7 Homestake Reference Information – Status and General Description

The miners' gold may be gone, but a vast deposit of researchers' and engineers' gold remains in the form of varied and voluminous data about the Homestake site. The data include information about the history, mining practices, microbial research in mineral processing and waste treatment, and engineering activities. The existing data include a tremendous literature on the geologic properties, distribution of geologic units, and economic potential. Production of over 42 million ounces of gold during the 126-year lifetime of the mine guaranteed that generations of talented geologists and engineers studied myriad parameters and concepts. Topics of studies in the geosciences ranged from investigations of the environments of deposition of the host rocks for the mineralization, the mineralization itself, regional metamorphism experienced by the host Precambrian rock, and the subsequent intrusion of a host of younger rocks during the Tertiary period ~ 55 million years ago. From an operational standpoint, the mine was a leader in geotechnical studies associated with deformational effects of construction in the underground environment. Engineering was a prime consideration in the safe and productive operation of the facility, and the documentation of the work was as complete as the engineering was competent.

As the mine is converted into a scientific facility, the types of data that will be of particular use can be categorized based on their immediacy of use for construction, value as scientific baselines, the historical significance. The categories include materials that are:

- Useful for providing the basis for advanced scientific and engineering studies,
- Of importance from a historical and educational standpoint,
- Useful for engineering studies for advanced construction of large or unusual cavities in the underground environment, and
- Useful for the routine operations of the future laboratory.

Furthermore, the data can be identified as to their nature. The types of materials include paper reports, maintenance manuals for apparently nearly every piece of equipment in the facility (including the vast array of equipment that has been donated), computer files, and materials from drill cores from both the Homestake underground and surrounding areas of the Black Hills. In addition to the materials themselves, the experience of the people who operated the mine is an invaluable asset. This might be termed "soft" information as opposed to the "hard data" preserved in files, and consists of the presence of former employees of the mine in both the local area and the region.

7.1 Paper and File Resources

The Homestake Mining Company has donated over 10,000 cubic feet of operational and maintenance records related to the Homestake Mine to the Adams Museum and House facility in nearby Deadwood, SD [57 and Appendix A16]. The Homestake collection includes thousands of historic photographs and glass negatives, architectural drawings, maps of the mine and area, blueprints and patents, geological records of the Black Hills, original correspondence, daily journals, Homestake operation and production records, original artwork, the extensive geological specimen collection, equipment manuals, and scientific records. This collection will provide the focus for the planned Homestake-Adams Research Center. The goals of this center are threefold:

- First, the collection will be re-housed in a climate-controlled facility and acid-free environment.
- Second, the archival management team will identify and scan the photographs, glass negatives, maps, blueprints and drawings deemed of major research value, making them digitally available both on-site and via the Internet. The Homestake-Adams Research Center will be located in Deadwood, South Dakota. The City of Deadwood has committed to investing over $1.5M to purchase and retrofit a building to serve as a climate-controlled and secure research center that will be operated by the non-profit Adams Museum and House and open to the general public. In early 2006, Deadwood completed the purchase of a building to house the research center.
- Third, In addition to serving as an archive, the Homestake-Adams Research Center will be the site for hosting scientific and historical lectures, and will include exhibits about the history of mining and Homestake.

The preservation of the Homestake records is of special significance in assisting the Authority as it works to create a deep underground science lab. Access to the Homestake records will save the Authority both time and money as well as providing critical information that will protect the health and safety of the miners and scientists who work underground.

Resources for preservation of the information have already been identified and an ambitious search for additional funds has begun. For over sixteen years and as mandated by State law, Deadwood has used revenue generated from gaming taxes to restore, preserve, interpret and protect this National Historic Landmark District. While the number of dollars dedicated to historic preservation is finite and spread over many projects, the non-profit Adams Museum and House receives half of its operating budget from gaming tax dollars. As the Black Hills' oldest history museum (built in 1930), the Adams Museum has emerged as a nationally recognized and award-winning museum.

