



**GENCAPD MINING PROJECT
MANAGING ENVIRONMENTAL AND SOCIAL
CONCERNS FOR MINING**

**Short course held at Royal Roads College
British Columbia**

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Report by:

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ABSTRACT

Through the GENCAPD mining project, three Guyanese Institutions were represented in the course entitled “Managing Environmental and Social Concerns in Mining”. Held at Royal Roads University in Vancouver Island, British Columbia, Canada, the course was designed for mining company personnel, consultants, regulators and other mining-focused stakeholders. The Guyanese participants were: Mrs. Karen Livan, Environmental Division Manager of GGMC, Ms. Aliesha Narrain, Senior Environmental Officer of the Environmental Protection Agency and Mr. John Loncke, Senior Lecturer, Division of Mining Engineering, Faculty of Technology, University of Guyana. Other participants, of a total of 17, were from Canada (5), United States (2), Sweden (6) and South Africa (1), representing Mining companies, Consultant Companies, Academic/Mining Research and Mining NGO’s (Non-Governmental Organizations).

The course focused on the following: Overview of the Mine Life Cycle, Mining and Sustainability, Environmental Impact Assessment evolution (definition, purpose and use), Effective Community Engagement, Environmental Baseline and Site Characterization, Climate-Hydrology and Water Management, Hydrogeology – basic overview, Waste Management (mine tailings), acid rock drainage, risk management, closure planning, Financial Assurance, Environmental and Social Management System (including ISO 14000), Effective team work and leadership practices and the role of Environmental NGO’s.

The course was delivered through 24 lectures, 7 vignettes (simulation exercises aiming to find solutions to problems associated with all stages of a mine life cycle) and 2 full-group workshops. It was considered beneficial for the Guyanese institutions as it provided participants with an excellent opportunity to develop a holistic view in terms of approaching and addressing environmental issues in mining. Thus, GGMC enhanced its knowledge related to environmental management in the mining industry and gained useful insights on associated topics related to social management, such as team building, consensus building, problem solving and intervention techniques. These insights will help the institution to more effectively play its role as ‘Agent of Change’ in the definition, promotion and implementation of environmental management practices in mining.

Apart from influencing good decision making related to the mining sector, EPA is now also better equipped to develop guidelines for closure planning and to advise and assist mining companies in developing environmental policies. For U.G., the information gathered during the course will be applied in the training program of the mining department to broaden its scope and give added awareness of worldwide issues and trends in environmental management in mining.

The present document presents the reports of the three Guyanese participants, including recommendations made and indicating ways that lessons and skills learnt and information gathered from the course will be beneficial to their own organization.

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1.0 REPORT BY KAREN LIVAN, GGMC

1.1 Outlines and Schedule

Managing Environmental and Social Concerns for Mining (MESCM) is a three-week intensive short-course designed for mining company personnel, consultants, regulators and other mining-focused stakeholders. It provides comprehensive technical and management training to address the environmental and social concerns that have become worldwide issues for mining.

A copy of the course schedule is attached as Appendix A. The course, held for the first time, enjoyed wide support of the Canadian Mining Industry and Industry Institutions.

1.2 Participants

There were seventeen participants; from Canada (5), United States (2), Sweden (6), Guyana (3) and Ecuador/South Africa (1); representing Mining Companies, EIA Consultancy firm, Academic/Mining Research for Reclamation, Regulatory Agencies (GGMC and EPA of Guyana) and two prominent Canadian and American NGO's working as 'watchdogs' to the Mining Industry, Environmental Mining Council of British Columbia and Mineral Policy Centre of Washington, D.C., respectively.

1.3 Course Details

The course was organized into five elements:

- 1) A pre-residency package of reading material and key references for review.
- 2) A series of seven 'vignettes' or simulations of real-world situations that span the complete life cycle of a mining project - exploration; detailed investigation, design and estimating; construction; operation and progressive rehabilitation; temporary closure; final closure and decommissioning and post closure in perpetuity. Working individually and in teams, participants assumed decision-making roles and were challenged to find practical ways of addressing the difficult environmental and social issues facing today's mining industry.

