

ITA Work and Experiences on the Urban Environment

Harvey W. Parker¹

¹ ITA President & Harvey Parker & Associates, Inc., Bellevue, WA 98004, USA

ABSTRACT

ITA has been deeply involved with environmental and safety issues since its beginning in 1974. Clearly, construction of underground facilities must protect the environment through which they pass by assuring that the adjacent ground, facilities, and surrounding environment are not adversely affected. ITA is working on several broad fronts to use risk management and other techniques to enhance the benefits of the underground and to understand and eliminate any potential for undesirable effects. Excellent construction techniques that result in a minimum of disruption to the public are essential to the positive image of our underground industry. Equally important to this positive image is the recognition by the public, the media, and the decision makers of the extraordinary benefits that underground construction provides society. This paper deals principally with the broader global aspect of the interaction of the underground with the environmental issues that have developed over the last several decades. In fact, use of the underground has always strongly improved the environment. Moreover, the underground industry and ITA are becoming increasingly and more intimately involved with the environment and sustainable development as the awareness of the benefits of tunnels becomes more widely known. It is likely that the largest part of future tunnel demand will come from a desire by society and decision makers to improve the environment and sustainable development. It should be recognized that, in urban areas, sustainability is not possible without infrastructure and often, the best form of infrastructure involves the underground. Accordingly, our industry must continue to develop a positive image by constructing projects with a minimum of disturbance to the adjacent areas & environment and by promoting the many advantages of the underground in general.

1. INTRODUCTION

Tunnels, underground works, and underground space, which are referred to in this paper as “the underground” offer society an ideal means for improving the environment. This is not a new revelation. Since man first began to use caves for shelter, use of the underground has protected man and simultaneously enhanced the environment. Long before the “environment” and “sustainable development” became household words, use of the underground has contributed to an improved environment, sustainable development, and, in general, an improved quality of life for society. This is particularly true of the urban environment.

Society has always looked to the underground anytime there was 1) a need for a safe haven, 2) whenever something needed to be protected against harm or for future use, 3) for disposal of undesirable waste or hazardous materials, and 4) to provide the all-important infrastructure that society requires for survival.

Sustainable Development is defined by the United Nations and most other organizations as:

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Environmental issues and the environmental movement have become major factors in the design and construction of underground facilities. Our industry needs to recognize the importance of the environment and act accordingly. In fact, if our industry becomes pro-active, an enormous amount of work will result because of the advantages of tunnels and underground spaces have toward the environment and sustainable development.

The good news is that embracing the environment is an investment, not a cost. The environment and sustainable development has been embraced by most of the mult-national companies. Many papers and articles have been written about the the fact that embracing the environment and sustainable development makes good business sense in terms of the bottom line.

This fact that attention to sustainability generally also results in improved business and more profits should be recognized by our industry. Done properly, your society and your country will benefit by improved environmental quality and your company or agency will experience financial benefits as well.

2. THE UNDERGROUND IS OUT OF SIGHT – OUT OF MIND

The advantages of the underground are taken for granted by almost everyone. The underground plays a dominant role in our standard of living and in the preservation of the environment. At least within developed urban cities, every time one turns on a faucet or flushes a toilet, an “environmental tunnel” is put into use. In fact, in urban areas, a large percentage of utilities and services that affect daily living depend on an extensive and robust underground. As areas develop, tunnels will play an increasing role in improving the quality of life. Yet the average person almost never makes this connection; even members of our industry take clean water in and wastewater out for granted because our tunnels have been doing such a good job for such a long time with so little maintenance that they are invisible to sight and to mind.

3. BENEFITS OF THE UNDERGROUND TO THE URBAN ENVIRONMENT

There are numerous environmental and societal benefits that are inherently associated with the underground. The benefits listed in Table 1 are adapted from Parker (1996).

