Appendix A10

***"Feasibility Evaluation of the Conversion of the Homestake Underground Mine to the Homestake Underground Laboratory"*, Dynatec Corporation dated 1 December 2004**

and

***"SDSTA Review Committee report of the Homestake Underground Laboratory Conversion Plan"*, dated December 2004**

Dynatec Corporation

Feasibility Evaluation of the Conversion of the Homestake Underground Mine

To The

Homestake Underground Laboratory

Prepared for the
South Dakota Science and Technology Authority - State of South Dakota
December 1, 2004

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1.0 EXECUTIVE SUMMARY

The development of a deep underground laboratory for study of the physics of neutrinos, protons and other areas of frontier science has been exceptionally well documented and justified by the science community. In October of 2000, Homestake Mining Corporation announced the closure of the 8,000 ft deep gold mine in Lead, South Dakota and leaders of the scientific community proposed the conversion of the mine to the deep laboratory. There have been several other locations proposed for the construction of such a deep laboratory. In May 2003, the National Science Foundation (NSF) identified the Homestake Mine as the preferred choice because of the excellent quality of the available rock and extensive infrastructure.

The Homestake Mine closed in June 2003 and all operations in the underground mine ceased, including the pumping of the naturally occurring small amount of water that enters what is essentially a dry mine with over 360 miles of drifts and shafts.

In June 2003 the Governor of the State of South Dakota, M. Michael Rounds, formed the Homestake Laboratory Conversion Project, with State funding authorized by the legislature, to enable the conversion of the mine to a deep laboratory. The Governor and Homestake Corporation have agreed that subject to specific terms and conditions, the ownership of the mine will be transferred to a new South Dakota authorized Authority when funding for the conversion is available.

An original unsolicited proposal, submitted by scientists, approached the development of the deep underground laboratory to include the excavations of several large experiment detectors as part of the laboratory. This proposal would have required funding in excess of $300 million dollars and remains unfunded. However, a new approach became feasible as the extensive capabilities of the mine, as it will be transferred, were reviewed.

The mine, as will be transferred, will include extensive infrastructure and operational capabilities that can provide the core support facilities of the Homestake Underground Laboratory with the ability to expedite the addition of various detector experiments as they are proposed, reviewed, and authorized far into the future without disruption of the already operating experiments. Additionally, the core Homestake Underground Laboratory has the potential to accommodate the requirements of the scientists for continued access to their experiments in an environment equivalent to the highest of quality university research laboratories.

This feasibility study is intended to demonstrate the ability of the mine to be converted into a Laboratory Support Facility by performing the following specific activities:

1. Prepare for mine re-entry
2. Refurbish and upgrade the Yates Shaft
3. Refurbish and upgrade the Ross Shaft
4. Remove water from the mine, refurbish and upgrade the #6 winze
5. Provide the Homestake Underground Laboratory Support Facility with the infrastructure to support future detectors
6. Demonstrate the ability of the Laboratory Support Facility to support the construction of laboratory rooms within existing infrastructure and future construction of additional rooms outside existing infrastructure for large detector experiments.

The objective of this feasibility study is to identify the cost to create the Homestake Underground Laboratory to support the inclusion of future detector experiments with a minimal need for additional infrastructure expense.

The base case for the study involves the conversion of the mine into and Underground Laboratory Support Facility, capable of supporting deep level science, Earth Science and Engineering studies in a completely dewatered mine. The study will also review options that will develop the Laboratory Support Facility with different levels of capabilities that would require less funding.

The plans developed for the conversion consider Life Safety issues as the primary concern in design considerations. The facility will be built to the highest level of safety standards.

The study concludes that it is feasible to convert the mine, as will be transferred, into the Homestake Underground Laboratory, with the capability to provide for continual development with the future addition of detector experiments.

The cost of the conversion of the Homestake mine to an Underground Laboratory Support Facility is $44.9M. With the construction and development of small initial Laboratory Rooms in the existing mine infrastructure, the total cost is $49.3M

2.0 FEASIBILITY STUDY

Dynatec Corporation has completed this study using its extensive knowledge in support of information provided by the Homestake Laboratory Conversion Project from the Homestake Mining Corporation and a number of consultants.

This report is organized by the analysis and evaluation of the system components of the mine to be used in the conversion to the underground laboratory.

The report concludes that it is feasible to convert the mine, as will be transferred, into the Homestake Underground Laboratory, with the capability to provide for continual development with the future addition of detector experiments.

2.1 PREPARE FOR MINE RE-ENTRY

2.1.1 Detailed Engineering

Detailed engineering will ensure that all required materials and equipment will be ready at the time they are needed to prevent interruptions in the mine conversion. Detailed engineering will be required in the following areas:

1. Working Platforms for the Shaft Rehabilitations
2. Ventilation Conversion
3. Hoist Upgrades and Automation
4. Mine Dewatering
5. Conversion of #6 Winze Hoists for Shaft Rehab and back to Production
6. Electrical Upgrades and new Installations
7. Rock Mechanics Evaluations of Proposed Excavations
8. Waste Water Treatment
9. Others as required

2.1.2 Permitting

In order to restart operations, it will be important that all required permitting issues are addressed prior to the start of activities. Applications for permits have been initiated by the State. Anticipated permits that will be required include the following:

1. Water Discharge and Treatment
2. Waste Rock Disposal
3. Others as required

2.1.3 Re-establish Power and Ventilation

One of the first tasks in the conversion will involve re-establishing power to the site. It is expected that the surface electrical distribution network will not require significant repairs to be returned into an operating state. As such, it is expected that power should be restored to the site within a few days.

The mine in its current closed state has had the main entries sealed. In order to re-establish ventilation, the seals on the Yates and Ross shafts will need to be removed to allow for the ventilation system to be re-activated. Once this is completed, the 1,200 HP fan on the Oro Hondo Shaft will be energized which will draw fresh air through the Yates and Ross shaft to allow for re-entry into the mine.

2.2. REFURBISH AND UPGRADE YATES SHAFT

2.2.1. Re-enter and perform a basic refurbishment of the Yates Shaft

The Yates shaft will be the secondary means of entry into the mine. The general process by which re-entry into the mine through the Yates shaft will be as follows:

1. Re-activate and commission the Service Hoist. This will involve powering up the hoist, testing all its mechanical and electrical functions and making repairs where necessary.
2. Perform a detailed shaft inspection. This will involve personnel riding on top of the service cage and inspecting the condition of the shaft infrastructure to determine what immediate repairs, if any, are required.
3. Complete the required shaft repairs to allow for safe access to the 4850 Level so that the Yates shaft can be used as the secondary means of egress during dewatering and Ross Shaft upgrades. In addition to some scaling and minor ground support installation, there are a total of 50 timber sets between 800 L and 1100 L that will eventually need to be replaced. There are also a number of miscellaneous pieces of structural timber that will need to be replaced for the remainder of the shaft length. Initial refurbishment will include all work necessary to safely re-enter the mine and establish the Yates Shaft as a secondary means of egress.
4. Install ventilation bulkheads at level locations to isolate the fresh air circuit from the old mine. A total of 52 shotcrete type bulkheads will be installed, complete with man doors for controlled personnel access.
5. Perform level rehabilitation on the 4850 L between the Ross and the Yates shafts and the #6 Winze. This will involve scaling, installation of required ground support, and removal of scaled material.

2.2.2. Yates Shaft Permanent Upgrades

Upon the completion of the Ross shaft Refurbishment and commissioning, it will be possible to commence with the permanent upgrade of the Yates shaft. The work associated with the Yates shaft upgrades will be as follows:

1. Complete the required detailed engineering necessary to perform the Yates shaft upgrades.
2. Install a new, efficient fresh air intake fan at the surface.
3. Complete the replacement of structural timbers between the 800 and 1100 levels. Additional structural timbers will be replaced below this level as required.
4. Replace Motor Generator sets on the Service hoist with Thyristor controls and automate hoist. The control station for hoist operation will be moved to the Ross shaft hoist room.

2.3. REFURBISH AND UPGRADE THE ROSS SHAFT

2.3.1. Re-enter and Perform a Basic Refurbishment of the Ross Shaft

The Ross Shaft will be the primary means of entry into the mine. The general process by which re-entry into the mine through the Ross shaft will be as follows:

1. Re-activate and commission the Service Hoist. This will involve powering up the hoist, testing all its mechanical and electrical functions and making repairs where necessary.
2. Perform a detailed shaft inspection. This will involve personnel riding on top of the service cage and inspecting the condition of the shaft infrastructure to determine what immediate repairs, if any, are required.
3. Complete the required shaft repairs for safe access to start dewatering. It is expected that in addition to some scaling and minor ground support installation, a total of 50 steel sets in the Ross Pillar area and the entire 12" discharge pipeline will eventually need to be replaced at a minimum. Initial refurbishment will be that which is necessary to safely re-enter the mine and reactivate the mine services including mine dewatering.
4. Replace existing pumps in pump stations with refurbished ones. There are pumps on the 1250 L, 2450 L, 3650 L and 5000 L that will need to be removed, refurbished and re-installed.
5. Install ventilation bulkheads at level locations to isolate the fresh air circuit from the old mine. A total of 38 shotcrete type bulkheads will be installed, complete with man doors for controlled personnel access.

2.3.2. Ross Shaft Permanent Upgrades

The work associated with the Ross shaft upgrades will be as follows:

1. Complete the required detailed engineering necessary to perform the Ross shaft upgrades.
2. Re-commission the Production Hoist to allow for use during the upgrades.
3. Install a winch in the collar house to be used for raising and lowering materials during the shaft upgrade.
4. Install a new, efficient fresh air intake fan at the surface.

5. Complete the replacement of steel sets in the Ross Pillar area. Additional steel sets located above or below this area will be replaced as required.
6. Install new services in the service compartment which will include water supply lines, water discharge lines, shaft guides, communication lines and power cables.
7. Replace Motor Generator sets on the Service hoist with Thyristor controls and automate hoist.

2.4 REMOVE WATER FROM MINE, REFURBISH AND UPGRADE #6 WINZE

2.4.1 <u>Removal of Accumulated Water</u>

The accumulated water below the 6200 Level will need to be removed. The process by which this will be accomplished will be as follows:

1. Rehabilitate the 4550 level to gain access to the #6 Winze hoist room from the Ross Shaft.
2. Re-activate the Service hoist by performing all mechanical and electrical inspections to determine repairs required for operation purposes.
3. Make all necessary repairs and power up hoist.
4. Remove the ropes and conveyance from the Service Hoist.
5. Convert the #6 Winze Service Hoist to a winch and commission. This will involve the removal of the existing drum shells and replacing them with winch liners. It will also involve the installation of a defector sheave. Install winch rope.
6. The temporary dewatering system will include the use of stationary and submersible pumps. The plan is to build a floating deck which will have a 250 HP submersible pump installed. It will be installed in the Cage compartment and will be set in place within the guides of the compartment. As the water goes down, it will slide down between the guides. This set up will move down the shaft in 200 foot increments, or to the closest level within that range. At that point, a temporary sump will be set up where another 250 HP submersible will be installed which will become an intermediary pumping station. This will be done until a point is reached where a total of 3 x 250 HP submersible pumps are pumping in stages for a total distance of 600 ft. At that point, a 700 HP stationary pump will be installed in a temporary sump which will be able to pump for a total of 600 ft vertical. The progression of submersible pumps will continue past this level in a similar fashion to the next 600 ft level. This system will be applied until the shaft is dewatered to the 8150 Level. Along the way, new 1000 HP pumps will be installed in the 6800 Level and two of the temporary 700 HP pumps will be installed in the 8000 level which will become the permanent pumps when the dewatering is completed.

The Ross Shaft currently has a 12” discharge pipe located in the Services compartment. It is expected that there will be some sections of pipes that will need to be changed for the initial mine dewatering. It was noted during the last stage of mine operations that the pipe line in this shaft is old and in need of replacement but should be suitable for initial dewatering.

The #6 Winze currently has a 12" discharge pipe installed in the Services compartment. Although there is a good chance that this pipeline will be serviceable after dewatering, it has been decided to replace this line with a new one which will allow for mine dewatering well into the future life of the lab. The new pipe will be installed during the #6 Winze rehab and mine dewatering.

For the purposes of this study, it has been assumed that the dewatering would commence in May of 2005. At that point, the height of the water would be at approximately the 6200 L. It has been calculated that it will take approximately 10 months to dewater the mine at an average pumping rate of 2,000 USGM per minute which will result in the lowering of the water level by an average of 6.5 ft per day.

2.4.2 Level Rehabilitation

The 4850 Level is the main level in the mine. This level will need to be rehabbed as soon as possible. The plan is to rehab the level from both the Ross and the Yates Shafts as soon as access is established to each level. The distance between Yates and Ross shafts is approximately 3000 ft.

Levels from the #6 Winze will be rehabbed as the Winze is dewatered. The levels will be rehabbed to where they intersect with the ramp. Generally, the distance between the #6 Winze and the ramp at the various levels is approximately 3200 ft. It is currently planned to rehab levels at 600 ft vertical intervals. Ventilation bulkheads will be installed every 300 vertical feet, at the intersection of the shaft and the levels, to control the ventilation.

Rehabilitation of the levels will consist of scaling, mucking and installing ground support as required. Ground conditions are not expected to have deteriorated significantly during the flooding and the installed ground support should still be providing support. An allowance of 1 bolt every 6-7 ft has been included in the cost of rehabbing the levels.

The pipes which are still in place should be usable for water and compressed air requirements. Electrical cables which have been under water are planned to be replaced.

Ventilation for the rehab work will be provided from a fan which will be installed in a bulkhead on the level which will draw fresh air down the #6 Winze. Vent tubing will be installed from the fan as the rehabbing advances along the level. The rehabbing will advance to the point at which the ramp intersects the level. From that point on, further rehab will be performed down the ramp to the next level.

2.4.3 Ramp Rehabilitation

The ramp from 4850 Level to 8000 Level will be rehabbed as the mine is dewatered. This ramp will serve as a secondary means of egress as the #6 Winze is dewatered, as well as a permanent secondary means of egress during Lab construction and operation.

