**Component/MFO1** : Policy, Planning, Monitoring and Evaluation

**Subcomponent 1.4** : Remediation of Risk

- Rehabilitation of Bagacay Mines
- Remediation Plans for Abandoned Mines

**Responsibility Center** : Mines and Geosciences Bureau (MGB)

- Mine Rehabilitation Project Management Unit
- Ecosystems Research Development Bureau (ERDB)

### 1.0 BACKGROUND OF THE COMPONENT

This report is concerned with presenting the rehabilitation measures undertaken at the Bagacay Mine, Eastern Samar. The Bagacay pyrite mine was mined during 1956 and it was abandoned in 1992. The mine site then became a substantial environmental liability as vegetation failed to re-establish itself on the site and contamination emanating from the mine that impacted downstream areas, notably the Taft River.

Overall, the rehabilitation of abandoned mines is an urgent initiative that is supported by the Philippine government. Thus, the Executive Order 270 entitled “National Policy Agenda in Revitalizing Mining in the Philippines” issued last January 16, 2001 stated in Section 2-i, that “Remediation and Rehabilitation of abandoned mines shall be accorded top priority to address the negative impacts of past mining projects.”

The rehabilitation of Bagacay Mine has been performed with funding from the World Bank, through the National Program Support for the Environment and Natural Resources Management Project (NPS-ENRM), The Mines and Geosciences Bureau (MGB), as the Lead Agency is implementing the project in coordination with the MGB- Regional Office VIII, DENR-Regional Office VIII and the Ecosystems Research Development Bureau (ERDB) also involved in sharing some responsibilities.

### 1.1. Location and Accessibility

Bagacay Mine is located in Bagacay, Hinabangan, Western Samar which is approximately 560 kilometers southeast of Manila.

The extent of the abandoned mine site is bounded by geographic coordinates 11047'06" to 11049'22" North latitudes and 125013'37” to 125016'44" East longitudes. The extent of the area is 92 hectares (Fig.1).
1.2. Climate

Bagacay Mine and its immediate areas are categorized under Type II of the Modified Coronas Classification by PAGASA. It has no dry season with pronounced maximum rainy months from November to January as shown in Fig. 2.

The area has evenly distributed rainfall characterized generally along or very near the eastern coast which are open to the northeast monsoon. The coolest months are December to February while the hottest months are May to September.

Historical rainfall data (1971 – 2000) revealed an average of 2,680 mm of rainfall per year and 212 average number of rainy days. The average annual relative humidity is about 82%.

The minimum temperature of the area is $23.5^\circ C$ while the maximum temperature is $32.2^\circ C$. The mean annual temperature is $27.8^\circ C$. Within the decade 1990 to 2000, average annual temperature in the area was measured to be $27.76^\circ C$ (Taft Watershed Management Plan, 2007).
Figure 1. Location Map of Bagacay Mine. (Modified from DENR-SIBP thru MGSD, April 2005)
Figure 1. Climate Map of the Philippines
1.3. Physiography

The immediate vicinity of Bagacay Mine has moderate to rugged terrain with highest elevation reaching up to 300 meters above sea level.

Barangay Bagacay has karst topography with occurrences of sinkholes, caverns, underground channels and streams are typical. The mine site was left barren; stripped of vegetation; and characterized by irregular landscape by the previous operator as shown in Fig. 3. Heavy erosion made slopes unstable and heavy siltation occurs along waterways. Presence of collapsed structures became part of the area topography.

![Bagacay Mine landscape after its operation.](image)

**Figure 3.** Bagacay Mine landscape after its operation.

The mine site is traversed by two streams: the Guila-guila and the Pyrite which both flow into the Taft River. The Taft River, in turn, flows northeast from the minesite towards the Pacific Ocean. Fig. 4 shows the intersection of Guila-guila Creek that joins the Taft River.
The width of Taft River ranges from around 5 to 20 meters in the upstream of the Municipality of Hinabangan and dramatically increasing in width approximately 30 to 100 meters downstream under Municipally of Taft.

The final repository of the sediment load from Bagacay Mine is the riverbed of the Taft, and ultimately coastal and nearshore / offshore areas of the Municipality of Taft and its outlying barangays such as Polangi, Dakul, Mantang, San Isidro, Nato, San Luis and Batiauan.

1.4. Vegetation

Remnants of primary and secondary forests still exist in the mountain ranges of limestone origin that surround the mined out area. Vegetative cover are present adjacent to the mine and covered mostly consists of grasses, ferns, shrubs and small trees with thinner topsoil which is relatively less acidic. Plant species which survives in the acidic soil at the mine sites are very limited and mostly present only in the periphery of the mine site as shown in Fig. 5.
1.5. Geology and Mineralogy

The geology of Samar island suggests two significant events have formed the island: the formation of the basement rocks and a subsequent sedimentary deposition.

The basement rocks were formed during the Cretaceous period which here was a time characterized by volcanic and orogenic activity with short cycles of clastic deposition. Extrusive and subsequent intrusive stages were the major geologic events at the end of the period. The relatively thin clastic sediments were metamorphosed through dynamic and thermal pressure during these times. Gradual marine transgression during the Miocene Epoch characterized the early stage of sedimentary deposition. Pervasive paralic and eventual destruction of vegetation allowed the accumulation of peat in subdued but relatively stable areas.

The subsequent and continuous submergence of the island resulted in the formation of reef carbonate deposits, after a short period of peat formation. Thick and extensive deposits of limestone capped most of the region. Submergence probably continued until the Late Miocene Epoch.

Rapid regression of the sea followed as a result of renewed tectonic activity.
Sedimentation was minimal until Late Miocene when the island was completely emergent delimiting the accumulation and formation of the reef carbonate deposits on the sea shelf.

The later stage of sedimentary deposition gave way to the formation of a thick and well-bedded graywacke marine sandstone sequence. It was formed as turbidite deposited peripheral to the island. The sequence accumulated during the Late Miocene up to the Pliocene Epoch.

Recent deposits in the area consisting of gravel, sand, mud, colluvial and organic materials are mainly deposited in floodplains, levees, and stream meander belts. Areas planted to grain crops are underlain by alluvium.

The Bagacay Mine is a Kuroko-type copper deposit associated with andesitic to rhyodacitic flows, pyroclastics and intercalated clastic sediments. The deposit consists of several lenticular gently dipping orebodies distributed in an arcuate east-west belt approximately two (2) kilometers long.

Two distinct ore type are known to occur in the area: a typical volcanogenic massive sulphide (VMS) deposit represented by the orebodies in Guila-guila Area and a carbonaceous type of mineralization represented by the Rosy-Purita orebodies west of the Bagacay Mine.

The bulk of the massive sulfide type of mineralization is near or underneath the gossan area. It is a 900m long, 450m wide and 60m thick massive deposit occurs mainly as lenses, pockets, fissure-fillings or breccia fillings. The ores are supergene sulfide lenses, replacement bodies, or angular to sub-angular breccia fragments. Ore minerals include pyrite, chalcopyrite, covellite, chalcocite, cuprite, bornite, sphalerite, and galena with subordinate amount of digenite, tetrahedrite, tennantite, marcasiite, silver sulfosalts, gold and silver minerals and tellurides (Muyco 1977).

Gangue minerals are quartz, clay minerals, gypsum and barite. A rough vertical zoning from top to bottom, as follows: 1) gossan; 2) high-grade copper ore (8-20% Cu); medium-grade copper ore (4-8% Cu); low-grade copper ore (1-4% Cu); and 5) quartz-pyrite zone. The lenses of high-grade copper ores are composed mainly of chalcopyrite-sphalerite-chalcocite, hosted by barite and enveloped by argillic materials resembling gouge. The medium-grade ores, occurring as lenses and fissure/ breccia fillings, are composed mainly of pyritic-chalcopyrite-sphalerite. The low-grades are largely pyritic. The deeper portions are sub-economic grade, composed of massive silicified rocks with pyritic disseminations.

The carbonaceous type of mineralization is associated with seams of carbonaceous materials found interbedded in one or more horizons in the shale beds. These carbonaceous seams are from 0.5 to 5.0m thick, occurring conformable to the bedding planes of the enclosing sediments. The sulfide minerals appear to be replacements of the peat or lignitic materials (Muyco 1977).

The carbonaceous ores are usually high-grade containing 10 to 25% Cu. The copper
containing minerals are mainly chalcopyrite, bornite, enargite, chalcocite, and covellite with associated pyrite and marcasite. The carbonaceous type of mineralization is manifested in nearby orebodies with massive sulfide bodies about four (4) m thick.

Figure 6. Geology of Eastern Samar (Adapted from MGSD).

1.6. Historical background
Mining and milling operation of copper and gold in the Bagacay Mine started in 1956. Below is the timeline of events based on available records:

- In December 1956, Mining Lease Contract-LLC-V-162 was issued covering nine (9) Lode claims to Marinduque Iron Mines Agents Inc. (MIMAI) for a period of twenty five (25) years in Barangay Bagacay, Hinabangan Samar.

