Environment - Risk Management - Feasibility Study - Social Development - Statistics - Management - Communications - Training and Advocacy

SEPTEMBER 2009

FMRDP for the Siana Gold Project

Prepared by BMP Environment & Community Care, Inc. for:

MERRILL CROWE CORPORATION

Greenstone
Resources Corporation

Republic of the Philippines
Department of Environment and Natural Resources
MINES & GEOSCIENCES BUREAU
Caraga Regional Office No. XIII
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October 13, 2009

DENR-MGB
SURIGAO CITY
RELEASED
DATE OCT 13 2009
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MEMORANDUM

FOR : **HON. HORACIO C. RAMOS**
Director
DENR-Mines & Geosciences Bureau
North Avenue, Diliman, Quezon City

ATTENTION : **THE CONTINGENT LIABILITY REHABILITATION FUND COMMITTEE (CLRFC)**

FROM : **ALILO C. ENSOMO, JR.**
OIC, Regional Director
Mines and Geosciences Bureau RXIII
Surigao City

SUBJECT : **EVALUATED FINAL MINE REHABILITATION AND/OR DECOMMISSIONING PLAN (FMR/DP) SUBMITTED BY** MERRILL CROWE CORPORATION (MCC) / GREENSTONE RESOURCES CORPORATION (GRC).

DOCUMENT ATTACHED : **COPY OF THE FMR/DP AND MRFC RESOLUTION**

Respectfully recommending herewith for FINAL REVIEW, DELIBERATION AND APPROVAL the FINAL MINE REHABILITATION AND/OR DECOMMISSIONING PLAN (FMR/DP) of MERRILL CROWE CORPORATION (MCC) / GREENSTONE RESOURCES CORPORATION (GRC).

Please be informed that the herein FMRD/P was presented and deliberated during the Interim Mine Rehabilitation Fund Committee (MRFC) Meeting held in October 12, 2009 in accordance with sections 170 and 187 of D.A.O. No. 96-40.

The said FMR/DP is hereby favorably endorsed for final approval per MRFC Resolution No. 02 series of 2009, a copy of which is hereto attached.

ALILO C. ENSOMO JR.
OIC, Regional Director

Republic of the Philippines
DEPARTMENT OF
ENVIRONMENT AND
NATURAL RESOURCES

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Excerpts from the minutes of the MERRILL CROWE (GREENSTONE) CORPORATION Interim Mine Rehabilitation Fund Committee (MRFC) Meeting October 12, 2009, MGB RXIII Training Center, Surigao City

RESOLUTION NO. 02
Series of 2009

RESOLUTION ENDORSING THE APPROVAL OF THE FINAL MINE REHABILITATION AND/OR DECOMMISIONING PLAN (FMRD/P) OF MERRILL CROWE (GREENSTONE) CORPORATION

WHEREAS, in accordance with R.A. 7942 Otherwise known as the Philippine Mining Act of 1995, MERRILL CROWE (GREENSTONE) CORPORATION is a duly organized corporation with mining project in Brgys. Siana and Dayano, Municipality of Mainit and Brgy. Cawilan, Municipality of Tubod, Province of Surigao del Norte.

WHEREAS, pursuant to DAO No. 96-40 and its amendment DAO No. 2005-07, the company is mandated to submit a Final Mine Rehabilitation and/or Decommissioning Plan (FMRD/P).

WHEREAS, the submitted Final Mine Rehabilitation and/or Decommissioning Plan (FMRD/P) of the Company for its Mining Project has complied with the mandated requirements and has made appropriate consideration of the relevant environmental and social issues that needs to be addressed during and after the life of the mine;

THEREFORE BE IT RESOLVED, that the submitted FMRD/P of MERRILL CROWE (GREENSTONE) CORPORATION is hereby endorsed to the Contingent Liability Rehabilitation Fund (CLRF) Steering Committee for approval;

BE IT FURTHER RESOLVED, that copies of this FMRD/P be furnished to the MGB Caraga Regional Office and Central Office.

APPROVED AND PASSED this 12th day of October 2009 at the MGB RXIII Training Center, Surigao City.

I hereby certify to the correctness of the above resolution.

JOSE HERTEODELUS B. BAYANA
Secretariat

ATTESTED BY:

REYNALDO Y. GONZALES
MGB RXIII/ Adhoc Presiding Officer

MARIETTA P. TUMULAK
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Barangay Del Rosario

FINAL MINE REHABILITATION AND DECOMMISSIONING PLAN FOR THE SIANA GOLD PROJECT

Prepared for

Greenstone Resources Corporation

By

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22 September 2009

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AUTHORSHIP AND REVIEW

Document Title: Final Mine Rehabilitation and Decommissioning Plan for the Siana Gold Project

Date: 22 September 2009

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Revision History

Revision	Date of Issue	Description	Authority	
			Name	Signature
0	1 September 2009	The document is issued to GRC for review.	Rolando V. Cuaño, Ph.D. President	
1	22 September 2009	Final comments of GRC considered and the document is issued to the MGB for review.	Rolando V. Cuaño, Ph.D.	

TABLES

FIGURES

PHOTOS

ANNEXES

A&D	Alienable and disposable
Ag	Silver
ANFO	Ammonium nitrate fuel oil
APCFTL	Annual Per Capita Food Threshold Level
APCPTL	Annual Per Capita Poverty Threshold Level
As	Arsenic
Au	Gold
AWD	All-wheel drive
bcm	Bank cubic meters
BMP	BMP Environment & Community Care, Inc.
BOD_5	Biochemical oxygen demand 5 days
Brgy	Barangay
Ca	Calcium
CBR	California bearing ratio
Cd	Cadmium
CEC	Cation exchange capacity
CH_4	Methane
CIL	Carbon-in-leach
Cl	Chlorine
CLF	Community livelihood farm
CN	Cyanide
COD	Chemical oxygen demand
CSIRO	Australian Commonwealth Scientific and Industrial Research Organization
$CuSO_4$	Copper sulfate
d	Day
DCP	Dynamic cone penetrometer
DENR	Department of Environment and Natural Resources
dt	Dry tonnes
E	East
ECC	Environmental compliance certificate
EIA	Environmental impact assessment
EIS	Environmental impact statement
EPCM	Engineering, Procurement, and Construction Management
EPEP	Environmental Protection and Enhancement Program
ESS	Environmental Systems and Services Pty Ltd
Fe	Iron
FMRDP	Final Mine Rehabilitation and Decommissioning Plan
Ft	Feet

GRC	Greenstone Resources Corporation
H	Horizontal
ha	Hectares
HCl	Hydrochloric acid
Hg	Mercury
ICOLD	International Committee on Large Dams
IRA	Internal Revenue Allotment
JCG	JCG Resources Corporation
K	Potassium
k	Kilo
km	Kilometers
L	Liters
LG	Low-grade ore
LGU	Local government unit
LPG	Liquefied petroleum gas
m	Meters
masl	Meters above sea level
mbsl	Meters below sea level
MCC	Merrill Crowe Corporation
MCE	Maximum credible earthquake
Mg	Magnesium
MGB	Mines and Geosciences Bureau
Mn	Manganese
MPDO	Municipal Planning and Development Office
MPSA	Mineral Production Sharing Agreement
MWES	Meyer Water Environmental Solutions
N	Nitrogen; north
Na	Sodium
NaCN	Sodium cyanide
NAF	Non-acid-forming
NaOH	Caustic soda or sodium hydroxide
NH_4	Ammonium
NNW	North-northwest
NSCB	National Statistical Coordination Board
NSO	National Statistics Office
OBE	Operating basis earthquake
oz	Ounces
P	Phosphorus

PAF	Potentially acid-forming
PAGASA	Philippine Atmospheric, Geophysical, and Astronomical Services Administration
Pb	Lead
PFZ	Philippine fault zone
PGA	Peak horizontal ground acceleration
pH	Power of hydrogen; measure of acidity or alkalinity
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PhP	Philippine pesos
PMF	Probable maximum flood
PPE	Personal protective equipment
PPIAF	Public-Private Infrastructure Advisory Facility
QA	Quality assurance
QC	Quality control
ROM	Run-of-mine
RL	Reduced level
S	South
s	Second
SAG	Semi-autogenous grinding
SDMP	Social Development and Management Program
SMBS	Sodium metabisulfite
SO_2	Sulfur dioxide
SO_4	Sulfates
SPT	Standard penetration test
SRC	Seismology Research Centre
st	Short tonnes
SURICON	Surigao Consolidated Mining Company
t	Tonnes
TPD	Tonnes per day
TPY	Tonnes per year
TSF	Tailings storage facility
UKDFID	United Kingdom Department for International Development
USEPA	United States Environmental Protection Agency
V	Vertical
VAT	Value-added tax
W	West
WAD	Weak acid dissociable
WRD	Waste rock dump
Zn	Zinc

1. COMPANY INFORMATION

Company Name:	Merrill Crowe Corporation (MCC) and Greenstone Resources Corporation (GRC)
Project Name:	SIANA GOLD PROJECT
Main Office:	Greenstone Resources Corporation Level 5, NOL Tower Commercial Avenue cor. Acacia Avenue Madrigal Business Park, Ayala Alabang Muntinlupa City
Project Site Location:	Brgy. Cawilan, Municipality of Tubod and Brgy. Siana, Municipality of Mainit
Contact Person:	Gregory C. Edwards
Position:	Managing Director Greenstone Resources Corporation
Telephone No.:	+632 807 2790, 807 2667
FAX No.:	+632 807 6658
Email Address:	gedwards@red5limited.com

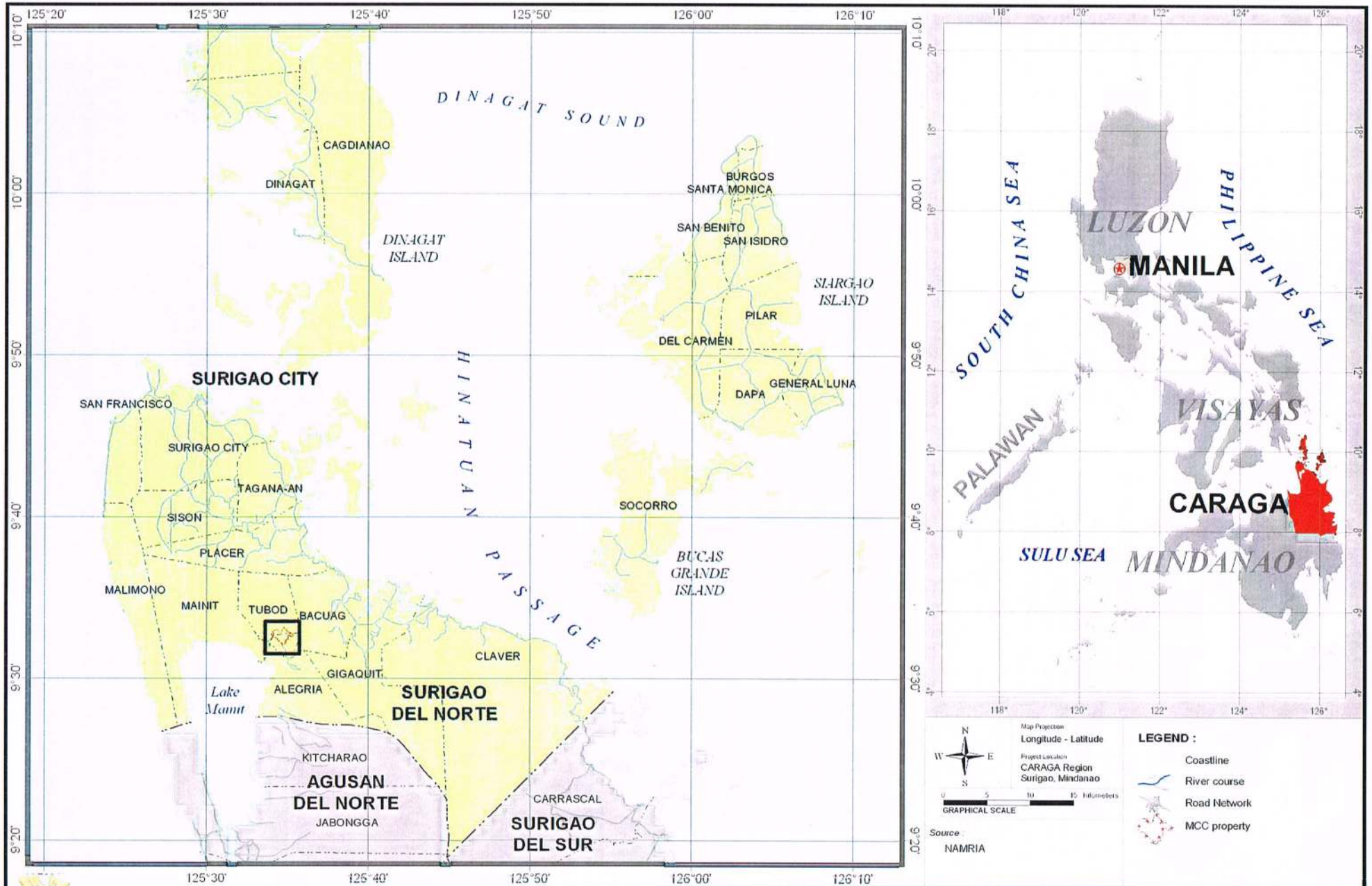
Figure 1-1 shows the location of the Siana Gold Project. It is approximately 39 km south of Surigao City in northeastern Mindanao. Access to the Project site is either from Surigao City through a 40-minute land trip or from Butuan City through a 2-hour land trip, both via the National Highway. Surigao City and Butuan City can be reached from Manila through commercial planes.

The Project site is within the 240-ha Siana mine property formerly operated by Surigao Consolidated Mining Company (SURICON). Portions of the property fall within Brgy. Cawilan of Tubod Municipality and Brgys. Siana and Dayano of Mainit Municipality. Province of Surigao del Norte (Figure 1-2).

All facilities of the Project are located within the northern block of Mineral Production Sharing Agreement (MPSA) No. 184-2002-XIII. The MPSA comprises two non-contiguous blocks with an aggregate area of 3,288.8 ha (Figure 1-3).

Legal Rights

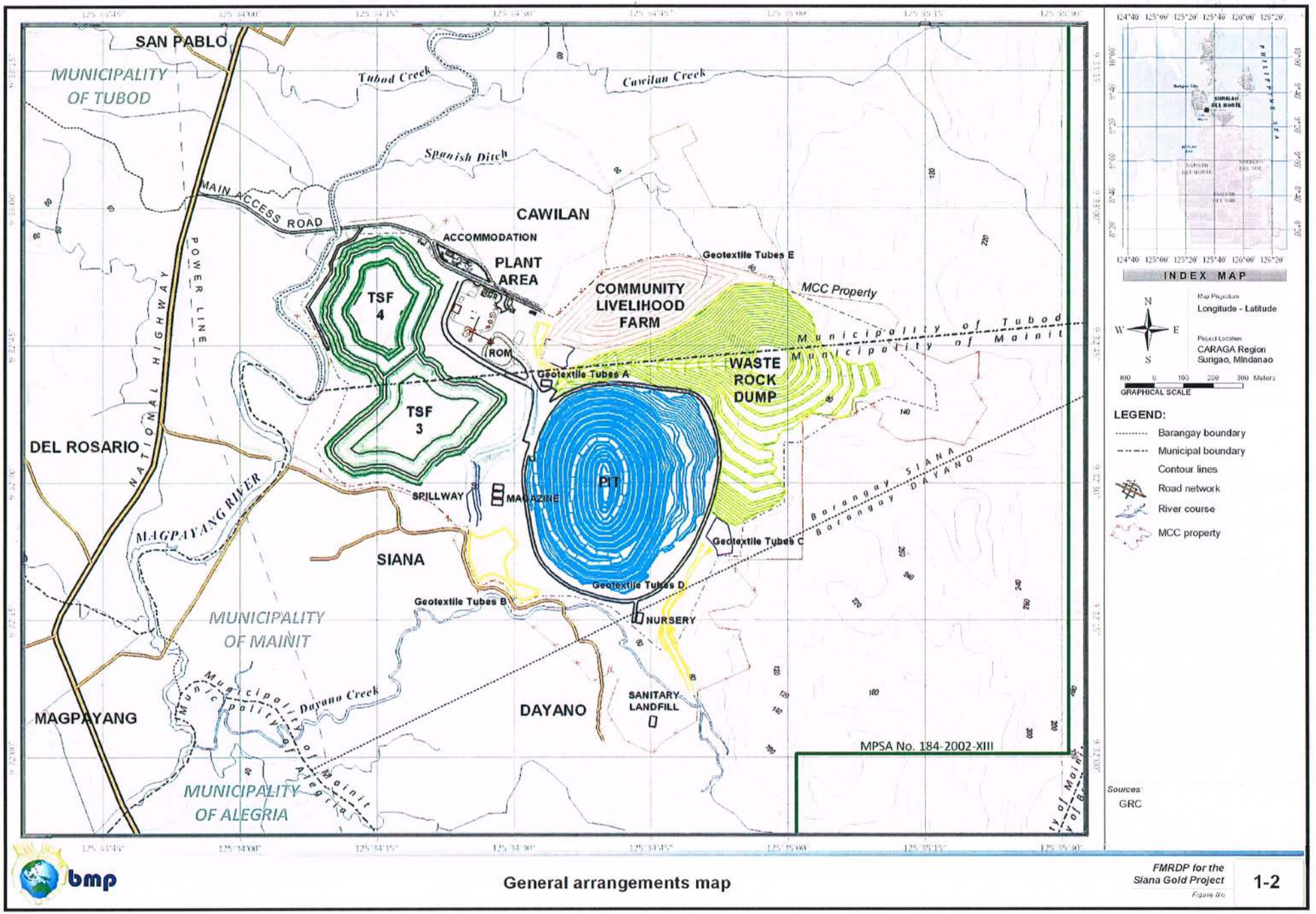
JCG Resources Corporation (JCG) acquired the Siana property after SURICON abandoned its mining operations in 1990. In September 1997, JCG applied for an MPSA covering the Siana property and other areas. In June 2002, Bremer Resources NL executed a Siana Joint Venture Heads of Agreement with JCG. The Agreement has several phases: due diligence and technical review, initial drilling,



Location of the Siana Gold Project

FMRDP for the Siana Gold Project

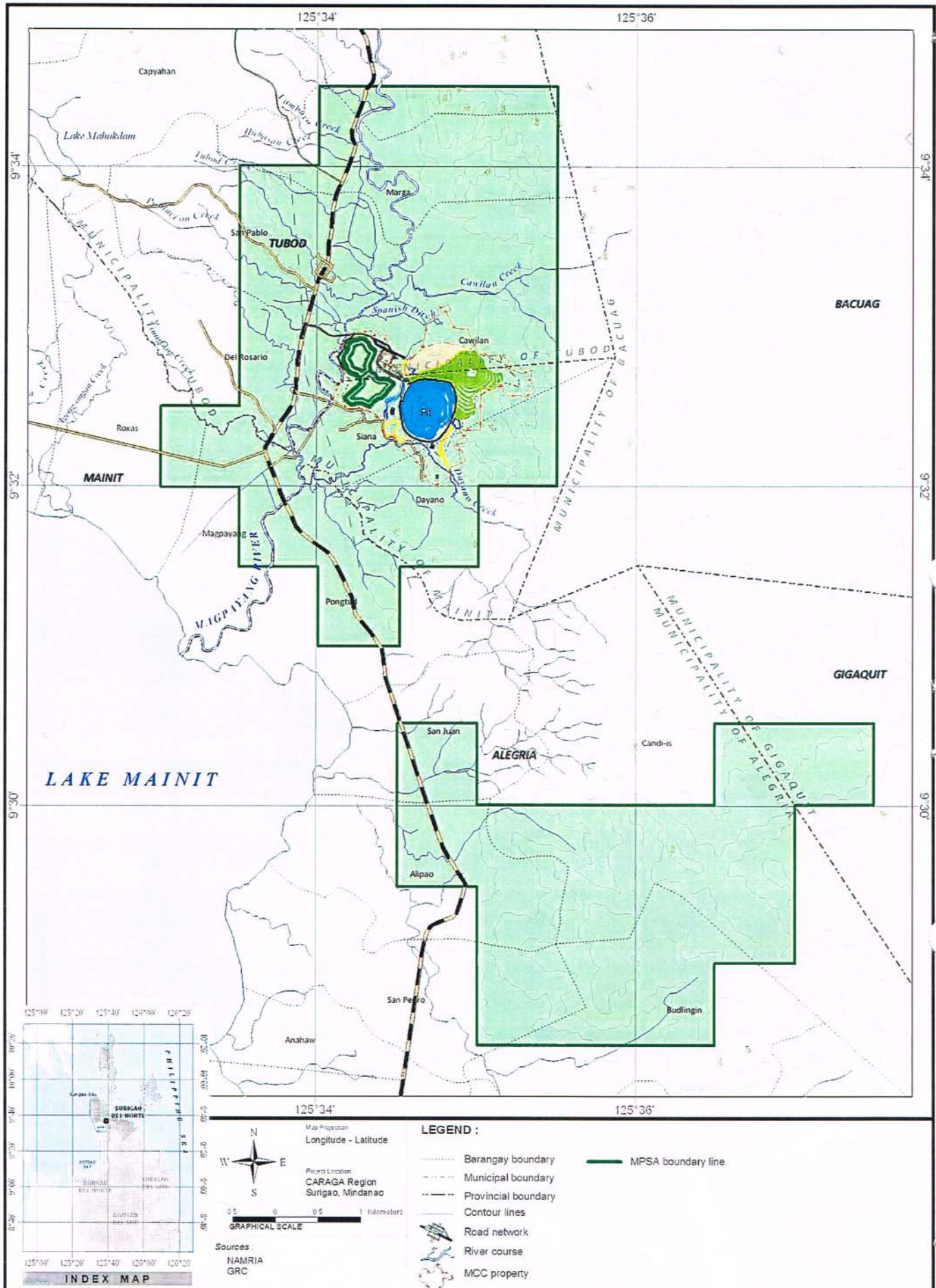
Figure No. 1-1



General arrangements map

FMRDP for the Siana Gold Project

1-2


125°34'
125°36'
9°34'
9°32'
9°30'
Capyahan
Lake Maluksalam
Tubod Creek
Marga
San Pablo
TUBOD
Cawilan Creek
Spanish Ditch
Cawilan
BACUAG
MUNICIPALITY OF BACUAG
Del Rosario
Roxas
Siana
Pit
MAINIT
Dayano
Magpayang
MAGPAYANG RIVER
Pongtud
MUNICIPALITY OF MAINIT
GIGAQUIT
MUNICIPALITY OF GIGAQUIT
San Juan
ALEGRIA
Candi-is
LAKE MAINIT
Alipao
San Pedro
Budlingin
Anahaw
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Longitude - Latitude
Project Location
CARAGA Region
Surigao, Mindanao
GRAPHICAL SCALE
Kilometers
Sources :
NAMRIA
GRC
LEGEND :
Barangay boundary
Municipal boundary
Provincial boundary
Contour lines
Road network
River course
MCC property
MPSA boundary line

exploration, and mining joint venture. In December 2002, MPSA No. 184-2002-XIII which covered the Siana property was issued to JCG (Annex 1). Bremer later assigned its interest in the joint venture to GRC.

GRC commenced reverse circulation percussion and diamond drilling in February 2003. A major resource diamond drilling program followed from November 2003 to February 2005. By October 2006, a total of 64 holes with an aggregate length of 25,133 m were completed and became the basis of the Bankable Feasibility Study for the Siana Gold Project.

On 15 August 2005, through a Deed of Assignment, JCG assigned to MCC its rights and obligations on the Siana MPSA and conveyed to the same entity full possession and control of the entire land area covered by the MPSA. On 19 August 2005, through an Agreement, GRC, among others, affirmed its consent to the assignment of claims. The Agreement likewise provided that MCC will immediately cause the transfer of the Siana MPSA from JCG to MCC and immediately thereafter to a Project company. This Project company is the restructured GRC where 60 % of the shareholdings is Filipino. MCC owns 10 % of GRC's shareholdings.

On 11 March 2008, the Mines and Geosciences Bureau (MGB) approved the transfer of the Siana MPSA to MCC (Annex 2).

On 21 April 2009, the Department of Environment and Natural Resources (DENR) issued the Siana Gold Project an environmental compliance certificate (ECC Reference Code: 0811-030-1010, Annex 3).

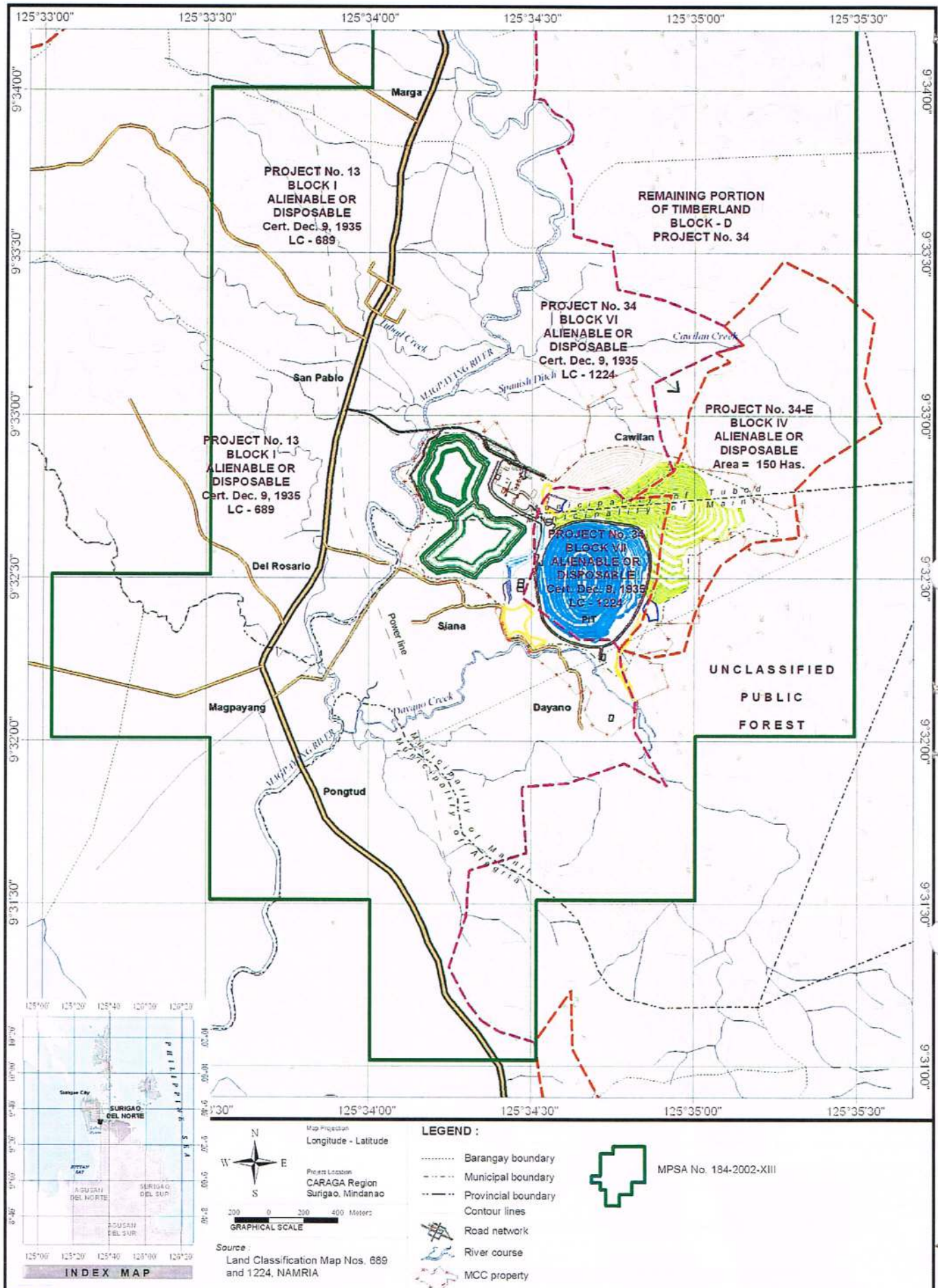
Figure 1-4 plots the Project facilities together with the mining tenement and land classification. As shown, all facilities are inside alienable and disposable (A&D) lands. Moreover, only the main access road is outside the 240-ha Siana property.

Project Facilities

The Siana Gold Project will redevelop the Siana property to produce gold and silver dore bars. The major activities are:

- Dewatering of the roughly 100-m deep open pit
- Construction and use of a 1.7-km all-weather access road and a 65-t causeway crossing
- Development and use of a mine camp, workshop, administration office, and 750 KVA standby generator
- Construction and operation of a 750,000 t per year (TPY), expandable to 1 million TPY, cyanidation plant
- Construction and operation of tailings storage facilities and waste rock dumps and
- Mining of the Siana gold deposit by open pit mining to an approximate depth of 215 m below the surface from the existing floor depth of about 100 m, then by underground mining over an approximately 355-m vertical interval.

Table 1-1 presents the Project facilities with their corresponding surface areas.



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Project facilities and land classification

FMRDP for the Siana Gold Project

Figure No. 1-4

Table 1-1. Project facilities and surface areas

Facilities	Approximate Area (m^2)
Main access road	11,550
Open pit	325,220
Underground mine	
Process plant area	
Process plant	2,240
Crusher	30
Reagents storage	240
Cyanide storage	150
Lime storage	50
Secondary containment pond	770
Laboratory	360
Plant office	250
Workshop/warehouse	350
Tank farm	470
Mine service area	
Mine fleet maintenance	1,090
Run-of-mine (ROM) pad	12,270
Fuel storage and dispensing	240
Main office	840
Accommodations area	6,550
Managers' camp	310
Senior camp	190
Staff camp	330
Dining and recreation building	730
Tailings storage facility (TSF)	
Open pit production	269,460
TSF 3	
Embankment	24,700
Impoundment	115,050
TSF 4	
Embankment	34,020
Impoundment	95,700
Emergency spillway	11,470
Underground mine workshop	1,090
Waste rock dump (WRD)	320,530
Community livelihood farm (CLF)	132,480

Facilities	Approximate Area (m^2)
Pond A (Plant feed water dam)	6,420
Pond B	27,180
Geotextile tubes	
Paste fill plant	880
Explosives magazine area	1,000
Pit perimeter road	23,090
Nursery	10,000
Sanitary landfill	20,000

From Table 1-1, the major Project facilities are the open pit with a total area of 32.5 ha, the WRD at 32.0 ha, the TSF for open pit mining operation at 26.9 ha, and the CLF at 13.2 ha. All facilities are inside the 240-ha titled Siana property.

2. EXECUTIVE SUMMARY

Major Issues

The mine closure issues that need to be addressed by the Final Mine Rehabilitation and Decommissioning Plan (FMRDP) may be classified into biophysical, chemical, and social.

The biophysical issues are:

- Physical stability and bare surfaces of the TSF embankments and impounded tailings.

  To accommodate 3.08 million t of tailings from the 5-year open-pit operation, a paddock-type TSF comprising two separate cells – TSF 3 at the southern portion and TSF 4 at the northern part – will be built over SURICON's tailings dams 1, 2, and 3. The outer wall has a slope of 1(V):3(H) equivalent to 18.4° and inner slope of 1:2.5 or 21.8°. A common embankment with slopes of 1:2.5 or 21.8° divides TSF 3 and TSF 4. At their final heights, both TSFs will have a dam crest elevation of RL 67 m. This is 12 m taller than the current mean dam crest elevation of Tailings dam 3 and from 16 m to 20 m taller than the existing dam crest elevations of Tailings dams 1 and 2. The tailings solids will have a mean elevation of RL 64 m (Figure 2-1).

  The underground mining operation will generate about 1.3 million t of tailings net of the paste fill requirements of the underground stopes. GDH identified four options for the disposal of these residual tailings which have been used successfully in other mines.

  The major biophysical issues on the TSFs are landslide and wind and water-borne erosion of sediment and tailings. To address these concerns, the programmed closure activities for the TSF are drainage works, drying of the tailings, treatment of residual supernatant, and revegetation.

- Physical stability and bare surfaces of the WRD and CLF.

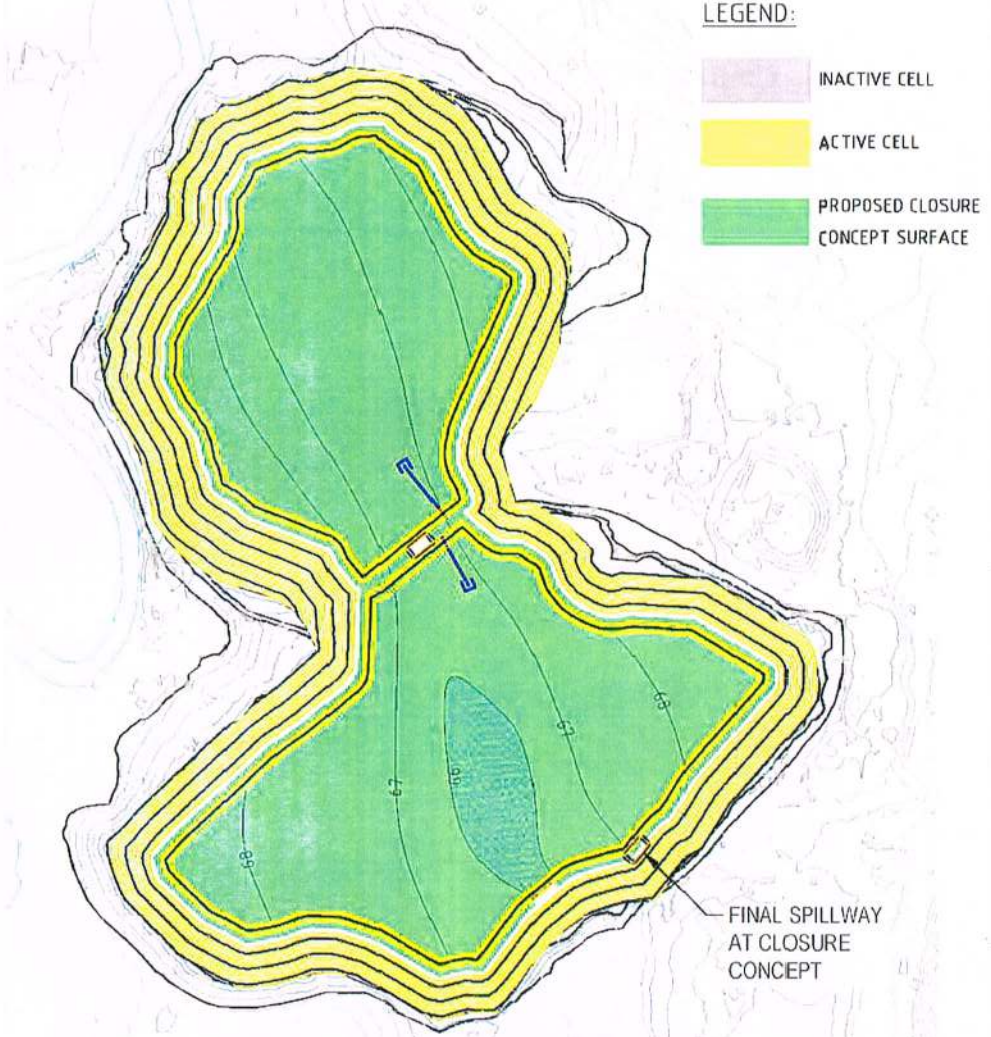
  The WRD and CLF will be built on top of SURICON's former Waste dump 2 and the vacant sloping area east of the open pit (Figure 1-2).

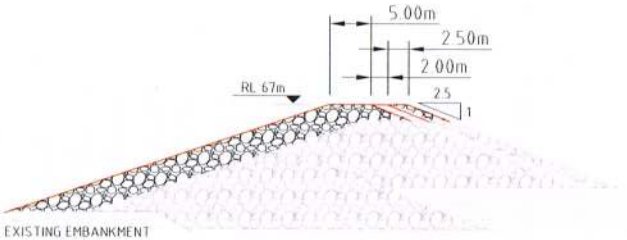
  The WRD which will accommodate mostly waste rocks has a total capacity of approximately 7.9 million bcm. It will have a final height of 85 m and overall slopes of around 6° W-E and 24° S-N and NW-SE. The CLF to store organic soils, subsoils, and clay-rich materials will have a capacity of roughly 1.8 million bcm. It will have batter angles of 15°, a final height of 20 m, and overall slopes of 7° SW-NE and 14° NW-SE (Figure 2-2). The CLF is intended to host the vegetable and fruit plantations of the community.

  The issues of the WRD and CLF are landslides and wind and water-borne erosion of sediments. Slope stabilization and drainage works are the management measures. The WRD will require soil conditioning and revegetation to cover the bare surfaces and slopes.

- Physical stability of the final open pit walls and void.

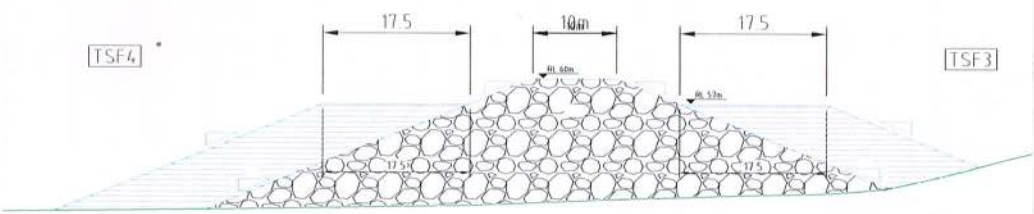
  The Siana Gold Project will deepen the open pit from its current elevation of – 50 m RL to – 165 m RL and push the pit walls by a maximum of 70 m at the northeastern sector. This will



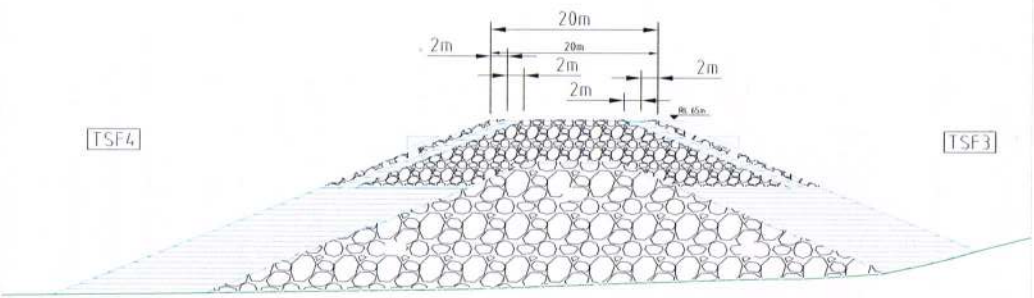


LIFT 3 (STAGES 5 AND 6) CONSTRUCTION

A SECTION
SCALE 1:250



STAGE 1 AND 2



STAGE 3 AND 4

LEGEND

ZONE A (WASTE ROCK)

ZONE B (COMPACTED TAILINGS)

STAGE 8 - CLOSURE

PRELIMINARY

No	Revision	Drawn	Checked	Approved	Date
A	ISSUED FOR COMMENTS	CM	AW		

0 5 10 15m
SCALE 1:500 AT ORIGINAL SIZE

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PO Box Y3106 Perth WA 6832
T 61 8 9429 6666 F 61 8 9429 6555
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Drafting Check		Design Check	
Approved			
Date			
Scale	1:500	Title Drawing must not be used for Construction unless signed as Approved	

Client: RED 5 LIMITED
Project: SIANA GOLD
Title: Figure 2-1 Ultimate plan and sections of TSF 3 & TSF 4

Original Size: A3
Drawing No: 61-22730-C005
Rev: A

Plot Date: 23 September 2009 at PM
Cad File No: C:\Documents_EMR\GHD\Report\figure 2-1 ultimate plan and section of TSF3 and TSF4.dwg

increase the pit surface area by 11 ha. The incremental increase in pit void volume is roughly 10.3 million m^3 (Figure 2-3).

At closure, the open pit will have a total depth of approximately 215 m and pit surface area of 32.5 ha. The pit void estimated from the current spilling elevation of about 45 m RL is approximately 18.5 million m^3. Over time, the pit void will accumulate water.

The issues for the pit walls and void are public safety, void wall slope stability, and uncontrolled discharges. The activities needed during mine closure are slope stabilization, drainage works, any additional plantation works at the pit margins, and posting of safety signs around the pit edge.

- Physical stability, bare surfaces, and impounded sediments of the settling ponds.

  Pond A which is located east of the ROM pad has two compartments with a total surface area of 6,420 m^2 and impounding capacity of 12,000 m^3. The pond embankment has an average height of 4 m and outer slope of 1:2.5 or 21.8°. The pond's maximum depth is 3 m.

  Pond B, located northeast of TSF 3, has a total surface area of 27,180 m^2 and impounding capacity of 100,000 m^3. The pond embankment height and outer slope are 6 m and 1:2 or 26.6°, respectively. The pond's maximum depth is 5 m.

- Physical stability and control of nuisance problems such as dust, odor, and vermin of the sanitary landfill.

  The sanitary landfill is located south of the open pit in Brgy. Dayano (Figure 1-2). Over an 11-year life, it will accommodate around 21,000 m^3 of domestic solid waste. The planned landfill will have dimensions of 120 m x 70 m x 3 m deep. It will have a 0.2-m thick soil cover at the end of each workday and a leachate collection and treatment and gas venting systems. It will be supported by a Material Recovery Facility.

  A final cover system is critical to the long-term management of the enumerated issues. The cover system design needs to consider a host of factors such as (Daniel and Koerner, 1993):

  1. Nature of the waste
  2. Site hydrogeology
  3. Cycling wetting and drying
  4. Penetration by plant roots
  5. Burrowing animals, worms, and insects
  6. Total and differential settlement caused by compression of underlying waste or foundation soil
  7. Downslope slippage or creep
  8. Wind or water erosion

9. Long-term moisture changes caused by water movement into or out of the underlying waste and

10. Alterations caused by gas derived from volatile components of the waste or decomposition products. After the design and construction of the cover system, an aftercare program is needed to include cover inspections and checking for differential settlement and other indicators of cover system compromise.

- Other built-up areas such as the process plant, mine service area, main office, accommodations, paste fill plant, explosives magazine, nursery, and sanitary landfill.

  During closure, these areas will impact on visual aesthetics and prevent the productive use of the land. The management program entails the decommissioning and removal of the facilities and structures and then, deep-ripping and revegetation.

- Soil provision or conditioning to support the re-establishment of robust endemic vegetation.

- Selection of indigenous floral species, *i.e.*, shrubs, vines, grasses, and trees appropriate to the contemplated post-mining land use.

The chemical issues include:

- Heavy metals associated with the ore at the TSFs and waste rocks at the WRD. The metals of concern are Fe (iron), Mn (manganese), Pb (lead), Zn (zinc), As (arsenic), Cd (cadmium), and Hg (mercury).

  The programmed closure activities such as drainage works, drying of the tailings, treatment of residual supernatant, and revegetation will contain the metals in the TSFs.

  For the WRD, slope stabilization, drainage works, soil conditioning, and revegetation are required. This assumes that any potentially acid forming (PAF) materials have been encapsulated with non-acid forming (NAF) materials during operations.

- Chemicals such as $CuSO_4$ (copper sulfate), NaCN (sodium cyanide), NaOH (caustic soda or sodium hydroxide), HCl (hydrochloric acid), and SMBS (sodium metabisulfite) which are stored in the reagents area, prepared in the mixing tanks, and used in the process plant.

  Unused chemicals need to be collected and removed from the site. Chemical-contaminated sediment and materials will require collection and disposal either at the TSF or in DENR-accredited facilities outside of the Project area.

- Industrial hazardous wastes such as used batteries, oil/grease-contaminated waste rugs, used oil filters, and used containers of hazardous chemicals such as NaCN, $CuSO_4$, NaOH, HCl, and SMBS. These wastes will be stored and collected by DENR-accredited recyclers.

- Leachate elevated in BOD_5, COD, SO_4, NH_4, N, and metals and methane gas from the sanitary landfill. The leachate treatment plant and gas collection system will need periodic inspection and maintenance. This is supplemented by a regular monitoring of effluent and air quality.

The major social issue is sustainability of the impact barangays after the depletion of the Siana gold deposit. Sustainability can be assured only through market-driven community-based sustainable livelihood and income generating projects of the Social Development and Management Program (SDMP). These livelihood projects should gradually make the residents less and less dependent on the Siana Gold Project and mining.

Alternative Post-Mining Land Uses

Six alternative post-mining land uses have been identified and evaluated for the Project. These are:

1. Residential
2. Industrial tree plantation
3. Aquaculture
4. Forestland
5. Agriculture
6. Ecotourism

Table 2-1 compares the alternative post-mining land uses in terms of strengths and weaknesses.

Table 2-1. Alternative post-mining land uses

End-of-Project Land Use	Advantages	Disadvantages or Caveats	Remarks
Residential	Accommodations established for Project employees are easily converted into residential units. There may be a demand in view of the scarcity of suitable habitation in the area.	At the end of the Project, population and disposable income in the impact barangays are likely to contract. This may only be averted if another industry, with labor requirements and income generation similar to those of the Siana Gold Project, can be established. Since this scenario is unlikely, the demand for residences may not be that strong.	The actual housing demand is difficult to forecast 12 to 13 years from now. In this FMRDP and pending the evaluation of demand two years before mine closure, the accommodations area northeast of TSF 4 is retained.
Industrial tree plantation	Industrial tree plantations need huge areas for propagation. Also, there is no danger of human metal uptake since the product is not for ingestion. Based on the site conditions, the prospective products from tree plantations include fuelwood and timber. The demand for said products in the adjacent and far communities is assured. Moreover, the availability of such products for community	The plantations must be designed such that replanting and harvesting will not disturb the ground. Moreover, the cutting cycles should not be too long. Trial plots are needed to confirm the best mix of species, soil conditioning, and planting design.	The dried TSFs and WRD of the Project may be developed into industrial tree plantations. A scientific material evaluation, soil conditioning, and trial plantations are needed prior to large-scale plantation.

End-of-Project Land Use	Advantages	Disadvantages or Caveats	Remarks
	use will reduce pressures on the remaining forests in the upland.		
Aquaculture	The fishermen in the area reported a declining fish catch. The use of available wetlands therefore for aquaculture, specifically fish farming, should be viable.	Fish farming introduces nutrients and organic debris into the water body. This will lead to plant and algae growth. Over time, water quality and fish productivity of the wetland will deteriorate. Dredging of the organic matter and soil from the water body bottom is undertaken to restore water quality and fish productivity. This is easily done for the settling and containment ponds but not for the deep open pit lake.	The settling and containment ponds of the Project may be used for fish farming. For the open pit lake, a highly regulated fish farming in terms of minimizing inputs and maximizing outputs of phosphorus is required. Moreover, insights can be gained from the failure of fish cages earlier set up by residents in the flooded open pit.
Forestland	The sites of some Project facilities, once decommissioned, can be converted into tree parks that feature premium endemic forest tree species. This is the company's contribution to the preservation of premium species in the locality as heritage trees for the future generation.	At the end of the Project, the hardstands may not be suitable for the propagation of forest trees.	A scientific material evaluation, soil conditioning, and trial plantations are needed prior to reforestation.
Agriculture	The surrounding communities are largely agricultural. At the time of closure, the CLF will have been fully developed for corn, vegetables, and fruit production.	The productivity of the CLF depends on the proper stockpiling and placement of topsoil on the dump during Project construction.	Unproductive areas within the CLF may need soil conditioning or reassessment of plant suitabilities.
Ecological park	The built-up facilities of the Project are set amidst slightly undulating topography that grades into the steep slopes of the Timamana limestone to the east. The pit lake, parks of premium endemic forest tree species, and industrial tree plantations can be combined with recreational areas to comprise an ecological park. These recreational areas include wilderness trails, bicycle lanes, camping areas, gardens, open air restaurants, and lake for boating and fishing. Depending on the progress of the Project's SDMP, the site may be linked to the Mamanwa village in	The redeveloped ecological park will have to compete with other ecotourism sites in Surigao and other parts of the country. The positioning and packaging of the park is critical.	To become viable, a market and feasibility study for an Ecological park is required. In this FMRDP and pending the confirmation of the demand two years before mine closure, consideration of an Ecological park as an alternative post-mining land use is deferred. Hence, no costs for the establishment of recreational areas and linking with the Mamanwa village are included in the FMRDP.

End-of-Project Land Use	Advantages	Disadvantages or Caveats	Remarks
	Brgy. Cawilan. This village will highlight the material culture and practices of the Mamanwas.		

Preferred Post-Mining Land Use

Table 2-2 lists the specific post-mining land uses programmed for each Project facility or structure together with the required decommissioning and rehabilitation works. All soil conditioning and planting activities are preceded by field revegetation trials.

Table 2-2. Specific post-mining land uses

Project Site	Area (ha)	End-of-Project Land Use	Required Works
Open pit	32.5	• Lake for recreation	• Haul out wastes • Decontaminate and remove oil spills • Remove pumps, pipes, cables, and equipment • Fix pit wall slopes that will be exposed after pit flooding • Fix pit outlet drainage by side slope flattening, widening, and rock armoring • Allow the pit to accumulate water from rainfall, surface runoff, and groundwater inflow • Condition the soil along the pit perimeter • Plant premium endemic forest tree species • Put up safety signages on the pit edge
Underground mine			• Haul out residual ore and wastes • Remove pumps, pipes, cables, and equipment • Seal decline and ventilation raises with paste fill
Process plant area			
• Process plant, crusher, laboratory	0.3	• Forest tree park	• Test residual process water for pH and CN, drain, and treat in the detoxification circuit if needed • Haul out crushed ore, unused reagents, and wastes • Remove conveyor belt, crusher, SAG mill, leach tanks, pumps, reactors, columns, kiln, electrowinning cells, oven, scrubber, furnace, etc. • Remove cables, pipes, roof, walls, racks, and concrete

Project Site	Area (ha)	End-of-Project Land Use	Required Works
			• Decontaminate and remove oil and chemical spills • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species
• Reagents storage, cyanide storage, lime storage, tank farm	0.1	• Forest tree park	• Haul out unused reagents and wastes • Confirm that there has been no leakage from the storage areas and tanks • Remove tanks, bag breakers, pumps, cables, pipes, roof, walls, racks, and concrete • Decontaminate and remove oil and chemical spills • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species
• Plant office		• Forest tree park	• Haul out unused cleaning materials, office supplies, and wastes • Remove equipment, furniture, cables, pipes, concrete, roof, and walls • Empty chambers of BioMAX treatment plant of water, test, and treat if required prior to discharge • Collect sludge from the treatment plant, analyze, treat if required, and use for soil conditioning. • Decontaminate and remove oil and chemical spills • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species
• Workshop, warehouse		• Forest tree park	• Haul out unused materials, consumables, and wastes • Remove saws, grinders, lathes, sanders, planers, cables, pipes, concrete, roof, walls, and racks • Decontaminate and remove oil and chemical spills

Project Site	Area (ha)	End-of-Project Land Use	Required Works
			• Test impounded water in oil-water separator, collect oil-contaminated water, drain clean water, and seal oil-water separator • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic species
• Secondary containment pond		• Fish farming	• Test impounded water for pH and CN, fully drain, and treat in the detoxification circuit if needed • Dredge impounded sediments and deposit in the TSF • Inspect and fix any cracks in the concrete walls • Enclose the water storage with 10-cm curbing to prevent surface runoff into the storage. At the lowest section, install a spillway with plastic mesh screening inclined inward for pond overflow • Allow the storage to fill with water • After filling, test the water quality • Add a few healthy fishes as final test • If results are favorable, stock the ponds with tilapia and other suitable fish • Plant endemic floral species along the water storage perimeter
Mine service area			
• Mine fleet maintenance	0.1	• Forest tree park	• Haul out unused materials, consumables, and wastes • Remove service, test and inspection, fabricating and welding, machining, cleaning, lubricating, and painting equipment and tools, cables, pipes, concrete, roof, walls, and racks • Empty chambers of BioMAX treatment plant of water, test, and treat if required prior to discharge • Collect sludge from the treatment plant, analyze, treat if required, and use for soil conditioning. • Decontaminate and remove oil and chemical spills • Test impounded water in oil-water separator, collect oil-contaminated water, drain clean water, and seal oil-water separator

Project Site	Area (ha)	End-of-Project Land Use	Required Works
			• Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic species
• ROM pad	1.2	• Forest tree park	• Haul out residual ore, earth materials, and wastes • Decontaminate oil spills • Fix topography and slopes • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species
• Fuel storage and dispensing		• Forest tree park	• Pump and haul out unused fuel • Confirm that there has been no leakage from the storage tank • Remove tanks, pipes, and concrete • Decontaminate and remove oil spills • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species
Main office	0.1	• Office and conference area	• Fix damaged sections and areas • Haul out unnecessary materials and wastes • Leave the structure as is
Accommodations area	1.6	• Accommodations area	• Fix damaged sections and areas • Haul out unnecessary materials and wastes • Leave the structure as is
TSF 3 and TSF 4			
• Embankment	5.9	• Shrubland	• Rehabilitate downslope batters and crests of the embankments • Remove tailings delivery and decant return pipe work • Decommission decant tower and underdrainage system • Provide permanent drainage systems and erosion and sediment control

Project Site	Area (ha)	End-of-Project Land Use	Required Works
			• Condition the soil • Plant vines and shrubs
• Impoundment	21.0	• Industrial tree plantation	• Pump out and treat tailings supernatant if required prior to release • Dry tailings aided by sprinkling and wicks and grading of surface • Condition the soil • Plant industrial tree species
TSF for underground mining operations	The options for disposal of tailings from underground operation include the TSF 3 and TSF 4, WRD, and open pit. No new area will be utilized.		
WRD	32.0	• Industrial tree plantation	• Haul out wastes • Decontaminate oil spills • Fix topography and slopes • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant industrial tree species
CLF	13.2	• Agriculture	• Reassess soil and plant suitabilities in problematic plantation sites • Fix topography, slopes, and drainage • Condition the soil and try new crops if needed
Ponds A (Plant feed water dam) and B	3.4	• Fish farming	• Test impounded water for pH and CN, fully drain, and treat in the detoxification circuit if needed • Dredge impounded sediments and deposit in the TSF • Inspect and fix any cracks in the clay liner • Undertake necessary repairs on the embankment and armor the outer wall with rocks • Fix the spillway and install plastic mesh screening inclined inward for the pond overflow • Allow the storage to fill with water • Plant endemic species along pond perimeter • After filling, test the water quality • Add a few healthy fishes as final test • If results are favorable, stock the ponds with tilapia and other suitable fish
Geotextile tubes area		• Forest tree park	• Rip open geotextile tubes and haul out trapped sediments for use in the repair

Project Site	Area (ha)	End-of-Project Land Use	Required Works
			of roads • Haul out ripped geotextile tubes • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species
Paste fill plant		• Forest tree park	• Test residual process water for pH and CN, drain, and treat in the detoxification circuit if needed • Haul out unused cement and wastes • Remove cyclones, agitator, pumps, disc filter, cooling tower, bag breaker, paste mixer, etc. • Remove cables, pipes, roof, walls, racks, and concrete • Empty completely the septic tanks and leach drains • Remove septic tank lids and break up bottoms of septic tanks • Backfill and compact the tanks and drains • Decontaminate and remove oil and chemical spills • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species
Explosives magazine area		• Forest tree park	• Supplier to haul out unused ANFO, emulsion, and blasting caps • Supplier to decontaminate and remove explosive and chemical spills • Remove cables, pipes, roof, walls, racks, and concrete • Empty completely the septic tanks and leach drains • Remove septic tank lids and break up bottoms of septic tanks • Backfill and compact the tanks and drains • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species
Nursery	1.0	• Forest tree park	• Haul out residual seedlings, earth

Project Site	Area (ha)	End-of-Project Land Use	Required Works
			materials, and wastes • Remove cables, pipes, roof, walls, racks, and concrete • Empty completely the septic tanks and leach drains • Remove septic tank lids and break up bottoms of septic tanks • Backfill and compact the tanks and drains • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species
Sanitary landfill	2.0	• Sports ground or public open space	• Develop and implement field trials of alternative capping designs for the filled cells • Finalize and implement capping design • Fix drainage for long-term utility by side slope flattening, widening, and rock armoring • Condition the soil • Plant endemic grasses and vines • Empty completely the septic tanks and leach drains • Remove septic tank lids and break up bottoms of septic tanks • Backfill and compact the tanks and drains • Haul out concrete, walls, and roof of Materials Recovery Facility • Provide fencing, bunding, and signage around the landfill to prevent access to dangerous places
Pit perimeter road	2.3	• Road	• Fix damaged sections and areas • Haul out unnecessary materials and wastes • Leave the structure as is
Main access road	1.1	• Road	• Fix damaged sections and areas • Haul out unnecessary materials and wastes • Leave the structure as is

Risks

Table 2-3 highlights the closure risks of the Project.

Table 2-3. Closure risks of the Project

Project Facility or FMRDP Activity	Risks	Particulars
Open pit	Failure of pit walls	The pit development plan provides for batter angles of 55.5° to 63° for the east wall and 62.5° to 63.5° for all other walls. The overall angles are 40° for the north wall, 44° for the east wall, 41° for the south wall, and 44° for the west wall. The bench height is 5 m. The mine ramp daylights at the western side (RSG, 2007). The current design of pit slopes is based on the comprehensive analyses of geotechnical logs for 60 drillholes within the open pit resource, three-dimensional modelling of rock mass quality data, slope stability modelling, and back analysis of the previous wall failure in the northeast of the pit. To manage the evolving risks of pit wall failure, geotechnical monitoring, mapping, and assessment will be undertaken during pit dewatering. This will continue throughout the operational phases. The monitoring will employ piezometers, computerized prism surveying, extensometers, inclinometers, and crack displacement measurements (Mining One, 2007). During closure, the pit will have an approximate surface area of 32.5 ha and an impounding volume of about 18.5 million m^3. As the equipment which includes pumps is pulled out, the pit will accumulate and fill with water. After mine closure, three failure modes are likely for the pit walls, especially those in the northeastern sector. These are by earthquakes, removal of support through erosion and wave action, and increase in lateral pressure by water in cracks and fissures. A pit wall failure is seen to have three major consequences: the loss of perimeter plantations, difficulty of revegetating the resulting escarpment, and fall of the waste rocks of the WRD into the flooded pit. A large volume of waste materials from the WRD plunging into the flooded open pit may create waves and surges into Dayano Creek. During closure, final stabilization of the pit slopes along the northeastern and eastern perimeter may have to be undertaken. This may involve slope flattening, placement of berms, rock support, backsloping, and revegetation. A decision will also be required on the spilling elevation.
	Uncontrolled flows from the pit	Uncontrolled water flows from the pit may be induced by the plunge of WRD failed materials, earthquake, extremely strong wind, or PMF. The adverse consequences are surges, waves, or floods towards Dayano Creek and flooding in Brgy. Siana. A hydrological study is required to estimate the probable maximum flood (PMF). Wind, earthquake, and failed materials plunge-wave modelling studies are needed to estimate wave heights. Based on the results, the minimum freeboard (*i.e.*, pit spilling elevation) and spillway size can be computed. The side slopes of the spillway need to be flattened and armored with rocks. Trash traps are to be installed for protection against blockage.

Project Facility or FMRDP Activity	Risks	Particulars
TSF 3 and TSF 4	Slope failure of dam embankment	Detailed investigations were completed on the volume of tailings for impoundment, type of tailings material, potential borrow materials for the dam embankment, site hydrology and hydrogeology, site seismicity, and site geologic and geotechnical conditions. The findings were used to design the TSF and to assess the stability of the design embankments. To avoid encroaching into new land, the TSF embankment will be raised following the upstream method. Initially, the embankment will be built on top of the existing SURICON embankment and tailings. To provide a foundation for future raises, an upstream berm consisting of moisture conditioned and compacted tailings is built behind the initial embankment. Structural rockfill and a core of low-permeability materials that can come from existing tailings or foundation excavations make up the embankment. The outer embankment wall has a slope of 18.4° and inner slope of 21.8°. A common embankment with slopes of 21.8° divides TSF 3 and TSF 4. At their final heights, both TSFs will have a dam crest elevation of RL 67 m. This is 12 m taller than the current mean dam crest elevation of Tailings dam 3 and from 16 m to 20 m taller than the existing dam crest elevations of Tailings dams 1 and 2. The slope stability of the design embankment was assessed under static and pseudo-static (seismic) loading conditions following ICOLD guidelines. The results indicated that the proposed embankments are stable under static conditions. Under pseudo-static conditions, the embankments are expected to deform. Under the maximum credible earthquake (MCE), the maximum expected vertical displacement occurring in TSF 3 is less than 1.0. Under the operating basis earthquake (OBE), the displacement is less than 0.2 m. Both values are less than the allowed subsidence of 1.0 m (GHD, 2009a).
		Golder (2007) assessed the liquefaction potential of the existing tailings. It was found that the existing tailings have a moderate to high in-situ density and they will not liquefy due to seismic loads. The likely failure modes for the TSF embankments are through an extremely strong earthquake, settlement and cracking of the emergency spillway, and erosion and gullying. The adverse consequences are loss of human life and damage to property, smothering of vegetation, drainage disruption, flooding and sedimentation of tailings enriched in heavy metals, and adverse aesthetic impacts. The stability of the TSF embankments will improve after the tailings are fully dried during mine closure. Subsequently, a full dam audit will be conducted to ensure the dam's long-term stability.

Project Facility or FMRDP Activity	Risks	Particulars
	Dam overtopping	Dam overtopping can result from the inadequately sized drainage capacity of the hydraulic structures or blocked drainageways. Water overtopping the dam embankment will weaken the structure and cause a dam breach. TSF3 and TSF4 will have individual emergency spillways with capacity to rout a 6-hour PMF with a return period of 1 in 10,000,000 years. The estimated total rainfall of this event is 1,160 m (GHD, 2009a). Both spillways will be broad-crested weirs lined with Reno Mattress. The TSF4 spillway with a total width of 20 m is located in the dividing embankment. The TSF3 spillway with a width of 12 m is located in the southern perimeter (*Ibid.*).
	Failure of the emergency spillway	The likely causes are settlement or erosion of the underlying ground which cracks the structure. As a result, water flows uncontrollably out of the spillway and erodes the ground. Erosion can lead to gullying that compromises dam integrity.
	Gully, sheet, and rill erosion	The dam embankment slopes and tailings surfaces are vulnerable to erosion and gullying. The embankment outer slope is designed at 1(V):3(H) equivalent to 18.4°. Based on Western Australia's Department of Minerals and Energy 1996 guidelines, a slope of 20° is associated with fair revegetation success; a slope of 15° has good revegetation success. To minimize erosion and gullying of the dam embankments and tailings surfaces, stormwater management measures are needed. These include dam crest backsloping, grading, rock cover, and revegetation.