Rehabilitation of the ramp will consist of scaling, mucking and installing ground support as required.

The pipes which are still in place should be usable for water and compressed air requirements. Electrical cables which have been under water will be replaced.

The rehabilitation of the ramp will start on the 4850 Level and progress as the water is lowered. Ventilation will be provided through a fan located on the 4850 level from which vent tubing will be added as the rehab advances. As levels which have connection to the #6 Winze are intersected the ventilation fan will be moved down to that level and ventilation will be advanced down the ramp from that new location. At each level, stopes and raises will be inspected to ensure that water has not pooled up behind bulkheads or muck piles that could release and present a hazard. Where pooled up water is found, measures will be taken to safely release this water. This system will continue until the mine is dewatered to the 8000 Level.

2.4.4 Permanent Upgrades to the #6 Winze

In the #6 Winze, it is planned to replace all the services that will be under water by the time the conversion begins. The condition of the shaft steel sets should be good and will not require significant repairs.

It is expected that the general condition of the steel sets in the shaft will be good. It is not expected that the flooding will result in any excessive corrosion of the shaft steel above that which would have occurred had the shaft been kept dry. All of the services in the shaft including compressed air lines, electrical and communication cables, industrial water lines, potable water lines, and discharge lines will be replaced. The rehab will be done from a platform built over the cage.

Upon completion of the dewatering, the #6 Winze Hoist will be converted back to a Koepe hoist by removing the winch ropes, drum liners and deflection sheave and then installing new friction hoist drum liners. New ropes will then be installed with the existing service cage. The hoist will then be upgraded for remote operation from the Ross shaft Hoist room.

2.5 PROVIDE THE LABORATORY SUPPORT FACILITY WITH INFRASTRUCTURE TO SUPPORT FUTURE DETECTORS

2.5.1 Services

The existing utility services will be used where possible and upgraded as required.

2.5.1.1 Ventilation

The ventilation of the Lab will consist of Fresh Air Intake and Return Air Exhaust. Fresh air will enter into the Yates and Ross shafts via the Tramway connecting the two shafts. Due to the significant reduction in ventilation requirements with the new Lab and associated construction activities, new and more efficient fans for mine ventilation will be installed. One new 125 HP intake fan and one new 250 HP fan will be located in the Tramway which connects the Yates and Ross shafts. These fans will be used to direct fresh air down each shaft separately. Natural gas fired mine air heating plants will be installed at each air intake location to heat the fresh air as required during the winter months.

Exhaust air will be removed from the lab via one new 350 HP exhaust fans, which will be installed on the Oro Hondo Shaft during the mine upgrading process. The existing surface ventilation infrastructure including the 3,000 HP Oro Hondo Fan and the 2 x 700 HP Kirk Fans located at the Kirk Adit will be left in place and made available for stand by.

During the reopening of the mine, construction crews will install shotcrete ventilation bulkheads at each level to provide an air tight seal, preventing fresh air from entering the old workings. This will mitigate the potential for mine fires to occur within the mined out areas.

The existing Oro Hondo and Kirk fans will be used until the new fans are installed.

A detailed study of the Ventilation plan and requirements for the conversion has been performed by Cam Seeber, an independent ventilation consultant specializing in mine ventilation. This study entitled: Ventilation Requirements for Construction and Operation of a Laboratory on the 7400 Level of the Homestake Mine can be found in Appendix 1. The original parameters of this study considered the #5 Shaft as the main exhaust way. Further analysis determined that the Oro Hondo Shaft provided a suitable alternative to the #5 Shaft as the main exhaust way and the ventilation plan was adjusted accordingly. In addition, the design considered laboratory construction within the Yates Rock Formation on the 7400 Level.

2.5.1.2 Mine Air Heating

Mine air heating will be kept to a minimum as requirements for cooling at depth will create a significant energy demand. Heating will be supplied through gas fired heaters located at the Yates and Ross intake areas and will provide heating capacity to raise the air temperature to 34 degrees F. A 7 million Btu heater will be required at the Yates Shaft intake and a 26 million Btu heater will be required at the Ross Shaft.

2.5.1.3 Mine Air Conditioning

Mine air conditioning will be required below the 4850 level during the shaft rehab, and during level excavation stages. Air conditioning units will also need to be installed for permanent lab operation on the 7400 Level. Based on the study which has been completed, it has been determined that the proposed Lab site in the Yates Rock Formation will require a 290 ton chilling unit which will provide sufficient capacity for future growth. This will be installed on the 7400 Level and will be the permanent air conditioning equipment for the lab. Spot 30 ton chillers will be installed in the 6,800 and 8,000 Level pump stations. During construction, a number of 30 ton chillers will be installed and moved as required as the conversion work progresses.

2.5.1.4 Power and Distribution

The source of electricity to the mine is through the Black Hills Power and Light power grid. Underground power is supplied to the Ross & Yates Shafts from three substations located on the surface (East Sub, Ross Sub, Oro Hondo Sub). The Ross and Oro Hondo substations provide Mine power to the Ross Shaft. The East Substation supplies power via the Yates Shaft to a substation at #6 Winze on the 7,700 level.

The power needs of the converted facility will be considerably less than what was required for the mine while it was in operation. The existing infrastructure provides an excellent base from which required power for the Lab can be directed. It is expected that the surface electrical equipment will not suffer from deterioration during the 1_ year shutdown. The existing surface infrastructures including power lines, transformers, and switchgears will be utilized for the conversion.

Additionally, emergency generator sets will provide back up power in the event of a power failure. The generators will be strategically located to ensure life safety needs are satisfied.

Further details on electrical requirements for the conversion can be found in a report entitled "Review of Electrical Requirements for the Conversion of the Homestake Underground Mine to the Homestake Underground Laboratory" located in Appendix 2 of this report. This plan was developed considering the Yates Shaft as the primary access into the mine. It considered auxiliary hoists in the Yates Shaft and #6 Winze as well as a new pumping system in the Yates Shaft. Upon further review, it was determined that a more practical conversion plan would be to develop primary access through the Ross Shaft and rehabilitate the existing pumping system without a need for auxiliary hoist access.

2.5.1.5 Water Treatment

Water Treatment at the mine currently utilizes Biological Treatment process to treat mine discharge and tailings runoff before it is discharged into the environment. The facility will require modifications to treat the dewatering process by the addition of a cooling system. Once the mine is dewatered, it is expected that minimal treatment will be required.

A Water Quality investigation of the mine discharge water was performed by Mark Nelson of the SD DENR. Samples were taken from various locations throughout the mine before the mine was shut down. The results of this study conclude that the general quality of the mine water is good.

By the time the dewatering starts, the water is expected to be at a temperature of approximately 95 degrees F. The maximum allowable discharge temperature limit of 65 degrees F will be accomplished through a combination of cooling and mixing lower temperature waters.

The Grizzly Gulch seepage collection will be treated by a new treatment plant installed and maintained by Homestake Mining Company at the base of Grizzly Gulch. The project will also eliminate any cross connections between the existing plant and new plant.

2.5.1.6 Permanent Mine Dewatering and Water Discharge

Due to the age of the dewatering system within the Ross Shaft, it has been decided to replace the existing 12” discharge pipeline with a new one during the Ross shaft upgrade. Homestake had made plans to install a new discharge line in this shaft before the shutdown announcement was made. It is felt that it would be prudent to follow through with this for the conversion.

The permanent mine dewatering system will have a capacity to discharge 2,000 gpm. This will be achieved by utilizing the existing pumping system which incorporates the use of 700 HP pumps in pumping stations located in the Ross Shaft at the 1250, 2450, 3650 and 5000 Level. Pumps used in the #6 Winze include 1,000 HP pumps at the 6800 pump station and 700 HP pumps in the 8000 Level pump station.

2.5.1.7 Communication

With the renovation of the Yates and Ross Shaft and the #6 Winze, a review of the communication systems will occur. The number of communication lines which currently feed the mine is listed as follows:

2.5.1.7.1 Voice Communication

Voice communications into the mine are through a telephone system. In the Ross Shaft, there are two 100-pair cables. It is expected that these cables should be reusable in the conversion. In the Yates Shaft there are two 100 pair cables as well. In the #6 Winze, there is one 100 pair cable which will need to be replaced during the shaft rehab.

2.5.1.7.2 Data Communications

All data communication cables into the mine currently originate from the main computer system in the Mine office building. Until the new Science Administration building is constructed, it is planned to continue with this system. The Fiber Optics cables used are 24 pair, 62.5 micron, multi-mode, Tbase 10, cable which goes down Yates Shaft to the 4850 level electrical shop. From the 4850 electrical shop, the cable goes down the #6 Winze to the 7400 level #6 Winze shop. It is planned to replace the Fiber Optic cable which currently goes down the # 6 Winze during the shaft rehab. The 24 pair cable currently has 21 available pairs. It is unknown exactly what the needs of the Laboratories will be in operation but there certainly is capacity in the line for significant data transfer.

All data communication operations, controls and monitoring will be located in the Ross Shaft central control station.

2.5.1.7.3 Mine Monitoring

A FIXMACS Mine monitoring system was used to monitor the entire mine, control pumps, fans, and a Carbon Monoxide sensor system. It is expected that all equipment relating to this system that has been under water will need to be replaced. However, there should be a portion that is recoverable that has not been under water.

2.5.1.7.4 Radio

A Leaky Feeder system is installed in the mine from the top to the bottom of all the shafts for transportation communication. It is also installed in the main ramp system from the 6500 to 8000 Level and Ross Shaft area from the 2000 to 4450 Level. The Leaky Feeder system includes a telephone interface, which provides for communications with any telephone on the surface. As with all other cables, those which have been under water will need to be replaced, but it is planned to recover all the remaining cable not under water.

2.5.1.8 Mine Automation

The conversion of the mine into an Underground Laboratory Support Facility will include the installation of the most comprehensive automation system available.

All the Service hoists in the Yates, Ross and #6 Winze will be fully automated and controlled in the Ross Shaft central command location. Within this location, other systems such as the ventilation, pumping, fire detection and control, gas monitoring, compressed air, personnel monitoring and security will also be monitored.

All electrical systems will be controlled through a demand monitoring system that will prioritize electric motor operations to minimize total demand.

The pumping system will be designed, operated and controlled to operate at times when the lowest energy rates are charged.

The ventilation including air volume, heating and air conditioning will also be controlled through an automated system which will provide only that which is required at any given time.

The benefit of this high level of automation will be to minimize the overall cost of operations of the Laboratory Support Facility.

2.5.1.9 Heating

Most of the surface buildings are heated with steam which originates from natural gas fired boilers. These units have been decommissioned properly. The boilers will be restarted and will be used for heating the existing required buildings during Lab conversion.

The main administration building currently is heated with natural gas.

2.5.1.9 Water Supply

The Mine has both potable and industrial water available.

2.5.1.9.1 Potable Water

The Lead-Deadwood District will provide potable (domestic) water to the facility. The potable water system is fed from several storage tanks located in

Lead. From these tanks, it is pumped through a network of pipes buried on surface to the various buildings in use and the Ross Shaft. This system will be used for the conversion. This system will also serve as the main building fire sprinkler reserve.

The Laboratory operations will require potable water for drinking and washing facilities. Most of the potable water in the Mine is fed through a 4" pipeline that extends from the surface to the 5000 level in the Ross Shaft. This line will be replaced with a new one in the Ross Shaft. Within the #6 Winze and down to the various levels, a new 2" line will be installed during the shaft rehab. The capacity of this system will be up to 400 gpm.

2.5.1.9.2 Industrial Water

Industrial water will be provided from the mine dewatering process. Also included is an above ground, 1.2 million gallon, reinforced concrete storage tank. Industrial water will be directed through surface pipelines to the Ross and the Yates shafts.

Industrial water is required for drilling, dust control, and mine equipment washing. When the mine was in operation, industrial water was sent underground at the Ross shaft in a 6" pipeline and the Yates shaft in a 4" pipeline. The capacity of this system was 1400 and 400 gpm respectively. It is expected that industrial water required for the conversion can be sourced from water being discharged. However, for the purposes of this study, it is planned to replace the existing 6" line in the Ross shaft with a new line. The resultant capacity of the new system will be 1400 gpm. The 6" line currently in the #6 Winze will be replaced with a new line during the shaft rehab.

2.5.1.9.3 Sewage

The sewage produced from the various surface facilities is directed through sewage pipelines to the City of Lead Sewage Treatment plant. This system will continue to be used for the conversion.

2.5.1.9.4 Compressed Air

The mine was supplied with compressed air through the Yates compressor station which has 4 electric compressors capable of providing over 30,000 cfm to the mine. Although the Lab's compressed air requirements will be significantly less than what was required for the mining operation, the existing plant will be used. Compressed air requirements for Lab operation and construction have been calculated to be approximately 6,000 cfm which means that only one compressor will need to run at any given time. The existing compressors are old but have been well maintained and properly decommissioned for future use.

The compressed air that enters the mine during operation was produced at the Yates compressor station and fed into the mine via a 12" pipeline in the Yates Shaft. This pipeline will be suitable for use in the conversion.

The #6 Winze currently has a 10" compressed air line installed in the pipe services compartment that is planned to be replaced with a new one during the shaft rehab and dewatering. This line will be evaluated during the rehab.

2.5.2 LABORATORY SUPPORT FACILITY DEVELOPMENT AND CONSTRUCTION

There are two alternatives which have been reviewed for Laboratory Support Facilities Development and Construction. The first alternative would be to locate support facilities within existing infrastructure on the 7400 L. These facilities would be able to support small scale experiments that do not require large excavations. It is this plan which has been estimated and scheduled.

The second alternative would be to construct support facilities outside the existing mine development infrastructure in the more competent Yates Rock formation between the 7100 and 7700 Levels which would be able to support large scale experiments requiring large excavations. The details of this plan are presented for information only and could be developed into the support facility as the laboratory develops.

2.5.3.1 Alternative #1 – Support Facility Within Existing Infrastructure – 7400 L

The general plan to develop a support facility within existing infrastructure on 7400 level involves the use of the Machine Shop located near the main access ramp as the area where small scale laboratory rooms would be constructed. Drawing # E771-200-02-D-205 A shows a general layout of the area with the associated required excavations for the Lab and support rooms.