- In 1957, another Lease Contract-LLC-V-183 was issued over nineteen (19) Lode claims for a period of twenty five (25) years.

- On May 16, 1979, four (4) more Lode claims were added to the lease contract (MRD 180), for a period of twenty five (25) years.

- In August 1985, renewal of the lease contract LLC-V-162 which makes it valid until August 2010.

- In 1985, the copper ore reserves were depleted and the mining operation was transferred to Philippine Pyrite Corporation (PPC) through a Memorandum of Agreement entered into between Marinduque Mining Industrial Corp. (MMIC) and Phosphate Fertilizer Corporation (PHILPHOS). PPC uses run-of-mine pyrite, one of the raw materials in the mine site for its operation.

- On December 15, 1986, former President Corazon Aquino created the Asset Privatization Trust (APT) through Proclamation No. 50. APT gained power to control the assets and properties of MMIC that was foreclosed by the Philippine National Bank (PNB). One of the MMIC properties that was transferred to APT was the Bagacay Mine.

- Based on records, from 1986 to the mine closure in 1992, PPC shipped 1,030,556 DMT of pyrite concentrate with an estimated value of PhP 611,171,604.00. The company have an accumulated mine waste and tailings fee of PhP 77,505.50 paid to the national government as reserve fund.

- In a study conducted by Regional Technical Director M. T. Machacon of DENR-8 during the Preliminary Inspection Report reflecting the operation of PPC revealed the impact of pollution of the operation to the Taft River.

- On June 2, 1988, Carlos M. Wutrich, PPC Resident Manager, applied for the construction of Tailings Pond No. 2 to the DENR which was subsequently granted.

- On August 11, 1989, DENR-EMPAS, Region 8 started monthly environmental quality monitoring of the Taft River as part of the Taft River Revival Project. DENR-EMPAS Region 8 also established monitoring stations for the PPC mill effluent and Taft River.
On April 27, 1990, Undersecretary Victor O. Ramos visited the mine site and allowed PPC management to construct Tailings Pond-No. 6.

On May 14, 1990, Assistant Secretary Antonio S. Tria endorsed the petition of Barangay Chairmen from San Pablo, Mabug, Gayam, Benaloan, Lumatod and Malinao to stop the operation of PPC due to the alleged pollution of Taft River.

On May 28, 1990, an Ex-Parte Order was issued by DENR-PAB under Case No. 08-00172-90 ordering PPC to Cease and Desist from its operation due to pollution of the Taft River. The order was lifted on July 9, 1990 by DENR-PAB.

On November 20 to 23 1990, DENR-EMPAS, Region 8, in its compliance monitoring reports, noted that all the anti-pollution measures established and employed by PPC were effective.

On February 20, 1991, DENR-EMPAS, Region 8 received a report from the Provincial Environment and Natural Resources Office (PENRO) that the Taft River has been polluted by PPC due to the water draining in from its tailings ponds. Such report was verified on April 4, 1991 after an investigation was conducted by PENRO-JICA.

On April 16, 1991, DENR-EMPAS, Region 8 furnished DENR-PAB a copy of the report with the recommendation that appropriate legal and administrative measures be imposed against PPC.

In February 1992, DENR-EMPAS, Region 8 EMPAS personnel disclosed that the quality of Guila-Guila Creek failed to meet the DAO 34 Water Quality Standard.

On May 26, 1992, PPC stopped its mining operations due to the increasing recovery cost of pyrite concentrates and aggravated labour dispute between PPC management and labour union.

On May 20, 1992, the Regional Technical Director of DENR-EMPAS, Region 8 sent a letter to the resident manager of PPC for the attendance of the latter to the technical meeting/conference to discuss some matters regarding the results of the findings of the inspection report conducted by the said office.

By virtue of Executive Order 471, dated November 17, 2005, PMO was created to take over APT. To date, PMO is the caretaker of the PPC Operation of Bagacay Mine.

Ore reserves as of 1981 was placed at 1.425 million tons at 2.40% Cu and 2.32% Zn on the average. From 1957 to 1981, the mine produced about 133,933 tons of copper metal; 1,126 kg gold and 75,318 kg silver. MGB figures cited 8 million worth of tonnage of pyrite deposits, and over a million tonnes of pyrite concentrate was produced for nearly
6 decades of mining operations in the area.

1.7. Bagacay Mine Rehabilitation Program

From the time the company ceased operation, no mine rehabilitation and maintenance works in Bagacay Mine have been undertaken. The total affected mine area is approximately 137.5 hectares including the mine pit, seven (7) tailings ponds, waste dumps and former industrial areas.

Executive Order 270 entitled “National Policy Agenda in Revitalizing Mining in the Philippines” issued last January 16, 2001 stated in Section 2-i, that “Remediation and Rehabilitation of abandoned mines shall be accorded top priority to address the negative impacts of past mining projects.” Through the National Program Support for the Environment and Natural Resources Management Project (NPS-ENRMP), the rehabilitation of Bagacay Mine was prioritized with funding from the World Bank. The Mines and Geosciences Bureau (MGB), as the Lead Agency is implementing the project in coordination with the MGB-Regional Office VIII, DENR-Regional Office VIII and the Ecosystems Research Development Bureau (ERDB) took responsibilities.

From 2000 to early 2012, several studies, researches and investigations were done in the area such as the following:

- The Sangguniang Bayan (SB) of Taft, Eastern Samar recognized the degradation of Taft River upon the conduct of their study. In January 11, 1999, SB endorsed to the DENR, Resolution No. 6, series of 1999, seeking for an inclusion of PhP 17,375,600.00 in the 1999 DENR budget for the rehabilitation of Taft River.

- A “Report on the Assessment of the Downstream Portion of Taft River” was submitted by Messrs. Armando S. Dupio, Jr., Romulo C. Babatugon and Ms. Alicia A. Lentejas of MGB Region VIII in September 1999. They noted siltation of Taft River coming from the mine site which resulted to the shallowing of the channel.

- Mr. Armando S. Dupio, Jr. of MGB Region VIII submitted in March 29, 2000, a “Report on the Assessment of Mine Affected/Abandoned Areas of Philippines Pyrite Corporation”. They noted Ticog plants thrived specifically in TP No.6 and suggested for it to be planted on the other tailings ponds to mitigate erosion and monitor water accumulation.

- A “Re-Assessment/Re-Evaluation on the Mine Affected Areas” was again conducted in August 16-18, 2000 by Messrs. Salvador E. Anagap and Raul L. Corias of MGB-Region VIII. Their findings were contradictory to TETRA TECH’s findings stating that failure of the tailing ponds impounding dike may be remote.
On February 13-15, 2001, TETRA TECH EM, Inc., the company commissioned by MGB-DENR to undertake “Semi-detailed Assessment of Abandoned Mines in the Philippines” visited the area to assess among others the status of the mine. Highlights of their study were the poor condition of the mine pits and the tailings ponds due to non-maintenance which are prone to erosion, instability and collapse which in effect will be detrimental to the people and the environment as well.

“River Assessment and Water Quality Monitoring of Taft River” was undertaken by the MGB on October 23-24, 2003 with the findings of a relatively neutral pH and a clear water both at the discharge point of the settling ponds and the recipient Taft River. Among major recommendation include the dredging of silt sediments particularly at the midstream and downstream portions. Planting of appropriate tree species to protect riverbanks from scouring was also suggested.

In August 11-13, 2004, as per DENR Special Order No. 2004-74, “Rehabilitation of Abandoned Mines/Out Areas in Samar Island”, a rapid appraisal of the Bagacay Mine, Hinabangan, Samar was conducted by technical personnel from MGB Region VIII.

Regional Executive Director Leonardo Sibbaluca of DENR Regional Office VIII endorsed the project proposal of ERDB Region 8 entitled “Structural and Vegetative Rehabilitation of Areas Affected by Mining Operation in Samar” with a proposed budget of PhP13,000,000.

In June 2005, a team from Marine Geological Survey Division (MGSD), MGB CO made a geo-environmental study along the downstream portion of Taft River and the adjacent Coastal and Nearshore/Offshore areas which are the main receiving bodies of water from the Bagacay Mine. The team came-up with an unpublished report entitled “Preliminary Report on Taft River and the Coastal and Nearshore/Offshore Environment of Taft, Eastern Samar”. Water quality analysis showed the potential of Hydrogen (pH) readings along the Taft River to be generally neutral and acid mine drainage was only slightly manifested in the receiving bodies of water. Results of laboratory analyses indicated that above average concentration of heavy metals, probably sourced from the abandoned mines, were present along Taft River, about 3 km north and south and about 4 km offshore of Taft Municipality.

Accordingly, the report recommended: 1) Extensive measures (i.e. engineering control, revegetation, and chemical treatment) should immediately be undertaken at the abandoned mine site; 2) dredging of heavily silted portions of the river such as in Barangays Benaloan, Calaynon, and Malinao; and 3) further monitoring studies.