Integrated into the element of finding practical solutions to existing challenges was the awareness of different '*thinking styles*', learning to work effectively as teams by applying the six modes of thinking to enhance the effectiveness of meetings/group activity and an appreciation of the role companies, agencies and individuals play in effecting change with respect to the introduction and application of the concept and practice of sustainability in the mining industry.

- 3) A series of 24 short lectures given by experts from the Mining Industry on key environmental and social issues from technical and management perspectives; best practices in the industry as well as leading edge, emerging approaches. *One lecture included the Omai dam failure as a case study.*
- 4) A final synthesis, that integrated the course material and produced a strategic document – a company manual for sustainability, that is of practical use to participants' needs.

- 5) Follow up. Instructors and participants will be linked electronically and a mechanism will be put in place to share the experience of participants through a 12-month follow-up period as they apply the ideas and insights of the course.

1.4 Presentations

Six participants, including K. Livan, made presentations during the course. K. Livan's presentation "The Challenge of Sustainable Small and Medium Scale mining in Guyana" was based on the presentation made at the Sixth International Symposium on Environmental Issues and Management of Waste in Energy and Mineral Production (SWEMP) 2000 Symposium in Calgary, Alberta, Canada, earlier on June 2, 2000.

There were facilitated discussions during team reporting sessions and lectures.

1.5 Observations

Vision Statement

Participants were divided into three teams that devised a Vision Statement for the group, as follows:

"Through shared experiences, to develop new skills and knowledge to lead to better decision making and solutions in environmental and social issues management."

Management/Team Building

Techniques and concepts introduced - Different thinking styles and modes, brainstorming through "brain mapping" and recognizing the elements of change and various roles of change agents, are useful for making meetings more productive; finding solutions to problems; consensus building and promoting and facilitating the introduction of the concepts of sustainability and environmental protection in mining.

Presentations by Team Members

The presentations provided valuable insights and served to reinforce the practicality and application of the course materials to the mining sector - notably the application of EIS, applied research related to Acid Rock Drainage, computation of geological reserves and uncertainties associated with reserve estimates, and economic calculations that underline early decision making. Presentations also gave insight on the work/research of presenters.

Seven Vignettes - Practical Group Exercises

Unfortunately, working through the vignettes did not afford opportunity to apply the considerable detailed background information that was provided. Notwithstanding, these exercises provided good experience in pooling and defining ideas, teamwork, creativity, and the application and reinforcement of the information, concepts and techniques provided in the lectures and discussions in problem solving and finding solutions.

Technical Information

Lectures given are shown on the Course Time Table, Appendix B. A wide range of Technical and Management subjects were covered, mainly in a general overview. These were supplemented by several publications, including booklists, guidelines/manuals, and publications by the two NGO's represented - Mineral Policy Centre (of the US) and Environmental Mining Council of British Columbia - that called into question the effects of mining on communities and the environment.

Two items of special interest were the reporting on the Omai spill in the 1997 publication by Mineral Policy Center of Washington, DC, entitled 'Golden dreams, Poisoned Streams' authored by C.D. Rose *et al.*, and the philosophical question of the utility of gold, leading to an invitation to public debate and review of the cost to the environment of gold mining versus its utility. This debate has been initiated in the two publications, "More Precious than Gold... Mineral Development and the Protection of Biological Diversity in Canada" by Environmental Mining Council of BC, May 1998, for World Wildlife Fund of Canada, and "Gold: At What Price? The Need for a Public Debate on the Fate of National Gold Resources" by John Young (February 2000) for the Mineral Policy Centre.

The information can be used to give insights, provide facts and details, provide basic information and give direction on additional details that are required.

Focus

There was continued emphasis on economic, social and environmental sustainability, called the 'triple bottom line'. Other pervasive themes were the Multi-stakeholder approach with underlying consensus, openness and shared information/communication; the importance of environmental management and management systems, including risk and crisis management, both of which require informing the local community of the risk, and the details of contingency plans (*the community's right to know*). Another theme was the introduction of environmental management with the goal of sustainability and community engagement from the start of the project employing sociologists, and planning for closure during the mine facilities planning and designing stage. Liability and responsibility for old mine sites past closure and decommissioning, and even "into perpetuity" as long as there were still problems resulting from tailings or waste disposal, such as Acid Rock Drainage (ARD) was another recurrent theme. The widespread problems of Acid Rock Drainage research and solutions applied were stressed. It was of interest to note that an articulated and accepted Environmental Policy is a prerequisite of an Environmental Management System, particularly the ISO 14000. Principles that are commonly espoused with such policies are integrity, honesty, fairness and respect, and this policy has to find acceptance first with management, then throughout and at all levels of the company or organization.

