

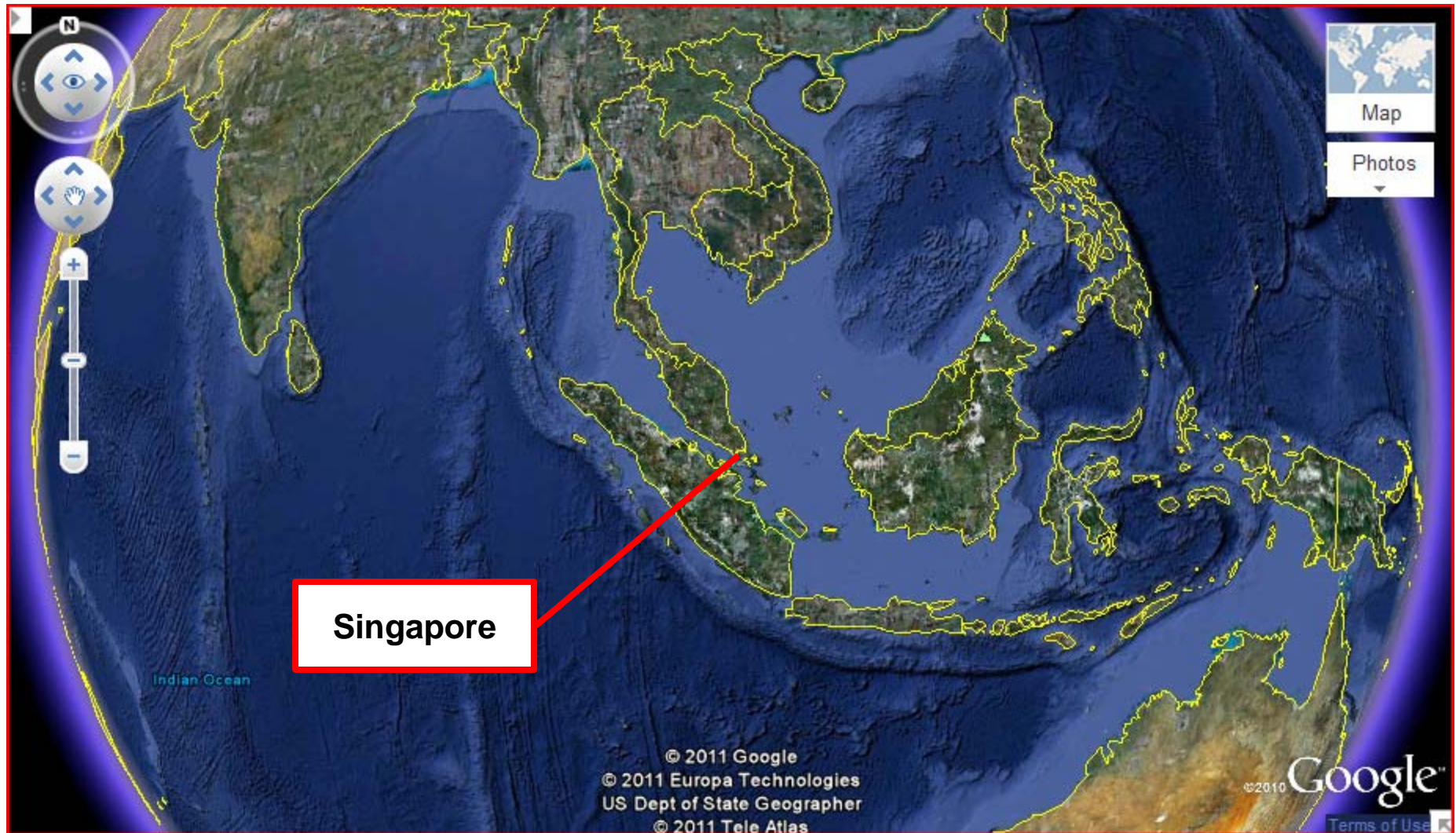
3D Cadastre in Singapore

Victor Khoo
Senior Principal Surveyor
Singapore Land Authority

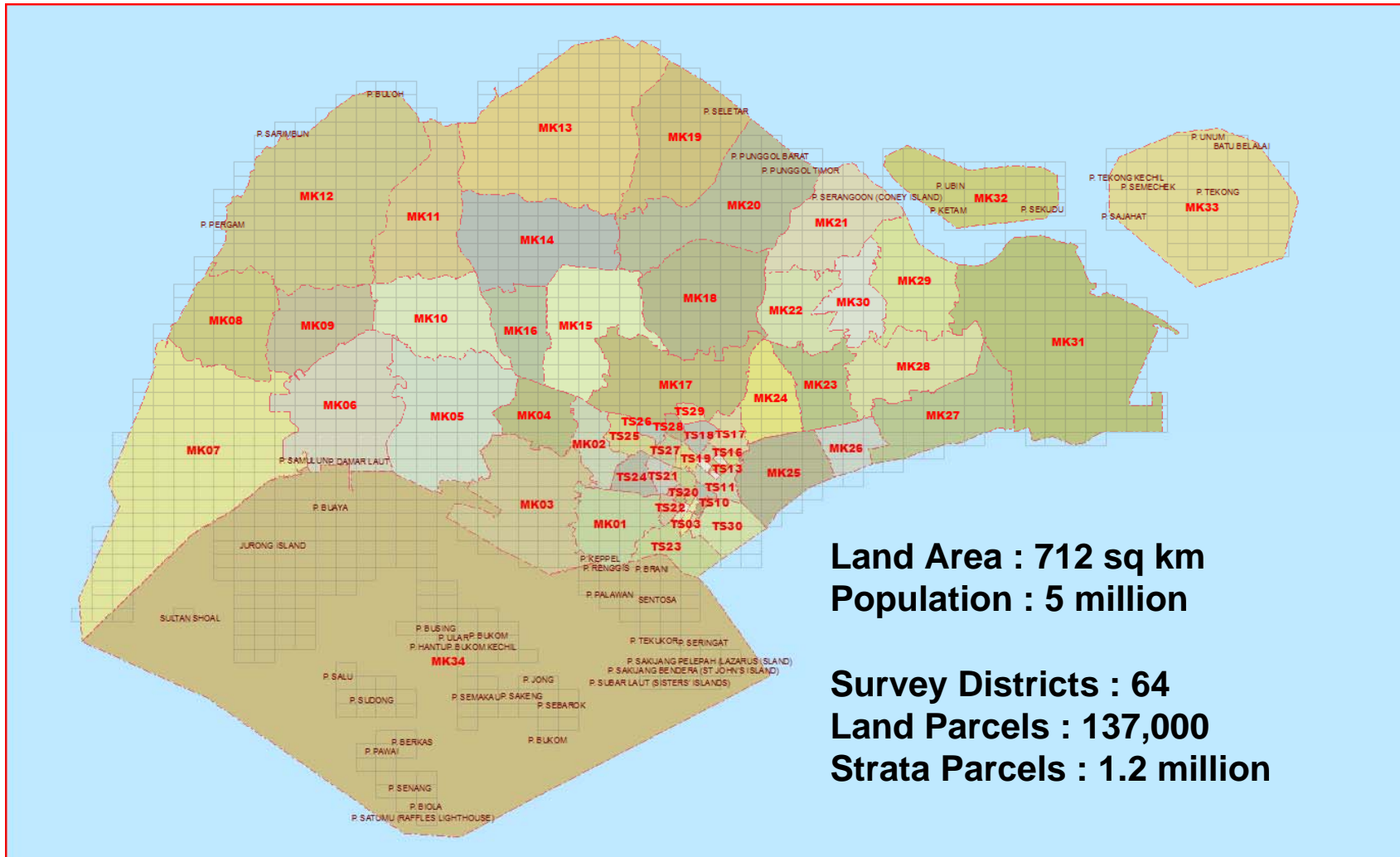
Outline

- Background
- Cadastre in Singapore
- Why need 3D?
- Challenges
- Going Forward

Where is Singapore?



