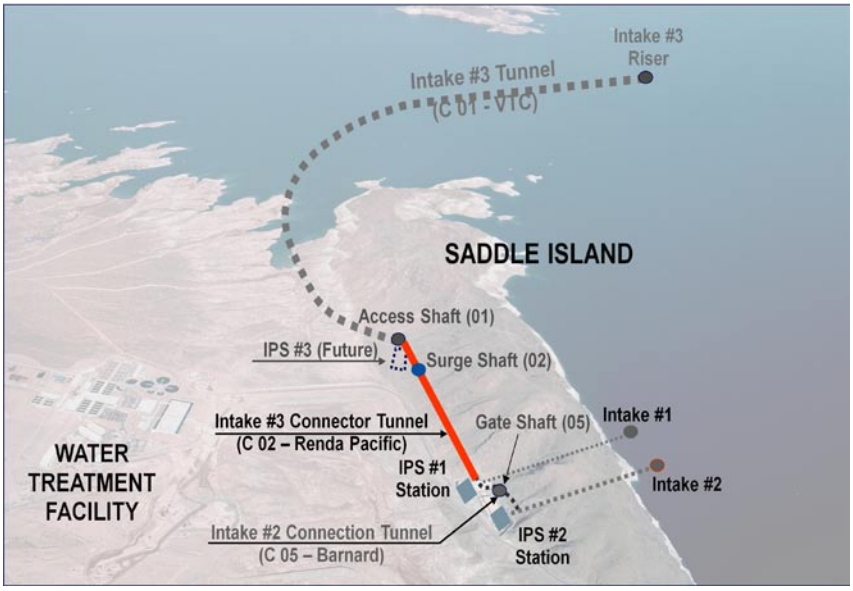
IMIA Short Paper
By Munich Re (Pia Steinberger, Heiko Wannick) Feb. 2012

Tunnelling in the United States: Lake Mead Intake No. 3 and Seattle Alaskan Way Replacement Project

Lake Mead Intake No. 3

The City of Las Vegas obtains 90% of its water supply from Lake Mead on the Colorado River from two existing intakes. Due to the constant drought in the Colorado River Basin in recent years the lake level has fallen by over 35 meters. In order to assure the existing draw-off capacity of the reservoir it has been decided by the Southern Nevada Water Authority (SNWA) to build a new intake system at a lower level. This will be achieved through implementation of the Lake Mead Intake No. 3 Project.

The project consists of three underground works packages. The largest contract (CO1) comprises of construction of the 183 m deep access shaft, the 4.5 km long intake tunnel and the intake structure. The second contract (CO2) consists of construction of a 137 m deep access shaft and an 860 m long connector tunnel between the CO1 shaft and the existing pumping station. The third contract (CO3) covers construction of a 174 m long connector tunnel.



Project layout

The project has suffered delay at an early stage when CO1's access shaft excavation hit water and required pre-excavation grouting. After the shaft reached the bottom in February 2010 the contractor successfully excavated the 122 m long TBM assembly chamber and a 28 m long short stub tunnel by drill and blast method. During excavation of the 120 m long TBM starter tunnel the contractor encountered a shear zone with embedded clay pockets and had to cope with significant water ingresses. Whilst the contractor started to install steel ribs as additional support the pre-excavation grouting campaign was stopped. On June 30, 2010 a front collapse occurred and large quantities of material flowed into starter tunnel, TBM assembly chamber and the stub tunnel. In addition, all underground works were flooded and the water level was kept at a level 50 m up the access shaft.

