials for effective smoke containment

Smoke Zone 3 (SZ-3) - Partial Transverse Ventilation:
- Employs a sophisticated multi-source air management approach
- Utilises SZ-2 for 50% natural replacement air supply
- Supplements ventilation with 50% mechanical air supply from the northern terminus
- Incorporates 100% mechanical exhaust capabilities through dedicated extraction systems
- Maintains calculated pressure gradients to prevent smoke migration

This zonal strategy exemplifies the integration of passive and active ventilation systems, optimising both energy efficiency and emergency response capabilities. The design's effectiveness has been validated through extensive Computational Fluid Dynamics (CFD) modelling and full-scale testing protocols.

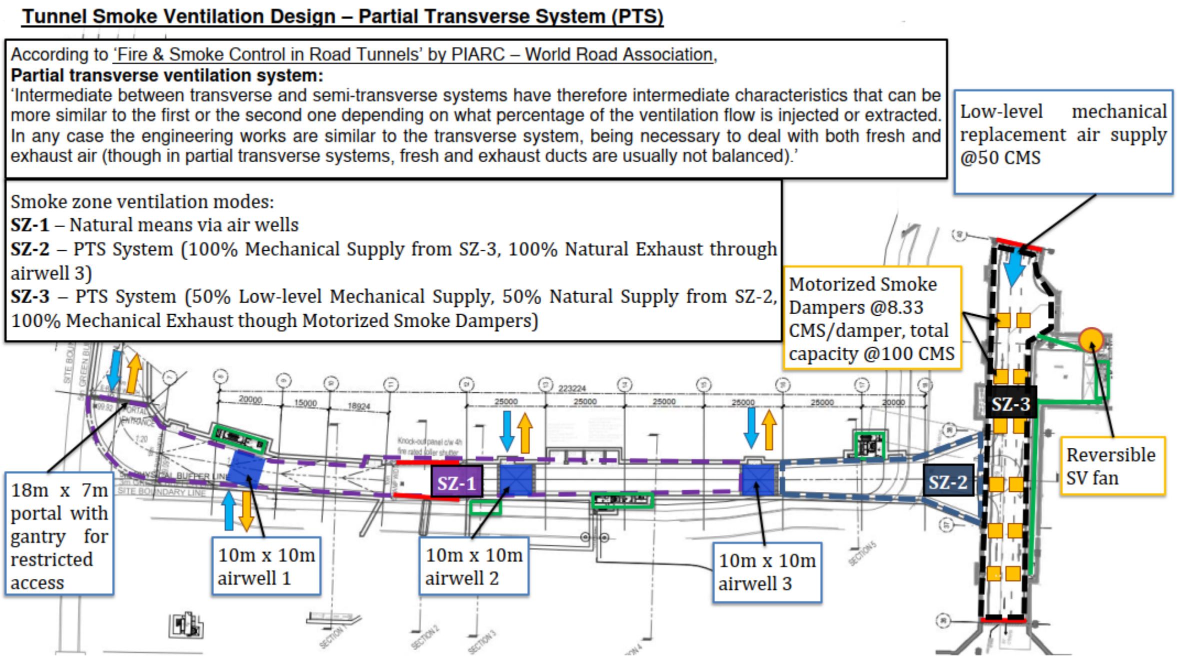


Figure 15. Tunnel Smoke Ventilation Design – Partial Transverse System (PTS)