Project Facility or FMRDP Activity	Risks	Particulars
WRD and CLF	Slope failure	The WRD which will accommodate mostly waste rocks has a total capacity of roughly 7.9 million bcm. It will have a final height of 85 m and overall slopes of around 6° W-E and 24° S-N and NW-SE. The CLF to store organic soils, subsoils, and clay-rich materials will have a capacity of roughly 1.8 million bcm. It will have batter slopes of 15°, a final height of 20 m, and overall slopes of 7° SW-NE and 14° NW-SE. The CLF is intended to host the vegetable and fruit plantations of the community. The stability of the WRD was assessed using material shear strength properties measured from geotechnical investigations. It was concluded that the WRD has negligible effect on pit wall stability and that the dump will be stable under seismic and dry loading conditions. However, the dump can tolerate only a limited saturation, *i.e.*, water levels within the dump not exceeding 104 m RL. Peter O'Bryan and Associates (2008) recommended the non-placement of large continuous volumes of clay-rich materials within the dump and bunding or construction of catch fences around the pit edge to contain any failed materials from the dump. Two additional failure modes are likely for the WRD during mine closure: pit wall failure and earthquake. As regards the CLF, it will have a foundation that is more stable and not exposed to wave action. It has a height and capacity one-fourth and almost one-fifth those of the WRD, respectively. Its slopes are also flatter. Compared to the WRD, its likelihood of failure is much reduced.
	Gully, sheet, and rill erosion	Since the CLF will consist largely of soils, the structure will be vulnerable to erosion. However, at the time of closure, the CLF will have been fully developed for vegetable and fruit plantations. This means that the appropriate erosion control measures have been installed. For the WRD, dump crest backsloping, rock covers, armoring of drainage channels, and revegetation are needed during closure.
Ponds A (Plant feed water dam) and B and secondary containment dam	Slope failure of wall or embankment	Within the process plant area, a concrete-lined secondary containment pond will be built. Outside the process plant area, two ponds contained by bulk earth fill embankments will be established. The pond impoundment will be lined by compacted clay. Over time, the back and base of the concrete walls may be scoured. This will destabilize and crack the structure. The bulk earth fill embankments may fail either by natural settlement, erosion, or strong earthquake. The clay liners are prone to differential settlement. This may lead to localized cracking. During mine closure, the water storages will be converted into fish farms. This will require full drainage of impounded water, dredging, inspection and repairs, drainage works, filling the storages with water, water quality and fish survival tests, and fish stocking.

Project Facility or FMRDP Activity	Risks	Particulars
	Pond overtopping	The secondary containment pond has no spillways. The ingress and spillway of Ponds A and B are suitable only during operations. The required works during mine closure are curbing and spillway works for the concrete lined ponds. The curbing will keep surface runoff away from the ponds. The spillway works will include the placement of plastic mesh screening to prevent the escape of fish during pond overflows. For Ponds A and B, the earth fill embankment may need repairs and strengthening. Plastic mesh screening will likewise be placed on the pond spillway.
Sanitary landfill	Failure of the landfill cap	A landfill cap is a key element in the rehabilitation of the landfill. Its functions are to minimize water infiltration into the waste, provide a long-term stable barrier between the waste and the environment, prevent the uncontrolled escape of landfill gas and provide land suitable for the intended afteruse. Failure of the landfill cap exposes the wastes to the environment. The likely contributors of cap failure are cyclic wetting and drying; penetration by plant roots, burrowing animals, worms, and insects; settlement caused by the compression of the waste; downslope slippage or creep; and wind or water erosion. Prior to closure, alternative landfill cap designs will be tested on the filled-up cells of the facility. The best design is then adopted for the landfill closure. Maintenance works will be needed to restore any depressions, seal minor cracks, prevent or control erosion, and to restore or maintain vegetation.
	Failure of the leachate collection and treatment	Leachate is liquid that seeps from the landfill. Its composition is dependent on the kind of waste and the state of waste decomposition. During the early years of a landfill cell when conditions are acidic, the leachate is usually elevated in BOD_5, COD, SO_4, Ca, Mg, and Fe. The concentrations of said parameters decrease when conditions are methanogenic, *i.e.*, methane producing. Concentrations of other parameters in the leachate such as Cl, Na, K, NH_4, and N remain unchanged (Ehrig, 1988). The design of the leachate treatment plant is yet to be finalized. Most likely, the treatment will be a combination of a biological method such as sequencing batch reactor and a chemical treatment like carbon adsorption. The likely failure modes of the leachate treatment are clogging of the drainageways leading to the facility, blinding or choking of filters, mechanical failures, and non-attainment of cycle times and optimal controls. From construction up to post-closure, the water quality of the influent and effluent leachate of the landfill will be regularly monitored. The leachate treatment will also need periodic maintenance works such as backwash, replacement of consumables, and clearing of drainage channels. Depending on the evolving leachate water quality, other forms of treatment may be installed.

Project Facility or FMRDP Activity	Risks	Particulars
	Failure of the landfill gas extraction system	The anaerobic decomposition of the waste in landfills generates numerous gases. The principal ones are CO_2 and CH_4. CO_2 is heavier than air and will migrate to the bottom of the waste facility and be removed with the leachate. CH_4 is lighter than air and will rise to the top of the waste. The gas collector system for the Project's landfill is yet to be designed. A typical system in the Philippines is perforated bamboos laid out on a grid. The failure mode for such a system is bamboo breakage due to waste settlement or slope failure. This system will need maintenance for the life of the landfill's gas generation. Gas generation is established by the regular monitoring of the landfill gas.
Soil substrate	Inadequacy of soil in terms of texture, structure, organic matter, CEC, soil pH, and nutrients for plant growth	Based on the soil investigations of 2005 and 2009, the waste rocks and dried tailings of SURICON after 19 years of closure have low fertilities compared to the natural soils in the area. The soil pH is moderately alkaline making any nutrients not available to plants, OM is low, and available P is not detected to low. The physical properties such as texture and drainage are also not suitable for plant growth. Soil conditioning prior to revegetation is therefore critical for the Project. The revegetation trials will try various methods of soil conditioning such as compost and inorganic fertilizer. This will minimize uncertainties relating to the conditioning of soil.
Revegetation	Low survival rate and percent cover of planted species	Failure in reforestation is attributed to a host of factors: lack of weed control especially during the early years of plant growth, inappropriate species, inadequate soil nutrition, poor planting stocks, drought, fire, livestock grazing, and agricultural cultivation. The quick re-establishment of vegetative cover is critical for the bare disturbed areas of the Project. To ensure this, species trials involving various types and mixes of floral species and schemes of soil conditioning are programmed prior to mine closure. The trials may last for up to two years. Subsequently, the best species and best soil amelioration treatment are determined. These will be used in the rehabilitation models that will be formulated and implemented
	Forest fire	Grasslands and thick dry forest litter are susceptible to forest fires. Thus, post-planting maintenance works such as ring weeding, pruning, mulching, and watering during dry days are required. Endemic species whose litter easily decomposes will be planted.

Costs

At this stage of the Project, only order-of-magnitude estimates, *i.e.*, accurate to within a range of 10 times too big or 10 times too small, are possible for the decommissioning and rehabilitation costs. This is in view of the following:

- The design of some components of the Project such as the TSF for residual underground tailings, explosives magazine, and paste fill plant is still conceptual.
- Others like the process plant are in more advanced stages but they still have to undergo a detailed engineering design. Hence, changes are very likely.
- For the other components which already passed the detailed engineering stage such as the TSF for the open pit mining operations, changes are still possible in view of the limitations in sampling and modelling studies. These changes will only become apparent during actual construction, operations, and monitoring.

As the foregoing uncertainties are resolved during Project implementation, a refinement of the initial estimates is in order.

The order-of-magnitude estimate of the total decommissioning and rehabilitation cost for the Siana Gold Project is P 22,929,845. The breakdown is as follows.

Table 2-4. Order-of-Magnitude Cost summary of FMRDP

FMRDP Activity	Cost (PhP)
Mine decommissioning	**560,000**
• Treatment of hazardous materials	560,000
Mine rehabilitation	**8,078,645**
• TSF 3 and TSF 4	4,055,011
• WRD	1,918,312
• Process plant and Mine service areas	789,641
• Settling ponds and Geotextile tubes	572,242
• Sanitary landfill	455,816
• CLF	195,058
• Explosives magazines and other areas	53,172
• Open pit and other areas	39,393
Maintenance and monitoring	**7,291,200**
• Salaries and wages	6,838,000
• Monitoring expenses	453,200
TOTAL	**15,929,845**

Note: The cost of removal of materials, equipment, and structures is assumed to be offset by the sale of refurbishable equipment and recoverable steel and copper scrap materials.

Excluded from the cost estimates are the following:

- Cost of hydrological assessment and wave modelling study for the open pit
- Livelihood seed fund for the host barangay families which is dependent on the outcome of the Project's SDMP and
- Retrenchment package and redeployment support programs for Project employees.

3. BACKGROUND INFORMATION

History

SURICON commenced the underground mining of the Siana orebody in 1938. This continued until 1941 when production was stopped by invading Japanese forces. Based on company records, the mine produced 95,200 oz (about 2.7 t) of gold (Au) from 381,000 st (about 346,000 t) of ore at an average grade of 0.25 oz/st (about 7.8 g/t).

In 1946, SURICON rehabilitated the mine and resumed limited production. In 1951, the mine reached pre-war production levels. In early 1960 due to the exhaustion of known high-grade ore above the 700 ft level, the Siana underground mine closed down. During the post-war period, the underground mine generated 442,700 oz (about 12.6 t) of Au from 1,371,500 st (about 1,244,200 t) of ore with an average grade of 0.32 oz/st (about 10 g/t).

A Feasibility Study for the open pit mining of the Siana remnant orebody was completed in 1979. The study delineated a positive ore reserve of 4.572 million dt at 5.2 g/t. This would be mined at 1,000 TPD over a mine life of 12 years.

Mine mobile equipment arrived in late 1980 and was deployed for the access roads and pit drainage bench works. Work on the open pit commenced in March 1981.

In May 1990, the operations suffered two major pit wall failures. Involving about 583,000 bcm of materials, the failures cut the main access ramps and covered a substantial portion of the programmed ore source. In December 1990, after the depletion of accessible ore, mining ceased just below the 300 level. Two months later, after reprocessing the tailings for two months, the Siana operation shut down. The total production from open pit mining was 321,000 oz (about 9.1 t) Au from 2.983 million t ore at an average grade of 3.35 g/t.

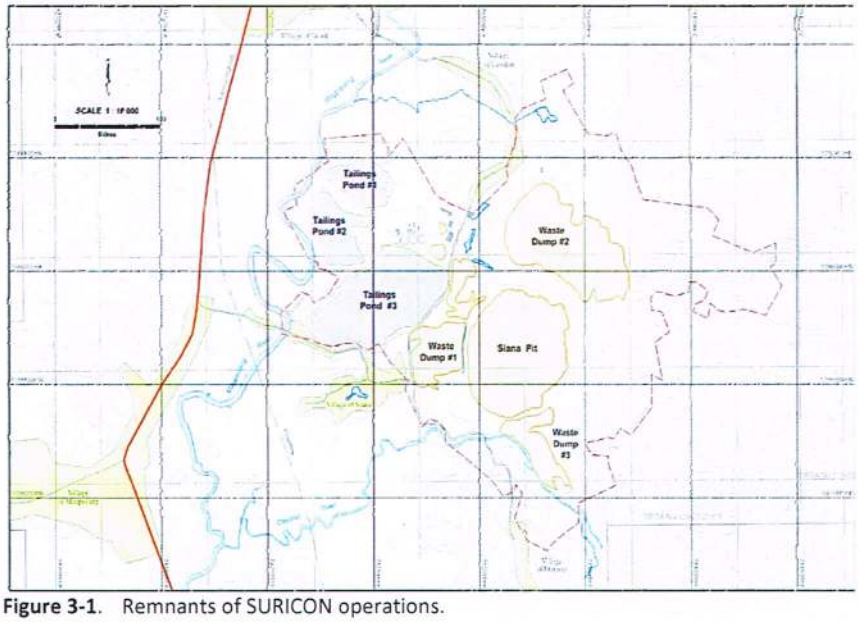


Figure 3-1. Remnants of SURICON operations.

The total tonnage of ore extracted by SURICON from the Siana deposit was roughly 4.57 million t averaging 5.5 g/t Au. The total gold produced was approximately 24.35 t. The remnants of SURICON operations are a flooded open pit, two dried and grass tailings ponds (Tailings ponds 1 and 2), one tailings pond with a pool of water (Tailings pond 3), three grassed waste rock dumps (Waste dumps 1, 2, and 3), and a workshop.

Photo 3-1. The former tailings ponds of SURICON are dry and covered with grass.

Photo 3-2. Another view of the tailings ponds from the north. The water is within Tailings pond 3.

Photo 3-3. Grass, shrubs, and coconuts cover the former waste dump 2.

Photo 3-4. The flooded Siana pit.

The Siana Gold Project

In accordance with the Siana Joint Venture Heads of Agreement executed with JCG, GRC commenced reverse circulation percussion and diamond drilling of the Siana orebody in February 2003. A major resource diamond drilling program followed from November 2003 to February 2005. By October 26, a total of 64 holes with an aggregate length of 25,133 m were completed and became the basis of the Bankable Feasibility for the Siana Gold Project (GRC and Intermet Engineering, 2007).

GRC commissioned additional studies in 2008 and 2009. Foremost of these are:

- Drilling of 15 holes with a total meterage of 37,480 m
- Siana underground resource estimate (Cube Consulting Pty Ltd, 2009)

- Detailed design of TSF 3 and TSF 4 (GHD Pty Ltd, 2009a)
- Detailed design of access road and related structures (GHD Pty Ltd, 2009b)
- Underground mining prefeasibility geotechnical assessment (Peter O'Bryan & Associates, 2008)
- Paste fill testwork (Revell Resources, 2009)
- Underground mining definitive study (Red Rock Engineering Pty Ltd, 2009)
- Environmental impact assessment of the Siana Gold Project (BMP, 2009a).

These studies together with the 2007 Bankable Feasibility Study were the references of the 2009 Siana Gold Project Feasibility Study which MCC submitted to the MGB in support of its Declaration of Mining Feasibility.

The 2009 Project Feasibility Study reported a total probable ore reserve for the Siana deposit of 5.13 million t averaging 4.3 g/t Au and 8.9 g/t silver (Ag). The breakdown is shown in Table 3-1.

Table 3-1. Probable ore reserve of the Siana deposit

Parameter	Stockpile	Open Pit	Underground	Total
Tonnes	83,000	3,109,000	1,938,000	5,130,000
Grade g/t Au	1.33	3.42	5.82	4.3
Grade g/t Ag	10.67	8.71	9.08	8.9
Ounces Au	3,500	341,400	362,800	708,000
Ounces Ag	28,500	870,000	566,000	1,465,000

Note: The underground ore reserve estimate is based on the 300,000 TPY road header option.
Source: MCC

In addition to the probable ore reserve, MCC reported a total of 1.54 million t of inferred resources grading 7.1 g/t Au and 11.5 g/t Ag.

Through a combination of open pit mining to an approximate depth of 215 m below the surface from the existing floor depth of about 100 m, then by underground mining over an approximately 355-m vertical interval, about 6.47 million t of ore grading 4.7 g/t Au and 8.9 g/t Ag will be extracted. A cyanidation plant with an initial capacity of 750,000 TPY expandable to 1,000,000 TPY will process the ore.

Production Process

The production of gold and silver dore bars by the Project entails the following:

- Mining by open pit or underground methods
- Gold cyanidation and

- Tailings and waste rocks management

Mining

Mining of the Siana deposit is firstly by open pit which will deepen the pit floor by 115 m from the current elevation of -50 m RL to -165 m RL, then by underground mining down to -520 m RL (Figure 3-2). The open pit mining will last for five years. The development works for the underground mine will commence on the third year of open pit operations and last for eight years.

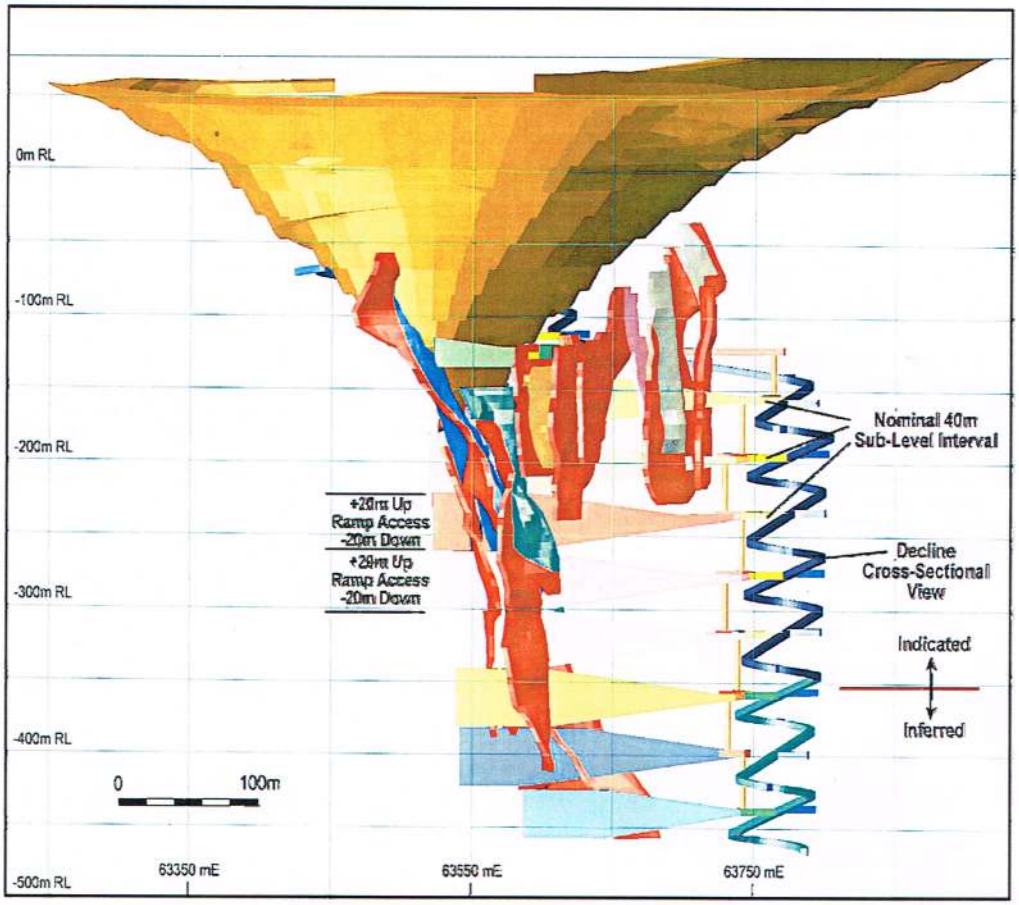


Figure 3-2. Open pit and underground mine design of the Siana Gold Project looking NNW (MCC).

Open Pit Mining

A 6-month pit dewatering and 9-month pre-strip will precede commercial open pit mining. Benches will be blasted in 5 m vertical lifts. Excavation is at 2.5-m intervals using a hydraulic excavator in backhoe configuration. Six-wheel all-wheel-drive (AWD) articulated trucks will transport the blasted materials. The operation will deliver roughly 750,000 t of ore per year at an overall strip ratio by volume of 7:1.

The open pit will have batter angles and overall slopes that vary depending on the rock mass quality. At the north end of the pit, the batter angles range from 63 to 63.5° and the overall angle is 40°. At the east wall, the batter slopes vary from 55.5 to 63° and the overall angle is 44°. At the south end,

the batter slopes are from 62.5 to 63° and the overall angle is 41°. At the west wall, the slopes are 62.5 to 63° and the overall angle is 44°. Berms of 6-m width will be left at 15-m vertical intervals. The access ramp which is designed at 12.5 % gradient and 16-m width will emerge at the northwest corner of the pit to lead directly to the waste rock dump (WRD) and run-of-mine (ROM) pad access ramp.

Photo 3-5. The Komatsu HM400-1 with a maximum payload of 36.5 t.

Photo 3-6. The Komatsu Excavator PC1250-7 with 5 m^3 bucket capacity.

Table 3-2 is the list of earthmoving and support equipment for the open pit.

Table 3-2. Earthmoving and support equipment for the open pit

Item	Make	Model	Total
Excavator	Komatsu	PC1250-7	1
Excavator	Komatsu	PC600-7	1
Truck	Komatsu	HM400-1	10
Dozer	Komatsu	D155A-5	2
Grader	Komatsu	GD555-3A	1
Loader	Komatsu	WA420-6	2
ITC	Komatsu	WA250PT-5	1
Water Cart	Komatsu	Water Cart	1
Service Truck	Plantman	Service Truck	1
Crane	Franna	Franna AT20	1
HIAB Truck	Plantman	HIAB Truck	1
L/C Wagon	Toyota	L/C Wagon	3
L/C Utility	Toyota	L/C Utility	5
Rockbreaker	-	Rockbreaker	1

Source: MCC

Supplementing the earthmoving equipment are four lighting towers, two 50 L/s downhole dewatering pumps, three 17 L/s downhole dewatering pumps, and two static booster slurry pumps.

Underground Mining

Access to the underground workings is via a 5 m x 5 m decline at 1:7 gradient commencing from a portal off the northwestern side of the new open pit at -75 m RL. Portal development will use a road header for the soft materials and a twin boom drilling jumbo for the hard materials.

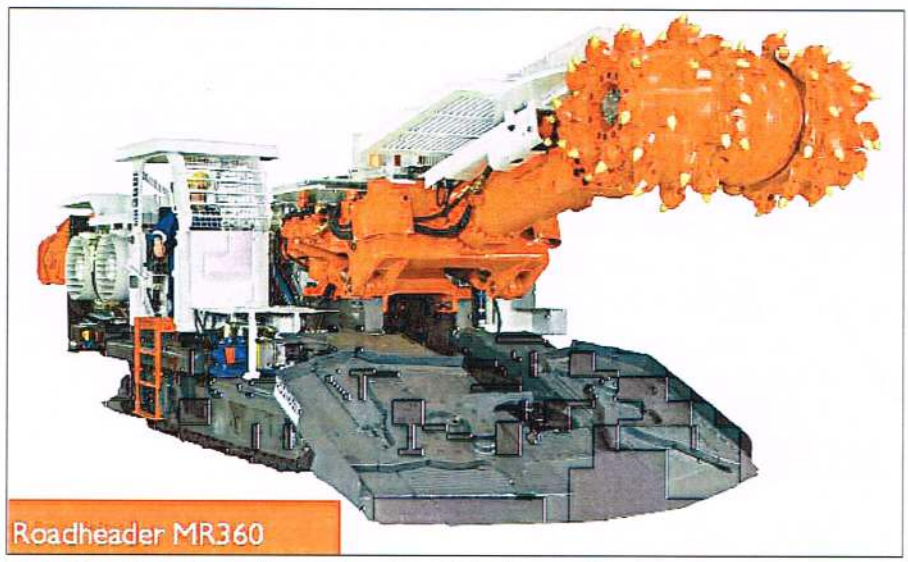


Photo 3-7. Two units of this and one unit MR620 will be used for the underground works.

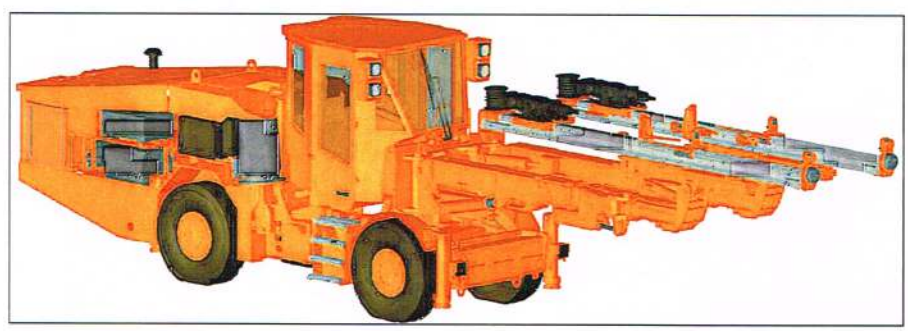


Photo 3-8. A twin boom drilling jumbo.

Cross cuts from the decline spaced at 40 m vertical distance will provide ramps going up and going down to the ore panels (Figure 3-2). The driving of production drifts and stoping on the ore panels are through nominal 4 m x 4 m openings cut by the road header. Stoping will be by underhand cut and fill involving two basic steps:

- Step 1 includes sidewall support and mechanical cutting using the road header. After completion of a stope run, the road header moves into another stope on the same level or it begins to drop down to the next level.

- Step 2 is the fill cycle which is undertaken once the panel is fully mined. The fill, placed under low pressure, incorporates pre-placed steel support which allows the subsequent extraction lift below the fill to be taken without the need for overhead support. Fill is supplied to the level via a bore hole and reticulation pipes which are installed into the fill mass as it extends down.

For harder ground, a twin-boom jumbo instead of a road header will be used.

A loader will pick up and load the broken materials into 50-t trucks for haulage to the surface ROM pad.

Table 3-3 is the list of underground break, loading, and trucking fleet.

Table 3-3. Underground break, loader, and trucking fleet

Item	Make	Model	Total
Twin boom jumbo	Sandvik	DD320-26	1
Road header	Sandvik	MR620	1
Road header	Sandvik	MR360	2
Loader	Sandvik	LH514	2
Loader	Sandvik	LH510	2
Truck	Sandvik	TH-550+	6

Source: MCC

The other major underground equipment includes:

- Two units of C103 x 7 mono pump + dam
- Three units of portable 103 Mono (55kW) + tank
- 20Kw Flyght + starter
- 8Kw Flyght + starter
- Surface compressor (220Kw/1200cfm)
- Primary surface fans (3 x 180 Kw)
- Underground secondary fans – 180 Kw
- Underground secondary fans – 110Kw
- Portable substation (1.5 MVA)
- Distribution boards
- Leaky feeder system
- 8-man refuge chamber

- Three units of Swellex installation pump
- Paste fill plant
- Underground Managers' wagon
- Two units of underground Ute
- Two units of shift wagon
- Two units of fitter Ute
- Two units of electrical UTE
- Fiber-crete spray and delivery units.

Gold Cyanidation

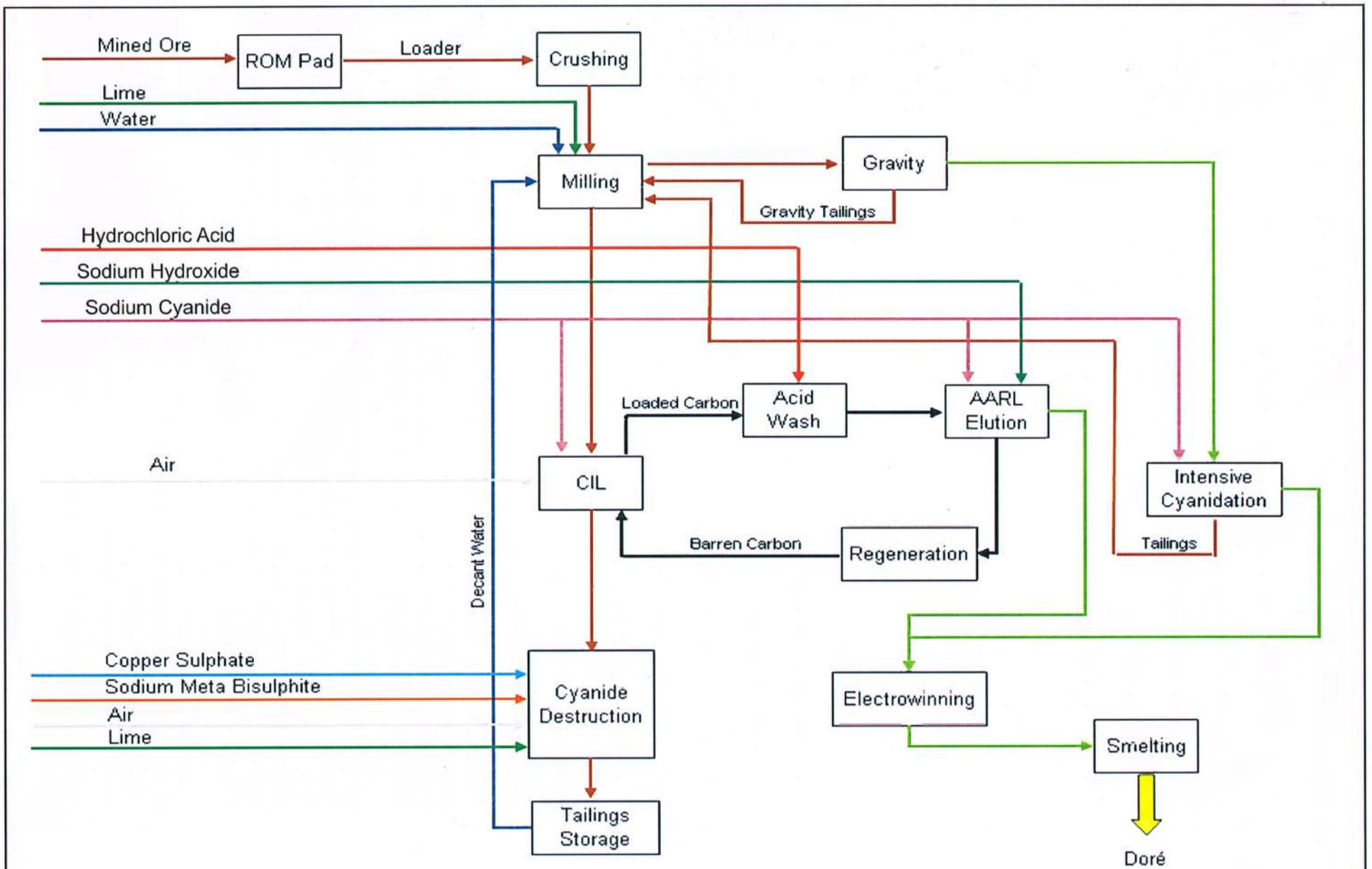
The standard-design process plant comprises single-stage crushing, SAG milling, gravity concentration and high-intensity cyanidation, leaching, and adsorption, followed by carbon elution and electrowinning to produce combined gold and silver dore bars (Figure 3-3). The major steps of the process are as follows:

- Ore from the ROM pad is reclaimed by a front-end loader and fed to a 70-t ROM bin. The bin has a grizzly with 700 mm opening and provided with a variable speed apron feeder. From the crusher, the ore goes to the SAG mill, where it is mixed with lime and water, and then through a cyclone.
- The cyclone overflow passes through a screen for removal of the coarse particles. Spray water is applied to the screen deck. The screen underflow gravitates to a centrifugal concentrator for recovery of the coarse free gold particles. The concentrator tails and screen overflow are returned to the mill feed chute.
- At the CIL section where cyanide (CN) is introduced, gold and other precious metals from the ore are dissolved, collected, and separated for purification. The cyclone overflow gravitates to one of six agitated CIL tanks. Flow is sequential through the six tanks with the cyanide solution in contact with the counter-current flowing activated carbon stream.
- The carbon, which is called "loaded carbon" because it is laden with gold and silver values, is collected through screens. It is washed with hydrochloric acid (HCl). Then, using diluted sodium hydroxide (NaOH) and CN, the loaded carbon is stripped of its values. The pregnant solution passes through electrowinning cells where the metallic elements adhere as precipitate. The stripped carbon is activated in a kiln.

The process plant design also includes various reagent mixing facilities as well as water, air, and electrical services.

The processing facility will have the following major equipment:

- Crusher feed – pay loader on ROM pad



Source : Intermet Engineering

bmp

Gold cyanidation flowsheet

FMRDP for the Siana Gold Project

Figure No. **3-3**

- Crushing – single stage crushing plant, spiral set rolls sizer
- Grinding – single stage SAG milling circuit - 5.3 m diameter x 7.8 m EGL, 3,600 kW twin drive
- Gravity recovery – 30 inch diameter centrifugal concentrator
- Leach reactor
- CIL cyanidation and carbon adsorption – six agitated leach tanks, associated pumps and motors
- Cyanide detoxification - one reactor single stage
- Carbon elution - single butyl rubber lined elution column
- Horizontal rotary carbon regeneration kiln, diesel fired
- Gold and silver recovery - four electrowinning cells
- Calcining oven/retort scrubber for removal and recovery of mercury
- Smelting furnace, diesel fired
- Electrical substation
- Emergency diesel generator set
- Reagents mixing and distribution equipment and
- Services (air and water).

Tailings and Waste Rocks Management

Tailings from Open Pit Mining

The open pit mining operations will generate about 3.08 million t of tailings. The tailings will be accommodated in a paddock-type TSF comprising two separate cells – TSF 3 at the southern portion and TSF 4 at the northern part (Figure 1-2). To avoid encroaching into new land, the embankments are built on top of the existing SURICON embankment and tailings materials.

Before discharge from the process plant, the tailings go through the cyanide (CN) detoxification circuit. The circuit uses sodium metabisulfite (SMBS), copper sulfate ($CuSO_4$), lime, and air. In the circuit, the CN in the tailings is brought down to safe levels that are compliant with the standards of the Department of Environment and Natural Resources (DENR). Pilot scale tests indicate an effective detoxification from a feed of 95 mg/L free CN and 120 mg/L weak-acid dissociable (WAD) CN to a product with below detection limit free CN and 0.03 mg/L WAD CN (MCC, 2009).

The detoxified tailings, with a nominal 32.5 % solids content, will be deposited via spigots placed at 20 m intervals along the perimeter embankment of TSF 3 and TSF 4. Tailings discharge is controlled through pinch valves or clamps. The tailings beach formed along the embankments will keep tailings water farther away and reduce hydrostatic pressures against the embankments.

Tailings from Underground Mining

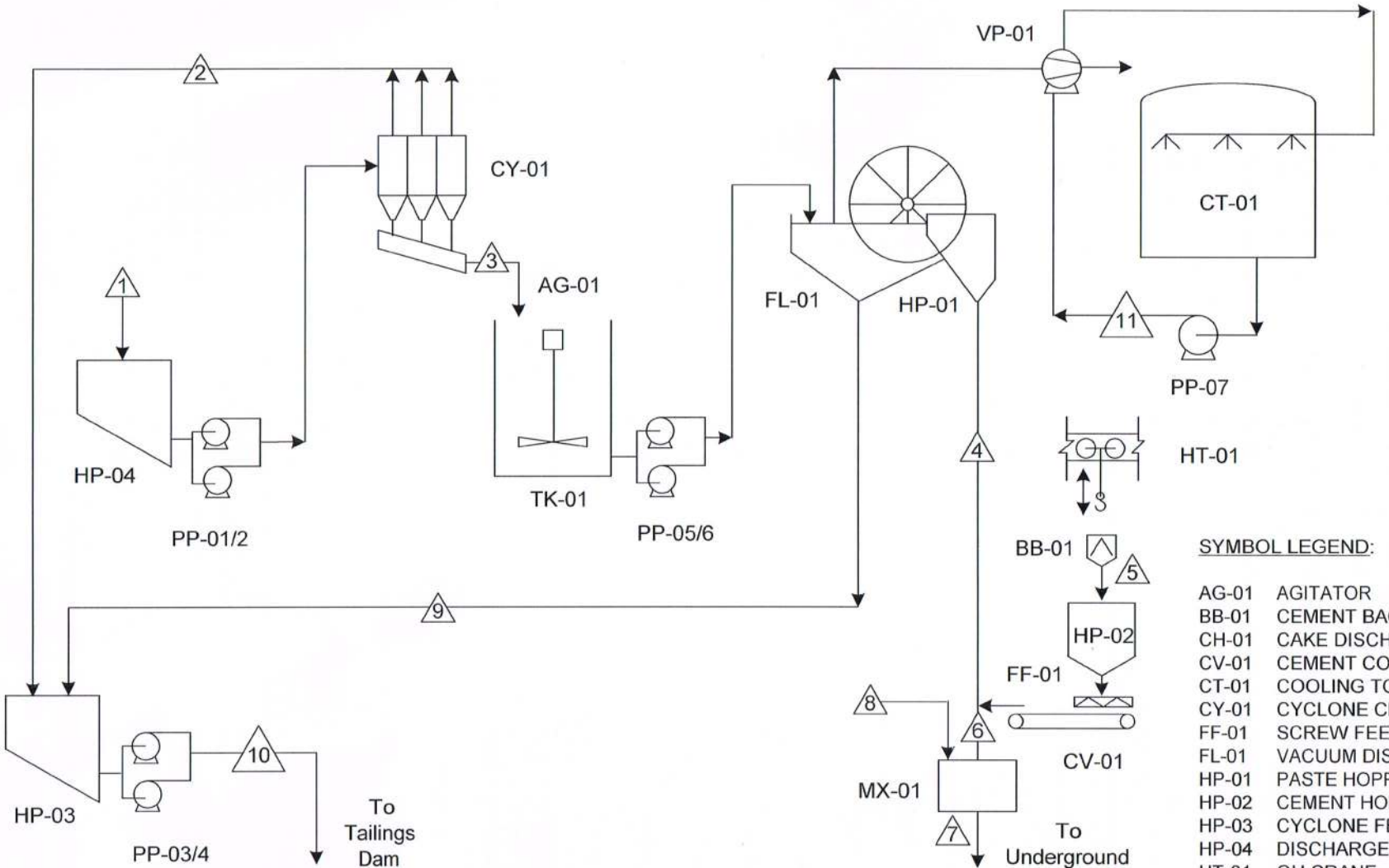
The detoxified tailings from underground operations will go to a paste fill plant. A cyclone cluster and vacuum disc filter at the plant increases the % solids from 32.5 % to 80 %. The filter product is then mixed with cement to generate the paste backfill for the underground stopes.

From Figure 3-4, about 40 % of the tailings solids will not go into the paste fill. Over the life of the underground mine, this will accumulate to roughly 1.345 million t or 1.0 million m^3 of tailings. Provision has been made in the Project Feasibility Study for the containment of these tailings by way of a contingency allowance that includes storage in TSF 3 and TSF 4.

GHD identified four options for the disposal of residual tailings from the underground operations. All options have been used successfully in other mines. Detailed design of the selected option will be completed before the commencement of underground mining.

The major equipment of the paste fill plant includes:

- Agitator
- Cement bag breaker
- Cake discharge chute
- Cement conveyor
- Cooling tower
- Cyclone cluster
- Screw feeder
- Vacuum disc filter
- Paste hopper
- Cement hopper
- Cyclone feed pump hopper
- Discharge pump hopper
- Overhead crane
- Paste mixer
- Cyclone feed pump
- Discharge pump
- Filter feed pumps
- Cooling tower spray pump



SYMBOL LEGEND:

AG-01	AGITATOR
BB-01	CEMENT BAG BREAKER
CH-01	CAKE DISCHARGE CHUTE
CV-01	CEMENT CONVEYOR
CT-01	COOLING TOWER
CY-01	CYCLONE CLUSTER
FF-01	SCREW FEEDER
FL-01	VACUUM DISC FILTER
HP-01	PASTE HOPPER
HP-02	CEMENT HOPPER
HP-03	CYCLONE FEED PUMP HOPPER
HP-04	DISCHARGE PUMP HOPPER
HT-01	OH CRANE
MX-01	PASTE MIXER
PP-01/2	CYCLONE FEED PUMP
PP-03/4	DISCHARGE PUMP
PP-05/6	FILTER FEED PUMPS
PP-07	COOLING TOWER SPRAY PUMP
TK-01	FILTER FEED TANK
VP-01	VACUUM PUMP

Stream No.	1	2	3	4	5	6	7	8	9	10	11
Solids, tph	60.0	24.0	36.0	36.0	2.5	38.5	38.5	0.0	0.0	24.0	0.0
% solids	32.5	19.3	60.0	80.0	100.0	81.0	75.0	0.0	0.0	17.2	0.0
Water, tph	124.6	100.6	24.0	9.0	0.0	9.0	12.8	0.0038	15.0	115.6	0.0
Pulp, m3/h	148.6	110.2	37.8	23.4	0.8	24.2	28.2	0.0038	15.0	125.2	11.7

N.T.S.

FLOW DIAGRAM
PASTEFILL PLANT

Source: Revell Resources

Figure 3-4 PASTE FILL PLANT DESIGN CRITERIA

- Filter feed tank
- Vacuum pump.

Waste Rocks

Over its 5-year life, the open pit operations will generate about 9.034 million bcm equivalent to 22.6 million t of waste rocks, soils, and clays. The underground operations, over its 8-year life, will generate roughly 273,000 bcm or 710,000 t of waste rocks. The total waste rocks to be generated amount to 9.307 million bcm or 23.31 million t.

A portion of the waste rocks, estimated by GRC at 1 million bcm, will be used for the TSF embankment construction. For the residual 8.307 million bcm of waste rocks, two storage facilities are provided. One is the waste rock dump (WRD) with a total capacity of 7.878 million bcm and the other is the CLF with a capacity of 1.813 million bcm (Figure 1-2). The WRD which will accommodate mostly waste rocks will have a height of 85 m and overall slopes of 6° to 24°. The CLF which will accommodate organic soils, subsoils, and clay-rich materials will have a height of 20 m and overall slopes of 7° to 14° (Figure 2-2). Upon completion, the CLF can host the vegetable, crop, and fruit plantations of the community.

Production

Table 3-4 is the open pit mining production schedule. A total of 3,109,000 t of ore grading 3.42 g/t Au and 8.71 g/t Ag is programmed for extraction from the open pit. Annual ore production will vary from 368,000 t on the fifth year to 812,000 t on the third year.

Table 3-4. Open pit mining production schedule

Mined	Unit	Total	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5
Waste	Kbcm	9,034	3,724	3,549	857	611	206	88
Ore	Kbcm	1,287	2	213	313	339	264	156
LG	Kbcm	1		0.5	0.5			
Total	Kbcm	10,322	3,726	3,762	1,170	950	470	244
Waste	Kt	22,600	9,374	8,997	2,064	1,461	496	209
Ore & waste	Kt	25,710	9,378	9,531	2,819	2,272	1,132	576
Ore	Kt	3,109	4	534	754	812	637	368
Ore	Au g/t	3.42	2.48	3.15	3.48	3.51	3.66	3.04
Ore	Ag g/t	8.71	12.09	15.53	9.87	6.15	6.55	5.73
LG	Kt	2		1	1			
LG	Au g/t	1.22		1.21	1.22			
LG	Ag g/t	24.2		26.32	23.03			

Notes: LG is low-grade ore surface stockpiles. Kbcm is kilo bank cubic meters, kt is kilo tonnes, g is grams, t is tonnes.
Source: MCC

The underground mining production schedule is shown in Table 3-5. A total of 3,362,000 t of ore grading 5.83 g/t Au and 9.12 g/t Ag will be extracted over an 8-year period. The annual underground mine ore production will vary from 328,000 t during the tenth year to 518,000 t on the sixth year.

Table 3-5. Underground mining production schedule

Mined	Unit	Total	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Waste	kbcm	273	46	79	33	16	16	18	28	37
Ore	kbcm	1,293	16	172	198	199	199	196	187	126
Total	kbcm	1,566	63	251	230	215	214	214	214	164
Waste	kt	710	120	206	85	42	41	47	72	97
Ore & waste	kt	4,072	163	653	599	559	558	558	558	426
Ore	kt	3,362	43	447	514	518	516	511	485	328
Ore	Au g/t	5.83	4.13	4.8	5.18	6.06	6.16	6.1	6.2	6.59
Ore	Ag g/t	9.12	5.78	5.25	5.8	8.43	9.94	11.58	12.23	11.38

Source: MCC

Table 3-6 is the combined open pit and underground mining production schedule. The total ore production is placed at 6,471,000 t grading 4.67 g/t Au and 8.92 g/t Ag. The annual ore production is expected to range from 328,000 t grading 6.59 g/t Au and 11.38 g/t Ag on the tenth year to 1,084,000 t grading 4.13 g/t Au and 6.01 g/t Ag on the fourth year.

Table 3-6. Combined open pit and underground mining production schedule

Mined	Unit	Total	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Waste	Kbcm	9,308	3,724	3,549	857	657	285	121	16	16	18	28	37
Ore	Kbcm	2,580	2	213	313	355	436	354	199	199	196	187	126
LG	Kbcm	1		0.5	0.5								
Total	Kbcm	11,887	3,726	3,762	1,170	1,012	721	475	215	214	214	214	164
Waste	Kt	23,311	9,374	8,997	2,064	1,581	702	294	42	41	47	72	97
Ore & waste	Kt	29,782	9,378	9,531	2,819	2,435	1,785	1,175	559	558	558	558	426
Ore	Kt	6,471	4	534	754	855	1,084	882	518	516	511	485	328
Ore	Au g/ t	4.67	2.48	3.15	3.48	3.54	4.13	4.29	6.06	6.16	6.1	6.2	6.59
Ore	Ag g/ t	8.92	12.09	15.53	9.87	6.13	6.01	5.77	8.43	9.94	11.58	12.23	11.38
LG	Kt	2		1	1								
LG	Au g/t	1.22		1.21	1.22								
LG	Ag g/ t	24.2		26.32	23.03								

Source: MCC

Manpower Complement

MCC provided workforce information on exclusively open pit or exclusively underground mining operation. For the open pit operation, the total manpower complement is 322 (Table 3-7). About 77 positions require no skills. For the underground operation, the manpower is expected to vary from 255 to 284 personnel (Table 3-8). About 36 to 42 positions are unskilled.

Table 3-7. Open pit stage manpower complement

Administration	No.	Processing	No.	Mining	No.
Operations Manager (expat)	1	Manager Processing	1	Manager – Mining	1
Manager - Health & Safety	1	Superintendent - Process	1	Senior Mine Geologist	1
Manager - Environment & Community	1	Superintendent - Process Maintenance	1	Senior Planning Engineer	1
Manager - Human Resources	1	Senior Metallurgist	1	Mine Foreman	1
Manager Commercial	1	Metallurgist	1	Senior Surveyor	1
Accountant	2	Chemist	1	Drill & Blast Engineer	1
Payroll	1	Supervisor - Plant	4	Geotechnical Engineer	1
Doctor	1	Laboratory Supervisor	1	Mine Geologist	3
Dentist	1	Supervisor - Maintenance	4	Junior Geologists	4
Environmental Engineer	1	Secretary / Receptionist	1	Junior Engineers	4
Nurses	3	Clerk - Processing	1	Surveyor	1
Safety Officer	1	Planner Maintenance	1	Shift Supervisor	3
Secretary	1	Technician - Instrument	1	Pump Crew	10*
Administration Clerk	2	Tradesman - Fitter	4	Service Crew	6*
Community Relations Officer	4	Tradesman - Electrician	4	Maintenance Tires	4
Human Resources Officer	1	Tradesman - Boilermaker / Welder	3	Excavator Operator	6
Commercial Clerk	3	Loader Operator	4	Truck Operator	36
Tenements Officer	1	Crushing Operator	8	Dozer Operator	6
Secretary/Typist - Health & Safety	1	Milling Operator	8	Grader Operator	3
Secretary/Typist - Environment & Community	1	CIL Operator	8	Water Truck Operator	3
Secretary/Typist - Commercial	1	Goldroom Operator	2	Crane Driver	3
Receptionist	1	Reagents Operators	2	General Labor/Timber Pickers	14*
Procurement Officer	2	Tailings Operators	4	Secretary	1
Senior Storeperson	1	Shift Relief Operator	4	Data Clerk	2
Officer - Expediter	1	Plant Day Crew	4*	Survey Assistants	6
Nursery Laborer	4*	Sample Preparers	4*	Sampler/Spotter	12*
Rehabilitation Laborer	4*	Analytical Technicians	8		

Administration	No.	Processing	No.	Mining	No.
Stores Laborer	6*	Laborer - Maintenance	4*		
Security Guards	40	Laborer - Cleaner	3*		
Laborer - Cleaner	6*				
Total Unskilled	**20**	**Total Unskilled**	**15**	**Total Unskilled**	**42**
TOTAL	**95**	**TOTAL**	**93**	**TOTAL**	**134**

Note: Those positions with asterisks require no skills.
Source: MCC

Table 3-8. Underground stage manpower complement

Administration	No.	Processing	No.	Mining	No.
Manager - Health & Safety	1	Superintendent - Process	1	UG Manager/Foreman	1
Manager - Environment & Community	1	Superintendent - Process Maintenance	1	Senior Mining Engineer	1
Manager - Human Resources	1	Senior Metallurgist	1	Drill and Blast Engineer	1-2
Manager Commercial	1	Metallurgist	1	Geotechnical Engineer	1
Accountant	2	Chemist	1	Senior Mine Geologist	1
Payroll	1	Supervisor - Plant	4	UG Geologists	2-3
Doctor	1	Laboratory Supervisor	1	UG Technicians	2-6
Dentist	1	Supervisor - Maintenance	4	Senior Mine Surveyor	1
Environmental Engineer	1	Secretary / Receptionist	1	Mine Survey Assistant	1-3
Nurses	3	Clerk - Processing	1	Data Clerk	1-2
Safety Officer	1	Planner Maintenance	1	Mine Foreman	1
Secretary	1	Technician - Instrument	1	Shift Supervisor	3
Administration Clerk	2	Tradesman - Fitter	4	Road header (RH) Operator	3-9
Community Relations Officer	3	Tradesman - Electrician	4	Bogger Operator	3-12
Human Resources Officer	1	Tradesman - Boilermaker / Welder	3	Truck Operator	3-18
Commercial Clerk	2	Loader Operator	3	Services/Chargeup	3
Tenements Officer	1	Crushing Operator	6	Shotcrete delivery truck op.	3-6
Secretary/Typist - Health & Safety	1	Milling Operator	6	Nozzleman/service/charge-up	3-6*
Secretary/Typist - Environment & Community	1	CIL Operator	8	General Services Crew	3-6*
Secretary/Typist - Commercial	1	Goldroom Operator	2	UG Maintenance Foreman (expat)	1
Receptionist	1	Reagents Operators	2	UG Electrical Supervisor (expat)	1
Procurement Officer	2	Tailings Operators	3	UG Electrician	3-6

Administration	No.	Processing	No.	Mining	No.
Senior Storeperson	1	Shift Relief Operator	3	Auto Electrician	1-2
Officer - Expediter	1	Plant Day Crew	4*	Boiler Maker	1-2
Nursery Laborer	2*	Sample Preparers	3*	Shift Fitter	3-6
Rehabilitation Laborer	2*	Analytical Technicians	6	Workshop Fitters	3-6
Stores Laborer	6*	Laborer - Maintenance	4*	Maintenance Planner	1
Security Guards	40	Laborer - Cleaner	3*	RH Operator Trainer (contractors, 12 months)	2
Laborer - Cleaner	6*				
Total Unskilled	**16**	**Total Unskilled**	**14**	**Total Unskilled**	**6-12**
TOTAL	**89**	**TOTAL**	**83**	**TOTAL**	**53-112**

Note: Those positions with asterisks require no skills.
Source: MCC

From the third year to the fifth year, open pit mining operation will coincide with underground operations. During that period, the manpower complement is estimated at 375 to 434. Of this number, from 83 to 89 positions require no skills.

Implications for Plant Closure

The Siana Gold Project can close down either unexpectedly or as programmed upon depletion of the Siana deposit. The closure of the Project will have grave social, economic, physical, chemical, and biological implications:

- **Loss of jobs directly related to the Project –** From the preceding Section, the projected manpower during operation varies - 322 during solely open pit mining, of which, 77 are unskilled positions; 375 to 434 during combined open pit and underground mining, of which 83 to 89 are unskilled; and 255 to 284 during solely underground mining, of which, 36 to 42 are unskilled.

  Based on an agreement with the Chairmen of the six impact barangays, 95 % of the total employment of the Project will come from the barangays. The employment sharing scheme is 10 % each for the indirect impact barangays of del Rosario, Magpayang, and Pongtud. The direct impact barangays of Dayano, Siana, and Cawilan will get 18 %, 23 %, and 25 % of the total employment, respectively. These jobs will be lost if the Project closes down. The jobs translate into P 42.6 million annually as salaries, wages, and other benefits.

- **Loss of jobs indirectly related to the Project –** The closure of the Project will also impact adversely those who provide goods and services for the Project and its contractors and employees. The goods include food items such as rice, vegetables, fruits, and meat; chemicals and reagents; equipment and spare parts; gloves, gowns, and other consumables, etc. The services may be laundry, cleaning, catering, etc. The MGB places the ratio of direct job to

indirect jobs at 1:5 to 1:6. Based on the ratios and depending on the stage of the Project immediately before closure, about 1,275 to 2,604 indirect jobs will be lost.

- **Loss of community development programs** – The Project will implement a Social Development and Management Program (SDMP) which, as required by law, has a minimum funding equivalent to 1 % of the Project's direct mining and milling cost. Over the Project life, the SDMP Fund is estimated at P 128.3 million. This will be shared among the six impact barangays based on the scheme agreed upon by the six Barangay Chairmen.

Table 3-9. Allocation of SDMP fund for the first 5 years of operations

Barangay	% Share	Annual SDMP (First 5 Years)	
		Minimum	Maximum
Cawilan	24.0	P 1,902,880	P 3,218,890
Siana	22.0	1,744,310	2,950,650
Dayano	16.0	1,268,590	2,145,930
Del Rosario	12.7	1,004,300	1,698,860
Magpayang	12.7	1,004,300	1,698,860
Pongtud	12.7	1,004,300	1,698,860

Sources: MCC and BMP, 2009b

The impact barangays have completed their SDMP planning for the first five years of Project operations. Table 3-9 shows the ranges of the barangays' annual SDMP Fund. About two-fifths of the Fund is earmarked for livelihood projects. One-fifth is allocation for education which is largely scholarships. Nearly a third is provided for infrastructure projects such as roads, health centers, water systems, and other communal facilities (BMP, 2009b). The closure of the Project will mean the termination of these projects.

- **Loss of taxes and fees** – The Project will pay various taxes and fees to the national and local governments. The major ones for the national government are the corporate income tax, excise tax, customs duties and fees, VAT, and withheld taxes. For the local government, comprised by the Provincial, Municipal, and Barangay governments, the major taxes and fees are business tax, real estate tax, wharfage fees, occupation fees, and community taxes.

  GRC estimates the annual taxes and fees from P 5.1 million to P 728.7 million. Of the amount, about P 0.3 million to P 3.0 million is real property tax. These taxes and fees will be lost once the Project closes.

- **Drastic downsizing of the local economy** – The closure of the Project will mean the loss of jobs, community programs, and taxes and fees. It will also mean the disappearance of about P 920.3 million which is the Project's estimated annual local purchases. These losses will lead to a drastic downsizing of the economies of the host and surrounding communities. With the disappearance of job opportunities and services, many of the local residents and migrants will leave the area and seek opportunities elsewhere.

- **Increased pressures on forests and aquatic resources** – Aside from the Siana Gold Project, the livelihood options in the area are limited to agriculture, fishing, and gold small-scale

mining. Returns from agriculture and fishing activities are meagre. The rewards of small-scale mining are highly uncertain. Increased pressures will therefore be placed on the forests in the area. Trees will be cut for quick cash or fuel wood. Forestlands will be turned into swidden farms. More people will compete for the fishes and shellfishes. Overcutting and overfishing will result, impacting the sustainability of the resources.

- **Deterioration of infrastructures** - The Project will leave behind access roads, a potable water treatment system, causeways, etc. for which the local government may not have the capacity to maintain. Over time, the structures will deteriorate and will no longer be usable.

- **Bio-physical and chemical effects in the absence of rehabilitation** – These include:

    1. Erosion (both wind- and water-borne) of the bare and disturbed areas of the TSFs, WRD, CLF, access roads, and landfill. Dust affects adversely human health, wildlife, and the photosynthetic activities of plants. It also impacts visual aesthetics. Water-borne sediments make the streams and coasts turbid and unfit for biotic and human use. Eroded into land, the sediments impact agricultural productivity and the existing vegetation.

    2. Heavy metals such as Fe, Mn, Pb, Zn, As, Cd, and Hg from the TSFs, sedimentation ponds, WRD, and sanitary landfill. The metals may contaminate water sources as well as edible fishes and shellfishes. Ingested by humans in excessive quantities, the heavy metals may cause vomiting, diarrhea, stomach cramps, nausea, organ failure, etc.

    3. Water and soil contamination, methane offgassing, disease vectors, and nuisance problems such as dust, odor, and vermin from the sanitary landfill.

    4. Physical instability of the TSF, WRD, CLF, sedimentation ponds, and sanitary landfill which endanger the downstream communities.

    5. Structures, equipment, concrete works, and hardstands in the process plant and other industrial areas which impact visual aesthetics and prevent the productive use of the land.

    6. Industrial and domestic wastes.

4. STAKEHOLDER INFORMATION AND INVOLVEMENT

Project Personnel

The Project has filed an application for a Declaration of Mining Feasibility with the MGB. After it is approved, MCC/GRC will file an application for a Mineral Agreement in the Development or Operating Period. After the Mineral Agreement is granted and Project financing is finalized, the company will select the Engineering, Procurement, and Construction Management (EPCM) contractor. MCC/GRC will organize a Project Team to oversee the EPCM contract.

The Project construction works are expected to last for roughly 17 months. It will involve about 400 contractual personnel. During this time, the Project's pre-production manpower complement of 95 personnel will have been filled and deployed.

In preparation for open pit mining, the Project's personnel will build up to 322. On the third year of operations, more personnel, from 53 to 112, will be hired for the underground mining operations. After the open pit reserve is exhausted on the fifth year, the number of Project employees will decline to 284.

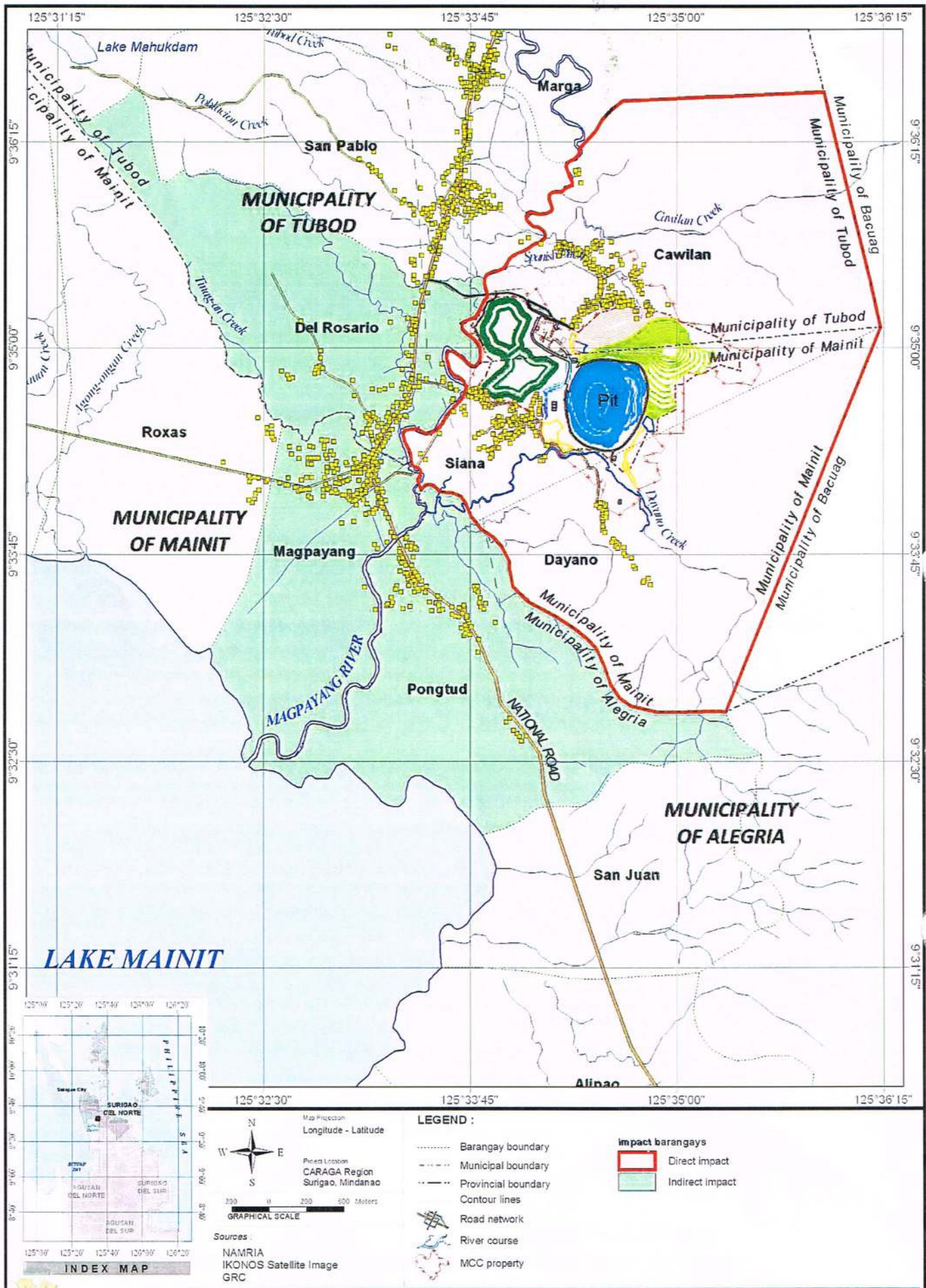
As the Project's workforce builds up, personnel details will be profiled on a continuing basis. The important parameters are age, length of service, civil status, original residence, educational attainment, size of household, income, sources of income of household members, and post-Project plans or aspirations. These will be the bases of retrenchment packages and labor support policies and programs to be implemented before or during mine closure.

Impacts and Impact Communities

Figure 4-1 shows the impact barangays of the Siana Gold Project. The barangays are classified into direct impact barangays and indirect impact barangays.

In a direct impact barangay, the direct or primary effects of the Project occur at the same time and place. The direct effects include:

- Physical or economic displacement
- Landslides or flyrocks
- Flooding
- Contamination of land and water
- Reduced flow or discharge of well or spring
- Dust and noise
- Acculturation
- Employment and livelihood



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Impact barangays of the Project

FMRDP for the Siana Gold Project **4-1**

Figure 4a

- Improved economic conditions
- Habitation space for non-resident Project personnel
- Increased cost of living
- Community development programs
- Taxes and fees.

The direct impact barangays of the Project are Brgy. Cawilan of Tubod Municipality and Brgys. Siana and Dayano of Mainit Municipality. In 2007, the populations of the three barangays are 1,290; 872; and 402, respectively, or a total of 2,564.

