

TASK FORCE ON LAND SUPPLY

Making Use of Rock Caverns and Underground Space

PURPOSE

This paper provides Members with an overview of (a) the Government's ongoing initiatives for the use of rock caverns and underground space in Hong Kong; and (b) the opportunities and challenges in making use of rock caverns and underground space as a source of land supply for development.

BACKGROUND

2. Rock caverns and underground space are viable sources of land supply, which can provide solution space for a broad variety of land uses and help address problems encountered in the congested urban environment. The enhanced use of these hidden land resources may offer opportunities for Hong Kong's planning and development gains. Since 2010, the Government has launched a number of strategic studies and pilot projects to explore the potential of systematic utilization of rock caverns and underground space. The intention is to formulate a holistic and long-term plan for wider applications of rock caverns and underground space in Hong Kong to create capacity for Hong Kong's sustainable growth.

Rock Cavern Development

3. In Hong Kong, the hilly terrain with strong rocks is highly suitable for developing rock caverns, particularly on the urban fringe. In the 1990s, there were a number of Government facilities purpose-built in rock caverns to meet the needs of the community while overcoming the lack of suitable surface sites at the locality, namely the Stanley Sewage Treatment Works, Island West Transfer Station and Kau Shat Wan

Government Explosives Depot. In 2009, the University of Hong Kong constructed rock caverns to re-house the Western Salt Water Service Reservoirs in order to release land for the Centennial Campus development. These projects have demonstrated that rock caverns can be a land supply option, while yielding additional safety, environmental and security benefits to suit specific needs.

4. In March 2010, the Civil Engineering and Development Department (CEDD) undertook the “*Enhanced Use of Underground Space in Hong Kong – Feasibility Study*” (**Cavern Feasibility Study**) to explore the opportunities of enhancing effective use of land resources through planned development of rock caverns. The study, completed in March 2011, demonstrated the broad viability of cavern development for a range of facility types and in different geographical areas. The study also identified key issues that would need to be addressed in developing caverns in a planned manner.

5. To follow up the findings of the Cavern Feasibility Study, CEDD carried out a study on “*Long-term Strategy for Cavern Development – Feasibility Study*” (**Strategic Cavern Study**) from September 2012 to March 2017, with the intention of formulating a holistic approach in planning and implementing rock cavern development for expanding land resources. With the support of the study findings, a suite of initiatives has been formulated to facilitate long-term systematic use of rock caverns in Hong Kong. Basically, the suite of initiatives is two-faceted.

6. Firstly, the Government has prepared a territory-wide Cavern Master Plan (CMP) to guide and facilitate wider application of cavern development in Hong Kong (**Annex**). The CMP delineates Strategic Cavern Areas (SCVAs) that are physically well placed for cavern development and provides general guidelines on project implementation, which can enable project proponents to identify suitable cavern sites for development. The Government will, as pilot, select suitable SCVAs and conduct early land use planning and zoning for coping with potential development needs.

7. Secondly, the Government will explore using caverns for accommodating suitable Government facilities and infrastructures. In this regard, for new projects involving sewage treatment works, refuse transfer stations and service reservoirs for which suitable cavern sites can be identified, the project proponents shall carry out cavern option assessment in the early planning stage. Besides, the Government has

identified some existing sewage treatment works and services reservoirs in Tsuen Wan, Shatin, and Kowloon areas for studying their feasibility of relocating to caverns nearby, with an aim to make way for housing or other beneficial uses¹. These facilities are all located in the built-up areas with established supporting infrastructure network. The released sites are therefore of high development potential and can create synergy effect with the adjoining districts. Moreover, the potential of cavern development for integrating with surface and subsurface developments will be holistically considered in the planning and land development studies in order to fully capitalise on the benefits and synergy effect.