With a commitment from the City of Deadwood to use bonded funds to purchase and retrofit a building to serve as a research facility, Homestake Mining Company donated the Homestake collection to the Adams Museum and House in May 2005. Since that time, the Adams Museum and House has received a five-year, $100,000 per year commitment from the Adams-Mastrovich Family Foundation to help support inventorying, cataloguing, relocating, creating digital access, and establishing the Homestake-Adams Research Center. A strategic plan has been developed, an archivist (hired April 2006) and two assistant archivists (starting in May 2006) have been hired, and a request for proposals to transform the former F.L. Thorpe building into a climate-controlled and secure facility has been prepared.

The commitment of identified funding guarantees a long-term, stable base for preservation efforts in the area. As a result, great confidence can be held that the paper documents detailing operations and important studies by the operation company will be properly archived. Cooperation between the Authority and the Adams Museum has been assured, although it must be noted that the voluminous nature of the records has precluded full assessment of their extent to date. Examples of specific data can be offered, however. In one instance, examination of one set of records showed that it contained a study of the water inflow into the underground as a function of level [Appendix A9]. This type of information has already proven to be invaluable in estimating the effect and extent of the water inflow in designing systems to intercept water and return it to the surface during the Homestake Early Implementation Program phase of the project.

Geologic maps for each level, incorporating both drifting and core information, are also preserved in this archive. Although some of this data may be redundant to the VULCAN database, which was also transferred to the Authority, the paper copies of the maps represent a compilation of untold numbers of geologists and engineers during the history of the facility.

7.2 Technical and Scientific Human Resources

Descriptions of the existing information would not be complete without a discussion of the data associated with an experienced workforce. Following the closure of Homestake, many of the operating personnel found employment in other underground mines. Others remained in the area in either alternative occupations or as part of the Homestake closure operation. Many of the more experienced and capable former employees have expressed a desire to return to the operation. As a result, the Authority is enjoying great success in contacting the key personnel who will be needed to operate the underground in an efficient and safe manner. The experience of the former Homestake technical staff is complemented by the documentation of the long Homestake experience in the routine operation of the facility. For instance, Homestake even had its own handbook for rock bolting. This wide range of experience extends to specific techniques in ground support, general maintenance, and construction.

Other resources that are available in terms of people and expertise are also notable. For instance, the South Dakota Geological Survey is actively participating in archiving the drill cores from Homestake. Although the headquarters for the South Dakota Geological Survey is located in the eastern part of the State, a well-staffed field office is located in the western part of the State. Similarly, Wyoming also has an active geological survey in keeping with the tradition of the importance of geology to the development of the western states.

From the standpoint of academic institutions, geosciences and geoengineering are represented well in the surrounding institutions. Within South Dakota, the South Dakota School of Mines and Technology offers degrees in geology and geological engineering at the undergraduate, Master's, and Ph.D. levels. Programs in mining engineering (Mining Engineering and Management) and civil engineering are also important at South Dakota School of Mines and Technology and provide the opportunity for both collaboration and experience to the DUSEL project. Elsewhere in South Dakota, the University of South Dakota has an undergraduate program in Earth Sciences, and South Dakota State University has several engineering programs including civil engineering.

Outside of South Dakota, but still within the general region, academic institutions with strong geoscience and engineering programs include the University of Wyoming (located within 540 km, or ~6.5 hours driving time, from Homestake), Montana Tech, University of Montana, Montana State University, University of Nebraska, North Dakota State University, and the University of North Dakota. Opportunities to form regional organizations promoting cooperation are abundant and will be discussed further in a later chapter in this report. In addition to the United States Geological Survey water resources regional office in Rapid City, the USGS EROS Data Center is located in Sioux Falls, SD. This large facility is a major data management and research center for remotely-sensed data. Memoranda of Understanding are in place between the EROS Data Center and both the South Dakota State University and the South Dakota School of Mines and Technology and have included exchange of personnel between the Center and the academic institutions. The interest of personnel from EROS in scientific

problems in the Black Hills is long-standing and has resulted in numerous imagery products and projects.