In an indirect impact barangay, the effects are indirect or secondary and occurring at a different time or place. The indirect effects are:

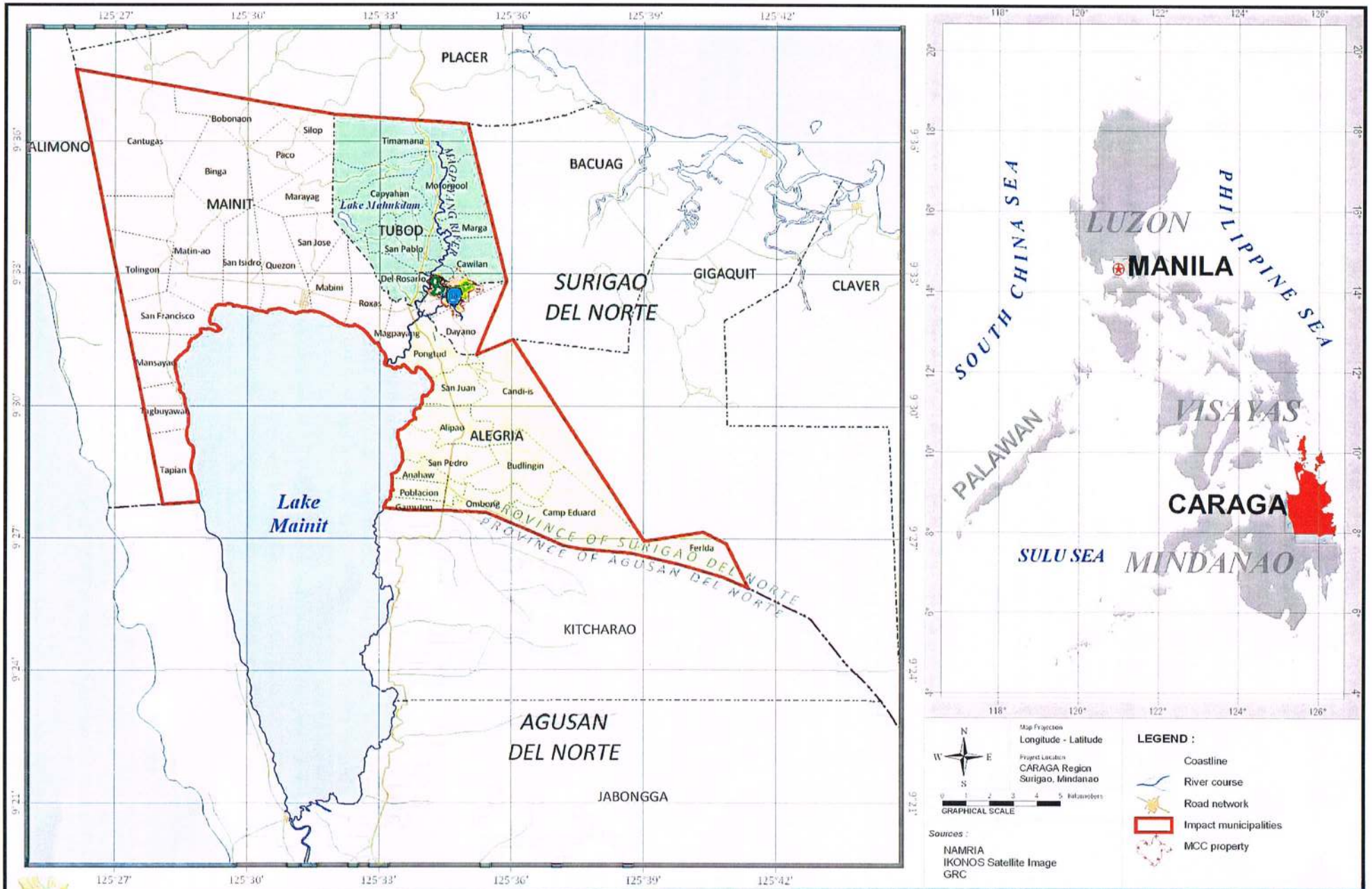
- In-migration
- Displacement at the host resettlement sites for Project-displaced persons (if the site is not within the direct impact area)
- Reduced flow or discharge of stream, well or spring that replaces the water source impacted by the Project
- Dust, noise, and increased traffic along roads used to transport personnel, goods, supplies, and equipment
- Improved economic conditions
- Taxes and fees.

The indirect impact barangays are Brgy. Del Rosario, Tubod; Brgy. Magpayang, Mainit; and Brgy. Pongtud, Alegria Municipality. The populations of these barangays are 1,249; 1,498; and 1,216, respectively, or a total of 3,963.

Impact Municipalities

Figure 4-2 locates the Project site and the impact municipalities of Tubod, Mainit, and Alegria. Tubod is landlocked while Mainit and Alegria enclose Lake Mainit. Mainit has the biggest land area and population of 15,354 ha and 23,952, respectively. Tubod has the smallest land area and population of 5,464 ha and 11,664.

Mainit is a fourth class municipality with an Internal Revenue Allotment (IRA) in 2008 of P 31,470,154. Tubod and Alegria are both fifth class municipalities with IRAs in 2008 of P 20,511,970 and P 22,428,428, respectively. Only 20 % of the IRA can be used for development projects by the municipalities. This gives an annual per capita development fund of P 263 for Mainit, P 352 for Tubod, and P 321 for Alegria. Table 4-1 provides the key socio-economic parameters of the impact municipalities.



Impact municipalities of the Project

FMRDP for the Siana Gold Project

Figure No. 4-2

Table 4-1. Socio-economic parameters of impact municipalities

Socio-economic Parameter	Tubod	Mainit	Alegria
Population			
2007 Population	11,664	23,952	13,969
2000 Population	10,923	23,417	12,923
2007-2000 Annual Growth	0.97 %	0.33 %	0.49 %
Land Area (ha)	5,464	15,354	6,670
2007 Population Density (persons/ha)	2.1	1.6	2.0
Municipality Class	Fifth class	Fourth class	Fifth class
2008 IRA	P 20,511,970	P 31,470,154	P 22,428,428
Development Fund (20%)	P 4,102,394	P 6,294,031	P 4,485,686
Per capita Development Fund	P 352	P 263	P 321
Barangays			
Total Number	Nine	Twenty-one	Twelve
Urban	• Poblacion • San Pablo • Timamana	• Magpayang • Magsaysay (Poblacion) • Matin-ao • Quezon • San Francisco	• Anahaw • Julio Ouano • San Pedro • Poblacion • Pongtud
Rural	• Capayahan • Cawilan • Del Rosario • Marga • Motorpool • San Isidro	• Binga • Bobonaon • Cantugas • Dayano • Mabini • Mansayao • Marayag • Paco • Roxas • San Isidro • San Jose • Siana • Silop • Tagbuyawan • Tapian • Tolingon	• Alipao • Budlingin • Camp Edward • Ferlda • Gamuton 3 • Ombong • San Juan
Major Crops	• Coconut • Rice	• Rice • Coconut	• Rice • Coconut
Fishing Areas	Lake Mahukdam	Lake Mainit	Lake Mainit
Commercial Establishments	As at May 2002 • Sari-sari stores – 141 • Eateries – 3 • Bakeries - 3 • Pharmacies – 2		• Sari-sari stores • Copra buyers • Fertilizers and agri-supplies retailers • Rural bank

Socio-economic Parameter	Tubod	Mainit	Alegria
	• Copra buyers – 9 • Cooperatives – 2 • Tailoring – 1 • Beauty parlor - 1		• Groceries – 2 • Mini-hardwares – 2 • Beauty parlor
Industries	• Mining companies (exploration stage) – 2 • Rice mills • Small welding shops • Blacksmiths • Wooden and bamboo furniture making		• Rice mills • Post-harvest facilities • Body building and welding – 4 • Vulcanizing shops • Jewerlry maker • Furniture maker • Cement factory • Hollow block factory • Trisikad fabricators - 3
Educational Facilities			
Kindergarten	None	• Brgy. Magsaysay – San Nicolas Academy and Early Childhood Learning Center	None
Elementary	• Brgy. San Isidro – Primary school • All other barangays – Complete elementary schools	• Eight barangays – Primary schools • All other 13 barangays – Complete elementary schools • Brgy. Tolingon – 1 primary school and 1 complete elementary school • Brgy. Cantugas – 1 complete elementary school and 1 Cultural community school for Mamanwas	• Two complete primary schools • Three incomplete primary schools • Four complete elementary schools
High School	• Brgy. Poblacion - Tubod National High School • Brgy. Timamana - Timamana National High School	Four public secondary schools and 1 private – the San Nicolas Academy	One
Technical School	None	Surigao del Norte College of Agriculture	None
College	None	None	None
Health Facilities			
Rural Health Unit	Brgy. Poblacion	Brgy. Magsaysay	
Barangay Health Centers	• Brgy. Timamana • Brgy. Capayahan	• Brgy. Paco • Brgy. Magpayang • Brgy. Matin-ao	

Sources: MPDOs of the three municipalities and NSO.

Impact Barangays

Social Context

The residents witnessed the opening, closure, re-opening, and second closure of the SURICON mine. They are familiar with both underground and open pit mining as the company employed both methods to extract the gold ore. The community timeline exercises conducted with the impact barangays revealed the people's unpleasant and depressing experiences with the SURICON mine (BMP, 2009b):

> In Brgy. Cawilan, the senior citizens recalled that underground mining was done using picks and shovels. Approximately 5 % of the workers came from the barangay. SURICON reportedly did not give any assistance to the community. When the company closed down in the 1960s, the caretaker sold the scrap and other materials that were left. The people resorted to small-scale mining to survive.
>
> When the mine reopened in the 1980s, the open pit mining method was used. The residents remembered the damage to the rice fields caused by chemical wastes. They said that the company went from house to house to negotiate for the payment of damages. Some landowners were forced to sell their land for P 0.30/m^2 when the going rate was P 5. According to them, a few have not been paid up to now. They also recalled that only one person from the barangay was employed and they lamented the "bata-bata" system or favoritism of the managers.
>
> Brgy. Siana had a similar experience. According to the residents, only a few people from the barangay were employed by the mine. They recounted that in the 1960s, many people suffered from the unpleasant odor from the buried trees. In the 1980s, the residents remembered the dust, noise, and polluted air and water coming from the mine. The worst incident involved the death of a man who was hit by boulders during blasting operations.
>
> The Siana residents validated the claim of the Cawilan folks that in the 1980s, the people were forced to sell their land at P 0.30/m^2. They narrated that SURICON provided a relocation area (now called Purok Relocation) for the landowners but some of them have not been paid until now. The company employed about 5 % of the population, most of them were landowners. It also provided a hospital and high school for the exclusive use of its employees. The residents recalled a one and only medical mission conducted by the company in its entire lifetime.
>
> In Magpayang, the people related the death of some animals and fishes in the river apparently contaminated by SURICON's chemicals. The ricefields were also damaged resulting to a decline in harvest. It was only when the company closed down in 1990 that conditions began to improve.
>
> Reports revealed that insurgency was also one of the causes of SURICON's closure. Some residents claimed that the rebels burned the administration building which contained important records of the mining operation after the mining company left.

GRC commenced its exploration program in the Siana property in February 2003. Mindful of the community's economic plight and experiences, GRC initiated a number of community development projects. The most notable of these are potable water and a Level 2 distribution to the three direct impact barangays, medical clinic with a fulltime doctor and nurse, free medicines, feeding program for

the malnourished, children's playground, school repairs and supplies, tree planting, and benevolent grants.

The EIA and public consultations for the Siana Gold Project were conducted in 2005 and 2008. Household surveys in April and May 2005 disclosed an 86 % Project acceptance in the three direct impact barangays and 80 % acceptance in the three indirect impact barangays. The major reasons for accepting the Project are employment and community development. Meetings with officials, health workers, and leaders and representatives of farmers', irrigators', women's, and youth groups in April 2008 confirmed the high community acceptance of the Project.

Socio-economic Profile

Table 4-2 provides the key socio-economic indicators of the impact barangays.

In 2009, the total number of households is 1,484. Of this, 602 reside in the direct impact barangays and 882 in the indirect impact barangays. More than half of the direct impact households reside in Cawilan.

In 2007, the total population is 6,527. Two thousand five hundred sixty-four reside in the direct impact barangays; 3,963 are in the indirect impact barangays. Compared to the 2000 levels, Cawilan posted the highest annual population growth of 2.5 %. Siana followed with a growth of 1.6 %. The other barangays registered a population decline, with Pongtud reflecting the highest annual decline of – 1.6 %.

The impact barangays have a total land area of 3,429 ha. A little over half of this, *i.e.*, 52 % is accounted for by the direct impact barangays. The overall population density is 1.9 persons/ha. Cawilan and the three indirect impact barangays have roughly the same population density of about 2.4 persons/ha. Siana and Dayano have population densities of 1.6 and 0.6, respectively.

The 2008 IRAs of the direct impact barangays range from P 489,513 for Dayano to P 665,650 for Siana. For the indirect impact barangays, the IRAs are from P 716,518 for Del Rosario to P 771,687 for Magpayang. Considering that 20 % of the IRAs comprises the development fund, the barangays' per capita development fund varies from P 103 for Cawilan and Magpayang to P 244 for Dayano.

With the exception of Dayano which only has a 2-grade primary school, the impact barangays have complete elementary schools each. The basic facilities of the barangays are typical of a rural agricultural setting. The Green Bank of Caraga, a rural bank that provides micro-credit to farmers and individuals has branches in Del Rosario and Pongtud. Of the six barangays, only Del Rosario has a dryer, a cockpit, and a cemetery. Cawilan and Siana have rice mills.

As discussed previously, a household survey was conducted in 2005 as part of the EIA of the Project. The survey involved 186 households of the six barangays. The sampling intensity was around 20 % for the direct impact barangays and 11 % for the indirect impact barangays. The salient findings are as follows:

- The median age is 19. Those belonging to the 15 to 64 age group, which is the economically productive or working group, comprise 58 %.
- Only 6 % finished college. Eleven percent finished high school; 21 % reached high school; 11 % finished elementary; the bulk of 32 % had some elementary education.

Table 4-2. Socio-economic parameters of impact barangays

Socio-economic Parameter	Direct Impact Barangays			Indirect Impact Barangays			ALL
	Cawilan	Siana	Dayano	Del Rosario	Magpayang	Pongtud	
Barangay Classification	Rural	Rural	Rural	Rural	Urban	Urban	
2009 Households	320	197	85	269	318	295	1,484
2007 Population	1,290	872	402	1,249	1,498	1,216	6,527
2007–2000 Annual Growth	2.5 %	1.6 %	-0.1 %	-0.6 %	-0.2 %	-1.6 %	0.1 %
Land Area (ha)	542	550	700	496	666	475	3,429
Population Density (Persons/ha)	2.38	1.59	0.57	2.52	2.25	2.56	1.90
2008 IRA	P 665,650	P 585,933	P 489,513	P 716,518	P 771,687	P 733,979	P 3,963,280
Development Fund (20%)	P 133,130	P 117,187	P 97,903	P 143,304	P154,337	P 146,796	P 792,656
Per capita Development Fund	P 103	P 134	P 244	P 115	P 103	P 121	P 121
School							
Name of School	Mariano Dapar Elementary School	Siana Elementary School	Dayano Primary School	Calang Custodio Elementary School	Magpayang Elementary School	Pongtud Elementary School	
Grades Offered	1 to 6	1 to 6	1 and 2	1 to 6	1 to 6	1 to 6	
Number of Rooms	9	8	1	7	8	8	
Number of Teachers	8	7	1	7	7	7	
Other Facilities	Mini Library	Mini Library		Mini Library	Complete Library and Mini Laboratory	Mini Library	
Day Care Center	1	1	1	1		4	8
Chapel/Church	2	2	2	3	3	4	16
Basketball Court	1	1		1	1		4

Socio-economic Parameter	Direct Impact Barangays			Indirect Impact Barangays			ALL
	Cawilan	Siana	Dayano	Del Rosario	Magpayang	Pongtud	
Gym		1	1			1	3
Multipurpose Hall						1	1
Health Care Center	2				1	2	5
Barangay Hall/Office	1	1	1	1	2	1	7
Waiting Shed		3	5		2	1	11
Potable Water	1					5	6
Cemetery				1		1	2
Cockpit				1			1
Dryer		1	1	1	4	1	8
Rice Mill	1	1				1	3
Green Bank				1		1	2
Public Market					1	1	2

Source: BMP, 2009b

- House and lot ownership is highest in Dayano at 93 %. It is the lowest in Cawilan at 63 %.
- Of the 102 households engaged in farming, 42 % do not own the lots they cultivate.
- Nearly half of the samples, *i.e.*, about 47 %, have GI sheet roofing. Twenty-seven percent have cogon or nipa roofing; 26 % have mixed roofing materials.

  Forty-one percent have concrete or brick walls; 58 % have walls made of wood, bamboo, amakan, lawanit, or coco lumber.

  Forty percent have cement floors, 30 % have wooden floors, 10 % have bamboo floors, and 20 % have bare earth as flooring.
- About 55 % of the samples have colored TV; 30 % have cassette recorder, and 25 % have refrigerators. Most households have jungle bolos and grass cutters.
- Fifty-six percent use wood and charcoal as cooking fuel. A third uses LPG, a tenth cooks with kerosene gas, and 3 % uses electricity.
- Seven percent have Level 1 water, *i.e.*, from jetmatic pumps and wells; 62 % obtain water from community faucets, *i.e.*, Level 2; 31 % have piped water, *i.e.*, Level 3.
- Eighty-five percent uses sanitary toilets. About 8 % have no toilets. Cawilan has the highest proportion of households without toilets, *i.e.*, about 20 %.
- For garbage disposal, 60 % practice burning and 30 % compost their solid wastes. About 10 % reported to throw their wastes in open pits, rivers, and creeks.
- The reported monthly household income ranges from P 600 to P 32,000. The median and mean incomes are P 4,456 and P 6,189, respectively.

  For 2005, the Annual Per Capita Poverty Threshold Level (APCPTL) and Annual Per Capita Food Threshold Level (APCFTL) estimated by the National Statistical Coordination Board (NSCB) are P 14,533 and 10,066, respectively. Using the sample population's average household size of 5.46, the monthly take-home pay required to attain the APCPTL and APCFTL are P 6,613 and P 4,580, respectively. At least half of the sampled households are living below the food threshold level and approximately 70 % exist below the poverty level.
- The occupations reported reflect the educational attainment. Majority of the jobs involve manual labor with farming as the predominant occupation and income source, *i.e.*, 40 %. The government and private companies employ about 30 %.
- Theft, alcoholism, and gambling – all economics related – are the three major problems.

Problem assessment workshops conducted with the key leaders and members of the impact barangays in 2005 and 2009 surfaced four major ones (BMP, 2009b):

- Lack of income and income opportunities
- Lack of basic social services

- Lack of basic infrastructures and
- Lack of technical and financial support to the farmers, fishermen, and other vulnerable groups.

All four problems are attributable to the lack of economic activities in the area that would spur demand and have multiplier effects such as increase in consumption due to an increase in income.

Community Consultations

As part of the community consultations for the FMRDP, GRC requested for an FMRDP presentation and discussion with the Mayors, Vice Mayors, and Sangguniang Bayan Members of the impact municipalities of Alegria, Tubod, and Mainit. The presentation and meeting with the Mayor, Vice Mayor, and Sangguniang Bayan Members of Alegria took place in the morning of 18 May 2009 at the Sangguniang Bayan Session Hall. The presentations and meetings with the officials of Tubod and Mainit were held in the morning and afternoon, respectively, of 19 May 2009 in the respective Session Halls. Annex 4 compiles the attendance sheets for the meetings with the Municipal Officials.

BMP prepared and gave a uniform Powerpoint® presentation to all three sets of Municipal Officials (Annex 5). The presentation had three parts, namely, the definition and nature of FMRDP, statutory basis of FMRDP, and role of the community in the FMRDP. The highlights of the presentation were as follows:

- "FMRDP" has two key words: "Rehabilitation" and "Decommissioning". Rehabilitation is the return of disturbed land to a stable, productive, and self-sustaining condition after taking into account the beneficial uses of the site and surrounding land. "Decommissioning" is the process that begins near, or at, the cessation of mineral production and ends with the removal of all unwanted infrastructures and services. "Closure" integrates the concepts of decommissioning and rehabilitation.
- Mine closure has two specific goals:
  - To prevent or eliminate long-term environmental impacts by returning mining-disturbed land to a physically and chemically stable, visually acceptable, productive, or self-sustaining condition
  - To ensure that alternative skills and sustainable livelihood opportunities are provided, established and left behind to mine employees and their dependents and to the host and neighboring communities.
- The Final Mine Rehabilitation Plan should lead towards the final land use identified and agreed upon with the stakeholders.
- To facilitate the identification and planning for the land use, the Siana Gold Project site is divided into several components, namely:
  - Open pit
  - Waste rock dumps

- Settling ponds
- Process plant
- TSF
- Workshops
- Offices and warehouses
- Accommodations area
- Roads

- The FMRDP report has nine parts:
    1. Company Information
    2. Executive Summary
    3. Background Information
    4. Stakeholder Information
    5. Risk Assessment
    6. Final Mine Rehabilitation and Decommissioning Plan
    7. Schedule of Operations and Costs
    8. Plans
    9. Technical Appendices
- The legal basis of an FMRDP is Section 187 of DENR Administrative Order No. 7, Series of 2005 which provides for the establishment of a Final Mine Rehabilitation and Decommissioning Fund.
- The community has critical roles to play in the formulation of the FMRDP:
    - Visioning of the post-mining land use
    - Identification and characterization of the closure issues and risks
    - Suggestions on how the community can avoid or cushion the negative impacts of mine closure
    - Comment and endorsement of the FMRDP.
- The World Bank has four conclusions and key messages on mine closure:
    1. Sustainability throughout the mine life cycle prepares the way for successful closure.
    2. Plan for closure early.

3. Consult stakeholders including workers, communities, and local government.

4. Share responsibility: develop and work in partnerships.

- Sustainability throughout mine life should be attained through the SDMP.

Table 4-3 lists the questions raised after the presentations together with the replies made by BMP and the MGB Resource Person.

Table 4-3. Questions raised after the FMRDP presentations

Questions	Replies
Is there any plan to extend the operation of the company to 13 years or more?	BMP's Dr. R Cuaño: It depends if the company discovers an additional source of ore.
How do you dry the pit and where does the water go during dewatering?	Dr. R Cuaño: The pit will be dewatered using pumps at a combined rate of 780 L/s during the less wet months of April to September. The water will go to Dayano Creek. A portion will go into Siana's irrigation facility, the bulk will discharge into Lake Mainit.
Do you apply soil during the drying of the mine tailings?	Some companies just let the tailings dry without adding any soil. But this takes time. To fast track the rehabilitation of the tailings area, enriched soil or fertilizers will be added to the planting sites in the tailings area.
If the FMRDP will not be followed or complied, who will be apprehended for the P 50,000 fine?	MGB's M Tumulak: The Environmental Management Bureau will be the one to give the notice of violation to the company. They will get the fine.

Photo 4-1. The meeting and presentation with the Municipal Officials of Alegria.

Photo 4-2. FMRDP presentation and discussions with the Municipal Officials of Tubod.

Photo 4-3. The presentation and discussion with the Municipal Officials of Mainit.

5. RISK ASSESSMENT

Figure 5-1 is a perspective view of the Project area at mine closure. The most significant of the Project facilities are the new landforms of the TSFs, WRD and CLF, and the enlarged and deepened open pit.

During closure, the Project facilities are expected to affect the impact barangays in various ways:

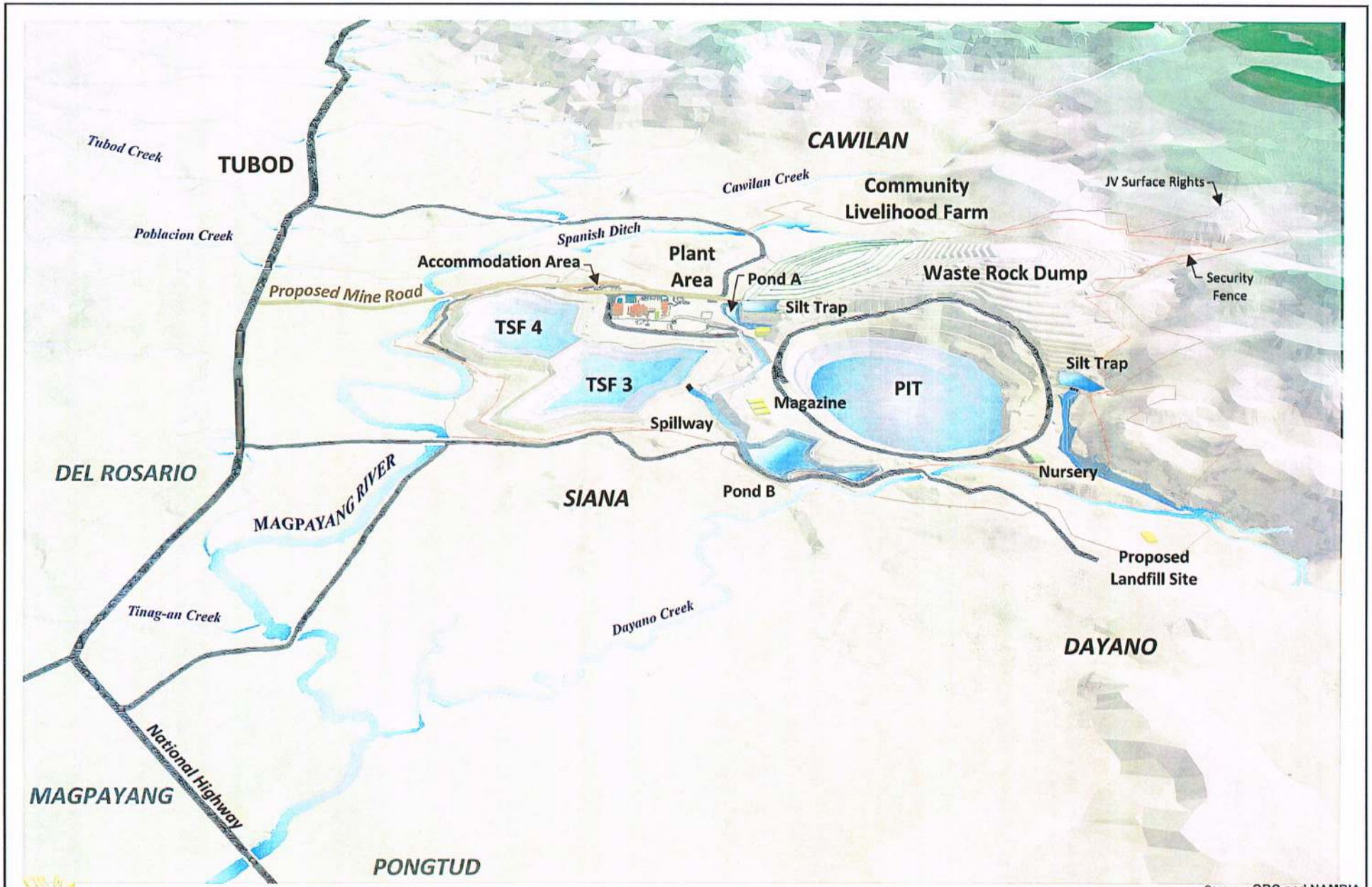
- Brgy. Cawilan by the failed or eroded sediments from the CLF and dust from the TSFs, CLF, and WRD
- Brgy. Del Rosario by the dust and rainfall-eroded sediments or tailings from the TSFs
- Brgy. Siana by the failed or eroded sediments or tailings from TSF 3, eroded sediments from the CLF and WRD, and uncontrolled water discharges from the open pit
- Brgy. Dayano by the foul odor, dust, vermin, leachate, and methane gas from the sanitary landfill
- Brgys, Magpayang and Pongtud by the eroded sediments or tailings from the TSFs, WRD and CLF and uncontrolled water discharges from the open pit.

The foregoing impacts are actually risks. Two inseparable factors characterize risks (Covello and Merkhofer, 1993):

- Possibility of an adverse outcome and
- Uncertainty over the occurrence, timing, or magnitude of that adverse outcome.

The risk sources and events likely during the closure of the Siana Gold Project are:

1. Open pit – Failure of pit walls and uncontrolled flows from the pit
2. TSF 3 and TSF 4 – Slope failure of dam embankment; dam overtopping; failure of the spillway; and gully, sheet, and rill erosion
3. Storage of tailings of underground mining operations – To be determined.
4. WRD and CLF – Slope failure and gully, sheet, and rill erosion
5. Ponds A (Plant feed water dam) and B and secondary containment dam – Slope failure of wall or embankment and pond overtopping
6. Sanitary landfill – Failure of the landfill cap, leachate collection and treatment, and landfill gas extraction system
7. Soil substrate – Inadequacy of soil in terms of texture, structure, organic matter, cation exchange capacity (CEC), soil pH, and nutrients for plant growth
8. Revegetation – Low survival rate and percent cover of planted species and forest fire.



Sources : GRC and NAMRIA

bmp

Perspective view of the Project site at plant closure

FMRDP for the Siana Gold Project

Figure No. 5-1

Environmental Setting

Climate

The climate at the Project site is classified as Type II under the Modified Coronas Classification (Figure 5-2). This climate type does not have a dry season. A very pronounced maximum rain period occurs from November to February. This is the consequence of the Northeast Monsoon and the passage of tropical cyclones close to the Project site during the period.

The synoptic station closest to the Siana Project site is the Philippine Atmospheric Geophysical Astronomical Services Administration's (PAGASA) Station 653 in Surigao City which is 30 km northwest of the site. Figure 5-3 plots the mean monthly rainfall for Surigao City based on climatological normal data compiled from 1971 to 2000 (Annex 6). The Figure also plots the greatest daily rainfall recorded for each month as extracted from the climatological extremes dataset based on various periods up to 2003 (Annex 7).

Figure 5-4 is a line graph of the average number of rainy days per month. The trend closely mimics that of the mean monthly rainfall.

Figure 5-5 plots the estimated rainfall of 24-hour storms against the various return periods for Surigao City (Annex 8). As shown, the two years' 24-hour storm has an estimated precipitation of 204.8 mm. For a hundred years' 24-hour storm, the computed rainfall is 593.6 mm.

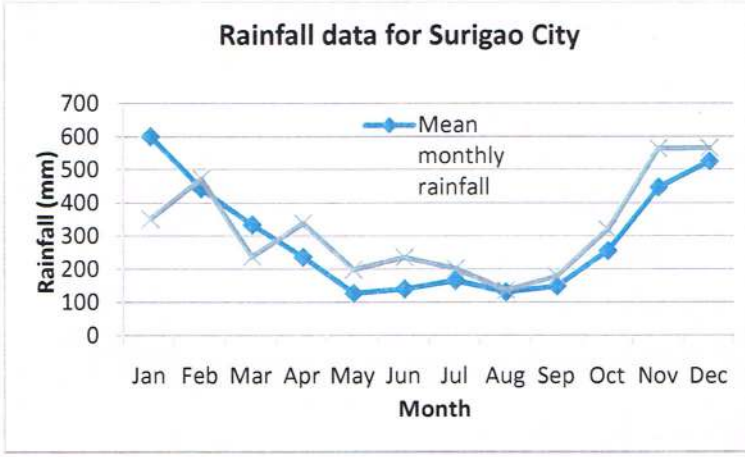
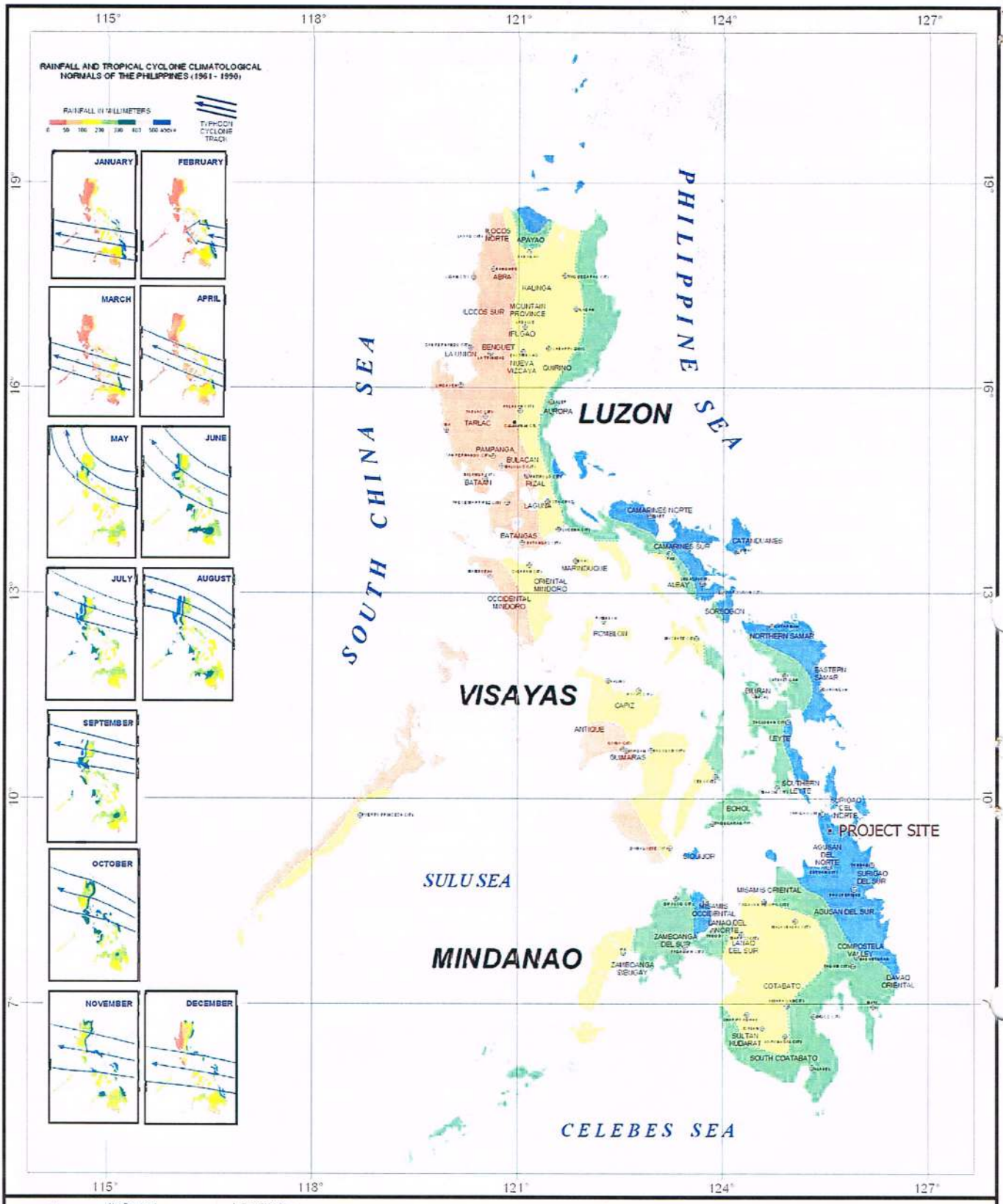


Figure 5-3. Line chart for mean monthly and greatest daily rainfall



Map Projection
Longitude - Latitude

Project Location
CARAGA Region
Surigao, Mindanao

0 50 100 150 Kilometers
GRAPHICAL SCALE

Source :
PAGASA

LEGEND :

	TYPE I	Two pronounced seasons; dry from November to April, wet during the rest of the year.
	TYPE II	No dry season with a very pronounced maximum rainfall from November to January
	TYPE III	Seasons not very pronounced; relatively dry from November to April and wet during the rest of the year.
	TYPE IV	Rainfall more or less evenly distributed throughout the year.

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Climate map of the Philippines

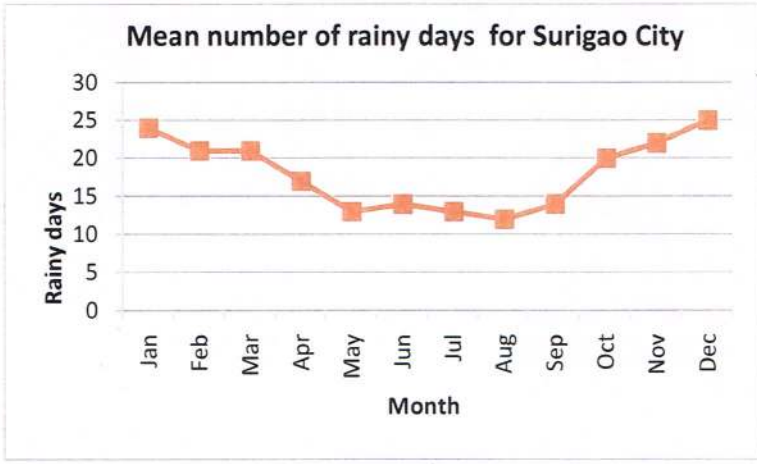


Figure 5-4. Line chart of mean number of rainy days

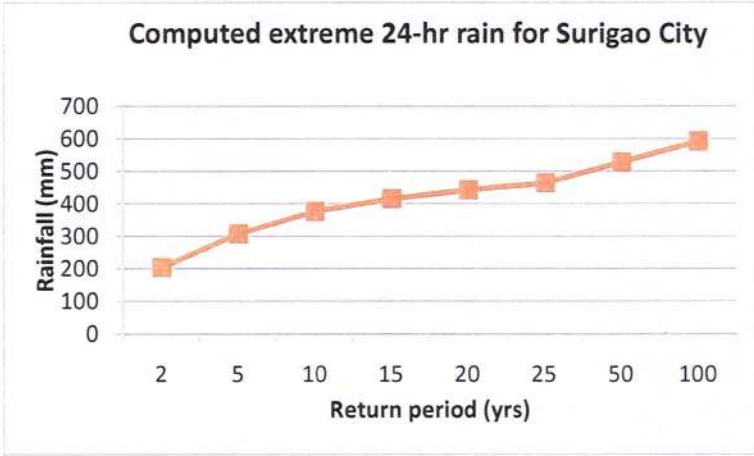


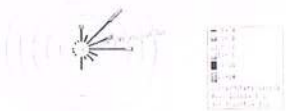
Figure 5-5. Estimated rainfall for 24-hour storms of various return periods

Based on the climatological normals, the annual mean wind speed measured in the Surigao City synoptic station is 2 m/s. The monthly mean wind direction blows from five directions (Figure 5-6):

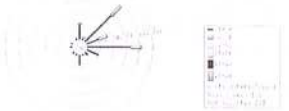
- From the east during the months of February to May
- Southwest from June to July
- West-southwest from August to September
- From the west in October
- From the east in November and
- Northeast in December and January.

The highest wind speed of 60 m/s blowing from the east-northeast direction was measured in September.

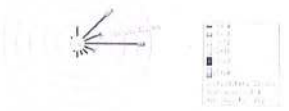
January



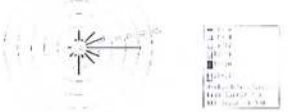
February



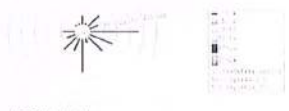
March



April



May



June

July

August

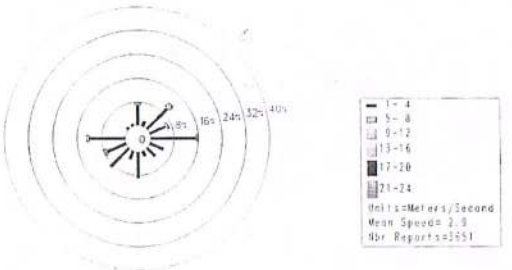
September

October

November

December

Annual



FREQUENCY TABLE (%)
Sungao, City
Wind Speed and Direction
ANNUAL (1987 - 1996)

Direction / Speed (mps)	N	NNE	NE	ENE	E	ESE	SE	SSE
CALM								
1 - 4	7.3	1.6	10.1	5.6	14.7	4.5	3.9	1.5
5 -8	.6	.2	2.1	.9	1.2	.1	.1	.0
>8	.1	.0	.1	.0	.0	.0	.0	.0
TOTAL	8.0	1.8	12.3	6.5	15.9	4.6	4.0	1.5

Direction / Speed (mps)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM									0.0
1 - 4	9.4	2.7	9.5	7.3	12.1	.4	.6	.8	92.1
5 -8	.0	.0	.2	1.2	1.2	.0	.0	.1	7.7
>8	.0	.0	.0	.0	.1	.0	.0	.0	.2
TOTAL	9.4	2.7	9.7	8.5	13.4	0.4	0.6	0.9	100.0

Source: PAGASA

Wind roses

FMRDP for the Siana Gold Project
Figure No. 5-6

Geomorphology

The Landsat Natural Color Image of Northern Mindanao highlights three main physiographic features (Figure 5-7):

- NNW-SSE trending predominantly andesitic ridge that is parallel and adjacent to the west coast of the Surigao Peninsula. Marked by steep hillsides and narrow valleys, the peak is Mt. Malimono at the north with an elevation of 900 masl. Geomorphologically, the ridge is a structural landform created by massive earth movements due to plate tectonics. The Philippine Fault Zone Surigao Segment marks the eastern edge of the landform.

- Central portion marked by clusters of volcanic peaks and conical hills, some reaching 600 masl at the north, and the Lake Mainit basin down south. The deepest portion of the lake is at 219 mbsl. Geomorpologically, this is another structural landform.

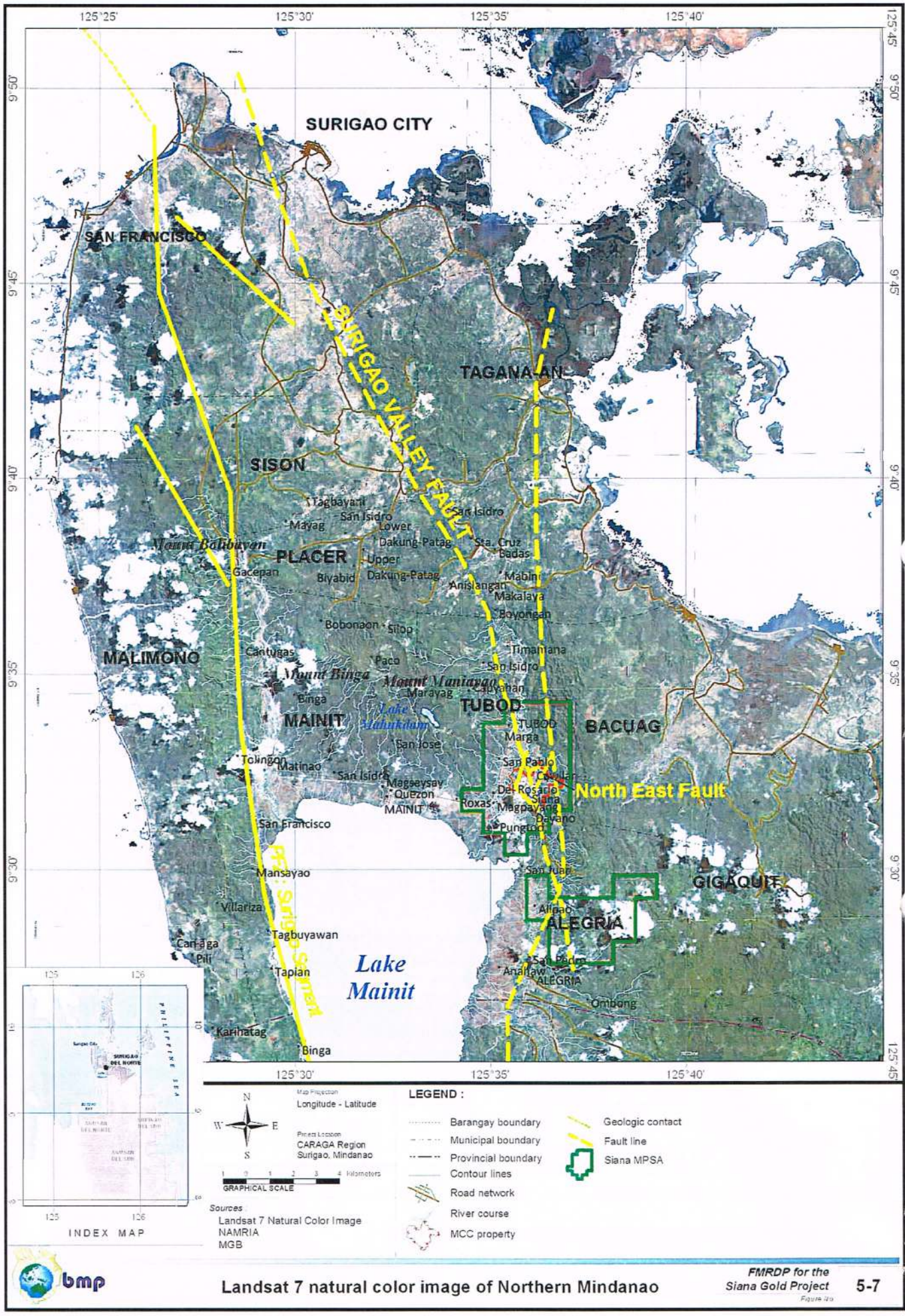
  The Paco area northwest of the Project site, with a 2-km diameter crater-like depression, resembles a large conical volcanic edifice. Three other depressions are discernible, namely, one in Capayahan and two others, which are probably explosion craters previously, are Lake Mahukdam and the small lake of Brgy. Silop. Mt. Binga, a prominent peak adjacent to Brgy. Binga is a volcanic plug with slopes covered by coconut trees. Aligned with this plug in a roughly northwest direction are the Masapelid Hill and Mt. Maragon-ong.

- Eastern portion which forms the northern extremity of the East Mindanao Ridge. The ridge is marked by gentle to moderate slopes on the western peripheries abruptly interrupted on the east by numerous irregular depressions typical of limestone areas. The maximum elevation is about 1600 masl at the south.

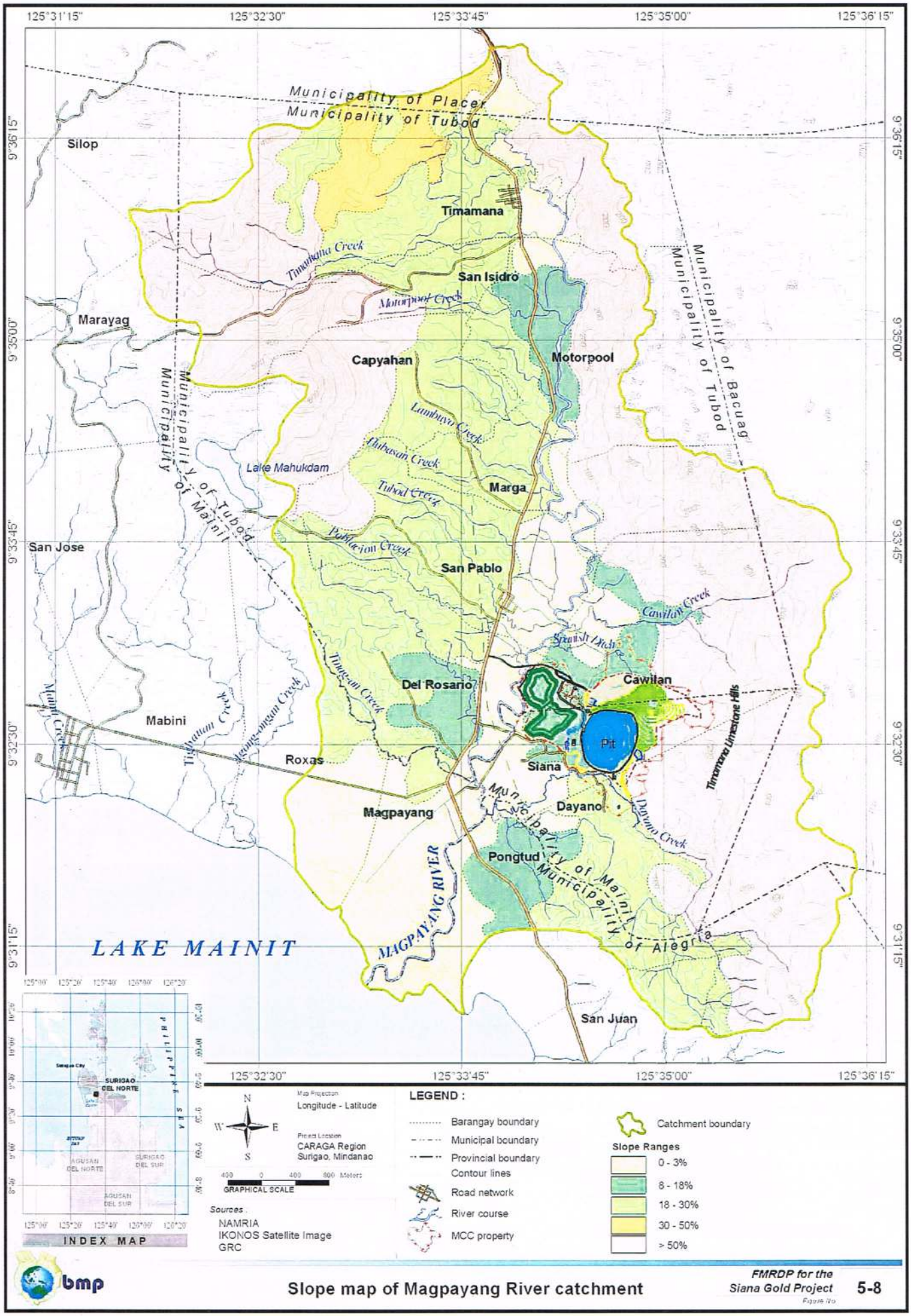
Two distinct narrow N-S trending lowlands separate the central portion north of Lake Mainit. These are the Mayag River valley to the west and Magpayang River valley to the east. Both are depositional landforms created by the placement of surface materials weathered and eroded from the limestone and andesitic ridges. The most productive agricultural lands in the area, they consist of the alluvial floodplains and the transitional upland fringe. The floodplains, which are areas on one or both sides of the stream channel that are inundated by floodwaters at some time, are planted to rice. The transitional upland fringe, a portion of the upland on one or both sides of the floodplain that serves as transitional zone or edge between the floodplain and the surrounding landscape, is planted to coconuts.

The Project site is part of the 5,700-ha Magpayang River catchment (Figure 5-8). Occurring southeast of the catchment, the Project site is bounded to the north and west by the low river terraces and floodplains of the Magpayang River. The western river terraces have an elevation of 40 to 45 masl and slope of 0 to 3 %. Eastward are the Timamana limestone hills with a local peak elevation of 400 masl and slopes in excess of 50 %. South of the site are the alluvial floodplains of the Magpayang River and Dayano Creek. Magpayang River and Dayano Creek are both meandering streams.

Figure 5-9 is the geomorphological map of the Magpayang River catchment. The Project site is generally part of the transitional upland fringe. It has a mean elevation of 50 masl and slopes of 8 to 18 %. The tailings surface elevation in the former Tailings dam 1 of SURICON varies between 43 to 45 masl. The tailings surface elevations are between 47 and 48 masl at Tailings dam 2 and between 51 and 53 masl at Tailings dam 3. The crest elevation of Tailings dam 1 varies from 47 to 49 masl; for



Landsat 7 natural color image of Northern Mindanao



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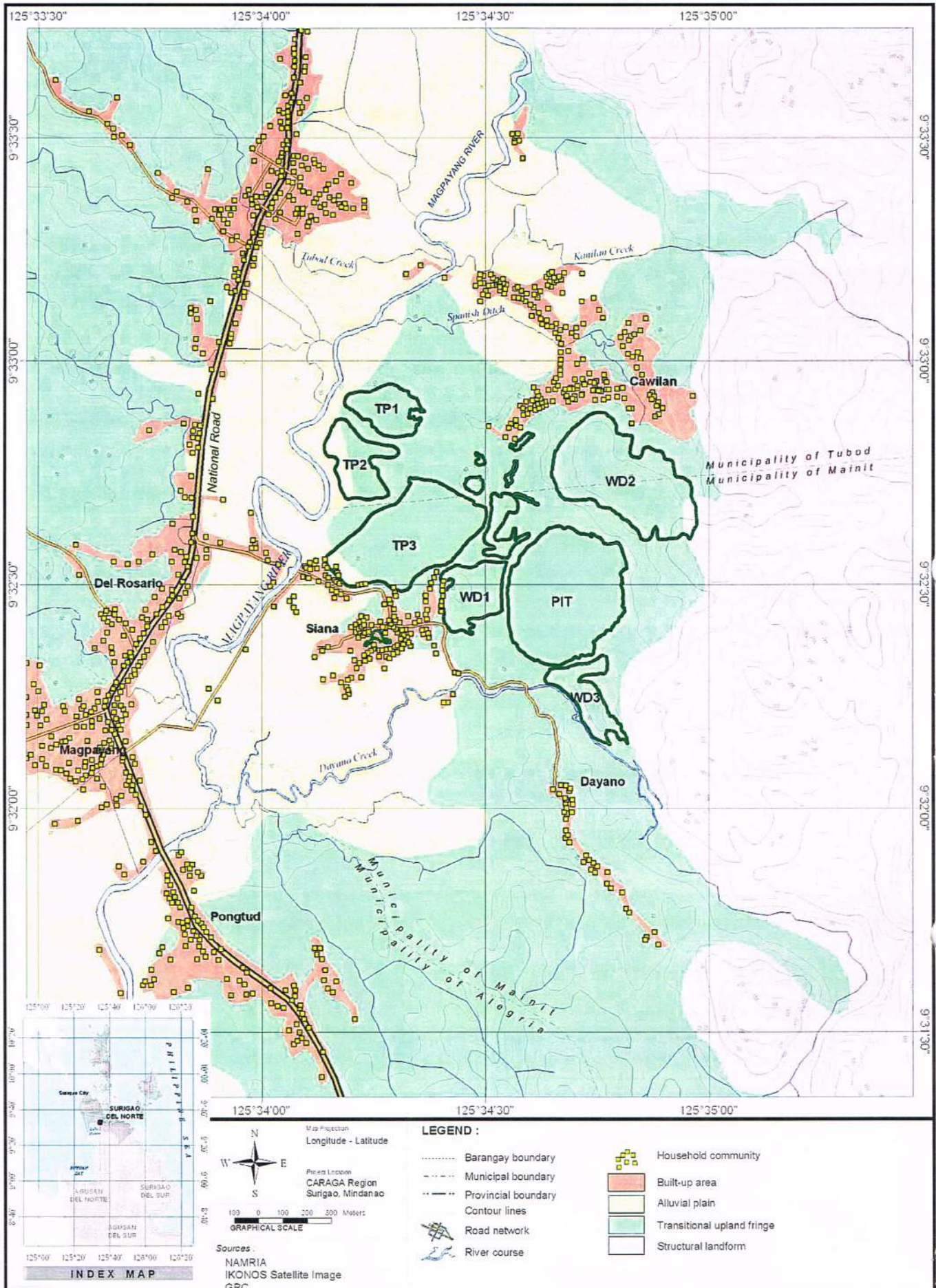
Slope map of Magpayang River catchment

FMRDP for the Siana Gold Project

Figure No.



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Geomorphological map of the Magpayang River catchment

Tailings dam 2, from 48 to 51 masl; and for Tailings dam 3, at roughly 55 masl. The old waste rock dumps adjacent to the open pit have elevations of 55 to 60 masl.

Land Use

The Magpayang River catchment extends as far north as Brgy. Timamana, Tubod; Brgy. Magpayang, Mainit and Brgy. Pongtud, Alegria to the south; and Brgy. Candiis, Alegria to the southeast. The catchment is predominantly coconutland. The forests are found in the elevated areas in the northwest and to the east of the catchment. The alluvial plains are planted to rice. There are patches of grasslands near Brgy. Magpayang and in Brgy. Cawilan (Figure 5-10).

The 240-ha Project site is predominantly grassland. The minor exceptions are the ricelands west of the site along the Magpayang River banks, the forests at the Timamana highlands to the east, coconut lands southeast of the property, and the flooded SURICON open pit.

Figure 5-10 shows the residences which are concentrated along the National Highway. There are also households occupying the former accommodations facilities of SURICON immediately north of the main waste rock dump. Southwest of the Siana property and at the toe of SURICON's Tailings dam 3 are the households of Brgy. Siana.

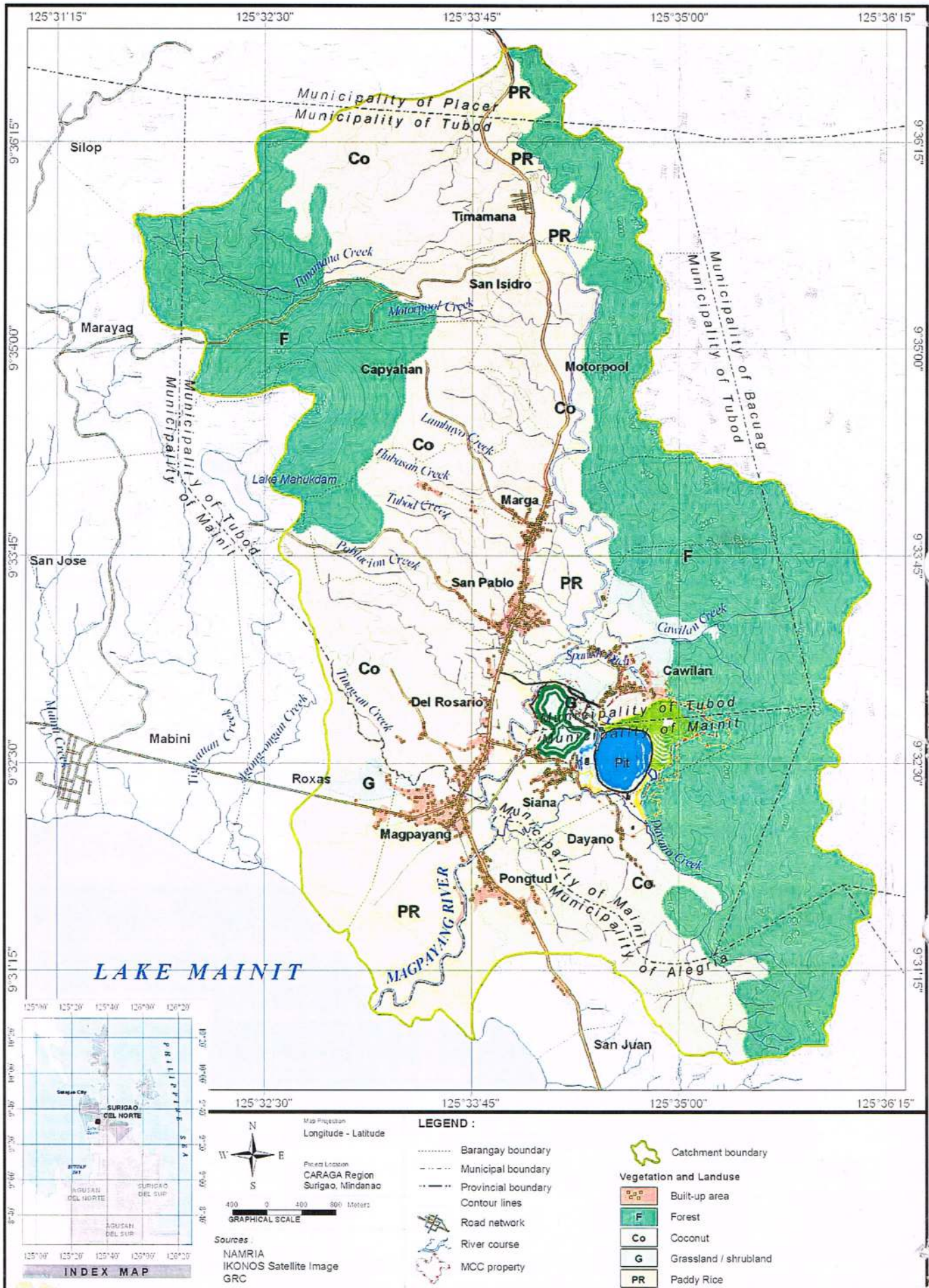
Gold small-scale mining without permits is active at the SURICON waste rock dumps and tailings pond areas. The number of miners dramatically increases during the rainy days. Near the southwestern end of Tailings dam 3, a gold CIL plant operates without a permit.

Surface Stream Hydrology

The dendritic Magpayang River is 15.3-km long. The river is a fourth-order single-thread stream that flows southeasterly from the headwaters in Brgy. Timamana, Tubod. Before reaching Brgy. Motorpool, the flow becomes southwesterly. At Brgy. Marga, the flow switches again to the southeast. Starting at Brgy. Poblacion, the river generally flows southwesterly ultimately discharging into Lake Mainit (Figure 5-8). About 27 other rivers and creeks drain into the lake. The lake discharges into the Bohol Sea.

Photo 5-1. The Spanish Ditch that drains the northern portion of the Project site

Photo 5-2. The wide river channel of Magpayang River where Harrison Bridge that connected the National Highway to Brgy. Siana used to stand.



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Land use map of the Magpayang River catchment

FMRDP for the Siana Gold Project 5-10

Figure 4a

Photo 5-3. The middle reach of Dayano Creek immediately downslope of the pit water discharge.

Photo 5-4. Magpayang River downslope of the Dayano Creek confluence. The channel is wide.

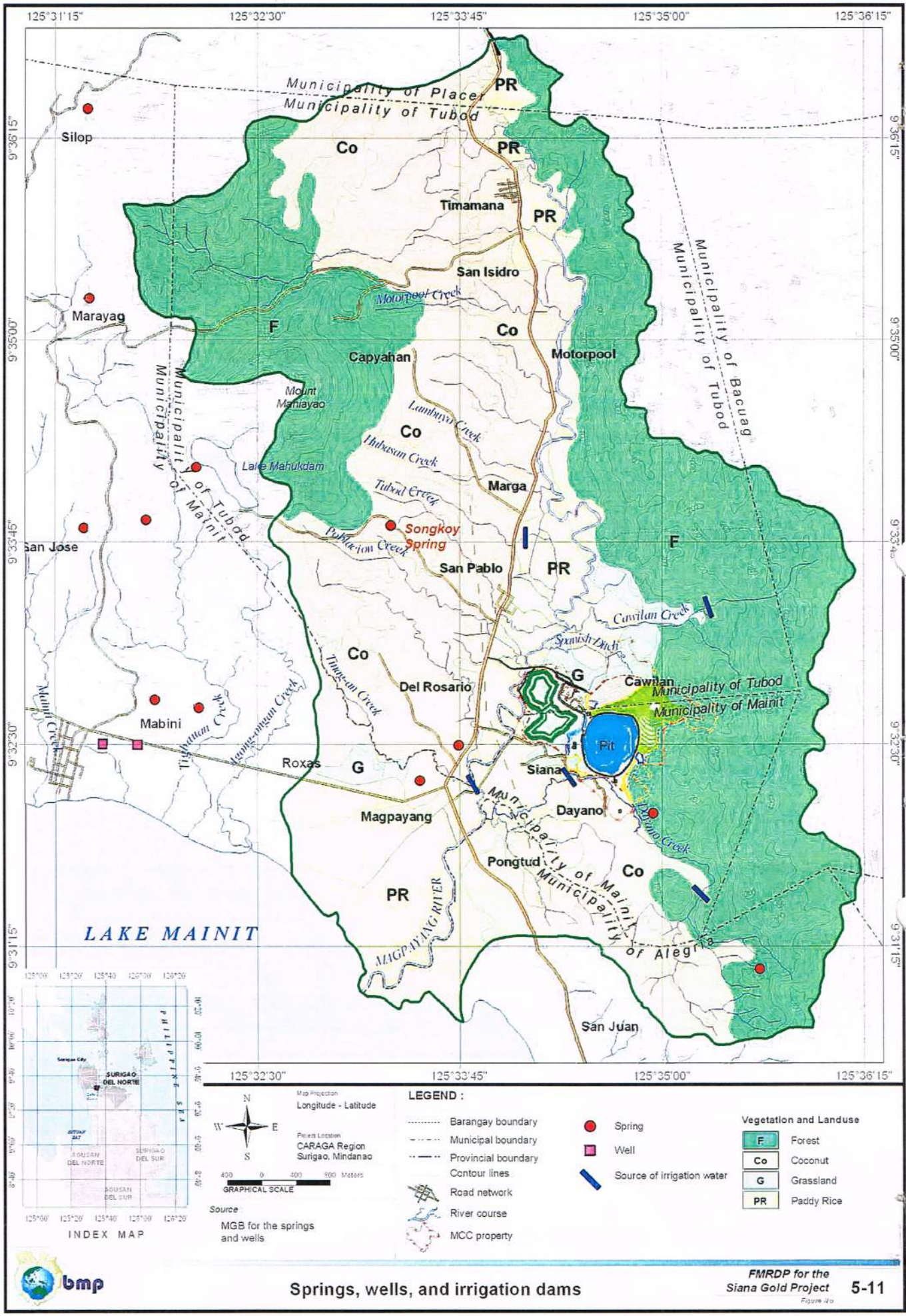
Photo 5-5. The irrigation dam at Magpayang River for Brgy. Magpayang immediately upslope of the bridge that connects Brgy. Siana to the National Highway (BMP, 2009a).

Photo 5-6. The irrigation dam at Dayano Creek services the rice fields of Brgy. Siana (BMP, 2009a).

The Project site is drained by three water bodies. These are the Spanish Ditch to the north, Magpayang River to the west, and the Dayano Creek to the south. Both the Spanish Ditch and Dayano Creek are tributaries of Magpayang River. The local residents rely on the Magpayang River for their agricultural needs, source of fish, washing of clothes, bathing, and care for their animals. Figure 5-11 shows the location of irrigation dams along Magpayang River and its tributaries. Two of these dams – one along Magpayang River immediately upstream of the bridge and the other along Dayano Creek in Brgy. Siana - are located downstream of the Project site.

