Mizunami Underground Research Laboratory
Program for Fiscal Year 2006

Independent Administrative Agency
Japan Atomic Energy Agency
Tono Geoscience Center

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Mizunami Underground Research Laboratory (MIU) Project began at the MIU Construction Site in Mizumani-city, Gifu in 2002. In the 2006 fiscal year, continuation of the construction phase (Phase II) of the MIU Project continues to be a major objective.

In the 2006 fiscal year, excavation will continue in the Main and Ventilation Shafts to a depth of approximately 200 m below ground level. Excavation will then begin on a horizontal tunnel, known as a Sub Stage, to connect the two vertical shafts, at 200 m depth. Current plans also include the performance of Scientific Investigations in Phase II simultaneously with the excavation activities. The main research activities include: investigations in the shafts and the Sub Stage to characterize the geological structure; hydrogeological investigations, including activities such as groundwater sampling to monitor and understand changes of the deep underground geological environment in response to excavation; and investigations using pilot boreholes drilled from the bottom of the shafts to understand the geological conditions ahead of the excavations. Based on the information from the pilot boreholes, the excavation design and construction can be optimized for the geological conditions and future scientific investigations can be planned in detail.
Furthermore, the appropriateness of the models of the geological environment, which are based on the results from prior investigations, will be assessed and revised as new data is obtained.

Collaborative research and joint use of the underground facilities with other Japanese research laboratories such as; the Association for the Development of Earthquake Prediction/Tono Research Institute of Earthquake Science (TRIES), the Advanced Industrial Science and Technology (AIST), Tohoku University, Gifu University, Kyushu University, Kumamoto University, Radioactive Waste Management Funding and Research Center (RWMC) and Central Research Institute of Electric Power Industry (CRIEPI), will be performed.

In addition to the use of the MIU as a research facility, the MIU will be used in cooperation with local organizations as a resource for the study and learning of geosciences. And furthermore, visits to the MIU by interested parties will be actively promoted.

1. Research and development plan

1) Surface-based and underground studies

Geological investigations and monitoring of groundwater inflow rates into the Research Galleries, the Main and Ventilation Shafts and the Sub Stage, will continue in the 2006 fiscal year (see Figure 1). This work has been ongoing since 2004.
Note: planned investigations may be modified to accommodate the actual underground conditions encountered or as required by the excavation schedule.

- Shaft wall investigations
A suite of shaft wall investigations will be undertaken. These will consist of shaft wall mapping (detailed geological description), shaft wall photography, shaft wall scanning using a 3D scanner and infrared thermography. Hand specimen sampling will also be carried out for detailed petrological, mineralogical and structural characterizations.

- Underground sampling for groundwater chemistry
Groundwater chemistry will be determined from samples obtained at the following locations; 1) a sub-horizontal borehole drilled from the 100 m Sub Stage in the sedimentary rock, 2) the water-collection rings, 3) seepage points on the exposed rock face.

- In situ stress determination using subsurface boreholes
In this study, two horizontal boreholes and a vertical borehole will be drilled, each 20 m length from the 100 m Sub Stage in the sedimentary rock. In situ rock stress conditions will be determined using these boreholes and laboratory testing of core specimens.

2) Long-term groundwater monitoring in surface boreholes

Long-term groundwater monitoring will continue in order to understand the long-term changes of groundwater flow and groundwater chemistry in the existing site borehole network (MIZ-1, MSB-1, MSB-2, MSB-3, MSB-4 and 05ME06) (see Figure 2).

3) Hydrological monitoring on the surface (see Figure 3)

In order to obtain the data necessary for estimating recharge into the deep underground, hydrological parameters, including the meteorology, groundwater table and soil moisture conditions will be continually monitored at the MIU Construction Site. Additionally, tilt meters will be used to monitor surface indications of deformation and to estimate groundwater level changes at the MIU Construction Site.