The hydrological team of the Mines and Geosciences Bureau submitted a
report on the “Geo-Resistivity Survey at Bagacay Mines Site and Vicinity” on March 2006. They were able to identify four distinct lithologic/resistivity layers excluding the topsoil which are dips towards the west. They concluded that contamination of groundwater was remote, and that the aquifer is somehow shielded by an impermeable shale layer.

- On November 6–7, 2006, two (2) consultants from the World Bank visited Bagacay Mines in connection with the final assessment of the ENRMP - Abandoned Mines Program proposed to the World Bank. They suggested to the MGB CO to undertake an Environmental Assessment of Abandoned Bagacay Mine.

- As requested by the World Bank Consultants, MGB CO conducted a Geotechnical Assessment of the Tailings Dam of Bagacay Mine on November 21–24, 2006.

- MGB hired the services of SR Metals Inc. to come up with a “Detailed Engineering, Planning and Design for the Rehabilitation of Bagacay Mine” which was accomplished in July 2008. Their two-phase design recommendation for the rehabilitation of the Bagacay Mine was not feasible at an estimated budget projection of PhP 305.28 Million.

- MGB Region VIII inspects and monitors initial rehabilitation activities on a regular basis. Limestone rock dam installed in the last quarter of 2007 was consistently maintained and progress of the tree planting activities was also documented.

- In October of 2009, ERDB’s research on Phytoremediation commenced. ERDB submitted quarter and year-end accomplishment reports for 2009 regarding the “Rehabilitation Strategies and Ecotourism Development for Mine Tailings Areas in Bagacay”.


- Also in February 2010, geophysical survey conducted by MGB was completed. The report “Resistivity Profiling and VLF-EM Surveys at Bagacay Mine, Hinabangan Samar”, disclosed the presence of distinct shallowand deep seated anomalies interpreted as the presence of massive sulfide bodies at depth. They recommended that the target area of rehabilitation be reviewed and exploration drilling of target anomalies be considered.

- MGSD submitted their final report on Coastal and Inland River Assessment last February 2011. They will again conduct the study upon the construction of the diversion channel.
• Geohazard assessment for the possible route of the diversion channel was conducted around September 2011.

• Actual geotechnical study of the mine pits, waste dumps, tailings pond and other structures scheduled on the second quarter of 2011 with a total budget of PhP 1,390,400.00 was not conducted due to manpower constraints. However, technical personnel capable of doing the study left the bureau. Bidding process was then conducted from October to December 2011 to hire experts for the geotechnical study wherein Lichel Technologies Inc. (LTI) was given a Notice of Award on December 20, 2011 with the total contract price of PhP 3,492,832.00

• The personnel from Mines and Geosciences Bureau-Central Office (MGB-CO) conducted fieldwork from March 26-30, 2012 together with MGB-VIII that monitored the accomplishment of the Diversion Channel/Pipeline as well as the conduct of geotechnical study.

• The Personnel from World Bank headed by Mr. Hakan Tarras Wahlberg, Consultant together with Mr. Josefo B. Tuyor, Operations Officer and Mark C. Woodward, Leader - Sustainable Development conducted fieldwork at the Bagacay mine site from June 19 – 24, 2012 as part of the World Bank – GOP 10th Supervision Mission Review for the National Program Support for Environment and Natural Resources Management Program (NPS-ENRMP). The said fieldwork monitored and evaluated the accomplishment of the Bagacay Mine Rehabilitation Project and validated the status of the Risk Assessment Study conducted by Axceltechs, Inc.

2.0. OBJECTIVES AND TARGETS

To provide rehabilitation and remediation plans for selected abandoned mines and mitigation and remediation measures for the abandoned Bagacay mine site.

3.0. PLANNED OUTPUTS AND OUTCOMES AS APPROVED IN THE WB-GOP LOAN AND GRANT AGREEMENT AND PROJECT APPRAISAL DOCUMENT

3.1. Rehabilitation of Bagacay Mines

<table>
<thead>
<tr>
<th>Component</th>
<th>Output Indicators</th>
<th>Target at the End of the Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of Diversion Channel/ Pipeline</td>
<td>□ Length of Pipeline Constructed (km)</td>
<td>□ 5 km pipeline was already installed since December 2012 □ On-going re-routing of pipelines that requires additional 700 meter</td>
</tr>
</tbody>
</table>
### Project Completion Report

#### Annex C: Remediation of Risk

**CY 2014**

### 3.2. Remediation Plans for Abandoned Mines

<table>
<thead>
<tr>
<th>Component</th>
<th>Output Indicators</th>
<th>Target at the End of the Project</th>
</tr>
</thead>
</table>

### 3.3. Information Technology Equipment and Accessories

<table>
<thead>
<tr>
<th>Component</th>
<th>Output Indicators</th>
<th>Target at the End of the Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>MGB Central Office</td>
<td>I.T. Equipment and Accessories procured (no. of units)</td>
<td>16 units were purchased last February 2011</td>
</tr>
<tr>
<td>MGB Regional Office No. VIII</td>
<td>I.T. Equipment and Accessories procured (no. of units)</td>
<td>7 units were purchased last December 2010</td>
</tr>
<tr>
<td></td>
<td>Field/ Technical Equipment procured (no. of units)</td>
<td>15 units were purchased last December 2010</td>
</tr>
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### 4.0. PROGRAM COST AND FINANCIAL PERFORMANCE

<table>
<thead>
<tr>
<th>Component</th>
<th>Allotted</th>
<th>Balance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of Diversion Channel/ Pipeline</td>
<td>PhP 5,444,055.74</td>
<td>PhP 2,250,948.16</td>
<td>On-going re-routing of the diversion channel/pipeline</td>
</tr>
<tr>
<td>Construction of Laboratory Building</td>
<td>PhP 2,200,000.00</td>
<td>None</td>
<td>Completed since October 2012</td>
</tr>
<tr>
<td>Component</td>
<td>Allotted</td>
<td>Balance</td>
<td>Remarks</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>---------------</td>
<td>---------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>Environmental Risk Assessment of and Preparation of the Final Mine Rehabilitation and/or Decommissioning Plan (FMR/DP) of Five (5) Abandoned/ Inactive/ Closed Mines</td>
<td>PhP 11,900,000.00</td>
<td>PhP 5,355,000.00</td>
<td>Final Payment for Axeltechs Inc. is in-progress</td>
</tr>
<tr>
<td>MGB Central Office - I.T. Equipment and Accessories</td>
<td>PhP 1,013,667.50</td>
<td>None</td>
<td>Completed since February 2011</td>
</tr>
<tr>
<td>MGB R.O. No. VIII - I.T. Equipment and Accessories</td>
<td>PhP 132,553.56</td>
<td>None</td>
<td>Completed since 2011</td>
</tr>
<tr>
<td>MGB R.O. No. VIII - Field/ Technical Equipment procured (no. of units)</td>
<td>PhP 1,063,706.00</td>
<td>None</td>
<td>Completed since 2012</td>
</tr>
<tr>
<td>TOTAL</td>
<td>PhP 21,753,982.80</td>
<td>PhP 7,605,948.16</td>
<td></td>
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</tbody>
</table>

5.0. PLANNED VS. ACTUAL IMPLEMENTED STRATEGIES

Table 1. Planned and Actual Implemented Strategies.

<table>
<thead>
<tr>
<th>Component</th>
<th>Present Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of Diversion Channel/ Pipeline</td>
<td>Completed installation of 5 km pipeline since December 2012; On-going re-routing of pipelines that requires additional 700 meters</td>
</tr>
<tr>
<td>Construction of Laboratory Building</td>
<td>Completed since October 2012</td>
</tr>
<tr>
<td>Environmental Risk Assessment of and Preparation of the Final Mine Rehabilitation and/or Decommissioning Plan (FMR/DP) of Five (5) Abandoned/ Inactive/ Closed Mines</td>
<td>Completed since October 2012</td>
</tr>
<tr>
<td>MGB Central Office - I.T. Equipment and Accessories</td>
<td>Purchased since February 2011</td>
</tr>
<tr>
<td>MGB R.O. No. VIII - I.T. Equipment and Accessories</td>
<td>Purchased since 2011</td>
</tr>
<tr>
<td>MGB R.O. No. VIII - Field/ Technical Equipment procured (no. of units)</td>
<td>Purchased since 2012</td>
</tr>
</tbody>
</table>

Table 2. Additional Implemented Strategies.