Table 1

Benefits of the Underground for Society & Sustainable Development

- Tunnels play a vital role by conveying clean water to urban areas and by conveying waste water out. Most major urban areas depend on tunnels for these services, which function with a minimum of maintenance
- Congestion in urban areas has been dramatically reduced by the use of the underground
- Tunnels provide safe, environmentally sound, very fast, and unobtrusive transportation for people in all walks of life in both developed and developing countries
- The usable space off a parcel of land can, in some cases, be almost doubled by adding transport or other communication lines, floor space or bulk storage below the ground surface
- Life-cycle cost analysis may reveal the underground alternatives to be much more cost-effective
- Underground space generally has a very long life; some have been in continuous use contributing to sustainable development for centuries
- Underground space requires little maintenance
- Long life & little maintenance not only reduce life-cycle costs but also reduce demand for renewable & non renewable resources
- Underground space is being used increasingly for industrial, office and even residential facilities.

- It has been demonstrated by several recent events that tunnels behave very well in earthquakes. If urban planners want an important lifeline to survive earthquakes, they should go out of their way to use tunnels.
- The underground is the only safe location for storage of nuclear waste and other hazardous or undesirable materials
- Underground space for bulk storage of food, liquids, and gas has gained increasing acceptance in various areas of the world
- Underground space inherently conserves energy. Because they are removed from climatic influences, underground facilities provide significant energy savings and conservation of energy
- Underground space is inherently energy efficient. Severe fluctuations of temperature are non-existent allowing more efficient control of temperature and energy.
- Use of the underground permits preservation of open space for habitat, environmental, and scenic values
- The Underground provides strong protection from natural hazards

4. WORLD POPULATION EFFECTS ON THE URBAN ENVIRONMENT AND TUNNELS

It is a fact that the world population is increasing at a staggering pace. In October, 1999, the world population passed 6 Billion. A major factor in world demographics that is important to tunnel planning, is that, in the future, most of the world's population will live, not in rural areas, but in urban cities. In 1950, only about 1/3 of the world's population lived in urban areas. By October, 1999, about 1/2 of the 6 Billion people lived in urban areas.

Accordingly, cities are becoming very large. So large, that the United Nations and other world bodies are giving special attention to those cities where more than 10 Million people live, the so-called Megacities. In 2001, there were only 19 Megacities. By 2015 it is estimated that there will be about 60 Megacities most of which will be in the developing world.

The trend will continue in the future. By 2030, it is estimated that 4.9 Billion people will live in cities which is 60% of the estimated 8.1 Billion world population. Abundant infrastructure must be constructed not just for these cities to be sustainable, but just for them to survive.

Fortunately for the underground industry, if the environment and sustainable development are considered, the underground is often the construction method of choice for much of the infrastructure. In fact, if managed properly, the rapid pace of development may result in a huge demand for underground projects to the extent that there may not be enough tunnellers to safely construct and operate such a large number of tunnels in such a short time. However, this huge demand will not just happen automatically. It will require those of us in the industry to be pro-active to inform the city officials and planners, at very early stages of a city's growth, of the importance of the underground to sustainable development and to quality of life.

5. RETROFITTING URBAN AREAS FOR SUSTAINABLE DEVELOPMENT

Cities, especially in developing countries, tend to grow rapidly and haphazardly. Accordingly infrastructure can not be constructed at the optimum time where construction can be efficient. To the contrary, infrastructure must be thrust onto an existing urban fabric. Underground construction provides ways that these essential services can be constructed beneath existing facilities with a minimum of disruption to the surface and to the public. Clearly this is good for the tunnel industry, and especially for microtunnelling methods, all of which will flourish in the future.

Another major issue is the retrofitting and rehabilitation of existing services in urban areas that have been in service for a number of decades or centuries. Deteriorating utilities must be rehabilitated or replaced and/or upgraded which creates another large demand for the underground.

6. ROLE OF ITA IN THE ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

The changes to ITA's Statutes and By-laws in 2003 now reflect our association's role with respect to the environment and sustainability. The Objectives of the International Tunnelling Association (ITA) now include the following: "to encourage the use of the subsurface for the benefit of the public, environment and sustainable development."

However, ITA and its journal, Tunnelling and Underground Space Technology (TUST) have been active in the environmental and sustainable development fields for a long period of time. Over the decades, there have been numerous articles in TUST addressing environmental issues and sustainable development. They are far too numerous to list but selected ones include: Celik (1996), Parker (1996), Roberts (1996), Sellberg (1996), Ray (1998). Most of these are available on ITA's website or electronically from TUST.