7.3 Digital Resources

The VULCAN software system describes itself as the world's leading 3D geological modeling, surveying and mine planning software. The VULCAN web site indicates that the program performs as a platform for spatial information, modeling, visualization and analysis in fields, and it is used in applications ranging from mine planning and design to rehabilitation and environmental management. During the 1990s, a concerted effort was initiated by Homestake to transfer mine maps, geochemical information, and locations of cores taken in the underground into the VULCAN database and program system. This leads to increases in efficiencies in the engineering and engineering design as well as providing a vehicle for better geological interpretations.

In addition to being a convenient format to store geological and engineering information, this database environment can provide a graphical environment to both display and manipulate the three-dimensional information that is an integral part of working in the underground. In the case of the Homestake database, the geology is mapped on each level, and the locations of the exploration drill holes are included as separate files. The database, therefore, can be used to evaluate what was done and also to evaluate the possible consequences of future actions.

It should be noted, however, that, although the database is a tremendous asset, it is only as good as the information that is contained within it. The data were generated throughout the history of the mine by numerous individuals with different approaches to mapping and, in some cases, different criteria for mapping and logging of the geology. This has resulted in some excellent work in selected areas, but vertical cross sections that integrate the geology from level to level upwards are not as complete at the present time. Considerable work will be necessary to fully integrate the geologic mapping that is currently available into a facility-wide system.

It is anticipated, however, that the VULCAN database will continue to be used and updated as the refurbishment and new construction proceeds because it is a widely used and extremely useful tool for mine planning and design. It should also be noted that excellent tools are available for exporting the data to other programs used for geological studies.

7.4 Closure Reports

During closure activities and investigations were undertaken by both government agencies and the operating company to document the conditions in the mine. The studies were performed from the viewpoints of the entities commissioning the work. For instance, the South Dakota Department of Environment and Natural Resources was particularly concerned with documenting what environmental hazards might be remaining in the underground, along with the present state of chemical parameters such as the composition of water within the mine. The department's perspective, although somewhat similar to that of the operating company, was to identify any problems that might remain from the operations in the mine and provide information about potential problems that might develop in the future, particularly from the standpoint of water geochemistry. Therefore, the department's documentation tended to be a snapshot of what the mine looked like at the time of closure (e.g., Nelson 2003a; Keenihan and Nelson 2003; Townsend *et al.* 2003; Nelson, 2003b). [58-61 and Appendices A17-A20] Records and studies from the operating company consist of extensive documentation regarding actions taken to

remediate potential environmental problems encountered during the closure, removal of equipment from the underground, and mothballing and preservation of facilities destined to remain underground. These records have been carefully maintained and are available to the South Dakota Science and Technology Authority (the Authority) and other State agencies.

Those records show the great efforts that were made to ensure that the underground did not develop environmental problems and assured the regulatory agencies that the steps were taken. Additional studies that will be extremely helpful during the refurbishment and future development stages were also undertaken. For instance, predictions regarding the rate of inflow and the rate at which the water level would rise were made by Zahn (2002) [55] based upon the methodology of Rahn and Roggenthen (2002) [62] and the available information from the VULCAN database. Other studies, such as that by Geochemica (2003), [63 and Appendix A21] were commissioned to predict how the geochemistry of the waters flowing into the mine would change as a result of chemical interaction between the water, wall rock, and back fill as a function of time. These studies and the supporting geochemical and geohydrological data will function as the baseline and characterization from which the next phase of geochemical and geohydrological studies will benefit greatly.

7.5 Literature Resources

The literature relating to the Homestake Mine and the surrounding area is voluminous and covers the span of history from the first expeditions by the U.S. government in the 1800's to the present day. DeWitt (2003) [64] assembled an extensive bibliography of the articles written on the geology of the Black Hills area up to the year 2003. Although the geologic bibliography is an important resource, it does not include many of the engineering studies. In all, over 3,600 references on the geoscience of the Black Hills region are listed in this compilation. Of these references, over 145 are identified as being specifically of interest to the Homestake area (Campbell, 2005) [65]. Other published resources consist of many geologic mapping projects that cover the entire Black Hills area at scales from 1:250000 and 1:125000 (e.g., Dewitt and others, 1989; Darton, 1921) [66, 67].