Singapore - Cadastral Perspective



Singapore - Skyline



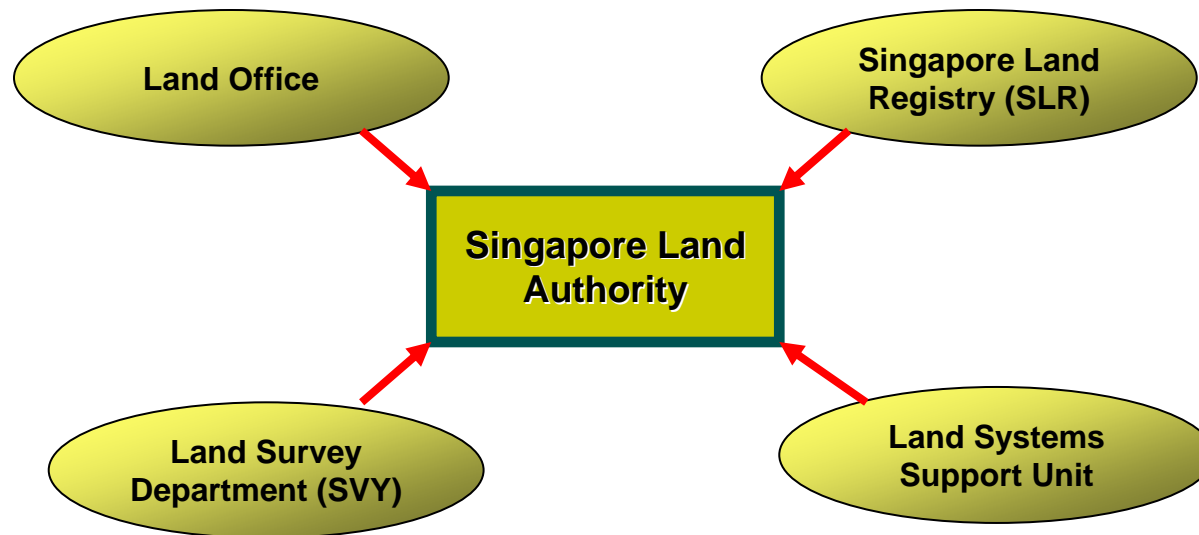
Where Most Singaporeans Live: HDB Flats



Singapore Land Authority (SLA)



- SLA is a statutory board formed by an Act of Parliament in June 2001.
- Merger of 4 former land departments

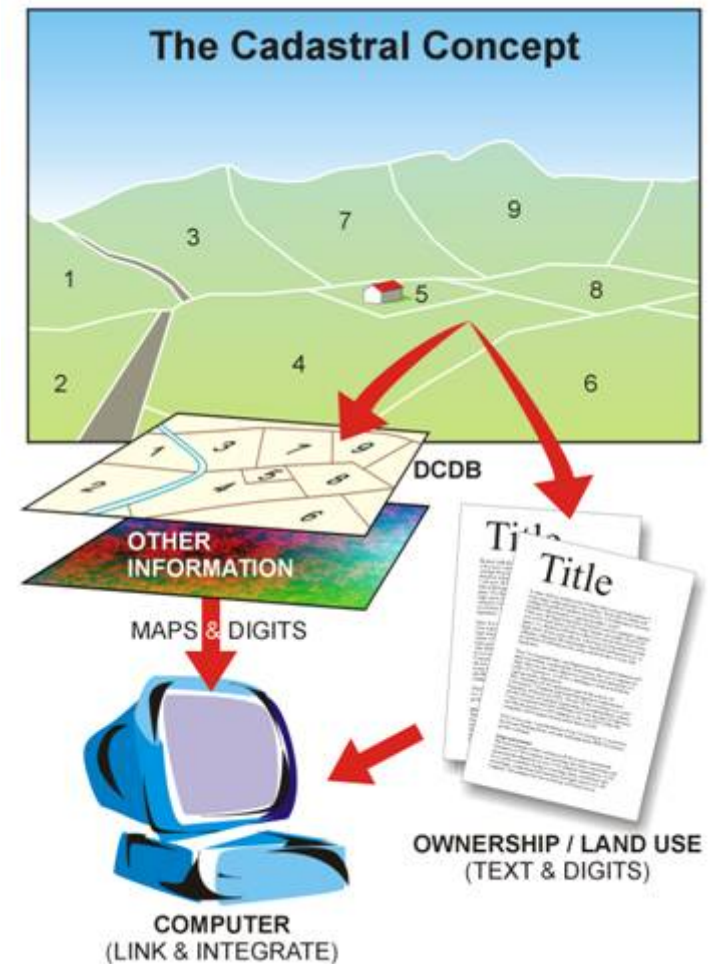


SLA's Vision and Roles

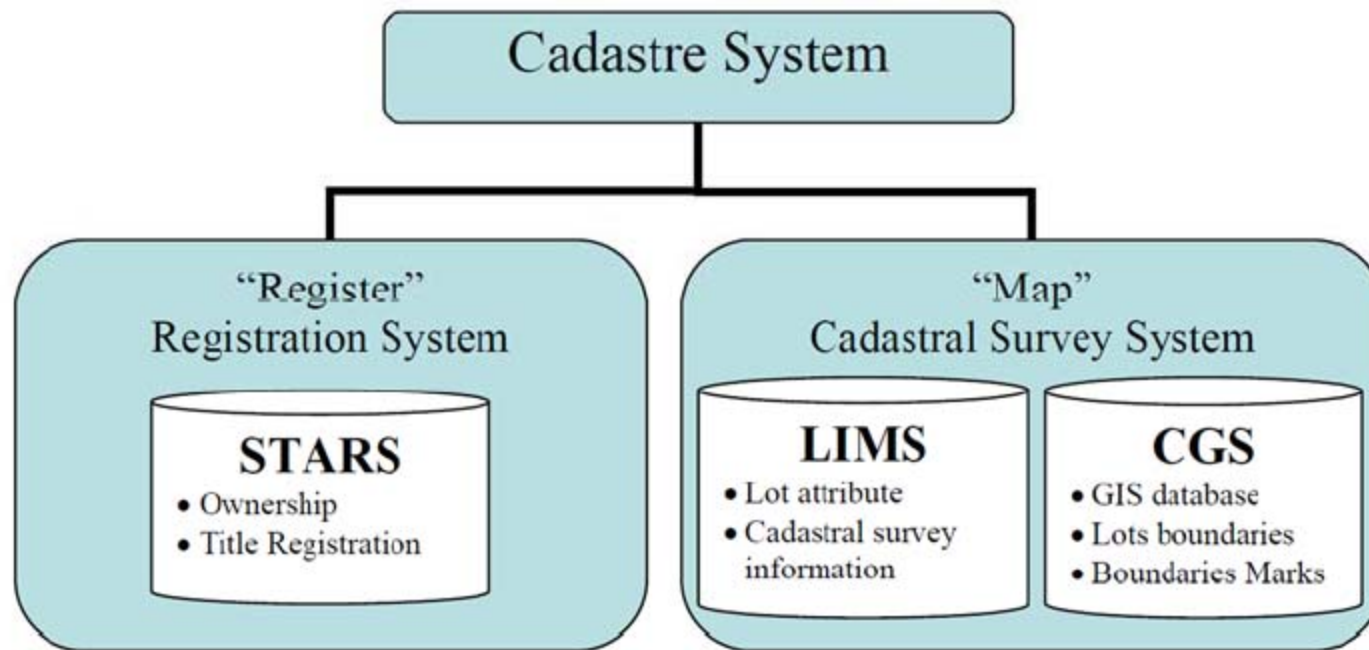
- Limited Land • Unlimited Space
- Mission – To optimise land resources for the economic and social development of Singapore
- Role
 - Manager of State land and properties
 - Regulator of cadastral survey and land Registration
 - Creator and provider of land information

Cadastral System in Singapore

- Property ownership framework
- Torrens system
 - The register: Registration of Titles
 - The map: Cadastral Survey
- Characteristics
 - Multipurpose Cadastre
 - Fixed boundaries
 - Rigorous inspection
 - Legislation



Cadastral System in Singapore



Cadastral Survey Development – last 18 years

Modern Cadastral Survey System (1992 -2010)

GPS Technology / Infrastructure

- Primary Triangulation with GPS technology (1992)
- Secondary control network known as Integrated Survey Network (ISN) (1995)
- Establishment of SIMRSN for DGPS applications (1999)
- Implementation of SiReNT CORS network (2006)

Co-ordinated Cadastre

- New local co-ordinate system, SVY21 (1995)
- Coordinated Cadastre pilot study (1996)
- Review of the survey directive based on Co-ordinated Cadastre concept (1998)
- Cadastre data conversion (1999)

Information / GIS Technology

- Electronic Submission via CORENET (2004)
- Job Data Storage System (JDS) (2004)
- Consolidated GIS System (CGS) (2004)
- Lot Information Management System (LIMS) (2011)

Regulations

- 1998 – Boundaries and Survey Maps Act (BSMS) - Coordinated Cadastre
 - Use of GPS technology
 - Electronic submission of cadastral survey
- 2000 – LSA amended to include all types of land survey work

Need for “The Map”

- To provide certainty in title registration
 - Legal requirement under Lands Title Act and Strata Title Act
 - Requirement under Torrens System
 - Property boundary security
 - Provide legal traceability
- To maintain National Digital Cadastre Database
 - Legal national record to safeguard ownership
 - Key information for national development planning and sustainability