In 2002 ITA published a booklet called 'Why Go Underground'. The booklet illustrated the many reasons and features of the use of underground space. In practice most projects can be placed under several of these heading but most involve significant benefit to the broad category of the environment. A paper about this publication is included in this conference and this publication can be downloaded from the ITA website.

ITA has actively promoted the advantages of the Underground to sustainable development and the environment to the United Nations for over a decade. ITA is recognized by the United Nations as a very active Non-Governmental Organization (NGO) in Consultive Status II. Some of ITA's work with the United Nations is discussed below.

7. ITA WORKING GROUP ACTIVITIES REGARDING THE ENVIRONMENT

In addition to the general support of environmental issues throughout the activities of ITA, the association has several specific groups and activities which concentrate on environmental issues. Working Group 4 on Subsurface Planning addressed environmental issues integrally with the work on subsurface planning. Working Group 13, Direct and Indirect Advantages of Underground Structures, also addressed environmental issues in their routine activities. When Working Group 4 concluded its work, a new working group, Working Group 20 on Urban Problems-Underground Solutions was started which also, as a matter of routine, keeps environmental issues at the forefront of their work. They are currently working on the objective of building a comprehensive database of worldwide examples for unique underground solutions to typical urban problems.

A specific working group on the environment, Working Group 15 on Underground Works and the Environment, was created in 1996. The initial investigation of the Working Group was a broad-reaching review of the global opportunities and constraints associated with the environment. The study included an analysis of selected case studies that demonstrated the environmental benefits that can be derived from the construction of underground works.

The main objective of the Working Group 15 was to help decision makers to take advantage of the many environmental benefits that tunnels and all underground works offer and to minimize the risks associated with the environmental hazards. The initial investigations of the Working Group, between 1966 and 1998, were based upon two main topics: 1) A review of the opportunities and constraints associated with the environment and 2) An analysis of selected Case Studies that demonstrate the environmental benefits that can derive from the construction of underground works. In order to develop the review, a questionnaire was sent out to all ITA Member Nations. This work was summarized in the ITA Newsletter Tribune in October, 2002 (ITA, 2002).

In 2000 Working Group 15 refocused its activities on the more practical aspects of underground works with the environment and sustainable development. A questionnaire was sent out to Member Nations to collect data on projects which have been placed underground for environmental and sustainable development reasons. The results of this work will be published in the near future.

However, several interesting projects were identified that illustrate the broad impact and close interactions between tunnels and the environment. Selected projects included:

- Transportation projects placed underground for environmental reasons
 - Metro projects worldwide
 - Highway Tunnels
 - El Azhar Tunnel, Cairo, Egypt
 - Central Artery Tunnel, Boston, MA USA
 - Railway Tunnels
 - Extension and Rehabilitation of existing tunnels
 - High speed railways; reduction of environmental impact
 - Tunnels to by-pass villages to lessen impact to village
 - Tunnels to restore continuity of a village previously separated by a railroad cutting through the village
 - The Groen Hart Tunnel in the Netherlands was put underground to minimize environmental impact and to preserve the rural atmosphere of farmland even though the cost of the tunnel was greater than surface alternatives
- Underground Storage, Emplacement and disposal
 - Products stored underground; reduction of environmental impact
 - Water
 - Wine
 - Paper
 - LPG
 - Gas
 - Various grades of petroleum
 - Products emplaced and/or disposed of underground to preserve environment
 - Chemicals
 - Nuclear Waste
- Water Supply and Waste Water Disposal
 - Underground sewage treatment plants reduce odor, environmental impact and improve efficiency of operations
 - Combined Sewer Overflow (CSO) storage tunnels
 - Numerous CSO projects worldwide minimize sewer overflows
- Protection of World Heritage Sites
 - By-pass tunnel at Stonehenge, UK
- Other Environmental Projects
 - Restoration of urban areas and city centers by placing essential facilities underground allowing the ground surface to be used for more noble purposes
 - Tunnels to improve environmental impact of mine works

8. ITA's WORK WITH THE UNITED NATIONS

Not all underground projects are complex or expensive. There are a large number of people who live or work underground on a small scale. In 2003, the United Nations requested proposals that could be used to reduce poverty. In response, the Author, together with David Bennett, FAIA, made a proposal to the United Nations on behalf of ITA in response to the UN program to reduce Rural Poverty. ITA proposed that the United Nations consider the inclusion of shelter design, and particularly the development of underground and earth sheltered construction be included as a part of the ECOSOC goals to create sustainable rural communities around the world.

