



ITA TUNNELLING
AWARDS 2017



Underground Cemetery in Tunnels

Arik Glazer



ITA TUNNELLING
AWARDS 2017

INNOVATIVE
UNDERGROUND SPACE
CONCEPT
- OF THE YEAR -

Urban Problems – Underground Solutions

1 >> INTRODUCTION

REPORT ON UNDERGROUND SOLUTIONS FOR URBAN PROBLEMS

ITA Working Group
Urban Problems - Underground Solutions

N° ISBN: 978-2-9700776-5-7

ITA REPORT N°011 / APR 2012



ASSOCIATION
INTERNATIONALE DES TUNNELS
ET DE L'ESPACE SOUTERRAIN

ITA
AITES

INTERNATIONAL TUNNELLING
AND UNDERGROUND SPACE
ASSOCIATION

For centuries, mankind has used underground space. The International Tunneling and Underground Space Association (ITA) was created in 1974 with a mission to encourage the use of the subsurface for the benefit of the public, environment and sustainable development, and to promote advances in the planning, design, construction, maintenance and safety of tunnels and underground space. Working groups within ITA provide special studies and publications to address the use and construction of underground space. Working Group N°20 was formed to provide an overview of the typical challenges of urban city planning and the solutions which are offered by the use of underground space. In this report we provide an overview of typical urban issues and an appendix of examples where the use of the underground and modern technology has been taken advantage of to provide overall benefits to the urban environment. Given increasing population growth world-wide, and continued aging of existing infrastructure, this publication elaborates on previous ITA work such as "Why Go Underground" (ITA, Godard, 2002), and provides new project examples to illustrate both traditional and creative uses of the underground to assist with beneficial urban space planning and preserving surface land for future use.

To understand why we use underground space, one must analyze the use of underground space versus the surface

area above. The underground may provide a setting that is difficult to build in, environmentally undesirable, and more costly to construct than surface facilities. On the other hand, it may offer better natural protection against environmental elements, including destructive weather, noise, and seismic events. At the same time, the space created for underground structures has the advantage of allowing use of the surface for other functions.

Over time, the uses for underground structures have developed from primarily shelter to space for infrastructure and a wide range of functional facilities.

The uses may be categorized into several primary uses: Infrastructure for transit and utilities, storage, and protection of the environment. **Increasingly, the public, especially in larger cities, demands a higher quality environment with respect to:**

- Reliable and safe transport of people and goods,
- Water distribution and sewerage systems,
- **Sustainability of the environment and containing sprawl,**
- **More green spaces and recreational areas,**
- Reduced use of fuel, and fuel emissions,
- Noise control,
- **Aesthetics,**
- **Efficient use of real-estate.**

All of these demands call for continuous improvement of sustainable and resource efficient urban planning and development, and is and can be facilitated by the use of underground structures.

Advanced underground construction technologies can provide solutions for reducing congestion and other environmental problems while contributing to energy efficiency. **However one of the greater aims of underground use in an urban environment may be to free surface space for other human needs and to improve the living conditions of cities.**

This paper is divided into three sections to present beneficial uses of the underground.

- The first section reviews typical urban problems for which use of underground space may offer a better alternative than use of the surface. Subject areas include architectural quality, safety and security, traffic congestion, noise, air quality, water distribution, flood control, and synergy effects.
- The second section describes typical solutions the underground can offer such as subway systems, road tunnels, underground manufacturing space, water and sewerage transport systems and storm water relief systems.
- The final section illustrates the



ITA TUNNELLING
AWARDS 2017

INNOVATIVE
UNDERGROUND SPACE
CONCEPT
- OF THE YEAR -

“Lifeless Islands”