<table>
<thead>
<tr>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reconnaissance of 17 abandoned/inactive mine sites in the country.</td>
</tr>
<tr>
<td>On-going Geotechnical and Hydrological Investigation and Preparation of Environmental Management Plan of North Davao Mine Tailings Dam</td>
</tr>
<tr>
<td>Risk Assessment and Preparation of Environmental Management Plan of Palawan Quicksilver Mines Inc.</td>
</tr>
</tbody>
</table>
6.0. ACHIEVEMENTS FROM 2009-2013

6.1.1. 2009-2010 Achievements

6.1.1. Vegetation Survey

In 2009, a reconnaissance survey of Bagacay Mine focusing on plant diversity assessment was conducted by Ecosystems Research Development Bureau (ERDB). Preliminary characterization of the area confirmed a combination of marginal brushland and open grassland vegetation within the periphery of the mine site. Accordingly, the plant biodiversity in the Bagacay Mine consists of five (5) tree species, three (3) shrub species, vines, herb and grass as shown in Table 3.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Family</th>
<th>Life Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talahib</td>
<td>Saccharum spontaneum</td>
<td>Poaceae</td>
<td>Grass</td>
</tr>
<tr>
<td>Aghoho del Monte</td>
<td>Gymnosomum rumpianum</td>
<td>Fabaceae</td>
<td>Tree</td>
</tr>
<tr>
<td>Hambabalud</td>
<td>Neonauclea formicaria</td>
<td>Rubiaceae</td>
<td>Tree</td>
</tr>
<tr>
<td>Datiles</td>
<td>Muntingia calabura</td>
<td>Elaeocarpaceae</td>
<td>Tree</td>
</tr>
<tr>
<td>Ipil-ipil</td>
<td>Leucaena leucocephala</td>
<td>Fabaceae</td>
<td>Tree</td>
</tr>
<tr>
<td>Hindang</td>
<td>Myrica javanica</td>
<td>Myricaceae</td>
<td>Tree</td>
</tr>
<tr>
<td>Kandi-kandilaan</td>
<td>Stachytrapheta jamaicensis</td>
<td>Verbenaceae</td>
<td>Herb</td>
</tr>
<tr>
<td>Malatungaw</td>
<td>Melastoma malabathricum</td>
<td>Melastomataceae</td>
<td>Shrub</td>
</tr>
<tr>
<td>Coronitas</td>
<td>Lantana camara</td>
<td>Verbenaceae</td>
<td>Shrub</td>
</tr>
<tr>
<td>Hagonoy</td>
<td>Chromolaena odorata</td>
<td>Asteraceae</td>
<td>Shrub</td>
</tr>
<tr>
<td>Binunga</td>
<td>Macaranga tanarius</td>
<td>Euphorbiaceae</td>
<td>Tree</td>
</tr>
<tr>
<td>Silver fern</td>
<td>Asplenium sp.</td>
<td>Pteridaceae</td>
<td>Fern</td>
</tr>
<tr>
<td>Uoko</td>
<td>Mikania cordata</td>
<td>Asteraceae</td>
<td>Vine</td>
</tr>
<tr>
<td>Bulakan</td>
<td>Merremia peltata</td>
<td>Convolvulaceae</td>
<td>Vine</td>
</tr>
</tbody>
</table>

In the same year, MGB R.O. No. VIII regularly inspected and monitored the mine site for the implementation of the rehabilitation activities.

6.1.2. Phytoremediation Research

ERDB also initiated the phytoremediation study in Bagacay Mine to address the problems related to Acid Mine Drainage (AMD) generated in the site. This mitigation measure was done by introducing potentially tolerant plants to improve the soil condition in the mine site without the need to excavate the contaminant material.

The main objective of this mitigation measure is to determine plant species that will survive the harsh environment and acidic soil condition in the mine site towards restoration of the productive potential and aesthetic beauty of the site. The
Phytoremediation research utilized various planting methods such as soil improvement with the addition of lime, organic fertilizer (chicken manure) and humus soil.

Field layout in preparation for the planting activity for selected plant species was done following East-West direction of planting spots. Staking was made at a distance of 3m x 3m as spacing interval. Figure 7 shows field layout and staking activity in Bagacay Mine.

Hired laborers dig 3,200 plant holes with a dimension of 0.5 meter wide and 0.5 meter deep following 3m x 3m spacing interval (Fig 7). Three replicates of the plant species were planted in designated experimental plots in order to assess diversity of species that could survive in the acidic soil. Seedlings of potential indigenous species such as A. Auri, Agoho sp., Patsaragon, Hambabalod, and Kulipapa were raised in the nursery for phytoremediation research. More than 5,000 seedlings were raised in the temporary nursery wherein the growth and survival of these seedlings were monitored diligently (Fig. 7).

Figure 7. Site preparation for the phytoremediation study in the mine site. (A – field layout and staking; B – planting hole; and C – Seedlings raised in the nursery).

Three (3) experimental blocks (I, II and III) located at Waste Dump 1 were regularly monitored and observed for best amelioration techniques. Figures 8 to 10 shows the initial performance of phytoremediation species planted in the site.
Figure 8. Outplanted species of *A. auri*, *A. mangium*, Narra, Mountain Agoho, and Vetiver grass in Block I (Planted in 2009).

Figure 9. Outplanted species in Block II (Planted in 2010).
Figure 10. Out-planted Species in Block III (Planted in 2010).

6.1.2. Reforestation within the Peripheral Site

Several areas within the periphery of the Bagacay Mine including former tailings areas were also included in the reforestation activity in the site. Initially, the target area for reforestation within the mine site periphery is 50 hectares and now being raised into 70 hectares.

Since 2008, MGB RO VIII reforested the mine site with Mountain Agoho trees, known to thrive in acidic soils reaching up to 1.5 feet in height as shown in Fig. 11.

Figure 11. Mountain Agoho Trees Planted Within Mine Site Periphery.

6.1.3. Monitoring / Maintenance of Limestone Rock Dam
A limestone rock dam was constructed on a creek beside the copper shipping grade extraction area in 2007 in order to neutralize the acidic surface water runoff that drains towards Taft River (Fig. 12). MGB RO VIII routinely inspected and monitored the said engineering mitigating measure.

![Figure 12. Limestone Rock Dam Looking Southeast.](image)

### 6.1.4. Coastal and Inland River Assessment

In December 2009, the technical team of the MGB Marine Geological and Survey Division (MGSD) assessed the impact of the Bagacay Mine to inland rivers as well as the coastal environment. The said assessment aimed to determine the water quality at coastal and nearshore/offshore areas of Taft and vicinities from Hinabangan, Western Samar to Taft, Eastern Samar. In addition, the assessment also identified the potential effects of mine wastes and tailings on the stream and marine waters downstream of the inactive/abandoned Bagacay Mine Sites particularly the issues on acid mine drainage, heavy metals contamination and sedimentation.

Three (3) types of sediment samples were collected from riverine, nearshore and offshore (Fig. 13). These locations also served as sampling location for water samples. A total of 24 samples were collected and evaluated. Initial results of the water analyses revealed that the water quality of Taft River met the DAO 34 Water Quality Standard, generally better than the water quality obtained in June 2006, except for one station. Minerals such as Cu, Pb, Zn, Cd, Fe, As and Hg have also increased in concentration at certain locations.
The survey team also generated a total of eighty-five (85) line-kilometers of echo sounding data. The said extent covered approximately 3,000 hectares used in the comparative analysis against the changes in depth/s and/or morphology of the sea bottom with other NAMRIA maps within the study area.

![Image of survey team](image_url)

**Figure 13.** Water and Sediment Sampling (Photos courtesy of MGSD).

### 6.1.5. Hydrological Study

The hydrological study aimed to evaluate the hydrologic behavior of the Bagacay watershed. Specifically, the study aims to determine the rainfall pattern in the area in order to quantify streamflow volume and quality.

Based on 2009 ERDB Accomplishment Report, secondary data gathering for hydrological study were conducted and locations for installation of monitoring instruments were initially selected. Fabrication of rain gauges had been initiated and production of staff gauges were also facilitated. In early 2010, several staff gauges were already emplaced as illustrated in Figure 14. The streamflow measurement and water quality assessment were done regularly with the initial findings discussed below. Figure 15 presented the streamflow discharge of the Taft watershed at its mouth and where Guila-guila creek joins Taft River.
The total drainage area of the creeks affected by the mining operation is approximately 417 hectares delineated in Figure 19. Guila-guila creek is the largest of the three affected tributaries while unnamed Creek B has the least drainage area. Guila-guila creek drains most of the water coming from the open pit and tailings ponds 1, 4 and 8 while Creek B drains most of the water coming from the tailings ponds 2, 3, 5, 6, 7 and waste dump 2. Least affected is Creek A that drains portion of waste dump 2 and 3. The area has a moderate topography except near the drainage channel which has a relatively steep slope. The three (3) small sub-catchments were covered by brush and secondary forest but the mine affected areas were almost devoid of vegetation.

Samples taken in three (3) sampling points along Guila-guila creek showed pH level at 3.02, 2.97 and 2.97 during December 2009 sampling while 2.32, 5.75, 2.32 during January 2010 sampling. Creek B has pH level of 7.62 and 7.32 during December 2009 and January 2010 sampling respectively. Creek B seems to indicate recovery from the effects of mining operation but needs more data to be gathered to have a conclusive result. The sand samples showed an almost similar pH values indicating that toxic heavy metals deposited at the creek still posed pollution problem when stirred by turbulent water during heavy rain.

