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Appendix J: Grasberg Riverine Disposal Case Study

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Contents

1 Introduction

The Grasberg mine is located in the central highlands area of the south side of Papua (formerly Irian Jaya), Indonesia (see Figure J1). It is the world's lowest-cost, largest producer of copper and gold.[1]

Figure J1. Location of the Grasberg Mine

Grasberg is an open pit mine owned and operated by PT Freeport Indonesia (PTFI), a subsidiary of Freeport McMoRan Copper & Gold Inc. (FCX). Mining operations began in 1973 and are currently expected to continue until 2041.

In the mine area, unstable geotechnical conditions for the construction of tailings facilities prevail. Tailings at Grasberg have been disposed of into the local river system since the mine opened. This disposal method was selected when production was approximately 7,500 tonnes of ore per day. Current production rates are 230,000 tonnes of ore per day. Tailings mostly deposit in a lowland area of the river system. Levees have been constructed to contain the tailings in a 130 km^2 area. It is estimated that the area will eventually contain a 10–15 m high tailings deposit. A number of long-term rehabilitation studies are underway to reclaim and revegetate this area once tailings deposition ceases.

2 Overview

Grasberg is officially managed by PT Freeport Indonesia (PTFI)[2]. FCX owns 85.9% of PTFI, the Indonesian government owns 9.36% and the remaining 4.8% is privately owned by PT Nusamba Mineral Industri.[3] Rio Tinto plc. also has an interest in Grasberg, as it owns 15% of Freeport. PTFI owns 100% of production up to 125,000 tonnes per day and 60%

[1] See Freeport-McMoRan Copper & Gold Inc. website at http://www.fcx.com (accessed April 2002)
[2] Referred to as Freeport or PTFI in the rest of the document.
[3] Ownership is described in more detail in Annex J1.

above 125,000 tonnes per day. A joint venture agreement with Freeport gives Rio Tinto a 40% of production in excess of 125,000 tonnes per day.

2.1 Physical Setting

The mine is located in the Ertsberg mining district of Papua, more than 4,000 m above sea level. The entire project area extends from the mine and concentrator site, along the river system, to the port site. The area stretches from the highlands, through the lowlands, and coast of the Arafura Sea. A 118 km-long road connects the Grasberg plant site to the port (Phelps, 2000; Figure J2). The Lorentz National Park, site of several glaciers and peaks, lies to the east of the mine.

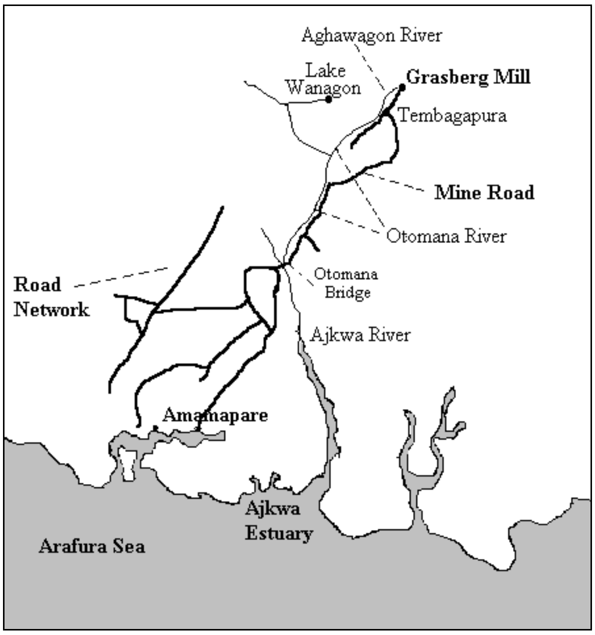

Figure J2. The Grasberg area

The Aghawagon River, which receives tailings, flows into the Otomona River and discharges via the Ajkwa Estuary on the coast of the Arafura Sea (see Figure J2).

The area has extremely high precipitation. The wet season is from September to May and annual precipitation is estimated at 8,000 mm per year at the mine site and 11,000 mm per year at the plant site (Phelps, 2000).