State Lands Act

- **3A.** *State lands which are alienated or otherwise disposed of, or in respect of which a lease or license to occupy is issued, under this Act may be alienated, leased or licensed —*
 - *(a) as a parcel of the surface earth, all substances thereunder and so much of the column of airspace above the surface as is reasonably necessary for the use and enjoyment thereof;*
 - *(b) as a parcel of airspace or subterranean space, whether or not held apart from the surface of the earth; or*
 - *(c) only down to such depth below the surface earth as the President may by order direct.”*

Land Titles (Strata) Act

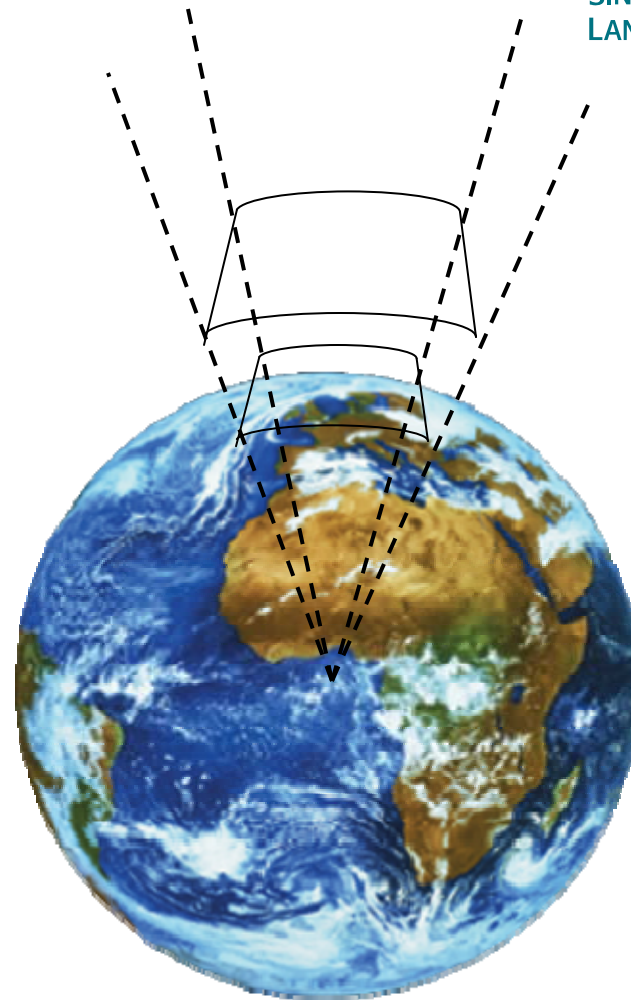
- The Land Titles (Strata) Act (Chapter 158) came into effect in 1967 to facilitate the subdivision of building or land into strata units

Type of Property Parcels

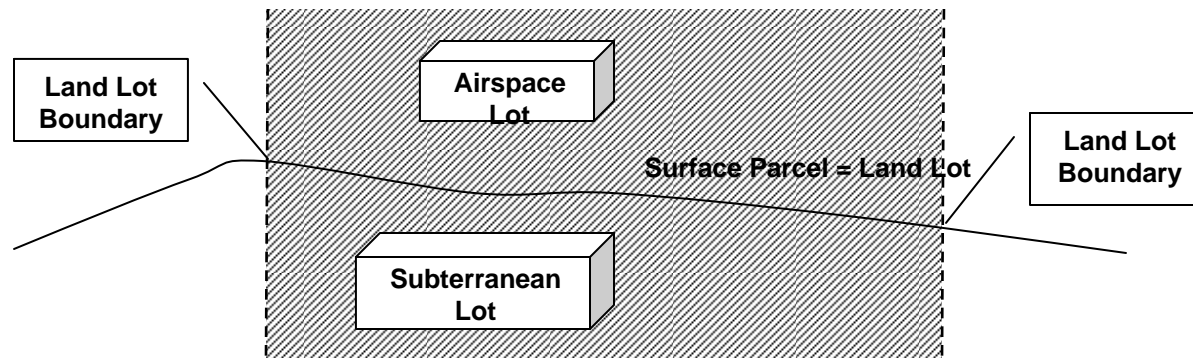
- The law allow for creation of 5 types of property parcels
 - land;
 - airspace;
 - subterranean;
 - strata, and
 - accessory lots.

Land Lot - Concept of Ownership

- 2D Cadastre - one owned everything from the centre of the earth to the heaven



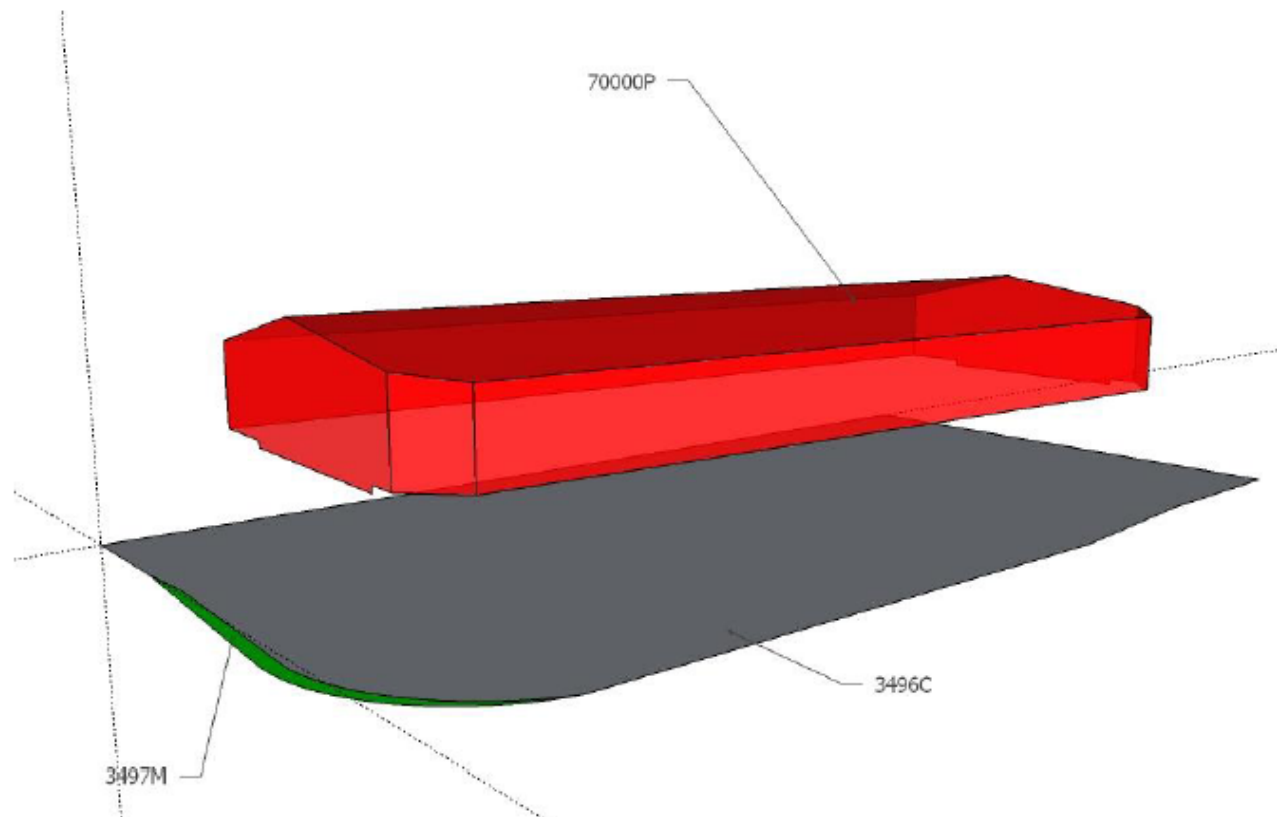
Concept of Airspace and Subterranean Lots



Train Station - Airspace Lot

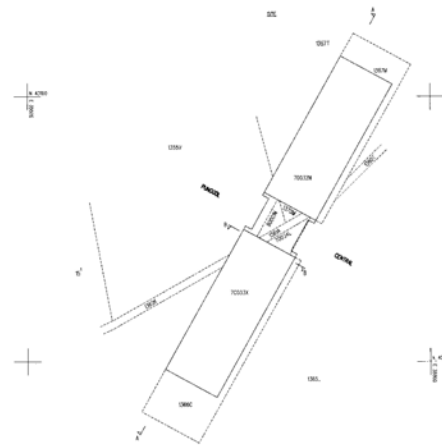
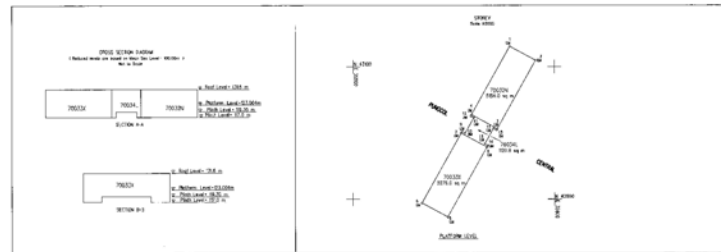