There was incorporation of the role and outlook of Mining NGO's, and concerns were raised by representatives of the large mining companies that junior companies, with their lack of resources and with the poor prevailing capital markets, would not be able to live up to the requirements of sustainability and the triple bottom line. The attitude of the seniors to the juniors is reminiscent of the current attitude of the Brazilian government to gold mining by garimpeiros. As a response to the capital market situation and the realities and responsibilities of sustainability, senior

mining houses are shifting their economic focus from capital appreciation through the acquisition of high risk, high profit mines to a steady flow of dividends to shareholders.

1.6 Insights Gained

Many insights were drawn, including the following:

- The importance of sincerity, consistency and disclosure in community and stakeholder engagement.
- The current emphasis on sustainability and the ‘triple bottom line’ of human, ecological and economic well being is in large measure driven by the very negative public image of the Mining Industry resulting from the recent spate of environmental accidents and the large number of abandoned mine sites many of which are polluting the environment. In one survey, the mining industry ranked behind the tobacco industry in poor public image.
- Recognition of the need for a ‘social license’ to mine.
- EIS should be incorporated into the EMS. EIS should be based on project design, that is, design of control facilities and practices are key factors. Assumptions of EIS need to be validated, with stakeholders’ involvement during project implementation. Success of control systems needs to be reviewed to meet predicted performance. Performance risk assessment should be done under operating conditions, to optimize risk assessment and management. Key questions to be asked are, “Were the predicted issues and control strategies correct and complete? Were the right measures adopted? If not, why not?”
- Monitoring is not mitigation. Monitoring is to test predictions of EIS.
- There should be a link and demonstrated consistency between EIS, permitting and monitoring, or cynicism results. Attaining regulatory numbers does not mean there cannot be problems if environmental aspects are not well managed.
- Inventions (public consultations) are for shared information and negotiations, rather than academic debates or power struggles. They should be aimed at educating, rather than dictating or pontificating.
- Negotiations should deal with real issues, not narrow technical issues or very broad concepts.
- Sustainable development goes beyond the concept of sustained economic growth. In this definition of sustainable development, the issue of equity between primary mineral producers who bear the environmental burden and the main beneficiaries of the final product is called into question.
- ISO 14000 does not set standards: regulatory standards are usually imposed. Its principal benefits are performance monitoring and corrective action, and its objective of improving performance and periodic external auditing (every 3 years).
- Risk assessment, contingency planning and risk management are important in EIA and environmental management. Emergency response plans must be communicated to workers and the community to be affected.
- Specialized skills are often needed in environmental management.
- Planning for closure and decommissioning is very important.
- *The political nature of the decision to approve a large mining project, even in developed countries, was acknowledged.* It was also evident that issues facing developed and

developing countries with respect to mining and sustainability are very different, since developing countries often face bread and butter issues of poverty, unemployment/underemployment and few economic choices. Nonetheless, higher standards of accountability in environmental management and sustainability are equally required.

1.7 Benefits to GGMC

- Useful information on the technical and social aspects of environmental management in mining, including technical presentations, publications and guidelines.
- Useful insights and techniques on team building, consensus building, problem solving and interventions.
- Useful insights on EIS, the role of monitoring, EMS and ISO 14000.
- Application of the concepts of continuous learning and constant improvement as underlying principles of sustainability.
- Better definition and understanding of the various roles that GGMC, and the Environmental Division are mandated to play as ‘Agent of Change’ in the definition, promotion and implementation of environmental management practices in mining.
- Better ideas of the concepts of hazards, incidents, risks, risk assessment, risk management and crisis management.
- *Learning the importance of building on previous successes, rather than starting from scratch.*
- The importance of sincerity and consistency when promoting and implementing new concepts of Environmental Management, to avoid cynicism and build credibility.
- The importance of defining success, so that the larger strategy and purpose of our efforts are not obscured by day-to-day activity.
- Useful professional contacts.
- Expanded thinking on sustainability - the ‘triple bottom line’ of economic, ecological and human well being, and how profoundly planning for sustainability can affect approaches to environmental management from the earliest exploratory/planning/mining stage.

