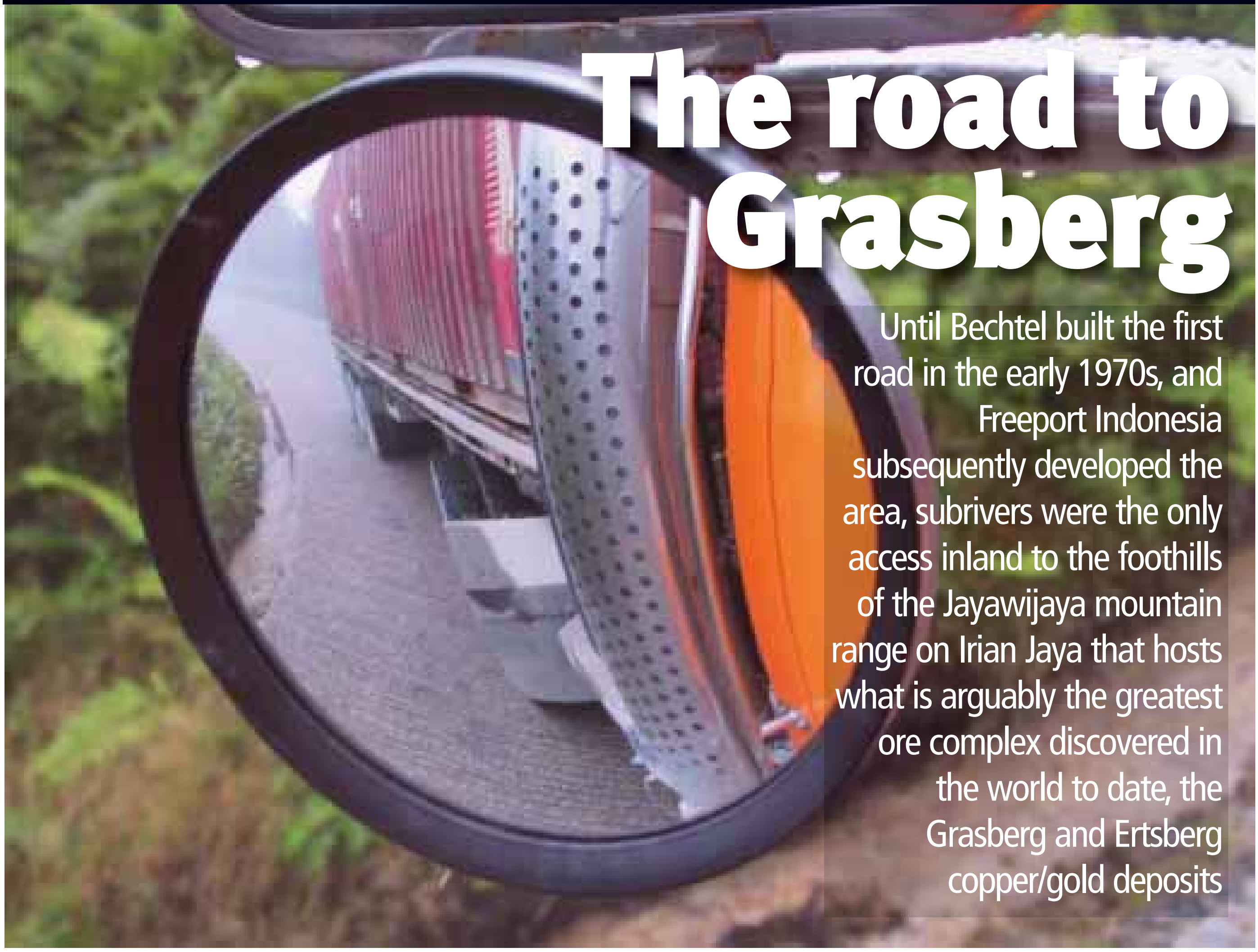


The road to Grasberg

Until Bechtel built the first road in the early 1970s, and Freeport Indonesia subsequently developed the area, subrivers were the only access inland to the foothills of the Jayawijaya mountain range on Irian Jaya that hosts what is arguably the greatest ore complex discovered in the world to date, the Grasberg and Ertsberg copper/gold deposits

PT Freeport Indonesia is always subject to negative media attention. Sadly recent news has been of unprovoked attacks on Freeport personnel. Such events are rare here, but are always possible at any large complex in an isolated part of the world.