Airspace Lot



Airspace / Subterranean Certified Plan

Lot No.	Lot Area	Remarks
70020A		Part of Airspace Lot
70020B		Part of Airspace Lot
70020C		Part of Airspace Lot



ALL INFORMATION SHOWN ON THIS PLAN IS FOR THE PURPOSE OF THE AIRSPACE / SUBTERRANEAN CERTIFICATION ONLY. IT IS NOT TO BE USED FOR ANY OTHER PURPOSE.	Project No. 80032	Scale: 1:1000	DATE: 11/01/2023
Drawn by: [Signature]	Checked by: [Signature]	Approved by: [Signature]	Project Manager: [Signature]
Checked by: [Signature]	Checked by: [Signature]	Checked by: [Signature]	Checked by: [Signature]
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80032

SCALE: 1:1000

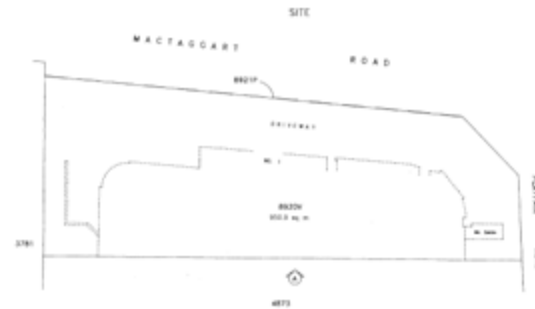
Strata Subdivision



Strata Certified Plan

Building No.	On Lot	On Plan	Building Subdivided into Strata Lots
1	#920V	35877	U35270A to U35270F

Typical Storey



STOREY

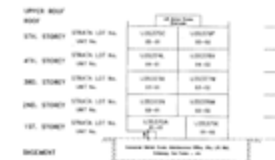


1st STOREY



TYPICAL STOREY

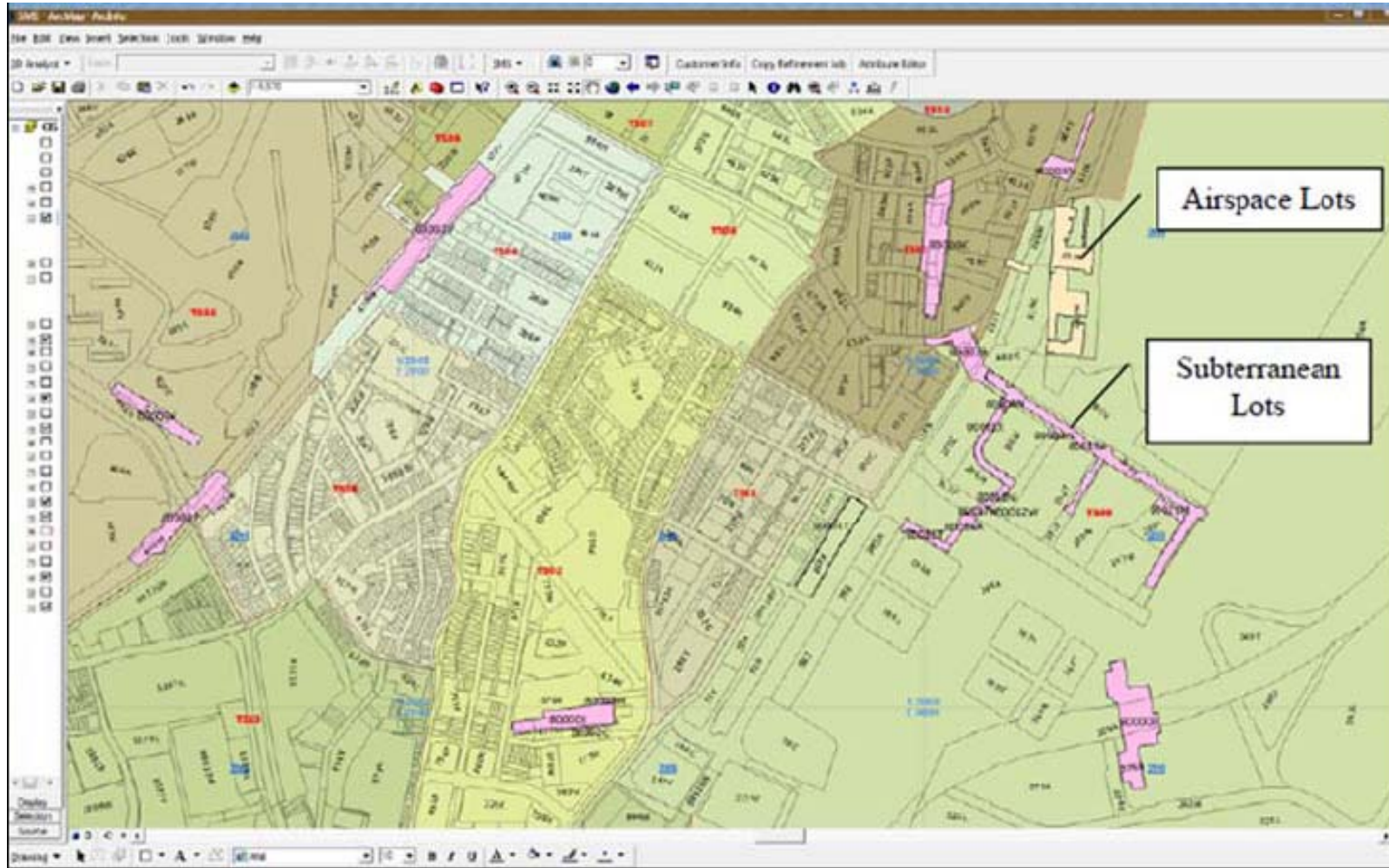
Representing Strata Lots from Unit 1 to 100, Strata Lot 101 (Common)



ELEVATION SKETCH SHOWING STRATA LOTS & UNIT NOS.

Prepared by: Mr. Tan Joo Koh Date: 14/08/2018	Drawn by: [Signature] Date: 14/08/2018	Checked by: [Signature] Date: 14/08/2018	Approved by: [Signature] Date: 14/08/2018
Checked by: Mr. Tan Joo Koh Date: 14/08/2018	Drawn by: [Signature] Date: 14/08/2018	Checked by: [Signature] Date: 14/08/2018	Approved by: [Signature] Date: 14/08/2018
Scale of Storey Plan: 1:100	Scale of Typical Storey Plan: 1:100	Scale of Elevation Sketch: 1:100	Scale of Site Plan: 1:100
MURKIN NO. 24		ST.35822	

The Cadastral Map - GIS



So, what is the problem?