2.2 Socio-Economic Setting

When mining began in the Grasberg area, the local population was less than 1,000 and was mostly concentrated in the village of Tembagapura (FCX, 2000a). Mine-related immigration and the Indonesian transmigration[4] programme both contributed to an accelerated

[4] Governmental policy of encouraging migration from populated Indonesian areas to less populated areas. Under this policy, it is estimated that over 10,000 families of sponsored migrants from Java and Sulawesi migrated annually to Papua (AWPA, 1995).

expansion of the local population. In 1999, the population in the Grasberg area was estimated to be 100,000–150,000.[5]

The traditional inhabitants of the highland mining area are the Amungme and today number about 8,000 (Minewatch, 1996). The traditional people of the lowlands in the mining concession area are the Kamoro. Due to rapid in-migration, these peoples are now outnumbered by Papuans from other parts of the island. In addition, the combined native Papuan population is outnumbered by non-Papuan Indonesians (FCX, 2000b).

Community groups in the region include LEMASA, the Amungme people's organisation, LEMASKO, the Kamoro people's organisation and *Walhi,* an Indonesian environmental group active in Papua.

3 Mining Operations

Gold and Copper are mined at Grasberg with a conventional open pit, truck and shovel technology. The 400 m deep open pit is operated in addition to an underground zone. At present, about 10% of the ore originates from the underground operation (Montgomery Watson, 1999). Approximately 635,000 tonnes per day of material is mined to produce 230,000 t/d of ore and 400,000 t/d of waste rock and overburden. The stripping ratio is approximately 2:1, and the cut-off grade is between 0.8% and 0.65% (Montgomery Watson, 1999).[6]

The ore is concentrated by flotation at the Grasberg processing plant. Processing produces approximately 1,739 t/d of copper concentrate; the rest of the ore is discarded as tailings. The concentrate is transported by pipeline to the port at Amamapare where it is dewatered, dried and stored prior to shipment. In 2000, 1.4 billion pounds of copper and 1.9 million ounces of gold were produced from the concentrate. Net cash production costs per pound of copper were US$0.23, making Freeport the world's lowest cost copper producer (FCX, 2000a). In 2000, proved and probable reserves at Grasberg were estimated at 2.51 billion tonnes of ore containing 50.9 million pounds of copper and 63.7 million ounces of gold (FCX, 2000a).

3.1 Waste Disposal

High precipitation and seismic activity in the mining area result in unstable geotechnical conditions and the topography in the immediate area around the mine is mountainous with no suitable sites for tailings disposal facilities. Downstream of the mine, high groundwater levels, a lack of cross-valley locations and the absence of adequate embankment material sources were cited by Freeport as limiting factors for the construction of a tailings disposal facility. Tailings are therefore discharged in the Ajkwa river system.

[5] Freeport-McMoRan Copper & Gold Inc. website. http://www.fcx.com

[6] Average copper cut-off grade in 1995 was 0.8%, over the mine life average cut-off grade is anticipated to be 0.65% (Freeport OMP, 1996).

At the time riverine disposal was selected, ore production was 7,500 t/d. Over the years, substantial increases in capacity have resulted in the quantity of tailings produced in 2000 being thirty times greater than in 1973. Approximately 230,000 t/d of tailings are currently discharged into the Aghawagon River and eventually deposit along the Otomona/Ajkwa river system, the majority in the Ajkwa Deposition Area. The properties of the discharged tailings are listed in Table J1.

Table J1. Tailings characteristics

	Tailings solids analysis mg/kg (dry basis)	Plant discharge – slurry (mg/l)	
		Dissolved	Total
pH	–	–	11.13
Total suspended solids	–	–	558,584
Al	28,900	–	–
As	49	<0.002	3.94
Cd	0.33	<0.0002	0.24
Cu	6,600	0.002	536
Fe	56,600	–	–
Pb	30	–	–
Mn	1,400	–	–
Hg	0.01	<0.0003	<0.0003
Se	3	<0.002	0.294
Zn	200	0.060	61.1

Source: FCX . Based on 2000 values.

Riverine disposal is reported to have worked adequately while mine tonnages were relatively low. However, in mid-1990, log debris carried by heavy rains blocked the Ajkwa River resulting in 'sheetflow' conditions. This event, and subsequent tailings deposition in the Ajkwa Channel altered the geomorphology of the river system preventing the Ajkwa from transporting tailings to the Arafura Sea, (Montgomery Watson, 1999). As a result, feasible alternative tailings disposal options were considered in a series of geotechnical studies. These included marine disposal, land disposal in the highlands and land disposal in the lowlands via pipeline transport.