![Figure 14. Streamflow Discharge of Taft Watershed at the Mouth (Q1) and Downstream of Confluence of Taft River and Guila-guila Creek.](image-url)
Figure 15. Sub-watersheds Affected by Mining Surface Working Areas
Water samples including sand materials at the creek bed taken last December 2009 and January 2010 were brought to Leyte State University Laboratory for analysis of pH, temperature and heavy metal content (iron, copper, cadmium, lead and zinc).

Table 4 presented the initial results showing that pH levels at Guila-guila creek, downfall of tailing pond and at the convergence with Taft River have pH of about 3.0. This indicates that water flowing in the said channel is still very acidic and toxic to living creatures.

Water quality sampling and streamflow measurements were taken at the end of the rainy season (December) until start of the dry season. Installations of instruments were also delayed due to administrative problems. It is recommended that a 1-year observation should be conducted to have a conclusive finding.

Table 4. Water Quality Analysis in Various Points of Tributaries.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Guila-guila Creek</th>
<th>Binaloaon Creek B</th>
<th>Downfall of Tailing Pond</th>
<th>Convergence with Taft River</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>3.015</td>
<td>7.620</td>
<td>2.970</td>
<td>2.975</td>
</tr>
<tr>
<td>Fe (mg/L)</td>
<td>4.657</td>
<td>3.206</td>
<td>4.469</td>
<td>4.649</td>
</tr>
<tr>
<td>Cu (mg/L)</td>
<td>1.776</td>
<td>0.076</td>
<td>1.442</td>
<td>2.727</td>
</tr>
<tr>
<td>Cd (mg/L)</td>
<td>0.006</td>
<td>Trace</td>
<td>0.071</td>
<td>0.021</td>
</tr>
<tr>
<td>Pb (mg/L)</td>
<td>1.243</td>
<td>0.575</td>
<td>0.705</td>
<td>1.853</td>
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<tr>
<td>Zn (mg/L)</td>
<td>1.1080</td>
<td>0.1130</td>
<td>1.7670</td>
<td>1.569</td>
</tr>
</tbody>
</table>

DECEMBER 2009

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Guila-guila Creek</th>
<th>Binaloaon Creek B</th>
<th>Downfall of Tailing Pond</th>
<th>Convergence with Taft River</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>2.315</td>
<td>7.320</td>
<td>5.745</td>
<td>2.320</td>
</tr>
<tr>
<td>Fe (mg/L)</td>
<td>4.476</td>
<td>0.279</td>
<td>0.871</td>
<td>4.538</td>
</tr>
<tr>
<td>Cu (mg/L)</td>
<td>1.433</td>
<td>0.018</td>
<td>0.192</td>
<td>1.534</td>
</tr>
<tr>
<td>Cd (mg/L)</td>
<td>0.046</td>
<td>0.007</td>
<td>0.004</td>
<td>0.002</td>
</tr>
<tr>
<td>Pb (mg/L)</td>
<td>0.630</td>
<td>0.345</td>
<td>0.468</td>
<td>0.580</td>
</tr>
<tr>
<td>Zn (mg/L)</td>
<td>0.623</td>
<td>0.1395</td>
<td>0.0419</td>
<td>1.7320</td>
</tr>
</tbody>
</table>

JANUARY 2010

6.1.6. Construction of Diversion Channel

Following the recommendations made by Mr. Hakan Tarras Wahlberg (Mining Specialist) in 2009, the MGB initiated a project to divert a natural spring – the Guila-Guila spring which is located directly upstream of the mine site. An existing hydrological study suggests that diverting this spring will reduce the amount of surface water flowing passed the mine site by 60-80%. This will, in turn, significantly reduce the amount of Acid Mine Drainage (AMD) generated at the site, and will substantially reduce the metal loading to the downstream Taft River. This should lead to a partial ecological recuperation of the Taft River and provide a real and readily measurable positive outcome. Furthermore, the water from the spring will be diverted to two nearby communities, the furthest one situated about 5 km from the spring, and will supplement the local water supply wherein investigations show that the water is potable (Fig. 16 and 17).
Figure 16. Five Kilometer Pipeline Layout at Bagacay Mine.

Figure 17. Installation of Pipelines.
6.1.6. Monitoring of the Project and Coordination with Partner Agencies and LGUs during Implementation

MGB Central Office (CO) is in-charge in the overall monitoring of the rehabilitation of the Bagacay Mine with coordination among concerned agencies and LGU’s. Courtesy calls were extended to the municipal officials and the immediate barangay leaders during monitoring of the project (Fig. 18). The partner agencies coordinated by MGB CO during the implementation of the project are ERDB, MGB RO VIII, and DENR RO VIII.

![Figure 18. Meeting at the Municipal Hall of Hinabangan last March 16, 2010.](image)

6.1.7. Geological Assessment

In 2009, MGB CO Lands Geological Survey Division (LGSD) and the Marine Geological Survey Division (MGSD) conducted geological assessment of the Bagacay Mine in relation to the rehabilitation project in the area. The succeeding sections presented the results of the said assessment.

6.1.7.1. Geophysical and Geochemical Study

Resistivity and Very Low Frequency-Electromagnetic survey (VLF-EM) were conducted as part of the geophysical study. Resistivity is a geophysical method used to indirectly investigate physical characteristics of the subsurface on the theory that
resistance to flow to electric current is typical to a specific earth material. Conduct of VLF-EM survey on the other hand, is ideally used in locating conductive materials and faults.

Results of the resistivity survey were the identification of low resistivity anomalies that are both shallow and deep. Anomalies are indications of the probable presence of an ore body at depth. Shallow anomalies reach a depth of approximately 25m. Deep anomalies are at depths of 45m to 150m below surface. Figure 19 shows resistivity profiles of the four (4) stations. Several resistivity anomalies coincide with VLF-EM anomalies which counterchecks the validity of the delineated anomaly.

LGSD recommended drilling at several locations to confirm strong anomalies as determined by resistivity and VLF-EM surveys. On the other hand, geochemical study is set to be initiated that will further contribute in identifying areas to be remediated together with the results of the rest of the studies being conducted.
Figure 19. Resistivity and VLF-EM Profile.
6.1.7.2. Sub-surface Investigation

Sub-surface investigations conducted as part of the geological assessment were auger drilling and test pitting at selected location in the mine site. There were eight (8) tailings ponds were targeted for the auger drilling activity. The location of the drill holes were logged using a Global Positioning Satellite (GPS) as summarized in Table 5. A total of seven (7) auger drill holes were completed yielding 73 bags of samples for a total aggregate depth of 36.5 meters. The samples are currently being analyzed at the Mines and Geosciences Bureau laboratory. The report on the assessment for this activity will be drafted upon the completion of the laboratory analyses.

Table 5. Drillhole Locations

<table>
<thead>
<tr>
<th>Drill Hole ID</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP 1</td>
<td>11.796977</td>
<td>125.26294576</td>
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<td>TP 2</td>
<td>11.794432</td>
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<tr>
<td>TP 3</td>
<td>11.793057</td>
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</tr>
<tr>
<td>TP 4</td>
<td>11.798617</td>
<td>125.26946160</td>
</tr>
<tr>
<td>TP 5</td>
<td>11.797535</td>
<td>125.26987315</td>
</tr>
<tr>
<td>TP 6</td>
<td>not drilled</td>
<td></td>
</tr>
<tr>
<td>TP 7</td>
<td>11.797125</td>
<td>125.26914686</td>
</tr>
<tr>
<td>TP 8</td>
<td>11.796715</td>
<td>125.27149614</td>
</tr>
</tbody>
</table>

6.1.7.3. Waste and Tailings Analyses

Data gathering and sampling activities for the waste and tailings analyses were completed from January 16 to 25, 2010 by the MGB Metallurgical Technology Division (MTD). A total of twelve (12) water samples and eleven (11) soil samples for analysis were gathered. However, the conduct of column test was decided to be carried out in the laboratory of the MGB CO due to weather and time constraints. The purpose of the study is to gather waste rock and tailings samples for column testing to possibly remedy any contaminations resulting to an acidic environment.

Accordingly, the results of the study revealed:

- Among the eight (8) soil samples taken from the tailings pond, TP-3 gave the highest Cu content of 3.14%. Considering 0.20% Cu as mineable head grade, only samples from TP-4 (0.14%) and TP-6 (0.081%) fall below the standard grade. There was no significant figure for Fe as all assays fall below 60% with grades ranging from 22.72% to 37.62% Fe. Same is true with the analyses of Pb, Cd, Cr and P. High Zinc contents are obtained from TP-1 (2.13%) and TP-3 (1.38%).

- Considerable grade of Cu was obtained from Waste Dump 3 (0.24%) while no significant figures resulted from the other two waste dumps.