4) Geophysical investigations

Reverse-VSP (Vertical Seismic Profiling) surveys using a variety of vibration sources originating from the underground construction activities will be conducted to develop the investigation techniques to predict the geological and rock mechanical conditions around the shafts (see Figure 4). Geophones will be placed at and around the MIU Construction Site during the investigation. Fluid Flow Tomography (FFT) will also be conducted to develop techniques to understand the magnitude and the direction of groundwater flow as it moves towards the shaft excavations. In this investigation, the streaming potential that occurs from the interaction between flowing groundwater and an artificial potential generated by an array of electrodes placed on the ground surface will be measured.

5) Modelling of the geological environment

Various models of the geology, geological structure (such as faults and fractures), groundwater flow, chemistry, and rock mechanics in and around the MIU Construction Site have been developed based on the results of Phase I studies and will be improved in Phase II.
In addition, disturbance of the rock mass, of the groundwater flow system and the hydrochemistry due to construction activities will be predicted based on numerical simulations of the response to these activities.

6) Studies on engineering technology

In fiscal year 2006, research will continue to build on the results from last year's activities. The technologies examined so far include: technologies for feedback of

performance measurements obtained from ongoing construction activities into the design and construction process; technologies for inspection and assurance of the quality of research and construction; technologies to assess the influence of earthquakes on underground research facilities; and, technologies for the continual improvement of safety in excavations. The applicability and an effectiveness of these techniques will be evaluated and further developed. Furthermore, rock mass conditions and water inflow into the shafts will be predicted based on the results of the pilot borehole investigations. The applicability and effectiveness of the countermeasures used to deal with water inflow will be evaluated and appropriate techniques will be developed.

2. Construction plan

1) Excavations

For fiscal year 2006, excavation of the Main and Ventilation Shafts will continue to a depth of approximately 200 m below ground level using shaft-sinking equipment. Construction, using drilling and excavating equipment mounted on cable hoisted working platforms, began in February 2005. Excavation of an interconnecting tunnel, known as a Sub Stage, will be started at 200 m depth (see Figure 5).

In addition, borehole-based investigations using pilot boreholes drilled from the bottom of the shafts will be used to characterize the geological environment and to predict groundwater inflow into the shafts. To control excessive groundwater inflow, grouting materials (e.g. cement) will be injected into the rock to seal water-conducting fractures at locations identified by the pilot borehole investigations. The excavation plan for the shafts and the Sub Stage may be modified, if necessary, to accommodate the actual geological conditions encountered.

2) Environmental monitoring and site maintenance

The continuous monitoring of important environmental parameters, such as the quantity and quality of water discharged from the site into the local river system, water levels and quality of groundwater as well as ground motion and noise from the underground construction activities, will continue. The data will be needed to show the status of the environmental conditions in the vicinity of the MIU Construction Site and to verify conformance with environmental regulations. In addition, the grounds maintenance program will continue to ensure the site is safe, orderly and well maintained.

3. Safety and Public Relations

Site operation, including all construction, research and related activities, will continue to be managed with a primary emphasis on safe working conditions.

The MIU facilities will continue to be available for visits and tours by individuals and groups. These visits will provide an opportunity for visitors to learn about the status of research activities at the MIU Site and to have questions and concerns answered and addressed. Furthermore, up-to-date information will continue to be available on the JAEA website in key areas such as: the status of the excavation, the geological conditions encountered, and the results of the environmental monitoring program as described in the Environmental Preservation Agreement, which was concluded by Mizunami City, Gifu Prefecture and JAEA in November 2005.