The selected disposal method was to continue riverine transport of tailings to the lowland floodplain (the Ajkwa Deposition Area or ADA) and to construct levees to retain the deposition area. The levées, which are about 3 km apart and 40 km long, were built on the Ajkwa river floodplain to contain tailings and natural sediment in a 130 km^2 deposition area (see Figure J3).

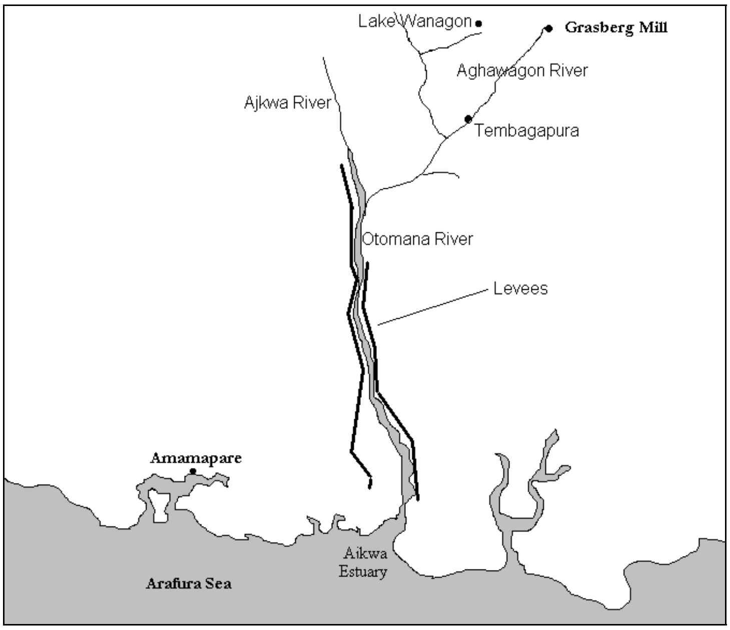

Figure J3. Map of the Ajkwa Deposition Area

According to a 1999 external Environmental Audit, this method represented the "*best alternative option when considering important geotechnical, topographic, climatologic, seismic and water quality criteria*" (Montgomery Watson, 1999).[7] In a review of this environmental audit by NW Corporate Accountability, it was underlined that mining at a much-reduced rate was an overlooked option that would dramatically decrease the adverse impacts downstream (Ortman and Subra, 2000).

According to the current mine plan, 3.2 billion tonnes of overburden and waste rock will be disposed of over the life of the mine (Dames and Moore, 1996). Overburden and waste rock are disposed of to the east of the mine (at Carstensz Meadow) and to the west of the mine (West Grasberg and Wanagon Overburden Stockpile) at a rate of approximately 420,000 t/d.

Waste rock and overburden facilities are designed to be stable. However, in May 2000 a slippage did occur at the Wanagon waste dump. The mine waste contains sulphide bearing minerals and is producing acid drainage. The leachate is treated with lime and the subsequent precipitate accumulates in the Wanagon water catchment basin near the lake.

[7] Marine disposal options were eliminated due to uncertain topography, bathemetry and geotechnical conditions. Land disposal sites in the highlands were eliminated due to lack of storage capacity or the requirement for extremely high embankment construction in a seismically active region. The pipeline transport option was also eliminated. The 1999 Environmental audit reported that this was because of the extreme terrain and the distance to the [tailings deposition area] from the mill would result in significant environmental impacts to the canyon systems, and be dangerous to operate due to the extreme flow variations in the river and extremely costly construction.

In 1995, OPIC[8] cancelled Grasberg's risk insurance because of the environmental concerns associated with the increased disposal of waste in the river system due to the expansion of the mine. Arbitration between OPIC and Freeport resulted in the reinstatement of the insurance in 1996. Freeport subsequently cancelled its political risk insurance with OPIC and MIGA.[9]

Operations are planned to continue at the present rate until mine closure in 2041. Expansion of the underground mine is planned to increase slightly to reach 25,000 tonnes of ore/day by 2004. The maximum capacity of the concentration plant is 300,000 t/d.