- On heavy metals analyses, the values from water samples taken from the tailings ponds 1 and 7 (0.35mg/L Pb and 0.18 mg/L As); open pit bridge (0.27
mg/L Pb and 0.10 mg/L As); Guila-Gula creek (0.28 mg/L Pb and 0.16 mg/L As); and Taft river (0.27 mg/L Pb and 0.16 mg/L As) are all higher than the limits set in DAO-34 which is 0.05 mg/L both for Pb and As for water quality criteria for toxic and other deleterious substances for fresh waters (For the Protection of Public Health).

- Majority of the samples have low pH values ranging from 3.2 to 5.5 except from the samples taken near the rock dam nearest to the community (pH 7.7-7.1) and their domestic water (pH 6.7). No significant changes in the alkalinity of water from samples taken before and after passing thru the rock dams.

6.2. 2011 Achievements

Pursuant to Section 2.i of Executive Order No. 270, otherwise known as the National Policy Agenda on Revitalizing Mining in the Philippines, the Mine Rehabilitation Program Management Unit (MRPMU) continues to address the need to remediate and rehabilitate abandoned mine with the activities as follows: Bagacay Mine Rehabilitation Project, Risk Assessment of Five (5) Abandoned/Inactive/Closed Mine Sites and Reconnaissance Survey of Five (5) Abandoned/Inactive/Closed Mine Sites.

The Bagacay Mine Rehabilitation Project focused on activities that addressed the environmental issues of the Bagacay Mine, namely: Acid Mine Drainage; Visual/Aesthetic Impact; and the fact that the mine is situated within Samar Island National Park. Interim environmental remediation activities such as phytoremediation research, maintenance of previously reforested area and construction of diversion channel/pipeline were carried out within the mine site. In addition, a group of experts were hired to conduct geotechnical study and to determine the suitable rehabilitation/mitigating measures plan for the Bagacay Mine.

For the risk assessment, the following abandoned/inactive/closed mine sites were chosen.

<table>
<thead>
<tr>
<th>PROJECT / COMPANY</th>
<th>LOCATION</th>
<th>REGION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benguet Corp. - Antamok Mine</td>
<td>Antamok, Itogon, Benguet</td>
<td>CAR</td>
</tr>
<tr>
<td>Black Mountain, Inc.</td>
<td>Tuba, Benguet</td>
<td>CAR</td>
</tr>
<tr>
<td>Dizon Copper-Silver Mines Inc.</td>
<td>San Marcelino, Zambales</td>
<td>Region III</td>
</tr>
<tr>
<td>Consolidated Mines, Inc.</td>
<td>Mogpog, Marinduque</td>
<td>Region IVB</td>
</tr>
<tr>
<td>CDCP Basay Mining Corp.</td>
<td>Basay, Negros Oriental</td>
<td>Region VII</td>
</tr>
</tbody>
</table>

Mines and Geosciences Bureau (MGB) has entered into a Consultancy Services Agreement with Axceltechs, Incorporated (Axceltechs) to conduct an Environmental Risk Assessment of the aforementioned mine sites. Though the contract was awarded on December 31, 2010, there was a delay in the issuance of the Notice to Proceed (NTP)
due to various circumstances. The NTP was issued on September 1, 2011 hence Axceltechs commenced with their activities on November 2011.

Reconnaissance survey was carried out on four (4) other abandoned/inactive/closed mine sites, namely: North Davao Mining Corp. (Tailings Dam) – Maco, Compostela Valley; Barlo Mines – Mabini, Pangasinan; Palawan Quicksilver Mines – Puerto Princesa, Palawan; and Philippine Iron Mines – Jose Panganiban, Camarines Norte. Reconnaissance survey was not conducted at Batong Buhay Mine – Pasil, Kalinga for security reasons – there is an ongoing tribal war within the area.

6.2.1. Environmental Assessment/Remediation

6.2.1.1. Research on Phytoremediation

ERDB continuously monitored the previously established Experimental Blocks I, II and III. Regular measurement of height and diameter of outplanted species was done as part of the monitoring activity and observation of best soil amelioration techniques.

Of the planted species, Narra (*Pterocarpus indicus*) obtained the highest average growth measurement followed by *Acacia mangium*. Both species showed a positive response to a soil amelioration condition of forest soil (FS), lime and inorganic fertilizer (Fig. 20).

Other activities that were conducted by ERDB were data gathering for the economic and socio-economic components and preparation of Information, Education and Communication Materials (IEC) materials.

![Figure 20. Out-planted Narra (Pterocarpus indicus) with forest soil+lime+inorganic fertilizer treatment.](image)
6.2.1.2. Reforestation within the Peripheral Site

Continuous care and maintenance was done by DENR VIII on previously reforested area. In 2011, the reforestation area was affected by grassfire destroying more than 5.5 hectares in Area 3 (Fig. 21). About 16,500 seedlings were produced in order to meet the target number of seedlings in re-planting the affected areas by grassfire.

![Figure 21. Grass fire occurrence in the site last August 29, 2011.](image)

Since then, DENR VIII provided continuous care and maintenance of the 70 hectare reforested land with 20 percent mortality replacement of the seedlings planted. Activities such as ring weeding/ spot cultivation, replanting of mortalities, maintenance of foot paths and patrol works are conducted monthly to maintain the established plantations.

6.2.1.3. Enhancement of constructed Limestone “Rock” Dam and Clearing/Cleaning of the previous airstrip and periphery

As of December 14, 2011, only 50% of the planned expansion of the previously constructed Limestone “Rock” Dam was done due to the delayed in budget download (Fig. 22). Consequently, complete removal of the remaining waste “ore” stockpile at the
previous airstrip and its periphery was not accomplished. The accomplishment of the said activities was targeted in 2012.

Figure 22. Expansion of Limestone Rock Dam in 2011.
6.2.1.4. Laboratory Building Area Preparation

Backfilling for the site preparation of the laboratory building was completed last December 2011 (Fig. 23). Perimeter fencing started in the first quarter of 2012.

![Construction of Laboratory Building at MGB RO VIII.](image)

**Figure 23.** Construction of Laboratory Building at MGB RO VIII.

6.2.1.5. Construction of Diversion Channel/Pipeline

A diversion channel/pipeline was constructed upstream of the Guila-Guila Creek to prevent the water from passing through the mine area aimed to minimize the generation of Acid Mine Drainage in the mine site. This structure served as source of potable water of 200 households at Barangay Bagacay. The contract of services for the Diversion Channel was awarded to Richmark Construction wherein notice to proceed was issued last December 2011. The work started in the second half of 2011 in which two water storage tanks were constructed (Fig. 24 and 25) and about 3.6 kilometers (of the total 5 km) of pipe was laid.
Figure 24. The consultant (Mark C. Woodward, Leader - Sustainable Development, World Bank) while inspecting the Water Water Reservoir Tank No. 1 with elevation of 219 meters (N11°48'34.2" E125°14'39.2")

Figure 25. The consultant (Mr. Hakan Tarras Wahlberg - Mining Specialist, World Bank) while inspecting the Water Reservoir Tank No. 2 with elevation of 212 meters (N11°48.710' E125°14.346').
6.2.1.6. Geotechnical Characterization

The MGB further initiated a project concerned with providing a better understanding of the geotechnical characteristics (slope stability and overall aspects related to geohazards such as subsidence, landslides etc.) of the Bagacay mine site, as well as its geohydrology.

Lichel Technologies, Inc. (LTI) was contracted upon approval of their proposed work coverage and project cost. The contractors are expected to recommend mitigating measures to minimize or eliminate the impacts of the identified hazards and to come up with an appropriate structural and environmental design for erosion-control, slope protection and mitigation. The work started last April 2012 and undertaken in four (4) months. However, due to the unwillingness of the state entity that controls the mine site - Privatization and Management Office (PMO), the contractor (LTI) had not been allowed to enter which caused significant delays.

6.2.1.6. Risk Assessment of Five (5) Abandoned/Inactive/Closed Mine Sites

Axceltechs was commissioned to conduct the environmental risk assessment of the five (5) abandoned/inactive/closed mine sites. The Notice of Award and Notice to Proceed was issued to Axceltechs last December 31, 2010 and September 1, 2011 respectively. There was a delay in the issuance of Notice to Proceed and implementation of the activities due to various circumstances.

Several consultations/meetings with Axceltechs were conducted during the first quarter of 2011 that discussed the direction and outcome of the study.

In June 8 – 15, 2011, an initial site assessment was conducted by personnel from selected MGB regional offices on all of the five (5) abandoned/inactive/closed mine sites together with Axceltechs and Mr. Håkan Tarras-Wahlberg, World Bank Mining Consultant as shown in Fig. 26. The latter discussed the findings, concerns and recommendations on all of the five (5) sites, which were considered in the preparation of the technical approach and methodology of the study.
The aforementioned document was presented before the technical personnel of MGB CO last September 30, 2011 by Axceltechs and was finalized in October 2011. The personnel from Axceltechs conducted fieldwork in preparation for the inception report.