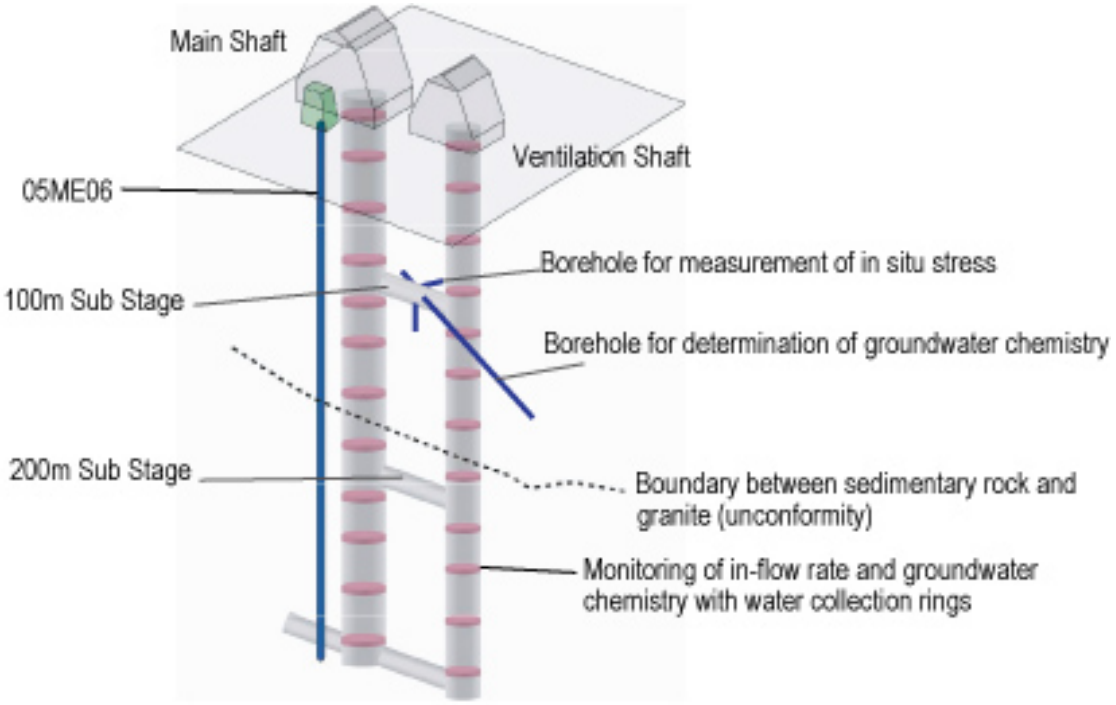

Figure.1 Schematic of Planned Investigations in the Research Galleries in FY 2006