1.8 Acknowledgments

Guyanese participants Karen Livan, Manager Environmental Division, GGMC; Mr. J.V. Loncke, Senior Lecturer, Division of Mining Engineering, Faculty of Technology, University of Guyana and Aleisha Narain, Senior Environmental Officer of the Environmental Protection Agency, were sponsored by CIDA through the Guyana Environmental Capacity Development (GENCAPD) Mining Project.

My appreciation is extended to CIDA/GENCAPD, and to GGMC for sponsoring and supporting my attendance at this course.

Karen Livan
Manager, Environmental Division, GGMC.

2.0 REPORT BY ALEISHA NARAIN, EPA

This summary highlights the key points and areas covered in the course on Managing Environmental and Social Concerns in Mining (MESCM) which was held from the 3rd to 23rd of June 2000 in Victoria, B.C, Canada and sponsored by the Guyana Environmental Capacity Development Mining Project. A more detailed report will be submitted upon receipt of course materials, which are delayed by post.

2.1 MESCM Objectives

The objective of the MESCM course was to provide participants with the opportunity to develop the skills necessary to become an effective player in managing the mining industry and society in a sustainable manner. Specifically the course focused on:

- Integrating human and ecological concerns into the mine life cycle,
- Deriving solutions to address environmental concerns and,
- Building a dynamic and transparent relationship between all stakeholders: mine operators, regulators, and society.

The MESCM course consisted of roughly 24 lectures, 7 vignettes and 2 full- group workshops.

Topics presented covered the following areas:

- Overview of Mine Life Cycle: overview of environmental ~~including~~ and social issues relevant from mine exploration to post closure, importance of designing for closure early in the life of a mine.
- Mining and Sustainability
- EIA evolution: definition, purpose and use of EIA's
- Effective Community Engagement: the importance of community and public involvement in all stages of the mine life cycle.
- Environmental Baseline and case study (The Tambo Grande Project): Characterization of site in terms of biological, chemical, physical and geo-chemical parameters.
- Climate, Hydrology and Water Management: types of parameters and data required for climatic monitoring, hydrology data collection, sampling techniques and equipment for hydrology and climate data collection.
- Hydrogeology: basic overview of hydrogeology and mining, fundamental principles of ground water flow, tailings settling and reservoir ponds.
- Waste Management: types of mine wastes, management of tailings including acid rock drainage.
- Acid Rock Drainage: Chemistry, prediction, prevention, reduction and control.
- Placer Dome's Sustainable Development Policy
- Risk and Risk Management: definition of key terms, techniques of predicting risks and management of risks.

- Closure planning: addressing community involvement and sustainability, contents of a good closure plan.
- Financial Assurance: types of financial assurances, bonding.
- Environmental and Social Management Systems: types of EMS, ISO 14000, description of categories, auditing.
- Effective teamwork and leadership practices
- Environmental NGOs (ENGOS): role of ENGOS in North America, community involvement and decision-making.

Lectures were complimented by 7 vignettes of group work, which consisted of simulation exercises with the aim of finding solutions to problems associated with all stages of a mine life cycle.

