Malaysia is a federation of thirteen States and three federal territories located on the Malay Peninsula south of Thailand and the northwest portion of the island of Borneo. The country is home to over 27 million people, with roughly 1.6 million people living in the capital city of Kuala Lumpur (fig. 1), which is situated in the southwest part of Peninsular Malaysia and covers 244 square kilometres. The entire Greater Kuala Lumpur metropolitan area has a population of over 7 million people.

Kuala Lumpur has witnessed rapid population and economic growth since the early 1980s. However, one result of this growth has been a marked increase in flash flooding in the area, occurring almost annually. The urbanization of Kuala Lumpur has encroached on the Klang and Gombak rivers, which merge in the centre of the city. The average annual flooding for the Klang River has increased nearly 300 per cent, from about 148 cubic metres per second before

Figure 1 | Kuala Lumpur.
1985 to 440 cubic metres per second since 1985.

The Government of Malaysia has monitored the situation since the early 1970s and responded with the development of the Klang River Basin Flood Mitigation Project. It has attempted to control flooding by creating holding ponds and increasing river channel capacity, but this has had only limited success. In 2001, the Government sought proposals for a more effective solution to flooding in order to prevent disruption to the city’s centre during a typical flood event lasting three to six hours. The original idea was for a tunnel to divert and store the storm water, but the idea progressed into the concept of a mixed-use tunnel that would allow traffic flow when the tunnel was empty of water. One factor in this evolution was that for liability reasons, the tunnel had to run below Government-owned land, which led planners to consider locating the tunnel beneath a road. This led to the idea of integrating a tolled motorway into the project. By allowing a portion of the tunnel to be tolled for traffic, private-sector participation in a public-private partnership (PPP) could be secured, reducing the costs of the project for the Government.

The Stormwater Management and Road Tunnel (SMART) was developed as a concession. The 12.7-kilometre tunnel project includes a holding pond at the northern entrance, a storage pond at the southern entrance, 9.7 kilometres of stormwater storage, and 3 kilometres of tunnel that doubles as stormwater storage and a motorway. The tunnel begins just before the confluence of the Klang and Ampang Rivers so that flood water can be diverted away from the Klang River, eliminating flooding in the city centre (fig. 2). The whole project provides storage for 3 million cubic metres of water, sufficient to prevent most of the flooding of the centre of the city.

The tunnel project operates in three different modes to meet the needs of Kuala Lumpur traffic and prevent flooding. In two of the modes, cars can continue to use the motorway tunnel and storm water is stored in holding ponds and under the motorway portion. In the third mode, the tunnel is closed to traffic and storm water is diverted into all levels of the tunnel. Once the flooding problem has passed and water has drained, the tunnel is dried, cleaned of debris and reopened to traffic, all within 48 hours of the tunnel closing.

The motorway tunnel was opened to traffic in May 2007 and the stormwater...
sections were fully operational a month later. Now when the water level of the Klang River is high, water is diverted into the tunnel, eliminating or greatly reducing flooding in the city centre. In addition, with the option of a tolled motorway, traffic congestion has been reduced on the Southern Gateway into the city.

**Project Objectives**

The primary goal of the SMART project was to mitigate flooding caused by heavy rains during the monsoon season. Flooding of the city centre was very costly for the Government and disruptive to the economy. By creating a storage tunnel as a release mechanism for the water, Kuala Lumpur can be spared the expense of flood damage and the retroactive responses to a flood. Simultaneously, businesses and residents are able to continue their normal activities.

A second objective of the project was to reduce congestion on Kuala Lumpur’s main southern route into the city centre. Kuala Lumpur is a busy urban centre, with frequent problems of high traffic congestion. Since toll roads are not uncommon in Malaysia, adding a toll tunnel under an existing road gives commuters the option of avoiding this congested traffic by paying to use the tunnel. Use of the tunnel also leads to traffic reduction on the above-ground roads.

**Project Description**

**Partners**

The joint venture portion of this PPP is composed of two private-sector Malaysian companies, with each partner owning 50 per cent. One company is one of Malaysia’s leading engineering and construction companies, which has worked on projects throughout Malaysia, Asia and the Middle East. The second partner is a mining company. The joint venture was the turnkey contractor for the project and formed the Syarikat Mengurus Air Banjir & Terowong Sdn Bhd (or SMART Sdn Bhd) company as the concessionaire operating the toll plazas. Specialized engineering consultant support to the PPP was provided by a subcontractor headquartered in the United Kingdom.

**Implementation Environment – Legislative and Administrative**

In 1983, the Government of Malaysia, through the Prime Minister, introduced the concept of “Malaysia Incorporated” (Malaysia Inc.) as a platform for its economic development policies. The concept called for closer cooperation and collaboration between the public and private sectors and labeled the nation a “business entity”, jointly owned by both sectors. National development was to be the responsibility of both sectors and required their mutual cooperation. The Government created a long-term devel-
opment plan, called VISION 2020, which emphasized the importance of the Malaysia Inc. policy in developing as an industrialized nation.

The Civil Service of Malaysia issued Development Administrative Circular No. 9 of 1991, “Guidelines on the Implementation of the Malaysia Inc. Policy”. The Civil Service implemented four major initiatives to facilitate private-sector development: strengthening public-private-sector working relationships; improving the quality of public services rendered to the private sector; improving information dissemination; and enhancing the understanding of the Malaysia Inc. policy among public service personnel.