Detractors of these operations would do well to educate themselves about the high environmental and sustainable development standards introduced and adhered to by Freeport. The mine and its support logistics are great engineering feats. It is, however, also important to remember the very significant feats in social advancement that have come with the establishment of this great mine. It has raised standards of living for many inhabitants in the Papua Province, particularly in the local Regency of Mimika, let alone the massive influence it has had on Indonesia in general, in improving living standards.

There can be few, if any, mining operations anywhere that have such a significant impact on the local economy. In 2008, Freeport was directly employing more than 11,000 people. In addition, employees of contractors, private companies and others servicing these operations totalled approximately 10,000 – giving a total of some 21,000 people benefiting from jobs through Freeport.

In 2008, also, financial benefits to the country of Indonesia from taxes, royalties, dividends, fees and other direct support amounted to $1.2 billion. Freeport also contributed 1.2% of Indonesia's national domestic product and 40% and 96% respectively of the Papua Province and *Kabupaten Mimika* (Mimika Regency) GDPs. The company accounted for 1.3% of all household income in Indonesia and 25% of that in Papua province.

The many challenges of building the Ertsberg (Ore Mountain)/Grasberg (Grass Mountain) mining complex included building a 121 km (75-mile) long access road to the deposit. The project included driving tunnels through two mountains – an 1,100 m tunnel under the 2,819 m high Mt Hanekam and an 845 m tunnel through 4,150 m Mt Zaagkam.

This is to be the first article in a series charting the PT Freeport Indonesia (PT-FI) facilities that support and are the Grasberg operations, from the mangrove swamps of the lowlands to the mines and concentrator in the mountains. These articles will run over the coming months in *International Mining*.

In his excellent 1996 book on Grasberg[1], George Mealey says the road "from the swamps of the Jaramaya River to the mill site in the valley below Ertsberg, was the most difficult aspect of the [project] construction, and in fact is almost assuredly the toughest road-building project attempted anywhere in the world." The road runs approximately north-south and traverses a mangrove coastal zone, sago forest, tropical rain forest, cloud forest, and sub-alpine regions in a relatively short distance.

The road is measured from milepost 0, Buoy A just off the coast, but it physically begins at milepost (MP) 6.5 (10.5 km), the cargo dock, in the labyrinth of mangrove swamps that hug the coast of Papua. It passes through the jungles of the 'lowlands' that seemed all but impenetrable at the time the road building was underway. Building the road foundations in the swamps could often use up 125 m^3 of gravel for 1 m of road, and then the construction crew could return the following morning and find it had sunk back into the swamp! In places, Bechtel built 3 km of road for every 1.5 km that survived. Sometimes the depth of mud in the swamps was over 10 m, before the crews hit hard rock.

Landslides buried earthmoving equipment, trucks fell into rivers and helicopters sank into swamps. It is beyond MP 12 (19 km) before the road gets out of the mangrove swamps and at MP 15 it is still only about 12 m above sea level.

The port site lies at MP 6 (9.7 km). The key activities here are:

- Shipping/receiving
- Material & supplies
- Coal (700,000 t/y)
- Diesel (455 million litres/y)
- Concentrate (2.5 – 3 Mt/y)
- Concentrate drying & storage
- Power generation (coal plant).

Concentrate Drying & Storage – The concentrate slurry that comes down the 109-km long, 100 mm diameter pipeline from the concentrator, 2,624 m above sea level, discharges into a surge tank and is dewatered in rotary vacuum filters and a pressure filter press. The filter cake from the rotary vacuum filters is further dried in a rotary kiln. Concentrate, at less than 10% moisture, is stored in the concentrate barns, which have a total capacity of about 135,000 t. Additional storage is available on concrete pads next to the dewatering plant.

Concentrate Shipping – Concentrate is loaded from the barns at the concentrate loading dock. Typically, the concentrate carrier vessels are partially loaded dockside and then anchor at Sea Buoy A to complete loading with Freeport's concentrate lighters. It is necessary to lighter concentrate because the water depth does not permit full loading of the ships. Freeport makes over 100 shipments of concentrate each year.

Power Generation – The 195 MW (3x65 MW) coal-fired power plant receives coal in shipments that are off-loaded in Freeport's coal lighter and then unloaded at the coal dock and stored in the coal barn. Power from the coal plant is transmitted to the mine and concentrator facilities via a 115 km 230 kV transmission line.