Hydrogeology

Four major lithologic formations underlie the Project site and Magpayang River catchment. Each formation allows groundwater flow in varying degrees. For the highly permeable sand and gravel deposits of the Quaternary Alluvium, the groundwater occurs mainly in unconfined condition. For the Timamana Limestone, the solution cavities and karstic nature are favorable to groundwater flow. The other stratigraphic units such as andesites and basalt allow groundwater flow either through the weathered mantle, solution-enlarged joints and fractures, or bedding planes (MGB, 2003).



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Springs, wells, and irrigation dams

At the Project site, three main aquifers are inferred (Meyer Water Environmental Solutions [MWES], 2007):

- Alluvial aquifer which is 6 to 12 m thick and located beneath the near-surface soils. It comprises yellow, orange and brown sands and gravels with inter-layered clays.
- Saprolite aquifer is within the highly weathered bedrock and above the fresh bedrock.
- Bedrock fractured aquifer which includes volcaniclastics, basalts on the eastern side of the pit, and karstic limestone.

The results of GRC-commissioned geotechnical investigation and monitoring of water levels around the tailings dam and proposed process plant site suggest that the groundwater in the deeper aquifers flows towards the Siana open pit from the north and west. Groundwater in the near-surface alluvial aquifer flows towards Magpayang River from the east and northeast and the area of the existing tailings dams.

Up to 2005, springs and shallow wells are the sources of potable water in Brgys. Cawilan, Siana, and Dayano (Figure 5-11). Songkoy Spring near Lake Mahukdam, which is hosted by diorite and floats of andesite, provides drinking water to Brgys. Marga, Poblacion, San Pablo, Del Rosario, and Cawilan of Tubod and even Brgy. Magpayang of Mainit. A spring in Brgy. Dayano, in an andesite porphyry, provides drinking water to that barangay and Brgy. Siana. Brgy. Pongtud residents get their potable water from a spring and shallow well.

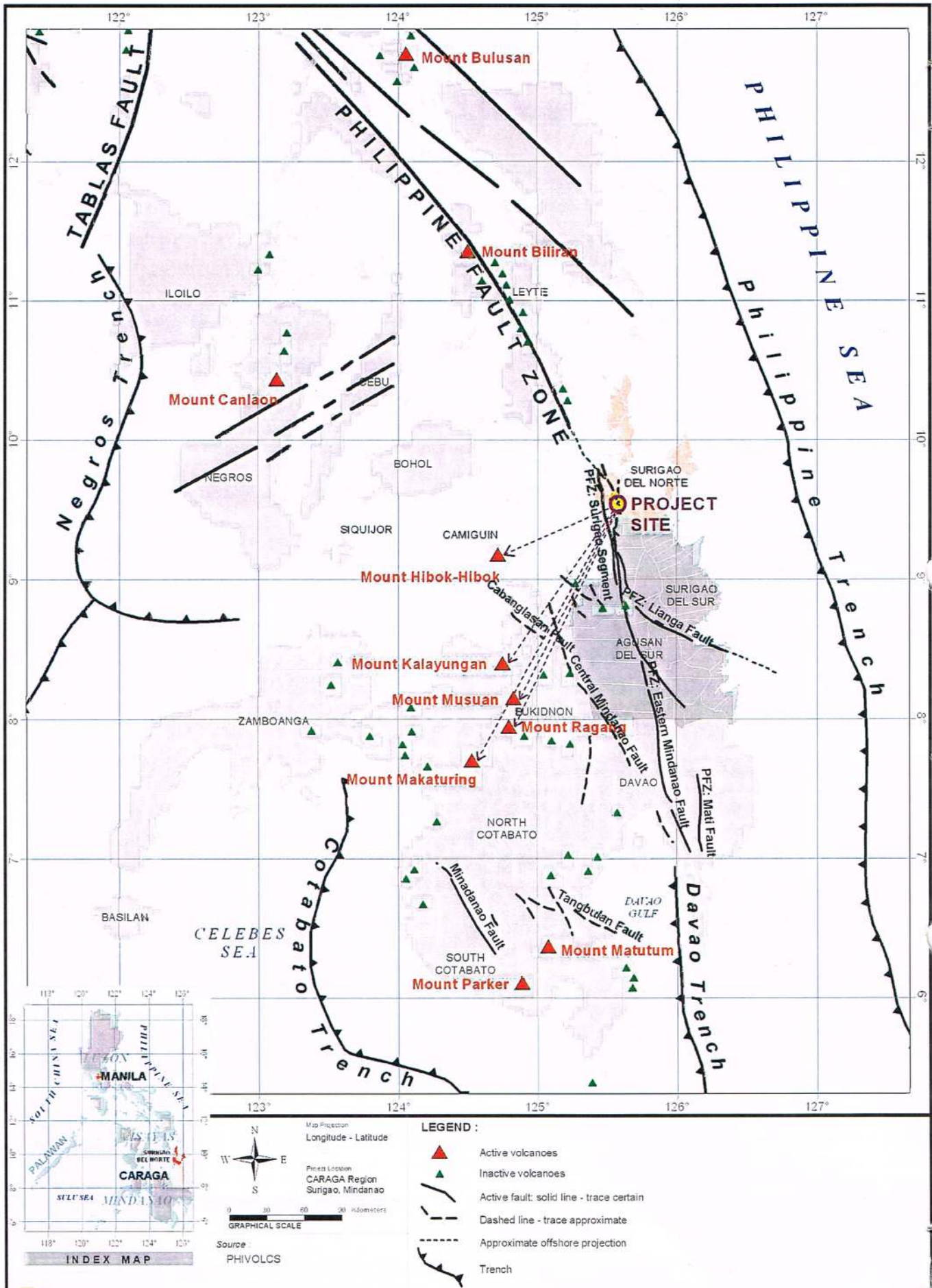
In 2005, GRC established a potable water supply and distribution system for the direct impact barangays of Cawilan, Siana, and Dayano. The water source is the open pit. Treatment consists of chlorination and filtration.

Natural Hazards

Faults, subduction zones, and volcanic activity are the primary generators of earthquakes in the Philippines. The hazards associated with earthquakes include ground shaking which can cause building collapse, ground rupture, liquefaction wherein cohesionless layers of sand become liquid, landslides, and tsunamis.

Figure 5-12 plots the faults, subduction zones, and active volcanoes proximate to the Project site (Rimando, 1994 and Punongbayan, 1994).

- About 25 km west of the Project site is the Philippine Fault Zone (PFZ). The PFZ is about 1,600 km long, extending from the Lingayen Gulf in Western Luzon down to the offshore Pujada Peninsula in southeastern Mindanao. It has been the site of many large historical earthquakes, *i.e.*, M_s larger than 5, and more numerous moderate to small events. The 1879 Surigao earthquake with magnitude M_s of 7.4 was attributed to the fault zone.
- Roughly 135 km eastward of the site is the Philippine Trench where the Philippine Sea Plate is being subducted.
- On the far west side, about 405 km, the seafloor of the Sulu Plate subducts along the Sulu Trench near the northwest side of Zamboanga Peninsula and Sulu Archipelago.



Faults, subduction zones and active volcanoes

- Southwest of the site, the Celebes Sea Plate subducts near the west side of Central Mindanao along the Cotabato Trench and in Davao Gulf along the Davao Trench.

- The major converging subduction zones such as the Philippine Trench, Sulu Trench, and Cotabato Trench led to the formation of volcanic centers and complexes. Five active volcanoes are within 200 km from the Project site. The most active, Mt. Hibok-Hibok in Camiguin Island, is about 103 km west (Martinez, 1994). Considering the distance, a Mt. Hibok-Hibok eruption can bring ash fall to the Project site.

Figure 5-13 locates the epicenters of destructive earthquakes in the country from 1608 to 2002. It also indicates the dates of occurrence, magnitude, and maximum intensity of the earthquakes. Within a 300-km distance from the Project site, the earthquake with the strongest magnitude is the earthquake of 12 July 1911. The M_s is 7.7 with epicenter located 67 km SE of the site. The earthquake wrought great havoc to many parts of Mindanao. It destroyed houses and felled many big trees. It caused massive landslides and tsunami which penetrated far inland (Mangao *et al.*, 1994).

Thenhaus *et al.* (1994) developed a probabilistic ground-motion hazard model for the Philippines. Through this model, peak horizontal ground accelerations (PGA) that have a 10 % probability of being exceeded in 50 years have been estimated for rock, medium soil, and soft soil. From Figure 5-14, the estimated peak ground accelerations for northern Mindanao range from 0.25 to 0.29g for rock, from 0.40 to 0.56 for medium soil, and from 0.70 to 0.80g for soft soil.

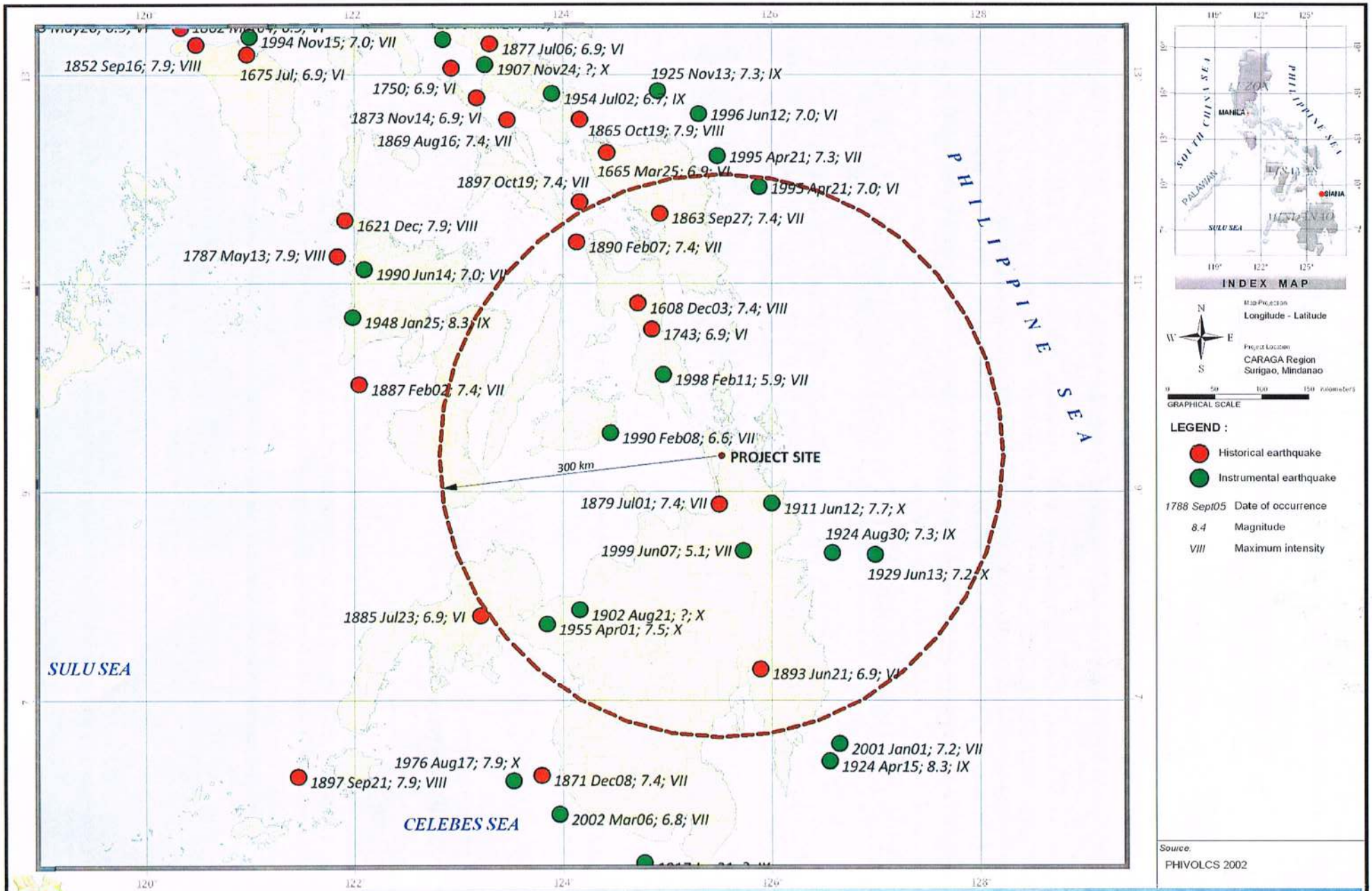
To guide the design of the tailings dams, GRC commissioned a seismic hazard assessment. The study estimated the PGA for an operating basis earthquake (OBE) at 500 years' return period at 0.25g. The PGA for a maximum design earthquake (MDE) at 10,000 years' return period is 0.60g.

Aside from earthquakes, the Project site is vulnerable to typhoons. During the community consultations as part of the Project's EIA, the residents of the host and surrounding communities recalled the devastating effects of two typhoons. One was Typhoon Ining in 1964. The other was Typhoon Nitang which ravaged the country from 31 August to 4 September 1984.

According to the residents, Typhoon Ining damaged agricultural lands, houses, schools, and other properties. Many carabaos and one person died. Typhoon Nitang was worse. Five persons reportedly died. In Brgy. Pongtud, Municipality of Alegria, around 60 % of the houses were destroyed. Based on the records of the Office of Civil Defense, Typhoon Nitang caused 900 deaths and a total property damage of P 3.913 billion nationwide.

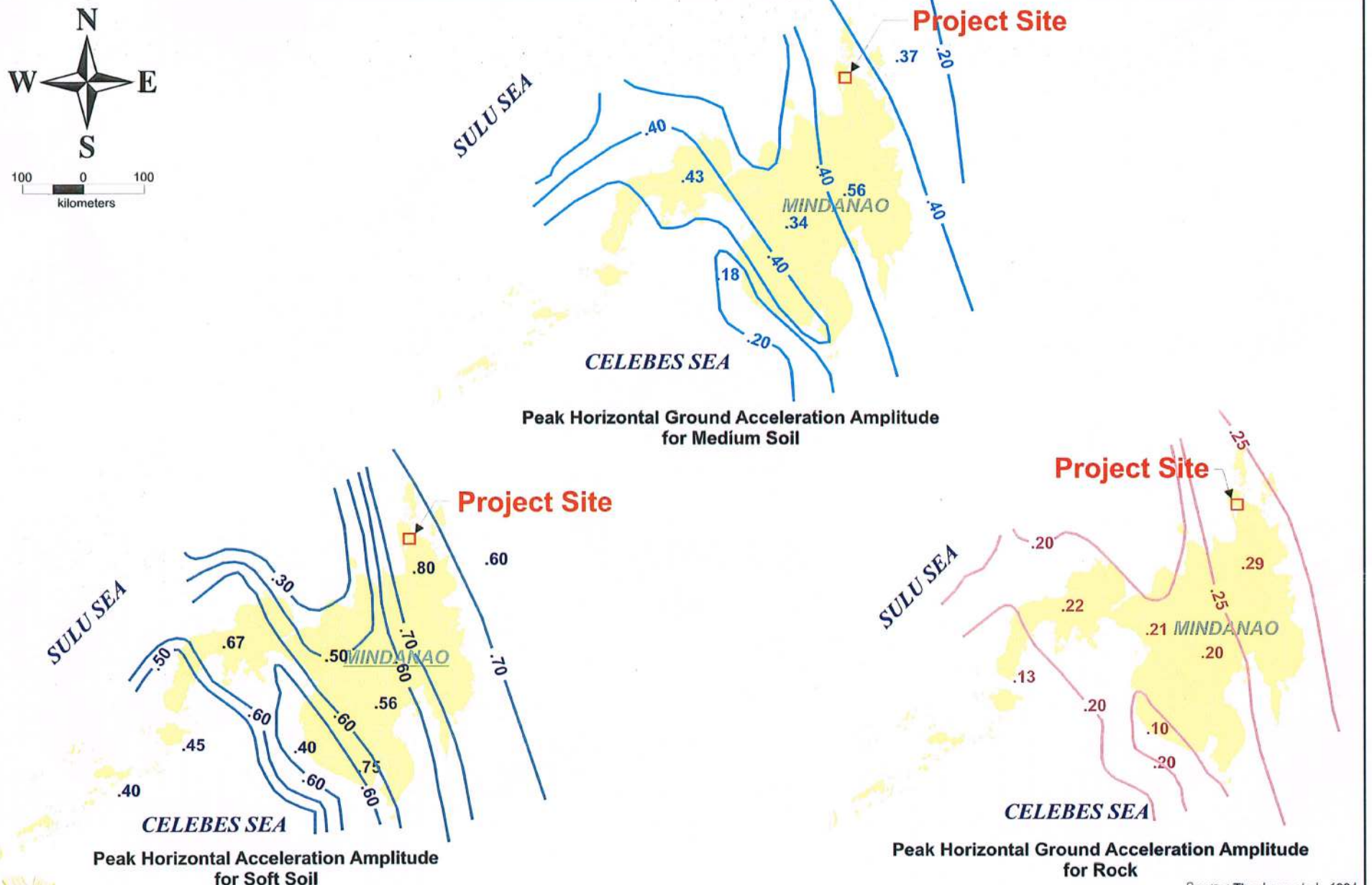
Open Pit

Photo 5-1 is a panoramic view of the flooded Siana pit. The topography surrounding the pit at its western half is gentle to slightly undulating with a local peak of about 65 m. East of the pit, the topography rises. Northward, the local peak is about 85 m RL. Northeastward, it is 190 m RL. Eastward and southeastward, the local peaks are 255 m RL and 160 m RL, respectively (Figure 5-15). Water currently discharges at the southern portion into Dayano Creek at about 45 m RL.



bmp

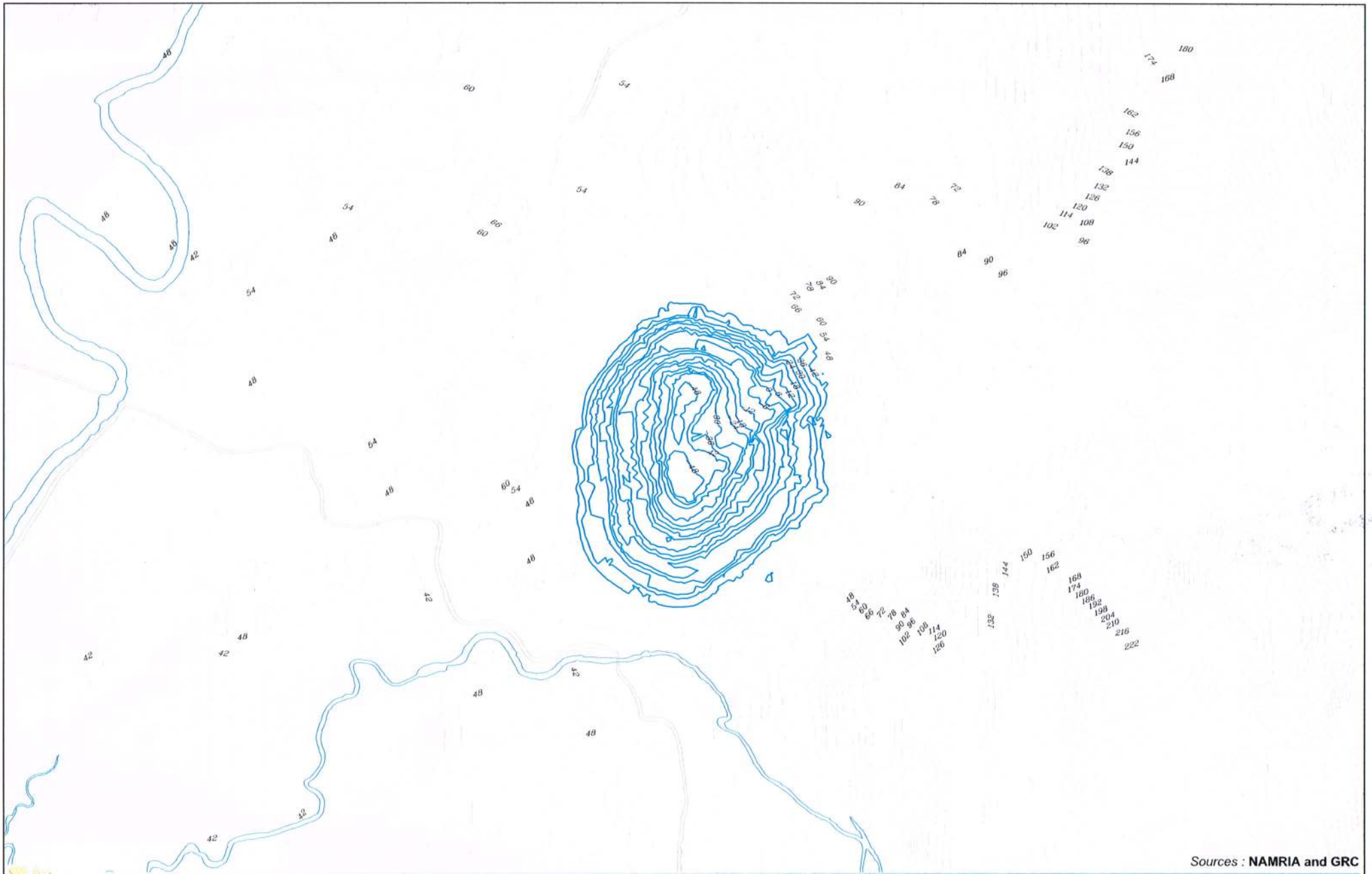
Philippine significant earthquakes 1608 - 2002



Source: Thenhaus et al., 1994

bmp

Peak horizontal ground acceleration amplitudes for Northern Mindanao



Sources : **NAMRIA and GRC**

Topography around the existing open pit

FMRDP for the Siana Gold Project

Figure No. 5-15

Photo 5-7. The flooded Siana pit in 2005. The fish cages and huts located at the right have since been taken out.

Mining One Pty Ltd (2007) undertook the geotechnical logging and analyses of 60 drill holes within the open pit resource. A three-dimensional modelling of rock mass quality data ensued. There was an opportunity to check the model through back analysis of the previous wall failure in the northeastern section of the pit. Based on the calibrated model, RSG Global (2007) designed the pit slopes, berms, and ramp.

RSG Global (2007) attributed the pit wall failure to a combination of flat west dipping structures which daylighted in the slope and the steeply dipping cross cutting structures that transect the Siana orebody. The steep structures acted as release mechanisms for the failure and most probably as conduits for groundwater. Available showings suggest that the flat west dipping structures are present throughout the eastern basalt. However, the release structures were confined only to the northeastern section of the pit.

The pit development plan provides for the deepening of the existing pit by 115 m to a final pit depth of 215 m below the surface. The walls will be pushed back by a maximum of 70 m at the northeast. The batter angles and overall slopes will vary according to the rock mass quality. For the east wall, the batter angles are 55.5° to 63°; for all other walls, the batter angles are 62.5° to 63.5°. The overall angles are 40° for the north wall, 44° for the east wall, 41° for the south wall, and 44° for the west wall. The mine ramp daylights at the western side of the open pit (Figure 2-3).

The pit benches will be 5 m high. At the west and north, the final pit crests are 50 m RL and 55 m RL, respectively. The final pit crests at the northeast and east are 90 m RL and 65 m RL, respectively. South of the pit, the pit crest is about 50 m RL (Figure 5-16).

Waste rocks from the open pit that are not used for the TSF construction will be deposited at the WRD immediately north and east of the pit. The WRD with an estimated total capacity of approximately 7.9 million bcm, will have a final height of 85 m and overall slopes of around 6° W-E and 24° S-N and NW-SE. Figure 5-16 show selected sections across the final pit and WRD.

There are limitations to the geotechnical assessment and design. They include:

1. Gaps in drill or sampling coverage
2. Biases and limitations in the methods of rock mass strength estimation and stability analyses
3. Occurrence of the Project in a high seismic hazard zone.

In view of these limitations, Mining One Pty Ltd (2007) recommended the commencement of geotechnical monitoring, mapping, and assessment during pit dewatering. This is to continue throughout the operational phases. The monitoring will employ piezometers, computerized prism surveying, extensometers, inclinometers, and crack displacement measurements. It will be done in-house on daily, weekly, and monthly bases, supplemented by external reviews every 3 to 6 months.

During closure, the pit will have an approximate surface area of 32.5 ha and an impounding volume of about 18.5 million m^3. As the equipment in the pit including pumps is pulled out, the pit will accumulate water. Over time, it will be fully flooded. The programmed post-mining use of the pit is lake for recreation.

Final slope stabilization works on the northeastern quadrant of the pit may be required. This may involve slope flattening, placement of berms, rock support, and backsloping. Revegetation will also be

required to minimize erosion. The pit spillway to Dayano Creek will have to be widened for the PMF and the side slopes flattened and armored for long-term stability.

Failure Modes

Mass movement involves the falling, toppling, sliding, spreading, or flowing of fairly large and sometimes relatively intact masses along a discrete failure surface (Cruden and Varnes, 1992). Falling and toppling are frequently associated with rock slopes; sliding, spreading, or flowing is related to soil slopes.

Mass movements are caused by processes that increase shear stresses or decrease shear strengths of the soil and rock mass. Processes that most commonly cause an increase in the shear stresses acting on slopes are (Highway Research Board, 1978):

1. Removal of support through erosion by streams and rivers or successive wetting and drying; natural slope movements such as falls, slides, and settlements; and human activity like cuts and excavations
2. Overloading due to natural causes such as weight of precipitation or accumulation of failed materials of past landslides and human activity like construction of fill
3. Transitory effects like earthquakes
4. Removal of underlying materials that provided support by rivers, weathering, underground erosion due to seepage, human activity like small-scale mining, and loss of strength of underlying material
5. Increase in lateral pressure by water in cracks and fissures and expansion of clays.

The factors that reduce shear strength in slopes are (*ibid.*):

1. Factors inherent in the nature of the materials like composition, structure, secondary or inherited structures, and stratification
2. Weathering and physicochemical activity
3. Effect of pore pressures
4. Changes in structure such as stress release and structural degradation.

Likelihood

Of the above processes that increase shear stresses or decrease shear strengths, the most likely to impact the open pit after mine closure are:

- Earthquakes – As discussed in the Environmental Setting Section of this Report, the Project site is proximate to the primary generators of earthquake.

- Overloading due to the weight of the WRD – Peter O'Bryan & Associates (2008) assessed the stability of the pit walls under the load of the WRD. They found the load to have negligible effect on the pit wall stability.

- Removal of support through erosion – The current spilling elevation of the pit is approximately 45 m RL. The final pit walls will be tallest at the northeastern quadrant with crest elevations ranging from about 55 to 90 m RL. If the spilling elevation would be retained during closure, the above water height of pit slopes at the northeastern quadrant would range from 15 to 50 m RL. The long term stability of this section will depend on the rock mass quality including the presence of cross cutting release structures and the scouring action of the water. The latter can be due to waves that are either seismic or extreme wind in origin.

- Increase in lateral pressure by water in cracks and fissures and expansion of clays – This is dependent on the occurrence and extent of cross cutting structures acting as release conduits for the groundwater. Said structures were observed at the northeast of the existing pit.

Adverse Consequences

A pit wall failure especially in the northeastern quadrant of the open pit is likely to lead to the following major consequences:

- Loss of pit perimeter plantations

- Escarpment that would be difficult to stabilize and revegetate

- Fall of the waste rocks of the WRD into the flooded pit.

A pit wall failure, if not remediated, may aggravate into a series of failures. This will compromise the stability of the WRD.

Another adverse consequence of the flooded open pit which may or may not be related to pit wall failure is uncontrolled water flows. The flows may be induced by the plunge of a large volume of failed WRD materials, earthquake, extremely strong wind, or a PMF. The effects are surges, waves, or floods towards Dayano Creek and flooding in Brgy. Siana.

Implications to the FMRDP

The continual geotechnical monitoring, mapping, and assessment to be implemented starting from pit dewatering is key to the smooth and full extraction of the Siana ore reserve. The assessment will highlight potential instability problems for which, slope stabilization measures can be designed and implemented. This will avoid work suspensions or premature mine closure as what happened during SURICON operations

By predicting the conditions after mine closure, *e.g.*, termination of pit dewatering, onset of flooding, and wave development, the geotechnical assessment can identify potential post-closure instability problems. Based on the problems, slope stabilization measures can also be designed and implemented to ensure the long-term stability of the pit walls.

Water management is a critical component of the slope stabilization measures and the pit lake. A decision will be required on what spilling elevation to adopt for the long-term stability of the high walls. The minimum freeboard which will also be based on the spilling elevation needs to be estimated based on the results of wave modeling. The spillway also needs to be sized to rout the PMF. Its side slopes need to be flattened and armored with rocks. Trash traps are to be installed for protection against blockage.

TSF 3 and TSF 4

Mining One Pty Ltd (2007) drilled 10 boreholes, with depths ranging from 7.5 m to 41.6 m, at the TSF area. Samples were recovered from the boreholes either as disturbed samples using a split spoon sampler in a Standard Penetration Test (SPT) or as undisturbed samples using a thin-walled open drive tube. Nine boreholes were converted to standpipe piezometers upon completion.

Nine test pits with a maximum depth of 5 m supplemented the boreholes. Along the test pit walls, shear vane tests were conducted to determine the in-situ shear strength of fine-grained material. Dynamic cone penetrometer (DCP) tests were performed adjacent to all test pits to assess the relative density of the soil profile.

A laboratory testing program was carried out on the borehole and test pit samples. The tests included classification tests (particle size distribution, Atterberg limits, and moisture content), consolidation tests, shrink-swell index tests, multi-stage undrained triaxial tests, multi-stage drained triaxial tests, Emerson classification, maximum dry density/optimum moisture content determinations, and soaked and unsoaked California bearing ratio (CBR) tests.

GHD Pty Ltd (2009) conducted further tests. Fourteen cone penetrometer with pore pressure measurement probes were sunk to a maximum depth of 14.2 below ground level. Seven probes were within the existing tailings impoundment, three were in the existing embankment, four were in the proposed water dam sites. In addition, nine test pits were excavated in the tailings area and two test pits in the existing waste dump. The test pits sought to assess the suitability of the materials for embankment construction.

Meyer Water Environmental Solutions (MWES) assessed the hydrology and hydrogeology of the Siana Gold Project. MWES (2007) identified three main aquifers: the alluvial aquifer, saprolite aquifer, and bedrock fractured rock aquifer. Most relevant to the TSF is the alluvial aquifer. MWES stated that "the alluvial aquifer comprises 6 to 12 m of yellow, orange and brown sands and gravels interlayered with clays. The sequence becomes more clayey at the surface and again with depth and passes into bedrock which comprises highly weathered bedrock overlying a saprolite aquifer and then fresh rock."

Based on the geotechnical and hydrological findings, operational requirements, as well as the constraints imposed on the disturbance of new land, GHD (2009) designed the TSF for the open pit mine tailings. The TSF is paddock-type with two separate cells, namely, TSF 3 at the south and TSF 4 at the north (Figure 1-2). It will be raised following the upstream method. Initially, the embankment will be built on top of the existing SURICON embankment and tailings. As a foundation for future raises, an upstream berm, consisting of moisture conditioned and compacted tailings, is built adjacent to the initial embankment. Structural rockfill and a core of low-permeability materials that can come from existing tailings or foundation excavations will make up the embankment (Figure 2-3).

Golder (2007) assessed the liquefaction potential of the existing tailings. It was found that the existing tailings have a moderate to high in-situ density and they will not liquefy due to seismic loads.

Based on the GHD (2009) design, the outer embankment wall will have a slope of 18.4° and inner slope of 21.8°. A common embankment with slopes of 21.8° will divide the TSF 3 and TSF 4. At their final heights, both TSFs will have a dam crest elevation of RL 67 m. This is 12 m taller than the current mean dam crest elevation of Tailings dam 3 and from 16 m to 20 m taller than the existing dam crest elevations of Tailings dams 1 and 2 (Figure 2-3).

The water management system of the TSFs includes decant towers with submersible pumps that will minimize the pool of supernatant in the facility, an underdrainage system that will help prevent a potentially unstable build-up of pore pressure in the fine-grained tailings deposits beneath the embankment, maintenance of a minimum freeboard of 3 m, and emergency spillways that will rout a 6-hour PMF with a return period of 1 in 10,000,000 years.

The slope stability of the design embankment was assessed under static and pseudo-static (seismic) loading conditions following ICOLD guidelines. The results indicated that the proposed embankments are stable under static conditions. Under pseudo-static conditions, the embankments are expected to deform. Under the MCE, the maximum expected vertical displacement occurring in TSF 3 is less than 1.0 m. Under the OBE, the displacement is less than 0.2 m. Both values are less than the allowed subsidence of 1.0 m (*Ibid.*).

The closure plan for both TSFs is a dry shedding cover. This will require the pump-out of all supernatant, drying of tailings, and surface grading works. Some soil conditioning is required to support the TSF's programmed use as industrial tree plantation. A dry cover results in increased dam strength and lower instability risks.

Failure Modes

The United Nations Environment Programme (2001) identified the typical causes of tailings dam failures as follows:

- Poor water management – Poor routing of surface runoff and water reuse may result in excessive rise in the level of water ponding. One consequence is the rise in phreatic surface within the embankment causing the dam to be unstable.
- Overtopping – The excessive rise in water level within the tailings reservoir can also lead to water overtopping the dam crest. Without an emergency spillway acting as a preferential flow path, overtopping water will erode the embankment quickly. Impoundment failure can follow.
- Drainage failure – This may involve physical damage to the slurry pipeline or failure of the spillway and uncontrolled water flow across the embankment. Both situations result in external scouring of the embankment and potential embankment failure. Another cause of drainage failure is pump failure or power supply failure. This will result in the excessive rise in the level of ponded water.
- Piping – This is erosion along the flowpath of seepage within or beneath the embankment. Excessive piping may result in local or wide scale embankment failure.

- Erosion - This has been discussed as the consequence of slurry pipeline or spillway failure. For abandoned TSFs, erosion of the embankment due to surface runoff may start with rills which later coalesce into larger and deeper channels called gullies. Gullying is a complex and destructive process which, when started, is difficult to stop. Embankment failure eventually ensues.

- Foundation failure - This is movement of the soil or rock underlying the dam embankment. This happens if the ground is too weak to support the dam. The consequence is partial or complete failure of the dam.

- Earthquakes – Earthquakes can cause ground shaking or rupture. Ground shaking can cause the embankment to fail or the foundations to liquefy. The latter is risky for embankments built on top of mine tailings, or other soft and wet ground.

Based on the record of major tailings dam failures from 1960 compiled by the World Information Service on Energy (WISE) Uranium Project, six occurred in the Philippines (www.wise-uranium.org/mdaf.html). These are:

- Concrete spillway failure of the abandoned tailings dam of Dizon Copper Silver Mines, Inc. in San Marcelino, Zambales in August 2002

- Tailings spill of around 700,000 t from a damaged concrete pipe of Manila Mining Corporation in Placer, Surigao del Norte in April 1999

- Loss of approximately 1,600,000 m^3 of tailings from a storage pit through the old drainage tunnel of Marcopper Mining Corporation in Marinduque in March 1996

- Dam foundation failure that released 50,000 m^3 from the tailings facility of Manila Mining Corporation in Placer, Surigao del Norte in September 1995

- Dam foundation failure that released 80,000,000 t of tailings in Philex Mining Corporation, Padcal, Benguet in January 1992

- Dam foundation failure that released 28,000,000 t of tailings in Marinduque Mining and Industrial Corporation, Sipalay, Negros Occidental in November 1982.

Likelihood

Poor water management and drainage failure are valid failure modes only during operations. Failure by piping can also be ruled out as the closure plan for both TSFs is a dry shedding cover.

Overtopping seems improbable given the planned sizing of the emergency spillways of TSF 3 and TSF 4 to rout the PMF at 1:10,000,000 years' return period.

Foundation failure is also unlikely based on the geotechnical investigations, slope stability modelling, and strict quality assurance and control (QA/QC) to be enforced during TSF construction.

This leaves only the following failure modes relevant to the Project at mine closure:

1. Earthquake. Seismology Research Centre (SRC) and Environmental Systems and Services Pty Ltd (ESS) conducted a seismic hazard assessment for the Project site. They recommended an OBE of 0.25g and MCE of 0.60g for the tailings dam. The OBE is generally considered as the earthquake with a 10 % probability of exceedance in a 50-year period, equivalent to a recurrence period of 475 years. It is used to assess the stability of tailings storages for the operating life of the structure. On the other hand, the return period of the MCE is typically about 1 in 10,000 years. The MCE is normally used for the design of closure measures for the tailings storages (Golder, 2007).

   GHD reviewed SRC and ESS' seismic hazard assessment. It increased the peak ground acceleration for the OBE from 0.25g to 0.39g and for MCE from 0.60g to 0.66g. These values were used for the slope stability assessment of the TSF under OBE and MCE conditions. GHD found the expected vertical displacement of the embankments under both conditions to be less than 1.0 m (GHD, 2009).

   As the tailings are dried during closure, the stability of the embankments against earthquakes will significantly improve.

2. Failure of the emergency spillway which may happen if the ground underlying the structure settles and cracks the spillway. Water therefore flows out of the structure and erodes the underlying ground. Erosion can lead to gullying that compromises the dam integrity.

3. Erosion. The dam embankment slopes and tailings surfaces are vulnerable to erosion and gullying. The vulnerability can be reduced by backsloping and revegetation. The embankment outer slope of 18.4° lends to a fair revegetation success following the Western Australia's Department of Minerals and Energy 1996 guidelines.

Adverse Consequences

The consequences of TSF failure after mine closure will depend on the location and extent of the breach. The potential consequences are:

- Loss of human life and damage to property
- Smothering of trees and other vegetation downslope, either naturally grown or planted as part of the company reforestation program or FMRDP
- Drainage disruption which may cause the diversion of surface flows or dam-break floods with greater risk of impacting larger areas
- Flooding and sedimentation which may affect domestic water use and irrigation. The tailings are expected to be enriched in Fe, Mn, Pb, Zn, As, Cd, and Hg (MCC, 2009).
- Effects on structures like roads
- Disruption of stream ecology and
- Adverse aesthetic impacts.

Implications to the FMRDP

Strict quality control throughout the construction of TSF 3 and TSF 4 is required to ensure that the facility is built as designed. This entails the following:

- Engagement only of a contractor experienced in tailings dam construction.
- Deployment of appropriately qualified personnel to ensure the contractor's compliance with the design drawings and specifications of construction materials.
- Installation of embankment stability monitoring equipment during construction and use of the equipment throughout the life of the facility.

During the closure of both TSF 3 and TSF 4, the following works are needed:

1. Assurance of the integrity and drainage capacity of the emergency spillways in perpetuity. This may require repair or stabilization works, installing trash traps and erosion protection measures, and monitoring and any required modification of the structures during the early years of mine closure to ensure their long-term utility.
2. Erosion management measures for the dam embankments and tailings surfaces. These consist of dam crest backsloping, grading, rock covers, and revegetation.

WRD and CLF

The WRD, which is located immediately northeast of the open pit, will accommodate mostly waste rocks that are not needed for the TSF construction (Figure 1-2). With a total capacity of roughly 7.9 million bcm, it will have a final height of 85 m and overall slopes of around 6° W-E and 24° S-N and NW-SE (Figure 2-2).

The CLF, located immediately northwest of the WRD, will store organic soils, subsoils, and clay-rich materials. With a total capacity of approximately 1.8 million bcm, its final height is 20 m with overall slopes of 7° SW-NE and 14° NW-SE (Figure 2-2). Upon attainment of full capacity and without waiting for mine closure, the CLF will host the vegetable and fruit plantations of the community.

Peter O'Bryan & Associates (2008) assessed the stability of the WRD using material shear strength properties that were based on information provided by Mining One, SRC, and ESS. They concluded that:

1. The location of the WRD immediately northeast of the open pit has a negligible effect on pit wall stability.
2. Under static and dry loading conditions, the WRD will be stable.
3. Under seismic and dry loading conditions, the WRD will essentially remain stable, *i.e.*, some localized movement of near-surface material may occur.
4. Only a limited saturation of the WRD can be tolerated. Water levels exceeding roughly 105 m RL within the dump would be expected to destabilize the slopes. An earthquake of sufficient magnitude or proximity to apply a horizontal acceleration of at least 0.25g coincidental with a

water level within the dump of above 104 mRL would cause failure. It was recommended that GRC avoid placing large "continuous" volumes of clay-rich material within the dump.

5. A worst-case situation in which earthquake-induced vibration coinciding with the presence of a substantial volume of water in the dump would be expected to cause slope instability. Slope movement would occur within the zone roughly 10 m behind or below the slope face. Breakout would occur near the toe of the slope. Consequently, some movement of waste towards the open pit is possible in the northern, northeastern, and eastern sectors. O'Bryan recommended bunding or the construction of catch fences around the pit edge to contain the material movement.

The programmed post-mining use of the WRD is industrial tree plantation.

Failure Modes

The failure modes are those processes that reduce shear strength or that increase shear stress on slopes (Highway Research Board, 1978). They have been discussed in the Open Pit Section.

Another failure mode that may be relevant specifically to the CLF is rainfall erosion. This starts with raindrop impact on bare ground. Soil particles are dislodged and moved a distance away. At the onset of runoff, water collects into small rivulets which can erode very small channels called rills. The rills may coalesce into larger and deeper channels called gullies. As discussed previously, gullying is a complex and destructive process which, when started, is difficult to stop.

Likelihood

Three failure modes are likely for the WRD during mine closure:

1. Removal of support or underlying materials through erosion – The WRD is located immediately northeast of the open pit. A pit wall failure due to factors enumerated in the Open Pit Section such as earthquake, wave action, or increase in lateral pressures, can destabilize the WRD and cause a mass movement.

2. Earthquakes – As discussed in the Environmental Setting Section, the Project site occurs in an earthquake-prone area. An extremely strong earthquake can destabilize the WRD either directly or indirectly through the pit walls.

3. Increase in lateral pressure by water in cracks and fissures and expansion of clays – Peter O'Bryan & Associates (2008) acknowledged this as the main threat to the WRD. He recommended the non-placement of large continuous volumes of clay-rich materials within the dump. Strict compliance with the recommendation and placement of piezometers to monitor the phreatic surface within the dump are required.

As regards the CLF, it will have a foundation that is more stable and not exposed to wave action. The failure mode of removal of support or underlying materials is therefore ruled out.

The CLF will also have a height and capacity that are one-fourth and almost one-fifth those of the WRD, respectively. Its slopes will be flatter. Hence, the likelihood of failure as a result of earthquakes and clay expansion is much reduced.

Finally, since the CLF will consist largely of soils, the structure will be vulnerable to erosion. However, by the time the mine will be closed, the facility will have been fully developed for vegetable and fruit plantations. This means that the appropriate erosion control measures have been installed.

Adverse Consequences

Failed materials from the WRD will most likely plunge into the open pit. As a worst-case scenario, a wave may develop and create a surge into Dayano Creek.

Failure at the northern portion of the WRD can be mitigated by the CLF. The price, however, is the loss of the vegetable and fruit plantations.

Implications to the FMRDP

The recommended management measures for the pit walls such as continual geotechnical monitoring, mapping, and assessment; prediction of the conditions after mine closure and geotechnical re-assessment; and water management are equally critical for the WRD.

In addition, strict day-to-day control on the placement of clay-rich materials within the dump is required. This needs to be complemented by the sinking and monitoring of piezometers within the dump.

To control erosion, stormwater management measures which include dump crest backsloping, rock covers, armoring of drainage channels, and revegetation are needed during mine closure.

Ponds and Water Dams

Within the process plant area, the Siana Gold Project will establish a secondary containment pond (Figure 1-2). The pond is excavated and concrete lined with dimensions of 29 m x 24 m and 4 m deep. It will collect and impound chemical spills that are not contained by the bunds and sumps as well as direct rainfall and limited surface runoff within the plant. On a daily basis, the impounded water is analyzed for pH and CN before unloading. The required treatment is done prior to discharge.

Two additional ponds outside of the process plant area will be established. One is Pond A which is located east of the process plant at the toe of the CLF; the other is Pond B which is downslope of the TSF 3 emergency spillway (Figure 1-2). Both ponds will have embankments made up of bulk earthfill. The inner walls together with the base for the water impoundment will be lined with compacted clay.

Pond A (Plant feed water dam) will store the excess supernatant from the TSFs for easy retrieval by the process plant as process water. It will also receive the water discharge of Silt trap A. The tubes will detain sediments in the surface runoff from the CLF and northern section of the WRD.

The pond will have a dam crest elevation of 54 m RL, crest width of 3 m, dam height of approximately 5 m, and dam outer slopes of 21.8°. The total storage is approximately 12,000 m^3. A division embankment will separate the pond into two parts. When the stored water level reaches 43 m RL, water from the northern section flows into the southern section. The northern section of the pond will have a pipework and pump to allow the recovery of stored water for plant use. The southern section has a spillway outlet that discharges ultimately to Pond B.

Pond B has dual functions. It serves as an emergency discharge storage for Pond A and a storage facility for flows from the TSF3 emergency spillway. With a dam crest elevation of 48 m RL and total storage of roughly 100,000 m^3, Pond B provides stormwater retention and settling of sediments suspended in the surface runoff. The pond discharges to geotextile tubes which perform a final filtration of the runoff prior to discharge to Dayano Creek.

At the end of mine life, the ponds and water dams will be drained, dredged, cleaned of pumps and pipes, and fixed to serve as water impoundments for fish farming.

Failure Modes

The expected failure modes for the ponds are:

- For the concrete walls of the secondary containment pond, the back and base may be scoured. The loss of support may destabilize and crack the structure.

  The bulk earthfill embankments of Ponds A and B may fail either by natural settlement, erosion and gullying, or a strong earthquake.

- The clay liners of Ponds A and B are prone to differential settlement. This may lead to localized cracking.

- Overtopping. Just like the TSFs, water may overtop the walls or embankments due to the inadequately sized spillways or blocked drainageways.

Likelihood

The secondary containment pond is not engineered to suit the requirements of mine closure. It has no spillways. Its surroundings are concrete paved; the walls are made of concrete. With exposure to the elements over time, the concrete will settle and crack.

The same is true with Ponds A and B. The embankments are not engineered and without rock armoring. The clay liner is prone to localized cracks. The ingress and outlet are appropriate only during operations.

Adverse Consequences

Without suitable closure works, the concrete containment pond will crack. Some water will be retained and will serve as breeding ground for mosquitoes. Visual aesthetics, public safety, and use of the land are the other issues.

Over time, the embankments of Ponds A and B will fail. This will lead to the same problems cited for the water dam and containment pond.

Implications to the FMRDP

There are two closure options for the ponds and water dams. One is backfill or removal of the embankments to reclaim the land. The other is retention of the water storage for fish farming. The latter option is chosen in view of the greater benefits that will accrue to the local residents.

The major steps required to convert the ponds and water dams into fish farms are:

- Analyze the impounded water, fully drain, and treat if required prior to discharge
- Dredge the contained sediments and deposit in the TSF
- Inspect and fix any cracks in the clay liner, concrete walls, or embankments
- Complete drainage works including the installation of plastic mesh screening to prevent the escape of fish
- Fill the storage with water
- Test the water quality and conduct fish survival test
- If results are favorable, stock the ponds with tilapia and other suitable fish.

Sanitary Landfill

The 2-ha sanitary landfill area is located south of the open pit in Brgy. Dayano (Figure 1-2). Its major features are a sanitary landfill, leachate collection and treatment system, gas venting system, soil cover dump, and a Material Recovery Facility.

Over an 11-year life, the landfill will accommodate around 21,000 m^3 of domestic solid waste. This is the aggregate of wastes generated by the Project personnel and households of Brgys. Siana and Dayano. The planned landfill will have dimensions of 120 m x 70 m x 3 m deep. It will have a clay liner at least 0.6 m thick with a permeability of 10^{-6} cm/s. At the end of each work day, the solid wastes will be fully covered by a 0.2-m thick soil cover.

The designs of the leachate treatment and gas collection systems are yet to be finalized. Most likely, the leachate treatment will be a combination of a biological method such as a sequencing batch reactor and a chemical treatment like carbon adsorption. The gas venting system may consist of perforated bamboos laid out on a grid.

Failure Modes

Soil covering at the end of every work day is a feature of the landfill. During closure, the soil cover needs to be supplemented by a final landfill cap. The functions of the cap are to:

- Minimize water infiltration into the waste
- Provide a long-term stable barrier between the waste and the environment
- Prevent the uncontrolled escape of landfill gas and
- Provide land suitable for the intended post-Project use.

The landfill cap may fail through various means. The contributors of failure are cyclic wetting and drying; penetration by plant roots, burrowing animals, worms, and insects; settlement caused by the compression of the waste; downslope slippage or creep; and wind or water erosion.

Leachate is liquid that seeps from the landfill. Its composition is dependent on the kind of waste and the state of waste decomposition. Leachate characterization undertaken by Ehrig (1988) in numerous municipal landfills of various ages disclosed elevated concentrations of the following: BOD_5, COD, SO_4, Ca, Mg, Fe, Cl, Na, K, NH_4, and N. During the early years of a landfill cell when conditions are acidic or acetic, the actual concentration of the first six parameters, *i.e.*, BOD_5, COD, SO_4, Ca, Mg, and Fe, becomes elevated. The concentrations of said parameters decrease when conditions change and become methanogenic, *i.e.*, methane producing. The concentrations of the last five parameters, *i.e.*, Cl, Na, K, NH_4, and N, are unchanged by the conditions prevailing in the landfill.

As discussed previously, the leachate treatment facility is yet to be designed. The treatment will most probably be a combination of biological and chemical methods. The biological methods work best for "young" leachate or the leachate of a recently opened landfill; the chemical methods are suitable for "mature" leachate or that of an old landfill.

The likely failure modes of the leachate treatment are clogging of the drainageway leading to the treatment facility, blinding or choking of filters, mechanical failures, and non-attainment of cycle times and optimal controls.

The anaerobic decomposition of the waste in landfills generates numerous gases, the principal ones of which are CO_2 and CH_4. CO_2 is heavier than air and will migrate to the bottom of the waste facility and be removed with the leachate. CH_4 is lighter than air and will rise to the top of the waste. A typical gas collector system used in the Philippines consists of perforated bamboos laid out on a grid. The bamboos may break due to waste settlement or slope failure.

Likelihood

Of the contributors to landfill cap failure listed previously, the ones most likely to impact the Project's sanitary landfill are cyclic wetting and drying and settlement due to the compression of waste.

For the leachate treatment facility and gas collector system, all enumerated failure modes such as drainageway clogging, blinding or choking of filters, mechanical failures, non-attainment of cycle time and optimal controls, and breakage of bamboo poles are likely.

Adverse Consequences

Failure of the landfill cap will lead to the uncontrolled generation of contaminated leachate and landfill gas. Dust, foul odor, and vermin are additional impacts. The landfill cannot be used as a sports and recreation area.

Failure of the leachate treatment and gas collector system will lead to air, water, and land pollution. Public health and safety will be at risk.

Implications to the FMRDP

The landfill cover system design needs to consider a host of factors such as nature of the waste; site hydrogeology; cycling wetting and drying; penetration by plant roots, burrowing animals, worms, and insects; total and differential settlement caused by compression of underlying waste or foundation soil; downslope slippage or creep; wind or water erosion; long-term moisture changes caused by water movement into or out of the underlying waste; and alterations caused by gas derived from volatile

components of the waste or decomposition products (Daniel and Koerner, 1993). For optimum results, several alternative cover system designs should be developed.

Prior to closure, the alternative landfill cap designs will be tested on the filled-up cells of the facility. The best design is then adopted for the landfill closure. Revegetation should follow the cover system installation. Subsequently, inspection and maintenance works will be needed to restore any depressions, seal minor cracks, prevent or control erosion, and restore or maintain vegetation.

The drainage channel around the sanitary landfill to divert surface runoff away from the facility should be redesigned to rout the PMF.

For the leachate treatment facility, the water quality of the influent and effluent leachate of the landfill needs regular monitoring up to and even beyond mine closure. The leachate treatment will also need periodic maintenance works such as backwash, filters replacement, slope stabilization and clearing of drainage channels, and mechanical, controls, and system check-ups. Depending on the evolving leachate water quality, other forms of treatment may be installed.

Finally, the gas collector system needs maintenance for the life of the landfill's gas generation. Gas generation is established by the regular monitoring of landfill gas.

Soil Substrate

The critical elements of mine rehabilitation works are length and steepness of slope, drainage planning, and revegetation. The length and steepness of slope determine the erodibility of the rehabilitated landform and the viability of proposed plantations. Drainage planning entails the delineation and shaping of rehabilitated catchments and establishment of appropriate drainage channels that will minimize erosion. As regards revegetation, its success depends on three (3) things. These are:

- Suitable soil
- Well-adapted species appropriate to the desired post-mining land use and
- Post-planting maintenance works.

The following discussions focus on the soil requirements.

Problem Assessment

Soils offer basic physical support for plants. It also supplies moisture, air, and nutrients to the roots. Good quality soil has the following properties:

- Texture refers to the size of individual soil particles, *i.e.*, sand, silt, and clay, and the relative quantity of each size present. It determines the amount of pore space in the soil. The more pore spaces, the more air and water the soil can retain.
- Soil structure is the manner and stability with which individual soil particles are bound together into larger particles called aggregates. The greater the degree of aggradation, the better the soil.

- Organic matter (OM) is primarily decayed or decaying plant and animal residues. It supplies available plant nutrients such as N, P, and S and it augments the soil's cation exchange capacity (CEC). OM helps to improve the soil's physical condition, water infiltration and water holding capacity. It also enhances the soil aggregate stability and it decreases soil erosion losses.

- CEC is the ability of a soil to retain cations (positively charged ions such as K^+, NH_4^+, H^+, Ca^{2+}, and Mg^{2+}) in a form that is available to plants. A soil's CEC depends on the amount and kinds of colloids present. The more clay or OM present, the higher the CEC. The higher the CEC, the more is the soil resistance to pH changes.

- Base saturation (BS) is the relative number in % of the CEC sites on the soil colloids that are occupied by bases such as Ca^{2+}, Mg^{2+}, and K^+. At pH 7, the BS is 100 %. BS declines by about 15 % for every 0.5 unit drop in soil pH.

- pH directly impacts nutrient availability and plant growth. The preferred pH range for most plants is between 5.5 and 7.

- Plant nutrients are classified into primary, *i.e.*, nutrients required by plants in the largest quantities such as N, P, and K; secondary, *i.e.*, nutrients just as important as the primaries but required in smaller quantities like Ca, Mg, and S; and micronutrients, *i.e.*, required by plants in extremely small quantities such as B, Mn, Zn, Cu, Fe, Mo, and Cl.

BMP conducted three separate soil investigations at or near the Project site.

The first was in January 2005 as part of the EIA of the Siana Gold Project. The investigation covered natural soils surrounding the Project site (Figure 5-17). From Table 5-1 which provides the physical and chemical properties of the auger hole samples, the following were inferred (BMP, 2009a):

1. The soils are classified into alluvial and upland soil. The upland soil evolved from igneous rocks and limestone.

2. The soil of the alluvial plain is clay loam to silty clay loam over clay, deep, and generally poorly drained. It is strongly to moderately acidic with medium to high organic matter. P, K, CEC, and base saturation percentage are all high. Cu is very high and Mn is low to medium. Overall, the soil has high fertility.

3. The soil in the upland that developed from igneous rocks is clayey, deep, and well drained. It is very strongly acidic with medium content of organic matter. P is low, K is high, CEC is high, and base saturation percentage ranges from low to medium. Cu is very low and Mn is from low to medium. Generally, the soil has medium fertility.

Table 5-1. Results of soil laboratory analyses for the EIA

Soil Properties	Soils of the Upland			Soils of the Lowland			
	Observation 1 Brgy. Dayano	Observation 2 Brgy. Cawilan	Observation 4 Brgy. San Pablo	Observation 3 Brgy. Cawilan	Observation 5 Brgy. Magpayang	Observation 6 Brgy. Siana	Observation 7 Brgy. San Pablo
Physical Properties							
Drainage	Well drained	Well drained	Well drained	Moderately well drained	Poorly drained	Poorly drained	Poorly drained
Slope (%)	28	36	10	1	<1	<1	<1
Texture	Clay	Loam over clay	Clay	Silty clay loam over clay	Clay loam	Clay loam over clay	Clay loam over clay
Soil depth (cm)	>100	>100	>100	>100	>100	>100	>100
Chemical Properties							
pH	4.8	5.5	4.7	5.7	5.4	5.7	5.3
Organic Matter (%)	2.63	2.15	2.85	2.88	3.63	2.78	3.12
Phosphorus (mg/kg)	0.51	7.36	0.98	52.5	35.7	57.1	15.1
Exch. Potassium (cmol/l)	0.26	0.29	0.44	0.49	0.39	0.43	0.48
Cation Exch. Capacity (cmol/l)	39.22	28.79	44.82	41.04	39.55	41.5	39.12
Base Saturation %	25.92	59.74	36.4	69.85	72.78	68.04	64.19
Zinc (mg/kg)	0.32	0.79	0.45	2.08	12.3	2.32	2.18
Copper (mg/kg)	0.25	1.13	0.11	3.52	5.55	3.75	4.13
Iron (mg/kg)	9	51	28	134	196	147	160
Manganese (mg/kg)	67	63	15	49	71	34	68

Note: The locations of the soil stations are shown in Figure 5-17.

Source: BMP, 2009a

4. The upland soil that developed from limestone is loam over clay, deep, and well drained. It is strongly acidic with medium content of organic matter. P, K, CEC, and base saturation percentage are high. Cu and Mn are low and medium, respectively. Overall, the fertility of the soil is medium.

BMP's second soil survey was in May 2009 as part of the FMRDP formulation for the Project. Unlike the first one, this survey covered SURICON's Tailings dam 3, Waste dump 2, and the area adjoining Waste dump 2. The location of the auger holes is shown in Figure 5-17; Table 5-2 provides the physical and chemical properties of the auger samples.

Table 5-2 Results of soil laboratory analyses for SURICON's tailings and waste dump

Soil Properties	Soil Observation Point			
	Obs. 1 and 2	Obs. 3, 4, 5, and 6	Obs. 7	Obs.8
Physical Properties				
Drainage (internal)	Moderate to somewhat poorly-drained	Moderate to somewhat poorly-drained	Poorly-drained	Moderate to somewhat poorly-drained
% slope	8-18%	30-35%	3-5%	Flat
Texture				
Depth (cm) 0 – 20	Clay Loam	Clay Loam	Clay	Silty Clay Loam
20 - 40	Clay Loam	Clay	Clay	Silty Clay Loam
40 – 55	Clay Loam	Clay	Clay	Silty Clay Loam
55 – 65	Clay Loam	Clay	Clay	Silty Clay Loam
65 - 80	Clay Loam	Clay	Clay	Silty Clay Loam
Chemical Properties				
pH	7.7 (MAI)	7.9 (MAI)	5.2 (MA)	7.5 (MAI)
% OM	1.08 (L)	0.7 (L)	3.16 (M)	0.98 (L)
Avail. P, ppm	0.3 (VL)	ND	3.0 (L)	2.0 (L)
Avail. K, ppm	78.0 (M)	117.0 (M)	312 (H)	39.0 (L)
Cu, ppm	5.5 (L)	4.53 (L)	12.18 (M)	18.32 (H)
Zn, ppm	4.9 (M)	1.73 (M)	31.81 (VH)	57.05 (VH)
Fe, ppm	14.43 (M)	13.37 (M)	16.06 (M)	31.82 (M)
Mn, ppm	13.16 (L)	9.29 (L)	72.58 (M)	75.12 (H)
General Fertility Rating	L	L	M	L*

Notes:

1. "MAI" is moderately alkaline, "MA" is moderately acidic, "L" is low, "M" is medium, "H" is high, "VH" is very high.
2. The general fertility rating for Obs. 8 is still low because of MAI pH which makes the soil nutrients in the soil not readily available to plants.

From Table 5-2, it was inferred that:

1. Observations (Obs.) 1 and 2, both within Waste dump 2, are near the southernmost edge of the dump. The soil has a mean depth of 1.0 to 1.5 m. It is clay loam in texture with excellent surface drainage, *i.e.*, general slope gradient of 8 to 18 %, and moderately well to somewhat poorly drained internally. The fertility is generally low. At a pH of 7.7, the soil is moderately alkaline which reduces the availability of micronutrients such as Cu and Zn to the plants. The use of inorganic N, P, and K combined with organic fertilizers is necessary. The soil can be planted to exotic fruit trees such as durian, nangka, marang, rambutan, and lanzones and annual agricultural crops like banana and abaca.

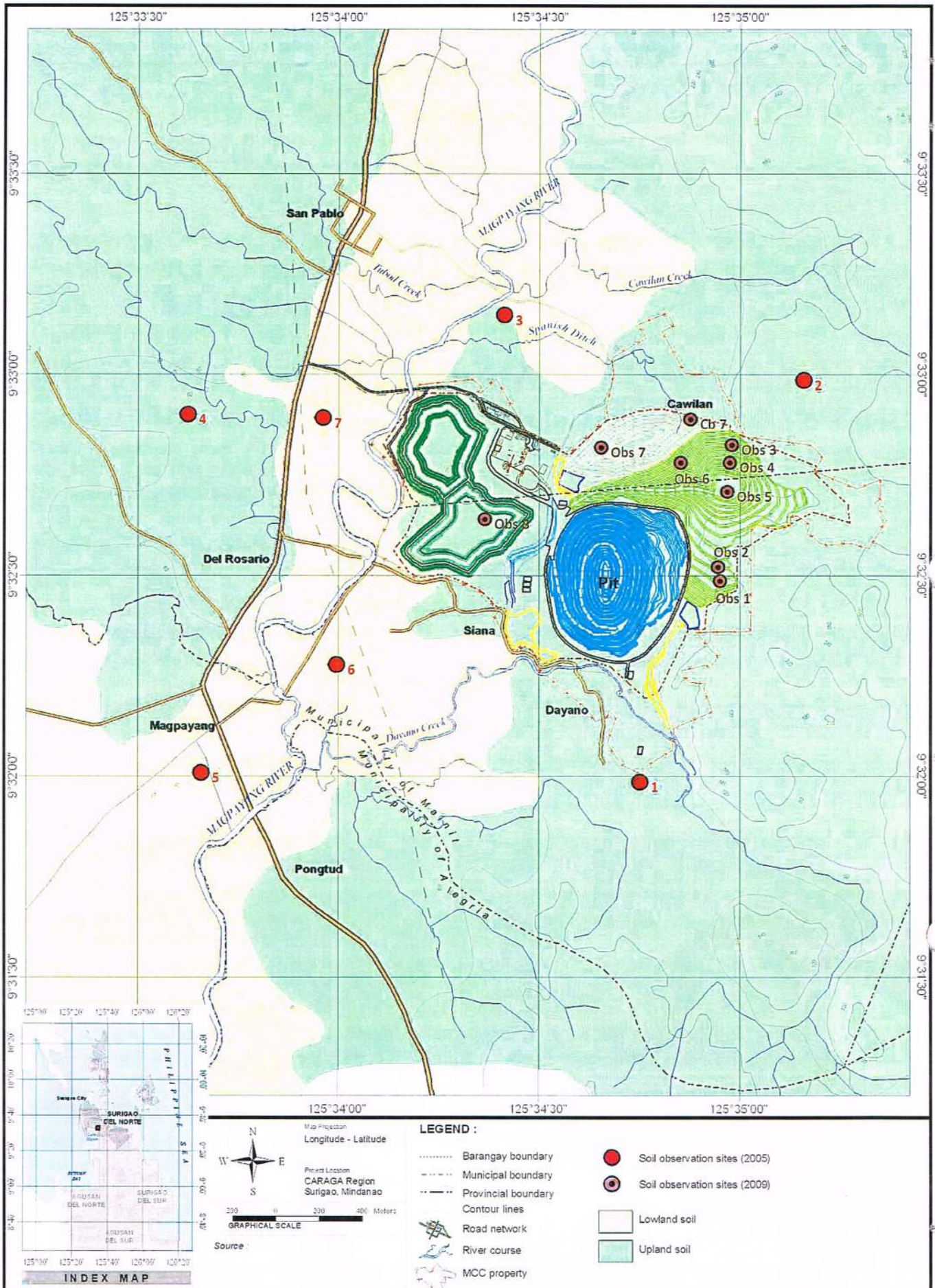
2. Obs. 3, 4, 5, and 6 are all within Waste dump 2. The auger holes are on open grassland with a mean gradient of 30 to 35 %. The soil is gravelly, rocky, and shallow clay loam over clay soils. The auger could hardly penetrate a 50-cm depth. The overall fertility rating of the soil is also low. The area is best suited for commercial forest tree species and fuel wood.