8. Based on the Strategic Cavern Study, there is a potential for integrating underground quarrying with development of a cavern land bank. With proper planning and design of underground quarries, usable cavern space can be formed to accommodate a variety of public or private sector facilities that could bring about benefits in terms of long-term land supply. In April 2017, CEDD commenced a two-year “*Technical Study on Underground Quarrying in Hong Kong – Investigation*” to establish the feasibility and various implementation requirements. Subject to the outcome of the study, the Government will consider launching pilot underground quarrying schemes at suitable sites.

Underground Space Development

9. Hong Kong has been using underground space for commercial developments, community and transport facilities for many years. However, most of them were carried out under individual projects, such as basement car parks, shopping arcades, subways and railway stations and tunnels. There has been a lack of holistic planning strategy from a macro multi-level perspective, which includes the consideration of underground space creation and connections. From overseas examples, underground planning and effective use of underground space could enhance the connectivity with the surroundings, improve at-grade urban environment, create space for various commercial and public facilities, and in overall term optimise the development potential of scarce land resources.

10. In an attempt to exploit the potential of systematic use of underground space resources in a comprehensive manner, CEDD with the

¹ The concerned existing Government facilities included: Sha Tin Sewage Treatment Works, Diamond Hill Fresh Water and Salt Water Service Reservoirs, Yau Tong Fresh Water and Salt Water Service Reservoirs, Tsuen Wan No. 2 Fresh Water Service Reservoir and Sham Tseng Sewage Treatment Works.

inputs of Planning Department commissioned two studies viz. (i) *“Territory-wide Study on Underground Space Development in the Urban Areas of Hong Kong – Feasibility Study”* (**Territory-wide Study**); and (ii) *“Pilot Study on Underground Space Development in Selected Strategic Urban Areas – Feasibility Study”* (**Pilot Study**).

11. The Territory-wide Study, commenced in December 2013, is a scoping study for identifying the key issues, opportunities and constraints of implementing underground space development in the urban context of Hong Kong. Completed in March 2017, the Territory-wide Study revealed that underground space development is technically feasible in the urban setting of Hong Kong. The Territory-wide Study suggested that, in the long run, underground space development could be an added source of solution space for suitable land uses in congested urban environment, and help alleviate the limitation on land resources and enhance connectivity in the congested district. However, the development potential of individual areas may be subject to various constraints in the existing urban context (e.g. land ownership issues, obstruction by underground structures). Technically speaking, there may be fewer constraints on developing underground space in new development areas (NDAs) and large-scale comprehensive development/redevelopment areas (CDAs). Advanced and holistic planning for underground space development in NDAs/CDAs, particularly at the early planning stage, may be worthy of pursuance.

12. As to the Pilot Study, four urban areas, viz. Tsim Sha Tsui West, Causeway Bay, Happy Valley and Admiralty/Wan Chai, have been selected to investigate in detail how to exploit underground space resources to address various district problems. These areas are all located within the dense urban core of Hong Kong. The heavy pedestrian and vehicular traffic flows in these districts have resulted in a very congested environment. Besides, given the already compact development form, there is limited scope for creating additional space in these areas to meet various community and economic needs except by underground space development.

13. The Pilot Study commenced in June 2015 for completion in 2018. The study seeks to (i) evaluate the overall merits and identify key issues of developing underground space in the four selected urban areas; (ii) formulate Underground Master Plans for these areas; and (iii) draw up suitable underground space development proposals for possible future implementation. The Pilot Study includes a two-stage public engagement (PE) programme. The first-stage PE (PE1) was conducted

from November 2016 to February 2017 with the focus on the opportunities, constraints and key considerations for developing underground space in the selected urban areas. Taking account of the comments received during PE1, suitable conceptual schemes of underground space development, with requisite assessments on various aspects, are being developed to evaluate the viability of the proposals. After that, the second-stage PE (PE2) will be launched to gather public views on the proposed conceptual schemes.

POTENTIAL FOR DEVELOPMENT

Rock Cavern Development

14. In the Hong Kong context where land shortage is a significant problem, cavern development could be a technically viable land supply option in conjunction with other above ground options. As aforementioned, relocation of suitable existing Government facilities to caverns can release surface sites for housing or other beneficial uses and can remove incompatible land uses by placing unpopular facilities in caverns. Rock caverns can also provide solution space to accommodate suitable public and private sector facilities where there is shortage of available surface land, thereby reducing further land take.