2.5.2.1.1 7400 Level Excavations

The existing excavations on the 7400 Level provide an excellent base from which to develop smaller type laboratories which do not require large excavations to support experiments. The specific area that was chosen on this level includes the area around the Machine Shop. This location is most favourable due to the size of the already excavated rooms as well as their location relative to the secondary escape way (ramp) and proximity to the #31 exhaust way for discharge of exhaust ventilation. It is also located close to the #7 Winze which will serve the purpose of heat rejection from air conditioning units.

Drawing #E771-200-02-D-205A shows the existing network of mine development excavations as well as proposed additional excavations and enlargements of existing excavations required for the initial Laboratory rooms.

The expected support rooms along with associated dimensions and excavation requirements are listed in the following table:

Name	Dimensions (ft)			Total Volume (cuft)	Excavated Volume (cuft)
	Length	**Width**	**Height**		
Equipment Car Wash	180	25	15	67,500	36,000
Air Filtration and Cooling	100	20	15	30,000	22,500
Electric Utilities	60	25	15	22,500	0
Wash/Change Room	50	25	15	18,750	16,875
Refuge Station/Cafeteria	185	20	15	55,500	34,000
Total				**194,250**	**129,625**

Development of the Support Facility infrastructure and Laboratory rooms will commence through the main access ramp once dewatering has reached this level. This will enable the completion of these facilities prior to the completion of the dewatering.

Additional ground support in these excavations will be only that what is required during the excavation and rehabilitation. This will include 8’ resin grouted rebars installed on a 5’ x 5’ pattern in addition to 20’ cable bolts installed in some of the larger excavations. Final construction will include 4” of shotcrete around the perimeter of the excavation and 12” of concrete on the floor.

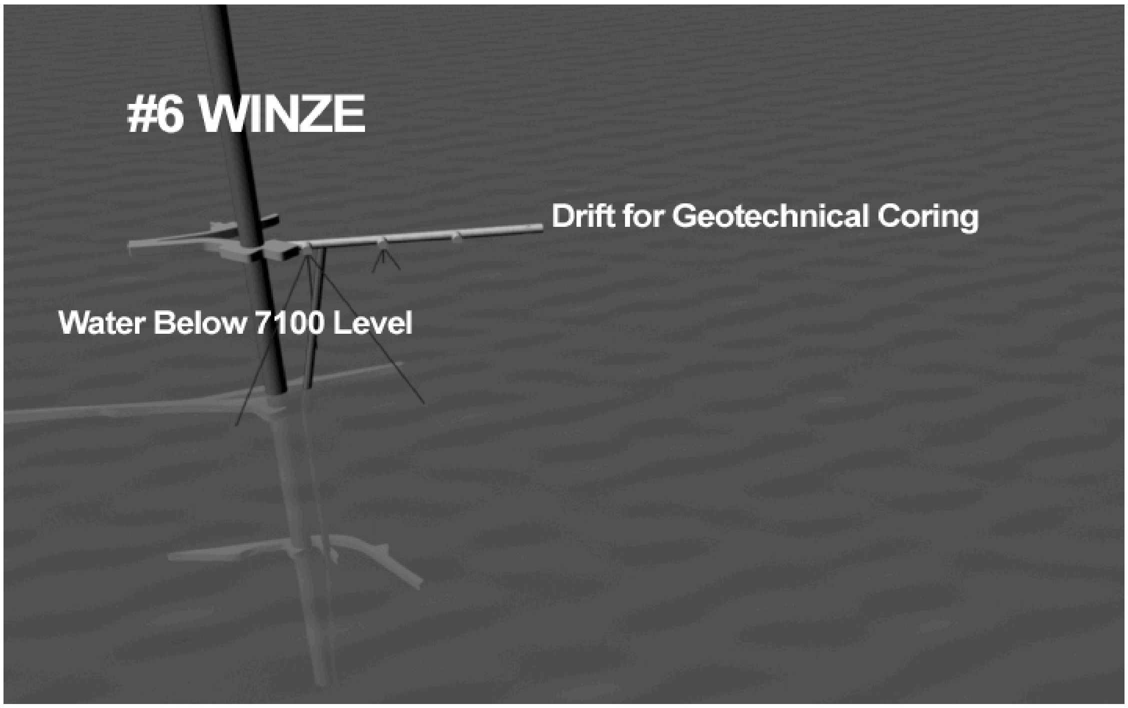
Due to the minimal quantity of excavations rock produced, waste will be disposed in available openings on the 7400 level.

2.5.3.2 <u>Alternative #2 – Support Facility Outside Existing Mine Development Infrastructure</u>

The area where it is planned to develop Laboratories outside the existing mine development infrastructure is Northeast of the #6 Winze on 7400 Level. Prior to the construction of the Laboratories on 7400 Level, excavations are required on 7100 L, 7400 L and 7700 L. These excavations are required in advance of the Laboratory construction as they will become part of the Laboratory Support Facility which will provide the services to the Lab. They will also provide the means by which the exploratory geotechnical drilling can be done for rock mechanics evaluation

2.5.2.2.1 7100 Level Excavation

The excavation on 7100 Level is shown in Drawing #E771-200-02-D-200 and will consist of a 15'w x 15' h drift driven northwest from the #6 Winze for a distance of 1047 ft. It is planned to start the excavation of this drift as soon as the water has been pumped to the 7100 L.



Access to the level will be through the main ramp from 4850 Level which should be rehabbed up to this point. This drift will serve two purposes:

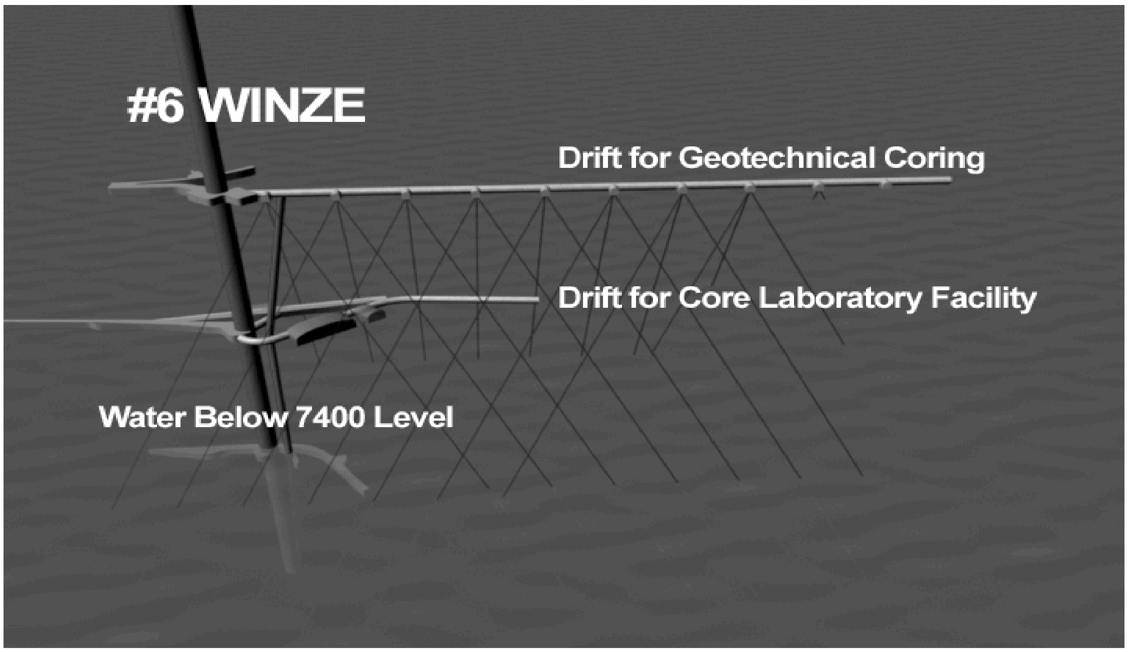
1. It provides for an access above the 7400 L from which geotechnical drilling can be performed in the vicinity of the planned locations of the major lab locations. Information from this geotechnical drilling will allow engineers to make adjustments to the final locations of the lab facilities if required, in addition to specify final ground support requirements.
2. It provides for a level above the labs on 7400 L from which an 11 ft diameter borehole will be excavated which will be used to draw exhaust ventilation from the lab.

Dewatering and shaft rehab will continue as the excavation of this drift occurs. It is planned to store the waste produced from the excavation in one of the many available openings on the level.

This drift will be driven with standard ground support installed which will include 8' resin grouted rebars installed on a 5' x 5' pattern. Shotcrete and floor concrete will be installed during lab construction.

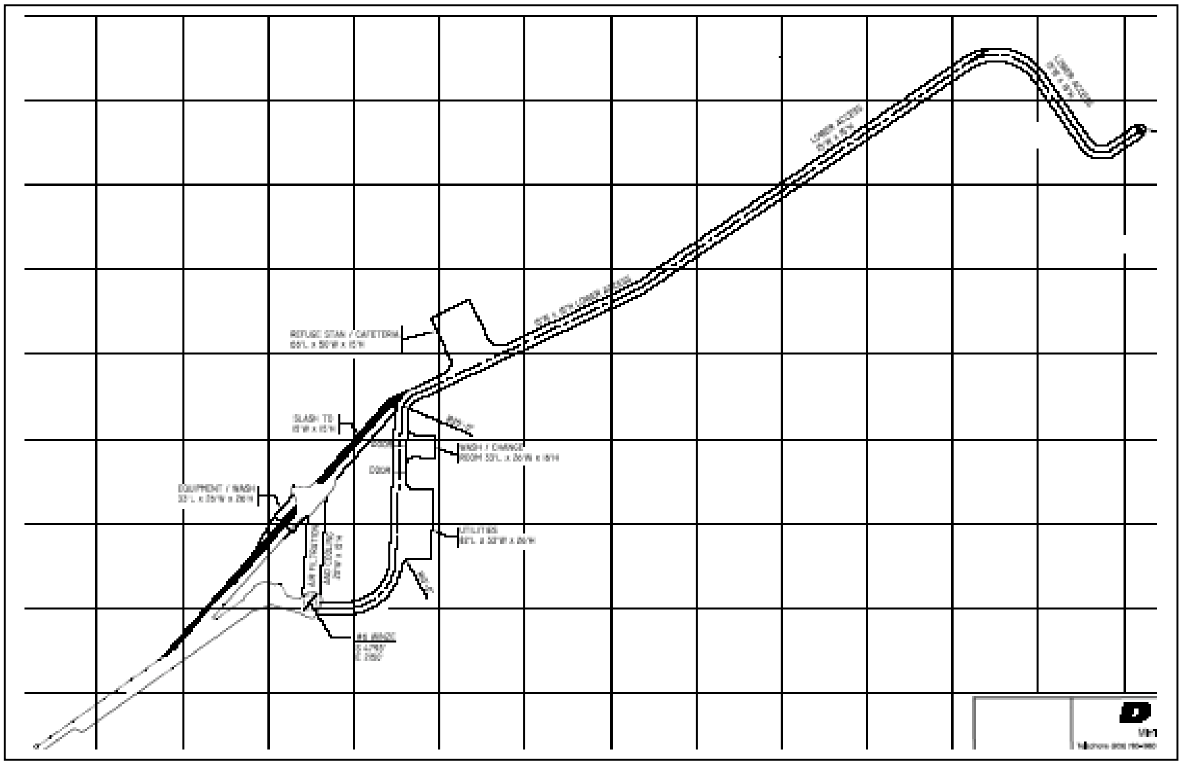
2.5.2.2.2 7400 Level Excavation

Once the dewatering has reached the 7400 L, excavation work will follow with development which will include the slashing of the existing 9’ x 9’ drift to the Northwest of the # 6 Winze to the required 15’ x 15’ dimensions. This drift will then be extended for approximately 840 ft through the center of the lab facilities. From this point, the drift will be driven an additional 280 ft to the Ventilation raise location.



Additional excavations will include the following which can be seen on drawing #E771-200-02-D-201:

Name	Dimensions (ft)			Volume (cuft)
	Length	Width	Height	
Equipment Car Wash	33	26	26	22,308
Air Filtration and Cooling	100	20	15	30,000
Electric Utilities	82	33	26	70,356
Wash/Change Room	33	26	16	13,728
Refuge Station/Cafeteria	66	50	15	49,500
Total				**185,892**

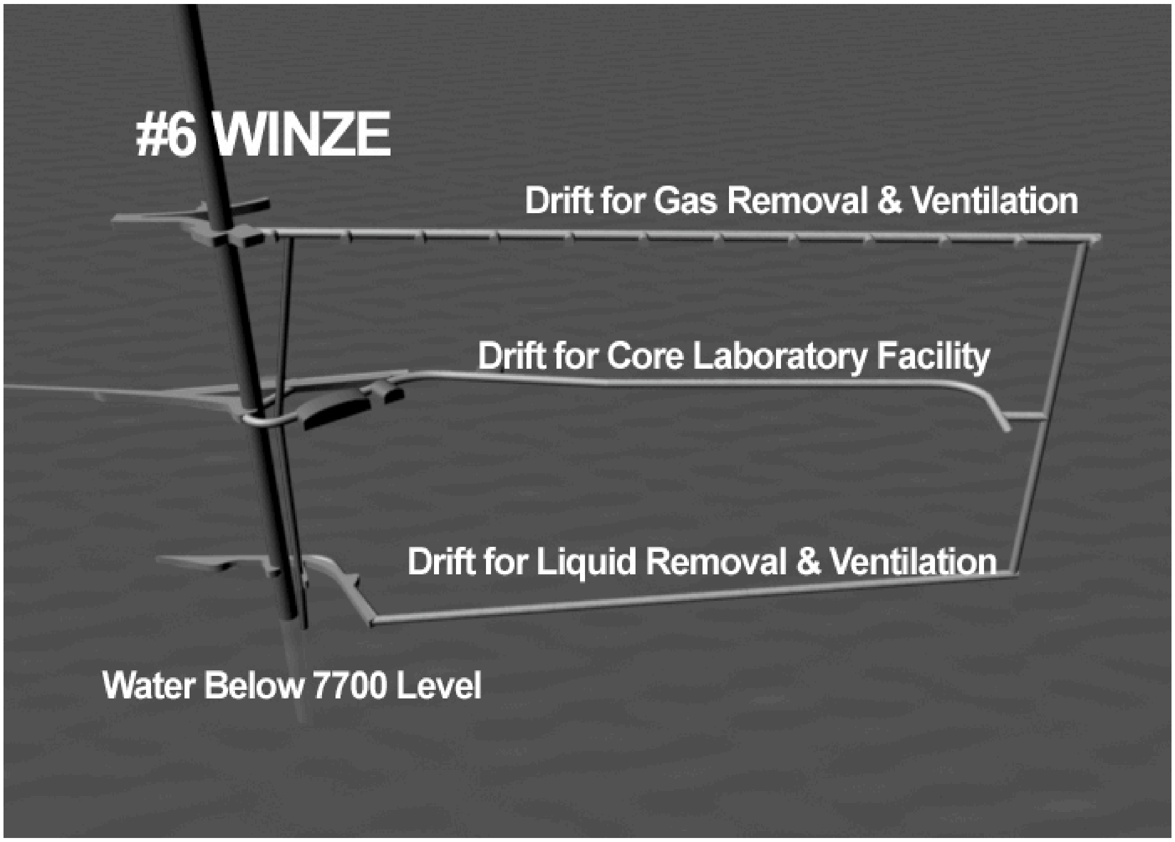


Ground support in these excavations will be only that what is required during the excavation . This will include 8' resin grouted rebars installed on a 5' x 5' pattern in addition to 20' cable bolts installed in some of the larger excavations. Final construction will include 4" of shotcrete around the perimeter of the excavation and 12" of concrete on the floor.