3. Obs. 7 and Check Boring (Cb) 7 are north of Waste dump 2 where the CLF will be built. The soil is clay. The water retention capacity is high, there is good soil surface drainage with 3 to 5 % slope, but poorly drained internally. With a pH of 5.2, the soil is moderately acidic. Under this condition, the inherent soil nutrients are still readily available to plants. The fertility of the soil is medium. Organic fertilizer and rice hull or carbonized rice hull are needed for good rooting system development of shallow-rooted crops to be grown.

4. Obs. 8 is on grassland inside SURICON's Tailings dam 3. The mean soil depth exceeds 1 m. It is silty clay loam with poor surface drainage and moderately well to somewhat poorly drained internally. OM, P, and K are low. The concentrations of micronutrients such as Cu, Zn, Fe, and Mn are moderate to very high. With a pH of 7.5, the soil nutrients present are not readily available to the plants. Because of the presence of Hg, Pb, and As in the soil as reported in the EIS (BMP, 2009a), agricultural crops for human consumption should be deferred until plant tissue analyses yield favorable results. Commercial forest tree species and other inedible crops like fuel wood can be grown in the area. Soil fertility management and surface drainage canals are necessary.

Photo 5-8. The site of Obs. 1 near the toe of SURICON's Waste dump 2.

Photo 5-9. The site of Obs. 2 is more agriculturally productive.



bmp

Soil investigations of 2005 and 2009

Photo 5-10. Obs. 3 is at the northern mid-slope of Waste dump 2.

Photo 5-11. Obs. 4 is at the peak of the northern slope of Waste dump 2.

Photo 5-12. Obs.5 is at the northwestern mid-slope of Waste dump 2.

Photo 5-13. Obs. 6 is at the eastern mid-slope of the waste dump.

Photo 5-14. Obs. 7 is north of Waste dump 2 where the CLF will be built.

Photo 5-15. Obs. 8 is inside the dried tailings of Tailings dam 3.

The soil investigations of 2005 and 2009 allow the comparison of natural soils and mining-disturbed soils that have recovered from 19 years of mine closure. The mining-disturbed soils, in terms of size, texture, and drainage, are less suitable to plant growth. They also have low fertilities, given the low OM, not detected to low P, and moderately alkaline pH. In contrast, the natural soils have much better physical and chemical properties. Their fertilities are medium to high.

The third soil investigation – a Landscape Function Analysis - was also conducted in May 2009 as part of the formulation of an FMRDP for the Project. It targeted a limestone forest (Transect 1), agro-forestry site planted with coconuts (Transect 2), and a site within Waste dump 2 undergoing natural succession (Transect 3, Figure 5-18). Transect 2 which was planted to a mixture of agricultural crops dominated by coconuts, represents a relatively mature system with human intervention after the cessation of SURICON operations. Transect 3 did not have human intervention so natural succession occurred.

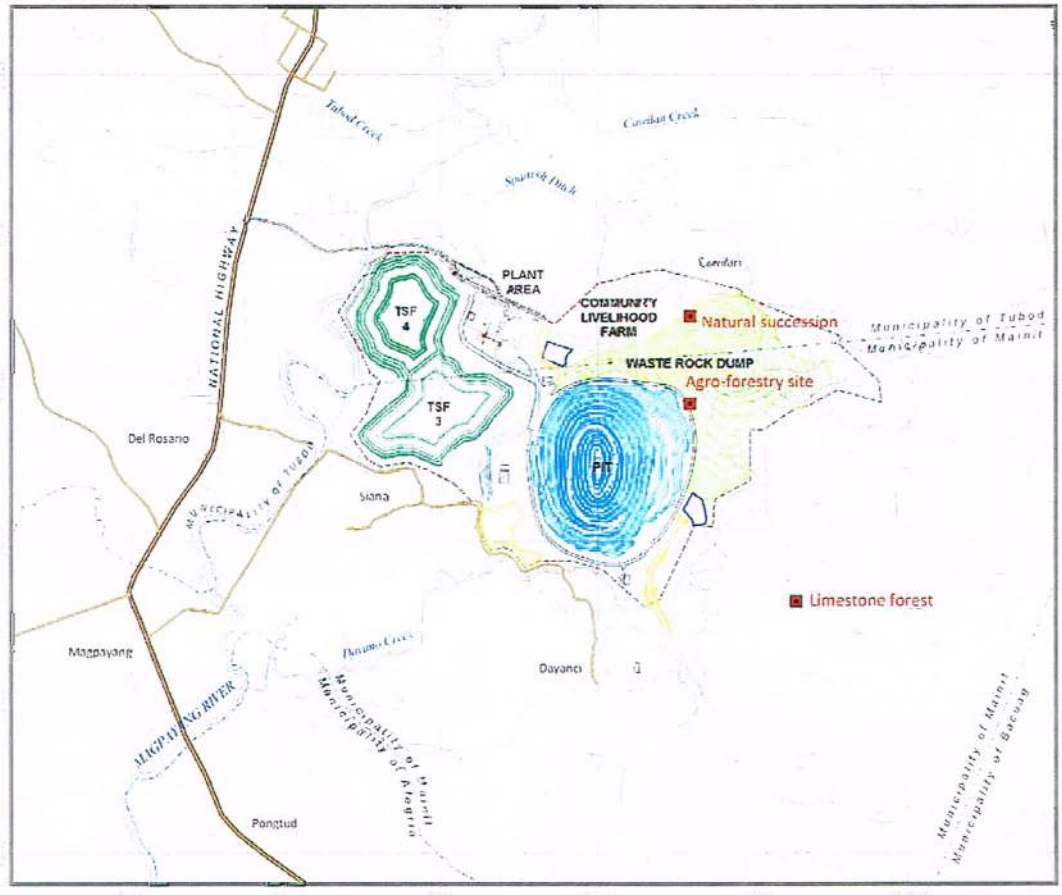


Figure 5-18. Sites for Landscape Function Analysis

LFA is one of three components of the Ecosystem Function Analysis (EFA) which was developed by the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) to assist in the assessment of rehabilitation at disturbed sites. It is a field monitoring procedure that uses simple indicators to assess how well a landscape is functioning as an ecological system.

The EFA model has three inter-related parts:

1. Landscape Function Analysis (LFA) – Simple field indicators are monitored to reflect stability or resistance to erosion, infiltration or water holding capacity, and nutrient cycling of the

landscape and soil. The indicators and their use as monitors for stability, infiltration, and nutrient cycling are shown in Figure 5-19.

The line transect for data collection is oriented in the direction of resource flow, usually downslope. Landscape features that interrupt, divert, or absorb runoff and transported materials are recorded. Zones of resource loss, *i.e.*, inter-patches, are distinguished from zones of resource gain, *i.e.*, patches, and their relative sizes measured. For each zone type, the indicators are assessed.

Two transects are usually adequate to gather LFA data. Monitoring of the rehabilitated landforms along the specific transects is undertaken annually. Over time, a time series record of ecosystem change or development may be constructed. Rill surveys can also be incorporated and undertaken perpendicular to the LFA transect to monitor the quantity and growth of rills and gullies.

The selection of analogue or reference sites is crucial to the effective use of the LFA. These sites, which are located in the vicinity of the Project area, represent a mature, highly functional landscape. They have many of the attributes of the final rehabilitated landscape and are self-sustaining. LFA data from these sites provide target values for the LFA indices in rehabilitation.

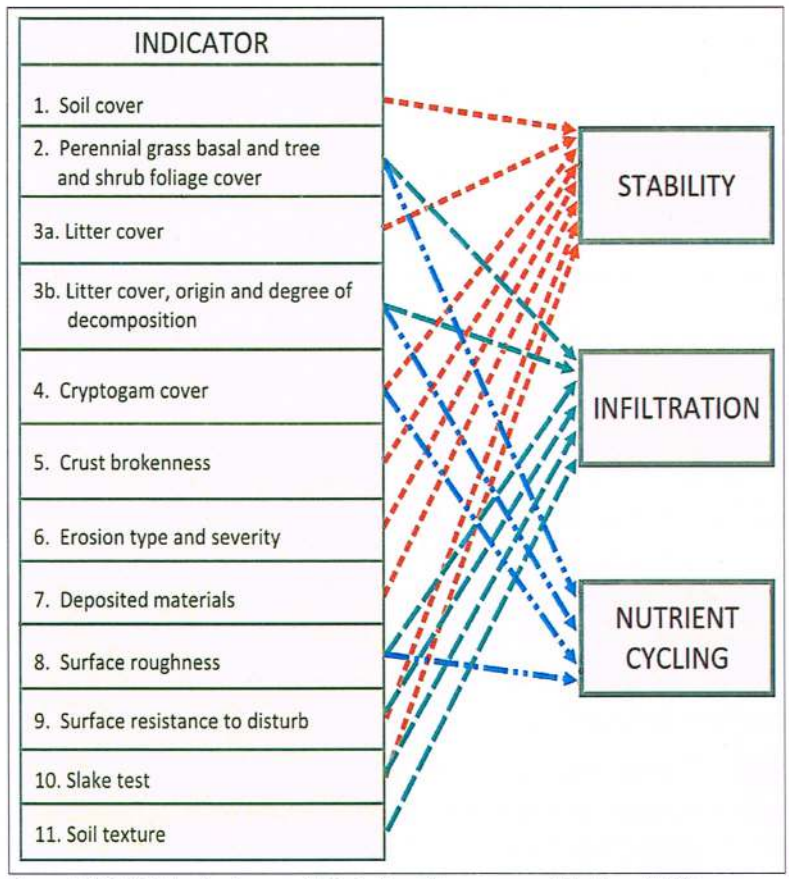


Figure 5-19. Field indicators and LFA indices (Tongway and Hindley, 2004)

2. Vegetation and structure composition – Vegetation has a highly functional role. It provides nutrients for an ecosystem and it provides suitable habitat, food, and shelter for the other biota. The monitoring of vegetation will define the species composition, structure, and functional role in the landscape.

3. Habitat complexity – The focus is on the habitat available for fauna and the status of fauna in the ecosystem. Indicators like ants, reptiles, and soil-litter biota have been used to monitor mine rehabilitation works.

The results of the soils transect of the LFA are shown in Table 5-3. No soil transect was run on the limestone forest for obvious reasons.

Table 5-3. LFA soil transect

Parameter	Transect		
	1 (Limestone Forest)	2 (Agro-forestry Site)	3 (Natural Succession)
Coordinates	9°32.206'N 125°35.092'E	9°32.628'N 125°34.864'E	9°32.815'N 125°34.865'E
General topography		12-18% slope (undulating to rolling)	30-35% slope (moderately steep)
Primary cover or vegetation		Coconut, mixed fruit trees, banana	Grasses (semi-perennials)
A. Crust brokenness		No crust present	No crust present
B. Erosion type and severity		Slightly eroded	Slightly eroded
C. Deposited materials		None	None
D. Soil surface roughness		Deep depression that have visible base (small gully; 1.5 m deep and 2.0 m wide)	Very rough (gravel and rock dumpsite)
E. Surface nature		Non-brittle (surface has no physical crust)	Non-brittle (surface has no physical crust)
F. Slake test		Stable	Stable
G. Soil surface texture (Feel method)		Clay loam Slow infiltration rate	Clay loam over clay Slow infiltration rate
H. Soil Fertility		Low	Low

Based on Table 5-3, Transects 2 and 3 differ in two respects. These are general topography and soil surface roughness. In terms of vegetation, Transect 2 has a more developed cover.

Adverse Consequences

The soil investigations of January 2005 and May 2009 highlighted the differences in physical, chemical, and fertility properties between natural soils and mining-disturbed soils. While the natural soils have fertilities of high to medium, the mining-disturbed soils have low fertilities. It should be noted that the mining-disturbed soils have gone through at least 19 years of natural recovery and succession. Thus, their assessment over-estimates actual soil condition at mine closure.

Poor soil properties and fertility will prevent the establishment of self-sustaining vegetation over the Project's disturbed sites. Thus, the sites will remain bare and vulnerable to rill and gully erosion.

Implications to the FMRDP

Successful rehabilitation programs in the country are attributed to the use on the plantation sites of topsoil recovered during the stripping of mining and facility sites. Topsoil refers to the A1 horizon of the soil which is usually darker than the underlying soil because of the accumulation of OM. Apart from OM, the topsoil contains seeds and other plant propagules, soil micro-organisms, and the more labile plant nutrients.

During mine closure, topsoil may not be enough to cover all disturbed sites. Thus, the soil substrate for the Project's plantations will lack OM, the vital primary and micro-nutrients, especially N and P, and the needed soil structure and texture.

Recycled organics comprise the compostable organic materials such as garden organics, food organics, residual wood and timber, biosolids (dewatered sludge of wastewater treatment), and agricultural residues. They are recoverable from the domestic solid waste which is deposited in the Project's sanitary landfill. Recycled organics have been used in mine rehabilitation as soil amendment, topsoil substitute, or fertilizer. Kelly (2006) found the following benefits from said materials:

1. Improved soil structure and moisture retention
2. Rich source of plant nutrients and water
3. Rapid establishment of microflora and microfauna needed for plant growth and
4. No need for separate and repeated fertilizer applications.

With respect to the third benefit, Muchovej and Pacovsky (1997) noted that the addition of organic residues to soil stimulates soil microbial activities and builds biomass in a fashion not duplicated by inorganic fertilizers. Since microbial decomposition is required for the release of N, P, and S into a plant-available form, organic fertilizers supply nutrients in a slow-release form. Such controlled release of nutrients usually results in significantly less leaching of nitrates and phosphates into the groundwater.

According to Kelly (2006), the characteristics of beneficial recycled organics as:

- High in primary and micro nutrients
- pH around neutral, thus providing buffering capacity
- Reasonable moisture content to provide water
- High in OM and microflora and fauna to encourage plant growth and the re-establishment of soil structure
- C:N ratio between 10:1 to 25:1 to make N available for plant use and

- Low available contaminants such as heavy metals, pesticides, salts, and nutrients in excess of plant requirements.

The recommended application rates of residual organics for mine site rehabilitation in Australia are 50 dt/ha for biosolids, 80 dt/ha for municipal solid waste, 150 dt/ha for flyash, 10 to 30 cm or 150 to 300 t/ha for mulch and 10 to 20 cm or 70 to 150 t/ha for compost (*Ibid.*).

Revegetation

Failure Modes

The final operation of the FRMDP is revegetation. The resultant plantation must meet two basic requirements:

- Provision of forage for livestock and habitat for wildlife consistent with the approved post-mining land use and
- Control of erosion from disturbed lands to the rate corresponding to the approved post-mining land use.

Revegetation involves the following steps:

1. Planning and preparation to ensure the best selection of planting species and use of optimum weather conditions, fertilization, soil preparation, planting, and mulching methods
2. Seedling production either from wildlings, seedling production, or cloning
3. Pruning and acclimatization of seedlings before planting
4. Ground preparation which involves contouring, breaking and loosening of soil surface, and soil conditioning
5. Planting and
6. Maintenance works such as mulching, weeding, watering during summer, pruning, trimming, and litter clean-up. A controlled burn is sometimes required to remove excessive ground litter.

To track the progress of revegetation works and ensure their success, regular monitoring of the plantations is required. Traditionally, monitoring has focused on the following (Ferris *et al.*, 1996):

- Percent (%) vegetation cover by species
- Percent total vegetation cover (as sum of all species)
- Percent total ground cover (as sum of vegetation, litter, and rock cover)
- Percent bare ground
- Herbaceous production

- Shrub density and
- List of species observed during sampling.

As discussed previously, CSIRO's EFA and LFA, when referenced to an analogue meaningful to the post-mining land use, provide a more structured and comprehensive framework of monitoring rehabilitation success.

Lamb (2005) in his compilation of studies on reforestation in Asia and the Pacific attributed the failures of reforestation to a host of factors that include:

- Lack of weed control especially during the early years of plantation growth
- Inappropriate species or provenance choices
- Inadequate soil nutrition
- Poor planting stocks
- Drought and
- Fire.

Other causes such as livestock grazing and agricultural cultivation may be cited.

As discussed previously, in August 2009, BMP conducted an LFA over a limestone forest (Transect 1), agro-forestry site planted with coconuts (Transect 2), and a site undergoing natural succession (Transect 3, Figure 5-18). The major vegetation findings of the LFA were:

1. The limestone forest had stumps, indicating timber poaching. The most prominent species cut was Molave (*Vitex parviflora*) for its very durable wood for furniture and construction. Miscellaneous species are the most dominant species, followed by molave, hindang, *Ficus sp.* and amugis.

   To assess the forest structure parameters, the point-center quarter method (PCQM) was used. Table 5-4 shows the biometrics of the limestone forest. The mean distance is 3.19 m. The number of trees per 100 m^2 is 9.78. The estimated volume of timber per hectare is 30.4 m^3.

Table 5-4. Biometrics of PCQM in the limestone forest

Sampling Point	Species local name	Distance (m)	DBH (cm)	Height (m)
1	Ilang-ilang	1.2	20	7.5
	Ficus sp.	2.1	20	6.8
	Ilang-ilang	11	22	8
	Syzygium sp.	3.9	13	5.6
2	Molave	1	22	7.6
	Molave	2	28	8.7

Sampling Point	Species local name	Distance (m)	DBH (cm)	Height (m)
	Malatambis	8.25	29	8.5
	Ficus sp.	3	25	6.4
3	Amugis	3	21	6.7
	Miscellaneous sp.	2.6	20	6.7
	Tiagkot	1.4	20	7
	Miscellaneous sp.	2.1	10	4.6
4	Malanangka	2.1	32	9.3
	Hindang	4.3	23	7.5
	Hindang	1.4	18	5.4
	Salinggogon	2.3	21	6.9
5	Duguan	2.2	20	6.8
	Molave	2.6	43	9.6
	Malatambis	3	14	4.3
	Amugis	4.5	15	4.9

Photo 5-16. Transect 3, the limestone forest, is surrounded by kaingin.

2. The agro-forestry site (Transect 2) has a ground cover of around 75 %. Along the transect, 17 species of plants were recorded (Table 5-5). At least three were forest tree species; the rest were herbs and vines. The latter are the product of a better micro-climate created by broad leaf species

such as Hagonoy (*Chomolaena odorata*) and coronitas (*Lantana camara*). These species will eventually replace cogon and talahib. If fire is continuously avoided, the site will evolve into a secondary forest.

Table 5-5. LFA vegetation data in the agro-forestry site

Distance (m)	Species/Patch	Close/Cover Patch Width (cm)	Height (m)	Remarks
0-0.2	Cogon	6	0.65	Mature
0-0.7	Hagonoy	5	0.55	Mature
0-0.8	Cogon	10	0.65	Mature
0-6.1	Cogon	503	0.65	Mature
0-6.5	Ipil-ipil	30	1	Seedling
0-6.8	Hagonoy	6	1.2	Mature
0-7	Ipil-ipil	60	1	Seedling
0-7.1	Hagonoy	16	1.5	Mature
0-7.2	Ipil-ipil	20	1	Seedling
0-7.3	Coronitas/Lantana	2.2	1.5	Mature
0-7.5	Hagonoy	30	1.5	Mature
0-7.7	Dahat/*Cyperus sp.*	100	1.6	Mature
0-12.95	Coronitas	70	0.65	Mature
0-14.2	*Stachytarfeta*	60	1.3	Mature
0-15.3	Coronitas	30	1.1	Mature
0-17.5	Dahat/*Cyperus sp.*	40	1.2	Mature
0-18.7	Hagonoy	40	1.2	Mature
0-19	Cogon	200	1.3	Mature
0-19.4	Ipil-ipil	40	1.5	Seedling
0-20.4	Talahib, cogon and hagonoy	750	1.5	Mature
0-23.2	Ipil-ipil	75	5	Pole
0-25.9	Talahib	150	4	Mature
0-27	Ipil-ipil	10	3.5	Pole
0-28	Bare	-100		
0-30	Coconut leaves	60		
0-32	Litters	60		
0-33.7	*Mikania cordata*	70	0.3	Vine
0-34.2	Ipil-ipil	20	0.5	Seedling
0-36.9	Lokdo (fern)	7	0.25	Seedling
0-37.1	Litters	40		

Distance (m)	Species/Patch	Close/Cover Patch Width (cm)	Height (m)	Remarks
0-38.7	*Cyrtococcum patens*	12	0.05	Seedling
0-39.2	Dahat/*Cyperus sp.*	8	0.15	Seedling
0-41.1	*Paspalum conjugatum*	15	0.15	Seedling
0-41.5	Lokdo (fern)	3	0.08	Seedling
0-42.1	*Paspalum conjugatum*	15	0.15	Seedling
0-42.7	Ipil-ipil	10	0.3	Seedling
0-43.2	Cogon	1	0.3	Seedling
0.43.7	Nito	12	0.15	Seedling
0.44.4	*Paspalum conjugatum*	20	0.2	Seedling
0-44.91	Dahat/*cyperus sp.*	7	0.2	Seedling
0-44.98	Fern	8	0.15	Seedling
0-45.2	Miscellaneous sp.1	10	0.15	Seedling
0-45.3	Bare	-30		
0-45.5	*Pneumatopteris nitidula*	15	0.3	Mature
0-45.83	*Melastoma sp.*	9	0.1	Seedling
0-46.1	Makahiya	10	0.1	Seedling
0-46.4	Hagonoy	15	0.15	Seedling
0-46.5	Miscellaneous sp. (tree)	18	2	Sapling
0-46.6	*Pneumatopteris laevis*	10	0.15	Seedling
0-46.7	Hagonoy	5	0.1	Seedling
0-46.8	*Pneumatopteris nitidula*	35	0.1	Mature
0-46.9	Makahiya	10	0.15	Seedling
0.46.95	Hauili	35	0.45	Mature
0-47.1	*Mikania cordata*	100	0.25	Seedling
0-47.23	Makahiya	10	0.4	Seedling
0-47.3	Hauili	400		
0-47.34	Coconut leaves	10	0.2	Mature
0-47.45	Mikania	15	0.2	Seedling
0-47.55	Miscel. Sp. 1	15	0.35	Seedling
0-47.63	Hauili	15	1	Sapling
0-47.66	Ipil-ipil	20	0.35	Mature
0-47.68	*Paspalum conjugatum*	40	0.25	Mature

Distance (m)	Species/Patch	Close/Cover Patch Width (cm)	Height (m)	Remarks
0-47.77	*Pneumatopteris laevis*	25	0.35	Mature
0.47.81	Bare	-50		
0-47.89	Fern	100	0.45	Mature
0-47.91	Hagonoy	5	0.45	Seedling
0-48.2	*C. patens*	30	0.25	Mature
0-48.67	Lokdo (fern)	25	0.35	Mature
0-48.78	Litters	122		
0-48.81	*Paspalum conjugatum*	20	0.25	Mature
0-49.3	Ipil-ipil	17	0.2	Seedling
0-49.67	*C. patens*	5	0.1	Seedling
0-50	*Pneumatopteris laevis*	10	0.25	Mature
Total	17 species	3757.2 cm		
% Cover		75.14% (close)		

Plants outside of the transect in the agro-forestry site were likewise assessed. Twenty-three plant species from various families were identified (Table 5-6). This confirms that succession will proceed once the micro-climate and other physical characteristics have improved and that harmful factors such as fires are prevented.

Table 5-6. Enumeration of plant species within the agro-forestry area

Species Local Name	Scientific Name (Family)
1. Bayabas	*Psidium guajava* (Myrtaceae)
2. Saging (wild)	*Musa sapientum*
3. Tibig	*Ficus nota* (Moraceae)
4. Bayok	*Pterospermum diversifolium* (Sterculiaceae)
5. Hauili	*Ficus hauili* (Moraceae)
6. Rambutan (introduced)	*Nephelium lappaceum* (Meliacee)
7. Marang	*Litsea perrottetti* (Lauraceae)
8. Santol	*Sandoricum coetjape* (Meliaceae)
9. Antipolo	*Artocarpus blancoi* (Moraceae)
10. Maguey	*Pandanus sp.* (Pandanaceae)
11. *Ficus sp.*	*Ficus sp.* (Pandanaceae)
12. Dona aurora	*Musaenda* sp (Rubiaceae)
13. *Callopogonium*	*Callopogonium muconoides* (Leguminosae)
14. Malapapaya	*Polyscias nodosa* (Araliaceae)

Species Local Name	Scientific Name (Family)
15. Miscellaneous sp. 1 (tree)	Miscellaneous sp.
16. Miscellaneous sp. 2 (tree)	Miscellaneous sp.
17. Gabi (wild)	*Alocasia macrorrhizos* (Araceae)
18. Tagbak	*Alpinia elans* (Zingiberaceae)
19. *Elephantopus tomentosus*	*Elephantpous tomentosus*
20. Niyog-niogan	*Ficus pseudopalma* (Moraceae)
21. Langka (introduced)	*Artocarpus heterophylla* (Moraceae)
22. Tubang usa	*Costus speciosus* (Costaceae)
23. Dilang butiki	*Centrosema pubescens* (Leguminosae)

Photo 5-17. The agro-forestry site 19 years after cessation of SURICON operations.

3. Transect 3 is within Waste dump 2. However, unlike Transect 2, no human intervention in the area was visible. The plant community is relatively poor. Only six species of plants were noted along the transect and cogon is dominant (Table 5-7). The site only has 57 % ground cover. As noted in the preceding Section, the area is generally rocky.

   In time and after the termination of ground disturbance due to mining operations, plant succession will proceed even without human intervention. However, as shown in Transect 3, the pace will be very slow. Human intervention through rehabilitation activities is needed to fast-track plant succession.

Table 5-7. LFA vegetation data in the natural succession site

Distance (m)	Species/Patch	Close/Cover Patch Width(cm)	Height (m)	Remarks
0-0.2	Bare	-30		
0-0.55	Cogon	15	0.34	Mature
0-0.63	*Desmodium triflorum*	96	0.15	Mature
0-1.76	Cogon	60	0.38	Mature
0-1.89	*Cyperus sp.*	37	0.77	Mature
0-2.91	Bare	-50		
0-3.0	*Desmodium triflorum*	5	0.1	Mature
0-3.2	*Cyperus sp.*	50	0.32	Mature
0-3.42	Cogon	50	0.4	Mature
0-3.78	*Desmodium triflorum*	6	0.21	Mature
0-3.98	Rock	30		
0-4.2	Bare	-30		
0-4.32	Cogon	30	0.23	Mature
0-4.45	Rock	5		
0-4.54	*Desmodium triflorum*	10	0.12	Mature
0-4.68	Cogon	13	0.5	Mature
0-4.87	Bare	-20		
0-4.9	Rock	25		
0-5.1	Cogon	14	35	Mature
0-5.66	Rock	40		
0-5.75	Talahib	40	0.4	Mature
0.5.98	Bare	-39		
0-6.02	Cogon	200	0.35	Mature
0-6.23	*Desmodium triflorum*	40	0.1	Mature
0-7.04	Cogon	100	0.35	Mature
0-8.0	Cogon	140	0.35	Mature
0-8.9	Bare	-30		
0-9.23	Cogon	10	0.3	Mature
0-10.1	Bare	40		
0-11.45	Cogon	20	0.3	Mature
0-12	Rock	10		
0-12.78	Cogon	60	0.3	Mature
0-13.21	Talahib	30	0.35	Mature
0-13.88	Bare	-150		

Distance (m)	Species/Patch	Close/Cover Patch Width(cm)	Height (m)	Remarks
0-14.32	Talahib	15	0.35	Mature
0-14.79	Hagonoy	9	0.27	Seedling
0-15.4	Bare	-30		
0-16	Rock	75		
0-16.8	Cogon	125	0.3	Mature
0-18.5	Bare	25		
0-19.8	Cogon	35	1	Mature
0-20.53	Hagonoy	15	0.75	Mature
0-20.63	Rock	75		
0-21	Cogon	5	Mature	Mature
0-21.2	Hagonoy	8	0.1	Seedling
0-21.6	Bare	-300		
0-21.7	Cogon	10	0.2	Mature
0-23.7	Rock	40		
0-24.0	Cogon	30	0.2	Mature
0-24.6	Bare	-40		
0-25.4	Cogon	35	0.25	Mature
0-26.7	Bare	-20		
0-26.9	Cogon	20	0.35	Mature
0-27.5	*Mimosa pudica*	8	0.1	Mature
0-28.5	Talahib	5	0.4	Mature
0-28.6	Bare	-140		
Total	6 species	1711 cm		
% Cover		57.03% (close)		

Photo 5-18. Transect 3 is rocky and has cogon as the dominant species.

Adverse Consequences

The adverse impacts of low survival and land cover rates for the plantations are:

1. Dust
2. Rainfall erosion
3. Rainfall-induced mass movement and
4. Visual aesthetic impacts.

Implications to the FMRDP

In order to prevent revegetation failures, the testing and trial planting of bet species before massive plantation establishment is recommended. Non-adapted exotics that have not fully acclimatized to local conditions must be avoided. The reasons for the use of endemic species are:

- Native species are more adapted to local conditions, hence, risks are eliminated and maintenance costs are less.
- Native species are hardy and they withstand extreme climatic and physical stress.
- Endemic species are environment-friendly and they require fewer pesticides and fertilizers because of natural adaptations.
- The use of native species promotes biodiversity.
- Endemic species are socially acceptable because they provide food and shelter for native wildlife.

- Native plants ensure there will be less chance for introduced plants to become invasive.

The tree species that may be included in the species trial experiment are:

1. Narra
2. Ipil-ipil
3. Molave
4. Salingogon
5. Ilang-ilang
6. Yemane
7. Kakawate
8. Magium
9. Moluccan sao
10. Aratilis
11. Kawayang tinik.

The list includes some introduced species. However, these species have long adapted to local conditions and because of their economic value, their use is widespread. None of them are considered invasive or known hosts of insect pests and diseases.

The recommended understory component that will provide immediate ground cover are:

1. *Callopogonium muconoides*
2. Wild daisy (*Wedelia biflora*).

Photo 5-19. *Callopogonium muconoides* as understory species to provide immediate ground cover.

Photo 5-20. *Wedelia biflora* as understory species and for slope stabilization.

The purpose of the species trial is to identify the best species that will be included in the design of rehabilitation models appropriate for post-mining land uses. Other than the selection of species, the trial will also determine the best soil amelioration technique.

Figure 5-20 is the experimental set-up of the species trial. The design is completely randomized with three replicates, four treatments, and 11 species to be tested. The four soil amelioration treatments are:

- T1 = control or no soil amelioration
- T2 = compost + plain soil
- T3 = Mycovam and
- T4 = complete fertilizer (14-14-14).

Each of the cells (*e.g.*, S1) must contain 20 seedlings of each species and planted at a spacing of 1 m x 1 m. From the 20 seedlings of each species, at least three randomly selected seedlings must be tagged permanently for quarterly monitoring and measurement of growth variables such as ground-line diameter (cm) and height (m). Alleys measuring 3 m must separate each treatment; 4 m alleys are to separate replicates.

The experimental set-up requires about 6,162 m^2. Roughly 240 seedlings of each species or a total of 2,640 seedlings for all species are needed. No replanting of mortality will be done. The mortality should be recorded to serve as basis for decision making.

The experiment may last for up to two years. Subsequently, the best species and the best soil amelioration treatment are determined. These will be used in the rehabilitation models that will be formulated and implemented.

After planting, maintenance works such as ring weeding, pruning, mulching, and watering during dry days are required. This will address the risks of failure due to weeds, drought, and fire.

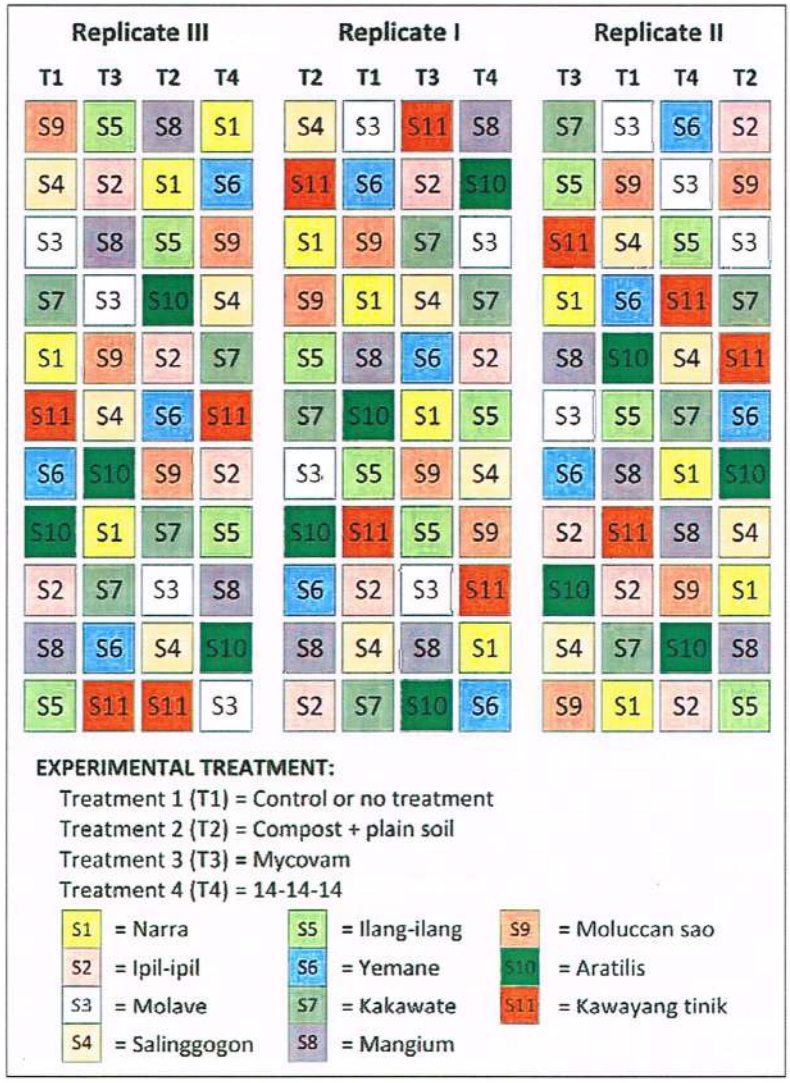


Figure 5-20. The experimental set-up of the species trial.

6. MINE CLOSURE PLAN

Final Land Use

DENR Administrative Order No. 1996-40, as amended, provides guidelines on the determination of a post-mining land use:

> *Minesite decommissioning and rehabilitation shall aim to establish a land use capability that is functional and proximate to the land use prior to the disturbance of the mine area, unless other more beneficial land uses are pre-determined and agreed in partnership with local communities and Local Government Units.*

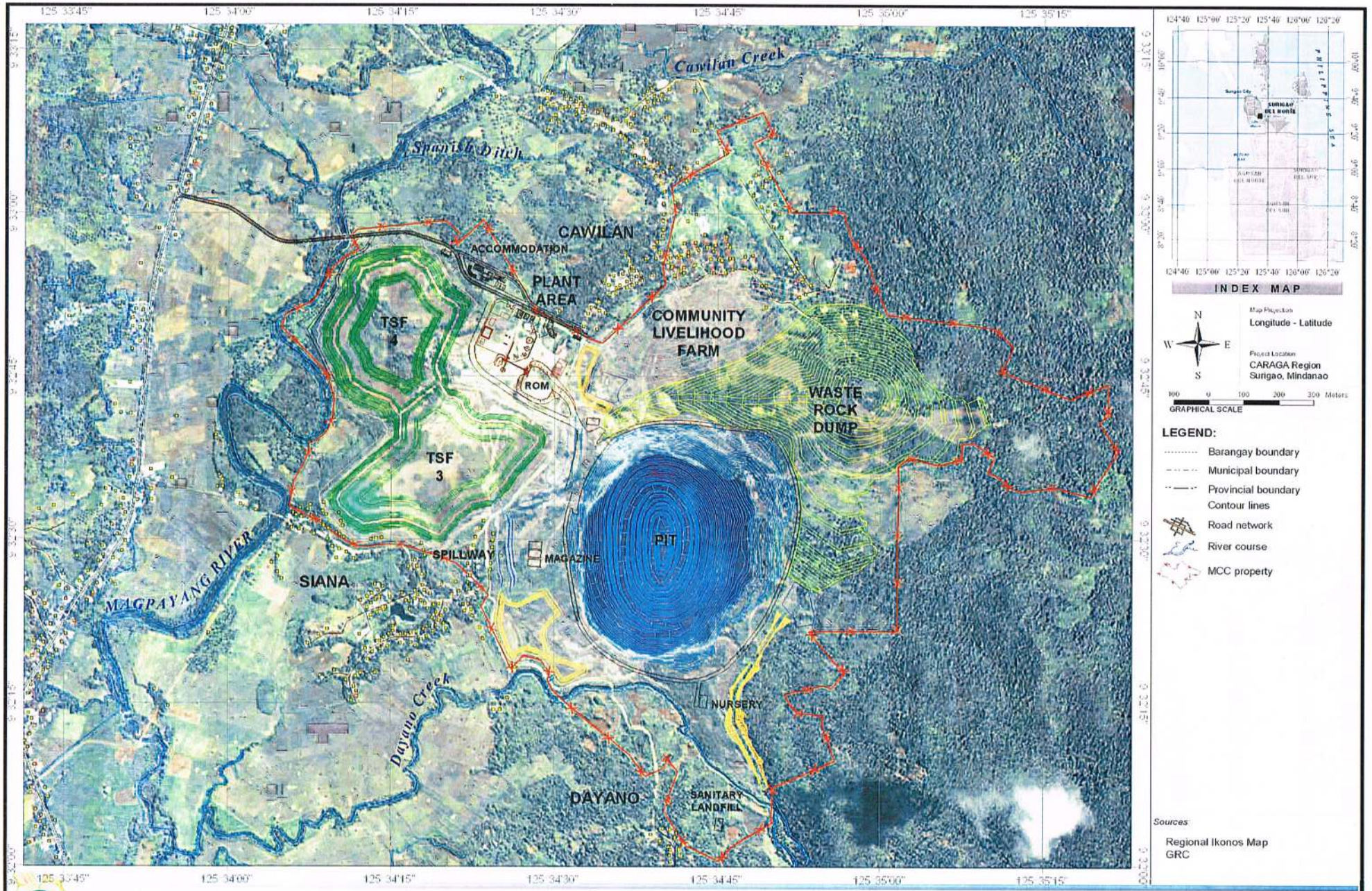
Therefore, the general rule is return of the mine-disturbed land to its original use. Other land uses may be considered provided that they are more beneficial compared to the pre-mining land use and the local communities and local government units (LGUs) agree on the land use change.

Based on the EIS of the Siana Gold Project (BMP, 2009a), the pre-Project land uses in the Project site are (Figure 6-1):

- Flooded open pit
- Dried tailings ponds with a pool of water in the southwestern corner
- Waste rock dumps
- Flooded settling pond south of the pit
- Abandoned sites of SURICON's process plant and buildings
- Site of old warehouse serving as GRC's field office
- Access road
- Former accommodations area of SURICON employees now occupied by Brgy. Cawilan residents
- Grassland, shrubland, and some wetlands.

With respect to the other prospective land uses, it is recalled that land use is determined by a host of physical, economic, market, and social factors. These are:

1. Soil type and fertility, slope, and climate which define, most of all, the agricultural possibilities
2. Recreational and conservation values
3. Nearness to and needs of markets, including housing and industries
4. Land use and developments in adjacent areas
5. Natural hazards



Ikonos image of the Project site

FMRDP for the Siana Gold Project

Figure No. **6-1**

6. Socio-cultural preferences and
7. Owner and investor preferences.

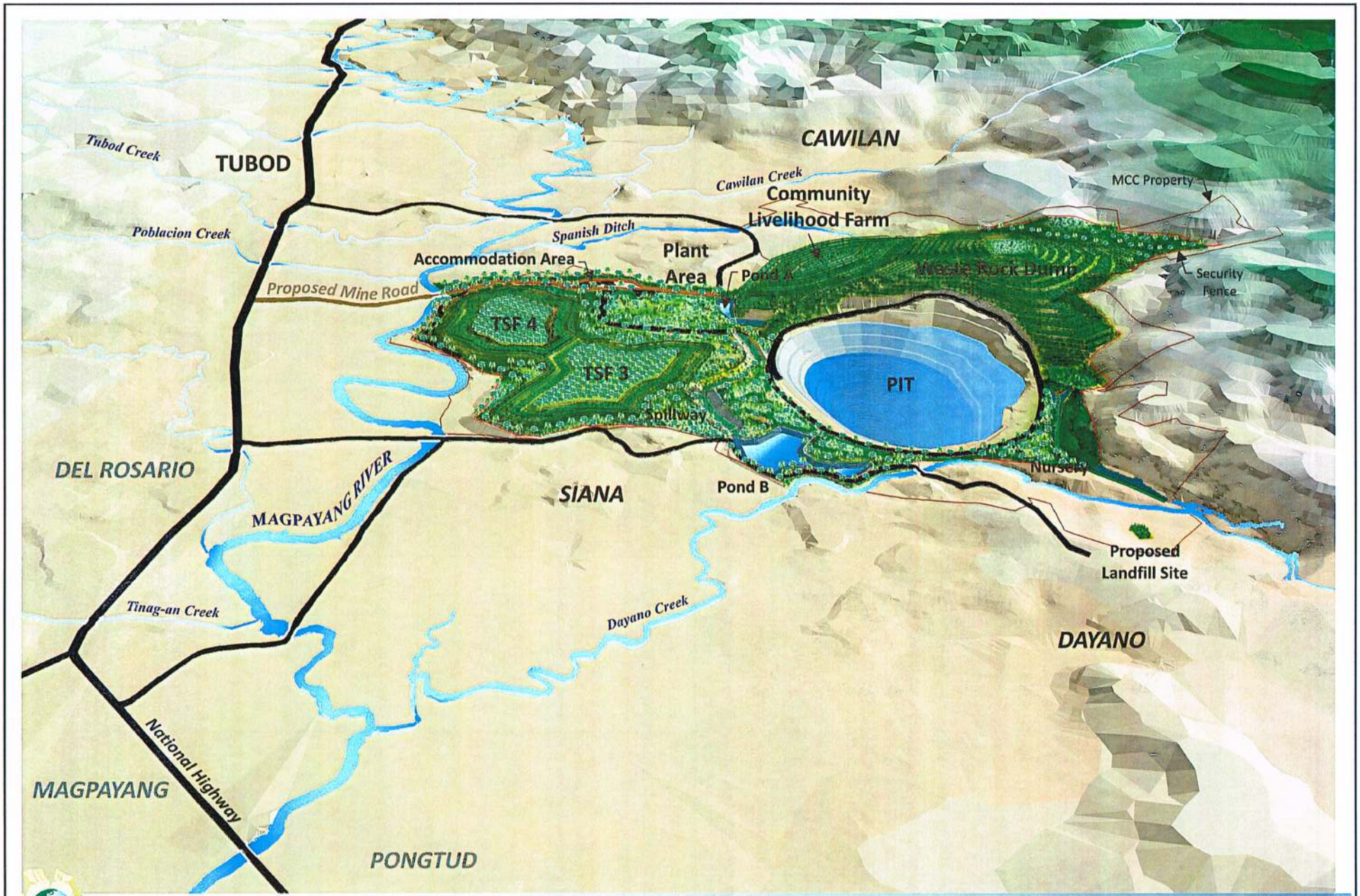
Based on the pre-Project land uses; physical, economic, market, and social factors; and the community consultations, six alternative post-mining land uses have been identified for the Project. These are:

1. Residential
2. Industrial tree plantation
3. Aquaculture
4. Forestland
5. Agriculture and
6. Ecotourism.

The strengths, weaknesses or caveats, and final evaluation of each land use have been presented in Table 2-1. Table 6-1 extends the post-mining land use selection by presenting for each major facility of the Project, the pre-Project land use and the post-mining land use options. Finally, the preferred post-mining land use is determined and the reasons for the preference provided. Figure 6-2 is a conceptual perspective view of the Project area after achievement of the preferred post-mining land uses.

Table 6-1. Pre- and post-mining land uses

Project Facility	Pre-Project Land Uses	Post-Mining Land Use Options	Preferred Post-Mining Land Use
Open pit	• Pit lake • Shrubland	• Pit lake • Part of an Ecological Park	Lake for recreation – SURICON's old pit is now a lake that is used by the local residents for bathing, picnics, and recreation. GRC also uses the lakewater as source for the community's potable water system. The pit will be dewatered to allow the open pit and underground mining of the ore. The pit walls will be pushed back by a maximum of 70 m to the northeast. The vegetation in the push-back areas is shrubs. The pit will be deepened by about 115 m from its current bottom. As the ore is depleted, all mining equipment including pumps will be taken out. The pit will again accumulate water as a result of direct rainfall, surface runoff, and groundwater inflows. Over time, it will fill with water. During mine closure, the pit lake shore will be planted with premium endemic forest tree species. To add more value to the lake, recreational areas such as wilderness trails, bicycle lanes, camping areas, gardens, open air restaurants, and boating and water sports facilities may be developed. This will, however, require a market and feasibility study. The best time to do the study is two years before mine closure.



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Conceptual perspective view of the area after mine closure works

FMRDP for the Siana Gold Project

Figure No. 6-2

Project Facility	Pre-Project Land Uses	Post-Mining Land Use Options	Preferred Post-Mining Land Use
			In this FMRDP and pending the confirmation of the market demand and feasibility, no costs for the establishment of recreational areas are included.
Process plant area excluding the secondary containment pond	• Bare areas • Grassland	• Forest tree park • Residential • Agriculture	Forest tree park – The actual housing demand in the area is difficult to forecast 12 to 13 years from now. Moreover, one major constraint is the proximity of the site to the TSFs. A residential use therefore is not attractive. Agricultural use of the site is problematic because of the materials and chemicals which have been stored or used during operations. Also, hardstands need to be ripped. The preferred use is a forest tree park that will feature premium endemic forest tree species. The trees will serve as heritage trees for the future generation. The use will complement the pit lake and plans for an Ecological park.
Secondary containment pond	• Bare areas	• Fish farming • Forest tree park	Fish farming – The water storages can be drained and then backfilled to support a forest tree park. Alternatively, the ponds can be converted into fish farms. This option is selected in view of the declining fish catch reported by the fishermen and a fish farm's greater socio-economic value compared to a forest tree park.
Mine service area	• Shrubland • Site of SURICON's former office • Bare areas	• Forest tree park • Residential • Agriculture	Forest tree park – This is preferred based on the same reasons raised for the process plant area.
Main office	• Shrubland	• Office and conference area • Residential • Agriculture • Forest tree park	Office and conference area – Conversion of the site into agriculture or forest tree park will require the removal of the roof, walls, equipment, furniture, cables, pipes, and concrete. This will be a waste as the facility can still be used even after the Project closes down. It can be remodeled to complement the final theme. In this FMRDP, the Main office will be maintained as it is.
Accommodations area	• Shrubland • Site of SURICON's former process plant	• Accommodations area • Residential • Forest tree park • Agriculture	Accommodations area – The preference as an accommodations area follows the same reasoning for the maintenance of the Main office.

Project Facility	Pre-Project Land Uses	Post-Mining Land Use Options	Preferred Post-Mining Land Use
TSF 3 and TSF 4	• Dried tailings ponds	• Agriculture • Grassland • Industrial tree plantation	Industrial tree plantation - Some abandoned TSFs in the country have been converted into rice paddies and vegetable plots. The problem however is that the tailings are elevated in heavy metals. When absorbed by vegetables and crops, the metals will pose major public health risks. The dried TSFs can also be converted into mere grasslands for cattle raising. This is not advisable because of the possible ingestion by cattle of the heavy metals. Grasslands solely without cattle do not result in socio-economic values. The preferred use is an industrial tree plantation which avoids the risks of human metal uptake. The promising products are fuelwood and timber. The plantation can be established, harvested, and maintained without much ground disturbance.
TSF for underground operations	The options for disposal of tailings from underground operations include the TSF3 and TSF 4, WRD, and open pit. No new area will be utilized.		
WRD	• Waste rock dump • Grassland • Shrubland	• Industrial tree plantation • Agriculture • Grassland	Industrial tree plantation – The physical properties and fertility of the WRD will not support agricultural use. Maintenance of the WRD as a grassland does not optimize the use of the land. The best possible use of the WRD is an industrial tree plantation.
CLF	• Waste rock dump • Shrubland • SURICON's employee housing	• Agriculture	Agriculture – The CLF was designed primarily to host the vegetables, crops, and fruit trees of the residents.
Ponds A (Plant feed water dam) and B	• Grassland • Bare areas • Wetland	• Fish farming • Forest tree park	Fish farming – This is the preference following the same reasons raised for the secondary containment pond.
Geotextile tubes area, paste fill plant, explosives magazine, and nursery	• Grassland • Shrubland • Bare areas • Waste rock dump	• Forest tree park • Agriculture • Residential	Forest tree park – Use of the sites for agriculture is not advisable because of the possible chemical contamination, soil compaction, and proximity to Project structures such as the open pit, TSFs, and WRD. The same reasons reduce the attractiveness of the sites as residential areas. The sites may be developed instead as forest tree parks. These will complement the pit lake and mask the major structures of the Project. A tree park is also complementary to an Ecological Park.

Project Facility	Pre-Project Land Uses	Post-Mining Land Use Options	Preferred Post-Mining Land Use
Sanitary landfill	• Grassland	• Sports ground • Public open space • Pastureland	Public open space – As discussed in the Risk Assessment of this FMRDP, a landfill cap is a key element in the closure of the landfill. To maintain its integrity, the vegetation which is needed to prevent surface erosion must have shallow roots. Any load on the landfill cap should also be avoided. This limits the post-mining use of the sanitary landfill to a public open space or sports ground. A pastureland may also not be viable because of the livestock's weight and burrowing which may compromise the landfill cap.
Main access road and pit perimeter road	• Rice fields • Grassland	• Road	Road – The Project site will still need access from the National Highway. This same access can also be used by the residents of Brgy. Cawilan. The inner road will be required to facilitate movement inside the site.

Closure Criteria

The MGB, in its guidelines for the preparation of an FMRDP, prescribes four goals for mine closure. These goals are adopted as the general closure criteria for the Project:

- Physical stability – The ability of the Project component to withstand failure or physical deterioration and not to pose a hazard to public health and safety. At close-out, the risk of failure of the component and the required level of maintenance is acceptably low.

- Chemical stability – The ability of the Project component to prevent the release of chemicals or contaminants into the environment. During closure activities, this may be enhanced by providing a system of containment, collection, and treatment systems.

- Visual acceptability – The ability of the Project component or the prior site of a component to blend with the surroundings. This goal is set with the understanding that the traces of a Project component cannot be completely removed. The visual acceptability and nuisance concerns cover the abandoned buildings or structures, derelict equipment, odors and smoke, and scarred landscape.

- Productivity or self-sustaining condition – Productivity is the ability to generate food, fuel wood, lumber, wood for furniture, or other safe and marketable products through rehabilitation of the mining-disturbed land into rainfed arable plots and plantations. Self-sustaining condition means that the end use can be sustained by natural processes and will not require human intervention.

Based on the general closure criteria, slope, slope length, and other FMRDP requirements of the Project may be formulated. These are shown in Table 6-2.

Table 6-2. Slope, slope length, and other FMRDP requirements

Project Component	FMRDP Requirements		
	Slope	Slope Length	Others
Hilltop or fluve			
• Crests and berms of TSF embankments, WRD, and CLF and dikes of settling ponds • Surfaces of sites of process plant, other industrial areas, TSFs, and sanitary landfill	20H:1V (*i.e.*, 3°) or flatter		Overall positive drainage with crests backsloped.
Hillslope			
• Open pit final walls	Dependent on geotechnical assessment and wave modeling studies to be conducted immediately before closure		
• TSF 3 and TSF4 outer slope	1(V):3(H) or 18.4°	38 – 63 m	There should be no erosion or instability marks on the slopes.
• Dividing embankment	1(V):2.5(H) or 21.8°	8 m	There should be no erosion or instability marks on the slopes.
• WRD	6° W-E 24° S-N and NW-SE	Varies	There should be no erosion or instability marks on the slopes. A sufficient clearance from the open pit edge should be maintained.
• CLF	7° SW-NE 14° NW-SE	Varies	There should be no erosion or instability marks on the slopes.
• Ponds A and B	Pond A: 1(V):2.5(H) or 21.8° Pond B: 1(V):2(H) or 26.6°		Dike exposed to the water should be rock armored. There should be no erosion or instability marks on the slopes.
Drainage channels	To mimic natural streams in grade	To mimic natural streams in banks and armoring	Design rainfall is 24-hour 20 years' storm.
Emergency spillways			
• TSF 3	Side slopes flattened and lined with Reno mattress for long-term stability		Broad-crested weir with a total width of 12 m; design rainfall is PMF; areas at risk of failure and drainage diversion should be regraded and sealed.
• TSF 4	Side slopes flattened and lined with Reno mattress for long-term stability		Broad-crested weir with a total width of 20 m; design rainfall is PMF; areas at risk of failure and drainage diversion should be regraded and sealed.
• Open pit	Side slopes flattened and lined with Reno mattress		Design rainfall is PMF; spilling elevation is estimated based on

Project Component	FMRDP Requirements		
	Slope	Slope Length	Others
	for long-term stability		the results of wave modeling.
Soil substrate	• Recover topsoil from all construction and work sites. If necessary, stockpile for use in buffer zone or idle lands revegetation within six months. • Compost garden and food organics, residual wood and timber, and agricultural residues. Sample the compost for analyses of nutrients, pH, moisture content, OM, C:N ratio, and heavy metals. Based on closure soil substrate and compost analyses, determine application rates for the plantations.		
Plantations	Plantations are in self-sustaining condition. Achieved ground cover is at least 90 %.		
• Forestland	The tree species are Narra (*Pterocarpus indicus*), Molave (*Vitex parviflora*), Salinggogon (*Cratoxylum formosum*), and Ilang-ilang (*Cananga odorata*). As understory component for immediate ground cover: *Callopogonium muconoides* and wild daisy (*Wedelia biflora*).		
• Industrial tree plantation	The tree species include *Acacia mangium*, *Albizia falcataria*, and Ipil-ipil (*Leucaena leococephalare*) for fuelwood and Yemane (*Gmelina arborea*) for timber. The understory species are *Callopogonium muconoides* and *Centrosema pubescens*.		
• Shrubland	Walis-walisan (*Cida acuta*) and wild daisy		

Table 6-3 reproduces the Project facility and specific post-mining land use given in Table 2-2. It then provides the specific closure criteria for each facility.

Table 6-3. Specific post-mining land uses and closure criteria

Project Site	Specific Post-Mining Land Use	Required Works
Open pit	• Lake for recreation	• Wastes hauled out. • Oil spills decontaminated and removed. • Pumps, pipes, cables, and equipment removed. • Pit wall slopes that will be exposed after pit flooding fixed based on geotechnical assessment. • Pit outlet drainage fixed based on PMF and wave modeling by side slope flattening, widening, and rock armoring. • Pit filled with water from rainfall, surface runoff, and groundwater inflow. • Soil along the pit perimeter conditioned. • Premium endemic forest tree species and understory thriving with ground cover of at least 90 %. • Safety signages on the pit edge installed.
Underground mine		• Residual ore and wastes hauled out. • Pumps, pipes, cables, and equipment removed. • Decline and ventilation raises sealed with paste fill.
Process plant area		

Project Site	Specific Post-Mining Land Use	Required Works
• Process plant, crusher, laboratory	• Forest tree park	• Residual process water tested for pH and CN, drained, and treated in the detoxification circuit if needed. • Crushed ore, unused reagents, and wastes hauled out. • Conveyor belt, crusher, SAG mill, leach tanks, pumps, reactors, columns, kiln, electrowinning cells, oven, scrubber, furnace, etc. removed. • Cables, pipes, roof, walls, racks, and concrete removed. • Oil and chemical spills decontaminated and removed. • Drainage fixed by side slope flattening, widening, and rock armoring. • Hardstands deep-ripped. • Soil conditioned. • Premium endemic forest tree species and understory thriving with ground cover of at least 90 %.
• Reagents storage, cyanide storage, lime storage, tank farm	• Forest tree park	• Unused reagents and wastes hauled out. • Absence of leakage from the storage areas and tanks confirmed. • Tanks, bag breakers, pumps, cables, pipes, roof, walls, racks, and concrete removed. • Oil and chemical spills decontaminated and removed • Drainage fixed by side slope flattening, widening, and rock armoring • Hardstands deep-ripped • Soil conditioned • Premium endemic forest tree species and understory thriving with ground cover of at least 90 %.
• Plant office	• Forest tree park	• Unused cleaning materials, office supplies, and wastes hauled out. • Equipment, furniture, cables, pipes, concrete, roof, and walls removed. • Chambers of BioMAX treatment system emptied of water and the water tested and treated if required prior to discharge. • Sludge of the BioMAX treatment system collected, analyzed, treated if required, and used for soil conditioning. • Oil and chemical spills decontaminated and removed. • Drainage fixed by side slope flattening, widening, and rock armoring.

Project Site	Specific Post-Mining Land Use	Required Works
		• Hardstands deep-ripped. • Soil conditioned. • Premium endemic forest tree species and understory thriving with ground cover of at least 90 %.
• Workshop, warehouse	• Forest tree park	• Unused materials, consumables, and wastes hauled out. • Saws, grinders, lathes, sanders, planers, cables, pipes, concrete, roof, walls, and racks removed. • Oil and chemical spills decontaminated and removed. • Impounded water in oil-water separator tested, oil-contaminated water collected, clean water drained, and oil-water separator sealed. • Drainage fixed by side slope flattening, widening, and rock armoring. • Hardstands deep-ripped. • Soil conditioned. • Premium endemic forest tree species and understory thriving with ground cover of at least 90 %.
• Secondary containment pond	• Fish farming	• Impounded water tested for pH and CN, drained fully, and treated in the detoxification circuit treated if needed. • Impounded sediments dredged and deposited in the TSF. • Concrete walls inspected and any cracks fixed. • Water storage enclosed with 10-cm curbing to prevent surface runoff into the storage. At the lowest section, a spillway with plastic mesh screening inclined inward for pond overflow installed. • Storage filled with water. • Water quality tested after filling. • Few healthy fishes added as final fish survival test. • Ponds stocked with tilapia and other suitable fish. • Endemic floral species thriving along the water storage perimeter with ground cover of at least 90 %.
Mine service area		
• Mine fleet maintenance	• Forest tree park	• Unused materials, consumables, and wastes hauled out. • Service, test and inspection, fabricating and welding, machining, cleaning, lubricating, and painting equipment and tools, cables, pipes,

Project Site	Specific Post-Mining Land Use	Required Works
		concrete, roof, walls, and racks removed. • Chambers of BioMAX treatment system emptied of water and the water tested and treated if required prior to discharge. • Sludge of the BioMAX treatment system collected, analyzed, treated if required, and used for soil conditioning. • Oil and chemical spills decontaminated and removed. • Impounded water in oil-water separator tested, oil-contaminated water collected, clean water drained, and oil-water separator sealed. • Drainage fixed by side slope flattening, widening, and rock armoring • Hardstands deep-ripped. • Soil conditioned. • Premium endemic forest tree species and understory thriving with ground cover of at least 90 %.
• ROM pad	• Forest tree park	• Residual ore, earth materials, and wastes removed. • Oil spills decontaminated and removed. • Topography and slopes fixed. • Drainage fixed by side slope flattening, widening, and rock armoring. • Hardstands deep-ripped. • Soil conditioned. • Endemic forest tree species and understory thriving with ground cover of at least 90 %.
• Fuel storage and dispensing	• Forest tree park	• Unused fuel pumped and hauled out. • Absence of leakage from the storage tank confirmed. • Tanks, pipes, and concrete removed. • Oil spills decontaminated and removed. • Drainage fixed by side slope flattening, widening, and rock armoring. • Hardstands deep-ripped. • Soil conditioned. • Premium endemic forest tree species and understory thriving with ground cover of at least 90 %.
Main office	• Office and conference area	• Damaged sections and areas fixed. • Unnecessary materials and wastes hauled out. • Structure left as is.
Accommodations area	• Accommodations area	• Damaged sections and areas fixed.

Project Site	Specific Post-Mining Land Use	Required Works
		• Unnecessary materials and wastes hauled out. • Structure left as is.
TSF 3 and TSF 4		
• Embankment	• Shrubland	• Downslope batters and crests of the embankments repaired. • Tailings delivery and decant return pipe work removed. • Decant tower and underdrainage system decommissioned. • Permanent drainage systems and erosion and sediment control provided. • Soil conditioned. • Vines and shrubs thriving with ground cover of at least 90 %.
• Impoundment	• Industrial tree plantation	• Tailings supernatant pumped out and treated if required prior to release. • Tailings dried and graded. • Soil conditioned. • Industrial tree species and understory thriving with ground cover of at least 90 %.
TSF for underground mining operations	To be determined.	
WRD	• Industrial tree plantation	• Wastes hauled out. • Oil spills decontaminated and removed. • Topography and slopes fixed. • Drainage fixed by side slope flattening, widening, and rock armoring. • Hardstands deep-ripped. • Soil conditioned. • Industrial tree species and understory thriving with ground cover of at least 90 %.
CLF	• Agriculture	• Soil and plant suitabilities in problematic plantation sites reassessed. • Topography, slopes, and drainage fixed. • Soil conditioned and new crops tried if needed.
Ponds A and B	• Fish farming	• Impounded water tested for pH and CN, drained fully, and treated in the detoxification circuit if needed. • Impounded sediments dredged and deposited in the TSF. • Clay liner inspected and any cracks fixed. • Necessary repairs on the embankment done and the outer wall armored with rocks

Project Site	Specific Post-Mining Land Use	Required Works
		• Spillway fixed and plastic mesh screening inclined inward for the pond overflow installed. • Storage filled with water. • Endemic species thriving along the pond perimeter with ground cover of at least 90 %. • Water quality tested after filling. • A few healthy fishes added as final fish survival test. • Ponds stocked with tilapia and other suitable fish.
Geotextile tubes areas	• Forest tree park	• Geotextile tubes ripped open and trapped sediments hauled out for use in the repair of roads. • Ripped geotextile tubes hauled out. • Hardstands deep-ripped. • Soil conditioned. • Premium endemic forest tree species and understory thriving with ground cover of at least 90 %.
Paste fill plant	• Forest tree park	• Residual process water for pH and CN tested, drained, and treated in the detoxification circuit if needed • Unused cement and wastes hauled out. • Cyclones, agitator, pumps, disc filter, cooling tower, bag breaker, paste mixer, etc. removed. • Cables, pipes, roof, walls, racks, and concrete removed. • Septic tanks and leach drains emptied completely. • Septic tank lids removed and bottoms of septic tanks broken up. • Tanks and drains backfilled and compacted. • Oil and chemical spills decontaminated and removed. • Hardstands deep-ripped. • Soil conditioned. • Premium endemic forest tree species and understory thriving with ground cover of at least 90 %.
Explosives magazine area	• Forest tree park	• Unused ANFO, emulsion, and blasting caps hauled out by supplier. • Explosive and chemical spills decontaminated and removed by supplier. • Cables, pipes, roof, walls, racks, and concrete removed. • Septic tanks and leach drains emptied completely.