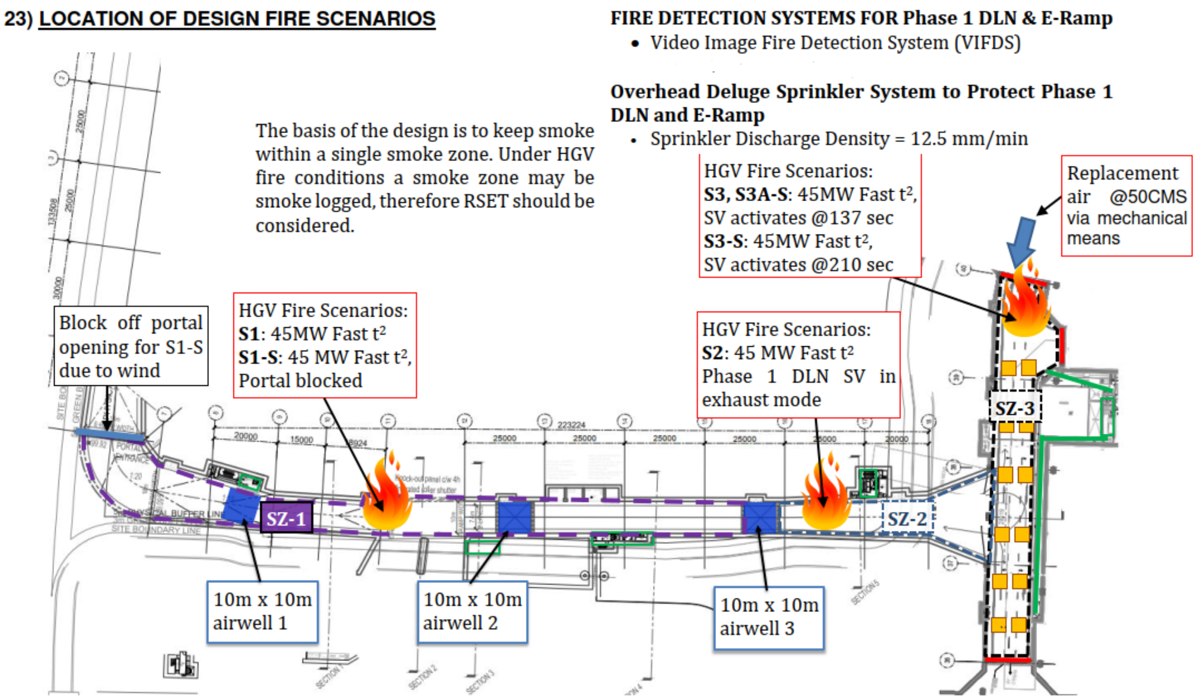


Figure 16. Location of Design Fire Scenarios

4. CONCLUSION AND FUTURE DEVELOPMENTS

4.1. The future with Centralised Distribution Centre (CDC)

The future of the District Logistics Network (DLN) at Jurong Innovation District (JID) would comprise a Centralised Distribution Centre (CDC) operating in tandem with the underground road network, with the aim of alleviating the inefficiencies of conventional freight movement. All HGVs entering the estate will be directed underground to the DLN's distribution centre, where containers of goods will break-bulk and be repacked into pallets and stored until required by companies. Upon companies' requests, the goods will then be loaded onto automated guided vehicles (AGVs) and transported to the companies' doorstep via the basement Goods Receiving Area (GRA).

One key advantage of the CDC in Bulim is that it allows industrial tenants and lessees in Bulim to declutter their production area by operating in a just-in-time (JIT) mode. Given that the CDC is sited within 1.5 km of the factories in Bulim, immediate stocks required for production within the next 2 days can be moved into the Goods Receiving Area (GRA) for temporary storage, below the tenants' production area, within approximately 1 hour of activating the stocks. A dedicated underground road also means that the response time is less vulnerable to adverse traffic conditions. Furthermore, this will reduce the movement of goods from many different 3rd party logistics (3PL) providers or warehouses between Bulim and various locations in Singapore, thus easing the local traffic conditions around JID.

Another benefit of the DLN is the promotion of centralized logistics operations. By sharing logistics resources, the bullwhip effect can be mitigated with improved system efficiency (Dongfei Fu, 2014). Given that the CDC will be able to manage product inventories and allow for JIT delivery, stocks may be delivered at any time and not only during peak hours. This would normalise the traffic level within the underground road throughout the day and allow for the DLN's design to be optimized.

In addition, centralisation would enable a larger throughput volume of goods to be handled, which makes automation more effective. As such, the CDC will feature an automated storage and retrieval system (ASRS) that operates continuously, enabling efficient handling of varying load sizes and types. The system's modular design allows for progressive capacity expansion, accommodating future growth and technological advancements. Furthermore, the network incorporates smart technologies for real-time tracking and monitoring, ensuring optimal route planning and resource allocation for last-mile delivery of palletized stocks to be handled by autonomous goods vehicles (AGVs), which will ply the underground road network between the CDC and the factory GRA.