Cargo Dock – Materials and supplies are received and unloaded at the cargo dock for transport to the various operating areas around the PT-FI site. The cargo dock area at port site acts as a staging area to transport material throughout site.

The access road traverses a mangrove coastal zone, sago forest, tropical rain forest, cloud forest, and sub-alpine regions

Port site at Amamapare, where required materials and supplies are received and from where concentrates are shipped

Flying in

Visitors to the Freeport project area arrive by air via scheduled Garuda Indonesia flights from Bali and other points in Indonesia, or an Airfast flight from Cairns in Australia. Aside from arriving by sea, there is no other access. Mangrove swamps cut the lowlands city of Timika off from the rest of the island and the only roads are local, or the main route into the mountains.

Visitors stay at the Rumba Papua Hotel

The airport was built early in the construction project, before the town development started. Timika has a population of more than 150,000 inhabitants. Two main rivers flow down from the mountains in the PT-FI project area. The lesser of the two is the Otomana, which joins the Ajkwa just beyond MP 32, and thence flows into the sea. Timika and all the 'lowlands' facilities are on the west side of the Ajkwa River, the tailings deposition area is on the east.

In the lowlands, reclamation research has repeatedly demonstrated that native species successfully and rapidly colonise naturally and

Freeport supports an active public outreach program to help make employees and local inhabitants more aware of the environment and their relation to it. The program makes use of the Twin Levees Reclamation Demonstration Area, the surrounding natural ecosystems and other Freeport lowlands operations related to the environment such as the Environmental Laboratory and the waste handling facilities. The program focuses on schoolchildren and teachers, but also includes local stakeholders, employees, government officials, local NGOs, media, police and army units. During 2006 a campground was developed in the MP 21 reclamation demonstration area

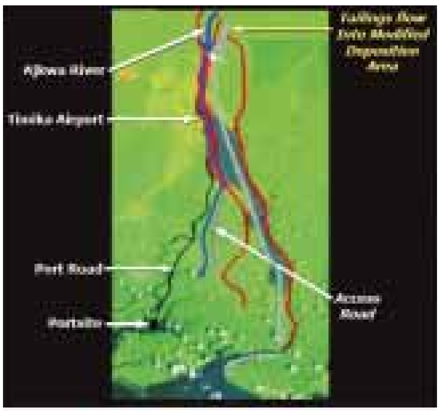
grow on soils containing tailings. Soils containing tailings when ameliorated with a small percentage of organic material are highly suitable for growing many agricultural crops. The reclamation and revegetation research program in the lowlands aims to speed the transformation of soils containing tailings in the deposition area into agricultural and/or other productive land use or to return the soils to native vegetation after mining is completed.

The Natural Succession Discovery Park is very important to the lowlands reclamation research and demonstration work. The activities include cattle farming; plantations of bamboo, matoa, eucalyptus, coconut, and king grass; a butterfly sanctuary; a model airplane aerodrome, and growing edible fruits and vegetables. Much of the work in this area is handled by local contractors, who are improving their business skills and their knowledge of the environment. These activities are sampled for monitoring purposes and the areas are used as part of Freeport's Public Education and Awareness programs.

A comprehensive sampling program monitors environmental conditions in the tailings deposition area. Numerous samples are taken from 57 varieties of edible plants and fruit for metals uptake analysis. Rigorous testing performed on these edible plants and fruits continues to demonstrate that metals uptake from the minerals naturally contained in the tailings is minimal and levels remain well below the maximum allowable levels stipulated by national and international standards.

Tailings management

In the mine area, unstable geotechnical conditions for the construction of tailings facilities prevail. The area has extremely high precipitation with a wet season from September to May and annual precipitation estimated at 8,000 mm/y at the mine site and 11,000 mm/y



at the plant site. So, the operations use controlled riverine transport with tailings flowing down the mountain from the concentrator at 2,800 m elevation in the river system (starting with the Aghawagon River) that forms the Otomona River. This carries the tailings to a designated area in the lowlands called the Modified Ajkwa Deposition Area (ModADA), where tailings and natural sediment are contained, controlled and revegetated. The program uses internationally-accepted methods and standards for design of levees and other structures. The system is designed, constructed and operated as approved by the Government of Indonesia in the 1997 300K ANDAL (Environmental Impact Assessment).