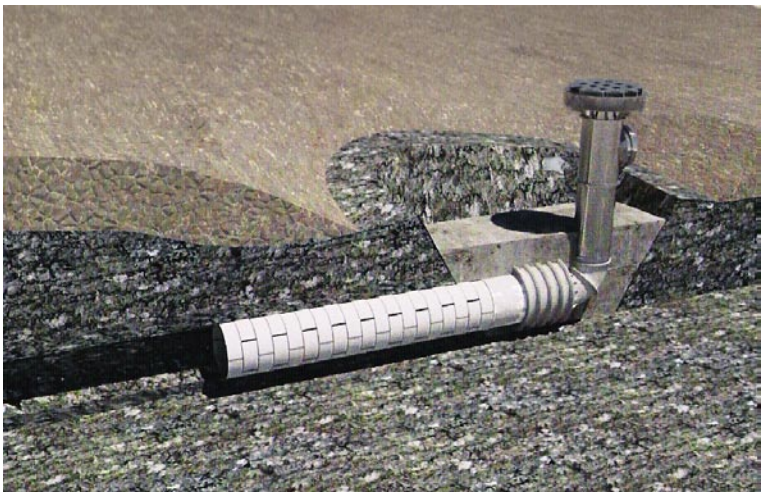
After three repair attempts failed, the contractor decided to abandon the starter tunnel and to build a realignment 23° offset from the original. The original starter tunnel was backfilled and plugged off with a bulkhead. For the new starter tunnel the contractor decided to install a pipe canopy at the tunnel roof in addition to pre-excavation grouting.

The main intake tunnel is being excavated by a hybrid-type tunnel boring machine. The 7.16m diameter TBM has started excavation in December 2011 and excavated the first 100 meter at the time of Insurers visit in early February. The machine is designed to cope with water pressures up to 17 bar and can operate in both open and closed (slurry) mode.

Hybrid TBM

The intake structure consists of a reinforced concrete lower part in which the TBM will penetrate and a stainless steel upper part. The concrete section has been casted on an offshore platform moored near Saddle Island. The stainless steel part was manufactured in an off-site facility and subsequently transported to the jobsite. The lake bed at the intake location is excavated by underwater blasting. The tower will be lowered to the ground in a high precision operation guided by a steel frame and the lower part embedded in 11,000 m^3 of lean concrete.

Due to the problems encountered during excavation of the starter tunnel CO1 is significantly delayed. Whilst CO3 has been successfully completed, CO2's drill and blast operation is slowed down by high quantities of water entering the tunnel which requires extensive grouting measures. The entire project is expected to be completed end of 2013.