3.2 Financial Provisions for Closure

FCX estimates that the ultimate reclamation and closure costs will be between US$100 million and US$150 million. A cash fund was set up in 1996 to pay for mine closure and reclamation costs (designed to have US$100 million by end of mine life). At closure, all costs are to be covered by this fund along with proceeds from sale of equipment, infrastructure and facilities. The closure costs, as well as reclamation activities throughout the mine life and for fifty years after mine closes, have been detailed in a 5-year reclamation/ acid drainage control plan. The plan has been submitted for approval to the Indonesian Government's Department of Mines & Energy. Based on assessment of ultimate liability the accrual is designed to cover US$150 million in mine reclamation and closure-related costs. The amount accrued by November 1999 was US$13.7 million (Montgomery Watson, 1999).

4 Environmental Impacts

The riverine disposal of tailings at Grasberg, and associated environmental impacts, constitute one of the most controversial issues associated with the mining operation. The main environmental impacts resulting from the riverine disposal of tailings at Grasberg are discussed below.

Much of the information is based on independent audits that were commissioned by Freeport. These include a 1996 Dames & Moore Environmental Audit and a 1999 Montgomery Watson Environmental Audit. The independence of the environmental audits has been questioned by different groups such as Minewatch (Minewatch, 1996) and NW Corporate Accountability (Ortman and Subra, 2000). One of the main criticisms is that no independent sampling was undertaken.[10]

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[8] Overseas Private Investment Corporation, a US governmental entity providing support for foreign investments.

[9] MIGA is the Multilateral Investments Guarantee Agency of the World Bank Group. Freeport cancelled its risk insurance stating that the coverage represented less than 5% of the total investment in Grasberg.

[10] Other independent studies include a 1996 LABAT-Anderson Social Audit, and a 1999 RFK Memorial Critique on Social and Human Rights Policy.

4.1 Sedimentation

Disposing of large volumes of tailings into the Ajkwa river system increases the sediment load in the river and results in aggradation downstream. At the Otomona Bridge, the mine derived sediment load represents approximately 93% of the total river sediment load.[11] The first point of tailings aggradation is located at the confluence of the Otomona and Ajkwa rivers, just downstream of the Otomona Bridge. Approximately 66% of materials discharged to this point of operations are stored in this area.[12]

In the Ajkwa Deposition Area (ADA), tailings have currently deposited over an area of 30 km^2. As tailings and natural sediment settle within the ADA, the river shifts laterally to deposit the material in adjacent areas (Montgomery Watson, 1999). The area between the levees will eventually have a layer of tailings 10–15 m thick. Due to sediment deposition, the amount of oxygen available to vegetation is reduced along the riverbanks and trees and vegetation have been killed. In the ADA, dieback will ultimately affect 230 km^2 of land.

Large-scale reclamation of the ADA is part of the closure plan. Reclamation cannot begin before the stabilisation of tailings, which will only occur once riverine disposal ceases. Reclamation tests for the tailings deposition area have been on-going for several years. Results have indicated which grasses, fruit trees and vegetables are best adapted to tailings-based soil.[13] Large scale trials for forest plantation, pasture, medicinal plants, arboretum, horticulture, wetlands agriculture and typical Irianese home gardens as well as fish and shrimp aquaculture will be conducted.

Less than 5% (11,500 tonnes per day) of the total tailings discharged reach the Arafura Sea. As the ADA fills with sediment, this quantity will increase to approximately one third of the tailings. At current discharge rates, the estuary would eventually receive approximately 76,000 tonnes per day of tailings. Potential impacts in the estuary are not known; they are being studied in an on-going Environmental Risk Assessment (Montgomery Watson, 1999).

A study of sediments in the estuarine area was carried out in 1997 and an analysis of sediment samples for total metal levels and particulate copper were compared to Australia New Zealand Environmental Consultative Council (ANZECC) guidelines (Montgomery Watson, 1999).

4.2 Water quality

Environmental monitoring and baseline studies were initiated in 1990 (Ortman and Subra, 2000)[14]. Before this date no such activity had taken place. A fully equipped laboratory has now been constructed to support the monitoring programme.

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[11] The calculation is based on a natural sediment load of 18,000 tonnes per day and a mine-derived load of 240,000 tonnes per day

[12] Data in this section based on information provided by FCX.

[13] Examples cited include the *Ficus armiti*, a naturally occurring plant in the area, and the sago tree

[14] See http://www.cs.utexas.edu/users/boyer/fp/dames-moore.html. Accessed November 2000

Water quality downstream of the Grasberg mine is monitored from Tembagapura, about 10 km downstream of the plant, through the ADA and into the estuarine area (Montgomery Watson, 1999). Table J2 summarises water quality at the discharge point, at the Otomona Bridge just before sediment deposition begins, and at a middle point in the ADA.