6.2.1.6. Reconnaissance Survey of Abandoned/Inactive/Closed Mine Sites

Reconnaissance survey was carried out on four (4) out of the five (5) targeted abandoned mine sites (Fig. 27), namely: North Davao Mining Corp. on May 10 -13, 2011; Barlo Mines on May 24 – 27, 2011; Palawan Quicksilver Mines on October 24 – 27, 2011 and Philippine Iron Mines on October 13 – 14, 2011. Fieldwork was not conducted on Batong Buhay Mine due to security reasons and prevailing tribal war within the area. For the Philippine Iron Mines, Mines and Geosciences Bureau Regional Office No. V conducted their own reconnaissance survey – personnel from the MRPMU were not able to join the said activity due to lack of manpower.
Figure 27. A - Upper benches of the old mining pit in Palawan Quicksilver Mines which was converted into sanitary landfill; B - North Davao Tailings Dam Decant Tower; and C – Open pit in Barlo Mines.

6.3. 2012 Achievements

6.3.1. Research on Phytoremediation

There were three (3) experimental blocks maintained and monitored by ERDB (Fig 28 to 30). These blocks having different treatments were planted with combined species of Auri (Acacia auriculiformis), Acacia or Mangium (Acacia mangium), Narra (Pterocarpus indicus) and Mountain Agoho (Gymnostoma rumphianum). The species adaption on the various treatments and condition per blocks were observed and recorded accordingly.
Figure 28. Block I planted with *Acacia auriculiformis*.

Figure 29. Block I planted with *Acacia mangium*. 
In September 2012, ERDB conducted a Planning Workshop at Camayan, Subic, Zambales to improve the strategies for the project implementation as well as address the legal issues on PMO. Moreover, meeting with MGB (Planning Policy Division and MRPMU) was conducted considering the coffee table book production, establishment of additional experimental blocks for phytoremediation research and the status of 2012 program of ERDB and the 2013 proposal on Revegetation/Reforestation of Bagacay Mine Area.

The areas in which establishment for additional blocks were identified. The hauling of soil and digging of planting holes for the establishment of additional blocks were conducted. Plant samples have been collected and analyzed for heavy metal content. The poster paper regarding the performance of the outplanted species in the Bagacay Mine was prepared and presented during the Forests and Natural Resources Research Society of the Philippines, Inc. (FORESPI) Symposium and General Assembly. Economic analysis of rehabilitating one hectare of mined-out land using treatments with lime and without lime was also conducted.

6.3.2. Reforestation within the Peripheral Site

A 70-hectare *Casuarina equisetifolia* and agroforestry crops planted in the periphery of the mine site were cared, maintained and protected by DENR RO VIII (Fig. 31). During the non-issuance of gate pass, the seedling production was the only continuing activity.
This production of seedlings served as mortality replacement on those outplanted species who had not survive in the field.

Figure 31. Outplanted reforestation species within the peripheral site maintained by DENR RO VIII.

6.3.3. Engineering Mitigating Measures

6.3.3.1. Construction of Diversion Channel/Pipeline

After the issuance of gate pass last October 2012, Richmark Construction completed the diversion channel/pipeline last December. The 5-km diversion channel was connected to two (2) concrete reservoirs and water impounding dam (Fig. 32). However, the contractor will conduct dry-run test before the release of full payment.

Figure 32. Constructed Water Impounding Dam.
6.3.3.2. Maintenance of Limestone Dam and Ore/Waste Stockpile Dam

MGB RO VIII has completed its work to move the process waste materials that were haphazardly deposited nearby the road (and previous runway) leading to the mine, and deposited it in a more controlled manner at a nearby site. A limestone rock dam was constructed downslope of this new deposit and successfully served to partly neutralise the acid leachate formed and also acts as a downstream siltation trap. The MGB RO VIII regularly maintained and monitored this dam (Fig. 33).

![Figure 33. MGB personnel while monitoring the dam.](image)

6.3.4. Construction of Laboratory Building

Notice to Proceed for the construction of the laboratory building was issued last May 21, 2012. The building was completed together with the construction of perimeter fence last October 2012 (Fig. 34).
6.3.5. Rehabilitation of Critical Areas/Structures

6.3.5.1 Geotechnical Study and Preparation of Environmental Management Plan of various structures at Bagacay Mine

The drilling activity commenced from November to December 21, 2012 (Fig. 35). The core samples were taken to the laboratory for analysis. Water sampling (Fig.36) and terrestrial flora survey were conducted last December 11, 2012.
6.3.6. Revegetation/Reforestation of Bagacay Mine Area

Reforestation includes the establishment of nursery; site characterization; and the reforestation itself that considers site preparation and layout, soil amendment, planting, protection and maintenance, monitoring and evaluation, and project management office. Initially, a nursery was constructed right after the gate pass has been issued. Assisted Natural Regeneration (ANR) was also conducted on the perimeter area of the project site.

6.3.7. Risk Assessment of Abandoned/Inactive Mines

Axceltechs have finished all the field activities needed for the risk assessment and preparation of EMP for each abandoned/inactive mine and the data gathered were collated. However, the release of the laboratory results on soil, water, air and noise sampling were delayed. Axceltechs requested a 5-month extension for the submission of said reports – two (2) months for delayed release of the laboratory results and three (3) months for the completion of the study and finalization of the draft report. The Policy Technical Working Group (PTWG) meeting was held last June 14, 2012 that discussed the said request by Axceltechs.

Axceltechs request of extension for the submission of draft reports of five abandoned/inactive mines was approved. Copies of draft reports on five abandoned/inactive mines were received by MGB on October 2012. These copies were distributed to the concerned Regional Offices for review and evaluation.
In November 2012, the WB Consultant, Hakan Tarras Wahlberg arrived to review and evaluate the said reports as part of the World Bank Mission. The Axceltechs presented the Draft Reports last November 22-23, 2012 at New Camelot Hotel attended by the Technical Representatives from MGB Central Office, Regional Offices, and WB Consultant. Several comments were raised during the presentation and which must be taken into consideration by the Axceltechs before submitting the Final Report at end of December 2012.

6.4. 2013 Achievements

All activities from January to April 2013 related to the research on phytoremediation were haltered due to non-issuance of gate pass. It was only in May when the gate pass was signed and approved

6.4.1. Research on Phytoremediation

On-going maintenance, monitoring and validation were done in Bagacay Mine Area. Four (4) field works were conducted within this semester such as the following:

<table>
<thead>
<tr>
<th>Date</th>
<th>MRPMU Personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>February 26 – March 1</td>
<td>Marcial H. Mateo / Tracy Ann C. Maghirang</td>
</tr>
<tr>
<td>April 22 – 26</td>
<td>Marcial H. Mateo / Tracy Ann C. Maghirang</td>
</tr>
<tr>
<td>June 24 – 28</td>
<td>Marcial H. Mateo / Jessica A. De Torres</td>
</tr>
<tr>
<td>August 5 – 8</td>
<td>Marcial H. Mateo / Teodorico L. Marquez, Jr.</td>
</tr>
</tbody>
</table>

Continuous care and maintenance of the three (3) experimental blocks were being practiced since 2010 up to present. The outplanted phytoremediation species are the following: *Acacia auriculiformis, A. mangium, Pterocarpus indicus, Casuarina equisetifolia, and Chrysopogon zizanioides* (Fig. 37 to 42)
Figure 37. Outplanted species of *A. auriculiformis*, *A. mangium*, *P. indicus*, and *G. rumphianum* in Block I Control Treatment.

Figure 38. Stunted growth of outplanted species of *A. auriculiformis*, *A. Mangium* and *P. indicus* Block I Organic/Inorganic Treatment.
Figure 39. *C. zizanioides* (Vetiver Grass) and small size of growing tree species of *A. auriculiformis*, *A. mangium*, *P. indicus* in Block II Control Treatment.

Figure 40. Outplanted species of *A. auriculiformis*, *A. mangium*, and *P. indicus* in Block II Organic/Inorganic Treatment.
Figure 41. Outplanted species of *A. auriculiformis*, *A. mangium*, *P. indicus*, and *C. zizanioides* in Block III Control Treatment.

Figure 42. Outplanted species of *A. auriculiformis* and *A. mangium* in Block III Organic/Inorganic Treatment.
Additional experimental blocks (IV and V) were established last June 2013 coupled with soil hauling and collection of planting stocks (Fig. 43 and 44). However, activities were suspended by the newly appointed PMO care taker last July 2013. It was only a month after when PMO allowed MGB RO VIII, DENR RO VIII and ERDB to resume on their respective activities in the site.

**Figure 43.** Established Experimental Block IV.

**Figure 44.** Established Experimental Block V.
It was also observed during the fieldwork last August 2013 that each outplanted species were marked with white painting in the root collar of the stem (Fig. 45). The said marking served as guide and common reference point in measuring the monthly diameter.

**Figure 45.** Outplanted *A. mangium* with white marking in the stem used in monitoring the diameter. (A - Plant hole showing stunted growth of *A. mangium*; B – Closer view of white markings located in the root collar of *A. mangium*).