Project Site	Specific Post-Mining Land Use	Required Works
		• Septic tank lids removed and bottoms of septic tanks broken up. • Tanks and drains backfilled and compacted • Drainage fixed by side slope flattening, widening, and rock armoring. • Hardstands deep-ripped. • Soil conditioned. • Premium endemic forest tree species and understory thriving with ground cover of at least 90 %.
Nursery	• Forest tree park	• Residual seedlings, earth materials, and wastes hauled out. • Cables, pipes, roof, walls, racks, and concrete removed. • Septic tanks and leach drains emptied completely. • Septic tank lids removed and bottoms of septic tanks broken up. • Tanks and drains backfilled and compacted • Hardstands deep-ripped. • Soil conditioned. • Premium endemic forest tree species and understory thriving with ground cover of at least 90 %.
Sanitary landfill	• Sports ground or public open space	• Field trials of alternative capping designs for the filled cells developed and implemented. • Capping design finalized and implemented. • Septic tanks and leach drains emptied completely. • Septic tank lids removed and bottoms of septic tanks broken up. • Tanks and drains backfilled and compacted • Drainage fixed for long-term utility by side slope flattening, widening, and rock armoring. • Soil conditioned. • Endemic grasses and vines thriving with ground cover of at least 90 %. • Concrete, walls, and roof of Material Recovery Facility hauled out. • Fencing, bunding, and signage around the landfill provided to prevent access to dangerous places
Pit perimeter road	• Road	• Damaged sections and areas fixed. • Unnecessary materials and wastes hauled out. • Structure left as is.

Project Site	Specific Post-Mining Land Use	Required Works
Main access road	• Road	• Damaged sections and areas fixed. • Unnecessary materials and wastes hauled out. • Structure left as is.

Decommissioning Plan

Mine decommissioning for the Project involves the following basic approaches (Queensland Department of Environment and Heritage, 1995 and Australian Mining Industry Council, 1990):

- Removal from the site of any materials, equipment or structures having residual value or any existing or potentially hazardous substance, equipment or structures.
- Treatment at site of any existing or potentially hazardous materials, equipment or structures by various means such as chemical treatment, fixing in solids (cementation or backfilling), or burial.
- Containment at site of any existing or potentially hazardous substances, equipment or structures through collection and storage in the smallest contaminated area possible, encapsulation, capping, submersion, burial, etc.

Non-hazardous Materials, Equipment and Structures

The decommissioning works will generate various non-hazardous materials, equipment, and structural parts of the Project. Table 6-4 lists these materials and the planned modes of disposition.

Table 6-4. Non-hazardous materials, equipment, and structural parts and mode of disposition

Materials, Equipment, and Structural Parts	Mode of Disposition
Stockpiles of waste rocks, soil, and borrow materials	Hauled to sites for rehabilitation and used for stabilization and grading purposes.
Empty jute sacks, wooden, plastic or cardboard containers	• Suppliers have the first priority in retrieving the containers. • The remaining containers are offered to recyclers for pick-up at the site. The residuals, which are expected to be insignificant, are disposed of in the sanitary landfill.
Conveyor belt sections, tires, spare parts, and consumables, either used or unused	• The materials are sold to users and recyclers for pick-up at the site. • The residuals, which are expected to be insignificant, are disposed of in the TSF.
Equipment for mining, crushing, grinding, CIL cynidation, CN detoxification, carbon elution, kiln, Au/Ag recovery, furnace, power generation, workshop, laboratory and assay, water treatment, office, etc. as listed in the Production Process Section.	• The equipment is sold to users and recyclers for dismantling, haul-out, and removal from the site. • The residuals, which are expected to be insignificant, are disposed of in the TSF.

Materials, Equipment, and Structural Parts	Mode of Disposition
Storage and mixing tanks	• Contents of storage and mixing tanks are drained and sold to users and recyclers for pick-up at the site. • The tanks are sold to users and recyclers for dismantling, haul-out, and removal from the site. • The residuals, which are expected to be insignificant, are disposed of in the TSF.
Cables, power lines, electrical wires, posts, and pipes	• Materials are removed and donated to the community. • The residuals are sold to users and recyclers for pick-up at the site. • Non-usables, which are expected to be insignificant, are disposed of in the TSF.
Tables, chairs, beds, drawers, and cabinets	• Furniture is donated to the community. • The residuals are sold to users and recyclers for pick-up at the site. • Non-usables, which are expected to be insignificant, are disposed of in the TSF.
Roofing, walling, toilet fixtures, doors, windows, and other fixtures	• Useable items are donated to the community. • Non-usables are sold as scrap or disposed of in the TSF.
Concrete floors and slabs	• Hauled to sites for rehabilitation and used for stabilization and grading purposes.
Sludge of septic tanks	The explosives magazines, paste fill plant, nursery, and sanitary landfill areas will be provided with septic tanks. The septic tanks are decommissioned as follows: • Septic tanks and leach drains are emptied completely by a DENR-accredited contractor. • Lids are removed and the bottoms of septic tanks are broken up. • The tanks and drains are backfilled and then compacted.
Sludge of BioMAX treatment plants	The accommodations, main office, process plant, and mine service areas will be provided with BioMAX treatment plants. During closure, the treatment plants of the last two areas will be decommissioned: • All chambers of the treatment plants are completely drained of water, analyzed, treated if required, and the safe portion is discharged to the environment. • The sludge is recovered and tested for pathogens and pollutants. Any required treatment is done to make the sludge safe. The safe sludge is used for soil amendment. • BioMAX plant is hauled out of the Project site.

Hazardous Materials and Wastes

DENR Administrative Order No. 36, Series of 2004 lists and defines the hazardous wastes that need special storage, treatment, transport, processing, recycling, and disposal. The hazardous waste types are:

A. Wastes with cyanide

B. Acid wastes

C. Alkali wastes

D. Wastes with inorganic chemicals

E. Reactive chemical wastes

F. Inks, dyes, pigments, paint, latex, adhesives, organic sludge

G. Waste organic solvent

H. Putrescible/organic wastes

I. Oil

J. Containers previously containing toxic chemicals

K. Immobilized wastes

L. Organic chemicals and

M. Miscellaneous wastes.

The hazardous materials and wastes of the Siana Gold Project can be inferred using these waste types.

As discussed in the Production Process Section, the Project will be using the following hazardous materials: cyanide (type A), acids – H_2SO_4 and HCl (type B), alkali – lime (type C), reactive chemicals – NaOH and SMBS (type E), and oil (type I). The use of these hazardous materials will generate hazardous wastes. In addition, type J wastes, *i.e.*, containers previously containing toxic chemicals, and type D wastes, *i.e.*, wastes with inorganic chemicals, such as used batteries will be produced. Table 6-5 presents the stocking levels of the hazardous materials.

Table 6-5. Stocking levels of hazardous materials

Hazardous Material or Waste	Stocking Level (t)
Copper sulfate ($CuSO_4$)	25
Sodium cyanide (NaCN)	175
Sodium hydroxide or caustic soda (NaOH)	24
Hydrochloric acid (HCl)	25
Sodium metabisulfite (SMBS)	170
Diesel	200

Source: GRC

The process plant is expected to generate varying volumes of process water depending on the feed ore. This process water will contain the chemicals enumerated above. The expected volumes of process water produced per month vary: 30,000, 115,000, and 130,000 m^3.

Aside from the process water, the Project will generate other hazardous wastes such as laboratory acid wastes, used oil, oil contaminated rags, used batteries, paints, containers of toxic chemicals, etc. GRC estimates the annual used oil generation rate at 52.4 to 91 m^3. During construction and operations, the company has to track the generation rates of the other wastes.

Table 6-6 presents the mode of disposition for the hazardous materials and wastes. The same modes will be adopted for the handling of oil and chemical spills or contaminated materials during decommissioning.

Table 6-6. Hazardous materials and mode of disposition

Hazardous Materials	Mode of Disposition
Process water with cyanide	• The tailings which contain the process water are treated in the CN detoxification circuit. The result is effluent that complies with DENR standards. The effluent discharges to the TSF.
Acids and wastes	• Unused chemicals and containers are sold to prospective users and suppliers for site pick-up. Residual containers are washed and buried at the TSF. • Acid wastes of the laboratory are neutralized with lime and disposed of in the TSF. • Treated effluent compliant with DENR standards is released to the environment.
Alkalis and wastes	• Unused chemicals and containers are sold to prospective users and suppliers for site pick-up. Residual containers are washed and buried at the TSF. • Alkaline wastes of the laboratory are neutralized and disposed of in the TSF. • Treated effluent compliant with DENR standards is released to the environment.
Reactive chemicals and wastes	• Unused chemicals and containers are sold to prospective users and suppliers for site pick-up. • Residual chemicals are picked up by DENR-authorized treaters. • Residual containers are washed and buried at the TSF.
Paints	• Unused chemicals and containers are sold to prospective users and suppliers for site pick-up. • Residual chemicals and containers are picked up by DENR-authorized treaters.
Oil, wastes, and sludge	• Unused oil and other petrochemicals are sold to prospective users and suppliers for site pick-up. • Oil wastes and sludge are picked up by DENR-

Hazardous Materials	Mode of Disposition
	authorized recyclers and treaters.
Batteries	• Unused batteries are sold to prospective users and suppliers for site pick-up. • Used batteries are picked up by DENR-authorized recyclers and treaters.

Safety and Health Plan

Table 6-7 presents the required works of the FMRDP by Project facility or structure together with the corresponding safety concerns and issues and applicable guidelines of the FMRDP Safety and Health Plan.

Table 6-7. FMRDP safety issues and guidelines

Project Facility or Structure	Required Works	Safety Concerns or Issues	Applicable Guidelines in the Safety and Health Plan of this FMRDP
Open pit	• Haul out wastes • Decontaminate and remove oil spills • Remove pumps, pipes, cables, and equipment • Fix pit wall slopes that will be exposed after pit flooding • Fix pit outlet drainage by side slope flattening, widening, and rock armoring • Allow the pit to accumulate water from rainfall, surface runoff, and groundwater inflow • Condition the soil along the pit perimeter • Plant premium endemic forest tree species • Put up safety signages on the pit edge	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls • Drowning	• Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE) • Section 5.2 (PPE) – Rule 855 for drowning
Underground mine	• Haul out residual ore and wastes • Remove pumps, pipes, cables, and equipment • Seal decline and ventilation raises with paste fill	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Slips and falls	• Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 5.1 (Control measures) and Section 5.2 (PPE)
Process plant area			

Project Facility or Structure	Required Works	Safety Concerns or Issues	Applicable Guidelines in the Safety and Health Plan of this FMRDP
• Process plant, crusher, laboratory	• Test residual process water for pH and CN, drain, and treat in the detoxification circuit if needed • Haul out crushed ore, unused reagents, and wastes • Remove conveyor belt, crusher, SAG mill, leach tanks, pumps, reactors, columns, kiln, electrowinning cells, oven, scrubber, furnace, etc. • Remove cables, pipes, roof, walls, racks, and concrete • Decontaminate and remove oil and chemical spills • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls • Chemical hazards • Electrocution	• Section 4.1 (Chemical hazards) and Section 7.3 (Chemical Exposures) • Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 4.6 (Electrocution) • Section 5.1 (Control measures) and Section 5.2 (PPE)
• Reagents storage, cyanide storage, lime storage, tank farm	• Haul out unused reagents and wastes • Confirm that there has been no leakage from the storage areas and tanks • Remove tanks, bag breakers, pumps, cables, pipes, roof, walls, racks, and concrete • Decontaminate and remove oil and chemical spills • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls • Chemical hazards	• Section 4.1 (Chemical hazards) and Section 7.3 (Chemical Exposures) • Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE)
• Plant office	• Haul out unused cleaning materials, office supplies, and wastes • Remove equipment, furniture, cables, pipes, concrete, roof, and walls • Decontaminate and remove oil and chemical spills	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress	• Section 4.1 (Chemical hazards) and Section 7.3 (Chemical Exposures) • Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and

Project Facility or Structure	Required Works	Safety Concerns or Issues	Applicable Guidelines in the Safety and Health Plan of this FMRDP
	• Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species	• Slips and falls • Chemical hazards	slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE)
• Workshop, warehouse	• Haul out unused materials, consumables, and wastes • Remove saws, grinders, lathes, sanders, planers, cables, pipes, concrete, roof, walls, and racks • Decontaminate and remove oil and chemical spills • Test impounded water in oil-water separator, collect oil-contaminated water, drain clean water, and seal oil-water separator • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic species	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls • Chemical hazards • Electrocution	• Section 4.1 (Chemical hazards) and Section 7.3 (Chemical Exposures) • Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 4.6 (Electrocution) • Section 5.1 (Control measures) and Section 5.2 (PPE)
• Secondary containment pond	• Test impounded water for pH and CN, fully drain, and treat in the detoxification circuit if needed • Dredge impounded sediments and deposit in the TSF • Inspect and fix any cracks in the concrete walls • Enclose the water storage with 10-cm curbing to prevent surface runoff into the storage. At the lowest section, install a spillway with plastic mesh screening inclined inward for pond overflow • Allow the storage to fill with water • After filling, test the water quality • Add a few healthy fishes as	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls • Chemical hazards • Drowning	• Section 4.1 (Chemical hazards) and Section 7.3 (Chemical Exposures) • Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE) • Section 5.2 (PPE) – Rule 855 for drowning

Project Facility or Structure	Required Works	Safety Concerns or Issues	Applicable Guidelines in the Safety and Health Plan of this FMRDP
	final test • If results are favorable, stock the ponds with tilapia and other suitable fish • Plant endemic floral species along the water storage perimeter		
Mine service area			
• Mine fleet maintenance	• Haul out unused materials, consumables, and wastes • Remove service, test and inspection, fabricating and welding, machining, cleaning, lubricating, and painting equipment and tools, cables, pipes, concrete, roof, walls, and racks • Decontaminate and remove oil and chemical spills • Test impounded water in oil-water separator, collect oil-contaminated water, drain clean water, and seal oil-water separator • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic species	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls • Chemical hazards • Electrocution	• Section 4.1 (Chemical hazards) and Section 7.3 (Chemical Exposures) • Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 4.6 (Electrocution) • Section 5.1 (Control measures) and Section 5.2 (PPE)
• ROM pad	• Haul out residual ore, earth materials, and wastes • Decontaminate oil spills • Fix topography and slopes • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls • Chemical hazards	• Section 4.1 (Chemical hazards) and Section 7.3 (Chemical Exposures) • Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE)
• Fuel storage and	• Pump and haul out unused	• Skeleton-muscular injuries or	• Section 4.1 (Chemical

Project Facility or Structure	Required Works	Safety Concerns or Issues	Applicable Guidelines in the Safety and Health Plan of this FMRDP
dispensing	fuel • Confirm that there has been no leakage from the storage tank • Remove tanks, pipes, and concrete • Decontaminate and remove oil spills • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species	pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls • Chemical hazards	hazards) and Section 7.3 (Chemical Exposures) • Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE)
Main office	• Fix damaged sections and areas • Haul out unnecessary materials and wastes • Leave the structure as is	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls	• Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE)
Accommodations area	• Fix damaged sections and areas • Haul out unnecessary materials and wastes • Leave the structure as is	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls	• Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE)
TSF 3 and TSF 4			
• Embankment	• Rehabilitate downslope batters and crests of the embankments • Remove tailings delivery and decant return pipe work • Decommission decant tower	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes	• Section 4.1 (Chemical hazards) and Section 7.3 (Chemical Exposures) • Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains,

Project Facility or Structure	Required Works	Safety Concerns or Issues	Applicable Guidelines in the Safety and Health Plan of this FMRDP
	and underdrainage system • Provide permanent drainage systems and erosion and sediment control • Condition the soil • Plant vines and shrubs	• Heat stress • Slips and falls • Chemical hazards	noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE)
• Impoundment	• Pump out and treat tailings supernatant if required prior to release • Dry tailings aided by sprinkling and wicks and grading of surface • Condition the soil • Plant industrial tree species	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls • Chemical hazards • Drowning	• Section 4.1 (Chemical hazards) and Section 7.3 (Chemical Exposures) • Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE) • Section 5.2 (PPE) – Rule 855 for drowning
TSF for underground mining operations	To be determined.		
WRD	• Haul out wastes • Decontaminate oil spills • Fix topography and slopes • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant industrial tree species	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls	• Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE)
CLF	• Reassess soil and plant suitabilities in problematic plantation sites • Fix topography, slopes, and drainage • Condition the soil and try new crops if needed	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes	• Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls

Project Facility or Structure	Required Works	Safety Concerns or Issues	Applicable Guidelines in the Safety and Health Plan of this FMRDP
		• Heat stress • Slips and falls	• Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE)
Ponds A and B	• Test impounded water for pH and CN, fully drain, and treat in the detoxification circuit if needed • Dredge impounded sediments and deposit in the TSF • Inspect and fix any cracks in the clay liner • Undertake necessary repairs on the embankment and armor the outer wall with rocks • Fix the spillway and install plastic mesh screening inclined inward for the pond overflow • Allow the storage to fill with water • Plant endemic species along pond perimeter • After filling, test the water quality • Add a few healthy fishes as final test • If results are favorable, stock the ponds with tilapia and other suitable fish	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls • Chemical hazards • Drowning	• Section 4.1 (Chemical hazards) and Section 7.3 (Chemical Exposures) • Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE) • Section 5.2 (PPE) – Rule 855 for drowning
Geotextile tubes area	• Rip open geotextile tubes and haul out trapped sediments for use in the repair of roads • Haul out ripped geotextile tubes • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls	• Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE)
Paste fill plant	• Test residual process water for pH and CN, drain, and treat in the detoxification	• Skeleton-muscular injuries or pains	• Section 4.1 (Chemical hazards) and Section 7.3 (Chemical Exposures)

Project Facility or Structure	Required Works	Safety Concerns or Issues	Applicable Guidelines in the Safety and Health Plan of this FMRDP
	circuit if needed • Haul out unused cement and wastes • Remove cyclones, agitator, pumps, disc filter, cooling tower, bag breaker, paste mixer, etc. • Remove cables, pipes, roof, walls, racks, and concrete • Decontaminate and remove oil and chemical spills • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species	• Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls • Chemical hazards • Electrocution	• Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 4.6 (Electrocution) • Section 5.1 (Control measures) and Section 5.2 (PPE)
Explosives magazine area	• Supplier to haul out unused ANFO, emulsion, and blasting caps • Supplier to decontaminate and remove explosive and chemical spills • Remove cables, pipes, roof, walls, racks, and concrete • Fix drainage by side slope flattening, widening, and rock armoring • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls • Chemical hazards • Electrocution	• Section 4.1 (Chemical hazards) and Section 7.3 (Chemical Exposures) • Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 4.6 (Electrocution) • Section 5.1 (Control measures) and Section 5.2 (PPE)
Nursery	• Haul out residual seedlings, earth materials, and wastes • Remove cables, pipes, roof, walls, racks, and concrete • Deep rip hardstands • Condition the soil • Plant premium endemic forest tree species	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls	• Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE)
Sanitary landfill	• Develop and implement field trials of alternative capping designs for the filled cells	• Skeleton-muscular injuries or pains • Noise	• Section 4.1 (Chemical hazards) and Section 7.3 (Chemical Exposures)

Project Facility or Structure	Required Works	Safety Concerns or Issues	Applicable Guidelines in the Safety and Health Plan of this FMRDP
	• Finalize and implement capping design • Fix drainage for long-term utility by side slope flattening, widening, and rock armoring • Condition the soil • Plant endemic grasses and vines • Haul out concrete, walls, and roof of Materials Recovery Facility • Provide fencing, bunding, and signage around the landfill to prevent access to dangerous places	• Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls • Chemical hazards	• Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE)
Pit perimeter road	• Fix damaged sections and areas • Haul out unnecessary materials and wastes • Leave the structure as is	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls	• Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE)
Main access road	• Fix damaged sections and areas • Haul out unnecessary materials and wastes • Leave the structure as is	• Skeleton-muscular injuries or pains • Noise • Hazards of heavy equipment operation • Dust and fumes • Heat stress • Slips and falls	• Section 4.2 (Physical hazards) and Section 7.2 (Medical emergency) for skeleton-muscular injuries or pains, noise, hazards of heavy equipment operation, and slips and falls • Section 4.3 (Dust and fumes) • Section 4.4 (Temperature extremes) • Section 5.1 (Control measures) and Section 5.2 (PPE)

1. General Site and Safety Information

1.1 Introduction

Major activities during the mine decommissioning and rehabilitation will include the haul-out of unused materials, spare parts, and wastes; dismantling and removal of equipment and structures; decontamination and removal of oil and chemical spills; grading of slopes and surfaces; fixing of drainage; breaking and removal of hardstands and parking areas; conditioning of the soil; planting of endemic and industrial floral species; and provision of fencing, bunding, and signages around the rehabilitated facility sites. The safety and health issues and concerns of these activities are listed in Table 6-7.

1.2 Site Description

The Siana Gold Project will employ open pit and underground mining to extract the ore. The gold and silver in the ore will be recovered through gravity concentration and cyanidation. Waste rocks will be deposited in a waste rock dump; the tailings, which will be detoxified through the SO_2. Air process, will be stored in a paddock-type TSF.

The major structures in the Project site for decommissioning and rehabilitation are:

- Open pit
- TSF 3 and TSF 4
- WRD and CLF
- Process plant area
- Mine service area
- Paste fill plant and explosives magazine
- Ponds A and B
- Sanitary landfill

2. Personnel and Basic Site Safety Requirements

The following Project personnel and offices are involved in the safety works for the final mine rehabilitation and decommissioning (FMRD):

- Project Manager (PM)
- Manager – Health & Safety (HSM)
- Mechanical-Electrical Manager
- Security Office
- Physician and Nurse and

- Fire Department.

The PM is in charge of all FMRD works at the site.

All personnel involved in the FMRD shall undergo a job briefing by the Health and Safety Manager or his assistants. Documentation of the job briefing will state the date, time, location, and names of personnel in attendance, and a brief synopsis of topics discussed.

Safety meetings with all workers will be held on a weekly basis to keep personnel updated of changes to the plan as well as changes in site conditions or operations that may impact safety and health. All safety meetings will be documented.

3. Emergency Response

The FRMD works shall have an emergency response plan. Emergency plans to be drawn up and reaction committees to be organized shall be retained and updated to conform with the new jobs on hand. All reporting protocols shall be strictly followed.

During emergencies, the Health and Safety Office (HSO) will first coordinate with the doctor or nurse on duty. Then, he will notify the PM as quickly as possible. In case of fire or evacuation is necessary, the HSO will contact the security and fire departments. If a contractor is involved, the HSO will notify the contractor's office.

All accidents, including injuries, incidents, and near misses must be reported as soon as practical, *i.e.*, no longer than an 8-hour shift, to the HSO, copy furnished the PM. The incident should be analyzed by the HSO and the results disseminated to the workers during the next safety meeting.

In times of typhoons or other natural calamities, the PM should immediately assess the situation and determine if workers' lives are at risk and a work suspension is required.

All Project employees and contractors handling hazardous materials and working in steep and unstable areas should undergo training. The duration and coverage of training programs shall follow Rule 31, Section 9, Chapter II of DENR Administrative Order No. 2000-98 titled "Mine Safety and Health Standards".

Training topics should include, but not be limited to, the following:

- First-aid
- Proper use of personal protective equipment (PPE) and
- Emergency notification protocols

The training should include a review of Health and Safety Policies, individual task descriptions and responsibilities, task hazards, and other safety and health related issues, hazards, and requirements unique to the working area. All trainings shall be documented and filed with the HSO.

4. Hazards Assessment

During the FMRDP works, Project employees and contractors will be exposed to the following hazard types:

- Chemical hazards
- Physical hazards
- Dust and fumes
- Temperature extremes
- Adverse weather and
- Electrocution.

4.1 Chemical Hazards

The chemical hazards emanate from the reagents and chemicals used in the process plant and paste fill plant such as cyanide, acids, alkalis, reactive chemicals; oil and lubricants in the generator set and mechanical shop; heavy metals and tailings in the TSF; and methane in the sanitary landfill.

Workers should minimize exposure to these elements through the use of rubber gloves, rubber boots, eye goggles, aprons, or other PPEs as appropriate.

Material Safety Data Sheets (MSDSs) for each chemical used in the Project must be maintained at the site and reviewed by all personnel who use or may be exposed to the chemical. The MSDS should always be consulted for information on chemical properties, spill response procedures, fire hazards, as well as handling, storage, and other special precautions to be implemented.

Workers assigned in the field should be aware of the common symptoms of exposure to airborne particulates or corrosive vapors, including irritation of the eyes, nose, or throat, coughing, nausea, dizziness, drowsiness, headache, respiratory distress, and effects due to dermal contact.

4.2 Physical Hazards

Physical hazards such as falls, trips, slips, and muscle strains are generally the most common source of workplace injuries. Workers may also be exposed to noise, heavy equipment, dust, and extreme temperatures hazards.

Slips, trips, and falls may be avoided through proper control measures, safe work practices, keeping work areas free of obstructions, provision of adequate lighting, weekly safety meetings that stress good housekeeping, safety mats and signages, and restrictions to entry.

To prevent skeleton-muscular injuries, workers will be reminded not to lift large or heavy objects without assistance. Appropriate materials handling equipment such as forklift, chain block, wheelbarrow, cart, etc. will be made available at the site.

Personnel exposed to excessive noise levels will wear earplugs. Noise absorbers, acoustic screens, or other noise-reducing barriers should be provided to enclose the noise source. Workers are to use standard hand signals when noise levels are above normal auditory communication.

Only fully trained, qualified, licensed, and authorized personnel will operate heavy equipment at the work site. Hazards commonly associated with the operation of heavy equipment include burns, hydraulic fluids and fuels, traffic movement and ground personnel contact, and rollover. The safety measures are:

- Burns – Avoidance of contact with hot surfaces such as radiators, exhaust pipes or mufflers, etc.; use of safety guards or covers; safety signages on or near hot surfaces.
- Hydraulic fluids and fuels – Immediate shutdown of equipment and containment of any spills; repairs to be done by a mechanic.
- Traffic movement and ground personnel contact – Wearing of brightly-colored, high-visibility safety vests by ground personnel working in heavy-traffic areas; use by equipment of backup lights and alarms; use of a field spotter to guide the heavy equipment operator when backing up or negotiating a tight crowded area; lowering of booms or buckets before ground personnel approach the equipment.
- Rollover – Fitting of mobile equipment with roll-over and protective structures, blinkers, and signal lights; personnel training; careful survey of travel route for obstructions, holes, slopes, ditches, etc.; use of seatbelts; observance of speed limits; immobilization of unattended equipment by grounding of buckets or insertion of blocks under wheels or tracks.

4.3 Dust and Fumes

All workers must use appropriate PPEs like dust masks when in the field. PPEs shall be maintained in good working and sanitary and hygienic condition; all equipment and vehicles must have regular engine check-ups. Adequate ventilation must be provided in confined areas and dusty areas must be sprinkled with water.

4.4 Temperature Extremes

- Heat stress – Workers are to observe each other for early signs of heat stress. Digital thermometers, drinking water, and electrolyte beverages should be made available at the site. During hot conditions, breaks must be scheduled every two hours for 10 to 15 minutes. Personnel whose oral temperature exceeds 38°C will not be allowed to work until his temperature returns to normal, *i.e.*, less than 37°C.
- Cramps – Victims are to be moved to a cool, covered area. The treatment includes one or two glasses of water or electrolyte beverage, gentle massage and warm, wet towel over the affected area.
- Exhaustion – The symptoms are body temperature in excess of 38°C, pale and clammy skin, profuse perspiration, lethargy and fatigue, dizziness, headache, nausea, and fainting. The victim is to be moved to a cool area and be made to lie flat except when drinking

with open clothing to allow air circulation. Water is to be drunk every 15 minutes for 3 or 4 doses.

- Stroke – The victims of stroke manifest body temperatures which may be as high as 40°C, red or flushed skin, nausea, dizziness, headache, rapid and strong pulse, possible loss of consciousness, delirium, or coma. The victim should be moved to a cool, shady area with all PPE removed and the victim's body sponged with isopropyl alcohol or cool water. An ice bag is also placed on the victim's head.

  The HSO will identify strenuous tasks which can be scheduled during early mornings or evenings to take advantage of the coolest time of the day. Workers will be provided with a temporary covered shelter with enough water and electrolyte beverage at all times. Hand-held radios will be given to personnel assigned in remote parts of the Project site.

4.5 Adverse Weather

Adverse weather conditions include strong winds, heavy precipitation, lightning and thunderstorms. Their associated hazards are poor visibility; slippery and unstable grounds; exposure to lightning and strong winds; loose materials becoming projectiles, and collapsed structures and uprooted trees. The PM is tasked to determine when work stoppages are necessary.

4.6 Electrocution

The control measures against electrocution are:

- Training of employees assigned to dismantle electric machineries and equipment
- De-energization of all equipment scheduled for demolition
- Live parts of electric equipment guarded against accidental contact by partitioning or screening
- At least two men shall work together. When necessary to leave a companion, the person left behind is to work only outside the hazardous area
- Temporary covers, guards, warning signs and other safety devices to be provided before leaving unfinished jobs
- Use of rubber gloves, shields, and other safety equipment by workers on energized electrical conductors or equipment operating at more than 150V to ground
- No work to be done on energized electrical equipment or conductor operating at 750V unless two or more experienced employees are present
- Exclusion of metal ladders while working in proximity to energized electrical equipment
- Personnel awareness of potential hazards due to unexpected start-up of equipment or the release of stored energy or material that can injure personnel

- Lockout or tag-out procedures to prevent startup of equipment, pumps, and other machinery that can move or release hazardous substances.

5. Controls

5.1 Control Measures

The Project is adopting the following engineering and administrative control measures during the FMRD.

1. The HSO is responsible for reminding all personnel to be aware of the chemical and physical hazards of the FMRD works.
2. A safety procedure for newly recognized hazards developed through a task safety analysis must be disseminated to all workers.
3. Each field team is responsible for ensuring that site control measures such as markings, warning signs, placards, barriers, etc. are implemented.
4. Field teams assigned to remote areas are to be provided with communications equipment.
5. All hazardous materials must be stored in a designated, placarded, well-ventilated secure storage site with adequate spill containment.
6. Containers of hazardous chemicals must be clearly labeled and regularly checked for leaks. Their MSDSs must be readily available in the HSO.
7. Only trained and properly protected personnel are allowed to work in FMRD areas. Corrosive-resistant PPEs such as boots, aprons, and gloves should be regularly checked for any perforations, punctures, or signs of wear and tear.
8. For high-risk areas and non-routine procedures, teams of no less than two should be assigned. This "buddy system" will allow an employee to give immediate assistance to an injured fellow.

5.2 PPE

The PPEs issued to each worker depend on the monitored conditions, hazards, and specific jobs to be performed. All workers must wear appropriate PPEs when there is potential exposure to physical and chemical hazards. The relevant provisions on PPEs found in DENR Administrative Order No. 98, Series of 2000 are:

- Rule 852 - When working on live electrical circuit or when handling high-tension wires or cables, appropriate high-tension rubber gloves, rubber mats or other suitable insulated materials shall be used for protection.
- Rule 853 - Employees handling materials likely to puncture, abrade, or irritate hands or arms shall be required to wear appropriate protective equipment except when the use of the equipment introduces equal or greater hazards.

- Rule 854 - Appropriate eye protection equipment shall be worn when there is exposure to eye injury.
- Rule 855 - Workers exposed to risks of drowning shall be required to wear life saving apparels.
- Rule 856 - Where there is harmful concentration of gases, vapors, mists or dusts, or oxygen deficiency, workers shall be required to wear appropriate respiratory protective equipment.
- Rule 857 - Personal protective equipment shall be maintained in good working and sanitary and hygienic condition.
- Rule 858 - Safety belts, harness, straps or lifelines shall be worn by all employees working at elevations 3 m above or where there is hazard of falling or slipping from dangerous heights.
- Rule 859 - Employees assigned to work in a confined space shall be provided with the necessary and appropriate personal protective equipment.

Respiratory, dermal, eye, head, hand, and foot protection are required when activities may result in exposure to chemical hazards. Enough water for drinking and washing must always be available at the working area.

6. Site Control

The following shall guide the HSO on the basic features of a site control plan:

- Access to the site should be limited to authorized personnel only.
- Sufficient warning or caution signs that prohibit entry to unauthorized personnel must be placed in all working areas. Other warning signs such as "*No Open Flame*" must be visibly placed.
- Only visitors with prior authorization from the PM will be permitted entry to the site. All visitors will be oriented on the ongoing works, including possible hazards at the site and shall be provided with the proper PPEs.
- All workers and visitors must be required to sign in and sign out when entering and leaving the site.
- Cordon-off areas and place appropriate signage when hazardous sites are being worked on.
- HSO staff must inspect hazardous work sites prior to entry of working teams. Additional safety measures must be implemented when deemed necessary.
- All disposable PPEs, plastic sheetings, and other items for disposal will be placed in plastic trash bags. These items are generally not considered hazardous and will not require disposal at a hazardous waste disposal facility.

7. Emergency Response and Preparedness Procedures

Emergency response and preparedness procedures during FMRD works must be in place at the site. Chapter X, Section 49, Rules 637 to 639 of DENR Administrative Order No. 98, Series of 2000 provide

guidelines in the preparation of these procedures. The guidelines require, among others, the following:

- Provision of alarm system for each type of emergency (*e.g.*, three short blasts mean fire, one long and one short mean slope failure, etc.)
- Designation of evacuation areas
- Frequency of first aid and rescue drills
- Information to be provided when reporting an emergency incident such as nature, location, size, and extent of emergency, any materials involved, and personnel injury.
- All accidents, including injuries, incidents, and near misses must be reported to the management and MGB Regional Office within 8 hours of occurrence or discovery.
- During emergency situations, communication lines between the PM, HSM and the rescue team or the emergency response team must be given priority.
- Whenever a major incident or high potential incident occurs, the PM and HSM must receive immediate verbal notification, followed by a written report.
- All incidents should be documented.
- A directory listing of all key personnel for the FMRD works must be available in all working areas.
- Any employee who suffers an injury or chemical exposure is required to see a physician. Depending upon the extent and type of exposure, illness, or injury, it is critical to perform follow-up testing within 24 to 48 hours. A worker may return to work only with the written approval of the attending physician.
- The HSO will maintain a project file of any safety and health-related activities and incidents occurring at the site. Any actual or potential exposures are to be recorded, as well as accidents or incidents that require the filing of a report (*e.g.*, injuries, illnesses, accidental damage to property, or "near miss" occurrences that could have resulted in personal injury).

7.1 Fire

The complete guidelines on fire protection are enumerated under Chapter XIX, Section 71, Rules 1082 to 1105 of DENR Administrative Order No. 98, Series of 2000. The major ones are as follows.

- In case of fire, the Leadman or other personnel will immediately call the Fire Department and the HSO, in this order, apprising them of the location, cause, and extent of fire. The authorities should also be informed of the type of materials stored inside the burning structure.
- The Fire Department should advise the workers whether to use fire extinguishers or to evacuate to a safer ground.
- Workers should shut-off all equipment and machineries that will be affected by the fire, if it

can be safely done. Otherwise, workers should stay far from the site especially where hazardous chemicals are stored.

- The workers should attempt to contain the fire if appropriate fire extinguishers are available, when properly advised by the Fire Department to do so, and if workers are properly trained to handle the emergency.
- If the fire cannot be controlled, the field team will evacuate all personnel to a location upwind of the work site.

7.2 Medical Emergency

A round-the-clock medical team must be available at the Project site. The number of medical staff assigned depends on the number of workers present as prescribed under Chapter XIV, Section 64, Rules 864 to 867 of DENR Administrative Order No. 98, Series of 2000.

- In the event of a serious injury, the employee must notify the clinic and HSO immediately.
- If the illness or injury allows the movement of the victim without any potential for further injury, the individual may be immediately transported to the clinic.
- Workers with suspected back or neck injuries are not to be moved. In such instances, the worker should be stabilized while waiting for assistance.

7.3 Chemical Exposure

In the event of a respiratory exposure, dermal or eye contact, or ingestion of a potentially toxic substance, the following procedures will be followed.

- Respiratory exposure (inhalation) – Move the victim to fresh air immediately. Any loss of consciousness or exposure to elevated levels of known toxic substances, even if the individual appears to have fully recovered, requires immediate treatment or surveillance by a qualified physician.
- Dermal Contact – Wash and rinse affected area for at least 15 minutes. Transport victim to the nearest medical facility.
- Eye Contact - Flush eye/s continuously for 15 minutes. Transport victim to the nearest medical facility. Follow-up treatment or examination by a qualified physician is required.
- Ingestion - Immediately transport to the nearest available emergency medical facility.

Mine Rehabilitation Plan

Attainment of Rehabilitation Goals

The rehabilitation goals of the FMRDP are identical to the closure criteria. The goals will be attained through the following:

- Physical Stability – The Plan recognizes and provides for two classes of disruptive forces (Robertson and Clifton, 1987):

    1. Short-duration extreme events like floods, fires, tropical cyclones, and earthquakes. Sometimes, these phenomena apply forces to structures in excess of the design values.

    2. Slow but perpetual action of forces which bring about deterioration such as water and wind erosion and intrusion by roots, animals, and men.

    To address floods, the closure outlet conduits of the TSFs and open pit will be designed for a PMF. The slopes will be stabilized and, if required, trash traps are installed upstream of the structures to prevent debris blockage. The spillways of less critical structures are designed for a lesser flow, *i.e.*, a 24-hour 20 years' storm event.

    For fires, the revegetation plan will be supplemented by weeding, watering, litter cleanup, and periodic controlled burns during the drier months and regular public education and forest patrol.

    As regards tropical cyclones, only grass, vines, and shrubs will be planted on the dam embankments and sanitary landfill cap. This is to prevent the toppling of trees and potential dam and landfill cap damage during gusty winds.

    The Project site is located in a seismic region. The destructive effects of earthquakes are factored into the MCE and OBE used in the stability assessments for the TSF and WRD design.

    Finally, to counter rill and gully erosion, the mine rehabilitation plan will use slope lengths and gradients as specified in Table 6-2. This is supplemented by berm backsloping, good drainage management, planting of tree and understory floral species, and armoring.

- Chemical Stability – Chemical stability may be critical for the TSF tailings, WRD, and sanitary landfill. Since chemical stability is contingent on physical stability, the measures discussed previously would be relevant. The measures would be supplemented by regular monitoring of effluents of the structures.

- Visual Acceptability – The FMRDP strives for visual acceptability of the rehabilitation works by using natural streams and slopes in the area as model landforms. Except for the industrial tree plantation, the selection of floral species for the plantation works was confined to those present in the area.

- Productivity - The tree species recommended for rehabilitation works such as Narra (*Pterocarpus indicus*), Molavé (*Vitex parviflora*), Salinggogon (*Cratoxylum formosum*), and Ilang-ilang (*Cananga odorata*) were selected after considering not only ecological factors but also economic and social criteria. The same is true for the suggested species for the industrial tree plantation.

    As regards the water storage areas, their maximum productivity is by conversion into fish farms.

- Self-sustaining Condition – Currently in the country, the evaluation of rehabilitation works is delimited to floral species', usually trees, survival rate. The approach is inadequate in that it disregards all other aspects of a fully functioning ecosystem. Hence, it cannot be used as a measure of self-sustaining condition.

  The EFA was developed by CSIRO to assist in the assessment of rehabilitation of disturbed sites. As discussed in the Soil Substrate Section, it is a field monitoring procedure that uses simple indicators to assess how well a landscape is functioning as an ecological system. Through application on a limestone forest, agro-forestry site, and natural succession site, BMP found the method applicable to the Siana Gold Project site. EFA will therefore be used as part of the monitoring works to determine whether the rehabilitated sites are in self-sustaining conditions.

Rehabilitation Models

Four rehabilitation models have been developed for the Project. These are:

1. Slope stabilization
2. Industrial tree plantation
3. Shrub and mulch cover for TSF embankment and
4. Premium forest tree species in flat and gently sloping areas.

The succeeding sections discuss each model. The species proposed are assumed to be those species that performed very well during the species trials. Each model also employs a soil amelioration technique which is assumed to have resulted in the best plant growth and development during the trials.

Slope Stabilization

Sloping areas produced by mining operations are most vulnerable to erosion and mass movement. For protection against erosion and gullying, the slopes will be covered with fast-growing vines (wild daisy or *Wedelia biflora*) in combination with deep rooted small trees (Aratiles or *Muntingia calabura*) that can hold the soil firmly. The species selection was based on the following criteria:

- The species must be capable of forming dense and permanent hedge that is resistant to overgrazing and fire. Only species planted as clones will grow in to each other to form such a hedge.
- It must be perennial and permanent, capable of surviving as a dense hedge for centuries.
- It must be both a xerophyte and a hydrophyte so it can survive the forces of nature.
- It must have a deep penetrating root system, capable of withstanding tunneling and cracking characteristics of soils. Roots must penetrate at least 3 meters.
- It must not compete with crop plants inter-planted with it.

- It must be cheap and easy to establish as a hedge and could easily be maintained and removed.
- It must be totally free from pests and diseases and it must not be an intermediate host of pest and diseases of any other plants.
- It must be capable of growing in all types of soil, regardless of nutrient status, pH, or salinity. This includes sands, shales, gravels, and even aluminum toxic soils.
- It must be capable of growing in a wide range of climate – from 200 mm of rainfall to 6,000 mm and from temperature of 9° to more than 50° C.

Aratiles and wild daisy are widespread in the area. They both thrive in poor soils. Aratiles can be eaten by humans and birds, while wild daisy is ornamental. At the planting design of 2 m x 2 m spacing for Aratiles and 0.3 m x 0.3 m for wild daisy shown in Figure 6-3, about 2,500 seedlings of Aratiles and 111,111 cuttings of wild daisy are needed per hectare.

Aratiles will have to be raised in the nursery for better survival. It must be grown in the nursery until it has attained a height of at least 30 cm. Wild daisy may be planted by cuttings. Cuttings with at least 3 or more nodes will improve survival rate as long as it is planted during the rainy season. For better growth of vegetation, slopes will be covered with about 5 cm garden soil for better nutrition at the early stages of plant growth. Slope stabilization will require less maintenance if the garden soil added at the surface is relatively fertile.

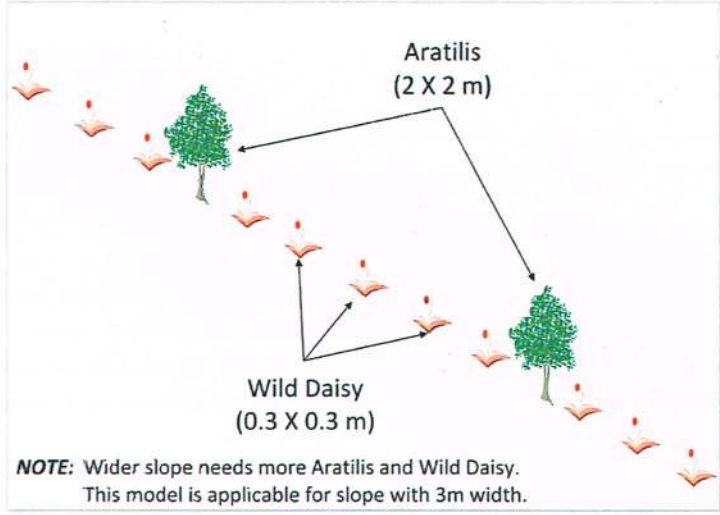


Figure 6-3. The rehabilitation model for slope stabilization

Industrial Tree Plantation

The impoundments of TSF 3 and TSF 4 and the WRD will be used primarily for the production of fuelwood and timber to supply the needs of the community. The species which were found to be performing well in the area for this purpose are *Acacia mangium* and Ipil-ipil for fuelwood and Yemane for timber. Mahogany is also doing well but not as good as yemane. *Albiaza falcata* may be planted but on fertile sites only.

The species selected for the TSFs are Yemane and Ipil-ipil. Yemane is harvestable in 8 to 10 years. It commands a better price as lumber. Now it is in demand for furniture-making. Ipil-ipil is a good source of fuelwood. It can also provide N to the soil. As a soil enhancer, *Centrosema pubescens* and *Callopogonium muconoides* will be broadcasted throughout the TSF after the seedlings have been planted. Figure 6-4 is the planting design.

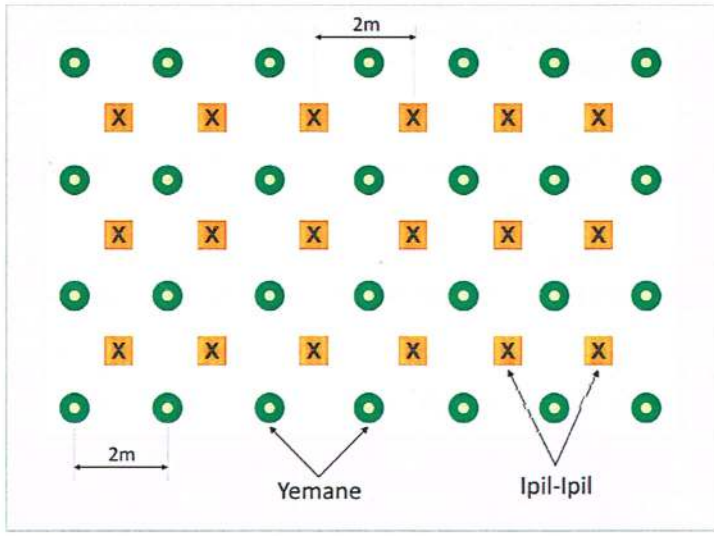


Figure 6-4. Planting design for the TSF impoundment area.

The flatlands of the WRD will utilize *Acacia mangium* and *Albizia falcata*. The former will serve as fuelwood for charcoal production and will be planted at a spacing of 1 m x 2 m. *A. falcate,* which is a raw material for veneer, will be planted at 2 m x 4 m. *A. mangium* can be harvested in 6 to 8 years. *A. falcata* is harvestable in 10 to 12 years. Figure 6-5 is the planting design.

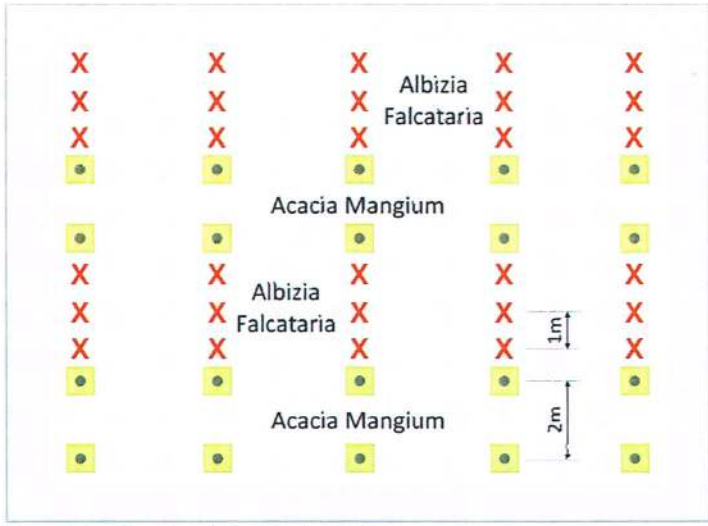


Figure 6-5. Planting design for the WRD.

Shrub and Mulch Cover

The TSF embankments consisting of the dam crests and slopes will be planted with shrubby walis-walisan (*Cida acuta*) and wild daisy. Walis-walisan which is widely dispersed in the site can be propagated by seeds. Wild daisy, an excellent vegetation cover because of its dense and fast creeping ability, is grown by cuttings. Wild daisy need not be grown in the nursery or in plastic bags since it regenerates easily if planted when soil moisture is sufficient.

Premium Forest Tree Species

The decommissioned sites of Project structures such as the process plant area, mine service area, etc. will be planted to premium forest tree species. These species include Narra (*Pterocarpus indicus*), Molave (*Vitex parviflora*), Salinggogon (*Cratoxylum formosum*), and Ilang-ilang (*Cananga odorata*).

One model will use Narra and Molave, planted alternately at a grid of 2 m x 4 m (Figure 6-6). The other model will employ Molave, Salinggogon, and Ilang-ilang. The spacing is 3 m x 3 m for all species (Figure 6-7).

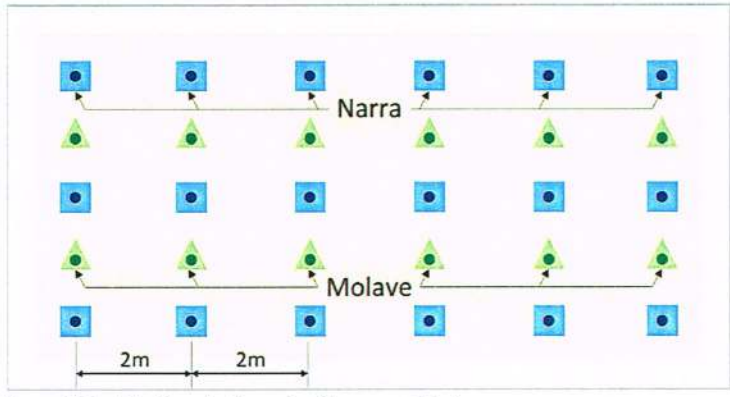


Figure 6-6. Planting design using Narra and Molave

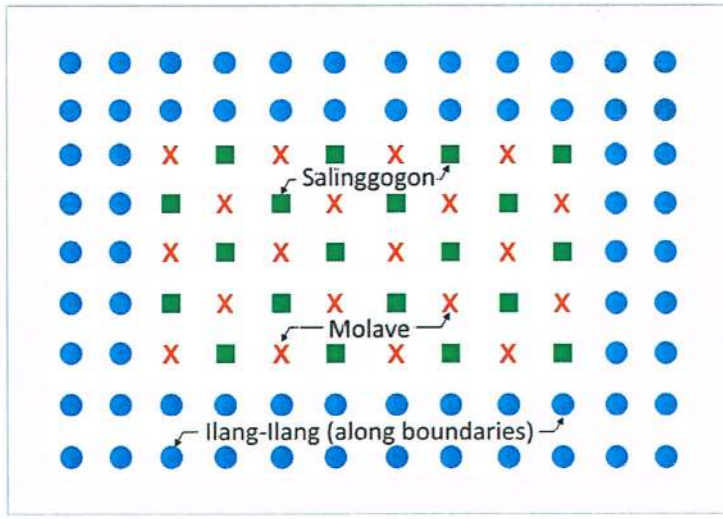


Figure 6-7. Planting design using Molave, Ilang-ilang, and Salinggogon

Soil Requirements

Based on experience worldwide in mine rehabilitation, adequate good-quality soil is a major determinant of success. The sources of good-quality soil are the topsoil recovered prior to the construction of facilities and the subsoil enriched by compost of the domestic solid waste.

Topsoil

The potential sources of topsoil include the 1.2-ha main access road, 11.3-ha enlargement of the open pit, 3.4-ha Ponds A and B, and the 0.7-ha accommodations area. At a mean topsoil depth of 30 cm, the recoverable volume of topsoil from these sites amounts to roughly 50,000 m^3. The topsoil can be used as surface capping for the buffer zone areas, as potting substrate for the seedlings in the floral nursery, or as surface capping for the CLF.

The topsoil should be recovered right after the clearing and grubbing operations and before the earth grading works[1]. To minimize losses of the topsoil due to incorporation into windrows, the clearing bulldozer should be equipped with a rootrake. This will enable the windrowing of the above and below ground woody vegetation without removing the soil. Subsequently, the topsoil is harvested using methods that minimize compaction. One method uses a grader to push the topsoil to one side of the working area. The exposed subsoil is then pushed by the same grader to the other side. A loader loads the soil into a truck which hauls the material into the designated stockpile site. The topsoil and the subsoil are stockpiled separately with the topsoil stockpile not exceeding 1 m high. This is to ensure aeration and minimized compaction for biological viability.

Composting

Composting is the controlled decomposition of organic (*i.e.*, carbon-containing) matter by microorganisms, mainly bacteria and fungi, into a stable humus material that is dark brown or black and with earthy smell. The material, *i.e.*, compost, is used primarily as a soil amendment to perform the following:

- Enhance the texture and appearance of soil
- Increase soil fertility
- Improve soil structure and aeration
- Increase the ability of the soil to retain water and nutrients and moderate soil temperature
- Reduce erosion and
- Suppress weed growth and plant diseases.

The process is managed to accelerate decomposition, optimize efficiency, and minimize any potential environmental or nuisance problems (USEPA, 1994).

[1] Clearing entails the cutting and removal of standing trees to make room for the embankment construction or the extraction of borrow materials for the embankment. Grubbing is the removal and disposal of stumps, roots, brush, small trees, embedded logs, and organic material overlying the soil. Earth grading includes the excavation of earth cuts and the construction of earth fills.

The feedstock for the composting process includes yard trimmings such as leaves, grass clippings, brush, and tree prunings; food scraps; scrap paper products; and other decomposable organics. The available composting methods can handle relatively homogeneous materials such as yard trimmings solely or heterogeneous domestic solid waste (DSW). The methods entail (*Ibid.*):

- Sorting of the feed materials to remove unwanted materials
- Size reduction by hammermills, shredders, or rotating drums
- Treatment to optimize composting conditions in terms of moisture content, carbon-to-nitrogen ratio, and pH
- Processing that may employ, in order of increasing complexity, passive piles, turned windrows, aerated static piles, and in-vessel systems and
- Curing where the compost is allowed to stabilize in piles or windrows as the remaining available nutrients are metabolized by the microorganisms that are still present.

Based on characterization studies of DSW in the Philippines, about 40 % is compostable. Assuming this proportion, roughly 8,400 m^3 of the 21,000 m^3 total estimated DSW is compostable. At 50 % composting success, about 4,200 m^3 equivalent to 5,460 t of compost at a density of 1.3 t/m^3 may be generated annually. At an application rate of 80 dt/ha as suggested by Kelly (2006), about 68 ha of mine-disturbed land can be soil conditioned.

Additional compost can be generated from the cleared vegetation in the open pit push-back area, accommodations area, etc.

Planting Program

Nursery Operations

Forest nurseries produce seedlings for a specified program. Thus, the seedlings must be of the required species, ready at the right time, *e.g.*, beginning of the wet season; of the right size and sturdiness; produced in sufficient numbers for the planting program, and must be numerous enough to accommodate the requirements. Nursery operations are vital to a successful rehabilitation work.

Because the Project is concerned with establishing good-quality plantations after mine life, the following nursery operations will be followed:

- Planning, controlling, and recording all stages from receipt of seed to consignment of plants to the planting site
- Seed storage and pre-treatment or preparation of cuttings
- Soil preparation in the seed-bed, container or medium for inserting cuttings or sowing of seeds
- Basal fertilizer application to improve nutrition for seedlings
- Sowing seeds or cuttings

- Operations of pricking out, standing out, and hardening
- Protection and maintenance until seedlings are ready for transplanting and
- Packaging and dispatch of seedlings to the planting area.

Given the size of the area to be rehabilitated, *i.e.*, about 200 ha, by the company, the total area needed for the nursery is about 0.5 to 0.75 ha.

The selection of a nursery site is determined by factors of management and silviculture such as accessibility or central location relative to the planting site, continuous supply of water for irrigation, not prone to flooding, ready availability of soil for nursery beds and filling containers, and relatively flat topography with moderate soil acidity of about 5.5-6.0. Based on these criteria, the area south of the open pit adjacent to Dayano Creek was selected as the nursery site (Figure 1-2).

The nursery area will be made compact and relatively square. It will be fenced to exclude astray animals. No waste and vacant grounds will be maintained to prevent weeds from growing. The Project will establish a modest nursery containing at least the following parts:

1. Office shed
2. Workers' potting sheds
3. Germination shed
4. Seedling shed for pricking out and initial growth of seedlings in shade
5. Storage of potting soil
6. Water pump installation
7. Water tank
8. Maturing/hardening beds where seedlings allowed to stand unshaded before outplanting.

Depending on the growth and development of individual tree species, the activities to be undertaken in the nursery are shown in Table 6-8.

Table 6-8. Nursery operations schedule

Activity	Month											
	A	S	O	N	D	J	F	M	A	M	J	J
1.Nursery establishment												
• Clearing and leveling, etc.												
• Construction of infrastructures												
2.Preparation of seedbeds												
3.Preparation of seedboxes												
4.Collection & procurement of seeds*												
5.Sowing of seeds*												

Activity	Month											
	A	S	O	N	D	J	F	M	A	M	J	J
6.Potting*												
7.Tending and caring of seedlings*												
8.Hardening off*												
9.Culling and grading*												
10.Packaging and transport*												

Note: Activities with asterisks are yearly until the end of mining operations.

Seedling Production

Seedlings will be raised and propagated according to the kind of species and sizes of seeds. All seedlings will be grown in plastic bags of appropriate size, e.g., 10 cm x 15 cm. The size has been found to result in better survival and ease in the transport of seedlings to the plantation site. The total number of seedlings that will be raised per year is shown in Table 6-9.

Table 6-9. Estimated quantity of seedlings to be produced for rehabilitation needs

Planting Sites and Species	Spacing (m)	Seedlings per hectare	Area (ha) for planting	Total Seedlings without Mortality	Allowance for Mortality (20 %)	Total Seedlings Required
TSF 3 and TSF 4						
Yemane	2 x 2	2,500	21.1	52,675	10,535	**63,210**
Ipil-ipil	2 x 2	2,500	21.1	52,675	10,535	**63,210**
Callopogonium seeds		2kg	80.8			
Process plant and Mine service areas						
Narra	2 x 4	1,250	7.9	9,913	1,983	**11,896**
Molave	2 x 4	1,250	7.9	9,913	1,983	**11,896**
WRD						
A. falcataria	2 x 2	2,500	32.1	80,125	16,025	**96,150**
A. Mangium	1 x 2	5,000	32.1	160,250	23,050	**193,300**
Other disturbed areas						
Molave	3 x 3	1111	36.9	40,951	8,191	**49,142**
Salinggogon	3 x 3	1111	36.9	40,951	8,191	**49,142**
Ilang-ilang	3 x 3	1111	36.9	40,951	8,191	**49,142**
Total						**609,888**

Care, Protection, and Conditioning of Seedlings

Watering

Provision of adequate moisture at all times is essential for seedlings in the nursery. Watering however, must be done early in the morning until 8 am only to avoid sun scalding. Watering in the afternoon may result to dumping off of some species. If possible, the water pH should be less than 7. Overhead watering using sprinkler must ensure that the soil in pots is not over soaked. Watering may be reduced to 3 waterings per week when seedlings get bigger.

Shading

Shading is related to watering since lower plant and soil temperatures reduce evapotranspiration stress. It must be remembered, however, that the need for shading differs according to species, stages of development, and nursery location. Tiny seedlings of small seeded species are usually very tender and full shade is needed over the nursery shed. Depending on the species, however, shading is quickly or gradually reduced. The system of shading in the nursery must be flexible enough to accommodate species differences, changes in weather, time of day, etc. A nursery bed normally has its own support and almost any covering material is suitable, *e.g.*, banana leaves, grass, wood or bamboo strips, netting, etc.

Seedling Nutrition

The production of healthy seedlings depends on an adequate supply of soil nutrients. If possible, soil used for potted seedlings must be fertile enough to boost growth. Normally, potting media with adequate amount of organic matter is preferred. If this is not possible, fertilizer in the form of granules may be applied before sowing. The rate of fertilizer application may be decided by local experimentation for species and potting medium concerned.

Protection Against Fungal and Insect Pest

Numerous diseases can damage tree seedlings; hence, careful observation is needed. The most serious disease affecting seedlings is damping off. This is characterized by having rotten tissue near the root collar, causing the typical symptom of seedlings toppling over. This is caused by over-watering of seedlings. Once this occurs, the damaged seedlings should be removed right away.

The tropics have a lot of insects that can damage young seedlings. This can be avoided by soil sterilization and the use of insecticides.

Hardening of Seedlings

Before the seedlings are to be planted in the field, the following treatments will be applied:

- Gradual reduction of irrigation or watering
- Cutting off of fertilizer application
- Gradual exposure to sunlight by reduction of shade
- Cutting back of shoots.

Nursery Supplies and Materials

The nursery supplies and materials with their estimated costs are shown in Table 6-10.

Table 6-10. Nursery supplies, materials, tools and other requirements

Particulars	Unit Price (PhP)	Quantity/ Size	Total Cost (PhP)
Plastic bags	0.20/pc	750,000	150,000
Potting media/garden soil	300/m^3	60 m^3	180,000
Rubber hose	25/m	500 m	12,500
Plastic sprinkler	150/pc	10 pcs	1,500
Spade	500/pc	10 pcs	5,000
Shovel	500/pc	10 pcs	5,000
Garden fork	500/pc	5 pcs	2,500
Rake	300/pc	5 pcs	1,500
Planting bar	300/pc	20 pcs	6,000
Bolo	250/pc	10 pcs	2,500
Sprayer	2,500/pc	5 pcs	12,500
Garden tools	1,000/set	3 sets	3,000
Wheel Barrow	900/pc	5 pcs	4,500
Multi-purpose shed	2,000/m^2	100 m^2	200,000
Working shed	500/m^2	100 m^2	50,000
Potting shed	500/m^2	75 m^2	37,500
Potted seedlings area (clearing/ levellng)	5/m^2	2,000 m^2	10,000
Hardening area	5/m^2	2,000 m^2	10,000
Germination area/shed	50/m^2	30 m^2	1,500
Water system/irrigation			75,000
Total			**770,500**

Social Plan

Project Personnel

The Project will create employment. However, because the ore reserve and Project activities are finite, the Project cannot sustain the employment indefinitely. Layoffs in varying degrees will happen at four distinct points of the Project timeline:

- The first one will involve the biggest number – about 400 employees of the contractors – immediately after construction.

  Of the four, this has the best timing because of the opportunity for re-hire as Project employees for operations.

- The second one will involve the 134 Project employees of the open pit operation which will happen on the fifth year of operation. Since the underground operation is into its third year by this time, the opportunity for re-hire by the Project is very limited.
- The third one to involve about 200 to 250 Project personnel in the Administration, Process Plant, and Underground Operations will occur on the tenth year of operation after the depletion of the Siana ore reserve.
- The final layoff will involve about 20 personnel upon the completion of mine closure activities.

Each of these layoffs will require an Employee Redeployment Support Program from the Project. The Program objective is to help displaced workers re-enter the job market or become self-employed.

The Public-Private Infrastructure Advisory Facility (PPIAF) of the World Bank distinguishes five main types of redeployment support. These are:

1. Pre-layoff advice and counselling which may cover advice on separation, services and support open to the displaced worker, trauma, finance, and life counselling.
2. Job-search assistance which can include placement help, time off for job search prior to termination, and help in building skills and confidence to find a new job.
3. Training which can either be retraining and skill upgrading for new paid employment elsewhere or training in small business or livelihoods for self-employment.
4. Employee enterprise which the company helps employees set up to do contractual work for the Project.
5. Large-scale, labor intensive public works programs, local community activities or small enterprise development projects funded by local government, nongovernment organizations, and community self-help groups.

According to PPIAF, the first three form the core of most redeployment programs. The last two are supplementary elements that can be appropriate in some circumstances.