Table J2. Water quality at different points in the Ajkwa Deposition Area

	Mill discharge		Otomona Bridge		Mid ADA		USEPA[a] ANZECC[b] standard
	Concentration (mg/l)						
	Dissolved	Total	Dissolved	Total	Dissolved	Total	
Total suspended solids	-	558,584	–	12,817	-	4968	–
Aluminium	–	–	–	–	–	–	–
Arsenic	<0.002	3.94	<0.002	0.126	<0.002	0.045	–
Cadmium	<0.0002	0.24	<0.0002	0.007	<0.0002	0.001	–
Copper	0.002	536	0.010	13.13	0.011	4.65	0.0029[a] 0.0050[b]
Iron	–	–	–	–	–	–	–
Lead	–	–	–	–	–	–	–
Manganese	–	–	–	–	–	–	–
Mercury	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	–
Selenium	<0.002	0.294	<0.002	<0.002	<0.002	<0.002	–
Zinc	0.060	61.1	0.002	1.80	0.002	0.536	–
pH	11.13		8.00		8.11		–

Source: FCX. Based on 2000 values. As reported in Ortman and Subra (2000)
ANZECC: Australia New Zealand Environmental Consultative Council

At all sampling locations, water quality meets Indonesian drinking water standards. However, the dissolved copper levels exceed the USEPA and ANZECC standards for the protection of aquatic organisms (respectively 0.0029 and 0.0050 mg/l). Background levels, reported to range between 0.001 and 0.008 mg/l, are also exceeded at most of the sampling points (Minewatch, 1996). The effects and implications of the elevated copper content of the tailings and waste rock were criticised as not having been studied sufficiently (Minewatch, 1996; Ortman and Subra, 2000).

Mistrust in water quality data has been expressed by different groups. According to one source, in 1997 river water was given a 'D public health rating' by an official of the Irian Jaya regional government who warned against drinking it (Kennedy *et al.*, 1998), although no further information exists.

There is an extensive groundwater monitoring network on both levees of the ADA. The 1999 Environmental Audit recommended that a groundwater study at the mine, that includes installing groundwater sampling wells downstream to the ADA, be prepared and implemented (Montgomery Watson, 1999).

Potential for acid drainage from tailings exists as the Grasberg ore body contains chalcopyrite and bornite, minerals which can develop acidic conditions through oxidation in deposited tailings. Limestone-rich underground ore is added to the concentrator feed in order to provide a sufficient neutralising balance (Golder Associates, 1994). The extent to which acid production could be an issue in the ADA depends on the nature and success of the reclamation programme.

4.3 Biodiversity

Biological monitoring undertaken by Freeport has shown no specific changes to the community structures either in areas receiving tailings or areas not receiving tailings (Montgomery Watson, 1999). In 1996, surveys on species of tree kangaroo, rats and rainbow fish were compared with areas of similar unaffected habitat. No significant risk of loss of biodiversity was identified; however, the database is not extensive and conclusive statements on biodiversity cannot be made (Dames and Moore, 1996).

An on-going Ecological Risk Assessment by Freeport is aimed at identifying and quantifying potential impacts and risks of the tailings management plan on human health and the environment, both in and around the Ajkwa Deposition Area as well as in estuaries and the Arafura Sea. The study is examining the potential copper uptake by aquatic organisms and potential human health and dietary implications, if any, and its results will guide future tailings management decisions.[15] See Annex J3 for available data on aquatic species tissue analyses as summarised in the NW Corporate Accountability Analysis (Ortman and Subra, 2000).

5 Socio-Economic Impacts

There are 71 villages in the mining area (Mimika district), 29 of them have been identified as the most critically impacted by PTFI's operations (Montgomery Watson, 1999). Highland villages include Banti, Waa and the company town of Tembagapura; lowland villages include Timika, Inauga, Sempan Barat, Nawaripi, Amamapare, and the original area capital Mapurujaya. Riverine disposal impacts mainly affect the villages in the lowlands.