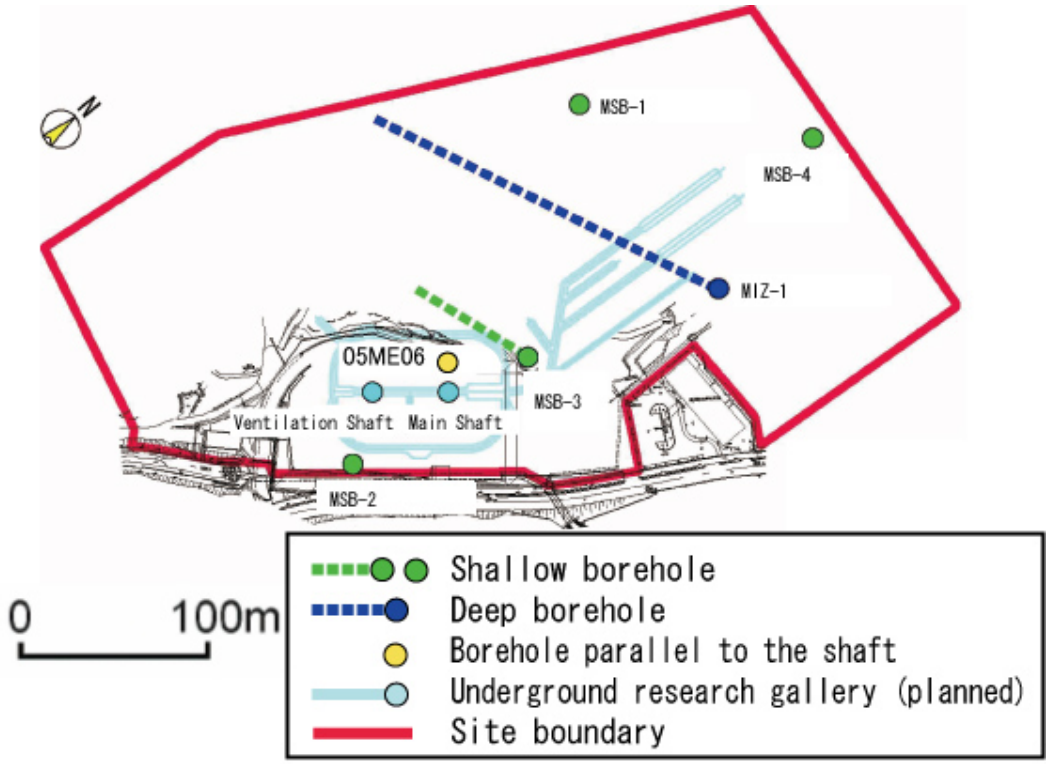

Figure.2 Location of Long-term Groundwater Monitoring Boreholes

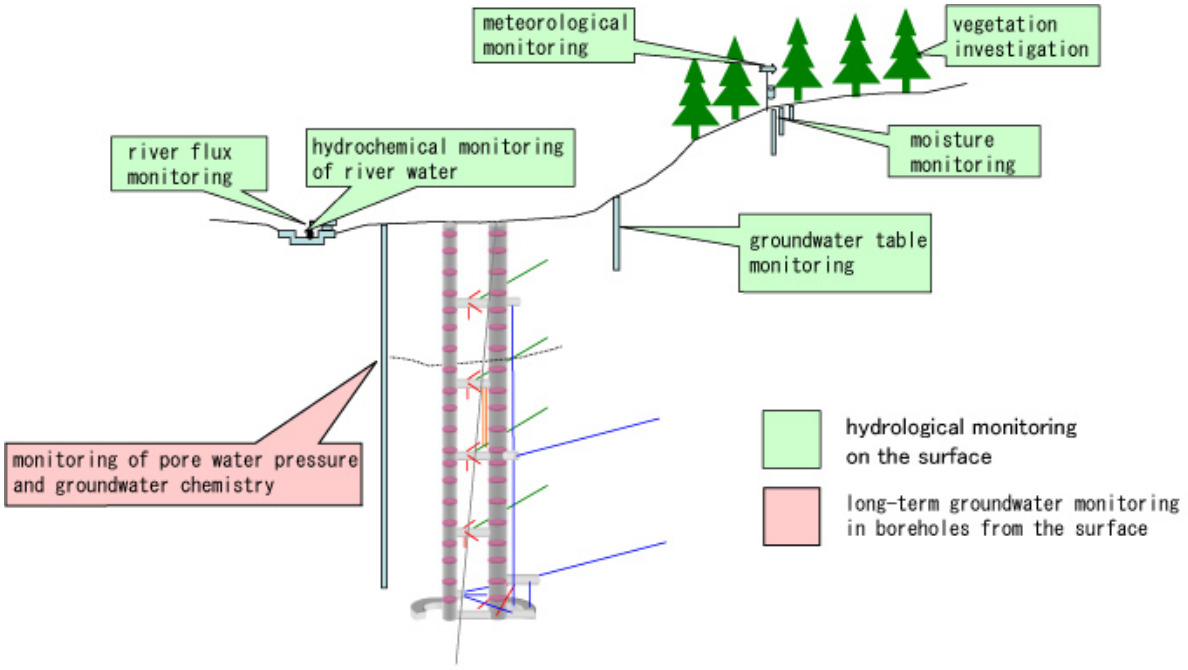