The PPIAF also mentioned that in order to come up with a meaningful redeployment program, three preparatory surveys are needed, namely:

- Survey of employees to understand their skills, capabilities, post-Project plans, and redeployment needs; to identify the most vulnerable groups; and to provide a baseline for subsequent monitoring and evaluation. Those at highest risk are unlikely to find jobs quickly and will benefit from job-creation activities and income support. Those with the most skills and mobility can benefit from job-search assistance, and skills upgrading or retraining.
- Survey of the labor market, both formal and informal, including areas of supply and demand. The survey is not one-time but done periodically to detect trends and changes and to improve the redeployment activities.
- Survey of redeployment service providers, types of service offered, and capacity to deliver.

Pending the full staffing and conduct of the three surveys by the Project and given the Project activities and timetable, the main features of a conceptual Employee Redeployment Support Program can be defined as follows:

- The advice on closure of Project activity, *e.g.*, construction, or the mine and the consequential termination of personnel must be relayed to the employee during the induction. The employee will also be briefed on the major elements of the redeployment support.
- The key elements of the Project's redeployment support are pre-layoff advice and counselling, job search assistance, and training. An employee survey and labor market survey will be conducted to define the employee needs, labor opportunities, and the features of the needed redeployment support. Depending on the survey results, additional elements can be provided.
- Upon completion of the redeployment support program, the Project will create a Redeployment Team with representation from the workers and the national and local governments.
- The counselling will target all employees and their spouses. The job search assistance will be open to all workers. The training will be given to workers based on the results of the counselling.
- The redeployment support program will be administered by the Project on years 4 to 5 and years 9 to 11. The years 4 to 5 program will be for those personnel who will be affected by the cessation of open pit mining operations. The years 9 to 11 program will be for all other personnel who will be affected when the Siana deposit is fully exhausted. The bulk will be terminated on year 10.
- The redeployment support program will be complemented by monitoring, evaluation, and improvement processes and public reporting based on measurable performance indicators.

Impact Communities

As emphasized by the World Bank, sustainability throughout the whole mine cycle is needed in order to avoid major community problems during mine closure.

Sustainability is recognized as an imperative by the MGB. In fact, sustainability has been adopted as the central objective for the SDMP. As shown in Figure 6-8, the SDMP will help the host communities achieve sustainability by transforming the latter into responsible, self-reliant, resource-based communities that are capable of developing, implementing, and managing community development projects. This transformation is consistent with people empowerment.

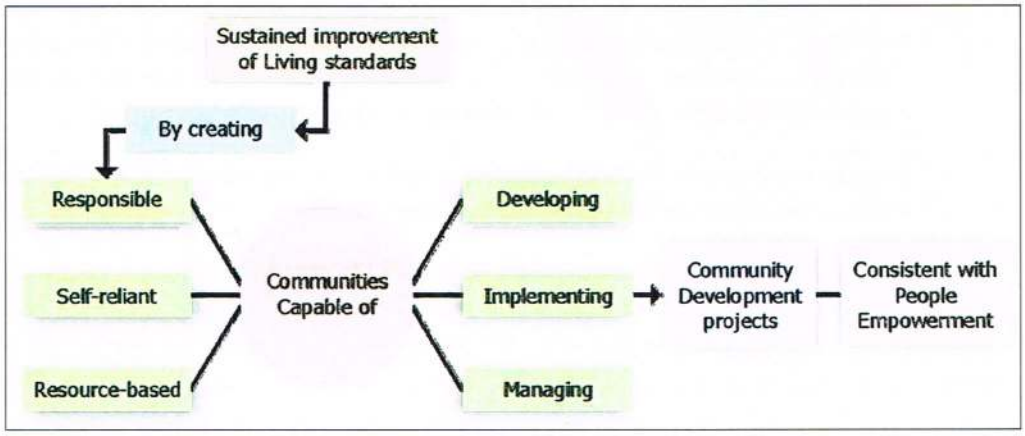


Figure 6-8. The central objective of MGB's SDMP

As discussed in the Impact Barangays Section, workshops conducted with the key leaders and members of the impact barangays in 2005 and 2009 highlighted four major problems (BMP, 2009b):

- Lack of income and income opportunities
- Lack of basic social services
- Lack of basic infrastructures and
- Lack of technical and financial support to the farmers, fishermen, and other vulnerable groups.

All four problems are attributable to the lack of economic activities in the area that would spur demand and have multiplier effects such as increase in consumption due to an increase in income.

The SDMP for the Project's first five years of operation was crafted by the host communities with sustainability beyond mining as the overriding objective. The total budget amounts to approximately P 64 million. About two-fifths is earmarked for livelihood projects; one-fifth is allocation for education which is largely scholarships; nearly a third is for infrastructure projects such as roads, health centers, water systems, and other communal facilities (BMP, 2009b).

One view of achieving sustainability is that by the time the Project is closed, the host and impact communities will have earned the assets, capital, or building blocks of a sustainable livelihood. The United Kingdom Department for Internal Development (UKDFID, 1999) identified five building blocks:

- Human assets or capital represent the skills, knowledge, ability to labor and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives.
- Social assets are the social resources such as networks, organizations, and relationships upon which people draw in pursuit of their livelihood objectives.
- Natural assets are the natural resource stocks from which resource flows and services useful for livelihoods are derived.

- Physical assets comprise the basic infrastructure and producer goods needed to support livelihoods. Infrastructure consists of changes to the physical environment that help people meet their basic needs and to be more productive. Producer goods are the tools and equipment that people use to function more productively.

- Financial assets are the financial resources, in the forms of available stocks and regular money inflows, that people use to achieve their livelihood objectives.

Murray and Ferguson (2001) adapted UKDFID's Sustainable Livelihoods Framework to the Canadian setting. This meant the introduction of a new asset type – personal assets – which comprised motivation, self-esteem, assertiveness, etc. Moreover, natural assets were made part of physical assets.

Table 6-11 lists UKDFID's five assets together with Murray and Ferguson's personal assets.

The SDMP will have its own annual monitoring program. Within the FMRDP or SDMP-FMRDP frameworks, a monitoring program can be tailored to focus on key quantifiable indicators of the six livelihood assets. Table 6-11 lists these indicators.

Table 6-11. Livelihood assets and key indicators

Asset or Capital	Examples	Key Indicators
Personal	• Motivation • Self-esteem • Self-confidence • Self-perception • Emotional well-being • Assertiveness • Spirituality	• Values formation program • Survey on life satisfaction and happiness • Share of very/fairly happy people
Human	• Skills (both technical and interpersonal) • Knowledge • Ability • Employability and earning power • Good health • Leadership	• Gross and net enrolment ratios • Adult literacy • Mean years of schooling • Life expectancy • Health facilities and services • Under 5 years old mortality rate • New schistosomiasis/TB cases per 1,000 population • Technical skills • Leadership training • Enterprise development skills • Employment status • Industries (classified into mining- and non-mining-related)
Social	• Cooperation • Networks and interconnectedness • Family support • Friendships • Relationships of trust and exchanges	• Effective community organizations • Participation levels in community and politics • Crime rate

Asset or Capital	Examples	Key Indicators
	• Partnership and collaboration • Political participation	
Natural	• Land • Forests • Wild resources • Water • Air quality • Erosion protection • Waste assimilation • Storm protection • Biodiversity	• Quantity and quality of natural assets • Access to resources • Productivity of resources • Environmental quality
Physical	• Child and elder care • Secure shelter • Clean affordable energy • Information • Basic consumer needs (*e.g.*, local grocery store and other services) • Affordable transportation • Tools and equipment	• Decent and sturdy habitation • Access to electricity • Safe water sources and distribution • Sanitary toilets and domestic waste management • Primary and secondary schools, facilities, and teachers • Farm-to-market roads • Rice dryers • Irrigation facilities • Lake flood management
Financial	• Income from productive activity (employment and self-employment) • Available finances and savings • Regular inflows of money (from government transfers, family, gifts, in-kind) • Credit rating • Access to credits	• Per capita income • Poverty incidence • Financial service organizations

Notes: The examples of personal, human, social, physical, and financial assets are taken from Murray and Ferguson, 2001. The examples of natural assets come from UKDFID.

The movement of these indicators through time can be measured. Problematic or non-optimal areas may then be identified together with corrective projects that are incorporated into the SDMP for the succeeding period.

Owing to the budget limitations of the SDMP, the corrective projects may also be funded from the excise and real property tax contributions of the Project to the Barangay, Municipal, and Provincial Governments. A complete coupling of the SDMP with the Comprehensive Land Use Plans of the municipality and province is key to the sustained improvement of living standards of the host communities.

The major elements of the Social Plan for the FMRDP are as follows:

Within the SDMP framework:

- Annual review of the SDMP's accomplishments, measurement of key quantifiable socio-economic indicators, identification of problematic or non-optimal areas, and development of corrective projects
- Funding of the corrective projects, singly or jointly, by the SDMP and local governments

Within the FMRDP framework:

- Meetings with the impact communities during Project construction to clarify the FMRDP, especially its social component
- Review of the key quantifiable socio-economic indicators of the host communities after five years of Project operation
- Development of corrective projects for funding singly or jointly by the SDMP and local governments in the next five years
- Discussion of the terms and conditions of transfer to the communities of the social assets after five years of Project operation
- Review of the key quantifiable socio-economic indicators of the impact communities and terms and conditions of transfer to the communities of the social assets two years before plant closure
- Development of corrective projects for funding singly or jointly by the SDMP, local governments, and FMRDP
- Final review of key quantifiable socio-economic indicators of host communities at plant closure.

Maintenance and Monitoring Plan

Care and Maintenance Plan

The established plantations will require the following maintenance works:

- Pruning – The pruning of unnecessary and diseased branches is indispensable to making the plantations healthy and free of pests. The removal of diseased branches will prevent the increase in populations of the disease. Branches damaged by insects or pathogens must be burned outside of the plantation.
- Fertilizer application - Fertilizer application may be done at the beginning of the wet season, *i.e.*, October, and before the end of the rainy season, *i.e.*, February. The recommended rate of application could be 20-30 g/tree for the first year and then increased to 40 and 50 g/tree in the next two years. Complete fertilizer (14-14-14) may be used.

- Replanting - This should be done one year after planting in order to attain the desired density of the stand. A 20% allowance for mortality was assumed in the calculation of the number of seedlings for each species.
- Weeding - Minimum weeding of competing species near the base of the seedlings is recommended. The removal of other species must be avoided as they provide ground cover and prevent erosion.
- Pests and diseases – The monitoring of signs or occurrence of pests and diseases will be done regularly. Any outbreak must be controlled very early. Affected parts will be removed completely by burning. Chemical application is a strategy of last resort.

The decommissioned Project facilities and structures will also require maintenance works in terms of removal of unwanted vegetation, regrading, repairs, and re-establishment of drainage channels.

The maintenance works are listed in Table 6-12. The entity responsible for the works is also shown.

Table 6-12. FMRDP maintenance works

Project Facility or Component	Maintenance Works	Frequency	Responsible Entity
All plantations	Minimum or basal grass brushing or ring weeding to eliminate competing vegetation	Once for all the sites during the drier months of April to September beginning year 3.	MCC/GRC initially and a cooperative or individual caretakers subsequently
	Watering of plants	Every other day during the drier months for the first 2 years, except when raining.	
	Fertilizer application	Twice a year for all sites – in October and February for the first three years; as required for the next two years.	
	Pruning and inspection for pests and diseases	Once a year for all sites starting on year 4 and onwards; inspection every quarter beginning year 4.	
	Replanting	One year after planting.	
Slopes along the walls, berms, and embankments of the TSFs, WRD, CLF, ponds, and sanitary landfill	Repair of surface protection or re-armoring	As required.	MCC/GRC
	Removal of undesirable vegetation	As required.	
	Repair of cracks, subsidence, bulging, erosion, gullies	As required.	
Level surfaces of the TSF tailings area, sanitary landfill, process plant, mine service area	Regrading	As required.	MCC/GRC
	Re-armoring or replacement of gravel surfacing material	As required.	

Project Facility or Component	Maintenance Works	Frequency	Responsible Entity
	Repair of cracks, subsidence, bulging, erosion, gullies	As required.	
	Removal of undesirable vegetation	As required.	
	Establishment of drainage channel	As required.	
Secondary containment pond, Ponds A and B	Removal of twigs, leaves, and debris in the water	Once every two weeks for the first year. As required beginning year 2.	MCC/GRC initially and a cooperative or individual caretakers subsequently
	Aeration of the ponds using pumps	As required.	
	Reduction of fish stocking to control ammonia and nitrite	As required.	
	Propagation of pond plants that introduce oxygen into the water and that consume nitrogen chemicals	Quarterly.	
Closure outlet conduits of TSFs and drainage channels	Repair of broken and cracked channels and trash traps	As required.	MCC/GRC
	Removal of undesirable vegetation	As required.	
	Removal of any settled section and reconstruction	As required.	
	Removal of sediment and debris in the channels and trash traps	As required.	
	Removal of sediment and debris that can migrate to block the drainage	As required.	
	Re-armoring and improving the channel sinuosity	As required.	
	Backwash and replacement of filters of the leachate treatment	As required.	
Leachate treatment system of sanitary landfill	Backwash and replacement of filters and consumables	As required.	MCC/GRC
	Clearing of drainage channels	As required.	
	Check-up of mechanical, controls, and alarm systems	Once a year.	

It is expected that maintenance works for the decommissioned and rehabilitated facility will extend to the fifth year after the end of use of the Project facility.

Monitoring Plan

Table 6-13 summarizes the mine closure monitoring plan required for each Project component.

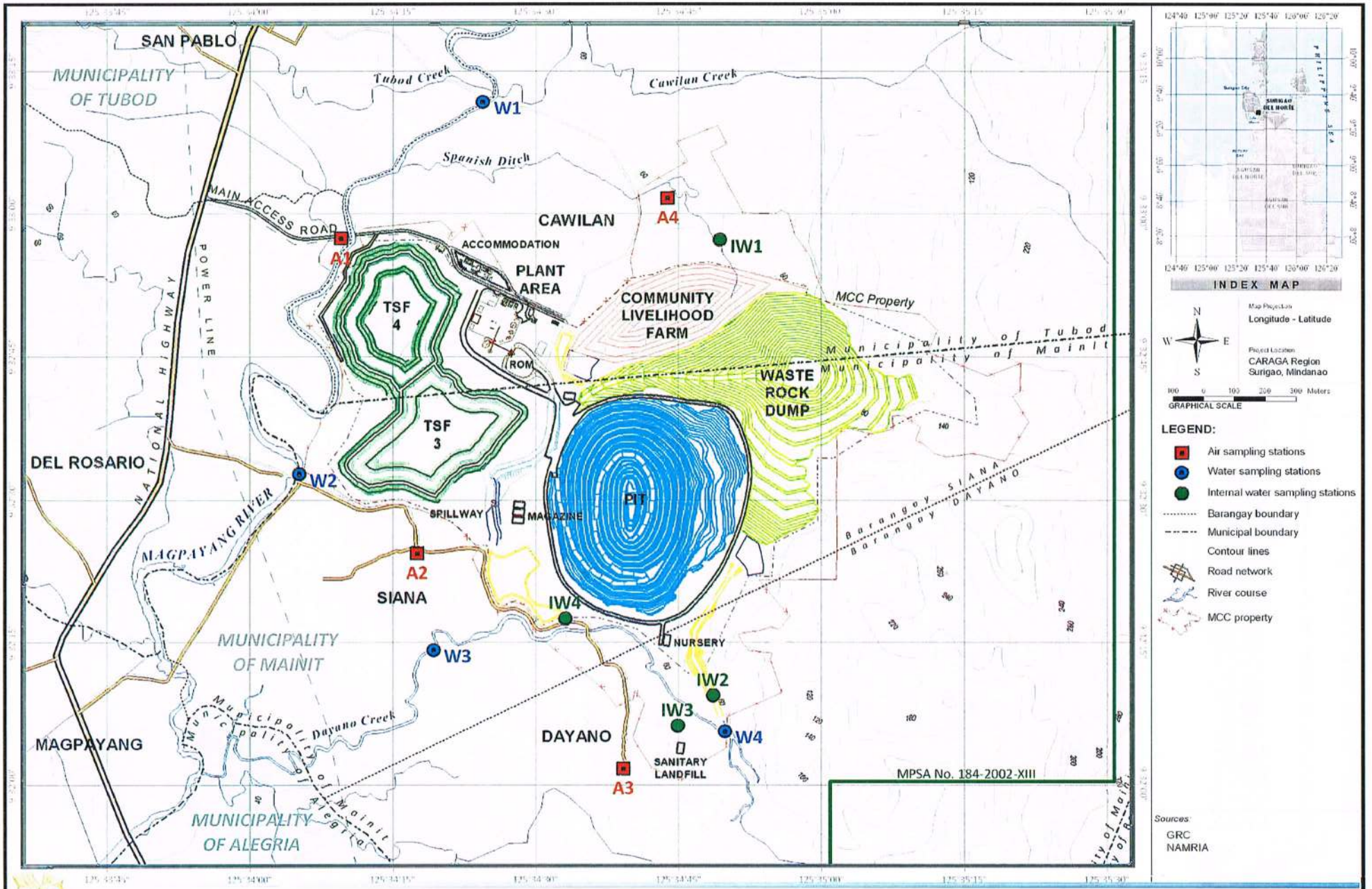
Table 6-13. Mine closure monitoring plan

Project Facility or Component	Parameters	Monitoring Approach	Frequency
Plantations	LFA Soil transect (2 transects per facility site) – Crust brokenness, erosion type and severity, deposited materials, soil surface roughness, surface nature, slake test, soil surface texture, soil fertility	Visual and feel – all LFA soil transect parameters except soil fertility Laboratory analyses - N, P, K, Ca, Mg, S, Mn, Zn, Cu, Fe, Mo	Annual
	LFA Vegetation transect (collocated with soil transect) – Floral species composition, structure, and role in the landscape; tree cover, litter cover; growth and development of trees	Visual – Floral species identification and structure characterization Measurement – Tree growth, canopy, and litter covers	
	Habitat complexity – Habitat description, faunal species including ants	Visual – Faunal species identification and structure characterization, and habitat description	
Process plant, mine service, explosives magazine, past fill plant, and nursery areas	Surface stability	Visual – Settlement, ponding, gully, sheet, or rill erosion, other signs of instability or failure, and bare areas	Weekly during the wet months of October to February or right after a heavy rain and monthly during the drier period for the first two years. Monthly during the wet months or right after a heavy rain and quarterly during the drier period for the next three years.
TSF 3 and TSF 4	Embankment slopes stability	Visual – Tension cracks, settlement, gully erosion, alluvial fans, other signs of instability or failure, bare areas, and unwanted vegetation Measurement - Piezometers	Weekly during the wet months or right after a heavy rain and monthly during the drier period for the first two years. Monthly during the wet months or right after a heavy rain and quarterly during the drier period for the next three years.
	Dam crest stability	Visual – Settlement, ponding, gully, sheet, or rill erosion, other signs of instability or failure, bare areas, and unwanted vegetation	

Project Facility or Component	Parameters	Monitoring Approach	Frequency
	Seepage	Visual – Wet spots, discoloration, or seepage through embankment Measurement – Flow rates	
	Tailings surface area stability	Visual – Settlement, ponding, gully, sheet, or rill erosion, other signs of instability or failure, and bare areas	
	Closure outlet conduits and drainage channels stability	Visual – Blocks, cracks, scour, settlement, and other signs of instability or failure	Weekly during the wet months or right after a heavy rain; monthly during drier months up to the fifth year.
WRD	Slope stability	Visual – Tension cracks, settlement, gully erosion, alluvial fans, other signs of instability or failure, bare areas, and unwanted vegetation Measurement - Piezometers	Weekly during the wet months or right after a heavy rain and monthly during the drier period for the first two years. Monthly during the wet months or right after a heavy rain and quarterly during the drier period for the next three years.
	Crest and berm stability	Visual – Settlement, ponding, gully, sheet, or rill erosion, other signs of instability or failure, bare areas, and unwanted vegetation	
	Drainage channels stability	Visual – Blocks, cracks, scour, settlement	Weekly during the wet months or right after a heavy rain; monthly during drier months up to the fifth year.
Sanitary landfill	Landfill cap integrity	Visual – Settlement, tension cracks, gully, sheet, or rill erosion, other signs of instability or failure, bare areas, and unwanted vegetation	Weekly during the wet months or right after a heavy rain and monthly during the drier period for the first two years. Monthly during the wet months or right after a heavy rain and quarterly during the drier period for the next three years.
	Diversion and drainage channels	Visual – Blocks, cracks, scour, settlement, and other signs of instability or failure	Weekly during the wet months or right after a heavy rain; monthly during drier months up to the fifth year.

Project Facility or Component	Parameters	Monitoring Approach	Frequency
	Influent of leachate treatment system	In-situ and laboratory analyses – pH, BOD_5, K, NH_4, and N	Quarterly for the first two years. If results do not vary much and are compliant with DENR standards, annually for the next three years.
	CH_4 in ambient air	Laboratory analysis – CH_4	Annual
Adjacent and downstream areas	Dust	Visual – Suspended particulates during dry and windy days Measurement – dust deposition rates from dust deposition gauges	Weekly for visual. Quarterly for measurement for the first two years. Annually for the next three years.
	Surface water quality	Visual – turbidity and water staining In-situ and laboratory analyses – pH, TSS, As, Cd, Cu, Fe, Hg, Mn, Pb, Zn, BOD_5	Weekly for visual and in-situ analyses. For the laboratory analyses, quarterly for the first two years. If results do not vary much and are compliant with DENR standards, annually for the next three years.
	Aquatic biology	Laboratory analyses – Plankton, benthos, insects Electrofishing, identification, weighing, and heavy metal tissue analyses - Fishes	Annual

Figure 6-9 locates the major environmental monitoring stations during mine closure.



Environmental monitoring stations during mine closure

FMRDP for the Siana Gold Project

Figure No. 6-9

7. SCHEDULE OF OPERATIONS AND COSTS

Schedule of Decommissioning and Rehabilitation

Table 7-1 presents the schedule of the various decommissioning and rehabilitation works for the Siana Gold Project. The timings are based on the planned production rates, facility capacities, and available inventory of gold ore.

Table 7-1. Schedule of decommissioning and rehabilitation works for the Siana Gold Project

Project Facility	Component	Parameter/Works	Area/Post-Mining Land Use/Timing
CLF	Various		13 ha - Agriculture
		Projected end of operations	2012
		Decommissioning	2013
Open pit	Various		33 ha - Lake
		Projected end of operations	2015
		Hydrological assessment and wave modeling study	2015
		Decommissioning	2021
		Rehabilitation	
		• Grading and drainage works	2021
		• Nursery operations	2021
		• Plantation establishment	2022
		• Replanting	2023
		• Protection and maintenance	2023 - 2031
		Monitoring	2022 - 2031
TSF 3 and TSF 4	Embankment		6 ha - Shrubland
		Projected end of operations	2015
		Decommissioning	2016
		Rehabilitation	
		• Grading and drainage works	2016
		• Nursery operations	2016
		• Plantation establishment	2017
		• Replanting	2018
		• Protection and maintenance	2018 - 2026
		Monitoring	2017 - 2026
	Impoundment		21 ha - ITP
		Projected end of operations	2015
		Decommissioning	2016
		Rehabilitation	

Project Facility	Component	Parameter/Works	Area/Post-Mining Land Use/Timing
		• Drying of tailings	2016 - 2017
		• Grading and drainage works	2018
		• Nursery operations	2017
		• Plantation establishment	2018
		• Replanting	2019
		• Protection and maintenance	2019 - 2027
		Monitoring	2018 - 2027
Process plant and mine service area	Various		7 ha - Forestland
		Projected end of operations	2020
		Decommissioning	2021
		Rehabilitation	
		• Grading and drainage works	2021
		• Nursery operations	2021
		• Plantation establishment	2022
		• Replanting	2023
		• Protection and maintenance	2023 - 2031
		Monitoring	2022 - 2031
Other areas – explosives magazine, paste fill plant, nursery	Various		Forestland
		Projected end of operations	2020
		Decommissioning	2021
		Rehabilitation	
		• Grading and drainage works	2021
		• Nursery operations	2021
		• Plantation establishment	2022
		• Replanting	2023
		• Protection and maintenance	2023-2031
		Monitoring	2022 - 2031
Accommodations and main office	Various		0.2 ha – Buildings maintained 0.5 ha - Forestland
		Projected end of operations	2020
		Repairs and haul-out of wastes	2021
		Rehabilitation (surroundings)	
		• Nursery operations	2021
		• Plantation establishment	2022
		• Replanting	2023
		• Protection and maintenance	2023-2031

Project Facility	Component	Parameter/Works	Area/Post-Mining Land Use/Timing
		Monitoring	2022-2031
TSF for underground residual tailings	To be determined.		
WRD	Various		32 ha - Shrubland
		Projected end of operations	2020
		Decommissioning	2021
		Rehabilitation	
		• Grading and drainage works	2021
		• Nursery operations	2021
		• Plantation establishment	2022
		• Replanting	2023
		• Protection and maintenance	2023 - 2031
		Monitoring	2022 - 2031
Secondary containment pond	Various	Secondary containment pond	770 ha – Fish farm
		Projected end of operations	2020
		Decommissioning	2021
		Conversion to fish farm	2022
Sanitary landfill	Various		2 ha - Grassland
		Projected end of operations	2020
		Testing of alternative landfill caps	2017 – 2020
		Decommissioning	2021
		Rehabilitation	
		• Grading and drainage works	2021
		• Nursery operations	2021
		• Plantation establishment	2022
		• Replanting	2023
		• Protection and maintenance	2023 - 2031
		Monitoring	2022 -2031
Ponds A and B	Various	Pond A	6,420 ha – Fish farm
		Pond B	27,180 ha – Fish farm
		Projected end of operations	2028
		Decommissioning	2029
		Conversion to fish farm	2030

Note: ITP is industrial tree plantation.

Cost of Decommissioning and Rehabilitation

The cost of decommissioning and rehabilitation is dependent on the specific facilities, structures, and works of the Project which are present at the time of closure. In turn, the latter will depend on a host of factors like the design, changes made during construction, and additional changes made over the Project life.

Currently, the design of the facilities and structures of the Siana Gold Project is in various stages of completion. For some facilities such as the paste fill plant, explosives magazine, and sanitary landfill, the design is conceptual. For the other facilities such as the process plant, the design is in a fairly advanced stage. For all facilities, changes in their design are still likely as the Project is turned over to the EPCM contractor. As pointed out, even after the facility is built, changes may still be done for reasons of optimization, departures from the model, new information, etc.

In view of the current design status and the likelihood of design changes over the life of the Project, only order-of-magnitude estimates are possible for the decommissioning and rehabilitation costs. Environment Australia (2002) acknowledges this limitation early on in the mining project life cycle. As the project moves on to construction, operation, and the last few years of the ore reserve, the cost estimates may be updated and refined to achieve an accuracy of ± 15 % (*Ibid.*).

Decommissioning

As discussed in the Decommissioning Plan of the previous Section, mine decommissioning works can be broken down into three components:

- Removal from the site of materials, equipment or structures
- Treatment at site of any existing or potentially hazardous materials, equipment or structures and
- Containment at site of any existing or potentially hazardous substances, equipment, or structures.

Dismantling and Removal of Equipment and Structures

The various items that need to be dismantled and removed from the site are the various mechanical equipment, steel structures, tanks, piping, and electrical equipment of the Project. The cost of their dismantling and removal can be offset by the sale of the dismantled equipment or the steel and copper scraps.

Environment Australia (2002) provides indicative infrastructure demolition and removal or disposal costs for a typical gold operation in the arid zone. Table 7-2 reproduces these indicative costs.

Table 7-2. Infrastructure demolition and removal or disposal indicative costs

Item	Aus$ Cost/Unit*
Primary crusher	$ 40,000 – 60,000
SAG mill	$ 50,000 – 80,000
Ball mill	$ 40,000 - 60,000

Item	Aus$ Cost/Unit*
Tankage CIP, thickeners, etc.	$ 10 – 20/m^3
Conveyors	$ 30 – 50/linear m
Power poles and lines	$ 2,000 – 3,000/km
Poly pipe 100/400 mm	$ 2,000 – 3,000/km
Transportable units	$ 2,000 – 3,000/unit
Fuel storage tank	$ 5,000 – 30,000/tank
Elution circuit	$ 20,000 – 30,000/unit
Gold room	$ 20,000 – 30,000/unit
Water storage tanks	$ 2,000 – 5,000/tank
Cyclone mesh fence	$ 2- 5/linear m
Light industrial buildings (includes concrete floor)	$ 60 – 80/m^2
Heavy industrial buildings (includes concrete floor)	$ 80 – 100/m^2
Concrete slabs and footings	$ 40 – 60/m^2
Wash-down bay	$ 2,000 – 3,000/bay

Note: *Assumes no resale value.
Source: Environment Australia, 2002.

As a preliminary estimate, the indicative costs of Table 7-2 were applied to the Project's process plant. GRC and Intermet Engineering (2007) provided the list of equipment for the plant. Table 7-3 presents the resulting cost estimates.

Table 7-3. Preliminary estimates of demolition and removal cost for the process plant

Item	Description	Estimate (Aus $)
Primary crusher	Twin rolls with 150 t/h capacity	50,000
SAG mill	5.3 m Ø x 7.8 m L, 423 t/h capacity	70,000
Tankage, CIP, thickeners, etc.	ROM bin, surge bin, CIL tanks, tailings detoxification reactors, electrolyte tank, elution water tank, solution tank, mixing tanks, storage tanks, storage hopper – total volume of 6,300 m^3	94,500
Water storage tanks	Process water, raw water, potable water – total capacity of 1,750 m^3	10,500
Conveyors	Crusher discharge, mill feed, emergency stockpile stacking – total length of 152 m	6,080
Elution circuit		25,000
Gold room		25,000
Transportable units	Feeders, bag breakers, chutes, feed screw, hoists, grizzly, weightometer, chutes, gravity concentrator, cyclones, pumps, trammel, screens, agitators, boiler, flux boxes, educator, scrubber exhaust fan, regeneration kiln, scrubber – total 170 units	425,000
TOTAL		706,080

Notes:

1. No resale value of equipment and sale of scrap are assumed.
2. The cost of removal of concrete foundations of buildings and tanks is considered part of the grading and drainage works.

At a currency exchange rate of P 40 = Aus $ 1, the estimate of Aus $ 706,080 is equivalent to P 28,243,200. However, this estimate needs to be deflated in view of the higher labor, equipment rental, and haulage rates in Australia compared to Philippine rates. At a deflator of 1/5, the adjusted cost is P 5.65 million.

There are other facilities to be decommissioned, namely, the paste fill plant, explosives magazine, mine fleet maintenance, and the decant system of the TSFs. The dismantling and removal cost of said facilities may be estimated as a little less than that of the process plant. This gives a total dismantling and removal cost of roughly P 10 million.

The process plant contains over 1,700 t of heavy structural and plate steel. At current scrap steel prices, the recoverable value of the steel alone without the sale of mechanical equipment or copper scrap is approximately P 26 million. Using a conservative factor of two-thirds of the value recovered due to transportation costs and material losses, the income from the sale of scrap steel is estimated at P 17 million.

At the end of Project life, gold process plants are more commonly sold as refurbishable assets to be dismantled and constructed on another site by the purchaser. Intermet Engineering estimated the salvage value of the process plant to be in the order of P 100 million. According to GRC, the ball mill alone has recently been appraised for financial audit purposes at P 48 million.

For conservatism, the FMRDP assumes that the cost of dismantling and removing all plant and equipment from the site will be offset by the sale of reusable equipment and scrap materials.

Treatment

Table 6-5 gives the stocking levels of hazardous materials for the Project. When closure is planned, all stocks will be depleted on the day of closure. When closure is sudden or abrupt, the maximum amounts of materials on stock correspond to the stocking level. Since the materials are unused, they can be repurchased by the supplier or a recycler.

For the hazardous wastes for which external treatment or containment is required such as used oil and batteries, their retrieval by the DENR-accredited treater is monthly. For used oil, the Project's maximum monthly generation rate is 7.6 m^3 which is equivalent to about 40 drums. The going rate for pick-up per drum of used oil is about P 1,000. Thus, the total treatment cost is roughly P 40,000.

The other hazardous wastes listed in Table 6-6 such as process water with CN, acids, alkalis, etc. can be treated either in the CN detoxification circuit or in the laboratory. In terms of quantity, the most significant would be the process water. At full capacity of the process plant, about 130,000 m^3 of process water per month or 5,200 m^3 per day will be generated. The latter value can be adopted as the maximum volume of process water for treatment. Based on GRC estimates, the corresponding treatment cost for 5,200 m^3 of CN-laden process water is P 420,000.

Finally, the decommissioning will also require the removal of sludge from the septic tanks and BioMAX treatment plants. For the septic tanks of the explosives magazine, paste fill plant, nursery, and sanitary landfill, a budget of P 40,000 is earmarked. For the BioMAX plants of the accommodations, main office, process plant, and mine service areas, the sludge removal budget is P 60,000.

Adding up the cost estimates, the total treatment cost is estimated at P 560,000.

Containment

The TSFs are meant to contain the tailings solids of the Siana Gold Project. During closure, rehabilitation works will be undertaken to ensure that the TSFs will contain the tailings in perpetuity.

Similar works are required for the sanitary landfill.

Both costs will be reflected in the grading and drainage component of the rehabilitation cost.

Rehabilitation

Mine rehabilitation works follow after mine decommissioning. They consist of the following:

- Earth and rock grading works to achieve the desired slopes and slope lengths
- Fixing of drainage channels, inlets, and outlets in terms of gradient, side slopes, armoring, and sinuosity and
- Revegetation works which include nursery operations, soil amelioration, planting, plantation maintenance and protection.

Grading and Drainage Works

Table 7-4 provides the cost details of the grading and drainage works for each major Project component. As discussed, the costs are order-of-magnitude estimates given that the Project is still in the design stage.

Table 7-4. Cost estimates of grading and drainage works

Project Facility or Component/Works	Timing of Grading and Drainage Works	Area, ha	Volume, m^3	Unit Cost, P	Total Cost, P
Community livelihood farmland					
Fix slopes	2012		39,744	4.91	195,058
TSF 3 and TSF 4					
a. Dry impoundment area	2016 - 2017	21.1			
b. Fix drainage	2016				
Unload silt			998	58.50	58,398
Haul silt			998	14.58	14,552
c. Grade impoundment area to free draining	2017	10.5		4.91	517,141
Process plant and mine service areas					
a. Remove foundations	2021				
Ripping			19,007	4.91	93,284

Project Facility or Component/Works	Timing of Grading and Drainage Works	Area, ha	Volume, m^3	Unit Cost, P	Total Cost, P
Loading			19,007	10.42	198,105
Hauling			19,007	8.75	166,303
b. Fix drainage	2021				
Unload silt			100	58.50	5,868
Haul silt			100	14.58	1,462
Magazine and other areas					
a. Remove foundations	2021				
Ripping			629	4.91	3,088
Loading			629	10.42	6,559
Hauling			629	8.75	5,506
b. Backfill with soil	2021				
Loading			629	10.42	6,559
Hauling			629	8.75	5,506
Grading			629	4.91	3,088
Open Pit					
a. Fix drainage	2021				
Unload silt			539	58.50	31,535
Haul silt			539	14.58	7,858
WRD					
a. Fix drainage	2021				
Unload silt			630	58.50	36,855
Haul silt			630	14.58	9,184
Sanitary landfill					
Landfill capping	2021	1.0	13,500		325,082
Geotextile tubes					
Remove silt	2028		6,882	10.42	71,726
Haul silt			6,882	8.75	60,211
Settling ponds					
a. Remove silt	2029		19,908	10.42	207,496
Haul silt			19,908	8.75	174,186
b. Apply clay lining	2029	1.2		4.91	58,623

Project Facility or Component/Works	Timing of Grading and Drainage Works	Area, ha	Volume, m^3	Unit Cost, P	Total Cost, P
Total					**2,263,232**

Notes:

1. The volumes indicated are based on assumed areas, depths, perimeters and proportions of these values.
2. The unit costs are based on contractors' rates submitted to GRC.

Table 7-5 is the cost schedule of the grading and drainage works.

Table 7-5. Cost schedule of grading and drainage works

Project Component	2012	2016	2017	2018	2019	2020	2021	2029	Total
TSF 3 & 4									
Dry impoundment area									
Fix perimeter drainage		72,949							72,949
Grade area to free drain			517,141						517,141
Sub-Total		72,949	517,141						590,090
Process plant and Mine service areas									
Remove foundations							457,691		457,691
Fix perimeter drainage							7,331		7,331
Sub-Total							465,022		465,022
Waste rock dump									
Fix drainage							46,039		46,039
Open Pit									
Fix drainage							39,393		39,393
Explosives magazines									
Remove foundations							15,153		15,153
Scarify soil							15,153		15,153
Sub-Total							30,306		30,306
Settling ponds									

Project Component	2012	2016	2017	2018	2019	2020	2021	2029	Total
Remove and haul silt								381,682	381,682
Add clay lining								58,623	58,623
Sub-Total								440,305	440,305
Geotextile Tubes									
Remove silt								131,937	131,937
Community livelihood farmland									
Fix slope	195,058								195,058
Sanitary landfill									
Capping							325,082		325,082
GRAND TOTAL	**195,058**	**72,949**	**517,141**	**0**	**0**	**0**	**905,842**	**527,242**	**2,263,232**

Failure of the landfill cap is one major risk of the sanitary landfill. To manage the risk, the FMRDP provides for the development and testing of alternative landfill caps on the filled up cells prior to closure.

Pending the determination of the best cap design and for budgeting purposes, the landfill cap design shown in Figure 7-1 is tentatively adopted. From bottom to top, the components are:

- 0.3-m thick gas collection layer which is built on top of the final daily soil cover to transmit the gas to the sides of the closed landfill
- 0.15-m thick subsoil to fulfil the DENR's requirement of a 0.6-m thick foundation layer (DENR Administrative Order No. 34, Series of 2001)
- 0.30-m thick barrier layer to minimize the infiltration of water into waste and the escape of gas from the waste
- 0.30-m thick drainage layer to drain away percolating water and to dissipate seepage forces and
- 0.30-m thick cover soil for vegetative growth, water storage, and protection of underlying cap layers.

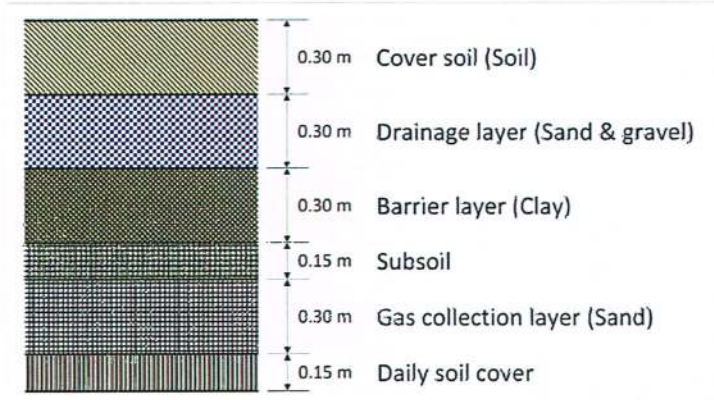


Figure 7-1. Tentative landfill cap design

Revegetation Works

Revegetation works on a per hectare basis were assessed for the various rehabilitation models. The models covered the TSF 3 and TSF 4 (both impoundments and embankments), WRD, process plant and mine service areas, and other areas including unused portions of the 240-ha Siana property. The cost estimates are shown in Table 7-6.

Using the revegetation cost estimate per hectare for the various post-mining land uses, the cost of revegetation works for each major Project facility or component is computed. The results are likewise shown in Table 7-6.

Table 7-6. Cost estimates of revegetation works

Project Facility	Post-Mining Land Use	Area, ha	Plantation Period	Unit Cost, PhP	Total Cost, PhP
TSF 3 and TSF 4					
• Embankment area	Shrubs and grass	6	2017 - 2018	99,201	582,518
• Impoundment area	ITP	21	2022 - 2023	136,775	2,882,403
Process plant and Mine service areas	Forest land	7	2022 - 2023	44,645	324,620
Magazines and other areas	Forest land	0.35	2022 - 2023	65,367	22,865
WRD	ITP	32	2022 - 2023	58,413	1,872,273
Sanitary landfill	Shrubs and grass	2	2022 - 2023	65,367	130,734
Total					5,815,414

Table 7-7 is the cost schedule of the revegetation works.

Table 7-7. Cost schedule of revegetation works

Project Component	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Total
A. TSF 3 & 4													
Impoundment													
Nursery operations		249,940											249,940
Plantation establishment			316,077										316,077
Plantation maintenance & protection				694,916	579,097	463,277	347,458	231,639					2,316,386
Embankment													
Nursery operations	189,164												189,164
Plantation establishment		101,814											101,814
Plantation maintenance & protection			87,462	72,885	58,308	43,731	29,154						291,540
Sub-total	189,164	351,754	403,539	767,801	637,405	507,008	376,612	231,639					3,464,921
B. Process Plant													
Nursery operations						54,888							54,888
Plantation establishment							54,524						54,524
Plantation maintenance & protection								64,562	53,802	43,042	32,281	21,521	215,208
Sub-total						54,888	54,524	64,562	53,802	43,042	32,281	21,521	324,620
C.Waste rock dump site													
Nursery operations						302,417							302,417
Plantation establishment							320,535						320,535
Plantation maintenance & protection								374,796	312,330	249,864	187,398	124,932	1,249,322

Project Component	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Total
Sub-total						302,417	320,535	374,796	312,330	249,864	187,398	124,932	1,872,274
D. Explosives area and other areas													
Nursery operations						2,670							2,670
Plantation establishment							2,331						2,331
Plantation maintenance & protection								5,359	4,466	3,573	2,680	1,786	17,864
Sub-total						2,670	2,331	5,359	4,466	3,573	2,680	1,786	22,865
E. Sanitary landfill													
Nursery operations						15,268							15,268
Plantation establishment							13,330						13,330
Plantation maintenance & protection								30,641	25,534	20,427	15,320	10,214	102,136
Sub-total						15,268	13,330	30,641	25,534	20,427	15,320	10,214	130,734
Grand total	189,164	351,754	403,539	767,801	637,405	882,251	767,332	706,997	396,132	316,906	237,679	158,453	5,815,414

Cost of Maintenance and Monitoring

Tables 6-12 and 6-13 present the FMRDP maintenance and monitoring work programs, respectively. They will be implemented by a dedicated team headed by a Project Manager and consisting of an Environment Officer, Health and Safety Officer, Forester, Construction Officer, Nursery Foreman, and their assistants. This team is downsized as FMRD works progress to completion. Table 7-8 lists the team members and their salaries and wages.

Table 7-9 presents the cost of maintenance and monitoring over a period of 10 years. Aside from the salaries and wages of FMRD personnel, the other cost component is the water quality sampling. Maintenance and monitoring works for the plantations are included in the revegetation costs shown in Table 7-7

Table 7-8. Schedule of salaries and wages of the FMRD Team

Position	Salary	Year 1		Year 2		Years 3 - 10		
		No. of men	Annual Salaries/ Wages	No. of men	Annual Salaries/ Wages	No. of men	Annual Salaries/ Wages	Total Salary
Project Manager	40,000	1	520,000	1	520,000			
Secretary	8,000	1	104,000	1	104,000			
Environmental Officer	20,000	1	260,000	1	260,000	1	260,000	2,080,000
Safety & Health Officer	20,000	1	260,000	1	260,000			
Safety Assistant	6,000	1	78,000					
Forester	20,000	1	260,000	1	260,000			
Nursery Foreman	10,000	1	130,000	1	130,000	1	130,000	1,040,000
Construction Officer	20,000	1	260,000					
Laborers	6,000	2	156,000	2	156,000			
Total		10	2,028,000	8	1,690,000	2	390,000	3,120,000
Grand Total								6,838,000

Table 7-9. Cost of maintenance and monitoring

Cost Item	Year 1	Year 2	Years 3 - 10
Salaries and wages	2,028,000	1,690,000	3,120,000
Monitoring cost			
• Water quality	146,400	146,400	160,400
• Dust			
Total	2,174,400	1,836,400	3,280,400
Grand Total			7,291,200

Note: The cost of maintenance and monitoring of plantations is subsumed under revegetation costs.

Total Cost of FMRDP

Table 2-4 is the cost summary of the FMRDP for the Siana Gold Project. The total cost is estimated at P 15,929,845. It should be noted that the estimate excludes the cost of hydrological assessment and wave modeling study for the open pit, livelihood seed fund for the host barangay families, and retrenchment package and redeployment support programs for Project employees.

Table 7-10 shows the annual programmed expenditures for the FMRDP broken down into decommissioning cost, grading and drainage works, soil plantation works, and maintenance and monitoring.

Build-up of FMRD Fund

Table 7-11 is the schedule of deposits required to build up the Siana Gold Project's FMRD Fund of P 15,929,845 in accordance with Table 1 of DENR Administrative Order No. 7, Series of 2005. The Funds build-up is spread over a period of seven years.

Table 7-10. Annual programmed expenditures for the FMRDP

	2012	2016	2017	2018	2019	2020	2021	2022	2023
Decommissioning									
Treatment of spoils							560,000		
Grading and drainage works	195,058	72,949	517,141				905,842		
Soil and plantation works		189,164	351,754	403,539	767,801	637,405	882,251	767,332	706,997
Maintenance and monitoring							2,174,400	1,836,400	410,050
Total		262,113	868,895	403,539	767,801	637,405	4,522,493	2,603,732	1,117,047

	2024	2025	2026	2027	2028	2029	2030	TOTAL
Decommissioning								
Treatment of spoils								560,000
Grading and drainage works						527,242		2,263,232
Soil and plantation works	396,132	316,906	237,679	158,453				5,815,413
Maintenance and monitoring	410,050	410,050	410,050	410,050	410,050	410,050	410,050	7,291,200
Total	806,182	726,956	647,729	568,503	410,050	937,292	410,050	15,929,845

Table 7-11. Schedule of deposits for the FMRD Fund

Year	% Payment per DENR AO 7, Series of 2005	FMRD Fund	Cumulative FMRD Fund
2010			
2011			
2012			
2013	26.5	4,221,409	4,221,409
2014	22.5	3,584,215	7,805,624
2015	17.7	2,819,583	10,625,207
2016	16.3	2,596,565	13,221,771
2017	9.5	1,513,335	14,735,107
2018	5.5	876,141	15,611,248
2019	2.0	318,597	15,929,845
2020			

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Annex 1. MPSA No. 184-2002-XIII

PHO59

MINERAL PRODUCTION SHARING AGREEMENT

No. MPSA No. 184-2002-XIII

This **MINERAL PRODUCTION SHARING AGREEMENT** ("Agreement") is made and entered into in Quezon City, Philippines, this _____ day of DEC 11 2002 by and between:

THE REPUBLIC OF THE PHILIPPINES, herein referred to as the **GOVERNMENT**, represented in this act by the Secretary of the Department of Environment and Natural Resources, with offices at the Department of Environment and Natural Resources Building, Visayas Avenue, Diliman, Quezon City

and

J.C.G. RESOURCES CORPORATION, a corporation duly organized and existing under the laws of the Republic of the Philippines, herein referred to as the CONTRACTOR, with office at 11th Flr., Gotesco Corporate Centre, Bilibid Viejo corner Gil Puyat Streets, Quiapo, Manila and represented in this act by its President, **Joel T. Go**, as authorized by its Board of Directors (please refer to ANNEX "A")

WITNESSETH :

WHEREAS, the 1987 Constitution of the Republic of the Philippines provides in Article XII, Section 2 thereof that all lands of the public domain, waters, minerals, coal, petroleum, and other natural resources are owned by the State and that their exploration, development and utilization shall be under the full control and supervision of the State;

WHEREAS, the Constitution further provides that the State may directly undertake such activities, or it may enter into a Co-Production, Joint Venture, or Mineral Production Sharing Agreement with Filipino citizens, or cooperatives, partnerships, corporations or associations at least sixty per centum of whose capitalization is owned by such citizens;

WHEREAS, pursuant to Republic Act No. 7942, otherwise known as "The Philippine Mining Act of 1995", which took effect on 09 April 1995, the Secretary of the Department of Environment and Natural Resources is authorized to enter into Mineral Production Sharing Agreements in furtherance of the objectives of the Government and the Constitution to bolster the national economy through sustainable and systematic development and utilization of mineral lands;

WHEREAS, the Government desires to avail itself of the financial resources, technical competence and skill which the Contractor is capable of applying to the mining operations of the project contemplated herein;

WHEREAS, the Contractor desires to join and assist the Government in the sustainable development and utilization for commercial purposes of certain **gold, copper, silver** and other associated mineral deposits existing in the Contract Area (as herein defined);

WHEREAS, the Contractor has access to all the financing, technical competence, technology and environmental management skills required to promptly and effectively carry out the objectives of this Agreement.

NOW, THEREFORE, for and in consideration of the foregoing premises, the mutual covenants, terms and conditions hereinafter set forth, it is hereby stipulated and agreed as follows:

SECTION I

SCOPE

1.1 This Agreement is a Mineral Production Sharing Agreement entered into pursuant to the provisions of the Act and its implementing rules and regulations. The primary purpose of this Agreement is to provide for the rational exploration, development and commercial utilization of certain **gold, copper, silver** and other associated mineral deposits existing within the Contract Area, with all necessary services, technology and financing to be furnished or arranged by the Contractor in accordance with the provisions of this Agreement. The Contractor shall not, by virtue of this Agreement, acquire any title over the Contract/Mining Area without prejudice to the acquisition by the Contractor of the land/surface rights through any mode of acquisition provided for by law.

1.2 The Contractor shall undertake and execute, for and on behalf of the Government, sustainable mining operations in accordance with the provisions of this Agreement, and is hereby constituted and appointed, for the purpose of this Agreement, as the exclusive entity to conduct mining operations in the Contract Area.

1.3 The Contractor shall assume all the exploration risk such that if no minerals in commercial quantity are developed and produced, it will not be entitled to reimbursement.

1.4 During the term of this Agreement, the total value of production and sale of minerals derived from the mining operations contemplated herein shall be accounted for and divided between the Government and the Contractor in accordance with Section VIII hereof.

SECTION II

DEFINITIONS

As used in this Agreement, the following words and terms, whether singular or plural, shall have the following respective meaning :

2.1 "Act" refers to Republic Act No. 7942, otherwise known as the "Philippine Mining Act of 1995".

2.2 Agreement means this Mineral Production Sharing Agreement.

2.3 Associated Minerals mean other ores/minerals which occur together with the principal ore/mineral.

2.4 Bangko Sentral means Bangko Sentral ng Pilipinas.

2.5 Budget means an estimate of expenditures to be made by Contractor in mining operations contemplated hereunder to accomplish the Work Program for each particular period.

2.6 Calendar Year or Year means a period of twelve (12) consecutive months starting with the first day of January and ending on December 31, while "Calendar Quarter" means a period of three consecutive months with the first calendar quarter starting with the first day of January.

2.7 Commercial Production means the production of sufficient quantity of minerals to sustain economic viability of mining operations reckoned from the date of commercial operation as declared by the Contractor or as stated in the feasibility study, whichever comes first.

2.8 Constitution or Philippine Constitution means the 1987 Constitution of the Republic of the Philippines adopted by the Constitutional Convention of 1986 on October 15, 1986 and ratified by the People of the Republic of the Philippines on February 2, 1987.

2.9 Contract Area means the area onshore or offshore delineated under the Mineral Production Sharing Agreement subject to the relinquishment obligations of the Contractor and properly defined by latitude and longitude or bearing and distance.

2.10 Contract Year means a period of twelve (12) consecutive months counted from the Effective Date of this Agreement or from the anniversary of such Effective Date.

2.11 Contractor means **J.C.G. RESOURCES CORPORATION** or its assignee or assignees of interest under this Agreement. Provided, That the assignment of any of such interest is accomplished pursuant to the pertinent provisions of the implementing rules and regulations of the Act.

2.12 Declaration of Mining Feasibility means a document proclaiming the presence of minerals in a specific site that are recoverable by socially acceptable, environmentally safe and economically sound methods specified in the Mine Development Plan.

2.13 Department or DENR means the Department of Environment and Natural Resources.

2.14 Director means the Director of Mines and Geosciences Bureau.

2.15 Effective Date means the date of execution of this Agreement by the Contractor and by the Secretary on behalf of the Government. In case an Exploration Permit/Temporary Exploration Permit had been availed of by the Contractor, the Effective Date of this Agreement shall be the date of issuance of said Exploration Permit/Temporary Exploration Permit.

2.16 Environment means all facets of man's surroundings: physical, ecological, aesthetic, cultural, economic, historic, institutional and social.

2.17 Exploration means searching or prospecting for mineral resources by geological, geophysical and geochemical surveys, remote sensing, test pitting, trenching, drilling, shaft sinking, tunneling, or any other means for the purpose of determining the existence, extent, quality, and quantity of mineral resources and the feasibility of mining them for profit.

2.18 Exploration Period shall mean the time period from the Effective Date of this Agreement which shall be for two (2) years, renewable for like periods but not to exceed a total term of eight (8) years subject to the pertinent provisions of the implementing rules and regulations of the Act.

2.19 Force Majeure means acts or circumstances beyond the reasonable control of the Contractor including, but not limited to war, rebellion, insurrection, riots, civil disturbances, blockade, sabotage, embargo, strike, lockout, any dispute with surface owners and other labor disputes, epidemics, earthquake, storm, flood, or other adverse weather conditions, explosion, fire, adverse action by the Government or by any of its instrumentality or subdivision thereof, act of God or any public enemy and any cause as herein described over which the affected party has no reasonable control.

2.20 Foreign Exchange means any currency other than the currency of the Republic of the Philippines acceptable to the Government and the Contractor.

2.21 Government means the Government of the Republic of the Philippines or any of its agencies and instrumentalities.

2.22 Gross Output means the actual market value of the minerals or mineral products from each mine or mineral land operated as a separate entity, without any deduction for mining, processing, refining, transporting, handling, marketing, or any other expenses: Provided, That if the minerals or mineral products are sold or consigned abroad by the Contractor under C.I.F. terms, the actual cost of ocean freight and insurance shall be deducted: Provided

further, That in the case of mineral concentrates which are not traded in commodity exchanges in the Philippines or abroad such as copper concentrate, the actual market value shall be the world price quotation of the refined mineral products contained thereof prevailing in the said commodity exchanges, after deducting the smelting ,refining, treatment, insurance, transportation and other charges incurred in the process of converting mineral concentrates into refined metal traded in those commodity exchanges.

2.23 Mine Development refers to work undertaken to prepare an ore body or a mineral deposit for mining, including the construction of necessary infrastructure and related facilities.

2.24 Minerals mean all naturally occurring inorganic substances in solid, liquid, gas or any intermediate state excluding energy materials such as coal, petroleum, natural gas, radioactive materials and geothermal energy.

2.25 Mineral Products mean materials derived from mineral ores/rocks and prepared into marketable state by metallurgical processes which include beneficiation, cyanidation, leaching, smelting, calcination and other similar processes.

2.26 Mining Area means that portion of the Contract Area identified by the Contractor as defined and delineated in a Survey Plan duly approved by the Director/concerned Regional Director for purposes of development and/or utilization and sites for support facilities.

2.27 Mining Operations means mining activities involving exploration, feasibility study, environmental impact assessment, development, utilization, mineral processing, and mine rehabilitation.

2.28 Notice means notice in writing, telex or telecopy (authenticated by answer back or confirmation received) addressed or sent as provided in Section 16.2 of this Agreement.

2.29 Ore means naturally occurring substance or material from which a mineral or element can be mined and/or processed for profit.

2.30 Pollution means any alteration of the physical, chemical and/or biological properties of any water, air and/or land resources of the Philippines, or any discharge thereto of any liquid, gaseous or solid wastes or any production of unnecessary noise or any emission of objectionable odor, as will or is likely to create or render such water, air, and land resources harmful, detrimental or injurious to public health, safety or welfare or which will adversely affect their utilization for domestic, commercial, industrial, agricultural, recreational or other legitimate purposes.

2.31 Secretary means the Secretary of the Department of Environment and Natural Resources.

2.32 State means the Republic of the Philippines.

2.33 Work Program means a document which presents the plan of major mining operations and the corresponding expenditures of the Contractor in its Contract Area during a given period of time, including the plan and expenditures for development of host and neighboring communities and of local geoscience and mining technology, as submitted and approved in accordance with the implementing rules and regulations of the Act.

SECTION III

TERM OF AGREEMENT

3.1 This Agreement shall have a term of twenty-five (25) years from Effective Date, and may be renewed thereafter for another term not exceeding twenty five (25) years. The renewal of this Agreement, as well as the changes in the terms and conditions thereof, shall be upon mutual consent by the parties. In the event the Government decides to allow mining operations thereafter by other Contractor, this must be through competitive public bidding. After due publication of notice, the Contractor shall have the right to equal the highest bid upon reimbursement of all reasonable expenses of the highest bidder.

SECTION IV

CONTRACT AREA

4.1 Size, Shape, and Location of Contract Area. This Agreement covers a total area of Three Thousand two hundred eighty eight and 7,676/10,000 hectares (3,288.7676 has.), situated in the Municipalities of Alegria, Mainit, Tubod and Bacuag, Province of Surigao Del Norte, bounded by the following geographical coordinates (please refer to ANNEX "B" - 1:50,000 scale Location Map/Sketch Plan):

BLOCK I – 1,265.0309 Hectares

CORNER	LATITUDE	LONGITUDE
1	9°28'30"	125°35'00"
2	9°29'30"	125°35'00"
3	9°29'30"	125°34'30"
4	9°30'30"	125°34'30"
5	9°30'30"	125°35'00"
6	9°30'00"	125°35'00"
7	9°30'00"	125°36'30"
8	9°30'30"	125°36'30"
9	9°30'30"	125°37'30"
10	9°30'00"	125°37'30"
11	9°30'00"	125°37'00"
12	9°29'00"	125°37'00"
13	9°29'00"	125°36'30"
14	9°28'30"	125°36'30"

BLOCK II – 2,023.7367 Hectares

CORNER	LATITUDE	LONGITUDE
1	9°31'00"	125°34'00"
2	9°31'30"	125°34'00"
3	9°31'30"	125°33'30"
4	9°32'00"	125°33'30"
5	9°32'00"	125°33'00"
6	9°32'30"	125°33'00"
7	9°32'30"	125°33'30"
8	9°34'00"	125°33'30"
9	9°34'00"	125°34'00"
10	9°34'30"	125°34'00"
11	9°34'30"	125°35'30"
12	9°32'00"	125°35'30"
13	9°32'00"	125°35'00"
14	9°31'30"	125°35'00"
15	9°31'30"	125°34'30"
16	9°31'00"	125°34'30"

SECTION V

EXPLORATION PERIOD

5.1 Timetable for Exploration - The Contractor shall commence Exploration activities not later than three (3) months after the Effective Date for a period of two (2) years, renewable for like periods but not to exceed a total term of six (8) years, subject to annual review and approval by the Director to evaluate compliance with the terms and conditions of this Agreement: Provided, That further renewal may be granted by the Secretary under circumstances as defined in the implementing rules and regulations of the Act.

In case where a Temporary Exploration Permit was issued, the Period of such Temporary Exploration Permit shall be included as part of the Exploration Period of this Agreement.

5.2 Work Programs and Budgets - The Contractor shall strictly comply with the approved Exploration and Environmental Work Programs together with their corresponding Budgets (please refer to ANNEXES "C" and "D")

The amount to be spent by the Contractor in conducting Exploration activities under the terms of this Agreement during the Exploration Period shall be in the aggregate of not less than that specified for each of the Contract Years, as follows:

For the Exploration Work Program:

1st Contract Year	:	PhP 2,600,000.00
2nd Contract Year	:	PhP 4,400,000.00
Total	:	PhP 7,000,000.00

For the Environmental Work Program : PhP 700,000.00

In the event of renewal of the Exploration Period, the amount to be spent every year shall first be agreed upon by the parties.

In the event of termination of this Agreement, the Contractor shall only be obliged to expend the pro-rata amount for the period of such Contract Year prior to termination. If during any Contract Year, the Contractor should expend more than the amount to be expended as provided above, the excess may be subtracted from the amount required to be expended by the Contractor during the succeeding Contract Years, and should the Contractor, due to unforeseen circumstances or with the consent of the Government, expend less during a year, then the deficiency shall be applied to the amount to be expended during the succeeding Contract Years.

5.3 Relinquishment of Total/Portion of the Contract Area - During the Exploration Period, the Contractor may relinquish totally or partially the original Contract Area. After the Exploration Period and prior to or upon approval of a Declaration of Mining Project Feasibility, the Contractor shall finally relinquish any portion of the Contract Area not necessary for mining operations and not covered by any Declaration of Mining Project Feasibility.

5.4 Final Mining Area - The final Mining Area shall not be more than five thousand hectares (5,000 has.) for metallic minerals. The Director may allow the Contractor to hold more than one (1) final Mining Area subject to the maximum limits set under the implementing rules and regulations of the Act: Provided, That each final Mining Area shall be covered by a Declaration of Mining Project Feasibility supported by a Mining Project Feasibility Study, Development/Utilization Work Program and application for survey.

5.5 Survey of the Contract Area - The Contractor shall cause the survey of the perimeter of the Contract Area through an application for survey, complete with requirements, filed with the concerned Regional Office simultaneous with the submission of the Declaration of Mining Project Feasibility. Survey returns shall be submitted to the concerned Regional Director for approval within one (1) year from receipt of the Order of Survey complete with the mandatory requirements stated in the implementing rules and regulations of the Act.

5.6 Declaration of Mining Project Feasibility - During the Exploration Period, the Contractor shall submit to the Director through the concerned Regional Director, a Declaration of Mining Project Feasibility together with a Mining Project Feasibility Study, a Three (3)-Year Development and Construction or

Commercial Operation Work Program, a complete geologic report of the area and an Environmental Compliance Certificate. The Mining Project Feasibility Study and Work Program are subject to approval by the Director. Failure of the Contractor to submit a Declaration of Mining Project Feasibility during the Exploration Period shall be considered a substantial breach of this Agreement.

5.7 Reporting

a) Periodic Reports - During the Exploration Period, the Contractor shall submit to the Director through the concerned Regional Director, quarterly and annual accomplishment reports under oath on all activities conducted in the Contract Area from the Effective Date of this Agreement. The quarterly report shall be submitted not later than fifteen (15) days at the end of each Calendar Quarter while the annual accomplishment report shall be submitted not later than thirty (30) days from the end of each Calendar Year. Such information shall include detailed financial expenditures, raw and processed geological, geochemical, geophysical and radiometric data plotted on a map at a minimum 1:50,000 scale, copies of originals of assay results, duplicated samples, field data, copies of originals from drilling reports, maps, environmental work program implementation and detailed expenditures showing discrepancies/deviations with approved exploration and environmental plans and budgets as well as all other information of any kind collected during the exploration activities. All information submitted to the Bureau shall be subject to the confidentiality clause of this Agreement.

b) Final Report - The Contractor shall submit to the Director through the concerned Regional Director, a final report under oath upon the expiration of the Exploration Period which shall be in the form and substance comparable to published professional reports of respectable international institutions and shall incorporate all the findings in the Contract Area including location of samples, assays, chemical analysis, and assessment of mineral potentials together with a geologic map of 1:50,000 scale at the minimum showing the results of the exploration. Such report shall also include detailed expenditures incurred during the Exploration Period. In case of diamond drilling, the Contractor shall, upon request of the Director/concerned Regional Director, submit to the Regional Office a quarter of the core samples which shall be deposited in the Regional Office Core Library for safekeeping and reference.

c) Relinquishment Report - The Contractor shall submit a separate relinquishment report with a detailed geologic report of the relinquished area accompanied by maps at a scale of 1:50,000 and results of analyses and detailed expenditures, among others.