Rio De Janeiro



Hong Kong



Tokyo



Paris



New York



Prague



ITA TUNNELLING
AWARDS 2017

INNOVATIVE
UNDERGROUND SPACE
CONCEPT
- OF THE YEAR -

Current Solutions

Santos



Barcelona



Modena



Iraq



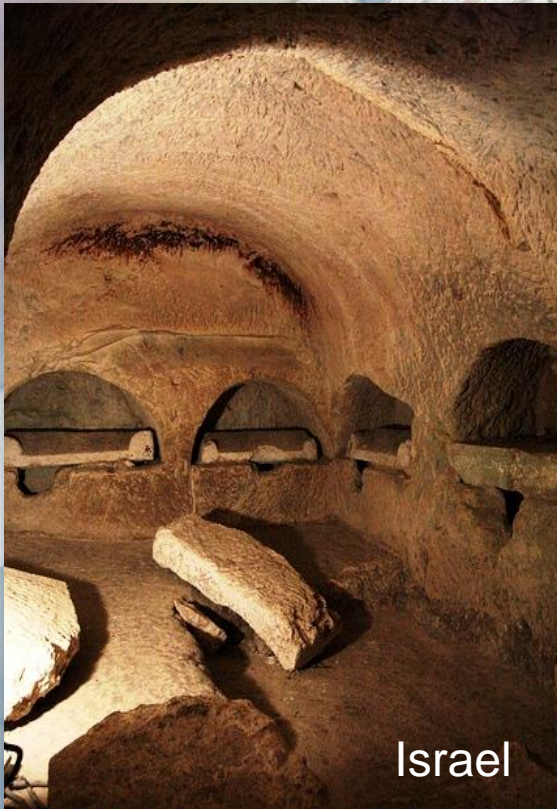
Jerusalem



ITA TUNNELLING
AWARDS 2017

INNOVATIVE
UNDERGROUND SPACE
CONCEPT
- OF THE YEAR -

Burial in caves and tunnels



Israel



Italy



Egypt



Ukraine



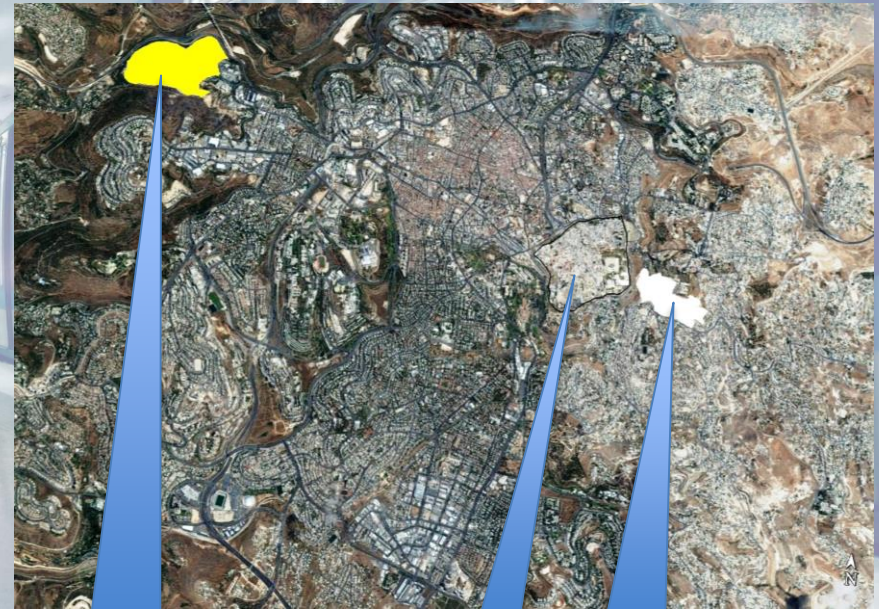
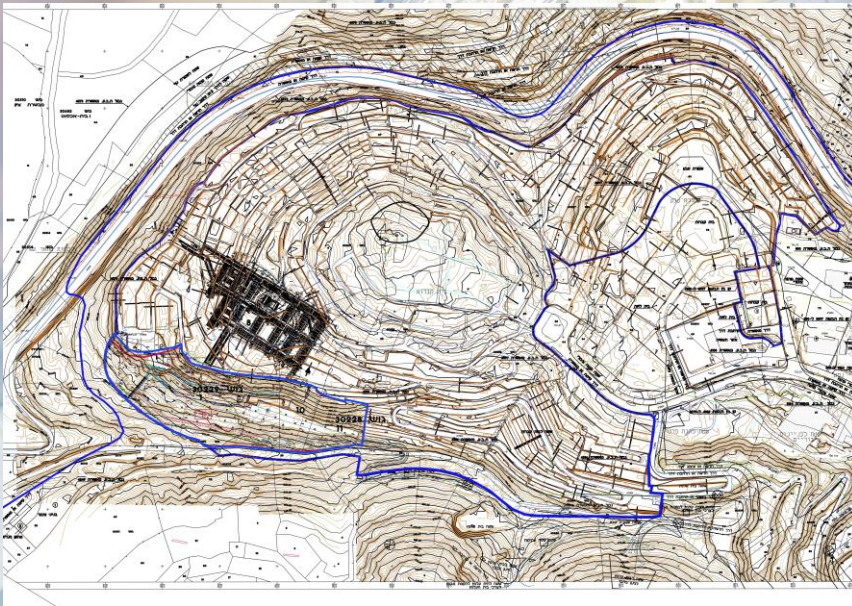
Malta