Waste disposal will start with available openings on the 7400 Level. Once the dewatering is completed and the loading pocket in #6 Winze refurbished, waste muck will be disposed of through the #6 Winze/Ross hoisting system.

2.5.2.2.3 <u>7700 Level Excavation</u>

Excavation on the 7700 Level will commence following the completion of the excavations on 7100 L along with the dewatering to this elevation. The existing access on 7400 L will be slashed from the existing 9' x 9' drift to 15'w x 15'h. This access will then be extended for a distance of 830 ft to reach the location of the base of the ventilation raise.



The excavation on the level will serve two purposes:

1. It will allow for the exhaust of heavier than air gases that could be created in the event of a failure within one of the labs.
2. It will serve as a conduit for leaking liquids to be directed towards a containment area on the 7700 Level, away from the lab facilities on 7400 L.

This drift will be driven with standard ground support installed which will include 8' resin grouted rebars installed on a 5' x 5' pattern. Shotcrete and floor concrete will be installed during lab construction.

2.5.2.2.4 Exhaust Raise

Once the 7700 L has been completed, an 11' diameter raise will be excavated from 7700 L to 7100 L. The raise will be driven with a Raise Bore machine which performs the task by first drilling a pilot hole from the 7100 L to intersect the 7700 L. Once the pilot has broken through, an 11' diameter reaming head is attached at the breakthrough and the pilot is then reamed to its final dimensions. Waste muck is drawn from the breakthrough location and will be removed from the mine via the #6 Winze/Ross hoisting system. Ground support, shotcrete, manway and services will be installed during lab excavation and construction.

2.5.3 LIFE SAFETY ISSUES

The conversion of the mine must make life safety the highest priority in design considerations. The following life safety issues have been addressed in the report.

2.5.3.1 Fire Prevention and Containment

An important consideration in the planning of the Lab construction will be fire prevention and containment. A water tank containment reservoir will be constructed on the 7100 L. and will supply the Lab with an emergency supply of fresh water for fire fighting. This water will be via gravity feed from a reservoir to the 7400 L. The Lab will need a sprinkler system installed so that the fire can be contained with a sprinkler system.

The Lab will also need a stench gas warning system installed for release into the fresh air system in the event of a fire in any location within the mine. The mine was required to have this system in place during operation and it is expected that this system will be able to be restored for use in the conversion.

The fire containment system will also be accomplished through a series of air-tight ventilation bullheads.

2.5.3.2 Emergency Power Generation

Emergency power will be supplied to the facility through the inclusion of diesel backup generators. The power supplied by these generators will be of sufficient capacity to run the Ross Shaft and #6 Winze Service hoists in a controlled fashion to provide for the emergency evacuation of personnel. It will also provide power to the Oro Hondo exhaust fan to maintain fresh air supply to the Support Facility.

Emergency power will also be available to maintain the operation of limited specific science experiments and other essential life safety services. This will ensure that the safety of all underground personnel will be maintained in the event of a power interruption.

2.5.3.3 Noxious Gas Release and Ventilation

The ventilation system has been designed to supply the Lab with sufficient quantities of fresh air. The design of the Lab has considered that the exhaust for the Lab will always be directed away from the main entries into the Lab. Therefore, in the event of a fire in the lab or accidental release of a noxious gas related to an experiment, the exit from the lab will always be in fresh air. Evacuation from the mine will always be up the #6 Winze and out the Yates shaft which will always be in fresh air.

The Exhaust system has been designed so that exhaust gases can be drawn from the lab either up or down, depending on the relative weight of the gas to the weight of air.

2.5.3.4 Hazardous Material Release, Containment and Removal

With potentially hazardous fluids used in the experiments, consideration has been made for released hazardous fluids to be directed towards a containment area on 7700 L. The spill would flow into a sump in the Lab which would direct the fluid through a pipeline or borehole to an emergency containment area located in the exhaust way of the level where it would be stored until it had effectively evaporated and was discharged from the mine through the exhaust air system.

2.5.3.5 Emergency Refuge Stations

Emergency Refuge Stations will be constructed on the 7400 L at the location shown on drawings # E771-200-02-D-201 and 205. These will be located in fresh air and will be adequately stocked with emergency supplies such as food and fresh water. Communications to the refuge station will be in place and will include telephone, radio and data communication.

2.5.3.6 Mine Rescue

As required by law, a mine rescue team, complete with all necessary mine rescue equipment will need to be put in place for the conversion. It is planned to utilize the existing mine workforce for this purpose. The required number of individuals will be assembled and trained to the level required to be a practicing mine rescue team. The team will need to meet regularly for refresher training and practices to ensure that they can provide effective mine rescue capability for the conversion.

2.5.3.7 Regulatory Issues

Standards of safety for the entire Homestake site shall be the most stringent of applicable codes, laws and practices. Although not an MSHA regulated site, the Authority has requested MSHA oversight with regard to the mining operations on surface and underground. Where MSHA is not applicable on a majority of the surface site, OSHA standards may be recognized as the minimal standard, if codes, laws and practices are not applicable.

For the purposes of this study, it has been assumed that the regulations that govern underground mining as outlined by MSHA will be that which the mine will operate under. The Lab may operate under OSHA regulations separately but will likely also need to follow the minimum MSHA regulations as well.

The construction of the lab has also considered industrial regulations in the design.

2.5.3.8 Security

Surface operations will be separated into secure and non secure areas, all of which will be overseen by a Homestake Site person dedicated solely to safety concerns. Both the secure and non secure areas will also be characterized by their function with regard to science education and outreach, mine maintenance and operations, or science assembly, research or storage.

All underground areas will be considered as secure. Some areas of the underground will have additional levels of security. Underground areas will be separated into mining areas and science chamber areas. The mining areas will follow the MSHA standards for underground operations as a minimum and include areas of rescue for associated science chamber areas. The science chamber areas will be constructed to conform to similar surface facilities regarding the life / safety elements of codes, laws, and practices.

The monitoring of personnel location will incorporate the use of an electronic "tag board" system which will be tied into the central control station in the Ross Shaft Headframe.

2.5.3.9 Safety Management

The safety system employed at the facility will require compliance with MSHA training requirements as a minimum. This will include MSHA training in underground life safety areas. The Homestake Site and the Science Management Team will establish distinctions between underground visitors and individuals working underground on a routine basis. Visitors will be required to attend a lesser safety training orientation program. The routine workers will be required to have full mine safety training, similar to those miners working underground and be updated regularly on mine operations. All safety training will be required to stay current.

The safety system will also require incorporation of a more proactive program to ensure the safest possible work place. The current system employed by Dynatec at all of its work sites, would provide a program that would accomplish this. This system is called the Loss Control System. The important elements of this program include the following:

Induction/Orientation Program

Each newly hired employee will be required to participate in an orientation that covers site safety rules and what is expected of each worker.

Five Point Safety System

The five point safety system should be employed on site. This system is a common system used in the mining industry that forces an employee to inspect his/her work place, ensure there are no hazards, ensure the travel way is free of obstructions, asks the employee if he/she will work safely and forces the person to perform an act of safety.

Accident/Incident Investigation

It is essential that all incidents and/or accidents which result in or have the potential to result in employee injuries, or illness, property and equipment damage, or loss to process be promptly reported to by employees to their immediate supervisor.

Site management must be well trained in accident/incident investigation and strive to ensure that investigations are done in a timely and efficient manner. All reports are reviewed by senior management with prevention in mind.

Communications - Weekly Group Safety Meetings

In order to ensure the effective communication of industry related safety topics and to provide workers with an opportunity to participate in the Safety & Loss program, weekly group safety meetings will be required. Each supervisor will be responsible for conducting one meeting per week.

Occupational Health & Safety Committees

A Management/Employee Health & Safety Committee must be established. This committee will perform monthly work place inspections, identify hazards in the work place and ensure corrective actions have been taken.

Planned Inspection Program

Management teams must ensure that every effort is taken to identify and correct any substandard practices and/or conditions that exist in a workplace through the implementation of a planned inspection program. Each supervisor will be required to perform one inspection every two weeks. The Project Manager and Safety Superintendent will perform one inspection per month.

Job Task Analysis & Procedures

Management must ensure that all critical tasks on any project are identified, analyzed, and that job procedures are written in a timely manner. These procedures will be periodically reviewed with all crews at group safety meetings.

Job Observations

A job observation is an action whereby a supervisor performs an observation of an employee performing a certain job task and documents the level of compliance to the specific job procedure. This is an effective tool in determining if an employee fully understands the various steps in performing a task.

Each supervisor should be required to perform one job observation every two weeks. The Project Manager and Safety Superintendent should perform one job observation every two weeks.

System Engineering/Failsafing

Prior to beginning an unusual or non-routine job or part of a job, management must take every precaution reasonable to protect its workers and clients from the occurrence of accidents through the use of system engineering/failsafing. This will incorporate the development of specific procedures to perform tasks that eliminate the risk of injury to employees. These procedures are developed jointly with management and hourly employees.

Promotion - Safety Award Program

In order to recognize individual and group safety achievements, an effective safety award program should be in place. Results have indicated that safety awards are an effective motivator towards workers working safely.

Safety Audits and Program Measurement

Safety program measurement is essential in achieving success in accident prevention on our projects. Management should conduct a minimum of one safety audit per project per year. The audit will be performed by the Laboratory Safety Director and a team of impartial auditors that are selected to assist in the process.

Training and Education

To ensure the health and safety of employees through the continuous process of safety and skill training, Management must provide all relevant training as per the state and federal regulations as well as that required by our site specific internal standards. This should include training in the following areas: WHMIS, First Aid &

CPR, Common Core training for miners and supervisors, Ground Control and management training courses.

Injury Management

Management must pro-actively injury claims. This can be achieved through providing modified duty for any employees that are injured and capable of performing some meaningful work.

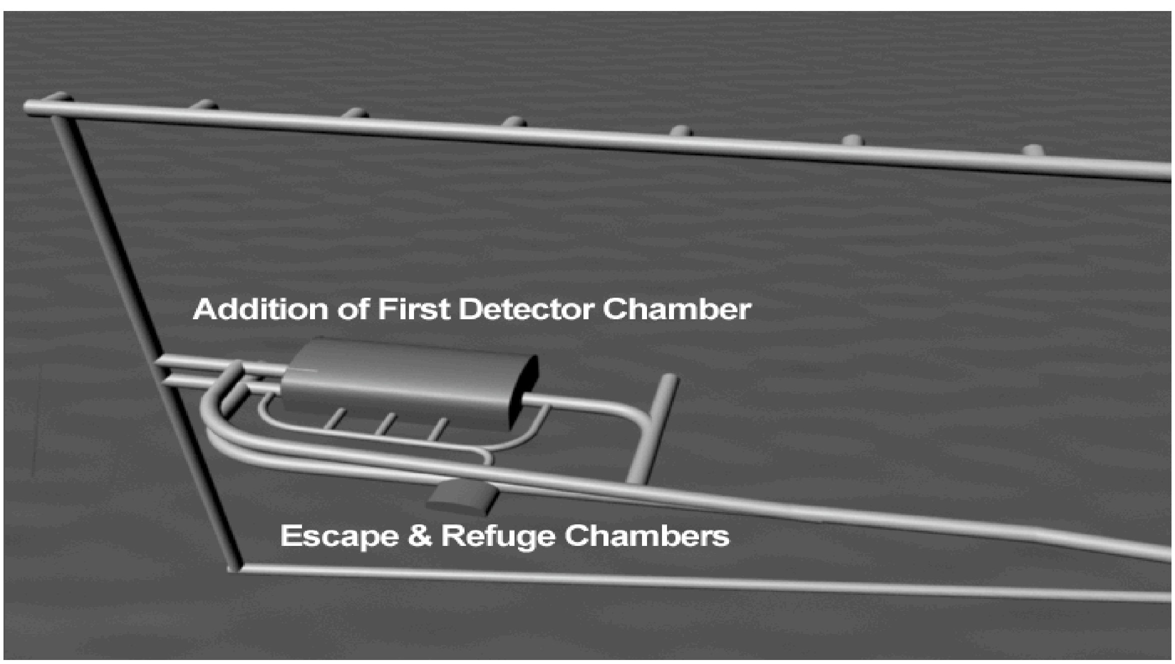
2.6 ABILITY OF LABORATORY SUPPORT FACILITY TO SUPPORT FUTURE EXPERIMENTS

For the purposes of this study, Laboratory Development and Construction has been considered in both the Yates Rock formation, outside the existing mine development and inside the existing mine development on 7400 Level.