SECTION VI

DEVELOPMENT AND CONSTRUCTION PERIOD

6.1 Timetable - The Contractor shall complete the development of the mine including the construction of production facilities within thirty six (36) months from the submission of the Declaration of Mining Project Feasibility, subject to such extension based on justifiable reasons as the Director may approve, upon recommendation of the concerned Regional Director.

6.2 Reporting

a) Annual - The Contractor shall submit, within sixty (60) days after December 31 of each year, to the Director through the concerned Regional Director, an annual report which states the major activities, achievements and detailed expenditures during the year covered, including maps, assays, rock and mineral analyses and geological and environmental progress reports during the Development and Construction Period.

b) Final Report - Within six (6) months from the completion of the development and construction activities, the Contractor shall submit a final report to the Director through the concerned Regional Director. Such report shall integrate all information in maps of appropriate scale and quality, as well as in monographs or reports in accordance with international standards.

SECTION VII

OPERATING PERIOD

7.1 Timetable - The Contractor shall submit, within thirty (30) days before completion of mine development and construction of production facilities, to the Director through the concerned Regional Director, a Three-Year Commercial Operation Work Program. The Contractor shall commence commercial utilization immediately upon approval of the aforesaid Work Program. Failure of the Contractor to commence Commercial Production within the period shall be considered a substantial breach of the Agreement.

7.2 Commercial Operation Work Program and Budget - During the Operating Period, the Contractor shall submit to the Director through the concerned Regional Director, Work Programs and Budgets covering a period of three (3) years each, which shall be submitted not later than thirty (30) days before the expiration of the period covered by the previous Work Program.

The Contractor shall conduct Mining Operations and other activities for the duration of the Operating Period in accordance with the duly approved Work Programs and corresponding Budgets and any modification thereof shall be subject to approval by the Director.

7.3 Expansion and Modification of Facilities - The Contractor may make expansions, modifications, improvements, and replacements of the mining facilities and may add new facilities as the Contractor may consider necessary for the operations: Provided, That such plans shall be embodied in an appropriate Work Program approved by the Director.

7.4 Reporting

a) Quarterly Reports - Beginning with the first Calendar Quarter following the commencement of the Operating Period, the Contractor shall submit, within thirty (30) days after the end of each Calendar Quarter, to the Director through the concerned Regional Director, a Quarterly Report stating the tonnage of production in terms of ores, concentrates, and their corresponding grades and other types of products; value, destination of sales or exports and to whom sold; terms of sales and expenditures.

b) Annual Reports - During the Operating Period, the Contractor shall submit within sixty (60) days from the end of each Calendar Year, to the Director through the concerned Regional Director, an Annual Report indicating in sufficient detail:

b.1) The total tonnage of ore reserves, whether proven, probable, or inferred, the total tonnage of ores, kind by kind, broken down between tonnage mined, tonnages transported from the minesite and their corresponding destination, tonnages stockpiled in the mine and elsewhere in the Philippines, tonnages sold or committed for export (whether actually shipped from the Philippines or not), tonnages actually shipped from the Philippines (with full details as to purchaser, destination and terms of sale), and if known to the Contractor, tonnages refined, processed or manufactured in the Philippines with full specifications as to the intermediate products, by-products or final products and of the terms at which they were disposed;

b.2) Work accomplished and work in progress at the end of the year in question with respect to all the installations and facilities related to the utilization program, including the investment actually made or committed;

b.3) Profile of work force, including management and staff, stating particularly their nationalities, and for Filipinos, their place of origin (i.e., barangay, town, province, region); and

b.4) Ownership of the Contractor, particularly with respect to nationality.

The Contractor shall also comply with other reporting requirements provided for in the implementing rules and regulations of the Act.

SECTION VIII

FISCAL REGIME

8.1 General Principle - The fiscal regime of this Agreement shall be governed by the principle according to which the Government expects a reasonable return in economic value for the utilization of non-renewable mineral resources under its national sovereignty while the Contractor expects a reasonable return on its investment with special account to be taken for the high risk of exploration, the terms and conditions prevailing elsewhere in the industry and any special efficiency to be gained by a particularly good performance of the Contractor.

8.2 Registration Fees - Within fifteen (15) days upon receipt of the notice of approval of the Agreement from the concerned Regional Office, the Contractor shall cause the registration of this Agreement with the said Regional Office and pay the registration fee at the rate provided in the existing rules and regulations. Failure of the Contractor to cause the registration of this Agreement within the prescribed period shall be sufficient ground for cancellation of the same.

8.3 Occupation Fees - Prior to registration of this Agreement and at the same date every year thereafter, the Contractor shall pay to the concerned Municipal/City Treasurer an occupation fee over the Contract Area at the annual rate provided in the existing rules and regulations. If the fee is not paid on the date specified, the Contractor shall pay a surcharge of twenty five percentum (25%) of the amount due in addition to the occupation fees.

8.4 Share of the Government - The Government Share shall be the excise tax on mineral products at the time of removal and at the rate provided for in Republic Act No. 7729 amending Section 151 (a) of the National Internal Revenue Code, as amended, as well as other taxes, duties, and fees levied by existing laws.

For purposes of determining the amount of the herein Government Share, the Contractor shall strictly comply with the auditing and accounting requirements prescribed under existing laws and regulations.

The Government Share shall be allocated in accordance with Sections 290 and 292 of Republic Act No. 7160, otherwise known as "The Local Government Code of 1991".

8.5 Pricing of Sales - The Contractor shall endeavor to obtain the best achievable price for its production and pay the lowest achievable marketing commissions and related fees. The Contractor shall seek to strike a balance between long-term sales comparable to policies followed by independent producers in the international mining industry.

The Contractor shall likewise seek a balanced distribution among consumers. Insofar as sales to Contractor's affiliates are concerned, prices shall be at arm's length standard and competing offers for large scale and long-term

contracts shall be procured. The Bureau shall be furnished a copy of the said Sales Agreement subject to confidentiality between the Bureau and the Contractor.

8.6 Associated Minerals - If minerals other than **gold, copper, silver** and other associated deposits are discovered in commercial quantities in the Contract Area, the value thereof shall be added to the value of the principal mineral in computing the Government share.

SECTION IX

WORK PROGRAMS

9.1 Submission to Government - Within the periods stated herein, the Contractor shall prepare and submit to the Director through the concerned Regional Director, a Work Program and corresponding Budget for the Contract Area stating the Mining Operations and expenditures which the Contractor proposes to carry out during the period covered with the details and particulars set forth elsewhere in this Agreement or in the supporting documents.

9.2 Government's Examination and Revision of Work Program - Should the Government wish to propose a revision to a certain specific feature in the Work Program or Budget, it shall, within thirty (30) days after receipt thereof, provide a Notice to the Contractor specifying in reasonable detail its reasons therefore. Promptly thereafter, the Government and Contractor will meet and endeavor to agree on the revision proposed by the Government. In any event, the revision of any portion of said Work Program or Budget in which the Government shall fail to notify the Contractor of the proposed revision shall, insofar as possible, be carried out as prescribed herein. If the Government should fail within sixty (60) days from receipt thereof to notify Contractor of the proposed revisions, the Work Program and Budget proposed by the Contractor shall be deemed to be approved.

9.3 Contractor's Changes to Work Program - It is recognized by the Government and the Contractor that the details of any Work Program may require changes in the light of changing circumstances. The Contractor may make such changes: Provided, That it shall not change the general objective of the Work Program: Provided further, That changes which entail a variance of at least twenty percentum (20%) shall be subject to the approval of the Director.

9.4 The Government's approval of a proposed Work Program and Budget will not be unreasonably withheld.

SECTION X

ENVIRONMENTAL PROTECTION AND MINE SAFETY AND HEALTH

10.1 The Contractor shall manage its Mining Operations in a technically, financially, socially, culturally and environmentally responsible manner to achieve the sustainable development objectives and responsibilities as provided for under the implementing rules and regulations of the Act;

10.2 The Contractor shall prepare a plan of mining so that its damage to the environment will be minimal. To the extent possible, control of pollution and the transformation of the mined-out areas or materials into economically and socially productive forms must be done simultaneously with mining;

10.3 The Contractor shall submit an Environmental Work Program during the Exploration Period as prescribed in the implementing rules and regulations of the Act;

10.4 An Environmental Compliance Certificate (ECC) shall be secured first by the Contractor prior to the conduct of any development works, construction of production facilities and/or mine production activities in the Contract Area;

10.5 The Contractor shall submit within thirty (30) Calendar days after the issuance and receipt of the ECC, an Environmental Protection and Enhancement Program (EPEP) using MGB Form No. 16-2 covering all areas to be affected by development, utilization and processing activities under this Agreement. The Contractor shall allocate for its initial environment-related capital expenditures approximately ten percent (10%) of the total project cost or in such amount depending on the environmental/geological condition, nature and scale of operations and technology to be employed in the Contract Area;

10.6 The Contractor shall submit, within thirty (30) days prior to the beginning of every calendar year, an Annual Environmental Protection and Enhancement Program (AEPEP), using MGB Form 16-3, which shall be based on the approved EPEP. The AEPEP shall be implemented during the year for which it was submitted. To implement its AEPEP, the Contractor shall allocate annually three to five percent (3%-5%) of its direct mining and milling costs depending on the environmental/geologic condition, nature and scale of operations and technology employed in the Contract Area;

10.7 The Contractor shall establish a Mine Rehabilitation Fund (MRF) based on the financial requirements of the approved EPEP as a reasonable environmental deposit to ensure satisfactory compliance with the commitments/strategies of the EPEP/AEPEP and availability of funds for the performance of the EPEP/AEPEP during the specific project phase. The MRF shall be deposited as Trust Fund in a government depository bank and shall be used for physical and social rehabilitation of areas affected by mining activities and for research on the social, technical and preventive aspects of rehabilitation;

10.8 The Contractor shall set up mitigating measures such as mine waste and mill tailings disposal system, mine rehabilitation or plan, water quality monitoring, etc. to minimize land degradation, air and water pollution, acid rock drainage and changes in hydrogeology;

10.9 The Contractor shall set up an Environmental and Safety Office at its minesite manned by qualified personnel to plan, implement and monitor its approved EPEP;

10.10 The Contractor shall be responsible in the monitoring of environmental, safety and health conditions in the Contract Area and shall strictly comply with all the rules and regulations embodied under DAO No. 2000-98, otherwise known as the "Mine Safety and Health Standards;"

10.11 The Contractor shall be responsible for the submission of a final mine rehabilitation and/or decommissioning plans including its financial requirements and incorporating the details and particulars set forth in the implementing rules and regulations of the Act.

SECTION XI

RIGHTS AND OBLIGATIONS OF THE PARTIES

11.1 Obligations of the Contractor:

a) To exclusively conduct sustainable Mining Operations within the Contract Area in accordance with the provisions of the Act and its implementing rules and regulations;

b) To construct and operate any facilities specified under the Mineral Agreement or approved Work Program;

c) To determine the exploration, mining and treatment process to be utilized in the Mining Operations;

d) To extract, remove, use and dispose of any tailings as authorized by an approved Work Program;

e) To secure all permits necessary or desirable for the purpose of Mining Operations;

f) To keep accurate technical records about the mining operations as well as financial and marketing accounts and make them available to Government representatives authorized by the Director for the purpose of assessing the performance and compliance of the Contractor with the terms of this Agreement. Authorized representatives of other Government Agencies may also have access to such accounts in accordance with existing laws, rules and regulations;

g) To furnish the Bureau all the data and information gathered from the Contract Area and that all the books of accounts and records shall be open for inspection;

g) To allow access to Government during reasonable hours in inspecting the Contract Area and examining pertinent records for purposes of monitoring compliance with the terms of this Agreement;

i) To hold the Government free and harmless from all claims and accounts of all kinds, as well as demands and actions arising out of the accidents or injuries to persons or properties caused by Mining Operations of the Contractor and indemnify the Government for any expenses or costs incurred by the Government by reason of any such claims, accounts, demands or actions;

j) In the development of the community:

j.1) To recognize and respect the rights, customs and traditions of indigenous cultural communities over their ancestral lands and to allocate royalty payment of not less than one percent (1%) of the value of the gross output of minerals sold;

j.2) To coordinate with proper authorities in the development of the mining community and for those living in the host and neighboring communities through social infrastructure, livelihood programs, education, water, electricity and medical services. Where traditional self-sustaining income and the community activities are identified to be present, the Contractor shall assist in the preservation and/or enhancement of such activities;

j.3) To allot annually a minimum of one percent (1%) of the direct mining and milling costs necessary to implement the activities undertaken in the development of the host and neighboring communities. Expenses for community development may be charged against the royalty payment of at least one percent (1%) of the gross output intended for the concerned indigenous cultural community;

j.4) To give preference to Filipino citizens who have established domicile in the neighboring communities, in the hiring of personnel for its mining operations. If necessary skills and expertise are currently not available, the Contractor must immediately prepare and undertake a training and recruitment program at its expense;

j.5) To incorporate in the Mining Project Feasibility Study the planned expenditures necessary to implement (j.1) to (j.3) of this Section;

k) In the development of Mining Technology and Geosciences:

k.1) In the course of its operations, to produce geological, geophysical, geochemical and other types of maps and reports that are

appropriate in scale and in format and substance which are consistent with the internationally accepted standards and practices. Such maps shall be made available to the scientific community in the most convenient and cost effective forms, subject to the condition that the Contractor may delay release of said information for a reasonable period of time which shall not exceed three (3) years;

k.2) To systematically keep the data generated from the Contract/Mining Area such as cores, assays and other related information, including economic and financial data and make them accessible to students, researchers and other persons responsible for developing mining, geoscience and processing technology subject to the condition that the Contractor may delay release of data to the science and technology community within a reasonable period of time which shall not exceed three (3) years;

k.3) To transfer to the Government or local mining company the appropriate technology it may adapt in the exploration, development and commercial utilization of the minerals in the Contract Area;

k.4) To allocate research and development budget for the advancement of mining technology and geosciences in coordination with the Bureau, research institutions, academe, etc.;

k.5) To replicate data, maps and reports cited in (k.1) and (k.2) and furnish the Bureau for archiving and systematic safekeeping which shall be made available to the science and technology community for conducting research and undertaking other activities which contribute to the development of mining, geoscience and processing technology and the corresponding national pool of manpower talents: Provided, however, that the release of data, maps and the like shall be similarly constrained in accordance with (k.1) and (k.2) above;

l) To incorporate in the Mining Project Feasibility Study the planned expenditures necessary to implement all the plans and programs set forth in this Agreement; and

m) To pay all other taxes and fees mandated by existing laws, rules and regulations.

11.2 Rights of the Contractor

The Contractor shall have the right:

a) To conduct Mining Operations within the confines of its Contract/Mining Area in accordance with the terms and conditions hereof and that it shall not interfere with the rights of other Contractors/Lessees/Operators/ Permittees;

b) Of possession of the Contract Area, with full right of ingress and egress and the right to occupy the same, subject to surface and easement rights;

c) To use and have access to all declassified geological, geophysical, drilling, production and other data relevant to the mining operations;

d) To sell, assign, transfer, convey or otherwise dispose of all its rights, interests and obligations under the Agreement subject to the approval of the Government;

e) To employ or bring into the Philippines foreign technical and specialized personnel, including the immediate members of their families as may be required in the operations of the Contractor, subject to applicable laws and regulations: Provided, That if the employment connection of such foreign persons with the Contractor ceases, the applicable laws and regulations on immigration shall apply to them. Everytime foreign technologies are utilized and where alien executives are employed, an effective program of training understudies shall be undertaken. The alien employment shall be limited to technologies requiring highly specialized training and experience subject to the required approval under existing laws, rules and regulations;

f) To enjoy easement rights and use of timber, water and other natural resources in the Contract Area subject to pertinent laws, rules and regulations and the rights of third parties;

g) Of repatriation of capital and remittance of profits, dividends and interest on loans, subject to existing laws and Bangko Sentral rules and regulations; and

h) To import when necessary all equipment, spare parts and raw materials required in the operations in accordance with existing laws and regulations.

11.3 Obligation of the Government

The Government shall:

a) Ensure that the Contractor has the Government's full cooperation in the exercise of the rights granted to it under this Agreement;

b) Use its best efforts to ensure the timely issuance of necessary permits and similar authorizing documents for use of the surface of the Contract Area; and

c) To cooperate with the Contractor in its efforts to obtain financing contemplated herein from banks or other financial institutions: Provided, That such financing arrangements will in no event reduce the Contractor's obligation on Government rights hereunder.

SECTION XII

ASSETS AND EQUIPMENT

12.1 The Contractor shall acquire for the Mining Operations only such assets that are reasonably estimated to be required in carrying out such Mining Operations.

12.2 All materials, equipment, plant and other installations erected or placed on the Contract Area of a movable nature by the Contractor shall remain the property of the Contractor. The Contractor shall have the right to remove and re-export such materials and equipment, plant and other installations from the Philippines, subject to existing rules and regulations. In case of cessation of Mining Operations on public lands occasioned by its voluntary abandonment or withdrawal, the Contractor shall have a period of one (1) year from the time of cessation within which to remove its improvements; otherwise, all social infrastructures and facilities shall be turned over or donated tax free to the proper government authorities, national or local, to ensure that said infrastructures and facilities are continuously maintained and utilized by the host and neighboring communities.

SECTION XIII

EMPLOYMENT AND TRAINING OF PHILIPPINE PERSONNEL

13.1 The Contractor agrees to employ, to the extent possible, qualified Filipino personnel in all types of mining operations for which they are qualified; and after Commercial Production commences shall, in consultation and with consent of the Government, prepare and undertake an extensive training programme suitable to Filipino nationals in all levels of employment. The objective of said programme shall be to reach within the timetable set forth below the following targets of "Filipinization":

	Unskilled (%)	Skilled (%)	Clerical (%)	Professional (%)	Management (%)
Year 1	100	100	100	75	75
Year 3	100	100	100	80	80
Year 5	100	100	100	90	90
Year 7	100	100	100	95	95
Year 10	100	100	100	95	95
Year 15	100	100	100	95	95

13.2 Cost and expenses of training such Filipino personnel and the Contractor's own employees shall be included in the Operating Expenses.

13.3 The Contractor shall not discriminate on the basis of gender and shall respect the right of women workers to participate in policy and decision-making processes affecting their rights and benefits.

SECTION XIV

ARBITRATION

14.1 The Government and the Contractor shall consult with each other in good faith and shall exhaust all available remedies to settle any and all disputes or disagreements arising out of or relating to the validity, interpretations, enforceability, or performance of this Agreement before resorting to arbitration as provided for in Section 14.2 below.

14.2 Any disagreement or dispute which can not be settled amicably within a period of one (1) year from the time the issue was raised by a Party shall be settled by a tribunal of three (3) arbitrators. This tribunal shall be constituted as follows: one to be appointed by the Contractor and another to be appointed by the Secretary. The first two appointed arbitrators shall consider names of qualified persons until agreement on a mutually acceptable Chairman of the tribunal is selected. Such arbitration shall be initiated and conducted pursuant to Republic Act No. 876, otherwise known as the "Arbitration Act".

In any event, the arbitration shall be conducted applying the substantive laws of the Republic of the Philippines.

14.3 Each party shall pay fifty per centum (50%) of the fees and expenses of the Arbitrators and the costs of arbitration. Each party shall pay its own costs and attorney's fee.

SECTION XV

SUSPENSION OR TERMINATION OF CONTRACT, TAX INCENTIVES AND CREDITS

15.1 This Agreement may be suspended for failure of the Contractor: (a) to comply with any provision or requirement of the Act and/or its implementing rules and regulations; (b) to pay taxes, fees and/or other charges demandable and due the Government.

15.2 This Agreement terminates or may be terminated for the following causes: (a) expiration of its term, whether original or renewal; (b) withdrawal from the Agreement by the Contractor; (c) violation by the Contractor of the Agreement's terms and conditions; (d) failure to pay taxes, fees/or charges or financial obligations for two (2) consecutive years; (e) false statement or omission of facts by the Contractor; and (f) any other cause or reason provided under the Act and its implementing rules and regulations, or any other relevant laws and regulations.

15.3 All statements made in this Agreement shall be considered as conditions and essential parts hereof, and any falsehood in said statements or omission of facts which may alter, change or affect substantially the fact set forth in said statements shall be a ground for its revocation and termination.

15.4 The Contractor may, by giving due notice at any time during the term of this Agreement, apply for its cancellation due to causes which, in the opinion of the Contractor, render continued mining operation no longer feasible or viable. In this case, the Secretary shall decide on the application within thirty (30) days from notice: Provided, That the Contractor has met all the financial, fiscal and legal obligations.

15.5 No delay or omissions or course of dealing by the Government shall impair any of its rights under this Agreement, except in the case of a written waiver. The Government's right to seek recourse and relief by all other means shall not be construed as a waiver of any succeeding or other default unless the contrary intention is reduced in writing and signed by the party authorized to exercise the waiver.

15.6 In case of termination, the Contractor shall pay all the fees and other liabilities due up to the end of the year in which the termination becomes effective. The Contractor shall immediately carry out the restoration of the Contract Area in accordance with good mining industry practice.

15.7 The withdrawal by the Contractor from the Mineral Agreement shall not release it from any and all financial, environmental, legal and fiscal obligations under this Agreement;

15.8 The following acts or omission, *inter alia* shall constitute breach of contract upon which the Government may exercise its right to terminate the Agreement:

a) Failure of the Contractor without valid reason to commence Commercial Production within the period prescribed; and

b) Failure of the Contractor to conduct mining operations and other activities in accordance with the approved Work Programs and/or any modification thereof as approved by the Director.

15.9 The Government may suspend and cancel tax incentives and credits if the Contractor fails to abide by the terms and conditions of said incentives and credits.

SECTION XVI

OTHER PROVISIONS

16.1 Any terms and conditions resulting from repeal or amendment of any existing laws or regulation or from the enactment of a law, regulation or administrative order shall be considered a part of this Agreement.

16.2 Notice

All notices, demands and other communications required or permitted hereunder shall be made in writing, telex or telecopy and shall be deemed to

have been duly given notice, in the case of telex or telecopy, if answered back or confirmation received, or if delivered by hand, upon receipt or ten days after being deposited in the mail, airmail postage prepaid and addressed as follows:

If to the Government:

THE SECRETARY
Department of Environment and Natural Resources
DENR Building , Visayas Avenue
Diliman, Quezon City

If to the Contractor:

THE PRESIDENT
J.C.G. Resources Corporation
11th Flr., Gotesco Corporate Centre
Bilibid Viejo corner Gil Puyat Streets
Quipo, Manila

Either party may substitute or change such address on notice thereof to the other party

16.3 Governing Law

This Agreement and the relation between the parties hereto shall be governed by and construed in accordance with the laws of the Republic of the Philippines. The Contractor hereby agrees and obliges itself to comply with the provisions of the Act, its implementing rules and regulations and other relevant laws and regulations.

16.4 Suspension of Obligation

a) Any failure or delay on the part of any party in the performance of its obligation or duties hereunder shall be excused to the extent attributable to *Force Majeure* as defined in the Act.

b) If Mining Operations are delayed, curtailed or prevented by such *Force Majeure* causes, then the time for enjoying the rights and carrying out the obligations thereby affected, the term of this Agreement and all rights and obligations hereunder shall be extended for a period equal to the period involved.

c) The Party, whose ability to perform its obligations is affected by such *Force Majeure* causes, shall promptly give Notice to the other in writing of any such delay or failure of performance, the expected duration thereof and its anticipated effect and shall use its efforts to remedy such

delay, except that neither Party shall be under any obligation to settle a labor dispute.

16.5 Amendments

This Agreement shall not be annulled, amended or modified in any respect except by mutual consent in writing of the herein parties.

IN WITNESS WHEREOF, the Parties hereto have executed this Agreement, as of the day and year first above written

THE REPUBLIC OF THE PHILIPPINES

BY :

DEC 11 2002

HEHERSON T. ALVAREZ
Secretary
Department of Environment and
Natural Resources

J.C.G. RESOURCES CORPORATION
TIN _____

BY:

JOEL T. GO
President

SIGNED IN THE PRESENCE OF :

GREGORY C. EDWARDS
(Signature over Printed Name)

(Signature over Printed Name)

ACKNOWLEDGMENT

Republic of the Philippines)
Quezon City) s s

Before me, a Notary Public for and in the City of Quezon, personally appeared **HEHERSON T. ALVAREZ**, with Community Tax Certificate No. 00496785 issued on January 7, 2011 at Manila, in his capacity as Secretary of the Department of Environment and Natural Resources, and **JOEL T. GO**, with Community Tax Certificate No. 15898780 issued on February 5, 2011 at Manila, in his capacity as President of J.C.G. Resources Corporation, both known to me and to me known to be the same persons who executed the foregoing instrument consisting of twenty four (24) pages, including this acknowledgment page, and acknowledged to me that the same is their voluntary acts and deeds.

IN WITNESS WHEREOF, I have hereunto set my hand and affix my notarial seal, this 12th day of December 2011.

ANSELMO C. ABUNGAN
NOTARY PUBLIC
UNTIL DECEMBER 31, 2011
PTR NO. 2106443 1/4/11 QC

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Page No. 124
Book No. IV
Series of 2011

C2/proforma/jcg.doc/mpsa

Annex 2. Approval of transfer of MPSA No. 184-2002-XIII from JCG Resources Corporation to Merrill Crowe Corporation

Republic of the Philippines
Department of Environment and Natural Resources
Visayas Avenue, Diliman, Quezon City
Tel Nos. (632) 929-66-26 to 29 • (632) 929-62-52
929-66-20 • 929-66-33 to 35
929-70-41 to 43

IN RE: Deed of Assignment Executed By and Between J.C.G. Resources Corporation (Contractor/Assignor) and Merrill Crowe Corporation (Assignee) Involving Mineral Production Sharing Agreement No. 184-2002-XIII

x----------x

ORDER

WHEREAS, on December 11, 2002, the Philippine Government represented by the Secretary of the Department of Environment and Natural Resources (DENR) and J.C.G. Resources Corporation (JCG) entered into the Mineral Production Sharing Agreement (MPSA) No. 184-2002-XIII covering an area of 3,288.7676 hectares located in the Municipalities of Alegria, Mainit, Tubod and Bacuag, Province of Surigao del Norte;

WHEREAS, on August 15, 2005, the Deed of Assignment (Deed) was executed, wherein JCG assigned to Merrill Crowe Corporation (Merrill Crowe) its rights in MPSA No. 184-2002-XIII;

WHEREAS, the Deed was duly registered in the Mines and Geosciences Bureau (MGB) Regional Office (RO) No. XIII on February 23, 2006;

WHEREAS, MGB RO No. XIII, thru its Memorandum dated October 26, 2007, forwarded to MGB Central Office the subject Deed for further evaluation;

WHEREAS, the MGB Director has recommended the approval of the assignment of MPSA No. 184-2002-XIII from JCG to Merrill Crowe pursuant to the Deed thru the Memorandum dated January 30, 2008;

WHEREAS, the verification of pertinent records showed that:

1. The Deed includes the required proviso that the Assignee shall assume all the Assignors' obligations under the MPSA;

2. JCG has complied with the terms and conditions of MPSA No. 184-2002-XIII;

3. Merrill Crowe is a Filipino corporation duly organized and existing under and by virtue of the laws of the Republic of the Philippines, and

CERTIFIED TRUE COPY
02Apr08
LEO L. JASARENO
Director II and
Chief, Mining Tenements Management Division
Mines and Geosciences Bureau

registered with the Securities and Exchange Commission on May 19, 2005; and

4. Merrill Crowe meets the eligibility requirements as Assignee of the MPSA pursuant to the pertinent provisions of DENR Administrative Order No. 96-40, as amended;

WHEREAS, the execution of the Deed and the subsequent endorsement thereof by the MGB are in accordance with the provisions of Section 46 of DENR Administrative Order No. 96-40, as amended, and other applicable provisions of Republic Act No. 7942, the Philippine Mining Act of 1995;

WHEREFORE, the foregoing premises considered, the assignment by J.C.G Resources Corporation of the Mineral Production Sharing Agreement No. 184-2002-XIII to Merrill Crowe Corporation pursuant to the Deed of Assignment of August 15, 2005 is hereby **APPROVED.** Accordingly, the said Mineral Production Sharing Agreement shall now be recorded in the name of **Merrill Crowe Corporation.**

SO ORDERED.

Quezon City, Philippines, MAR 11 2006.

JOSE L. ATIENZA, JR.
Secretary

Republic of the Philippines
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
IN REPLYING, PLS CITE:
SENR-014840

CERTIFIED TRUE COPY

LEO L. JASARENO
Director II
Chief, Mining Tenements Management Division
Mines and Geosciences Bureau

ACCOUNTABLE FORM NO. 51-C
Revised January, 1992 (ORIGINAL)

Official Receipt of the Republic of the Philippines

No 4003099 L

Date March 31, 2008

Agency MINES & GEO-SCIENCES BUREAU | Fund

Payor Greenstone Corporation

Nature of Collection	Account Code	Amount
Certified true copy + photocopy fee		₱ 50.-
TOTAL		₱ 50.-

Amount in Words Fifty Pesos

	Drawee Bank	Number	Date
☑ Cash			
☐ Check			
☐ Money Order			

Received the amount stated above.

per OR
EVELYN ANSOLEDA-VIDAD
Collecting Officer

NOTE: Write the number and date of this receipt on the back of check or money order received.

FINFORM CODE No. 2

Republic of the Philippines
Department of Environment and Natural Resources
MINES AND GEOSCIENCES BUREAU
Quezon City

ORDER OF PAYMENT

No. _____
Date: March 31, 2008

The Collecting Officer
Cash Unit

Please issue Official Receipt in favor of

Greenstone Corporation
(Name)

440 Agoncillo Street, Ayala Alabang Village, Muntinlupa City
(Address/Office)

in the amount of Fifty Pesos, (PhP 50.00) in cash, as payment for certified true copy and photocopying fees per the Letter dated March 24, 2008 of Greenstone Corporation pursuant to Section 1.8 of DENR Administrative Order No. 2005-08.

(Purpose)

By Authority of the Director :

LEO L. JASARENO
Chief, Mining Tenements Management Division

per Official Receipt No. 4039099
dated 3/31/08

Please deposit the collections under Bank Account/s:

No.	Name of Bank	Amount
		PhP
	TOTAL	**PhP**

Republic of the Philippines
Department of Environment and Natural Resources
MINES AND GEOSCIENCES BUREAU
North Avenue, Diliman, Quezon City, Philippines
Tel. No. (+63 2) 928-8642 / 928-8937 Fax No. (+63 2) 920-1635 E-mail: central@mgb.gov.ph

March 25, 2008

IN RE : **DEED OF ASSIGNMENT EXECUTED BY AND BETWEEN J.C.G. RESOURCES CORPORATION (CONTRACTOR/ASSIGNOR) AND MERRILL CROWE CORPORATION (ASSIGNEE) INVOLVING MINERAL PRODUCTION SHARING AGREEMENT NO. 184-2002**

x----------x

NOTICE OF ISSUANCE OF AN ORDER

MR. JOEL T. GO — **Registered Mail**
President
JCG Resources Corporation
12th Floor, Ever Gotesco Corporate Centre
1962 CM Recto Ave., Manila

MS. WILMA C. CRISOSTOMO — **Registered Mail**
President
Merrill Crowe Corporation
2003 The Peak Tower
107 LP Leviste St., Salcedo Village
Makati City

MR. ALILO C. ENSOMO, JR. — **Registered Mail**
Regional Director
Mines and Geosciences Bureau
Regional Office No. XIII
Km. 2, National Highway
Surigao City

Please be notified that an Order was issued by the Secretary of the Department of Environment and Natural Resources on March 11, 2008 on the subject, a copy of which is attached.

HORACIO C. RAMOS
Director

Annex 3. Environmental compliance certificate of the Siana Gold Project

Republic of the Philippines
Department of Environment and Natural Resources
Visayas Avenue, Diliman, Quezon City 1110
Tel. Nos.: (632) 929-66-26 to 29 • (632) 929-65-52
929-66-20 • 929-66-33 to 35
929-70-41 to 43

APR 2 1 2009

ECC Ref. Code: 0811-030-1010

Mr. Gregory C. Edwards
Managing Director
GREENSTONE RESOURCES CORPORATION
Level 2, NOL Tower, Commerce Avenue cor. Acacia Avenue
Madrigal Business Park
Ayala Alabang, Muntinlupa City

SUBJECT : **ENVIRONMENTAL COMPLIANCE CERTIFICATE**

Dear **Mr. Edwards**:

This refers to your submitted Environmental Impact Statement (EIS) in connection with your application for an Environmental Compliance Certificate (ECC) for your proposed **SIANA GOLD PROJECT** to be located at Barangay Cawilan, Municipality of Tubod, and Barangays Siana and Dayano, Municipality of Mainit, all in the Province of Surigao del Norte.

After satisfying the requirements in the said application and upon recommendation of the Environmental Management Bureau (EMB), this Department has decided to grant an ECC to the above-mentioned project.

With the issuance of this ECC, you are expected to implement the measures presented in the EIS intended to protect and mitigate the project's adverse impacts on community health, welfare and the environment. Environmental considerations shall be incorporated in all phases and aspects of the project. You may proceed with the project implementation after securing all the necessary permits from other pertinent Government agencies. This Office will be monitoring the project periodically to ensure your compliance with stipulations cited in the attached ECC.

Please be guided accordingly.

Very truly yours,

Republic of the Philippines
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
IN REPLYING, PLS CITE:
SENR-020053

JOSE L. ATIENZA, JR.
Secretary

cc: EMB Regional Office No. XIII
MGB Central Office
MGB Regional Office No. XIII
LGU – Province of Surigao del Norte
LGU – Municipality of Tubod
LGU – Municipality of Mainit
LGU – Barangay Cawilan
LGU – Barangay Siana
LGU – Barangay Dayano

Republic of the Philippines
Department of Environment and Natural Resources
Visayas Avenue, Diliman, Quezon City 1110
Tel. Nos.: (632) 929-66-26 to 29 • (632) 929-65-52
929-66-20 • 929-66-33 to 35
929-70-41 to 43

ENVIRONMENTAL COMPLIANCE CERTIFICATE

(Issued under Presidential Decree No. 1586)

ECC Reference Code: 0811-030-1010

THIS IS TO CERTIFY THAT THE PROPONENT, **GREENSTONE RESOURCES CORPORATION (GRC)**, as represented by its Managing Director, **Mr. Gregory C. Edwards**, is granted this Environmental Compliance Certificate (ECC), for its proposed ***SIANA GOLD PROJECT*** to be located at **Barangay Cawilan, Municipality of Tubod, and Barangays Siana and Dayano, Municipality of Mainit, all in the Province of Surigao del Norte** by the Department of Environment and Natural Resources (DENR) through the Environmental Management Bureau (EMB).

SUBJECT to the conditions and restrictions set out herein labeled as Attachments A and B, this Certificate is issued for the proposed **Siana Gold Project** with the following details:

PROJECT DESCRIPTION

This Certificate shall cover the Siana Gold Project of Greenstone Resources Corporation (GRC) within the 240-hectare Siana property covered by a Mineral Production Sharing Agreement (MPSA No. 184-2002-XIII) located at Barangay Cawilan, Municipality of Tubod, and Barangays Siana and Dayano, Municipality of Mainit, all in the Province of Surigao del Norte, granted on 12 December 2002, and bounded by the following geographical coordinates:

Corner	Latitude	Longitude
1	9°33'10"	125°33'55"
2	9°33'10"	125°35'25"
3	9°32'00"	125°35'25"
4	9°32'00"	125°33'55"

Note: Based on the Luzon (Philippines) datum.

The Project has the following components:

1. Dewatering of the open pit with current approximate depth of 90 m;
2. Mining of the gold deposit by open pit method to an approximate depth of 200 m below the surface from the existing floor depth of about 90 m, then by underground method over an approximately 200 m vertical interval;
3. Construction and operation of a 750,000 tons per year (TPY), expandable to one million TPY, cyanidation and flotation plant;
4. Construction and operation of mine tailings ponds and waste rock dumps;
5. Development and use of a mine camp, workshop, administration office, and 750-KVA standby generator;
6. Construction and use of a 1-km all-weather access road and a 65-ton causeway crossing; and
7. Mine rehabilitation and decommissioning.

This Certificate is issued pursuant to the provisions of Presidential Decree No. 1586, in accordance to DENR Administrative Order (D.A.O.) No. 2003-30. Non-compliance with any of the provisions of this Certificate shall be a sufficient cause for the cancellation of this Certificate and/or imposition of a fine in an amount not to exceed Fifty Thousand Pesos (₱50,000.00) for every violation thereof. The EMB, however, is not precluded from reevaluating, adding, removing, and/or correcting any deficiencies or errors that may be found after issuance of this Certificate.

Issued at DENR, Quezon City, Philippines, this APR 2 1 2009.

Recommending Approval:

JULIAN D. AMADOR
Director, EMB

Approved by:

JOSE L. ATIENZA, JR.
Secretary

Republic of the Philippines
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
IN REPLYING, PLS CITE:
SENR-020054

SWORN ACCOUNTABILITY STATEMENT

I, **Mr. Gregory C. Edwards**, as the proponent of this Siana Gold Project located at *Barangay Cawilan, Municipality of Tubod, and Barangays Siana and Dayano, Municipality of Mainit, all in the Province of Surigao del Norte*, take full responsibility in complying with all conditions contained in this Environmental Compliance Certificate (ECC).

Signature

TIN E3074009

ASR- E0044b4

QUEZON CITY

Subscribed and sworn to before me in this ____ day of APR 21 2009 2008, the above-named affiant taking oath presenting his Community Tax Certificate (CTC) No. _____ issued on _____ 2008 at _____.

ATTY. FELIXBERTO F. ABAD
NOTARY PUBLIC
Until December 31, 2009
PTR No. 1197[illegible]-8-09-FOR 2009
ATTORNEY'S ROLL No. 24842
IBP No. 747[illegible] Q. C./1-8-09
OFFICE OF THE CITY ATTY. Q.C.

Signature of Administering Officer

361
DOC. NO. 74
BOOK NO. 2
SERIES OF 2009

ATTACHMENT A

I. CONDITIONS

ENVIRONMENTAL MANAGEMENT

All commitments, mitigating measures and monitoring requirements, especially those contained in the Environmental Management Plan (EMP) in the Environmental Impact Statement (EIS), including all their modifications and additional information as approved by the EMB, shall be instituted to minimize any adverse impact of the project to the environment throughout its implementation, including the following:

1. Observance of good vegetative practices, proper land use, and sound soil management throughout the project implementation such as:

    a. Properly stockpiling and disposal of the materials generated from the mining site, silt materials scooped-out from the sediment/silt ponds, and other solid waste in permanent, stabilized areas to avoid pollution of any water body and drainage systems, and maintaining them in safe and non-polluting conditions;
    b. Strictly effecting stabilization and erosion control of the affected side slopes of the roads and nearby gullies, creeks, rivers and sediment/silt ponds within the project site;
    c. Using the recovered topsoil for i.e. re-soiling, as soil cover on waste dumps, for landscaping or stockpiling on designated suitable areas, maintained at not more than three (3) meters high and stabilized by temporary vegetation to protect it from erosion;
    d. Limiting the clearing of vegetation within the planned areas to be mined and planting idle land areas in the site with appropriate species;

2. Conduct of an effective Information, Education and Communication (IEC) Campaign to inform and educate all stakeholders, especially its local residents, on the project's mitigating measures embodied in its EIS, the conditions stipulated in this Certificate and measures in surface mining and processing for greater awareness, understanding and sustained acceptance of the project. The proponent shall implement an annual detailed IEC campaign in coordination with the Mines and Geosciences Bureau (MGB) Regional Office No. XIII and EMB Regional Office No. XIII. The proponent shall also conduct a Knowledge, Attitude, Practice (KAP) Evaluation to determine the effectiveness of the IEC Campaign, copy of such evaluation provided to the MGB and EMB Regional Offices;

3. Design and construction of roads with minimal land and ecological disturbance and with adequate drainage. It shall continuously maintain access roads and other public/private roads within the project site to offset impact of heavy vehicle traffic and nuisances/damages to the people and properties, as well as conduct regular water spraying and require vehicles to maintain low speed in dusty roads;

4. Establishment of a reforestation and carbon sink program to mitigate greenhouse gas (GHG) emissions of the project in line with the DENR's

thrust for GHG emission reduction programs. The program shall be submitted to EMB prior to the project implementation;

5. Protect the headwaters and natural springs/wells within the project site that are being utilized as sources of potable water by the community. Should the development activities affect the headwaters and natural springs/wells, the proponent shall immediately provide alternative source of potable water to the affected community;

GENERAL CONDITIONS

6. The mining and milling/processing operations shall conform with the provisions of R.A. No. 6969 (*Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990*), R.A. No. 9003 (*Ecological Solid Waste Management Act of 2000*), R.A. No. 9275 (*Philippine Clean Water Act of 2004*), and R.A. No. 8749 (*Philippine Clean Air Act of 1999*);

7. The proponent shall comply with the environmental management and protection requirements of the pertinent provisions of the Philippine Mining Act of 1995 (R.A. No. 7942 and its Revised Implementing Rules and Regulations (D.A.O. No. 96-40, as amended), as well as the pertinent provisions of the Memorandum of Agreement (MOA) between the EMB and MGB executed on 16 April 1998, such as, but not limited to, the following:

   a. Submission of Environmental Protection and Enhancement Program (EPEP), with the Final Mine Rehabilitation and/or Decommissioning Plan (FMR/DP) integrated thereto, to the MGB, for approval;
   b. Setting up of a Contingent Liability and Rehabilitation Fund (CLRF) and Environmental Trust Fund (ETF);
   c. Setting up of a Mine Environmental Protection and Enhancement Office (MEPEO) to competently handle the environment-related aspect of the project. In addition to the monitoring requirements as specified in the EMP, the MEPEO shall also monitor the actual project impacts vis-à-vis the predicted impacts and management measures in the EIS;
   d. Establishment of Mine Rehabilitation Fund Committee (MRFC) and Multipartite Monitoring Team (MMT). A local DOH representative shall be included as member in the MMT;
   e. Submission of a Social Development and Management Program (SDMP), within thirty (30) days from receipt of this Certificate, to the MGB Regional Office No. XIII, for approval. The EMB shall be furnished with the SDMP within thirty (30) days from its approval; and
   f. Designation of a Community Relations Officer (CRO);

8. The proponent shall ensure that its contractors and subcontractors properly comply with the relevant conditions of this Certificate;

9. The proponent shall conduct detailed geotechnical and hydrogeological studies to predict the hydrological impacts of underground mining and submit the results of the studies to EMB-XIII and MGB-XIII prior to project operation.

II. RESTRICTIONS

10. The gold deposit shall be mined by open pit method to an approximate depth of 200 m below the surface from the existing floor depth of about 90 m, then by underground method over an approximately 200 m vertical interval and shall be processed by cyanidation and flotation; and

11. Transfer of ownership of this project carries these same conditions and restrictions for which written notification must be made by herein grantee to EMB within fifteen (15) days from such transfer.

O.R. No. : 6833359
Date : 03 November 2008
Processing Fee : ₱6,000.00

Attachment B

PROJECT ASSESSMENT PLANNING TOOL

For the assistance of the Proponent and the Government agencies concerned in the management of the project and for better coordination in mitigation on the impact of the project on its surrounding areas and to the environment, and by way of recommendation, the following have been taken notice of by the EIA Review Committee and are forwarding these recommendations to the parties and authorities concerned for proper appreciation and action.

REGULATORY CONDITIONS	Government Agencies/Institutions Concerned
1. Compliance with the Sanitation Code of the Philippines	DOH
2. Compliance with the Labor Code of the Philippines, including occupational health and safety standards	DOLE-Bureau of Working Condition/MGB
3. Compliance with the Building Code of the Philippines	LGU-MPDO
4. Provision of proper storm drainage canal, concrete culverts, and other flood control measures to adequately receive and channel the silt-laden runoff from nearby receiving bodies of water	Provincial/Municipal Engineering Office
5. Coordination and consideration of the NWRB conditions or requirements in the allocation of water supply	NWRB
6. Presentation of the EIA findings for consideration in the approval by FMB-DENR of its Tree Cutting Permit	DENR - FMB
7. Coordination with the LGUs concerned on the implementation of the Solid Waste Management System	LGU
ENVIRONMENTAL PLANNING RECOMMENDATIONS FOR THE PROPONENT	
8. The Emergency Response Plan (ERP) shall be prepared to include an off-site emergency plan based on APELL (Awareness and Preparedness for Emergency at the Local Level)	
9. Priority of employment shall be given to qualified local residents. Adequate public information for jobs shall be made available to local residents in the affected areas.	
10. The Proponent need to implement a Risk Management Program to address environmental risks including contingency measures in case of accidents, equipment/machine malfunctions/failures, and other emergencies;	
11. An independent third party shall be commissioned to undertake an environmental audit, including a continuing study on the effects of the project on the health of the workers and affected residents, particularly women and children. The result of the third party environmental audit, including the auditing of risks and hazards of the project, shall be submitted to EMB and the MGB, while the result of the continuing health study shall be submitted, every two (2) years, to the Department of Health (DOH), for evaluation.	

DR. DAISY J. SERRANO
EIARC Chair

CESAR S. SIADOR, JR.
OIC, EIAM Division

JULIAN D. AMADOR
Director

Annex 4. Attendance sheets of meetings with the Municipal Officials of Alegria, Tubod, and Mainit

GREL. STONE RESOURCES CORPORATION

SDMP BRIEFING

LGU TUBOD

ATTENDANCE SHEET

May 19, 2009

	NAME	POSITION	SIGNATURE
1	Apolinario Talitan	SB.	
2	RICARDO E. CHIZON	S.B.	
3	ZITA N. BIONG	SB	
4	CHARLITO A. IGNALIG	SBM.	
5	ALEXANDRO A. DAMOLE SR.	S.B.M.	
6	Ma. Luisa A. Panaguiton	SB Sec.	
7	Leah M. Lopez	SB Clerk	
8	Wilson A. Ignalig	CBMS	
9	LAUREL M- GALES	Liga. Pres/	
10	ABNER BRYAN A. PALARCA	SK FED.	
11			
12			
13			
14			
15			

GREENSTONE RESOURCES CORPORATION

SDMP BRIEFING

LGU MAINIT

ATTENDANCE SHEET

May 19, 2009

	NAME	POSITION	SIGNATURE
1	Cicilio B. Emico Sr.	SB Member	
2	ARTURO M. MOSOTE	SB MEMBER	
3	ROXIE S SALINO	SB MEMBER	
4	AL RODIN C. BEHAGAN	SB MEMBER	
5	FELY M. OPTOJAN	SB Member	
6	RONNIE N. MOSENDE	SB MEMBER	
7	CAYETANO L RECABO	SB MEMBER	
8	NELSON R. REYES	SB MEMBER	
9	JESSNAR C. MOSENDE	VICE MAYOR	
10	TESSIE R. PAZ	SB SEC	
11			
12			
13			
14			
15			

Annex 5. BMP's Powerpoint® presentation on the FMRDP

COMMUNITY CONSULTATION ON FMRDP

MERRILL CROWE CORPORATION
Greenstone

bmp Environment & Community Care, Inc.

Part 1: What is the FMRDP?

Part 2: Statutory basis of FMRDP

Part 3: Role of the community

Part 1:

What is the FMRDP?

FMRDP consists of two key words:

- REHABILITATION
- DECOMMISSIONING
  - REHABILITATION is the return of disturbed land to a stable, productive and self-sustaining condition after taking into account the beneficial uses of the site and surrounding land (ADITR).

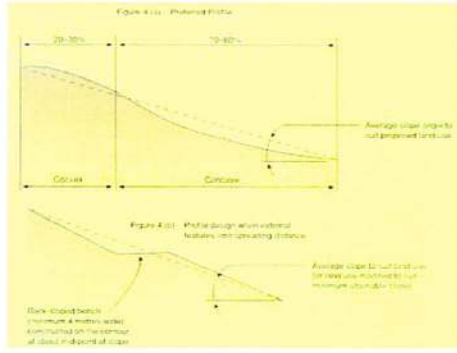
FMRDP consists of two key words:

- DECOMMISSIONING is the process that begins near, or at, the cessation of mineral production and ends with the removal of all unwanted infrastructure and services *(Ibid.)*.
- CLOSURE integrates the concepts of decommissioning and rehabilitation. It is a whole-of-mine-life process which typically culminates in tenement relinquishment *(Ibid.)*.

What are the specific goals of mine closure?

- According to the MGB's "Guidelines in the Preparation of an FMRDP and Establishment of a FMRDF pursuant to DAO 1996-40", there are two specific goals:
  1. To prevent or eliminate long-term environmental impacts by returning mining-disturbed land to a physically and chemically stable, visually acceptable, productive, or self-sustaining condition, taking into consideration the beneficial uses of the land and the surrounding areas and as agreed with the stakeholders.

Physically stable shall mean that the mine facility does not pose a hazard to public health and safety as a result of failure or physical deterioration, and that it continues to perform the function for which it was designed for its design life. It should not erode or move from its intended location under the extreme events or perpetual disruptive forces, to which it shall be subjected after closure.



Chemically stable shall mean that a mine facility should be chemically stable and not releasing chemicals (contaminants) into the environment. Using proven techniques, the production of contaminants should be controlled at a source using a system of containment, collection, and treatment systems in order to meet regulatory standards.

However, the use of effluent-treatment facilities should not be considered as rehabilitation but a temporary measure to meet regulatory requirements, or while awaiting the development of technically and economically viable rehabilitation methods or while waiting for the rehabilitation measure put in place to reach its maximum efficiency and until the water output can be treated by passive treatment or discharged directly in the environment.

Visually acceptable should take into account that the trace of a mining site cannot be completely removed. All buildings and surface infrastructures must be dismantled unless they are required for other purposes. Accordingly, consultation with the local governments and communities can help define what is visually acceptable.

Productive or self-sustaining condition – Productive use may include agroforestry, agriculture, or industrial facilities which may require passive or active care. Self-sustaining use shall mean that the end use can be sustained by natural processes and will not require actions by man.

What are the specific goals of mine closure?

2. To ensure that alternative skills and sustainable livelihood opportunities are provided/established and left behind to mine employees and their dependents and to the host and neighboring communities.

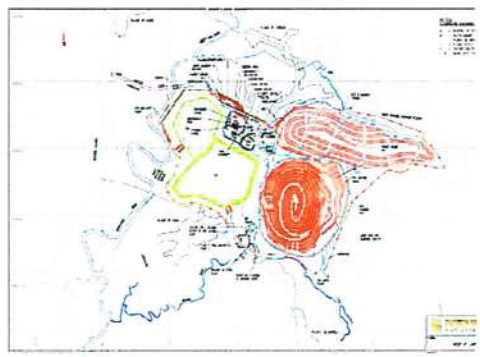
The Final Mine Rehabilitation Plan should lead towards the Final Land Use identified and agreed upon with the stakeholders.

The Final Land Use is guided by the following:

- Naturally occurring hazards in the area.
- The level of environmental and social impacts caused by the operation.
- The expected post-closure operational use of the land and
- The productivity of the land surrounding the site.

To facilitate the identification and planning for the land use, the mine is divided into several components:

- Open pit
- Waste rock dumps
- Sediment retention ponds
- Process plant
- Tailings storage facility
- Workshops
- Offices and warehouses
- Accommodations area
- Roads



Outline of FMRDP

1. Company Information
2. Executive Summary
3. Background Information
4. Stakeholder Involvement
5. Risk Assessment
6. Final Mine Rehabilitation and Decommissioning Plan
7. Schedule of Operations and Costs
8. Plans
9. Technical Appendices

Part 2:

Statutory Basis of FMRDP

Statutory basis of FMRDP

Sec. 187 of DAO 2005-07 titled "Amendments to Chapter XVIII of DENR Administrative Order No. 96-40, as amended, providing for the establishment of a Final Mine Rehabilitation and Decommissioning Fund":

Statutory basis of FMRDP

Using risk-based methodologies/approaches, the FMRDP shall consider all mine closure scenarios and shall contain cost estimates for the implementation of the FMRDP, taking in consideration expected inflation, technological advances, the unique circumstances faced by the mining operation, among others.

Statutory basis of FMRDP

Provided, that such estimates shall be based on the cost of having the decommissioning and/or rehabilitation works done by third party contractors: Provided further that the estimates on a per year basis shall cover the full extent of work necessary to achieve the objectives of mine closure such as but shall not be limited to decommissioning, rehabilitation, maintenance and monitoring and employee and other social costs, including residual care, if necessary, over a ten-year period.

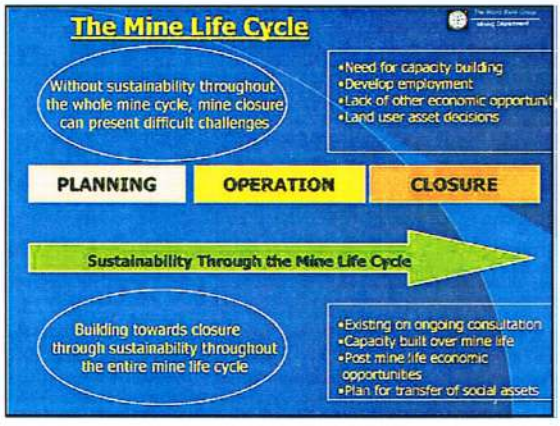
Part 3:

Role of the Community

The community has critical roles to play in the formulation of the FMRDP:

1. Visioning of the post-mining land use
2. Identification and characterization of the closure issues and risks
3. Suggestions on how the community can avoid or cushion the negative impacts of mine closure
4. Comment and endorsement of the FMRDP.

SOCIAL ASPECTS OF THE FMRDP



Conclusion and Key Messages

- Sustainability throughout the mine life cycle prepares the way for successful closure
- Plan for Closure Early
- Consult Stakeholders
  - Including workers, communities, and local government
- Share Responsibility: Develop and Work in Partnerships

SUSTAINABILITY THROUGHOUT MINELIFE SHOULD BE ATTAINED THROUGH THE SDMP

Project Selection and Prioritization Criteria

•Sustainability – Will the community be able to maintain the project as a going concern on its own after FRC-PGPRC funding, management and other forms of assistance have ceased?

•Magnitude, impact, and equitability (MIE) – What benefits can the community derive out of this project? How many will be benefited and how? Does the project have a negative impact on the environment and people?

•Cost – How much funds are required? Is it substantial and does it constitute a major percentage of the available funding?

•Technical feasibility – Does the project require specialized and highly technical expertise to start and to maintain? Is the expertise available in the area? If not, how much and what is the cost of training required?

•Social/cultural acceptability – Does the project fit within the community's norms?

•Timetable – How long would it take, from project start-up before the community reaps the benefits of the project?

Preliminary Information Dissemination and Consultation on Mine Closure

FMRDP Requirements

What mine closure entails

Social, Economic and Cultural impacts

- Loss of jobs and income
- Effects on local employment, businesses, sale of goods and services
- Other effects, negative and positive

Stakeholder Consultation

- GRC
- Employees
- Contractors
- Community
- NGAs
- NGOs and Pos
- LGUs

SA INYONG PALAGAY, ANU-ANO ANG MAGIGING PROBLEMA NG KOMUNIDAD KAPAG NAGSARA ANG MINA?

Annex 6. Climatological normals at PAGASA's Surigao City Synoptic Station

Annex 6. Climatological normals at PAGASA's Surigao City Synoptic Station

STATION :653 - SURIGAO, SURIGAO DE NORTE
LATITUDE :09° 48' N LONGITUDE :125° 30' E ELEVATION : 39.0 m
PERIOD :1971 - 2000

	RAIN-FALL	NO OF	TEMPERATURE DEG. C							--WIND--				
MONTH	MM	RD	MAX.	MIN.	MEAN	DRY BULB	WET BULB	DEW PT.	VP MBS.	RH %	MSLP MBS.	DIR	SPD MPS	CLD OKT	DAYS TSTM	WITH LTNG
JAN.	600.8	24	29.3	22.7	26.0	25.8	24.2	23.6	29.1	88	1010.7	NE	3	6	2	1
FEB.	443.2	21	29.6	22.7	26.2	25.9	24.2	23.6	29.0	87	1011.0	E	3	6	1	0
MAR.	334.6	21	30.4	23.1	26.8	26.5	24.6	23.9	29.6	86	1011.0	E	3	5	1	1
APR.	236.3	17	31.6	23.7	27.7	27.5	25.3	24.5	30.7	84	1010.0	E	2	5	4	3
MAY	127.2	13	32.7	24.2	28.4	28.3	25.8	25.0	31.5	82	1009.1	E	2	5	7	11
JUNE	140.3	14	32.5	24.1	28.3	28.1	25.7	24.9	31.4	82	1009.1	SW	2	6	7	12
JULY	165.9	13	32.2	24.1	28.1	28.0	25.4	24.5	30.6	81	1008.8	SW	2	6	7	15
AUG.	131.4	12	32.6	24.2	28.4	28.2	25.5	24.6	30.8	80	1009.0	WSW	2	6	6	15
SEPT	149.0	14	32.6	24.1	28.4	28.2	25.5	24.6	30.8	80	1009.4	WSW	2	6	8	15
OCT.	255.6	20	31.9	23.8	27.8	27.6	25.4	24.6	30.9	84	1009.2	W	2	6	9	14
NOV.	447.2	22	30.6	23.5	27.1	26.9	25.0	24.3	30.4	86	1009.4	E	2	6	7	8
DEC.	524.9	25	29.8	23.3	26.6	26.3	24.7	24.1	30.0	88	1010.2	NE	2	6	3	3
ANNUAL	3556.4	216	31.3	23.6	27.5	27.3	25.1	24.3	30.4	84	1009.7	E	2	6	62	98

PREPARED BY: PAGASA/CAB/CDS

Annex 7. Climatological extremes at PAGASA's Surigao City Synoptic Station

Annex 7. Climatological extremes at PAGASA's Surigao City Synoptic Station

YEAR - AS OF 2003

	TEMPERATURE, DEG C				GREATEST DLY RAINFALL, MM		HIGHEST WIND, MPS		SEA LEVEL PRESSURE, MBS			
MONTH	HIGH	DATE	LOW	DATE	AMOUNT	DATE	SPD	DIR	DATE	HIGH	DATE	LOW	DATE
JAN.	33.7	15-16	18.6	02-78	351.8	24-63	25/	N	24-75	1019.5	29-98	984.9	24-75
FEB.	33.3	02-06	18.2	24-05	472.9	12-74	20/	NE	21-97	1019.1	02-98	1002.5	29-96
MAR.	35.0	31-39	18.8	01-49	237.5	19-59	29/	NW	03-67	1019.3	12-64	999.8	04-89
APR.	35.2	19-87	18.9	05-63	339.0	05-86	35/	WSW	04-94	1018.3	14-93	990.5	05-94
MAY	36.3	22-87	20.8	18-72	198.1	16-62	36/	SSE	07-54	1015.9	09-57	986.1	06-54
JUNE	37.5	15-87	20.7	13-65	235.3	29-70	22/	SSW	30-70	1015.5	08-97	1000.7	30-70
JULY	36.2	31-16	20.0	06-61	201.9	01-52	31/	WNW	02-52	1015.6	04-89	995.2	02-52
AUG.	37.0	19-16	20.0	22-93	137.4	15-40	25/	WSW	17-86	1016.4	11-97	1000.2	15-74
SEP.	37.2	16-87	20.6	01-66	179.4	01-84	60/	ENE	01-84	1016.5	10-93	1000.8	11-00
OCT.	35.6	11-05	20.5	16-06	320.6	13-19	30/	W	23-88	1016.5	03-97	981.8	27-91
NOV.	36.2	02-75	19.7	12-11	564.7	18-68	46/	WSW	18-68	1018.3	23-92	977.3	12-90
DEC.	34.6	18-05	19.1	21-25	566.4	18-03	56/	E	21-86	1017.4	12- 2	977.5	21-86
ANNUAL	37.5	6-15 1987	18.2	2-24 1905	566.4	12-18 2003	60/	ENE	9-01 1984	1019.5	1-29 1998	977.3	11-12 1990
PERIOD OF RECORD	1903 - 2003				1902 - 2003		1950 - 2003			1949 - 2003			

NOTE : 1. EQUAL SIGN(=) MEANS YEAR 1800
2. NO RECORD FOR THE PERIOD 1941-1945

Annex 8. Rainfall intensity-duration-frequency data of PAGASA's Surigao City Synoptic Station

Annex 8. Rainfall intensity-duration-frequency data of PAGASA's Surigao City Synoptic Station

Based on **36 years** of record

COMPUTED EXTREME VALUES (in mm) of PRECIPITATION

Return Period (yrs)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	3 hrs	6 hrs	12 hrs	24 hrs
2	16.3	24.7	31.8	37.8	47.5	57.4	64.2	74.5	83.8	90.8	100.1	108.6	143.5	177.9	204.8
5	24.5	37.2	48.2	56.9	71.1	85.4	95.2	111.0	125.5	136.8	151.5	164.6	216.8	269.1	308.9
10	29.9	45.5	59.0	69.6	86.8	104.0	115.8	135.2	153.1	167.3	185.6	201.7	265.4	329.4	377.8
15	32.9	50.2	65.1	76.7	95.6	114.5	127.3	148.8	168.6	184.5	204.8	222.6	292.8	363.5	416.7
20	35.0	53.5	69.4	81.7	101.8	121.8	135.5	158.3	179.5	196.5	218.2	237.2	311.9	387.3	443.9
25	36.7	56.0	72.7	85.6	106.5	127.5	141.7	165.7	187.9	205.8	228.6	248.5	326.7	405.7	464.9
50	41.8	63.8	82.8	97.4	121.2	144.9	161.0	188.4	213.8	234.3	260.5	283.2	372.2	462.3	529.5
100	46.8	71.6	92.9	109.2	135.8	162.1	180.1	210.8	239.5	262.6	292.2	317.7	417.4	518.4	593.6

EQUIVALENT AVERAGE INTENSITY (in mm/hr) OF COMPUTED EXTREME VALUES

Return Period (yrs)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	3 hrs	6 hrs	12 hrs	24 hrs
2	195.6	148.2	127.2	113.4	95.0	76.5	64.2	55.9	50.3	45.4	40.0	36.2	23.9	14.8	8.5
5	294.0	223.2	192.8	170.7	142.2	113.9	95.2	83.3	75.3	68.4	60.6	54.9	36.1	22.4	12.9
10	358.8	273.0	236.0	208.8	173.6	138.7	115.8	101.4	91.9	83.7	74.2	67.2	44.2	27.4	15.7
15	394.8	301.2	260.4	230.1	191.2	152.7	127.3	111.6	101.2	92.3	81.9	74.2	48.8	30.3	17.4

Return Period (yrs)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	3 hrs	6 hrs	12 hrs	24 hrs
20	420.0	321.0	277.6	245.1	203.6	162.4	135.5	118.7	107.7	98.3	87.3	79.1	52.0	32.3	18.5
25	440.4	336.0	290.8	256.8	213.0	170.0	141.7	124.3	112.7	102.9	91.4	82.8	54.5	33.8	19.4
50	501.6	382.8	331.2	292.2	242.4	193.2	161.0	141.3	128.3	117.2	104.2	94.4	62.0	38.5	22.1
100	561.6	429.6	371.6	327.6	271.6	216.1	180.1	158.1	143.7	131.3	116.9	105.9	69.6	43.2	24.7

prepared by:

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