Socio-economic impacts resulting from riverine disposal of mine waste depend on the pre-mine uses of the river. The Ajkwa drainage was formerly used for hunting and fishing, as well as for the gathering of sago and other forest products, by the Kamoro from two adjacent villages. The land where tailings are being deposited was formerly owned by several clans that make up the villages of Tipuka and Nawaripi. Land rights to the ADA area have been released in exchange for compensation in the form of community development projects (see discussion below about compensation).

[15] See http://www.fcx.com/mainpages/esp-home.html

The Ajkwa River was also used by local people for drinking, washing, bathing and fishing. It is unknown to what extent these activities have been impacted, as they depend on the availability of alternative water bodies.

Fishing in the river has reportedly been impacted. According to one Kamoro villager living in a small community of 160 people along the Ajkwa River; "*today it is hard to find the yaro, lifao, mufao, irao and ufurao – the traditional fish that we used to catch. […] We have to walk 20 kilometres from here to find food*" (Chatterjee, 1996; as cited in Kennedy *et al.*, 1998).

Impacts of riverine disposal on human health are not clear. A 1999 NGO report states that the people in the mining impacted area complain that this dumping is causing illness among the people (ToBI, 1999). No specific health impacts are reported. A Freeport Environmental Risk Assessment is currently analysing the potential risks from the tailings management system to human health.

Other issues associated with the development of the mine exist, but are not linked with riverine disposal. Land disputes, social pressures from the new wave of migrants, and benefits sharing disputes led to violent riots in 1996, thought to be associated with an independence movement in Papua. In addition, two court cases were brought against FCX in New Orleans for environmental violations and human rights abuses. Both cases were dismissed. Freeport has developed a Social and Human Rights Policy. The Policy aims to promote and protect basic human rights wherever the company operates, including full co-operation with human rights investigations. Employees are educated about human rights and immediate reporting on human rights violations is required.

Negotiations for conflict resolution have led to a Memorandum of Understanding (MOU) signed in August of 2000 with LEMASA and LEMASKO. The MOU is an agreement on socio-economic resources, human rights, land rights and environmental rights. Initial projects were also announced such as the establishment of a LEMASA owned company, which will maintain the levees and undertake earth-moving projects. Initial steps under the MOU included, the building of office buildings for LEMASA and houses for community elders as well as an integrated agriculture, aquaculture and animal husbandry project partly controlled by LEMASA and LEMASKO, funded by Freeport (FCX, 2000c).

5.1 Compensation

Most of the compensation benefits for mine-affected land has been for communal property rights or 'Hak Ulayat'. Communal benefits known as 'recognisi' are provided for the release of communal property rights. Compensation was also paid for the temporary and permanent loss of hunting and fishing and the availability of the sago palm.

Land rights were negotiated with the highland people (Amungme) in 1974. The lowland people (Kamoro) negotiated land rights in 1997. In response to criticism that the amount of recognisi, which had been negotiated in 1996 between the government and the local people, had not been adequate, the PT-FI voluntarily proposed a land trust fund under which the Amungme and Kamoro people would receive additional funds (approximately $500,000 per year) and an opportunity to participate in the operation.[16] The Kamoro recognition programme included the involvement of the Kamoro people, and involved the building of homes, schools, markets and places of worship for the use of their communities. The programme also included reclamation and economic development.[17]

Freeport provides one percent of annual gross revenues for the development of the 71 villages in the mine area under the Freeport Fund for Irian Jaya Development (FFIJD). The People's Development Foundation (LPMI) manages the funds under an umbrella structure. The LPMI's board consists of tribal leaders, church leaders and representatives from the local government and Freeport. In 1999, Freeport contributed US$14.4 million to the fund. Since its' founding in 1996, US$54.8 million has been contributed to the fund in addition to a US$6.5 million supplement funded by Rio Tinto plc. Contributions to fund will continue over the next 10 years, and include projects such as the construction of a primary care hospital.[18] Perceptions of land rights and historic compensation claims are a continuing source of dissatisfaction and conflict in the mining area. To address ongoing discontent and claims for compensation for the Amungme and Kamoro people, PTFI has proposed a 'land rights trust fund' as voluntary additional recognition, separate from and beyond the 1% fund.[19]

5.2 Benefits

In 1999 FCX directly employed 6,357 people, 1,244 of whom are Papuans. Contract workers and companies providing services to PTFI create an additional 6,851 jobs. In total approximately 14,000 people are employed directly by the company (FCX, 1999). Indirect job creation is estimated by Freeport to be 75,000.[20]

Indonesian income taxes paid by Freeport in 1999 were about US$157.17 million. Royalties paid to the Indonesian government (in Jakarta) and dividends associated to government's ownership since 1991 total US$1.42 billion. Royalties are distributed to Papua and Indonesia according to the Indonesian regulations. These regulations are currently being reviewed and redrafted by the Government of Indonesia.