In 2004, in response to another request from the United Nations, the author and Mr. Bennett and prepared another proposal to the United Nations on behalf of ITA which emphasized underground shelter and especially food storage.

Each of these proposals made it clear that the sophistication of earth-sheltered structures, and underground space in general, can range from simple habitats to highly sophisticated high-tech complexes or communities depending on the needs and resources of the users. Housing and other community buildings can be built largely with local materials by local labor usually by cut-and-cover-techniques or earth-mounding. Underground facilities can be maintained with relatively little energy, providing pleasant and comfortable interior spaces. These facilities promote the environment and sustainable development by conserving energy, leaving a clean environment and open scenery above ground, and by giving the landowner multiple use of the land. Earth-Sheltered Facilities represent almost the ultimate in environmentally-friendly sustainable development.

It has been demonstrated that, contrary to popular opinion, properly-constructed underground structures behave very well in earthquakes. Currently, it is believed that the use of the underground, including properly-constructed underground structures could be, under the proper circumstances, excellent facilities, not only for living quarters, but also for schools and meeting facilities in areas of extreme cold or hot climates including earthquake-prone areas. The facilities would be warmer in the winter, cooler in the summer, and resistant to the effects of earthquakes. The possibilities to minimize the impact of future major earthquakes in areas of extreme climates, such as Pakistan, are significant.

9. DEMAND FOR ENVIRONMENTAL TUNNELS & UNDERGROUND SPACE

It is likely that the bulk of future tunnel demand can be attributed in some way or another to a desire by society and decision makers to improve the environment and sustainable development. Our industry needs to fully embrace the environment, as have many other professions and industries, and consciously use the strong benefits of tunnels to be the driving force in selecting the below-ground alternative. There will almost always be competing surface options which, at first glance, may appear to a decision maker or voter to be less expensive.

However, our industry has not yet developed a convincing quantitative database showing just how important the Underground is to sustainable development and the environment. Mere suggestions that tunnels contribute to improve sustainable development will not be enough to increase the demand for tunnels either locally or worldwide. This is especially true where there is an urgent demand for infrastructure and where the demands on infrastructure are so massive that the least expensive initial cost will be the deciding factor on whether to go underground or not. Clearly these considerations must be adapted to everyone's local financial and cultural environment.

Our industry must begin to identify the specific quantitative sustainable development and environmental benefits of the Underground and collect and publish case histories that confirm these benefits giving specific quantitative environmental benefits. This would be in terms of how much less 1) pollution, 2) noise, 3) energy demand, and 4) space needs, etc. can be expected if the underground alternative is chosen. Particularly for water and wastewater, our industry needs to quantify just how much better the standard of living is and how much better health is improved by the use of the Underground. We need to aggressively market the Underground as being the alternative that should be selected because of its superiority for sustainable development and the environment. The benefits are listed in Table 1 but mostly involve the following:

- Lower energy used
 - Flatter grades
 - Shorter distances
 - Less energy demand during operation
- Reduced noise
- Reduced air pollution
- Multiple use of land parcels

- Longer Life
- Lower maintenance
- Reduced long term demand on renewable & non-renewable resources

10. IMPORTANCE OF QUALITY, SAFETY AND RISK MANAGEMENT

Clearly, construction of underground facilities must protect the environment through which they pass by assuring that the adjacent ground, facilities, and surrounding environment are not adversely affected. ITA is working on several broad fronts to use risk management and other techniques to enhance the benefits of the underground and to understand and eliminate any potential for undesirable effects. Excellent construction techniques that result in a minimum of disruption to the public are essential to the positive image of our underground industry. Many papers presented at this conference deal directly with these very important issues. ITA Working on Quality (Working Group 16) has recently published a report which emphasizes the absolute necessity of controlling and maintaining quality (ITA, 2004a).