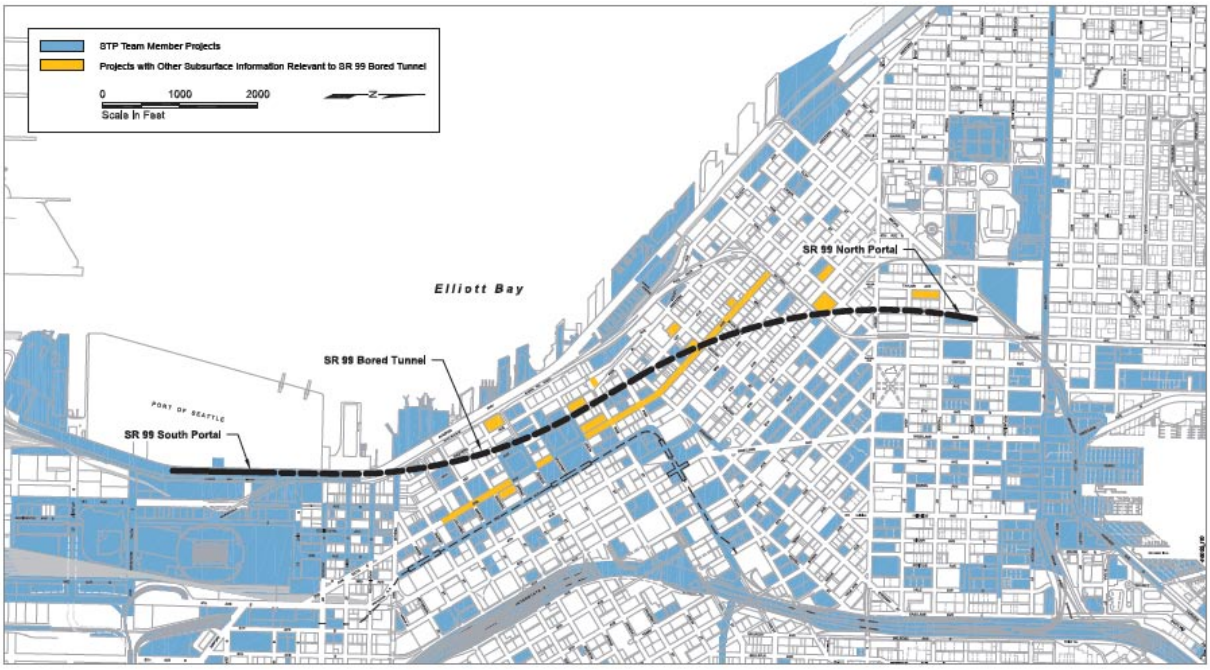
Intake Tower and segment lined tunnel

The Builders' Risk policy is owner controlled and led by Munich Re London. The total sum insured is US$ 520 million Regular site surveys are conducted on a bi-annual basis. In order to assure professional risk management standards the ITIG Tunnel Code of Practice has been introduced to the project. All contractors are in full compliance with the requirements of the Code.

SR 99 Tunnel - Alaskan Way Viaduct Replacement Project

The Alaskan Way Viaduct's central waterfront section, which begins at S. King Street and runs along Seattle's downtown waterfront up to the Battery Street Tunnel, will be replaced with a bored tunnel beneath downtown Seattle. The Federal Highway Administration (FHWA), Washington State Department of Transportation (WSDOT) and the City of Seattle released the project's Final Environmental Impact Statement in July 2011, and FHWA signed the Record of Decision in August 2011. Initial construction activities have commenced in autumn 2011. The tunnel is scheduled to open to traffic in late 2015.

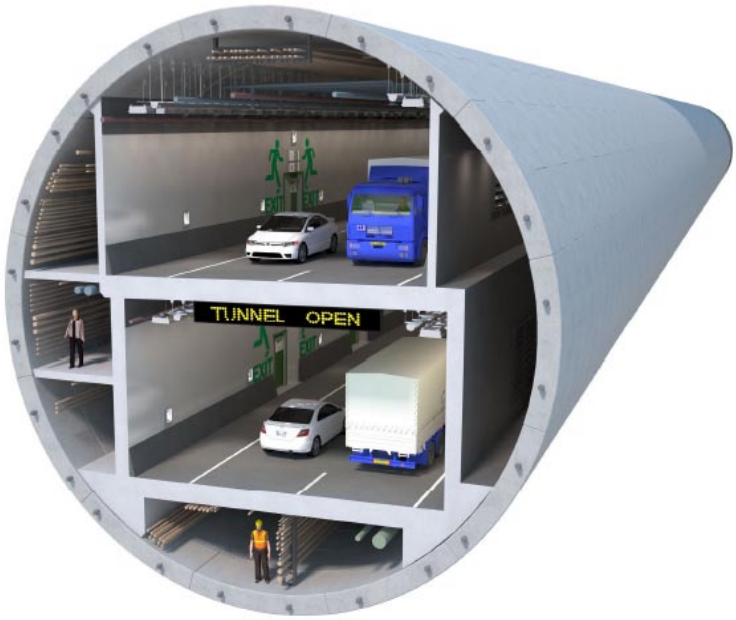
The SR 99 tunnel route begins on Alaskan Way S. south of S. King Street, then moves toward First Avenue near Yesler Way, turns north near Stewart Street and ends at Sixth Avenue N. and Thomas Street. The tunnel's south portal will connect to the new SR 99 roadway south of downtown. The north portal will connect to SR 99/Aurora Avenue N.



Tunnel alignment

The contractor is currently working on the final design for the project along with the TBM manufacturer. He will supply the 17.5 m diameter Earth Pressure Balance tunnel boring machine. The TBM is the largest machine ever for the time being and will tunnel through extremely complex ground conditions beneath heavily built up urban areas. It is anticipated that regular interventions will have to be carried out to change the cutting tools of the TBM. In order minimize hyperbaric interventions and to assure highest possible safety standards the owner has specified a cutterhead with accessible spokes. They will allow tool changes under atmospheric conditions.

The design-build contract totals US$ 1.35 billion. More than 90 percent of the design & build work will be performed for a fixed price.



Tunnel cross section

The Builders' Risk insurance policy for the project is lead by Munich Re London. The Lead Insurer has nominated a group of risk engineers who will conduct a Risk Management Program during the construction phase of the project. The group consists of risk engineering specialists from various disciplines. The project has adopted the principles of the ITIG Tunnel Code of Practice.