Figure.3 Schematic of Long-term Groundwater Monitoring

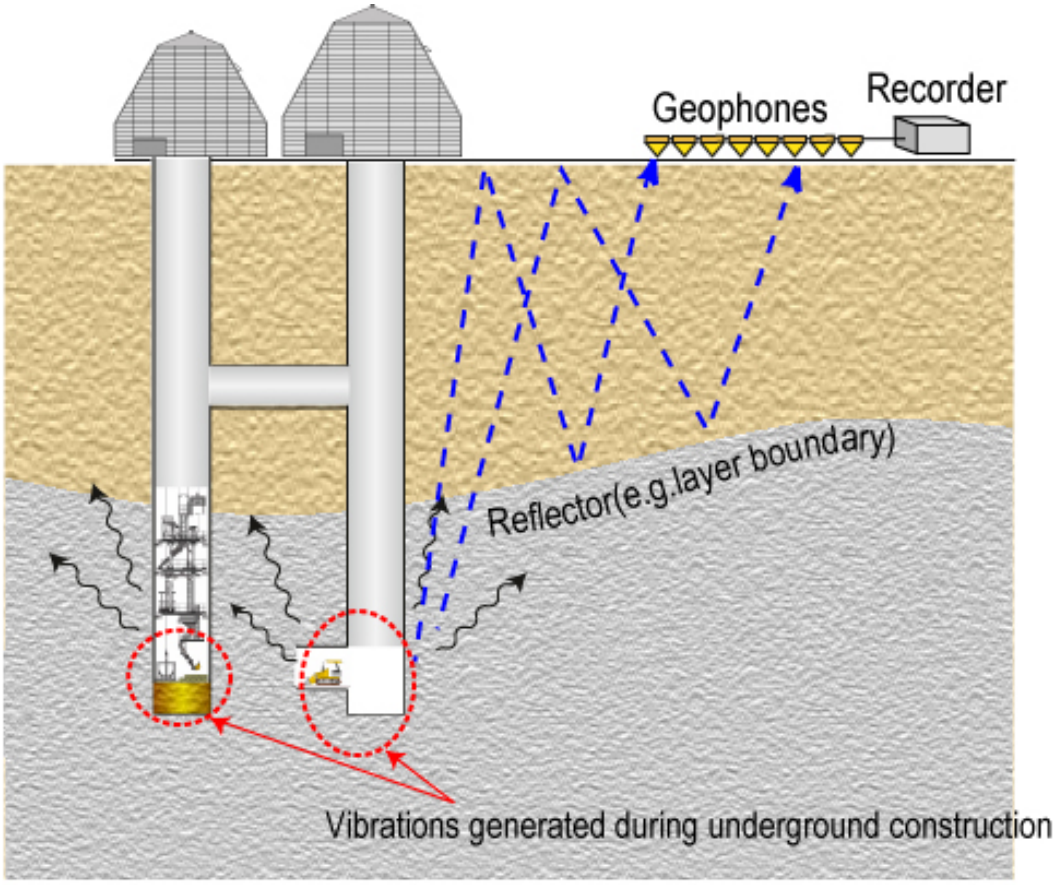

Figure.4 Seismic (Reverse-VSP) Survey Using Vibrations Generated During Underground Construction