Underground Development Connected to Subway Station



ION Orchard

Inter-locking Development

The Interlace Condominiums



Complex Architecture

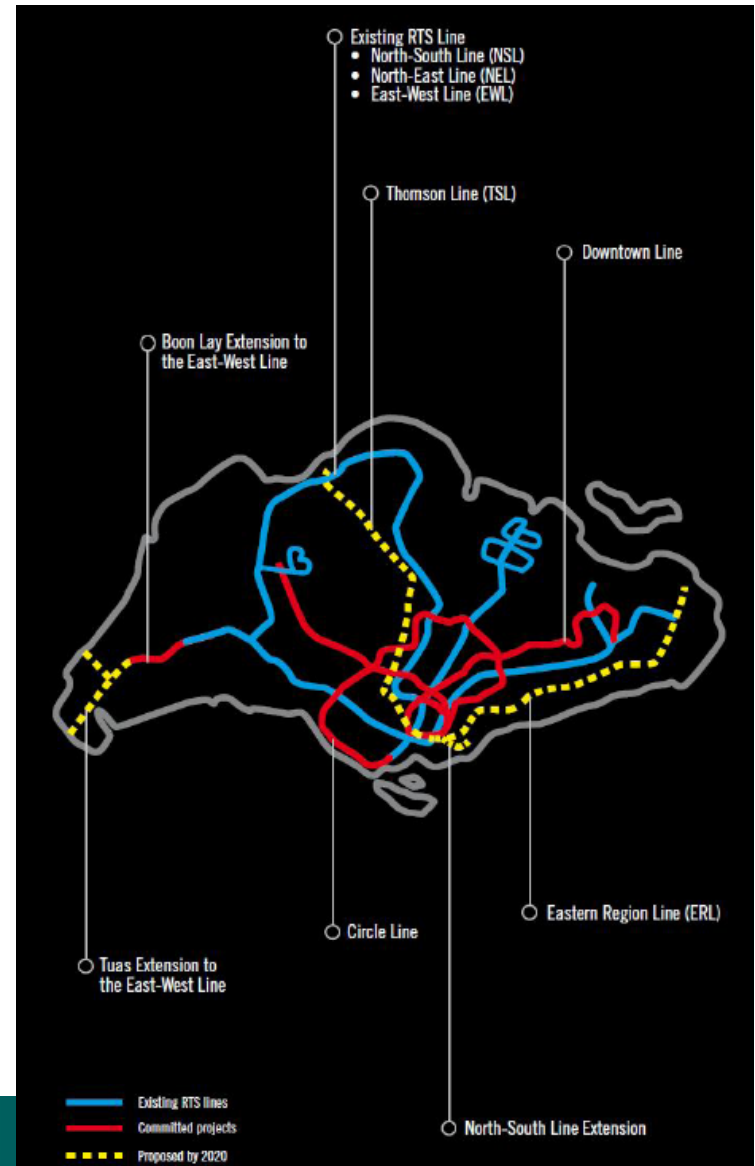


Complex Architecture



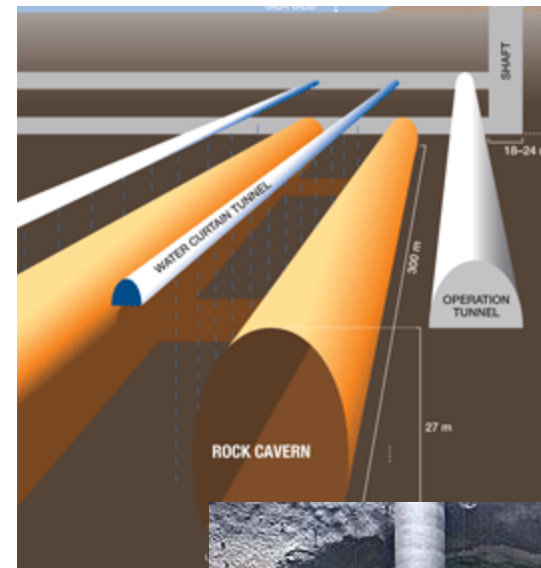
Train Stations Development

- More above ground and underground MRT station developments

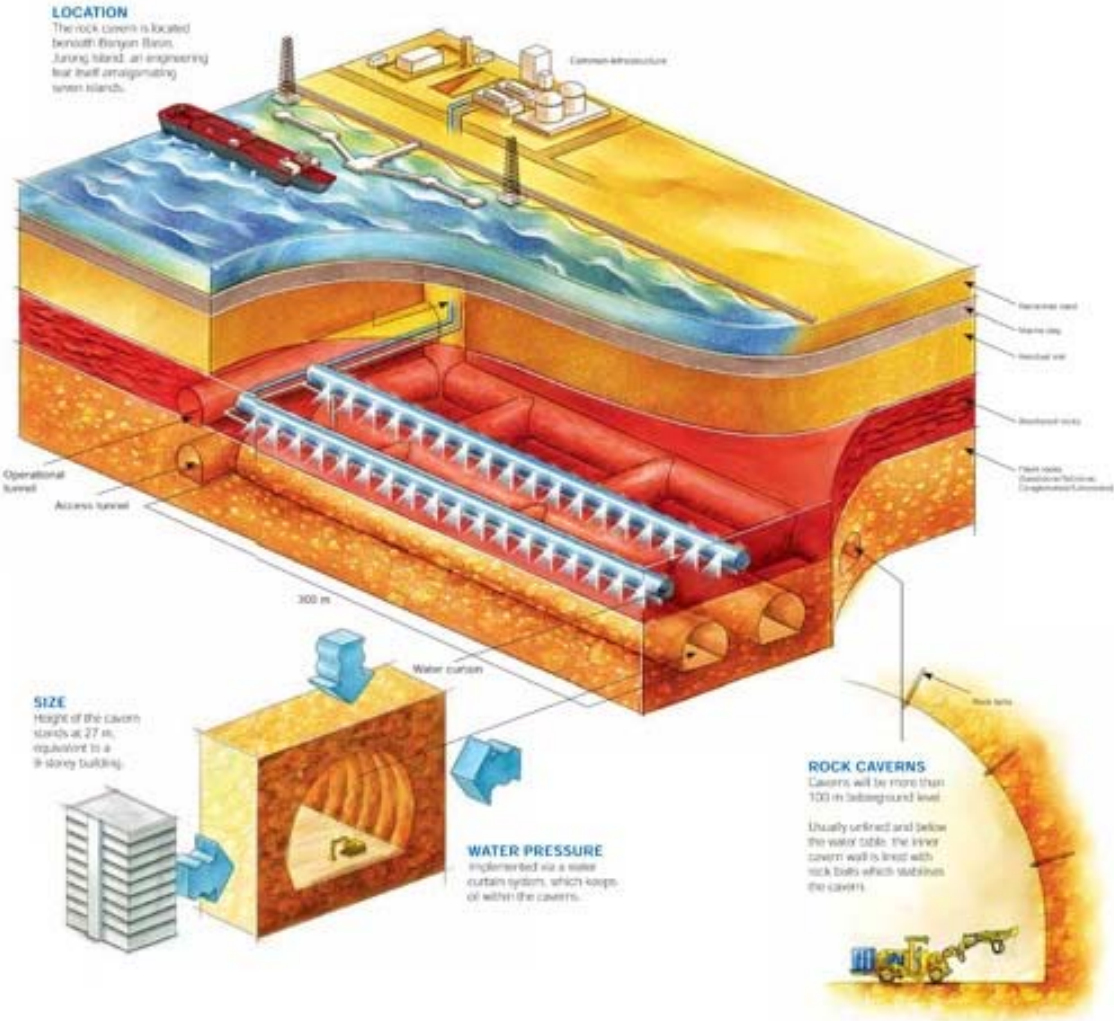


Underground Rock Cavern

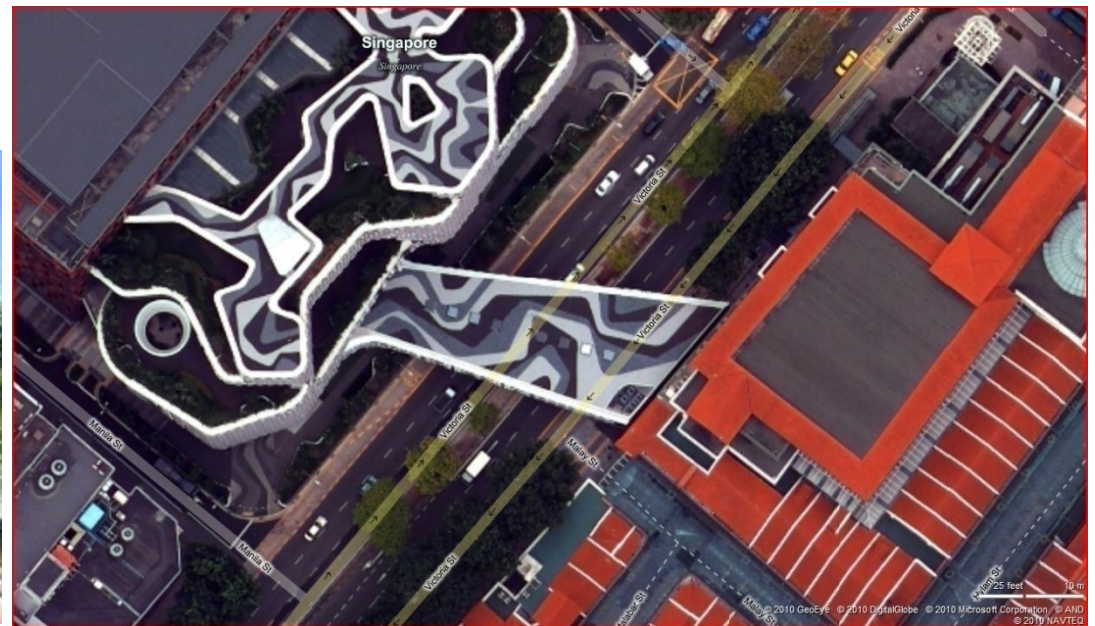
- Jurong Rock Cavern, South-east Asia's first underground rock cavern for oil storage



Complex Industry Development



Walkway Link Above Road



Mixed Development



Toa Payoh Bus Interchange



What is the Problem?