(A) Potential Land Uses

15. There are various potential land uses which are considered suitable for rock caverns. Besides the local experience to use rock caverns for accommodating public facilities as mentioned in paragraph 3, overseas experience demonstrates that the applicability of cavern development can extend to a wide variety of beneficial uses that meet the development need of the society, such as (i) community and recreational facilities (sports centre, swimming complex); (ii) storage facilities (archives, food, wine, oil and gas); (iii) commercial and industrial facilities (data centres, logistics/ warehousing, maintenance depots); and (iv) special facilities (e.g. columbaria, testing laboratories).

16. Introducing wider cavern usage would help accommodate some facilities that have difficulty in finding suitable surface sites (e.g. maintenance depots, sewage treatment works and columbaria) and cater for others that could be benefited from the stable and secure environment underground (e.g. archives, warehousing, laboratories and data centres).

(B) Potentially Developable Areas

17. In the CMP, the Government has identified a number of SCVAs that are considered potentially, technically and strategically developable as rock caverns (**Annex**). Future proposals of suitable projects for cavern development within these areas, including the sizes and locations, should be subject to the need and detailed technical feasibility studies.

(C) Challenges

18. Development of caverns is costly and lengthy. Cost-wise, the development cost of individual cavern projects may vary, depending upon a host of factors including site situations, geotechnical conditions, environmental considerations and the specific land uses. Comparing with other pursuable land development measures, cavern development option may perhaps be the most costly one in terms of per square meter of floor area. Time-wise, rock cavern development may likely involve statutory procedures (e.g. those under Environment Impact Assessment Ordinance², Country Parks Ordinance³, Town Planning Ordinance, and so forth). Together with the cavern construction and associated engineering works which may vary with project scale and technical complexity⁴, a cavern development project may take a long lead time of 10 to 15 years from its conception to realisation. In terms of space creation under the same period of time and budget, cavern option may likely create much less space than other land supply options (e.g. rezoning, reclamation). As a matter of fact, cavern development cannot offer a quick fix to the imminent problem of shortage of developable land, particularly when the subsurface land created by caverns is not suitable for residential uses. Under the Government's multi-pronged strategy⁵ to increase land supply, rock caverns are therefore positioned as a sustainable source of long-term land supply to supplement other short- and medium-term land development options.

² Rock cavern development is a Designated Project under the Environment Impact Assessment Ordinance.

³ Relevant to development of rock caverns within Country Parks.

⁴ Cavern development involves technical issues such as fire safety, geotechnical and environmental concerns, etc.

⁵ The Government adopts a multi-pronged strategy to increase land supply in the short, medium and long term, through the continued and systematic implementation of a series of measures, including the optimal use of developed land as far as practicable and identification of new land for development.

Underground Space Development

(A) Potential Land Uses

19. Similar to rock caverns, underground space can offer an alternative source of land for different uses. Albeit overseas experience displays a wide range of potential usages of underground space development, their applicability to Hong Kong is much limited by the local densely developed and populated urban settings. Nevertheless, as aforementioned in paragraph 11, the Territory-wide Study suggested that, in the long run, underground space development could help alleviate the limitation on land resources and enhance connectivity in the congested districts through formation of underground linkage networks. Where public desires and individual site situations permit, underground space development may pursue further opportunities for creation of additional space underground to, where appropriate, accommodate community and recreational facilities, provide covered public space where at-grade space is lacking, offer land for retail and other commercial activities as well as space for other uses which complement, or even enhance, the existing context of the urban areas.