Many 7 1/2 degree quadrangles have been mapped at the 1:24000 scale in the Black Hills but, more importantly, the entire northern tier of the Black Hills uplift is now mapped at this scale and those maps are available for use in geological studies. Aeromagnetic maps are available for the entire Black Hills area (e.g., United States Geological Survey, 1962) [68] as well as company reports commissioned by Homestake during its exploration activities in the northern Black Hills. Similarly, measurements of gravity field of the Earth in the region are closely spaced and well documented (e.g., Kleinkopf and Redden, 1975 [69] and Homestake company reports). Within the mine itself, Nutsch (1989) [70] made approximately 1200 measurements of the gravity field on many of the levels, yielding an overall average of 2.82 g/cm^3 for the underground.

Although it is not possible to describe the great number of previous investigations that are available, below we call particular attention should be called to examples of data that will be especially useful to the construction, design, and maintenance of the facility. Because Homestake has been a site for physics experiments for over 40 years and has been considered for an underground laboratory for more than six years, a substantial amount of information is available that is pertinent specifically for the physics community.

For instance, the radon content has been measured at the 4850 Level and was found to be ~ 1 – 5 pCi/l. The U, Th, and K content of rocks from the Homestake underground was measured

recently from cores from the Homestake Core Archive. Table 7.1 shows the values for these elements in cores from Yates Member, the Poorman Formation, and rhyolite dikes from nine different boreholes drilled from near the 4850 and the 7400 Levels. The low values of all three of these radiogenic elements in the Yates are consistent with a basalt as the parent rock type. The values from the volumetrically smaller Tertiary rhyolitic intrusive rocks were averaged because the differences between samples were small.

Table 7.1. Uranium, Thorium, and Potassium values from the Homestake Core Archive [71]

Core/Core Location	**U (ppm) ± 5 - 10%**	**Th (ppm) ± 5 – 10%**	**K (%) ± 1-2%**
Core #11537 Yates Member - vertical hole starting at 4850L (1/2way between Ross and Yates Shafts)	0.160 0.55	0.20 0.30	1.54 2.12
Core #11553 Yates Member drilled from 4850L – multiple samples measured	0.21 0.19	0.30 0.19	1.12 0.92
Core #15537 Poorman Fm. Horizontal hole at 7200L	0.080	0.25	0.010
Core #15532 Yates/Poorman from 7300L to 7450L multiple core samples measured	0.080 0.085	0.25 0.25	0.104 0.125
Core #18627 Yates Member drilled from 7400L – multiple samples measured	0.18 0.49	0.24 0.20	1.01 0.57
Cores #15680-820, 17581-822, 11553-059, 11537-180, rhyolite dikes -- averaged from four samples	8.6	10.8	2.9

Geotechnical information and analyses are available for the Homestake underground due to the requirements imposed upon mining over the course of the history of the mine and requirements specific to the construction of rooms to support physics experiments at the 4850 and 7400 Levels. Table 7.2 shows the *in-situ* stress stated in psi determined for the Homestake underground as a function of depth below the surface in feet (h).

Table 7.2. In-Situ Stresses in Homestake Underground Formations

	Pariseau *et al.* (1987) [35] 6950 to 7100 level	Tesarik *et al.* (2002) [37] 3050 to 7400 L
Vertical Stress	$S_v = 1.25h$	$S_v = 1.25h$
Horizontal Stress perpendicular to strike	$S_{h1} = 2078 + 0.57h$	$S_{h1} = 2078 + 0.53h$
Horizontal Stress parallel to strike	$S_{h2} = 121 + 0.53h$	$S_{h2} = 121 + 0.55h$