Defining the 3D Problem in the Cadastre

- Unable to catch up with creative land developments
 - Design of buildings becoming very creative and complex
- Underground spaces are heavily used in future and such constructions are getting closer to each other
 - Boundary inaccuracies of the underground space will cause neighborly disputes and encroachment issues
- All strata boundaries are not captured in GIS
 - It is impossible to do any substantial or effective spatial planning and analysis
 - Inadequate information to support national development
- Current subterranean and airspace survey method not rigorous and data captured in 2D GIS format
 - Inadequate information for new alienation
 - Inadequate information to support national development

Need for 3D

- The existing cadastral survey system is inadequate to support the rapid and dense development in our city state
 - not able to support the modelling of complex volumetric parcels that overlaps and interlock with each other.
- Industry demand should be the key driver for 3D cadastre in Singapore.
 - Architect and engineers has also started to use 3D design tools in their work.
 - In productivity drive, building and planning authorities have also started to require design submission in 3D BIM format.
- Cadastral survey system and processes needs to stay relevant with the market to support its stakeholders.

Do we already have 3D cadastre in Singapore?

3 major components of our Cadastre System

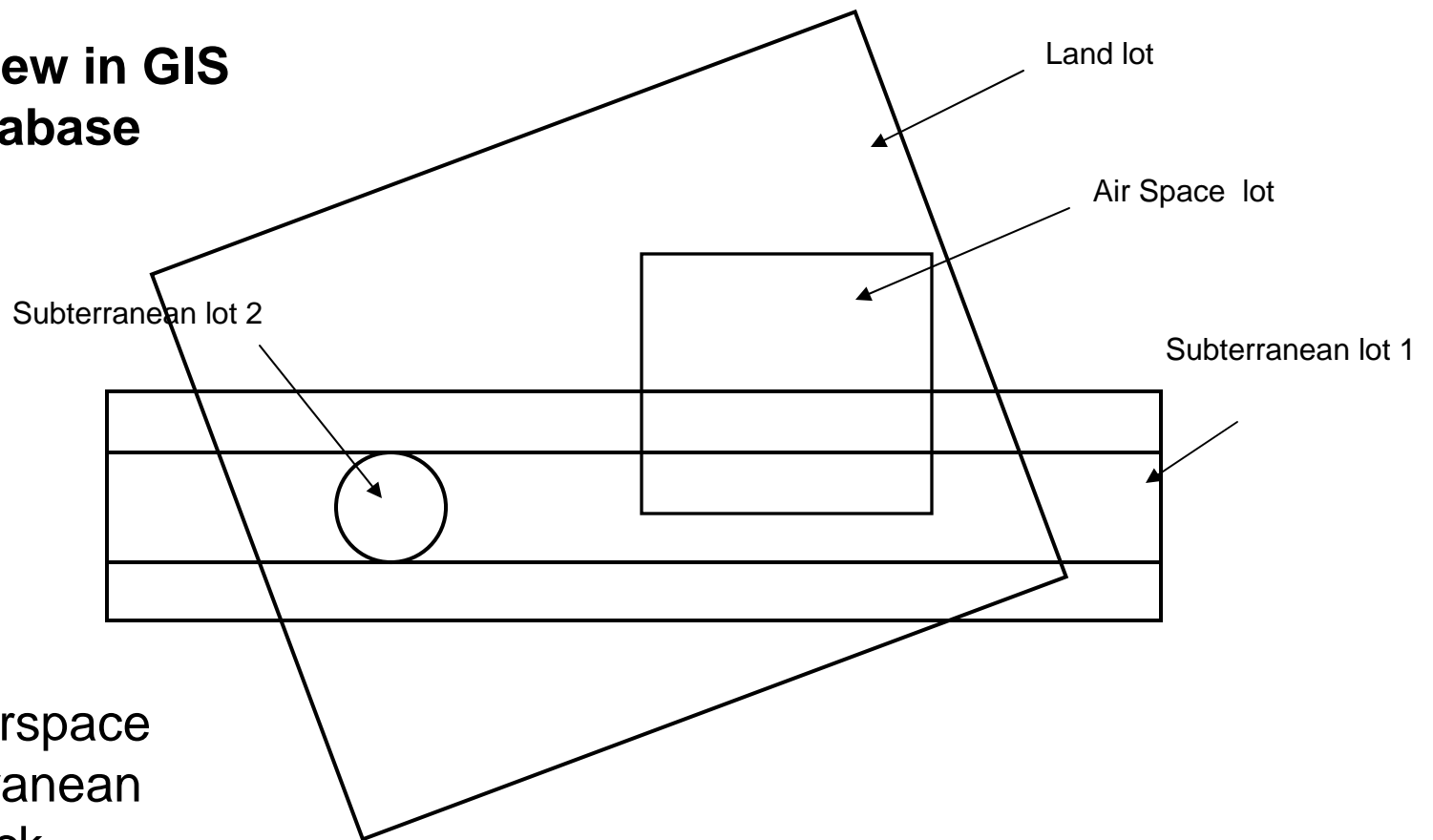


Where do we go from here?