(B) Challenges

20. Underground space development in urban areas is usually restrained by various constraints arising from the built environment⁶, which limit the availability of developable sites and scale of development. Besides, long lead-time and substantial cost may be required to resolve various technical and implementation issues for underground space development, such as fire safety, land ownership and town planning issues, interfaces with existing underground uses (e.g. rail stations), impact on above-ground facilities, nuisance to public, the heavily front-loaded development cost, facilities management and maintenance arrangements. In addition, in comparison with above-ground structures/facilities, operation and maintenance cost of underground building facilities and structures are bound to be higher.

⁶ The constraints in built environment include building foundations, underground utilities and rail stations/tunnels, as well as narrow streets, busy traffic environment, mixed and/or divided land ownerships, etc.

VIEWS FROM STAKEHOLDERS/COMMUNITY

21. Under the *“Increasing Land Supply by Reclamation and Rock Cavern Development cum Public Engagement – Feasibility Study”* commissioned by CEDD in 2011, public engagement had been conducted to gather public views on the multi-pronged land supply approach. The results revealed that there was a broad support for a multi-pronged strategy to increase land supply⁷, including rock cavern development to which the public was generally receptive. Nevertheless, there were also site-specific public concerns expressed on the projects for relocation of existing sewerage treatment works and services reservoirs to caverns. These concerns are mostly related to potential odour and traffic impacts, disturbance of blasting vibration on nearby buildings and structures, environmental nuisance (e.g. dust and noise), lengthy and costly construction, etc.

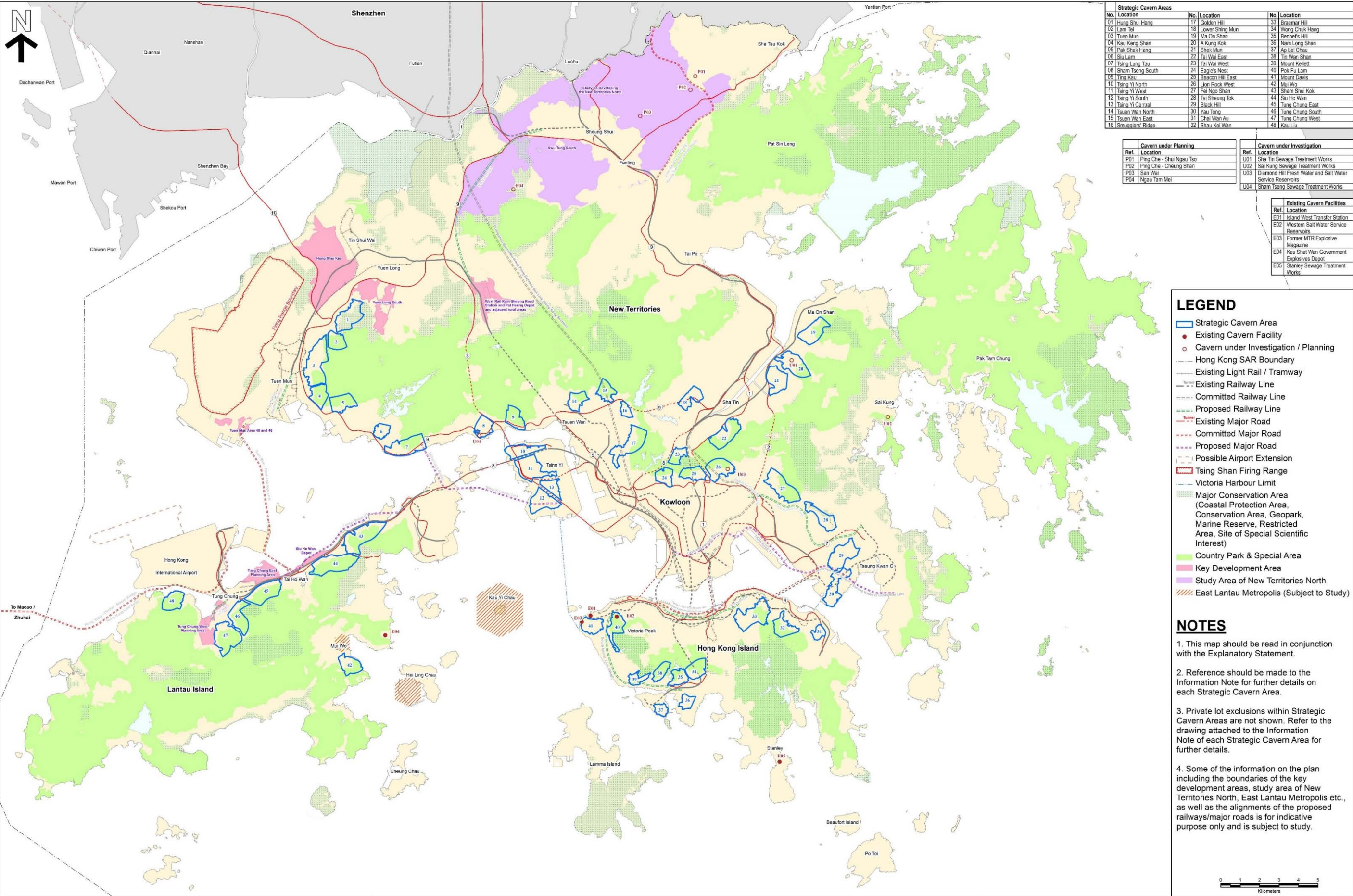
22. Based on the PE1 conducted under the Pilot Study, mixed views were received on the underground space development in the urban areas. While there was general public support to enhance the use of underground space resources to address the district needs, concerns about possible disturbance to existing at-grade facilities (e.g. parks and playgrounds) during construction of underground space beneath them, occupation of at-grade spaces by surface structures arising from the underground space development (e.g. ventilation facilities), traffic and environmental impacts, increased pedestrian flow due to creation of new development, high development cost were noted.