Numerous reports and papers dealing with the stability of rooms for the physics experiments have been prepared. An initial modeling study by Tesarik *et al*. (2002) [42] showed that large rooms with 50m roof spans in the Poorman Formations are stable at 2141 m below the surface when the rock is reinforced with cable bolts. Later modeling studies included those performed by RESPEC, Inc. (2001) [43], which showed that the rock was strong enough to provide stable excavations of 18 x 18m cross section at a depth of 2256 m (7400 Level) and 2438 m (8000 Level) and 50 x 50m cross section at a depth of 1478 m (4850 Level). More recent work by Golder Associates Ltd. (2006) [44] evaluated a more detailed geometric model that was 50 m long x 20 m wide x 15 m high at the 4850, 7400, and 8000 Levels. Based upon this work, the recommended spacing between the rooms at the 7400 and 8000 Levels should be 60 m from the

center of one room to the next. However, these modeling analyses are based upon relatively few measurements of the properties of the Yates Member and Poorman Formations. Additional measurements will be required as the design of the excavations proceeds.

7.6 Homestake Geothermal Gradient

The temperature profile as a function of depth is important for a number of the proposed research areas at the Homestake DUSEL, including investigations of the limits of life in extreme thermal environments and hydrological flow systems. Immediately upon exposing the rock to the cooling effects of ventilation, the rock temperature begins to fall and care must be taken to determine the original temperature of the rock in order to calculate an accurate geothermal gradient that will allow prediction of temperatures at greater depths with some confidence.

Estimates of the geothermal gradient based upon measured temperatures exhibit significant variation, although temperature measurements in the underground are relatively sparse. Roy *et al.* [72] provided two estimates of the geothermal gradient based upon measurements from the Homestake underground. Measurements in the vicinity of the Lead #4 Winze for a depth range of 1455-2048 m yielded a value of 23.4 (+/- 0.8)^{o} C/km and a value of 19.0 +/- 1.2^{o} C/km in the Yates Shaft for a depth range of 584-1508 m. Ashworth [73] documented the instrumentation of a borehole that extended over 14 m into the rock on the 7000 Level. Temperatures were acquired from the borehole over an extended period of time and showed that the effects of ventilation could be felt over the entire length of the borehole. Extrapolation of the well-behaved temperature variations in the borehole, however, allowed Ashworth to predict that the virgin rock temperature at that level to be 55^{o} C. Assuming an average surface temperature of 7.5^{o} C, this corresponds to a geothermal gradient of 22.3^{o} C/km.

The 120^{o} C isotherm represents one of the current estimates as to the thermal limit of life in the subsurface. The variations in thermal gradient yield estimates of the depths to reach the 120^{o} C isotherm of 15,800 ft (4.8 km), 16,550 ft (5.0 km), and 19,400 ft (5.9 km), respectively. Although the range in estimates of the geothermal gradient may be due inadequate equilibration of the temperature measurements in some cases and cannot be ruled out, variations in thermal conductivity of the rock and rock/water systems that might also be operating are another possibility. Clearly, additional measurements of the thermal system in the Homestake underground are required.

7.7 Porosity and Permeability in the Homestake Underground

The rocks that were originally deposited in the area of the Homestake Laboratory probably had abundant porosity and permeability. This sequence of sedimentary rocks ranged from the anoxic fine-grained sediments of the Poorman Formation to greywackes that would become the Ellison formation. The Poorman Formation also contains the Yates Member at its bottom, which has been interpreted as part of a volcanic pile upon which the younger units were deposited [74], The sequence, which may include up to 7500 m in the vicinity, was metamorphosed between 1.72 and 1.84 Ga [75]. Therefore, any porosity and permeability associated with the original sedimentary rocks probably was eliminated at that time. Later intrusion of rhyolite dikes during the Tertiary also did not have any significant associated porosity.