2.6.3 Laboratory Development and Construction at 7400 Level in the Yates Rock Formation

2.6.3.1 Initial Construction and Development

Following the completion of the Laboratory Support Facility construction, the facility will be ready for the addition of the first detectors or other experiments at the 7400 level. For the purposes of this report, we have conceptualized the construction of a Lab opening that will be 252'l x 66'w x 55'h with an arched back. The general configuration of the lab can be seen in plan and section view on Drawing # E771-200-02-D-201A.



The excavation of the General Purpose Lab will commence with a 15’w x 15’h access drift driven on both the southwest and northeast sides of the Lab. The southwest and northeast sides will be extended for a distance of 125 ft to the southeast and stopped. The lower access will be driven through the center of the lab to the northeast and will connect up with the northeast access close the vent raise. An incline will be driven from the Main Access drift to upper elevation of the large Lab. From this incline, an access will be driven along the Northwest side of the Lab from which an entry will branch off into the top of the Lab. The excavation of the top 15 ft will be excavated from the upper access on the Northwest side and the bottom 40 ft will be benched through the access on the Southeast side.

Ground support installed during the upper level excavation will consist of 8’ resin grouted rebars installed on a 5’ x 5’ pattern with welded wire mesh. 30’ long cable bolts will be installed in the back on an 8’ x 8’ pattern and 4” of shotcrete will be installed over the bolts and screen. Rockweb will be applied to the surface of the shotcrete and concrete to provide a barrier against radon gas emission. The bottom wall perimeter will have similar ground support installed with the exception that the cable bolts in the walls will be 20’ in length. The floor of the excavation will be constructed with 12” of reinforced concrete.

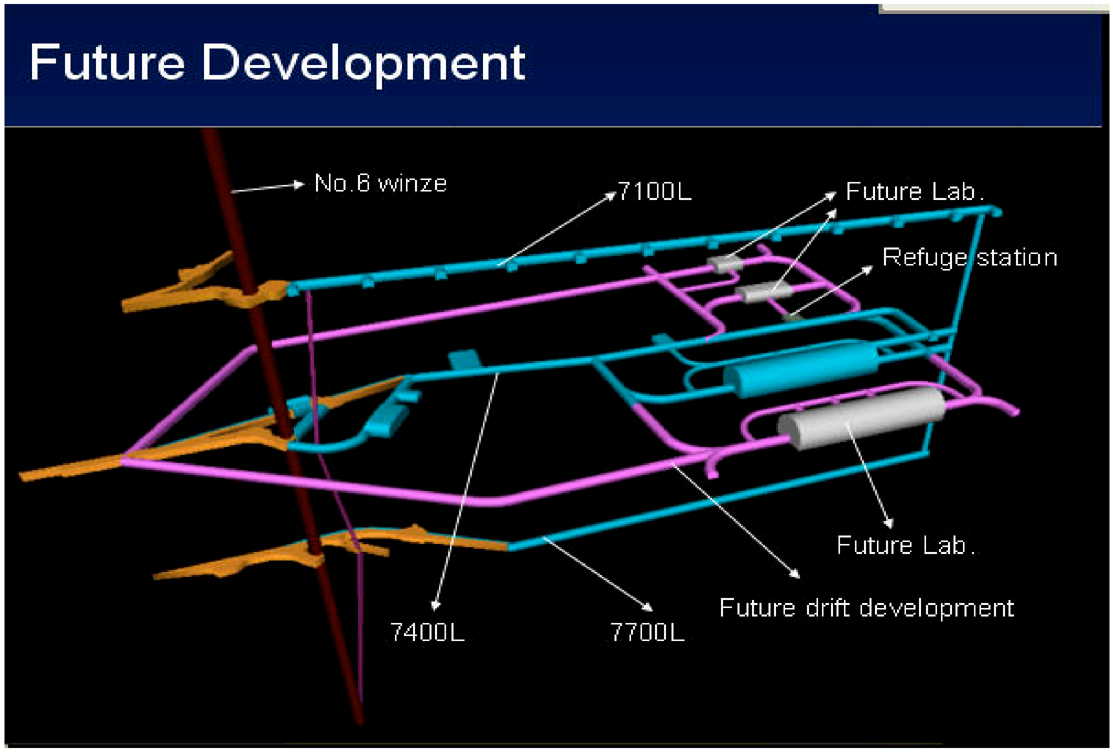
Before the bottom 40 ft is benched, an overhead crane will be installed in the back for the length of the room and will have a capacity of 10 Tons.

During the excavation of the Lab on 7400 L, final ground support consisting of 4” of shotcrete and 12” of concrete on the floor will be applied to the excavations completed on 7100 L, 7400 L, and 7700 L. Final construction within the Exhaust Raise will also be performed at this time and will consist of 4” of shotcrete applied around the wall perimeter and a steel manway with pipes and emergency electric cables within its full length. This is shown in detail on drawings E771-216-01-D-208 and 209.

Following the completion of excavation with full ground support and concrete floor, the Lab will be ready for Science equipment construction and installation.

2.6.3.2 Future Expansion – Additional Laboratories

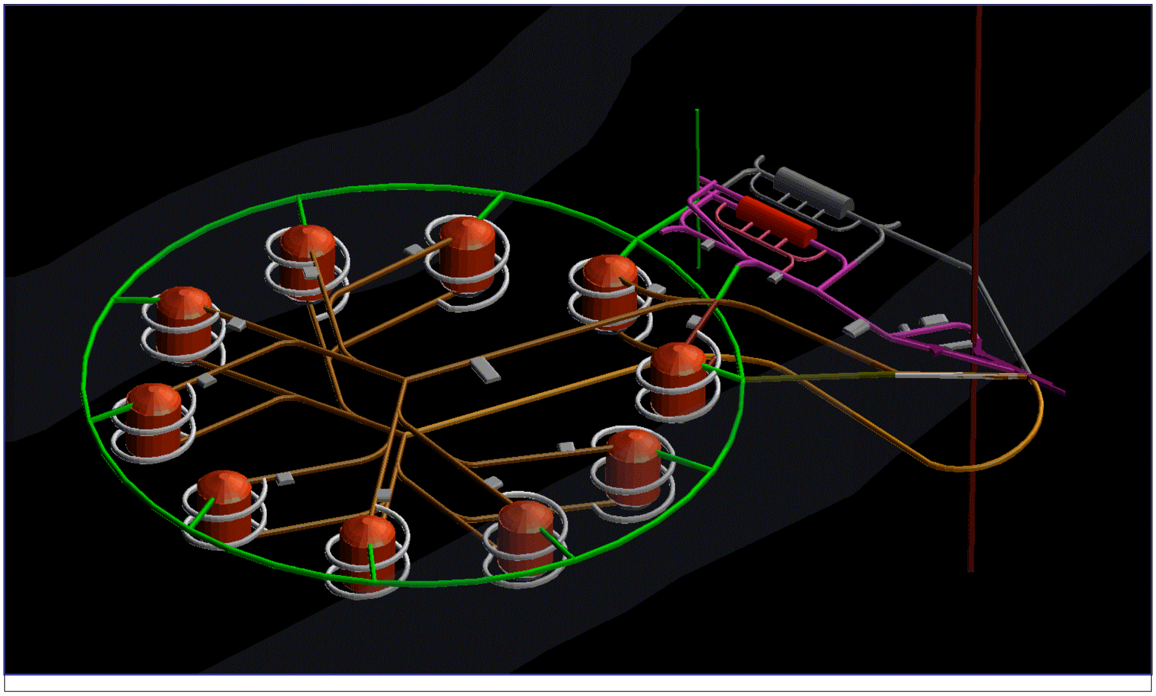
The excavation of future Labs on the 7400 L will be accomplished by developing new entries from the Southwest side of the #6 Winze on 7400 L that would be driven north to access the Northwest side and East to access the Southeast side. Drawing #E771-200-02-D-201A shows a conceptual layout of future Labs on the 7400 L. All excavation would be done outside the Science area and would not interfere with the experiments. Concrete bulkheads will be installed to provide a barrier between the Lab and new excavations to prevent interference during breakthrough.



The system has been designed to assure that the basic services to the Laboratory can be adjusted to future demands. Variable speed fans will be installed to adjust ventilation quantities as required. Power and utilities will be sized to allow for further expansion. It should also be noted that should additional demands be made to the system, it will be possible to add to the infrastructure without affecting the operation of the labs.

It is intended that access for excavation and construction crews be done through the #6 Winze. At this time, the scientists will be using the Auxiliary hoist exclusively and will be disembarking at the 7400 L through the east end of the station. Construction crews will disembark through the west end and should not interfere with the Science personnel.

Based on a Geotechnical Study preformed by Golder Associates, the feasibility of construction of large detector rooms in the Yates Rock formation has been verified, subject to a final more detailed structural evaluation of local rock conditions. The following is a representation of a Megadetector room general arrangement in the Yates Rock formation between 7400 and 7700 Levels.



2.6.2 Laboratory Development and Construction In Existing Mine Development on 7400 Level

2.6.2.1 Initial Construction and Development

Following the completion of the excavations associated with the support facility on 7400 Level, a minimal amount of excavation will be required for the first laboratories. As it is currently planned and shown in Drawing #E771-200-02-D-205, the general concept involves extending the three ladder type drifts in the Machine Shop for approximately 20 – 50 ft and connecting them with another drift in between. The net result of these excavations will be to create initial lab rooms capable of supporting experiments that require depth but not necessarily large excavations.

These excavations are currently supported with normal mine ground support which includes resin grouted rebars, welded wire mesh and shotcrete. Additional ground support is planned which will include 8’ resin grouted rebars installed on a 5’ x 5’ pattern with welded wire mesh. 30’ long cable bolts will be installed in the back on an 8’ x 8’ pattern at drift intersections and 4” of shotcrete will be installed over the bolts and screen. Rockweb will be applied to the surface of the shotcrete and concrete to provide a barrier against radon gas emission. The bottom wall perimeter will have similar ground support installed. The floor of the excavation will be constructed with 12” of reinforced concrete.

2.6.2.2 Future Expansion – Additional Laboratories

The development and construction of future laboratories in this area will be performed from the main access ramp which is east of the ladder labs. Construction crews will access the work area through the main ramp which will be completely independent of the science crews. Fresh air for this work will be down casting from the ramp and will exhaust up the #31 Exhaust way system.

The layout of future labs in this area will depend on science needs. The sizes of the openings will be determined by the overall structural capacities of the rock types in this area. Based on the vast quantity of geotechnical information that exists in this area, it will be possible to design future laboratories with a minimum of additional information required.

2.7 LABORATORY SUPPORT FACILITY DEVELOPMENT OPTIONS

The base case to develop the Laboratory Support facility involves the complete dewatering and upgrading of the mine to support deep science experiments. Based on the possibility that science needs may not initially require a completely converted mine, various options have been prepared for review that will enable various levels of science to be performed. The following options have been prepared:

1. Safely Re-Enter the mine, Provide Access to the 4850 Level, No Upgrades.
    a. Reactivate Pumping System up to the 5000 Level
    b. Reactivate Pumping System up to the Water Level at 6200 L
    c. Dewater the Mine

2. Safely Re-Enter the mine, Perform Upgrades.
    a. Provide Access to the 4850 Level, Reactivate Pumping System to the 5000 L.
    b. Provide Access to the 4850 Level, Reactivate Pumping System to the Water Level at 6200 L.
    c. Dewater the Mine, Provide Access for Deep Science Research.

2.7.1 Option 1 – Safely Re-Enter the Mine, Provide Safe Access to the 4850 Level, No Upgrades

In this option, only the work that is required to re-open the mine to provide safe access to the 4850 L will be performed. Generally speaking, this will include:

- Re-activation of surface services including power, heat and other utilities
- Re-activation of the Oro Hondo surface ventilation fan
- Basic rehabilitation of the Yates and Ross Shafts

- Construction of the Water Treatment Facility
- Commissioning of the Ross and Yates Service Hoists
- Construction of Safety Bulkheads in the Ross and Yates Shafts
- Rehabilitation of the 4850 Level between the Yates and Ross Shafts and #6 Winze

2.7.1.1 Option 1a - Reactivate Pumping System up to the 5000 Level

In this option, the pumping system located in the Ross Shaft will be re-activated. This will involve making the necessary repairs to the pumps in the pumping stations to enable their operation once the water level reaches the 5000 Level.

The completion of this work will result in the development of an Underground Laboratory Support Facility capable of providing limited access for Geo-Science research between surface and the 4850 L. It will also provide access for medium depth science research experiments at the 4850 L.

Since there will be no upgrades to any of the Support Facility Systems, the facility will incur long term higher operations and maintenance costs

2.7.1.2 Option 1b - Reactivate Pumping System up to the Water Level at 6200 L.

In this option, the pumping system will be re-activated to the 6200 L. It is at this level that the water level is expected to be at if Support Facilities development activities commence in the beginning of 2005. The work involved with this option will be the same as option 1a with the exception that access to the water level at 6200 L will be established through a winch and platform into the #6 Winze. Using this system for access, pumps will be lowered to this level, installed and commissioned.

The capabilities of the facility will be similar to those in Option 1a, however, the water level in the mine will be held at this location to prevent further flooding, reducing the time and cost of developing the facility below this level. There will be no access for any science activities below the 4850 L.

Ongoing operating and maintenance costs will be only slightly higher than Option 1a.

2.7.1.3 Option 1c - Dewater the Mine

In this option, the entire pumping system will be re-activated and the mine will be dewatered completely. The process by which this is performed will involve all the activities included in option 1a with the addition of the conversion of the #6 Winze to a winch to allow for dewatering past the 6200 L.

The capabilities of the facility will be exactly that which are described in Option 1b and there will be no access for science activities below the 4850 L.

Ongoing operating and maintenance costs will be slightly higher than that in Option 1b since pumping will be required from the bottom of the facility as well as the operation of the #6 Winze will be included.