2D Information

Plan View in GIS database

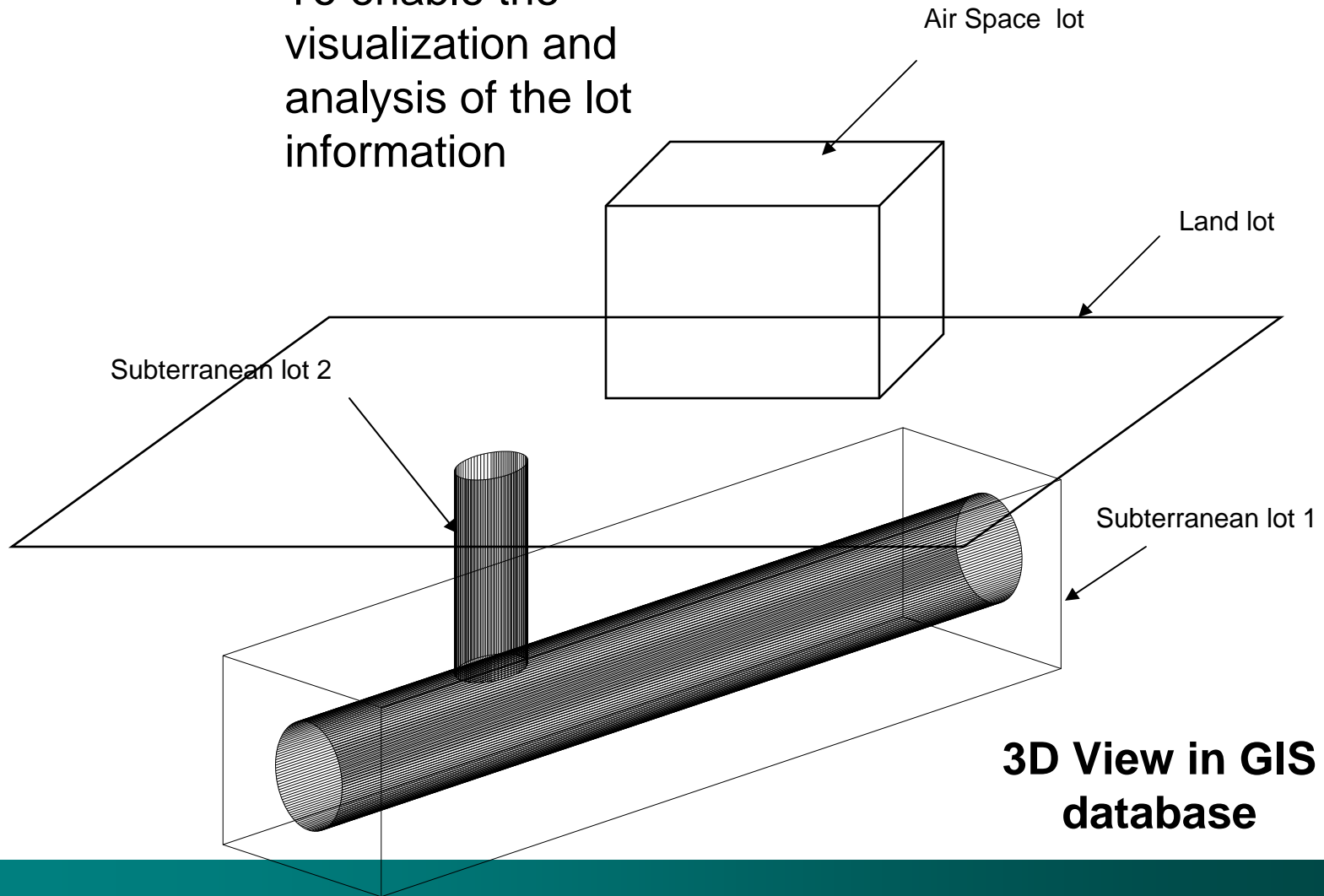


Complex airspace
and subterranean
lots inter-lock

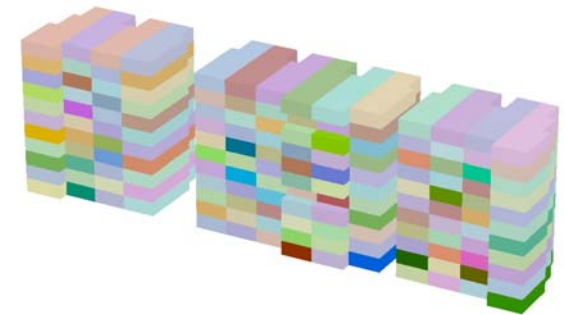
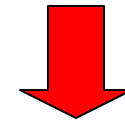
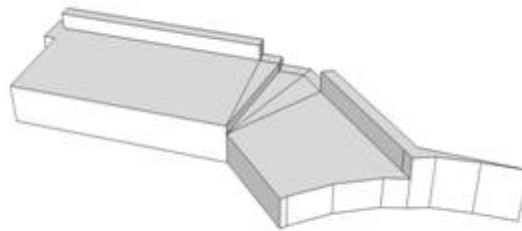
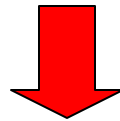
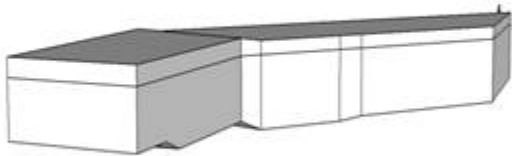
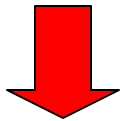
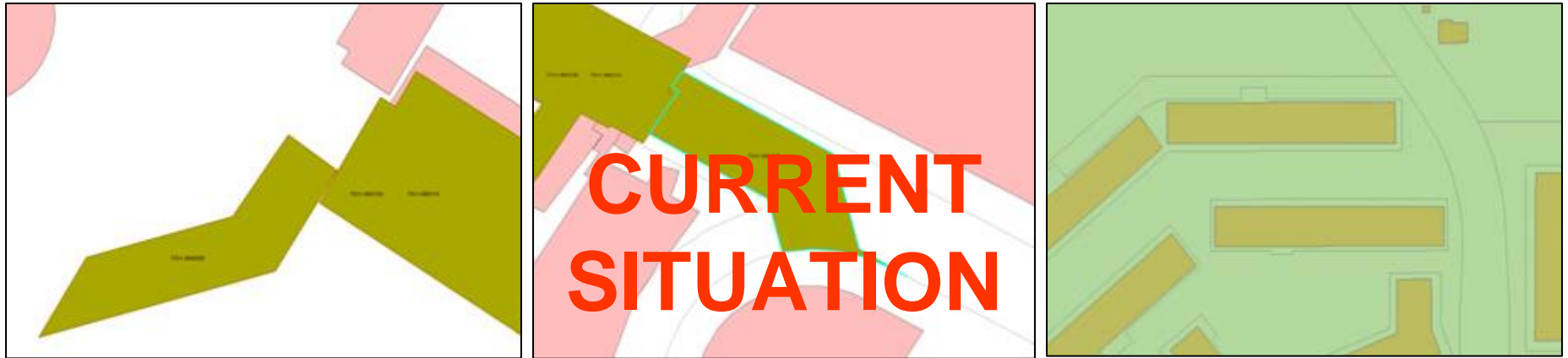
E.g. City Link, MRT
stations & underpasses