Because the original porosity was destroyed by metamorphism, the presently available porosity and permeability in these crystalline rocks must be associated with fractures and fracture networks developed in the vicinity of Homestake. Little information is available regarding the

present distribution of fracturing and fracture flow in the Homestake underground although indirect evidence for its existence is abundant. In general, two types of porosity and associated permeability can be identified. The first type is that which was developed as a result of creation of the underground workings themselves. Zahn [55] attempted to quantify the volume of voids created as part of the mining and dewatering program in the Homestake underground in order to prepare predictions of the rate of filling of the underground due to cessation of pumping. Zahn assigned a value of 0.01% to the rocks near the workings primarily based upon estimates of similar crystalline rocks from other areas. The hydraulic conductivity of these igneous and metamorphic rocks is low, approximately 10^{-7} cm/s, based upon pumping and recovery testing of the Precambrian rocks [55] (equivalent to a permeability value of 10^{-16} m^2). This value lies in the range for non-fractured metamorphic and plutonic rock, 10^{-17}–10^{-20} m^2, and fractured metamorphic and plutonic rocks, 10^{-12} – 10^{-15} m^2 [76].

The second type of porosity/permeability in the Homestake underground is associated with the fracture network that exists throughout the underground, albeit in highly variable fracture densities. Although definitive studies of fracture densities and locations are not available, a 1990 study of the sources of inflow of water into the underground can provide some information. This study showed that much of the inflow water originates directly from the surface. However, at least half of the 700 gal/minute being delivered to the underground workings must come via fracture systems. This water must be flowing from fractures that connect the workings to a much larger hydrologic system. The same 1990 study showed that the inflow at the 8000 Level amounted to approximately 110 gal/minute, and some of this water apparently was coming from boreholes drilled downwards as part of the deep drilling exploration activities. This suggests that the deeper boreholes tapped into a larger, deep hydrologic system that, while not capable of delivering large amounts of water, were nonetheless sufficiently significant in extent to deliver water on a continuous basis. The removal of water during the long history of mining apparently did not induce significant stream flow losses in the Homestake area, further indicating that the surrounding formation had a relatively low effective permeability and that the dewatering operation induced only localized unsaturated zones (to allow human entry into the underground workings, which are likely to be surrounded by a steep cone of lowered water table.)

7.8 Core Archives

In 2005, Homestake Mining Company transferred ownership of the archive of drill cores taken by the company over many years of operation; the core archive now contains about 91km of core. Curation of the core has been undertaken with the help of the Authority, private contractors, and the South Dakota Geological Survey. The South Dakota Geological Survey is archiving the core, establishing protocols for its use, and making the Homestake core accessible through its web-based database. The locations where the cores were acquired in the underground are included as part of the VULCAN database. The net effect of this is to increase the volume of the Earth's crust available for investigation from the approximately $30km^3$ exposed in the drifts of the mine to a total of $250km^3$. In addition, the cores provide information on the volume of rock between the exposed areas of the drifts. Thus, the drilling will assist the proper choice for sites for these experiments in terms of the rock properties, geohydrological characteristics, and physical logistics.

The uses for the core range from scientific to engineering studies that are uniquely suited to the use of rock from the cores. Material for detailed investigations of radiometric dating and

isotopic studies has already been furnished to both international and U.S. researchers. A study of the rock mechanics properties of the Yates Member of the Poorman Formation is being conducted in support of the DUSEL project using materials from core extracted from both the 4850 and the 7400 Levels. Some of the core is pertinent especially in relation to anticipated additional coring taken as part of the initial experiments to be conducted at DUSEL.

As Homestake Mining Company explored for additional reserves and attempted to understand the regional and local geology to the best extent possible, they drilled a series of holes to investigate the volume beneath the mine. It appears that they were able to recover core material in excess of 915 m. below the 8000 Level of the mine, and it is anticipated that core from this operation will be locatable within the database. This material would then be useful in designing and understanding cores derived from proposed drilling for geomicrobiological sampling. One of the more ambitious projects of this type would entail positioning a drill rig on the 8000 Level and drilling an additional 8000 ft. down to a total depth of 16,000 ft. which would ensure that the 120^{o} C. isotherm would be reached. This would, therefore, test the limits of life in this extreme geothermal environment. The existence of cores recovered from at least the upper portion of such geology would be helpful in both designing the sampling program and interpreting the results from the drilling.