ITA TUNNELLING
AWARDS 2017



Underground cemetery – Jerusalem



Cemetery "Har
Hamenuhot"

Old City

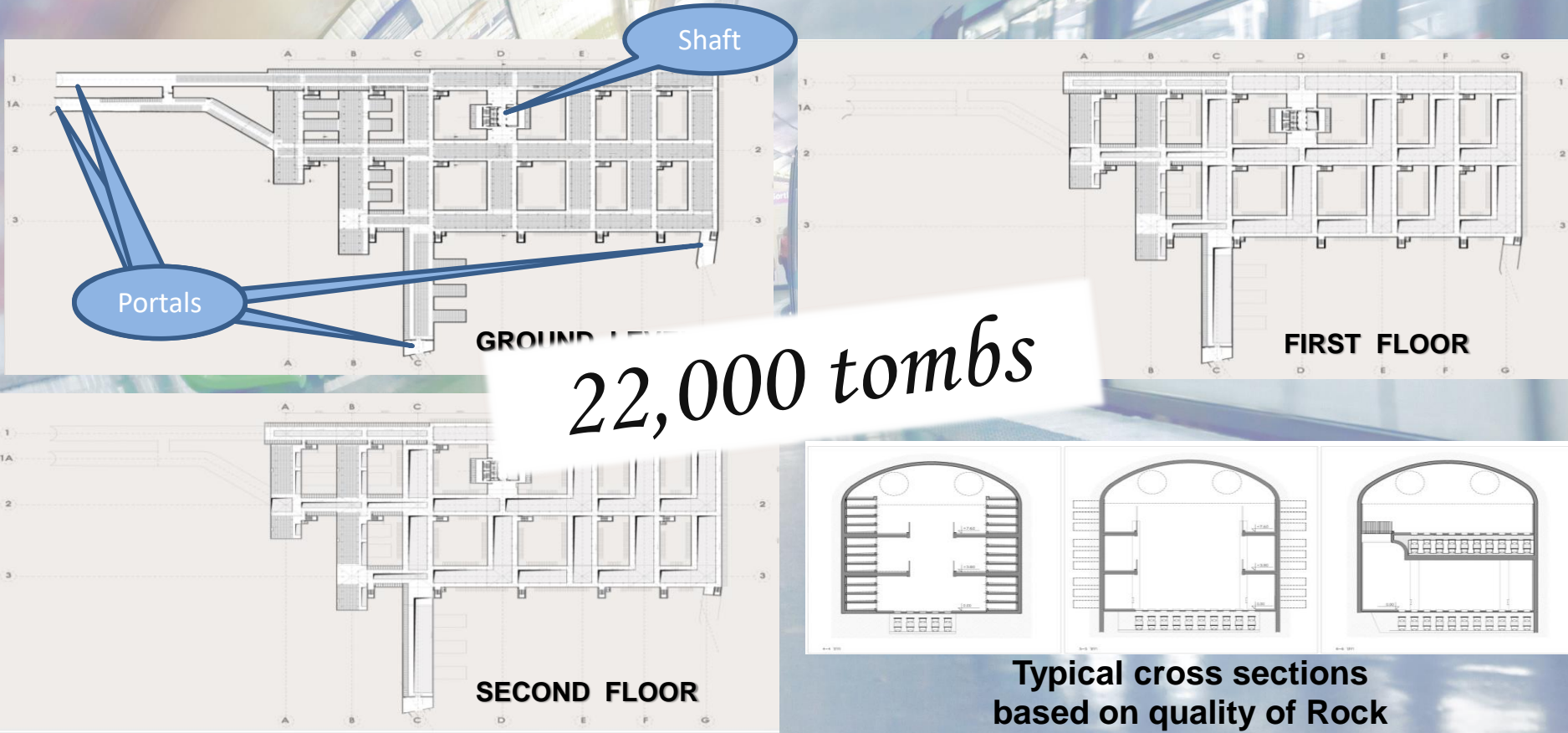
Mount Olives



ITA TUNNELLING
AWARDS 2017



The Jerusalem underground cemetery - Architecture

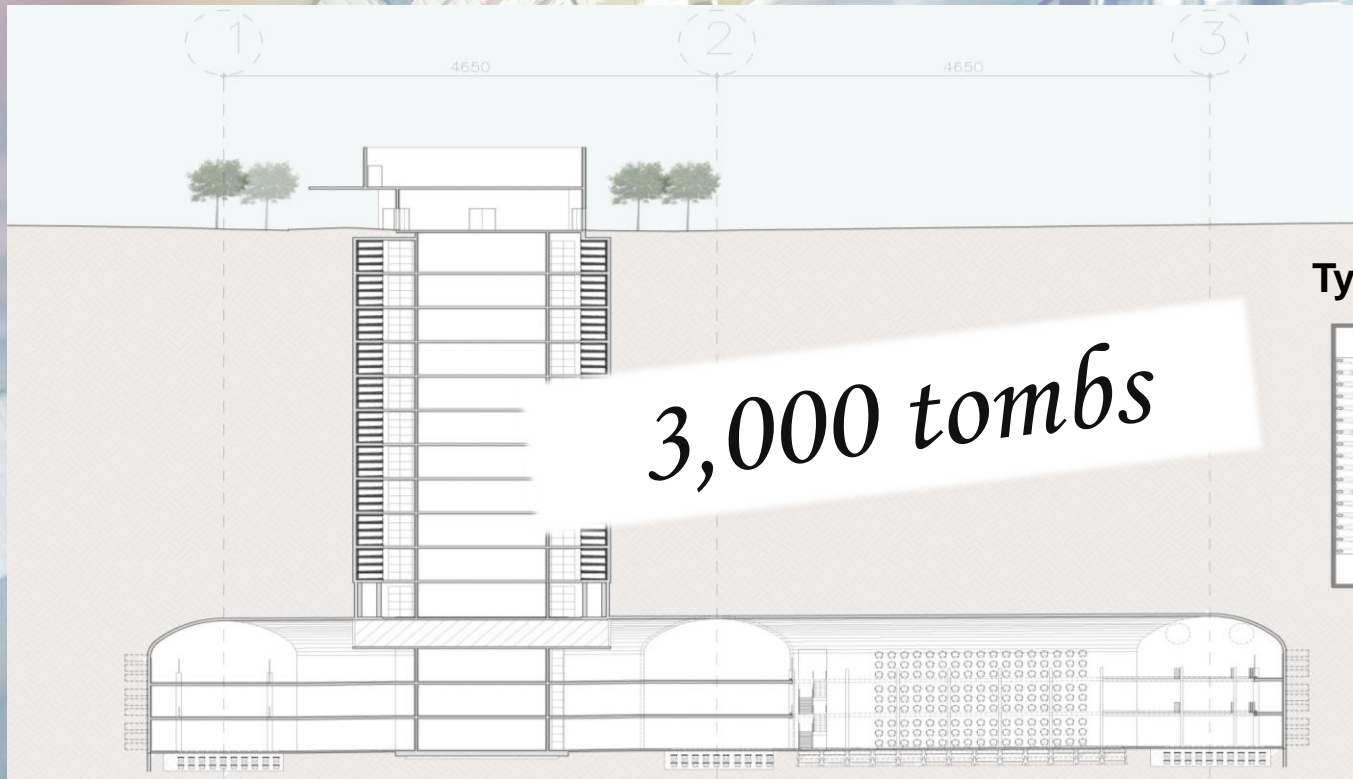




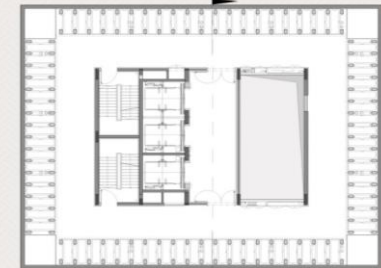
ITA TUNNELLING
AWARDS 2017

INNOVATIVE
UNDERGROUND SPACE
CONCEPT
- OF THE YEAR -

The Jerusalem underground cemetery - Architecture



Typical cross section





**ITA TUNNELLING
AWARDS 2017**

**INNOVATIVE
UNDERGROUND SPACE
CONCEPT
- OF THE YEAR -**

The Jerusalem underground cemetery - Illustration





**ITA TUNNELLING
AWARDS 2017**



The Jerusalem Project – Shaft





**ITA TUNNELLING
AWARDS 2017**

**INNOVATIVE
UNDERGROUND SPACE
CONCEPT
- OF THE YEAR -**

The Jerusalem Project – Tunnels & Caverns





**ITA TUNNELLING
AWARDS 2017**

**INNOVATIVE
UNDERGROUND SPACE
CONCEPT
- OF THE YEAR -**

The Jerusalem Project – Tunnels & Caverns





**ITA TUNNELLING
AWARDS 2017**

**INNOVATIVE
UNDERGROUND SPACE
CONCEPT
- OF THE YEAR -**

The Jerusalem Project – Tunnels & Caverns





ITA TUNNELLING
AWARDS 2017



Why go underground?