3D Information

To enable the visualization and analysis of the lot information

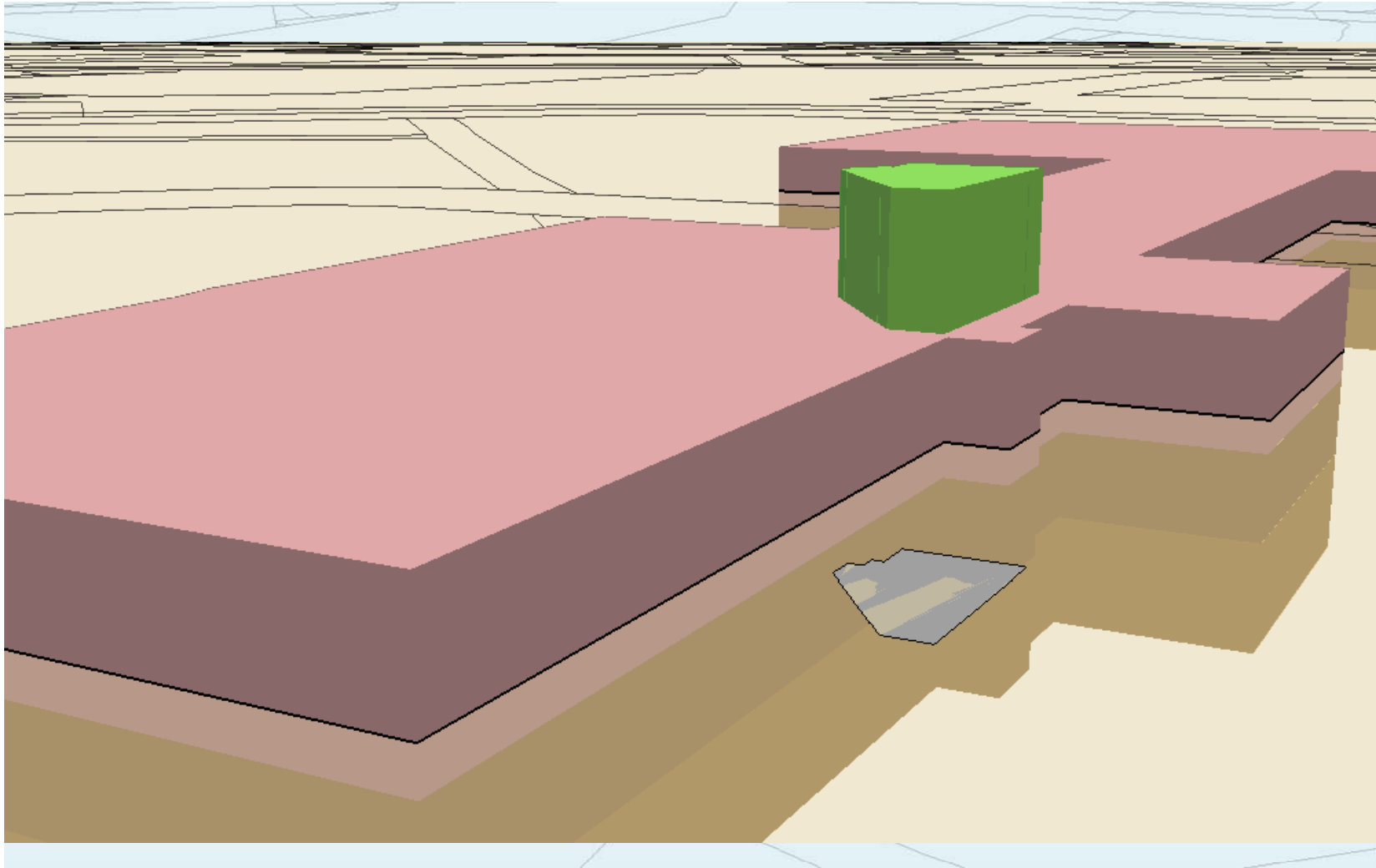


2D GIS to 3D GIS

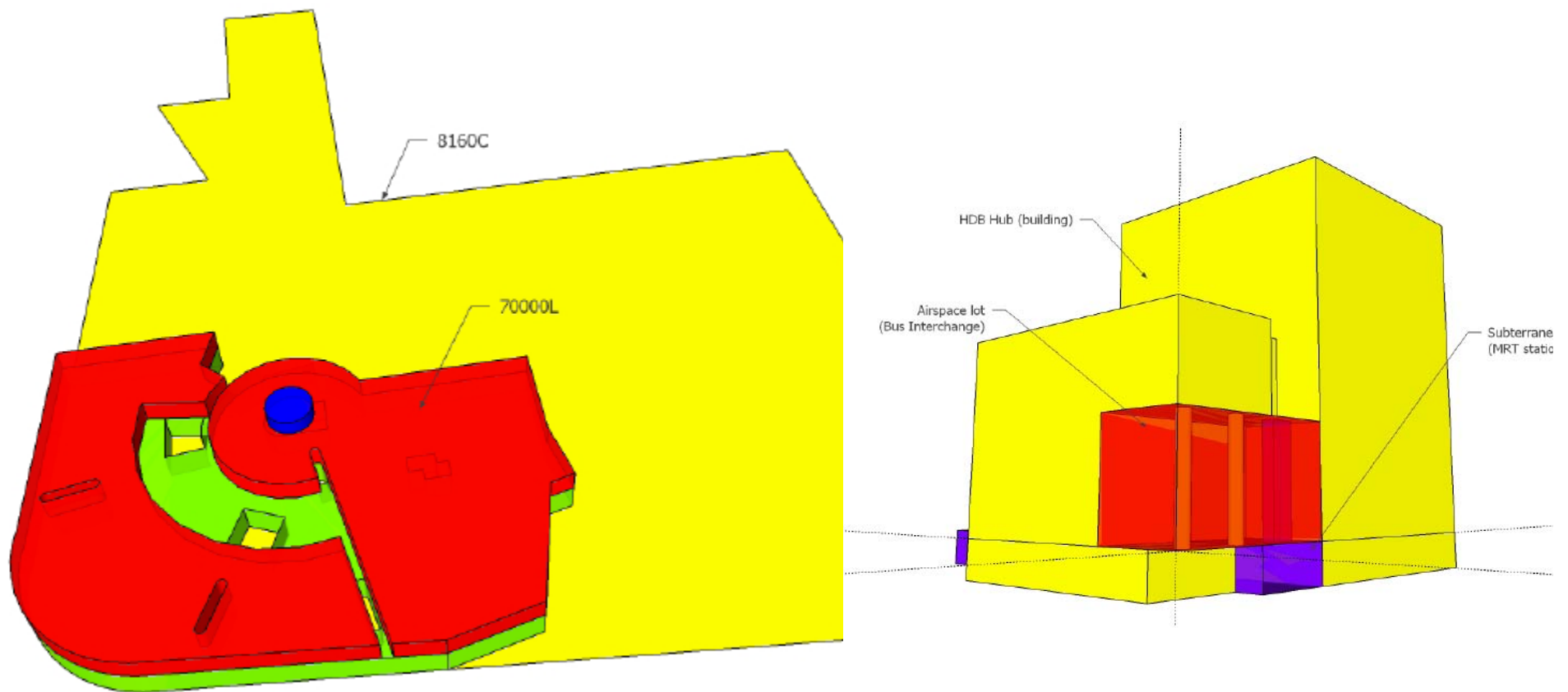


REALITY

3D GIS Visualisation



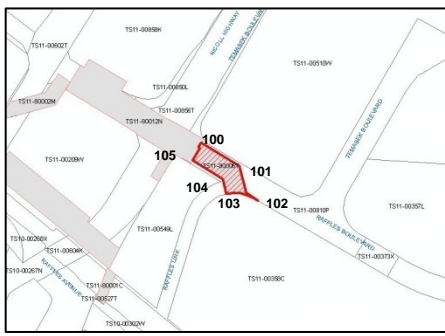
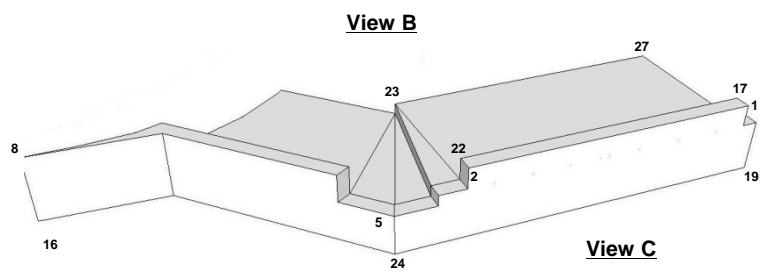
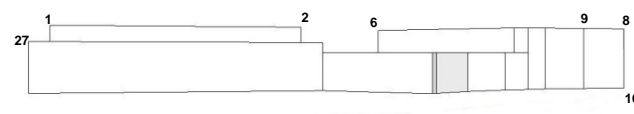
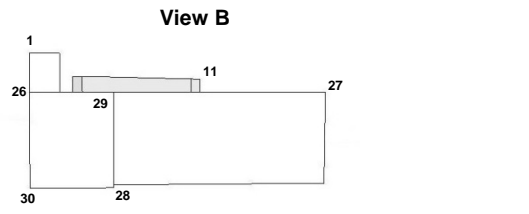
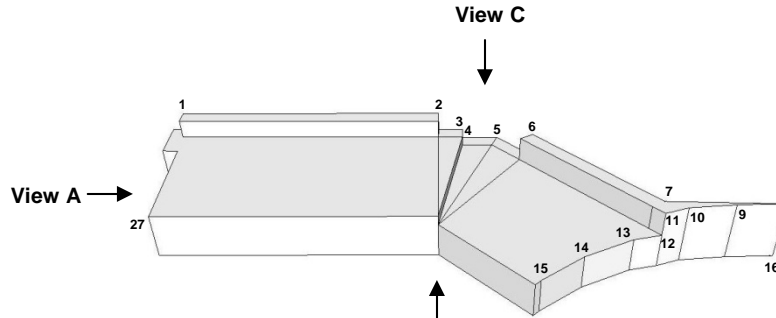
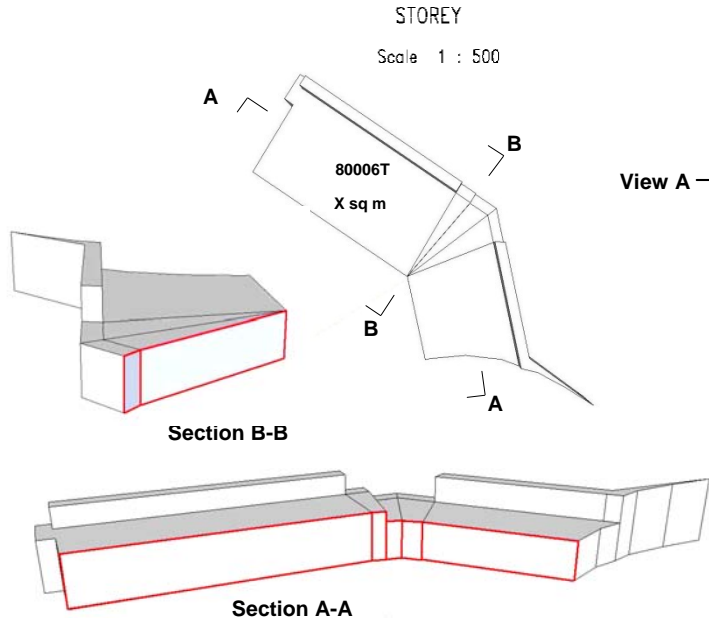
3D GIS Analysis



Survey Plan

Lot No.	On Plan	Remarks
80006T		Allotted For Subterranean Lot

Building No.	On Lot	Storey	Area (sq m)	Volume (cubic m)
	80006T	Pedestrian Underpass	1603.0	XYZ



Ground information

Pt	RL
100	Z
101	Z
102	Z
103	Z
104	Z
105	Z
106	Z
107	Z
108	Z
109	Z

	Northin	Easting	RL	
1	g	Y	X	Z
2	Y	X	Z	
3	Y	X	Z	
4	Y	X	Z	
5	Y	X	Z	
6	Y	X	Z	
7	Y	X	Z	
8	Y	X	Z	
9	Y	X	Z	
10	Y	X	Z	
11	Y	X	Z	
12	Y	X	Z	
13	Y	X	Z	
14	Y	X	Z	
15	Y	X	Z	
16	Y	X	Z	
17	Y	X	Z	
18	Y	X	Z	
19	Y	X	Z	
20	Y	X	Z	
21	Y	X	Z	
22	Y	X	Z	
23	Y	X	Z	
24	Y	X	Z	
25	Y	X	Z	
26	Y	X	Z	
27	Y	X	Z	
28	Y	X	Z	
29	Y	X	Z	
30	Y	X	Z	
31	Y	X	Z	
32	Y	X	Z	
33	Y	X	Z	
34	Y	X	Z	
35	Y	X	Z	
36	Y	X	Z	
37	Y	X	Z	
38	Y	X	Z	
39	Y	X	Z	
40	Y	X	Z	
41	Y	X	Z	
42	Y	X	Z	
43	Y	X	Z	
44	Y	X	Z	
45	Y	X	Z	
46	Y	X	Z	
47	Y	X	Z	
48	Y	X	Z	
49	Y	X	Z	
50	Y	X	Z	
51	Y	X	Z	
52	Y	X	Z	
53	Y	X	Z	
54	Y	X	Z	
55	Y	X	Z	
56	Y	X	Z	
57	Y	X	Z	
58	Y	X	Z	

RL is based on Survey Department Height Datum

Development of 3D Cadastre

- Improve our cadastral survey processes to capture 3D information in GIS
 - Data acquisition
 - Data management
 - Data visualization
- Collect sufficient information for 3D GIS to support national development

Implementation Plan

- Consultation and awareness for stakeholders
 - Surveyors
 - Developers / property owners
 - Related agencies
- Conservative implementation plan
 - Phase 1 - Feasibility study and requirement gathering
 - Phase 2 - Pilot Project
 - Phase 3 – Actual Implementation which include data conversion, system development and changes to current process

Concluding Remarks

- Cadastral Survey information will continue to play important role as the base map / base information for national development
- The future 3D Cadastre information will be the fundamental information for building virtual Singapore

Thank You