Lastly, the DLN and CDC will contribute to environmental sustainability by replacing fuel consumption by HGVs for the last-mile delivery of goods with electric-powered AGVs or AVs. Bringing the last-mile transportation of goods underground will also improve surface air quality and allow for surface roads to be reduced in width. The freed-up space can then be used for park spaces and greenery, contributing to JID's 30% estate-wide green cover target.

4.2. Conclusion

The District Logistics Network demonstrates the feasibility of subterranean logistics infrastructure as a transformative solution for land-scarce urban environments. Through innovative engineering solutions addressing complex geotechnical challenges, including karstic limestone formations and adverse ground conditions, the project successfully implemented a 3.5-kilometre underground network capable of accommodating 40-foot containers while meeting stringent safety and operational requirements. The integration of sophisticated ventilation systems compliant with NFPA 502 standards, coupled with the future implementation of a Centralised Distribution Centre (CDC), positions the DLN as a benchmark for sustainable urban logistics.

The infrastructure has demonstrably enhanced logistics efficiency by unlocking approximately 2.46 hectares of surface land while enabling just-in-time operations validates its role in advancing Singapore's vision of integrated underground space utilisation. As industrial estates evolve toward greater automation and environmental sustainability, the DLN's design principles and implementation strategies offer valuable insights for future underground logistics infrastructure development globally.

5. ACKNOWLEDGMENTS

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6. APPENDIX A.1

Land savings can be broken into two main categories – savings from (1) Reduction of land required for surface roads, (2) Reduction of loading/unloading bays

(1) Reduction of land required for surface roads

Referring to Fig. A, an estimated 2.8km of roads (corresponding to those likely plied by industrial developments now served by the DLN) are subject to Reduction of land required for surface roads, i.e., it is possible to support expected traffic in area via a 'Dual 2' (2 lanes in each direction) instead of a 'Dual 3' road (3 lanes per direction, i.e., minor arterial road). Referring to typical industrial road typologies within LTA's 2019 Code of Practice for Street Work Proposals (Safeguarded/Approved Road Reserves per P46, Table 2.5), the estimated reduction in width of 5m corresponds to further land savings of 14,000sqm.

Figure A - Plots served by the DLN (red verge) as well as roads subject to reduction (shown in black dash)

(2) Reduction of loading/unloading bays

In Singapore, the requirements for loading and unloading bays are based on developments' Gross Floor Area (GFA) – referring to Fig. E, plots served by the DLN total 29.9ha and are expected to support approx. 690,000sqm GFA. Based on the Land Transport Authority (LTA)'s 2019 Code of Practice on Vehicle Parking Provision, we obtain an estimated savings of 1.06ha from reduced provision of loading bays:

Land savings =
[Bay area×No.bays]
=[(14.0×3.3)×(690000÷3000)]
= 10,626sqm

*Assumes loading bay provision based on lower bound requirement of 1 bay per 3,000sqm GFA for multi-user industrial developments.

Conclusion

Based on the overall land savings of approx. 14,000sqm+10,626sqm = 24,626sqm (2.46ha), we can estimate from the Singapore Land Authority's LBC Table (see Table 1) that the prevailing land value in this area as of Mar 2025 is roughly $1000 per sqm, allowing us to derive a land cost savings of approx. 24,626sqm x $1000/sqm = SGD $24.63 million.

Table 1 shows the prevailing land betterment charge rates (SLA, SLA, n.d.) (SLA, https://www.onemap.gov.sg/#/LBCQueryInfo, n.d.) for industrial developments in the Bulim area (Group D – $707psm) which is approximate to 70% of the land value. Hence, land value is approximately $1000 per sqm.

BULIM SQUARE
1, BULIM LANE 2, SINGAPORE 648110

Sector 114

Group	Sep 2024	Mar 2025	Change
A	$10,500	$10,500	$0
B1	$4,830	$4,970	$140
B2	$6,720	$6,720	$0
C	$5,250	$5,460	$210
D	$693	$707	$14
E	$735	$770	$35
F	$10	$10	$0
G	$34	$34	$0
H	$1	$1	$0

Table 1 - Prevailing land betterment charge rates (Group D - $707psm)

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