Environmental aspects

- Land use/location – Close to the city
- Natural – Preserving the landscape
- Topographic – Usage of mountains

Social aspects

- Religion – Rites and customs
- History – Retrieving ancient tradition
- Social – Reusing cemeteries

Economical aspects

- Cost – Similar to buildings
- Maintenance – Preserving the tombs
- Size - Suitable for cremation as well
- Future – Eliminating “lifeless island”

*Reviving Burial in
Tunnels*

*Can be the solution
for many urban
communities*



ITA TUNNELLING
AWARDS 2017

INNOVATIVE
UNDERGROUND SPACE
CONCEPT
- OF THE YEAR -

Tunnel Business Relevance

3 >> DECISION MAKING PROCESS

3.3 AESTHETICS

The visual and aesthetic impact is often the major quoted reason for deciding to relocate infrastructure to the underground. Compared to above ground solutions, like elevated structures, an underground structure would not impact on the visual image and character of the environment. This may be important to hide unattractive technical facilities in sensitive locations or when industrial facilities must be sited adjacent to residential areas. This might also be important for the preservation of natural landscapes. The increasing requirement for all utility services to be placed underground stems essentially from visual impact considerations and concerns about protection against the elements. Underground solutions can also fulfill architectural requirements as shown in Figure 61. The Canary Wharf Station

is a good example how underground structures and architectural features can meet. With proper design an underground solution can be an aesthetic highlight in itself.

3.4 ECOLOGICAL AND ENVIRONMENTAL ASPECTS

Underground space utilization can help solve environmental and resource dilemmas in several ways. Underground facilities are typically energy efficient in their own right. The natural insulation provided by the soil regulates the temperature within the construction and thereby reduces the need for heating or cooling, lowering the energy consumption when compared to surface constructions. Over time the higher cost of construction may be compensated for by savings in power and the alternative use of the surface.

More importantly, by using underground space, higher urban densities can be supported with less impact on the local environment. In addition to the obvious benefit of preserving green space and agricultural land, higher urban density can lower fuel resource consumption by containing sprawl. Underground development will be an important tool in reshaping our urban areas to meet the challenges of the future without destroying their heritage or worsening their surface environment. (Esaki, 2005)

During the construction phase, however,

underground construction can have an influence on the environment, including effects on soil, water, air, climate, fauna, flora and their living space, cultural assets as well as on human beings. In the decision making process, the stakeholders need information on the environmental consequences of their decisions. It is therefore necessary to assess environmental effects of underground structures in the decision making process and observe them during the construction and operation phases.

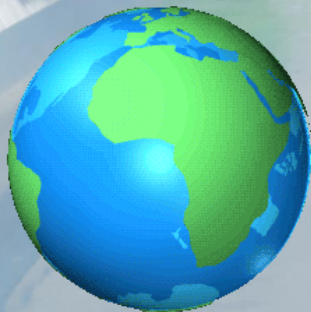
Some of the environmental impacts of underground structures are:

- Air pollution due to construction equipment,
- Effects on the groundwater level,
- Pollution and treatment of groundwater,
- Excavation of polluted material;
- Waste water originating from the construction,
- Pollution of surface water,
- Use and displacement of (natural) resources.

Of these effects, only air pollution and effects on the groundwater are discussed in detail, as these are of ongoing importance. The other effects are mostly limited to the construction phase and differ little for above-ground or underground construction techniques. A brief discussion of cut-and-cover methods is mentioned further below as this method may be particularly disruptive.