Chemically the tailings are relatively benign; the flotation reagents used in trace amounts in the concentrator degrade quickly. Furthermore, using the river channel to transport tailings from the high mountains to the lowlands deposition site enables naturally high-alkaline runoff to mix with the tailings in the river channel, thus adding additional buffering capacity and reducing its acid generating potential, another significant environmental consideration.

As the mining operations have expanded, a series of geotechnical studies have been undertaken to examine various other tailings disposal options, including marine disposal, land disposal in the highlands (no extensive land areas available) and land disposal in the lowlands via pipeline transport.

The decision was to continue riverine transport of tailings to the ModADA and to construct levees to retain the deposition area. The levees, which are about 3 km apart and 40 km long, were built on the Ajkwa river floodplain to contain tailings and natural sediment.

About 230 km^2 of land is contained between east and west levees in the ModADA. At the end of mine life, these levees could be 20-25 m high in areas of highest deposition but generally

Truck working on the West Levee of the tailings impoundment


Tailings deposition employs riverine transport to the ModADA

will be no more than 5-10 m. A number of long-term rehabilitation studies are underway to reclaim and revegetate this area once tailings deposition ceases.

The tailings retention plan divides the deposition area into three zones based on elevation, sediment grain size and type of flow, and details specific techniques that may be effective in each section. These retention techniques include the use of bio-filters, permeable groins, flow deflection structures and other engineering applications. Much of the work implementing these tailings management plans, including retention and reclamation, is handled by local contractors, putting money into the local community and developing local business skills. The average annual cost to implement the tailings management program over the past three years was approximately $15.5 million.

Tailings monitoring

Freeport's long-term environmental monitoring plan requires measuring of water quality, biology, hydrology, sediments, air quality and meteorology. In a typical year, the overall monitoring program includes the collection of more than 7,000 environmental samples and the conduct of over 50,000 separate analyses on these samples, which include aquatic biology, aquatic tissue, plant tissue, mine water, surface water, ground water, sanitary wastewater, river sediments and tailings.

The biological program monitors more than 200 sampling locations for nekton, benthos and plankton. In the last five years, more than 2,000 samples of aquatic fauna were analysed for trace elements with the total number of analyses exceeding 15,000. Results of current monitoring have shown that fish and shrimp flesh samples from tailings areas are suitable for consumption as regulated by Indonesian food standards.

The tailings are alkaline when released from the mill and comprehensive monitoring data show that the pH in the tailings river is also alkaline; so the tailings are not producing acid. When necessary, PT-FI adds limestone to the mill feed to insure that there is sufficient alkaline material to neutralise at least 50% more acid than the maximum amount potentially generated by the tailings. Comprehensive water quality sampling of the tailings management system shows that the water in the tailings river and the deposition area meets the Indonesian and US Environmental Protection Agency drinking water standards for dissolved metals. Data from biological sampling continue to demonstrate that the estuaries downstream of the tailings deposition area are functioning ecosystems, based on both the number of species and the number of specimens collected of nektonic, or free-swimming, organisms such as fish and shrimp.

Reclaiming tailings land

Cumulatively through the end of 2008, more than 160 plant species have been successfully cultivated on soils containing tailings. Some plant species that have been successfully tested to date include legume cover crops for fodder; local trees such as Casuarina and matoa; cash crops plants such as pineapple, melon, and banana; and vegetables and grains such as chili peppers, cucumbers, tomatoes, rice, string beans and pumpkins. Through 2008 some 690 ha of tailings deposition area were reclaimed.


In the past five years, several thousand samples of aquatic fauna were analysed for trace elements

In one demonstration project, two types of legume cover crops (Colopogonium muconoides and Centrosema pubescens) have been planted for use as biomass to accelerate the formation of soils in the tailings area. The legumes are also nitrogen-fixers that add nutrients to the soils containing tailings. In addition to the production of commercial crops, another strategy of tailings reclamation is to encourage natural ecological succession— the natural regrowth of native species — in designated areas. Natural succession occurs quickly in many parts of the tailings deposition area. Phragmites grass produces detrital biomass that enriches soils containing tailings. This process also improves water retention capacity of the soils so that other species can propagate.