2.7.2 Option 2 – Safely Re-Enter the Mine, Perform Upgrades

In this option, all the work associated with re-opening the mine, to provide safe access to the 4850 L, will be performed in addition to major upgrades. Generally speaking, this will include:

- Re-activation of surface services including power, heat and other utilities
- Re-activation of the Oro Hondo surface ventilation fan
- Installation of new efficient main exhaust fans
- Basic rehabilitation of the Yates and Ross Shafts
- Replacement of Services in the Ross Shaft
- Upgrades to the Yates and Ross Shaft
- Construction of the Water Treatment Facility
- Commissioning and Automation of the Yates and Ross Service Hoists
- Construction of Safety Bulkheads in the Shafts
- Rehabilitation of the 4850 Level between the Yates and Ross Shafts and #6 Winze
- Shotcrete and Concrete Floor for the Access Drift between the Ross Shaft and the #6 Winze
- Installation of Automation and Monitoring System.

2.7.2.1 Option 2a – Provide Access to the 4850 L, Re-Activate Pumping System to the 5000 L

In this option, the pumping system in the Ross Shaft will be re-activated up to the 5000 Level. This will enable the facility to remain dry up to the 4850 Level. The entire facility will be rehabilitated and upgraded as described under Option 2 up to the 4850 L.

The net result of the work performed in Option 2a will result in a fully upgraded and operational Support Facility capable of supporting limited access for Geo Science activities and unrestricted access for medium depth science research experiments.

The ongoing operating and maintenance costs will be relatively low due to the significant upgrades and high level of automation built into the facility.

2.7.2.2 Option 2b - Provide Access to the 4850 L, Re-Activate Pumping System to the 6200 L

In this option, all the activities performed in Option 2a will be performed with the addition of the installation of pumps at the water level at 6200 L. The method to gain access to the water level will be the same as is described in Option 1b.

The capabilities of the Support Facility will be the same as described in Option 2a. There will be no access for science research below the 4850 L.

The ongoing operating and maintenance costs for this option will be slightly higher than Option 2a due to the additional pumping from 6200 L.

2.7.2.3 Option 2c – Dewater the Mine, Provide Access for Deep Science Research

In this option, the mine will be totally converted to an Underground Laboratory Support Facility, capable of supporting deep science research up to the 7400 L and limited Geo Science access up to the 8000 L.

The process by which the conversion takes place is that which has been described in detail as the base case.

The ongoing operating and maintenance costs will be higher than Option 2b as the facility will require pumping from depth and maintenance of services to the 8000 L.

The following is a summary table that compares the development costs, schedule and ongoing operating and maintenance costs of each option.

Option #	Underground Development Cost ($)	Surface Development Costs ($)	Total costs ($)	Schedule (Months)	Annual Operating Costs
1a	9,049,000	900,000	9,949,000	5	3,700,000
1b	9,746,000	1,300,000	11,046,000	5	3,800,000
1c	21,237,000	1,400,000	22,637,000	13	4,100,000
2a	22,741,000	1,300,000	24,041,000	9	3,700,000
2b	28,904,000	1,300,000	30,204,000	15	4,100,000
2c	40,043,000	4,900,000	44,943,000	15	4,200,000

3.0 Drawings

The following is a list of drawings for this study:

Drawing #	Drawing Title
E771-200-02-D-200	New Development 7100 Level Plan
E771-200-02-D-201	Core Laboratory 7400 Level Plan
E771-200-02-D-201A	Future Laboratory 7400 Level Plan
E771-200-02-D-202	New Development 7700 Level Plan
E771-200-02-D-205 A	7400 L. Lab Construction Existing Inf.
E771-200-02-D-208	Vent Raise and Manway G.A. Sh 1/2
E771-200-02-D-209	Vent Raise and Manway G.A. Sh 2/2

4.0 List of Appendices

1. Ventilation Requirements for Construction and Operation of a Laboratory on the 7400 Level of the Homestake Mine
   Prepared by Cam Seeber, Ventilation Consultant

2. Review of Electrical Requirements for the Conversion of the Homestake Underground Mine to the Homestake Underground Laboratory"
   Prepared by Vaclav Visclo.

3. Detector Chamber Analysis, Homestake Mine, South Dakota
   Prepared by Golder Associates

4. Excel Cost Summary Spreadsheet – Lab Construction in Existing Infrastructure

5. Project Schedule – Re-Open Mine, Dewater, Upgrade, and First Experiment in Existing Infrastructure

6. Excel Spreadsheet – Power Costs.

7. Excel Spreadsheet – Ongoing Operating Costs

8. Estimate Files – Homestake Option 2D – Water Level at 6500 Level, Lab in Existing Infrastructure – Option Summary, Option Details, Option Resources.

South Dakota Science and Technology Authority
Review Committee Report

on the

Technical, Cost, Schedule, and Management Review

of the

HOMESTAKE UNDERGROUND LABORATORY CONVERSION PLAN

December 2004

EXECUTIVE SUMMARY

On 3-5 December 2004 a South Dakota Science and Technology Authority (SDSTA) Review Committee reviewed the Homestake Mine Conversion Project and the SDSTA's plans to manage the Conversion Project. The Review Committee consisted of scientists and underground mining and construction experts from within and external to the Homestake Collaboration. Several of the Committee had personal experience working in Homestake. Dr. Kevin Lesko chaired the Committee. The Committee assessed the status of the Conversion Project whose prime focus is the preservation of the Homestake site for the creation of a deep, multipurpose, and comprehensive underground laboratory. The Conversion Project addresses the reopening of the facility, reestablishment of safe underground access, refurbishment and upgrade of the underground conveyances, re-establishment of underground and surface utilities and infrastructure (including life safety), dewatering the facility, and commissioning the facility. The SDSTA correctly identifies that in the preservation of the site, a shallower, but significant underground science program would be possible. The SDSTA includes in the Conversion Project the identification of existing space for an initial suite of experiments and uses. The Conversion Project could provide beneficial underground space in the near future to the earth science, engineering and the physics communities and partially fulfill a near-term need in the United States underground science program.

- The plan for Conversion Project is advanced and comprehensive. The steps to regain beneficial occupancy underground and to deal with the water are well understood, estimated and scheduled. Several items in the Conversion Project will require careful attention as the project progresses, as these could not be evaluated from first-hand inspection. These include the shaft and ramp status and the quality of the water from the facility. No showstoppers for the Conversion Project are identified.

- To advance from the feasibility study to the final detailed engineering and construction phase the SDSTA recognizes the need to augment their organization and capabilities. Several key positions in management are indicated including EH&S, project, construction and contract management. An integrated project schedule with appropriate milestones should be developed, factoring in preparation for the Conversion Project, obtaining site title, project construction and scientific planning and operation. We note, in particular, that title to the site needs to be obtained in a timely fashion in order for the Project not to suffer significantly increased costs and schedule delays.

- A variety of options for obtaining access were evaluated. There is strong consensus that the Conversion Project should initially focus on developing access to the 4850-foot level and above.

Access to these levels will facilitate a more thorough evaluation of deeper sections of the facility. Beneficial occupancy to the levels at and above 4850-foot level will enable a strong program of earth science, engineering, physics research and education outreach to begin on a timescale for which there exist no comparable sites, thus potentially fulfilling a critical mission for the U.S. science program.

- There exists an equally strong consensus that the Conversion Project should expeditiously address the flooding of the mine and at least halt the advance of water at its level in the facility when access is gained and before the utility of the 4850-foot level is compromised. Securing title to the site should be the SDSTA's first priority, closely followed by addressing the problems posed by the flooding of the site. To reduce the overall project costs and risks to the schedule and infrastructure, the 4850-foot level must be secured and the pumping of the lower levels begun in the near future. The loss of the 4850-foot level would require a more complicated Conversion Project, increased costs, schedule delays and increased risks for degrading underground infrastructure.

- It is appropriate to begin planning in the near future for the integration of science, construction and operation of the facility at the 4850-foot level and establishing the necessary management and oversight functions from within the Authority and from the scientific community. The SDSTA is encouraged to maintain its strong ties with the scientific community to ensure that the appropriate infrastructure and capabilities are available in the facility.

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1. INTRODUCTION

On December 3-5, 2004 a South Dakota Science and Technology Authority (SDSTA) Review Committee conducted a review of the **Homestake Mine Re-entry and Conversion Project** at Dynatec Headquarters in Richmond Hill, Ontario, Canada. The Conversion Project is the first phase of the conversion the Homestake Gold Mine, in Lead South Dakota, into a deep multipurpose facility to pursue underground science, engineering and outreach. The SDSTA Conversion Project addresses: the reopening of the facility, reestablishment of safe underground access, refurbishment and upgrading of the underground conveyances, re-establishment of underground and surface utilities and infrastructure (including life safety), dewatering the facility, identification of existing spaces for an initial suite of experiments. In addition to the Conversion Project itself, the Committee reviewed the SDSTA's plans for commissioning the facility and providing beneficial occupancy for the earth science, engineering and physics scientific and outreach efforts. The first focus of the Conversion Project is to preserve Homestake site as a strong competitor for the NSF's Deep Underground Science and Engineering Laboratory (DUSEL). This requires expeditiously regaining access to the underground facility, securing the 4850-foot level, and halting the flooding of the deeper levels. There is significant time pressure to regain access and halt the flooding. Delaying the reentry significantly would result in the loss of additional underground infrastructure that would increase the cost of any subsequent reentry to the facility and increase the risks (both cost and schedule) for the Conversion Project. The SDSTA has correctly identified that the Conversion Project would provide beneficial occupancy to a variety of earth science, engineering, and physics programs in the near term. Consequently, attention has been paid to providing expedient access underground for this aforementioned science program and to establish a potential footing at the 4850-foot level for the possible future expansion to deeper levels and to encompass a larger underground footprint by the DUSEL process. A variety of options were presented and evaluated for obtaining safe access underground and supporting scientific endeavors. Initial concepts for a deep laboratory and requirements to gain access to deeper levels were also presented as background for the NSF process and to provide a rough estimate of the additional costs to be addressed in the NSF process for Homestake.

The mine has been closed since 10 June 2003 and with the closure has been flooding at approximately 700 gallons/min. On 10 November 2004 water sensors at 6800 feet indicated the flooding has reached this level, approximately one month behind expectations. The shafts and adits to the mine were sealed to control the underground environment and maintain infrastructure.

The Committee assessed 1) the status of the design of the Conversion Project and its suitability for near-term science projects, 2) the cost estimate, associated schedule and contingency assessment, 3) the near-term management plans for the Conversion Project, and 4) planning for the environmental, safety, and health (EH&S) aspects of the Conversion Project.

The Homestake conversion design, cost estimate and schedule are obtained from the Dynatec Corporation's study Feasibility Evaluation of the Conversion of the Homestake Underground Mine to the Homestake Underground Laboratory of 1 December 2004 contracted by the South Dakota Science and Technology Authority. The study was presented by Syd DeVries, John Marrington, and Tom Rannelli of Dynatec. The study includes additional work subcontracted by Dynatec detailing 1) underground ventilation, air heating and cooling and 2) electrical power, controls and communication.

The discussion of the construction management plans was led by David Snyder, Executive Director of the SDSTA, Bill Noordermeer from the Office of the State Engineer, South Dakota, and Dr. Richard Gowen of the SDSTA.

Dr. Gowen presented the environmental summary report for the Conversion Project. This summary includes reports of discussions with State Regulatory Agencies for water and waste rock permitting.

The discussion of safety plans was lead by Bill Noordermeer and included significant components from the Dynatec study. These discussions drew heavily on Dynatec's mining expertise and benefited from the Committee's experience with underground construction and science. Dynatec, founded in 1980, has completed over 1000 mining contracts. Of their three major divisions, their experiences in the Mining Services and Operations Division is the most appropriate for this project, however Dynatec also has substantial experience in Drilling Services and Metallurgical Technologies. They have an admirable safety record: in the 2003 calendar year their recorded lost-time accident frequency was just over 1 per 200,000 employee hours. Earlier years had comparable safety records.

A summary of available surface facilities and their current status was presented by Bill Noordermeer and includes components of an architectural and environmental assessment of the buildings and structures conducted by The Spitznagel Partners (TSP), an architectural firm from Lead, South Dakota.

In addition to these sources and references, reports from interviews of former Homestake employees, reports from the South Dakota Department of Environment and Natural Resources (DENR) inspections of the Homestake Facility, and official Homestake Mine Records are used to assess the status of the facility and to establish estimates of risk and maintenance requirements for the conversion of the facility. The inventory of existing components and supplies available on the site is integrated into the maintenance and Conversion Project. Many useful discussions between Homestake Mining Corporation and the SDSTA were noted.

The science roadmaps developed by the National Science Foundation S-1 process, those developed within the Homestake Collaboration tailored for Homestake, and those from earlier National Research Council studies were used to identify preliminary scientific requirements for the facility and assess the facility's suitability to support a phased scientific program. Additional information will be forthcoming from the NSF process and should be folded into the Conversion Project.

The SDSTA discussed their investigations to locate funding sources for the Conversion Project that are unassociated with the National Science Foundation process to establish DUSEL.

2. SCIENCE

As a gold mine, Homestake has a long, well documented and widely appreciated history around the world. Homestake's scientific history is shorter but attracted equally well-received worldwide recognition. With the closing of the mine its scientific prospects appeared to come to an end. With foresight, the State of South Dakota has presented through the SDSTA a set of options to preserve the viability of the Homestake site for participation in the DUSEL process. In addition to preserving Homestake's competitiveness, these options would begin a partial conversion of the mine to a condition suitable for some science in advance of the projected calendar for potential Federal funding of a full DUSEL. Consequently, adoption of one of these options would provide the US science community with 1) an extremely attractive site for a multipurpose deep underground laboratory to be more fully developed by the NSF process and 2) an excellent near-term opportunity for underground research and outreach for physics, earth sciences and engineering.