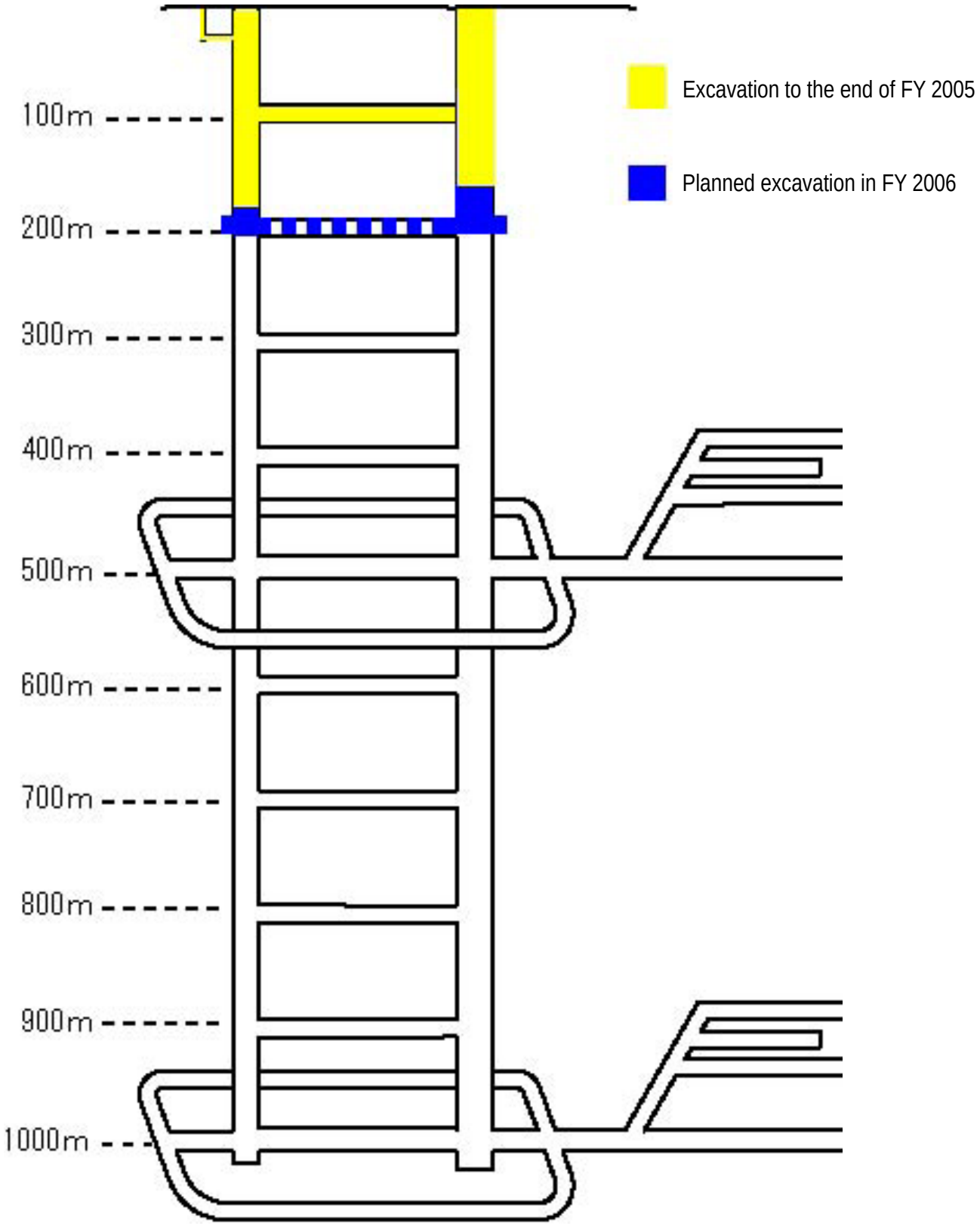

Figure 5. Underground Research Facilities Excavation Planned in FY 2006

MIU Project : Main Field Activities Schedule in 2006 Fiscal Year

	Items	FY 2006
Investigations	Surface-based and Underground Studies	(Shaft wall investigations /Observations of groundwater chemistry in boreholes/Measurements of in situ stress)
	Geophysical Investigations	(FFT: Fluid Flow Tomography / Reverse-VSP: Vertical Seismic Profiling)
	Long-term groundwater monitoring	(Pore water pressure and groundwater chemistry monitoring in surface boreholes)
	Hydrological monitoring	(Meteorological observations, groundwater table and soil moisture monitoring)
Facilities	De-watering	Pump water from the underground
	Excavation related activities	De-water/Excavation/ Test Grouting → Pilot borehole investigations from the shaft bottoms → Excavations – Both shafts: approximately 200 m depth – Sub Stage: 200 m depth Grouting: if necessary
	Environmental Monitoring	(Site Maintenance/Monitoring of environmental parameters: quality of discharged water, groundwater level, ground motion and excessive noise)