An independent research project on natural succession of native vegetation on tailings in an area outside the current deposition area, but which previously received tailings, found that in a period of only a few years, more than 500 plant species have naturally re-colonised and are growing well.

A fraction of the tailings pass straight through the tailings deposition area and on into the mangrove swamps. The new estuary areas formed from these sediments have been naturally colonised by mangroves. Seven mangrove species, 45 species of crabs and shrimp, and several species of snails, clams, fish, and marine polychaetes (worms) have been identified in these new estuary areas. In 2002, to accelerate the primary succession, PT-FI began an assisted mangrove colonisation program. Through 2008, hundreds of thousands of mangrove trees were planted. Survival and growth rates of these seedlings compares favourably with reported rates for similar programs. Mangrove swamplands are part of the native ecosystem, and also provide a protective barrier for inland residents.

Maurupauw Reclamation Center at MP21 was started in 1995 with the aim of, among other things, becoming a research centre for tailings reclamation methods and as a place to see examples of tailings use in the areas of agriculture, fishery, and forestry. Sitting on some 114 ha, this reclamation centre is part of the overall lowlands reclamation area.

Maurupauw is home to an orchid nursery, working gardens, butterfly sanctuary, and fishery. MP21 has also been the site of agriculture, gardening, and environmental monitoring workshops for schoolchildren;

outbound and team building training activities; recreational visits; organisational events; and camping, among others.

The reclamation centre has become a popular location for tree plantings. From 1996 to early 2009, some 30 different types of trees have been planted in the MP21 vicinity, totalling some 30,000 trees. During the same time period approximately 2.7 million trees have been planted throughout Freeport's lowlands areas as part of the commitment to minimising environmental impact on the surrounding areas.

Most recently, auditors from Crescent Technology Inc. (CTI) audited Freeport Indonesia's operations as part of the annual corporate internal auditing program. These annual audits have been taking place since 1994.

A team of CTI auditors conducted compliance inspections and Environmental Management System (EMS) implementation evaluation throughout the operations area, including at Grasberg mine, mill, the underground mine, the Tailings River Management Project area, highlands and lowlands operations and reclamation areas, as well as Portsite.

At the Jobsite audit closeout meeting, attended by PTFI President Director & CEO Armando Mahler, Executive Vice President - Operations and Technical Chief of Mine John Mosher, as well as management and departmental representatives, the auditors noted improvements made and presented recommendations for further improvement. PT-FI will respond to the audit with action plans to implement suggestions made by the auditors.

Further, PT-FI participates in the environmental performance rating program known as PROPER, which is administered by the Indonesian Ministry of the Environment. The most recent PROPER audit was conducted in early 2009. Additionally, the Freeport operations underwent a fifth triennial independent external environmental audit in late 2008. Results are posted on the company's web site at www.fcx.com.

Tailings construction

After many years of collaboration with scientists from the Institute Teknologi Bandung (ITB) and its Industrial Affiliation Institute and local businesses, construction materials made from tailings are starting to be used across the province of Papua, where new roads are leading to progress in Merauke Regency, on the border with Papua New Guinea. Here tailings are part of a solution toward Merauke's scarce resource of raw material for construction development. According to the researchers from LAPI-ITB, the properties of the material are conducive to construction applications, especially concrete, and the crushed rock from the ore milling process offers cost advantages over other basic material. The Merauke project is the first outside of Mimika Regency to use the tailings material in road construction.

Within the Mimika Regency, tailings have been used as a raw material for the construction and manufacturing of concrete, bricks, pipes and other infrastructure products. The joint Freeport/ITB team has completed several construction projects using tailings as a primary component of concrete. Projects include roads, public buildings and bridges in the regency, and roads, buildings, process equipment, and drainage improvements in the Freeport project area. Additionally, PT-FI has successfully demonstrated the use of tailings as a backfill material at the new Timika Airport departure terminal.

Papua Governor Barnabas Suebu, upon signing a 2006 Memorandum of Understanding with PT-FI on a landmark project to use tailings in construction projects throughout the province, referred to tailings as a vital part of his infrastructure development plan. ***IM***

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For more on the great achievements of Freeport Indonesia, this series of articles started in August 2009 and an article on aspects of this operation will be published every month into 2010.

Throughout 2008, hundreds of thousands of trees were planted by Freeport, sometimes involving employees, the local community, and company guests at Maurupauw and other locations