In addition, some outplanted species like *A. auriculiformis* and *A. mangium* were already in the flowering stage, an indication that the species is robustly growing and suited in the condition of the harsh condition site (Figure 46).

**Figure 46.** Outplanted *A. auriculiformis* during reproductive stage bearing with flowers. (A – Immature flowers of *A. auriculiformis*; B – Blossomed *A. auriculiformis* flowers).
Four (4) plant tissue samples (leaves, stems, roots and litters) per species per treatment were collected for plant tissue analysis. The said analysis aimed to examine the capacity of the plants in absorbing heavy metals. The samples were then dried and pulverized. Figures 47 and 48 presented the documentation of plant tissue analysis in the laboratory.

**Figure 47.** Grouping of plant samples in the MGB Metallurgical Laboratory Services Section with Engr. Mateo and Ms. Sylvia Alcantara.

**Figure 48.** Plants samples ready for tissue analysis.
Heavy metal analysis of about 108 samples are already forwarded to MGB Chemical Laboratory Services Section. Results of the first batch of samples were already processed and the remaining samples were continued to subject for heavy metal analysis.

To cater the increase in the quantity of samples to be analyzed, equipment such as Moisture Balance last April 26, 2013 and Microwave Sample Digester last June 7, 2013 were procured. The said procurement assured that the activity is aligned with the timeline of the program.

6.4.2. Reforestation within the Peripheral Site

On-going maintenance and monitoring in the 70 hectare reforestation project that include seedling production and care as well as maintenance and protection within Bagacay mine area. The conditions of species planted in the site this 2013 are shown in Figure 49 and 50.

![Image of reforestation site]

**Figure 49.** Sample Species Planted in the Peripheral Site.
Perimeter survey in the 70 hectare reforestation areas being maintained by DENR RO VIII is still in progress as recommended in the First Validation/Monitoring Report. The said survey aims to delineate the boundary of rehabilitation strategies initiated by DENR RO VIII between the reforestation activities with other agencies. Figure 51 shows the initial perimeter survey conducted in Area 4 (26.2 ha) using a hand held global positioning system (GPS).

**Figure 50.** Yakal species planted in the portion of Area 4.

**Figure 51.** The Survey Team using GPS in Area 4.
6.4.3. Engineering Mitigating Measures

6.4.3.1 Construction of Diversion Channel/Pipeline

Dry-run of diversion channel/pipeline is still in progress to enhance the effectiveness of water flow towards the reservoir tanks. A series of field works were conducted to monitor and evaluate the status of the project:

<table>
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<tr>
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<tbody>
<tr>
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<td>MGB CO and MGB RO VIII</td>
</tr>
<tr>
<td>April 22 – 26</td>
<td>DENR 8, MGB CO and MGB RO VIII</td>
</tr>
<tr>
<td>June 24 – 28</td>
<td>DENR 8, MGB CO, MGB RO VIII, PMO and World Bank</td>
</tr>
</tbody>
</table>

Re-routing of the diversion channel/pipeline is on-going since it failed to achieve the maximum gravitational flow of water during the dry-run test. Re-routing of pipelines will be done in a farther distance so that water flow will be maximized from the retention dam towards the two water reservoirs (Fig. 52). A site inspection will be scheduled upon completion of the pipeline re-routing so that payment for the said activities will be processed.

![Image](image.png)

**Figure 52.** Engr. Marcial H. Mateo and Mr. Doug Forno (WB Consultant) while inspecting the water reservoir.
6.4.3.2. Maintenance of Limestone Rock Dam

The bidding and implementation for the maintenance of the Limestone/Ore Waste Rock Dam was suspended due to the recently held local and national election.

Pertinent documents were prepared by MGB RO VIII prior to the release of fund for the maintenance of limestone and ore/waste stockpile dams. The Notice of Cash Allocation amounting to PhP253,930.00 was downloaded to MGB VIII last 21 February 2013. The maintenance of limestone rock dam was completed last July 23, 2013.

The limestone rock dam is being monitored by MGB RO VIII. The said structures specifically built in order to neutralize the acidity of the water flowing and to replace the heavily coated by Acid Mine Drainage (AMD) through piling of additional 20 cubic meters of limestone materials every year. At present, vegetation thrived near the limestone rock dam as indication neutralized leachate towards the downstream portion (Fig. 53)

![Limestone Rock Dam](image)

**Figure 53.** Limestone Rock Dam with presence of vegetation in the downward portion as indication of neutralized leachate.

6.4.3.3. Maintenance of Ore/Waste Stockpile Dam

This structure is similar to Limestone Rock Dam (Fig. 52 to 53) and was being maintained and monitored MGB RO VIII. This area indicated a highly acidic environment with pH value of 2.2.
Figure 54. Ore/Waste Stockpile Dam Near Old Airstrip.

Figure 55. Engr. Marcial H. Mateo, Messrs. Doug Forno (WB Consultant) and Josefo B. Tuyor, Jr. of WB, and Mr. Dante Pante of PMO during the conduct of inspection.
6.4.4. Rehabilitation of Critical Areas/Structures

6.4.4.1 Geotechnical Study and Preparation of Environmental Management Plan of various structures at Bagacay Mine

Technical Conference with Lichel Technologies Inc. (LTI) was held last June 25, 2013. Draft Report of Geotechnical Study and Preparation of Environmental Management Plan of various structures at Bagacay Mine were presented by the consultants (Fig. 56).

Accordingly, the Geotechnical Hydrological Investigation will include drilling of six (6) holes about 90 meters. LTI assured that stability of the slope materials will not be ruined due to the drainage canals to be constructed. Mitigation measures were also identified that can withstand various kinds of natural hazards such as seismic, mass movement and hydrologic hazards. The details of Final Mine Rehabilitation and/or Decommissioning Plan (FMRDP) was also presented on the said technical conference highlighting the advantage of bioengineering for slope stabilization coupled with soil amelioration measures and use of endemic species. Valuable comments were also raised in the said Technical Conference highlighting the importance of the completeness of report based on the approved Terms of Reference.

Figure 56. Technical Conference with Lichel Technologies Inc.

Axceltechs Inc. submitted their Final Report which was reviewed by World Bank and MGB (CO and ROs) last February 11, 2013. Incorporation of the comments and concerns on the said report was raised during the Technical Conference conducted last November 22-23, 2012. The final payment of Axceltechs Inc. is already in progress.

7.0. Impacts, Trends and Emerging Patterns

Generally, the non-issuance of gatepass since January 2013 by PMO impeded the implementation of all activities related to rehabilitation and mitigating measures in Bagacay Mine among the partner agencies.

A Tripartite Meeting was held last August 9, 2012 with Privatization Management Office (PMO), World Bank (WB), Department of Finance (DOF), Foreign Assisted and Special Projects Office (FASPO) and MGB to resolve the conflict on said gate pass. The said meeting came up with a Memorandum of Agreement (MOA) between PMO and MGB for the limitation of access and activities to be conducted on Bagacay Mine.

Also, there were series of meetings with PMO to discuss Confidentiality Agreement with the Contractors were held. The MOA was signed by Dir. Leo L. Jasareno and sent back to PMO last September 26, 2012. All activities mobilized after PMO issued the gate pass last October 2012.

8.0. Insights and Lessons Learned from the Implementation of the Project

This project enables MGB to gain considerable experience upon the implementation of rehabilitation measures of Bagacay Mine as well as in the development of rehabilitation plans for five other abandoned mine sites.

The rehabilitation measures in Bagacay Mine were undertaken through combined ecosystem development and improved forestation approach that simulate the process of ecological succession by modifying and improving the site conditions that enable vegetation growth. The unfertile barren land in the mine site was ameliorated using organic material that’s why phytoremediation species survived in the area.

The rehabilitation in Bagacay Mines was carried out in a holistic manner in partnership and coordination with partner agencies. Hence, it served as a reference point for MGB in replicating the measures for the remaining abandoned/inactive mine sites in the country.

In terms of the formulation of rehabilitation plans for five other abandoned mine sites, major issues and risks were assessed in terms of the impacts posed to the community and
environment upon its abandonment. Hence, appropriate rehabilitation and mitigation measures were forwarded in Final Mine Rehabilitation and/ or Decommissioning Plan (FMRDP) of the said remaining abandoned mine sites.

9.0. Recommendations

The following are the recommendations forwarded based on the implementation of this project:

- There should be an immediate discussion with PMO regarding on the renewal and issuance of gate pass that will allow MGB and its partner agencies to proceed on the rehabilitation measures in Bagacay mine.

- The respective partner agencies must continue to monitor the progress of activities being undertaken in Bagacay Mine so that necessary documentation will be made towards the preparation of guidelines for future rehabilitation of the remaining mine sites in the country.

- The outsourcing of a private consultant who conducted the risk assessment of the five abandoned/inactive mine sites proved to be effective and efficient in terms of providing technical assessment on the said mine sites. Hence, private consultant must also be tapped for the assessment of risk among the remaining abandoned/inactive mine sites in the country given the availability of funds.
10.0. References