At the end of the course, participants were drawn into 3 large groups and focused on the following activities:

- i. Mine acquisition
- ii. Development of a sustainable policy and manual for a mining company

Finally, participants were asked to highlight two activities, which they will implement upon return to their country. I chose the following:

1. Develop guidelines for closure planning: I found the sessions on closure planning very enlightening as the concept of designing early in the mine life cycle for closure became clearer. In addition, the issue of community sustainability especially in developing countries is an area, which needs to be further explored. Communities, which depend on mining or any other major industry, should be able to sustain themselves upon closure of that operation. Long term considerations such as community support, infrastructure, development of craftsmanship and tradesmanship skills are important in ensuring that the community survives economically upon mine closure. The principle of involving the community in developing the closure plan was also interesting and relevant to regions, which depend solely on one company for support. Based on these new ideas, I propose to develop guidelines on how to prepare closure plans which will be given to companies that need to meet this EPA requirement.
2. Guidelines on developing an environmental policy. Environmental policies are becoming a requirement of the EPA for most industries that go through the permitting system. In this regard I will use the guidelines given in the course to assist companies in developing an environmental policy that reflects the vision of the company. Because environmental policies are required for different operations, this action will be applied to all sectors.

2.2 Observations/Conclusion

The MESCM course provided participants with an excellent opportunity to develop a holistic view in terms of approaching and addressing environmental issues in mining. The underlying principles that are essential in good decision-making are all embodied in the course. However, the MESCM course also had a few areas, which I felt, could be improved. These are as follows:

1. The course focused a little too much on the social issues related to the mining sector. While most participants found this enlightening, social issues tend to be common for most types of environment and in this regard it was felt that too much emphasis was placed on this area throughout the course, and it became redundant in the vignettes.
2. It was felt by many participants that the course should have focused more on technical issues. Coming from a background of natural sciences, I expected to gain at the end of this course some in-depth knowledge on the engineering aspects of mining, for example: hydrology, hydrogeology, tailings dam design, however, this was not satisfactorily achieved. Some have argued that this course was, after all, on managing environmental and social concerns in mining. However, I believe that an understanding of technical issues such as the above is essential in proper environmental management. Furthermore, most of the case studies presented focused on what went wrong and the results of mishaps, and, more emphasis should have been placed on what could be done to prevent these mishaps from occurring.
3. Regulatory issues facing the industry were not dealt with in this course. Whilst the course focused on the private sector and the role of environmental NGOs it was lacking in dealing with national legislation, policies, and regulatory bodies and their requirements, which play key roles in the mining industry.

In conclusion, I found the MESCM course very informative. The shared experience and views of the other participants were enriching and these will be integrated into the decision making process of the EPA.

2.3 Acknowledgements

The writer wishes to thank the organizations and persons listed below for supporting his nomination to attend this course:

1. Guyana Environmental Capacity Development (GENCAPD) in the Mining Sector;
2. Mrs. Karen Livan, Manager, Environmental Division, Guyana Geology and Mines Commission;
3. Mr. Sherwood Lowe, Coordinator, Mining Engineering Division, University of Guyana;
4. Mr. Melvyn Sankies, Dean, Faculty of Technology, University of Guyana.

Aliesha Narain

Senior Environmental Officer, EPA.

3.0 REPORT BY JOHN LONCKE, U.G

3.1 Summary and Recommendations

This course is designed to address a wide range of technical, environmental and social problems that the mining industry is facing in today's world. The mining industry, in Guyana and around the world, is now 'under the microscope' not only from regulatory bodies but also from environmental non-governmental organizations (ENGOS), communities and other stakeholders. Major companies have generally been proactive in predicting environmental and social problems and introducing new technologies and methodologies to avert or alleviate them. However, junior companies as well as small- and medium-scale operators may not have the technical and/or financial capacity to match the efforts of the leaders of the mining industry.

In the 1970s and 1980s, the environmental consciousness of people was more or less directly related to the wealth of that nation. In this new century this is no longer true. The efficiency, availability and immediacy of worldwide communications have contributed to this change. In fact, social concerns often tend to supersede purely environmental considerations in blocking mining and other projects.

The changes in the industry and in factors affecting the viability of the industry have been rapid and have created a need for professionals involved in the industry to upgrade their skills and knowledge to keep in step with these changes. The **Managing Environmental and Social Concerns for Mining (MESCM)** course was designed precisely to meet these needs.

3.2 Recommendations

The mining program at the University of Guyana has very little content of an environmental nature and none when it comes to the social concerns associated with mining. In the first year of the diploma program, students are introduced to alluvial mining, but there is no formal content regarding the environmental impacts of mining.