**Financial Agreement**

The total cost of the SMART project was $510 million. The private sector provided a third of the total funds, with the Government expending $340 million and the joint venture covering the remaining $170 million. In order to recoup the capital investment and operating expenses, SMART Sdn Bhd charges a toll fee for using the motorway portion of the tunnel. Private cars and light vans are charged two Malaysian ringgits ($0.63) for each use of the tunnel. The toll rate is the same for taxis, but passengers pay the toll instead of the taxi operator.

**Contract Provisions**

SMART Sdn Bhd signed a 40-year concession with the Government, with the Malaysian Highway Authority and the Department of Irrigation and Drainage serving as the public partners. The concession is to operate and maintain the motorway portion of the tunnel. The Government maintains ownership of the land and the tunnel itself.

The Malaysian Highway Authority was the government agency that signed the concession agreement and is responsible for the technical regulation of the project. The toll rate is set based on the view of the Economic Planning Unit (EPU) as to an acceptable rate of return. The EPU and the Cabinet must approve all toll-rate increases prior to SMART Sdn Bhd setting new rates.

**Implementation Metrics**

In 2003, construction commenced on what would be the longest and most technologically advanced tunnel in Malaysia. The joint venture built a 12.7-kilometre tunnel that has a 13.2-metre external diameter and an 11.83-metre internal diameter. Given the dimensions, the motorway consists of two road decks: one to accommodate northbound traffic and one for southbound traffic, each featuring two lanes and a hard shoulder. The motorway was built to accommodate cars and light vans only.

The joint venture, with the help of its engineering consultants, had to devise a plan that would keep motorists safe from flood water while at the same time predicting floods early enough to evacuate motorists and convert the tunnel to flood use before the flood peak arrived. Automated gates at both ends of the
motorway, as well as ventilation shafts, were built in the tunnel to prevent damage to the structure caused by surge pressure. The ventilation shafts each contain an exhaust and fresh-air injection system that provides continued airflow and removal of exhaust fumes.

Cameras, message signs and emergency telephones throughout the motorway are engaged to facilitate traffic flow and alert SMART Sdn Bhd personnel of any problems. The motorway is equipped with cell phone capabilities as well as service for several radio stations, including channels provided for police, fire brigade and ambulance services. All these features have been waterproofed to avoid damage when the motorway is used for flood-water storage.

SMART Sdn Bhd also has two custom-built first-responder vehicles (FRVs) that are SMART motorway accessible and equipped to perform emergency fire and rescue operations. The FRVs and the Ronda Team, which are responders on motorcycles, are the emergency responders that are to patrol the tunnel in order to maintain traffic flow and handle any problems inside the tunnel.

As part of the Klang River Basin Flood Mitigation Project, the Department of Irrigation and Drainage developed an extensive flood warning system that uses rain gauges spread throughout the area to feed information in real time to the Stormwater Control Centre (SCC). The SCC is located at the point where water is diverted from the Klang River into the holding pond and tunnel so that it can monitor both the rainfall and the river level. These features allow SMART Sdn Bhd to decide in which mode the tunnel will operate, keeping motorists safe.

The tunnel operates in three modes to ensure maximum safety and cost-effectiveness. During the majority of the year when there is low rainfall and no major storms (peak river flow is less than 70 cubic metres per second), flooding of the Klang River is not a problem and the tunnel operates in Mode One, with the motorway remaining open.

Under Mode Two, which is for most storms during the monsoon season (peak river flow is between 70 and 150 cubic metres per second), the system is activated and the flood water is diverted into the lower chamber of the tunnel. Motorists are still able to access the motorway and the storm water collects in the storage pond at the southern end of the tunnel. The water is then drained from the storage pond into the Kerayong River, which runs to the south and east of the centre of Kuala Lumpur.

Mode Three is operational for major storms during the monsoon season and is expected to be operational only a few times a year. Once the river flow for the Klang River is predicted to exceed 150 cubic metres per second, SMART Sdn Bhd closes the tunnel to motorists. After checking to ensure that all motorists and disabled vehicles have been removed from the motorway, workers open automatic water-tight gates to allow flood water into all chambers of the tunnel.
Commentary

Methods for Overcoming Impediments

While many successful build-operate-transfer projects and PPPs have been established in Malaysia, there is not a specific law speaking to PPPs. The Government position could be made even more evident and transparent by including legislation that deals directly with PPPs. More private ventures might choose to invest in Malaysia if this were done.

Construction of the motorway should have been completed in June 2005 and of the stormwater management tunnel a year later, but both portions were not completed until the summer of 2007. The joint venture faced many challenges in drilling the tunnel due to the composition of the ground. Most of the ground for excavation was limestone, but part of the tunnel was dug through soft alluvium or ground disturbed by tin mining. Tunneling was very difficult, especially because ground settlement had to be controlled below the busy city to prevent infrastructure damage.

Key Points of Success or Failure

So far, the Stormwater Management and Road Tunnel (SMART) is a success. It faced its first test at the beginning of September 2007, when the motorway needed to be shut down for a major storm. Authorities at the Stormwater Control Centre sent the alert to clear the tunnel when the Klang River registered a reading of 70 cubic metres per second. The motorway was then reopened within eight hours of being shut down. SMART Sdn Bhd was able to keep the water level of the Klang River below the flood level, preventing a disturbance to the city centre.

The motorway has helped to reduce congestion and cut down on travel time into the city centre. Cars using the tunnel see an average commute time of just four minutes, compared to between 10 and 15 minutes for surface road users.

The Stormwater Management and Road Tunnel is an innovative project that combines two needs of Kuala Lumpur into one, less expensive, more cost-effective project. By using a PPP, the Government was able to effectively lower its costs on a much-needed flood relief tunnel. To date, the tunnel has prevented flooding in the city centre, which has allowed business to operate without interruption.