7.9 Project Websites

The project uses web-driven technology to collect and disseminate information among members and the general public. The primary portal for the Homestake collaboration is http://www.lbl.gov/nsd/homestake. This site contains much information and many links for communication with the members of the Homestake Scientific Collaboration as well as providing a location for storage of previous presentations, meetings, and news. Videos of presentations of Letters of Interest (LOIs) from the February 2006 meeting in Lead, S.D. are especially interesting because they preserve a snapshot of the concepts being considered at that time, many of which have now been incorporated into the DUSEL Initial Suite of Experiments discussed in this report. Links to the Authority are provided. Information of the PAC members, its charge, and its report is distributed to the public through this portal.

The vast array of data currently available through the literature and through private company documents contributed to the Authority and the DUSEL project is recognized as constituting a mass of information that is difficult to navigate. Therefore, web sites that begin the process of identifying where site characterization data and background literature can be found have been established. Although they are in the preliminary stages, they have already reached the point of being useful for geoscience and, to a limited extent, geoengineering investigations. These data and collection of existing information and added references are available to the public and the collaboration through the index *references* and through subsidiary compilations such as the Homestake Reference Information Book. At later phases of this initiative, it is anticipated that links from these resources will allow access to interactive applications that will allow manipulation of at least portions of the VULCAN database. It is also anticipated that pertinent information from some of the more important paper copies of Homestake-provided data would also be referenced and linked as resources become available.

7.10 Homestake Letters of Interest – Early Implementation Program and DUSEL

In November 2005, the Authority and the Homestake Scientific Collaboration issued a call for Letters of Interest from potential users of Homestake. The primary purpose of the solicitation of users was to assist in planning for Homestake's Early Implementation Program and to identify candidates for early access to the facility. These users would be composed of both research and development stages for experiments as well as including experiments that were ready for deployment in the near term and those following a phased approach where the first phase would be included in the Early Implementation Phase. The complete list of LOIs, the presentations made to the Program Advisory Committee, and the Program Advisory Committee report are presented at http://www.lbl.gov/nsd/homestake/LOI.html . We present in Appendix A5 the listing of the 85 Letters of Interest originally submitted with the first report. The Authority continues to receive additional Letters of Interest and inquiries about possible uses of Homestake. We anticipate subsequent calls for Letters of Interest in the coming years.

7.11 Memoranda of Understanding

Subsequent to the Program Advisory Committee meetings and receiving their recommendations the Authority and the Homestake Scientific Collaboration have focused on defining the near-term scientific users for Homestake's Early Implementation Program. The first step in this process is to work with the users to establish their facility requirements in greater details and to establish Memoranda of Understanding between the users and the Authority. The current status of Memoranda of Understanding is presented along with the Letters of Intent in Appendix A5.

7.12 Initial Research Efforts

The initial research efforts at Homestake's Early Implementation Program will necessarily focus on a few selected disciplines, but will include experiments of international importance. In physics, the initial efforts include dark matter searches, neutrinoless double beta decay experiments, and a low energy solar neutrino experiment, addressing some of the most compelling problems of the day. For the earth sciences we will focus on establishing the facility baseline prior to opening and dewatering the facility. This includes establishing a sensitive seismic array, as well as obtaining and analyzing water samples from the surface and the underground to begin establishing the geochemistry and geomicrobiology content of the water.

Several efforts to establish essential infrastructure, including low background counting, are being proposed to the NSF and the Department of Energy. Another collaboration is proposing to begin the geotechnical work and initial coring required to plan for large cavities. This effort will investigate rock properties, excavation and stabilizing techniques for large cavities, and geological features influencing the placement of ~ 100kT cavities. The conversion of the Ray Davis cavity to a large water shielded room is also under active discussion with a collaboration that wishes to pursue both the general purpose shielding infrastructure and R&D towards gadolinium doping of the water for neutrino detection.

Education and public outreach is actively working on establishing a presence at Homestake in the coming year to serve as the initial focus for an extensive education and outreach program.