In recent times, there have been increased vigilance and protests from hinterland communities concerning environmental damage from mining operations. These communities are clearly receiving the support of influential international organizations. The writer therefore wishes to make the following recommendations:

- 1) The Mines Division of the University of Guyana should immediately set about revising the present course outlines for its mining program to reflect greater environmental/social content.
- 2) The Mines Division should collaborate with the Environmental Studies Unit of the University of Guyana in developing programs appropriate to both Divisions/Unit. In fact, a very good case could be made for the Faculty of Technology absorbing the Environmental Studies Unit and creating a Department of Mining and the Environment.
- 3) In view of the importance of mining in the economy of Guyana, the University of Guyana should explore the possibility of staging the MESCM

Program here in Guyana. Participants from Barbados, Jamaica, Trinidad and Tobago, Suriname, Brazil and Venezuela could be invited to attend.

- 4) The University of Guyana should establish formal links with the Royal Roads University in British Columbia, Canada, particularly addressing (but not limited to) the Victoria area, of management of environmental and social issues in mining, including the underlying technical issues.

3.3 Course Outline: Lectures/Vignettes

The course Lecture and Speaker Outline is attached in Appendix A.

The course consisted of twenty-five lectures on the topics shown on the attached Lecture and Speaker Outline coupled with a series of seven vignettes which simulated typical environmental and social problems faced by the mining industry today. Lectures and vignettes were inter-related so that participants were able to apply the knowledge gained in the lectures to practical problem solving.

3.4 Review: The Lectures

Listed below, with some brief comments, are some of the topics covered in the lectures:

Mine Life Cycle (John Gadsby)

Designing for Closure

Prior to the 1970s, closure and post-closure were rarely considered parts of the mine life cycle. The result is that many countries have the problem of 'orphaned mines', mines which have closed down without rehabilitation of the site and/or which need continual care (due to ARD, for example) but whose owners have long gone out of business. The situation has changed and today probably all jurisdictions require closure and post-closure plans as part of the licensing procedure. These lectures emphasized the importance of closure and post-closure issues and of designing for closure.

Mining and Sustainability (Tony Hodge)

These lectures examined the concept of sustainability from the perspectives of society and the mining industry, and identified the ultimate objective as the well being of both people and ecosystems. A number of human ecosystem models were studied together with 'generic sustainability test criteria' for assessing progress towards sustainability. These criteria were based on the Bellagio Principles. The Results Triangle and a hierarchical presentation of data provide excellent mechanisms for identifying and tracking results.

Effective Community Engagement (Susan Joyce)

There has been, in the last decade, a rapid growth in the awareness and concern for the environmental damage and hazards that mining often brings with it. While governments, particularly in the developing nations, often view mining as an escape from economic depression, the affected communities are often resentful as they see themselves having to put up with the adverse effects of mining and not having a fair share in the economic benefits. Coupled with this is the steady growth of the concept of the 'rights' of indigenous peoples and the militancy of indigenous peoples in protecting these newly recognized rights. The result of this is

that mining companies need to establish good relations with communities even as they contemplate exploration.

Teams and Change (Anne Schultz)

Organizations and teams tend to develop certain traditions or habits in the way they function. This leads to resistance to change and strategies have to be used to overcome such resistance. These lectures dealt with ways of analyzing the 'culture' of an organization and using 'mind mapping' to identify the components of the system involved in the problem of change. The need for a Transition Team to implement and monitor change within an organization, the composition of the Team and how this Team should be selected, was also discussed.

Tailings Dams (Ian Bruce)

These lectures looked at the evolution of tailings dams and the occurrence of dam failures. They (the lectures) stressed that the design of a tailings dam was an iterative process, the elements of the design constantly being revisited and revised.

Some of the elements that need to be quantified are:

- ❖ nature of the bedrock
- ❖ nature of the effluent
- ❖ pH of the effluent
- ❖ grain size range
- ❖ void ratio
- ❖ porosity
- ❖ specific gravity
- ❖ pulp density
- ❖ compressibility / consolidation
- ❖ drained shear strength
- ❖ liquefaction resistance, etc.

Equally important are the questions of dam positioning, dam layout and types of dams.