There are many ways to address quality, one of which is the implementing the concept of Risk Management from the very beginning of a project. ITA is addressing this issue as part of our overall program to assure quality. ITA Working Group on Research (Working Group 2) recently published a report in TUST (ITA, 2004b) that addresses the complex and very important task of identifying risks in advance and adjusting designs and construction methods to reduce risks to a minimum. There are initiatives within our industry to increase our industry's awareness and use of Risk Management to reduce risk and, thus, improve quality. With respect to the environment, Working Group 15 has offered to help address risk issues which sometimes develop as a result of encountering adverse environmental conditions. Finally, for over a year, ITA has been in discussions with the insurance industry regarding methods to be used to assure that risk is managed and that projects are completed without incidents in a way that is fair to all involved parties.

Nothing is as important as safety. Often there is a tendency to slightly relax safety precautions when programs are accelerated or when projects are trying to meet a completion deadline. ITA has emphasized safety from the very beginning of the association. ITA recently re-published an updated booklet called "Safe Working in Tunnel" which is ideal for toolbox discussions of safety as well as safety presentations in general. The booklet is available from the ITA Organization in your home country or can be downloaded from the ITA website.

All these issues and the impact of construction delays and disruption to the public have a dominant effect on the image of the tunnel and underground industry. Accordingly, they affect the likelihood of a decision maker or the voting public to make a choice for an underground alternative.

11. CHALLENGE TO OUR UNDERGROUND INDUSTRY

Every move toward a cleaner environment and sustainable development include cost and secondary effects. Those of us in the underground industry must understand that this is not all bad. It should be noted that some costs are really "Investments" and very often the secondary effects are beneficial. It is the job of the leaders of our industry to be pro-active at the earliest stage of any project, even when a proposed project or underground alternative is only an "idea," to keep the underground option in the forefront of planners mind. We must demonstrate to planners and government officials that the earlier underground facilities are constructed, the more cost-effective they can be.

As the growth of urban cities, particularly the megacities, continues, they will all need abundant infrastructure and the demand for the underground will be enormous. We may not be able to build the required infrastructure fast enough. There simply may not be enough planners, designers, and contractors to do the work. Accomplishing all this work will be even more challenging if those working on the project are under pressure to finish the work. In fact, even if a fraction of the needed infrastructure is funded, the capacity of our industry will be challenged. Accordingly, we will need to

seek new methods to construct tunnels with a minimum of disruption to adjacent land and property and to develop and refine our ability to use training, risk management, and management principles in general to safely build underground facilities that preserve the urban environment.

We can not afford to wait for decision makers to become aware of the environmental benefits of the underground and our ability to safely build tunnels. We must be pro-active and let the world know that:

Resources spent on safety of people, property, and protection of the environment are investments, not costs,

Sustainability of the urban environment is not possible without infrastructure and, often, the best form of infrastructure involves the underground, and

The rate of underground design & construction must be increased but with safety and quality in order to provide the abundant infrastructure required for development.

REFERENCES

- Celik, Aliye P., 1996. The Challenge of Sustaining our Habitat in the Twenty-First Century. Tunnelling and Underground Space Technology, Vol. 11, No. 4, pp 377-379.
- ITA, 2002. Working Group No. 15 Report. ITA-AITES Tribune, No. 23, pp 23-26.
- ITA, 2004a. Quality in Tunnelling: ITA-AITES Working Group 16 Final Report. Tunnelling and Underground Space Technology, Vol. 19, No. 3, pp 239-272.
- ITA, 2004b. Guidelines for Tunnelling Risk Management: International Tunnelling Association Working Group 2. Tunnelling and Underground Space Technology, Vol. 19, No. 3, pp 217-237.
- Parker, Harvey, 1996. Tunnelling, Urbanization and Sustainable Development: The Infrastructure Connection. Tunnelling and Underground Space Technology, Vol. 11, No. 2, pp 133-134.
- Ray, Kalyan, 1998. Tunnels and infrastructure for metropolises: the Habitat Agenda Perspective. Tunnelling and Underground Space Technology, Vol. 13, No. 3, pp 313-315.
- Roberts, Don V., 1996. Sustainable Development and the Use of Underground Space. Tunnelling and Underground Space Technology, Vol. 11, No. 4, October, 1996, p 383-390.
- Sellberg, Bjorn, 1996. Environmental Benefits: A Key to Increased Underground Space Use in Urban Planning. Tunnelling and Underground Space Technology, Vol. 11, No. 4, pp 369-371.