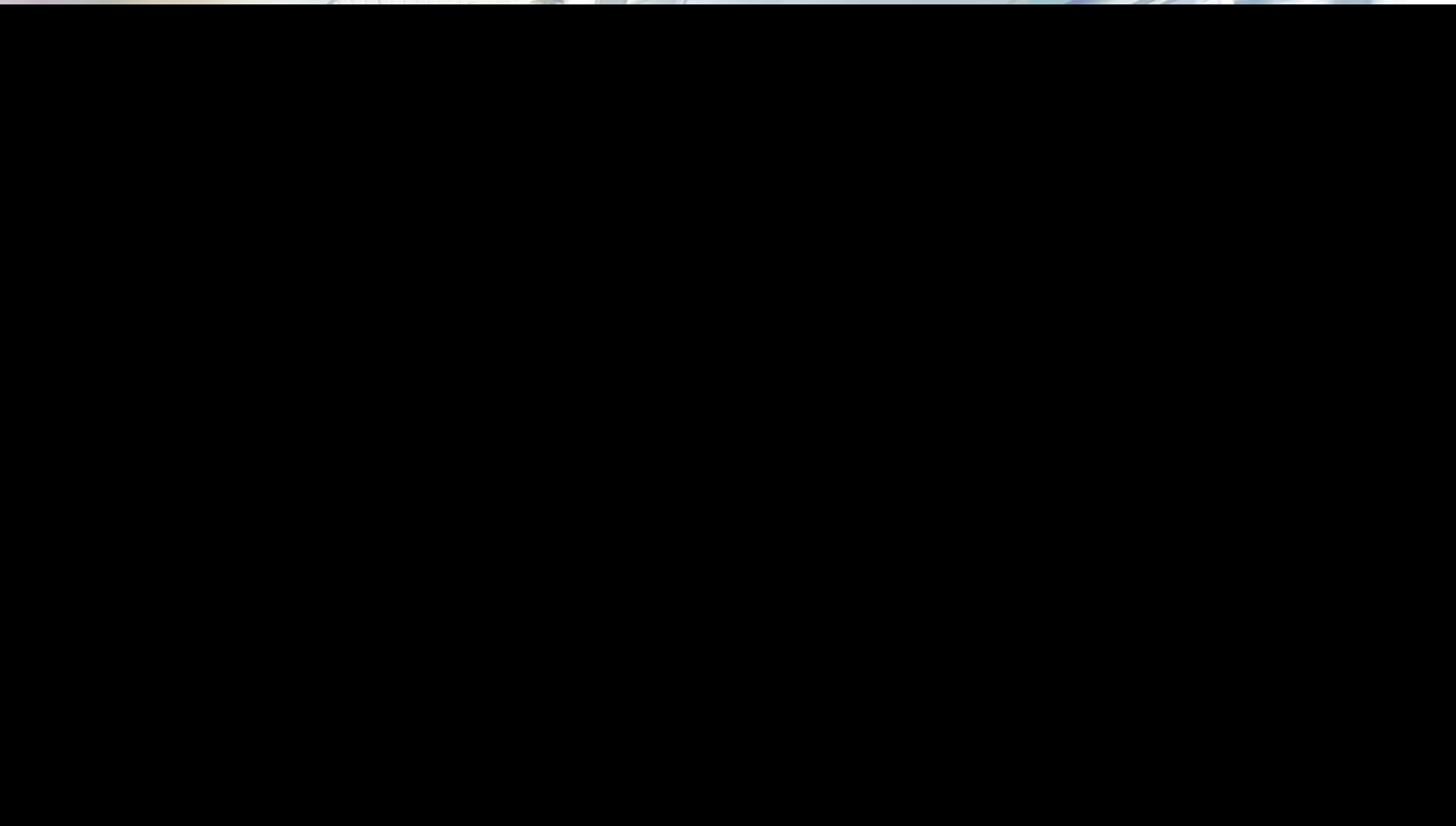
Figure 59, Wine Caves for Storage at controlled temperature





ITA TUNNELLING
AWARDS 2017

INNOVATIVE
UNDERGROUND SPACE
CONCEPT
- OF THE YEAR -





ITA TUNNELLING
AWARDS 2017



Stakeholders

Entrepreneur & Contractor – Rolzur Tunneling LP

Client – ***Chevra Kadisha Kehilat Jerusalem Burial Society***

Design Coordinator – ***Projects Planning & Mng.***

Prime Architect – ***Peleg Architects***

Tunnel Design – ***A. Rozen Eng.***

Structural Design – ***Danny Inbar Structural Eng.***

Ventilation Design – ***Doron-Shahar Consulting Eng.***

Fire Protection Design – ***JFPE Consultants***

Electricity Design – ***Ramor Consulting Eng.***

Water & Plumbing – ***Y. Lebel Consulting Eng.***

Lighting Design – ***Teichman & Co. Eng.***

Elevator Design – ***V.I.S Eng.***

Geology – ***M. Levin G.G.S***

Thank You