There was an enlightening presentation of different ways in which dams fail, including the OMAI dam failure.

Acid Rock Drainage (Peri Mehling)

The impact of acid rock drainage on water quality and on biological systems was examined. ARD occurs when sulphide-containing rocks are exposed to air and water typically in rock dumps at mine sites. The generation of ARD leads to metal leaching and increases the seriousness of the hazard. The important point was also made, however, that metal leaching could occur in a neutral or even alkaline environment, thus complicating the situation. The chemistry of ARD and the part played by biological agents was discussed, together with methods of predicting and preventing ARD.

Risk and Risk Management (Franco Foboni)

In normal everyday conversation, one seldom makes a distinction between a hazard and a risk and the terms are often used interchangeably. In the science of Risk Assessment, however, the distinction is clear. In all mining operations and at mine sites there are hazards. The hazards

might be steep pit walls, which could cave in or too high spoil piles, which could slump, or tailings dams, which could fail.

The 'risk' is defined as the product of the likelihood, P_H , of a hazard occurring multiplied by the consequences, C_H , of that event. Thus, the Risk: $R_H = P_H \times C_H$.

This gives a numeric value for the Risk, which increases in accuracy when a large number of mines or industries are compared.

A quantitative risk assessment enables one to identify and prioritize problem areas for preventative or mitigation measures.

Closure Planning: Financial Assurance (George Miller)

In many jurisdictions, mining companies are now required to put up some form of financial assurance to guard against orphaned mine sites and/or to ensure environmental performance. In some cases, an environmental financial security may be required, and may be desirable, at each stage of the mining cycle from exploration through development and exploitation to closure and rehabilitation.

Various types of financial instruments were looked at including performance bonds, cash trust funds, bank accounts in trust, deposit securities, letters of credit, corporate guarantees, etc. Some alternatives were also considered such as ISO 14000 and ICME/World Bank accreditation.

3.5 Review: The Vignettes

The vignettes were designed to give the participants practical experience in solving real-life environment and social problems associated with different stages in the life of a mine. The vignettes were sandwiched between the lecturers in such a way that participants were able to apply the ideas presented in the lectures in solving the problems posed by each successive simulation.

The setting for the vignettes was a tropical location, the Amanda River Valley, where the Guy Mining Corporation held three mineral properties at varying stages of development. The Company's operations impacted on four communities in the Valley: St. Stephens with a European population of eight thousand (8,000); Rio Blanco with a 'mixed' population of two thousand (2,000); and two communities of indigenous peoples - the Leusa with a population of seven hundred and fifty (750) and the Xhorrh with a population of three hundred (300). The cultural diversity and economic status and expectations of these communities would inevitably affect Guy Mining Corporation's policies and decisions and were obviously factors which participants had to consider in their solutions.

Comprehensive technical data was supplied on the Amanda properties including physiography and climate, lithology and stratigraphy, metal occurrences and distribution, groundwater, mineralogy, metallurgy, metal leaching and acid rock drainage, humidity cell tests, mineralogy/petrology analyses, sieve analyses, tailings disposal systems, etc.

The participants (17) were divided into three groups and tasked with solving the problems presented in Vignettes 1 to 5 and 7. In vignette 6, two groups were used and each participant assigned a 'role' (Company Executive, Mayor, Environmentalist, etc) in the discussions/debates.

The groups were asked to suggest solutions to social and environmental problems as described briefly below:

- 1) A twenty-five-year-old mine is nearing closure and must now attempt to rectify the environmental damage of old mining practices.
- 2) The Company faces the closure of an exploration program and must deal with social and economic impacts on the communities.
- 3) The Company must assess the potential risks (economic, technical, environmental, social) in moving from advanced exploration to mine development.
- 4) The Company must develop environmental and social design criteria for assessing the success of integrating the ideas of sustainability into project design.
- 5) The Company, presented by the participants, has to assess the social and environmental issues associated with the construction phase of a mining project.
- 6) The Company is faced with integrating the ideas of sustainability into mine design.
- 7) The participants were asked to prepare an intervention in a re-licensing hearing.

John Loncke
University of Guyana.

APPENDIX A

Lecture and Speaker Outline