2.1. History of Neutrino Physics at Homestake

The Homestake Gold Mine played a seminal role in the birth of neutrino astronomy and astrophysics. In 1965 the world's first solar neutrino detector was installed at the 4850-foot level of the Homestake Mine. This detector, which consisted of a 370,000 liter perchloroethylene neutrino target, was the first to experimentally demonstrate that the energy emitted by the Sun resulted from nuclear fusion reactions. Importantly, the Homestake solar neutrino detector was the first to frame the Solar Neutrino Problem as a consequence of their observations. Simply stated the Solar Neutrino Problem required that either solar models were seriously incomplete or that 2/3 of the neutrinos produced by the fusion reactions in the Sun transformed by the time they reached the

Earth. This problem required nearly 35 years to finally resolve – ultimately it was discovered that the solar models were accurate and that neutrinos were much more complicated and perplexing than had been assumed.

This observation of "oscillation of neutrinos" opened a new window on fundamental physics that led to the upgrading of the Kamiokande detector in Japan to directly observe neutrinos in real-time and to the development of the Sudbury Neutrino Observatory (SNO) in Sudbury, Canada, the European Gallium experiment (GALLEX) in the Gran Sasso in Italy and the Soviet American Gallium Experiment (SAGE) detector at Baksan in Russia as well as the various long baseline accelerator to underground detector neutrino beam facilities in the US, Europe and Japan. Ultimately the Homestake Chlorine experiment led to the neutrino revolution and to the first new physics beyond the Standard Model of Particle Physics in nearly thirty years. In recognition of this singular achievement, Raymond Davis was awarded the National Medal of Science in 2001 and shared the Nobel Prize in 2002 with Professor Koshiba the spokesman for the Kamiokande experiment.

2.2. Physics Research at the 4850-foot Level

The conversion of the Homestake Gold Mine into a major underground laboratory will build on this history and develop Homestake, in a phased approach, which will insure that the site can effectively compete to be the premier underground laboratory in the world. We strongly endorse the SDSTA plan to regain access, halt the flooding at the lower levels and as a consequence provide beneficial scientific occupancy of the upper regions of the Homestake Laboratory in the near future.

The initial stage of this facility, the 4850-foot level and above, would be the deepest underground laboratory in the United States and the second deepest physics laboratory in the world. Only the SNO laboratory in Canada, at a depth of 6800-foot, is deeper. Further, as the Conversion Project presents, by dewatering the facility down to the 8000-foot level the site can be the deepest multipurpose laboratory in the world. Initial studies at of the rock properties at the 7400-foot level support that large cavities (dimensions ~ 100 m) can be excavated and made suitable for long-term experimentation.

In addition to preserving Homestake's viability as a potential DUSEL, the anticipated timetable for scientific use of the 4850-foot level is as early as 2006. This access to Homestake, along with the availability of a number of existing rooms at the 4850-foot level and the ease with which additional chambers can be excavated at this level, will provide better or timelier experimental conditions for the geoscience and physics experiments than may be available elsewhere.

Some examples of experiments for which early access into Homestake would be attractive:

1) Experiments that are ready for installation within the next year or two, some of which are presently negotiating with other sites for space.
2) Underground experiments that are presently operating at shallower depths in other laboratories and would benefit from a greater reduction in cosmic ray background and thus greater depth for their further development.
3) Less advanced experiments that need underground space to test or evaluate prototypes of their proposed experiments or to develop new detectors. This would include shared infrastructure such as ultra-low background counting and screening facilities.
4) Some of the other experiments now only on the drawing boards may need to store pure construction materials in a reduced cosmic ray environment.

In addition to experiments that are ready for deployment, we anticipate that there will be groups that will require modest space to carry out tests and evaluations of prototypes of future experiments. It is very desirable that space be provided for development of these future experiments.

Some experiments may find the cosmic ray flux at the 4850-foot level low enough for their needs in the immediate future. For experiments that ultimately require the much lower cosmic ray flux characteristic of the deeper locations in the Homestake Laboratory, i.e., 7400-foot level, initial operation at the 4850-foot level will permit testing and staging and allow rapid and efficient transfer to the lower level laboratory when that becomes available.

2.3. Earth Science and Engineering at the 4850-foot Level and Above

Many attractions of the Homestake site are called out in the findings of the 2003 EarthLab report to National Science Foundation. The site occupies a volume of several cubic kilometers in an area of crystalline rock whose ground water flow and recharge is relatively unknown but which might be used to better characterize flow in other crystalline terrains. Metamorphic rocks with lesser amounts of more recent intrusive rocks dominate Homestake geology. These rocks, ranging from 1920 my to 53 my, would provide a diverse and varied environment for geologic investigations. Studies might involve variations in stress, fracturing and other geomechanical properties. These geomechanical insights can be integrated with investigations of large-scale fluid-rock interactions to better understand this world-class gold deposit. Establishing the rock mechanics behavior of the Homestake geologic section will allow design and excavation of experimental chambers with long-term stability. The SDSTA's plan to reoccupy and convert the facility down to this level as early as 2006 permits deep geoscience experiments as soon as construction occurs.

Particularly attractive are attributes of the facility that will allow geosciences research to begin as access is established to various locations within the facility down to the 4850-foot level. These include:

1. Existing records of hydrology, geology, and geochemistry, plus the historical perspective provided by individuals previously associated with the mine activities.
2. Existing drifts in the facility that provide access to a large volume of the underground both horizontally and vertically. The symmetrical layout of some of the drifts will be useful for some experiments dealing with the deformation properties of the rock. Other drifts provide access to areas with minimum disturbance due to drilling or mining.
3. Variability in the geology within the facility. The facility provides a unique window into the cratonic crust, which makes up a major portion of the continent. Until now the edges of this crust could only be studied because of limited access along the coasts.
4. Presence of relatively easily accessed life-forms that either live at the limits of conditions suitable for life or have been isolated from the surface biosphere for extended periods of time.

Many short-term geosciences experiments can be initiated in concert with rehabilitation of the laboratory, whereas others can be initiated immediately after safe access to drifts has been established. These include:

1. Investigations of flow path delineation in heterogeneous geologic settings.
2. Determination of rock movement that occurs as part of the normal deformation of the underground facilities without additional mining.
3. Characterization (e.g., biological, chemical, and isotopic signatures) of seepage from various locations.
4. Preliminary investigations of microbial communities.

Some early characterization activities such as fracture mapping, stress measurements, and ground water chemistry will likely be expanded as access to various locations within the facility is established. Other investigations such as those looking at thermal-mechanical-hydrologic coupling would expand in scope (i.e. from less than one cubic meter to tens of cubic meters) as larger blocks of rock become available. These experiments will address a central question of how geological properties vary with scale and how they vary spatially. The experience gained from developing the early phases of these experiments would be invaluable for a potential deeper phase, which would extend the laboratory down to 8000-foot. The development of groundwater models and characterization of the stress field will also be an asset to engineering for future expansions of the facility. Sampling of bacteria by drilling into virgin rock from accessible drifts would serve as a prelude to the major geomicrobiological research anticipated during the DUSEL phase of the laboratory. The geotechnical properties of the nearby Yates member, a target host rock for large caverns, are relatively unexplored.

In developing rehabilitation/construction project plans, it would be helpful to incorporate the following points:

- Simultaneous access to some drifts will be required for activities associated with more than one experiment.
- Protocols need to be developed for sampling (i.e., water, rocks, microbes etc.), monitoring microclimates (near ventilation shafts/drifts), fracture mapping, and other characterization activities.
- Gaining access to the volume of rock including both drifts (initially) and the core material is important. Some areas will require access over extended period of time. Provisions should be made for allowing geoscientists to have access and the facility must understand that the primary work is science. Safety procedures should allow for non-conventional access (e.g. microbial sampling under non-ventilated conditions).
- Individual boreholes and excavated cavities may be used for different experiments. The integrity of boreholes and other such features should be maintained.
- Maps/plans for areas most likely to be accessible should be prepared and integrated with the GIS/Vulcan database (including core availability). These activities can be part of the S-2 proposal.
- Geoscience work at lower levels can be performed in a phased approach following establishment of the overlying physics experiments.

2.4. Additional Support for Science

In addition to underground access, we recommend that the SDSTA provide some limited surface support facilities, such as a University-style "student machine shop", staging and storage space for equipment preparatory to going underground in this early phase. It is also recommended that all scientists working underground should have regular refresher training to better appreciate differences between surface work and underground work and the inherent risks associated with the underground workplace.

2.5. Possible Future Expansion

Independent of the 4850-foot level science mission we recognize that an effort to prevent the further rise in the underground water level would demonstrate how the dewatering of the lower levels of Homestake would be carried out. This demonstration would be of great value in proving the viability the Homestake site in rapidly providing underground access to the 8000-foot level in the forthcoming NSF solicitation process. The presentation of a clear method, timetable and cost for final dewatering and upgrading of the lowest levels of the facility is important in building confidence in the wider community of scientists and funding agencies. Timely access to the 4850-foot level will be of great help in carrying this out and further expanding the scientific community's interest in an underground facility. A delay would have a large negative impact on the viability of Homestake site in the NSF's DUSEL process.

In terms of the six options presented in the Review, the consensus was that the optimized reentry plan was between "1b" and "2b". Having defined the goal of establishing the 4850-foot level and the need to address the flooding and halt the advance of the water in the mine, the SDSTA in concert with the science community should define an option that would provide an attractive mix of opportunities for science experiments appropriate to their own timelines, of the potential SDSTA funding profile and a demonstration to the scientific community that Homestake can be the site of choice for DUSEL.

The loss of this near-term moderate depth facility in the US could have a negative impact on scientific programs currently looking for sites to stage experiments or to perform prototype experiments.

3. COST, SCHEDULE AND CONTINGENCY

Syd DeVries presented a full cost estimate and associated schedule for the Conversion

Project. An outline of refurbishment costs for surface buildings was presented by Bill Noordermeer. This cost estimate includes the full, so-called, "2d" option – with mine dewatering to 8150-foot level and a Physics capability at the 7400-foot level with modest new caverns and comprehensive access to the facility for earth sciences and engineering including the ability to obtain very deep cores. Six additional options and associated schedules provided the framework for additional discussion. The risks and associated contingencies of these options were discussed.

The Conversion Project consists of a collection of tasks commonly employed in underground construction and mine maintenance. Thus the steps, required to re-commission conveyances, reestablish suitable ventilation and perform the necessary inspection and maintenance of the ground support, are fairly routine in the mining industry. The process of reestablishing access to the lower levels of a deep facility and dewatering a flooded mine have recent relevant precedence in the industry.

Prior to the closure of the facility, inspections of the facility were made. These records, Homestake's own mining records and maintenance history and the long documented quality of the naturally occurring water in the mine all support the conclusion that the degradation of infrastructure in the facility (ground support and other mining infrastructure) should be, at this point, predictable and within reason. In some mines exposure to ground water has resulted in significant loss of underground infrastructure (principally ground support) due to accelerated corrosion. This is not thought to be the case in Homestake. The underground water in Homestake is well documented as being non-acidic and the full encapsulation of the infrastructure under water should help preserve it due to the reduced oxygen exposure.

Conversion Project includes new or refurbished components for elements that are known to be advanced in their design life. In many cases replacement components are known to exist within the site inventory and are scheduled into the project. For example there are spare steel sets for the Ross shaft and a recent inspection of the shaft, prior to closure, estimated the maintenance requirements. The Conversion Project maintained a conservative approach on replacing components in many cases (that is assuming that more needed to be replaced) based on their assessment of the status of the underground site. It should be stressed that the final assessment of the replacements and maintenance can only be accomplished once visual inspection takes place. The tasks are assembled to optimize and reduce indirect costs associated with management and oversight. Many tasks are paralleled and scheduled in a manner to provide flexibility in adapting to unforeseen situations. The Conversion Project would benefit, now that the engineering feasibility is completed and once a particular option for re-entering Homestake is selected, with a specific and detailed risk assessment and management plan.

Several significant steps of the estimate could not benefit from a first-hand inspection of the underground site. In these cases the estimate relies on existing mine records and maintenance reports made available to the SDSTA and interviews of former employees and workers from the Homestake mine. Corroboration of multiple interviews provides some assurance of the validity of the conclusions drawn from these sources, however the final conditions will not be known until visual inspection can be accomplished. This argues for an expanded level of contingency for these items. Dynatec's long history in underground construction and excavation was clearly of assistance in assembling this information into the detailed engineering study for the SDSTA.

3.1. Findings

The cost and schedule are comprehensive, well organized and professional. Detailed backup was reviewed and found to be reasonable. Because of the inability to perform first hand inspections, the estimate assumptions were largely based on interviews and documentation from the Homestake Corporation. There are uncertainties with the status of ground control, the condition of electrical and mechanical systems and the underground water quality that would influence the water treatment to meet DENR requirements.

The fundamental assumptions in the costing of the Conversion Project were that access to the facility would be gained in the near future, that flooding would not have advanced too high in the mine and that the 4850-foot level would be used as an underground staging platform. If the flooding continues above the 4850-foot level, significantly higher costs would result for the underground conveyances and the replacement of much of the upper level infrastructure including the #6 winze. Access into the facility would be delayed and the schedules for all subsequent underground work negatively impacted.

While a variety of options were examined, the actual engineering for each option was not extensively optimized. Thus if the goal was to rapidly regain safe access to the facility and to hold the water at its then current level, rather than completely dewatering the facility, smaller pumps could be specified and significantly reduced operating costs would result, for example. It would be prudent to optimize the Conversion Project with the final option and timetables for the entire project in mind. The detailed risk assessment of the revised Conversion Project may suggest natural divisions of the Project into units based on results of underground inspections as access is regained.

3.2. Comments

1. No showstopper issues are identified for the Conversion Project, that is we could not identify any item that by itself or in concert with other items poses a significant risk to the successful completion of the project. However, several areas of construction risk are outstanding (including those that will be delineated by physical inspection such as the shaft conditions, the ramp system ground conditions below 4850-foot level, and water treatment requirements).

2. Changes in market conditions should be monitored and cost estimate reevaluated on a regular basis (commodity prices, escalation, skilled miner availability).
3. Comprehensive insurance costs should be factored into the cost estimate.
4. A significant delay to the start of the Conversion Project allowing the mine to flood above the 4850-foot level would have serious implications on cost and schedule for any subsequent use of the facility.