ADVICE SOUGHT

23. Members are invited to offer views on the Government’s initiatives and ongoing/planned measures to make use of rock caverns and underground space as a source of land supply, and to give advice on any further initiatives and/or measures as they may consider necessary/desirable.

Development Bureau
2 November 2017

⁷ *Ibid.* Footnote 5.



Strategic Cavern Areas		
No.	Location	No.
01	Hung Shui Hang	17
02	Lam Tai	18
03	Tuen Mun	19
04	Kau Keng Shan	20
05	Pak Shek Hang	21
06	Siu Lam	22
07	Tsing Lung Tau	23
08	Sham Tseng South	24
09	Ting Kau	25
10	Tsing Yi North	26
11	Tsing Yi West	27
12	Tsing Yi South	28
13	Tsing Yi Central	29
14	Tsuen Wan North	30
15	Tsuen Wan East	31
16	Smugglers' Ridge	32
33	Braemar Hill	
34	Wong Chuk Hang	
35	Benner's Hill	
36	Nam Long Shan	
37	Ap Lei Chau	
38	Tin Wan Shan	
39	Mount Kellett	
40	Pok Fu Lam	
41	Mount Davis	
42	Mui Wo	
43	Sham Shui Kok	
44	Sau Ho Wan	
45	Tung Chung East	
46	Tung Chung South	
47	Tung Chung West	
48	Kau Liu	

Cavern under Planning		Cavern under Investigation	
Ref.	Location	Ref.	Location
P01	Ping Che - Shui Ngau Tso	U01	Sha Tin Sewage Treatment Works
P02	Ping Che - Cheung Shan	U02	Sai Kung Sewage Treatment Works
P03	San Wai	U03	Diamond Hill Fresh Water and Salt Water Service Reservoirs
P04	Ngau Lam Mei	U04	Sham Tseng Sewage Treatment Works

Existing Cavern Facilities	
Ref.	Location
E01	Island West Transfer Station
E02	Western Salt Water Service Reservoirs
E03	Former MTR Explosive Magazine
E04	Kau Shat Wan Government Explosives Depot
E05	Stanley Sewage Treatment Works

Cavern Master Plan

CIVIL ENGINEERING AND DEVELOPMENT DEPARTMENT
PLANNING DEPARTMENT



DATE: 2016-12-22
VERSION: P35