3.3. Recommendations

1. The Conversion Project identifies many of the risks in the project. However, an identification of risks by major category should be provided. The level of contingency needs to be reevaluated and incorporated in a risk management plan.
2. The SDSTA should consider contract mechanisms for managing and mitigating risk.
3. The SDSTA should incorporate critical decisions as milestones in the integrated schedule to facilitate management of the project and to assist in maintaining the schedule.

4. MANAGEMENT

4.1. Findings

The SDSTA has a good understanding of the Conversion Project and its requirements. Dynatec has assembled a competent engineering study for regaining access to Homestake and halting the flooding. With the upcoming transition from feasibility to detailed engineering and construction the SDSTA recognizes the need to augment their organization and capabilities. For similar projects at Department of Energy national laboratories significant commitments of dedicated staff would be expected as the Project moves towards construction.

It remains important that the SDSTA maintain close ties with the science community to ensure that the detailed design continues to optimize the science program for the facility.

4.2. Comments

1. A review of the SDSTA's overall schedule, including critical NSF DUSEL decisions, indicates that enhanced construction oversight and managerial effort will soon be needed to support critical path activities associated with the underground Conversion Project: In particular, there is an urgent need to identify personnel and select and define appropriate safety and environmental codes and practices.

2. If National Laboratory practices were followed for a contract of this size, a number of dedicated staff would be required. Project staffing would typically include a dedicated project manager and contract administrator, and underground safety and environmental professionals.

3. To maintain the estimated Project Schedule and Costs the SDSTA should expeditiously proceed to obtain title to the property and initiate the steps to preserve the utility of the 4850-foot level.

4.3. Recommendations

1. Once the specific construction option is adopted the Project Schedule should be updated and integrated. Management should continue to develop the comprehensive Project Schedule and incorporate additional milestones on the critical path. Milestones could be modeled after Department of Energy Critical Decision milestones.

2. A clear organization structure should be expediently developed by the SDSTA. The Organizational Chart should include positions such as project manager, construction manager, contract manager and safety & environment personnel. These positions should be filled in time for them to properly fulfill critical project roles.

5. ENVIRONMENT, HEALTH and SAFETY

5.1. Findings

The SDSTA clearly expressed that environmental protection, and worker health and safety were top priorities. They presented plans to create a program of excellence in environment, health and safety (EH&S). This philosophy aligns well with that of DOE and the NSF. The SDSTA established that safety and environmental attitudes should be firmly embedded into the work planning and practices so that the contractors, staff and visitors develop a "culture of safety".

Management intends to take immediate ownership of safety and environmental responsibilities and ensure that all users understand that they are equal stakeholders in the EH&S programs.

The work and working environment will be regulated by the appropriate local, state and federal agencies and a variety of standards or regulations could apply to the different phases of the Conversion Project. The SDSTA intends to incorporate the most stringent work standards that are appropriate. The framework for the safe operation of the Conversion Project was presented and is based on successful programs in the mining industry.

Plans are being established to dispose of excavated rock and treating and disposing pumped water. Options for rock disposal both on-site (above and underground) and off-site are under consideration and permitting initiated. Discussions with DENR on water permitting have begun.

The SDSTA addressed issues related to local surface contamination. These areas will not be transferred with the Conversion Project and responsibility for mitigation remains with the Homestake Mining Company.

5.2. Comments

1. The committee strongly endorses the SDSTA's commitment to EH&S. The culture of safety should be seamless, spanning contract workers, staff, scientists, and visiting student and across all phases of the project.
2. While in use as a scientific laboratory (and not as an operating mine), MSHA code and regulations may provide a good complement to OSHA for the facility.
3. To successfully integrate the EH&S program with construction, operations, and scientific endeavors requires expedient actions. Foremost of these is the creation and filling of EH&S positions in management.
4. There may be EH&S and Cost and Schedule advantages in collecting and pumping underground water at several different levels in the facility to take advantage of the differences in water temperature and other qualities. The SDSTA should consider evaluating these advantages in their Integrated Project Schedule.

5.3. Recommendations

1. The SDSTA should continue to assemble a complete set of DENR inspection records of the site before both and at time of mine closure with special emphasis on the property to be transferred to the Conversion Project.

2. SDSTA should document existing underground laboratories and their EH&S records and programs for consideration in developing the equivalent programs at Homestake. An examination of similar mine de-watering efforts, especially with similar features (depth, rock type, etc) may provide valuable empirical data for the evaluation of the Conversion Project and should be initiated in the near future.
3. The code of standards and practices, which will regulate the activities underground and above, should be expeditiously determined. An integrated training program to orient the workers and scientists to these standards and practices should be initiated. Special attention should be given to developing the training for students and other less experienced personnel. The DOE national laboratory integrated safety management plan could be considered as a model.
4. Methods of monitoring the ingress of surface water into the facility should be considered and techniques to further isolate the underground site from these sources evaluated.

Appendix A. Charge to the Committee

November 22, 2004

Gentlemen,

Thank you for agreeing to participate in the mine reentry plan review. These plans and its review are critical to the State of South Dakota and to the South Dakota Science and Technology Authority. It is also essential this review take place for inclusion in our S2 response.

Various options for reentering the mine were discussed and accepted by the Collaboration at the Berkeley Meeting (August 2004). These six options presented below have been estimated by the SDSTA using Dynatec and State personnel, primarily Syd DeVries and Bill Noordermeer, under the supervision of Dick Gowen, Interim Executive Director of the SDSTA.

At this point the HC, the SDSTA, and the Governor's Office would benefit from a review of the plans and a careful vetting both of the scope of science that could be permitted by the options, the reliability of estimations, the organization that will conduct the work, the plan for the work, and the interfaces and connections between the organizations that will conduct the work and the science community that will make use of the facilities.

It has to be realized that the integration of the SDSTA's plans and the HC science program are still developing and that an interim management plan needs to be developed and implemented to ensure effective communications and that appropriate lines of authority exist. The approach for the review would be that the HC would make use of the facility, but that the SDSTA would own and operate the facility in the interim, until the NSF process would replace or redefine the roles. I would invite comment on the appropriate management structure for the interim operations of the Homestake facility to ensure optimum safe use of the facility and a management structure that would easily adapt or evolve to future NSF plans for DUSEL.

To review the science program and connections between the science program and the mine re-entry options representatives of the HC (its executive committee) will be asked to serve on the review board. To review the costs, schedule and management functions an independent panel of experts will be asked to review the plans. I would invite the "science team" to observe and participate in the "technical team" deliberations and process, and vise versa.

Six Options defined by the Homestake collaboration

1. Re-Entry; Safe Access for Mining Personnel; Basic shaft safety operation; rehab 4850 and access to 3950; safety/ventilation/limited access from bulkheads surface to 4850;Ventilation, water treatment, Continuing minimum pumping operation, Geosciences access in coordination with mining personnel only,

a. Hold water at 4850-foot level
b. Hold water at current level
c. Remove accumulated water

2. Re-Entry; Safe access for Mining Personnel and Research; shaft upgrade; rehab 4850 and access to 3950; safety/ventilation bulkheads surface to 4850; Ventilation, water treatment; Continuing pumping operation, Safe Access for Physics and Geosciences
    - **a.** Hold water at 4850-foot level, 4850 research and above
    - **b.** Hold water at current level, 4850 research and above
    - **c.** Remove accumulated water, deep research

1. Science Plans and NSF S-2 Response (HC)

This section is primarily aimed at defining the science and the science requirements for the mine and for defining the limitations on the science program by the different options. The connection between the initial plan to re-enter the mine and the NSF DUSEL efforts should be considered. Coordination, communication and authority issues between SDSTA and HC should be considered.

1. Do the re-entry plans enable a reasonable program of underground scientific endeavors? What are the experimental programs that could be entertained with the different options and what is a rough estimate of the timeline for these programs?
2. If the plans limit particular experimental programs, programs or uses, are the limitations reasonable when considering the national long range plans and funding profiles for the different fields?
3. Are safety and environmental issues adequately addressed by the plans?
4. Would the access and operational costs be reasonable for the programs?
5. What are the limitations on the program, initially, for experimental materials, personnel access, power, HVAC, other utilities?
6. Does a reasonable upgrade path then exist from these plans to a full NSF DUSEL?
7. Are the lines of authority and communication between the SDSTA and the HC well defined and effective?
8. Please present your comments or proposals on the interim management of the facility to unite the SDSTA facility with the HC.

2. Project Organization (SDSTA) (limit discussion to SDSTA's reentry project)

This section, in a normal DOE project, would be investigating the leadership of the project. In regards to the Homestake project, some assurance that the project would be conducted in an effective manner with assurances that the project has an excellent chance of succeeding on-schedule and on-budget is requested, but it would not require full conformance to DOE practices and protocols. Issues relating to the integration of the HC to the SDSTA should be considered.

9. Does the project have an effective organizational structure?
10. Does the project leadership style mesh with the project team?
11. Do you have any concerns and/or suggestions regarding project roles and

responsibilities?

3. Project Plan (SDSTA) (limit discussion to SDSTA's reentry project)

Similar to §3, the interest in the Project Plan is to obtain assurance that the Project has the appropriate structures in place to have a good chance of succeeding, but it would not necessarily require full conformance to DOE practices and protocols. The Project Plan should have adequate detail and be accessible by the HC to assure that their requirements are addressed. The Project Plan should clearly define scope of the project. If details are not yet defined by the science community a plan for defining these needs to be laid out.

12. In your estimation, is the proposed project plan an effective tool to guide the project from inception to completion?

13. Does the project plan include relevant portions, appropriate to the phase of project, such as the Statement of Work (SOW), Work Breakdown Structure (WBS), Project Execution Plan (PEP), Risk Management Plan, and the Budget and Schedule Estimates?

i. Within the Statement of Work (SOW), are project requirements defined?
ii. Within the Work Breakdown Structure (WBS), is the scope and level of detail appropriate?
iii. Within the Project Execution Plan (PEP), is there a proposed approach for Configuration Management, Design Control, Quality Control, and Safety?
iv. How are issues of Title, License, and Right-of-way dealt with? Is the title held clear and free of encumbrances or restrictions?
v. In order to satisfy liability and indemnification issues, what legislature and action is required by the state of South Dakota?
vi. Are Environmental and Safety issues adequately addressed in plan? What additional Environmental legislation or action by the State, Federal, or local officials is required? What has been accomplished to date? Under which Safety Agency jurisdiction will Homestake fall? Are actions in place to ensure compliance for the safety of the workers and the scientists?

4. Technical Aspects (SDSTA) (limit discussion to SDSTA's reentry project)

14. Does the project have a clear development plan for all the technical goals?
15. Does the baseline design meet the project's objectives?
16. Are technical tests and anticipated results stated?
17. Are design options analyzed against the baseline design?

5. Cost (SDSTA) (limit discussion to SDSTA's reentry project)

18. Is the Budget Estimate comprehensive and verifiable?

6. Schedule (SDSTA) (limit discussion to SDSTA's reentry project)

19. Is the Schedule Estimate comprehensive and verifiable?
20. Are schedule milestones clearly identified, and are the milestones frequent enough to gauge progress?
21. Does the schedule specify relationships, critical paths, slack paths, and resources in the appropriate phases and detail?

7. Risk (SDSTA) (limit discussion to SDSTA's reentry project)

22. Have risks been identified and managed appropriately?
23. While a DOE Risk Management Plan may not be appropriate, how are the risks identified and what measures are taken to reduce the impact of these risks on the costs and schedule?
24. Does the plan include a method for managing technical risk, budget risk, and schedule risk?
25. Are sources of risk prioritized based on their risk rating and is this rating method appropriate?

A tentative agenda is attached for the review process in Toronto. Thank you again for agreeing to help us with this review and I look forward to meeting with you on December 3.

Sincerely,

Dave Snyder
Executive Director

Appendix B. Committee Membership

Dr. Kevin T. Lesko, Chair
Nuclear Science Division
Lawrence Berkeley National Laboratory

Dr. Dana Beavis
Physics Department
Brookhaven National Laboratory

Dr. Steve Kettell
Physics Department
Brookhaven National Laboratory

Prof. Ken Lande
Department of Physics and Astronomy
University of Pennsylvania

Prof. Robert Lanou
Physics Department
Brown University

Dr. Chris Laughton
Project Manager for Underground Design and Construction
Fermi National Accelerator Laboratory

Mr. Mark Laurenti
Quarry Manager (Former Homestake Mine Technical Service Superintendent)

Prof. William Roggenthen
Dean, Earth System
South Dakota School of Mines and Technology

Dr. Rohit Salve
Earth Science Division
Lawrence Berkeley National Laboratory

Prof. Herb Wang
Geology and Geophysics
University of Wisconsin

Appendix C. Agenda

DUSEL Review Committee
Dynatec Headquarters
9555 Yonge Street, Suite 200
Richmond Hill, Ontario, Canada
Phone (905) 780 1980 Syd DeVries extension: 400
December 3-5, 2005

Tentative Agenda
(Times are suggested; the committee can adjust as warranted)

Friday December 3
8:00 A.M. Welcome and Committee Introductions
Dave Snyder
8:15 A.M. Executive Session of the Review Committee
9:15 A.M. Presentation of the Plan: Syd DeVries
Bill Noordermeer
Dave Snyder
12:30 Noon Lunch
1:30 P.M. Matching Initial Science Requirements to the Rehabilitation Plan: Access, Infrastructure, Existing Space, and Expansion. Connections to the Scientific Community
5:30 P.M. Break for dinner
7:00 P.M. Resume Science Requirement Review

Saturday December 4
8:00 A.M. Underground Work Considerations &
Costs and Schedule for the Rehabilitation
12:00 Noon Lunch
1:00 P.M. Resume Costs and Schedule Review
2:30 P.M. Management of the Rehabilitation Plan
4:00 P.M. Safety & the Environment
5:30 P.M. Break for dinner
7:00 P.M. Resume Sessions

Sunday December 5
8:00 A.M. Close out and Report Writing
12:00 A.M. Adjourn
Note: Hotel accommodations at the Sheraton Parkway Toronto North,
600 Highway 7 East, Richmond Hill, Ontario. Telephone 1-800-668-0101.