Indirect benefits from 1992 to 1999, including wages and benefits paid to workers, purchases of goods and services, charitable contributions and reinvestments in operations total US$6.32 billion (FCX, 1999).[21] Other indirect benefits are generated through company projects such as the creation of the Public Health and Malaria Control Department that includes medical treatment and mosquito control. Company schools were also opened for Amungme children in the Banti area and scholarships are offered by Freeport as well as educational aid. A business incubator programme also exists to assist in the start-up and success of new local business ventures.

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[16] Freeport-McMoRan Copper & Gold Inc. website at http://wwwfcx/com

[17] Ibid.

[18] Ibid.

[19] Ibid.

[20] See http://www.fcx.com/mr/fast-facts/ff-overview.html

[21] This makes an average since 1991 of about US$157 million a year paid in royalties and dividends and US$702 million of indirect benefits.

6 Governance

Until recently, the decision-making process seems to have been almost entirely in the hands of the Indonesian Government and Freeport. The Freeport contract of work is with the Indonesian National Government in Jakarta; no contract exists with the local provincial government in Jayapura. Environmental governance involves the Ministry of the Environment at the national level and the Environmental Impact Management Agency or BAPEDAL at the national and regional levels (Montgomery Watson, 1999). Environmental Impact Assessments are submitted to the BAPEDAL for approval.

A LABAT-Anderson social audit found that most of the mine related conflicts resulted from inadequate governance structure including a lack of public participation, unequal power, dialogue and process problems and a lack of trust.

To increase the local voice in the governance of the company, three local leaders were asked to join PTFI's Board in 1999. The new Board members include the founder of LEMASA, the 1984-1989 Governor of Irian Jaya and a local Kamoro leader. The present Governor of Irian Jaya was already serving as a Board member.[22]

The FFIJD managing body was also restructured to its present form (the LPMI umbrella structure) in order to address problems with the fund, identified by the LABAT-Anderson Social Audit. These included inadequate representation of the people, too central a role for PTFI as well as a lack of sound process and transparency in the Indonesian Government's decisions concerning the distribution of this fund.

Strengthening institutional development for the community outside the corporate structure was also identified as an issue. The Social Audit recommended establishing a network of development agents independent of Freeport and the Indonesian Government, to work with local people on strengthening local institutions and developing their ability to implement programmes.

Following this recommendation, Freeport has worked with different groups; the 'Sejati Foundation', a non-profit institution acting as a facilitator between the local people and Freeport, the 'Village Heartbeat Foundation', set up to help highland leaders to address their needs themselves with limited outside help (FCX, 1999), and the 'Yayasan Sejati', active in the lowlands area of Mimika on land issues and compensation programs.

The LABAT-Anderson Audit also underlined that people's organisations should be given greater opportunities for dialogue with Freeport and the Government. A Critique on social and human rights[23] by the RFK Memorial recommended that a consultation system be developed that satisfies the requirements of affected local community representatives (RFK, 1999). In response, a Community Liaison Programme has been set up to improve communications and understanding with local communities. Indonesian employees trained

[22] Freeport-McMoRan Copper & Gold Inc. website at http://wwwfcx/com

[23] Undertaken by the RFK Memorial Center for Human Rights

in community relations work in local villages and act as a first point of contact for the company and the people.

References

See separate References for the Main Report and Appendices.

Acronyms

DOME	–	Indonesian Government Department of Mines & Energy
EPA	–	Environmental Protection Agency (US)
FCX	–	Freeport McMoran Copper & Gold Inc.
FFIJD	–	Freeport Fund for Irian Jaya Development
KOMNAS HAM	–	Indonesian National Commission on Human Rights
LPM	–	Lembaga Pengaembangan Masyarakat-Irian Jaya or People's Development Foundation, Irian Jaya
OPIC	–	Overseas Private Investment Corporation (US)
OPM	–	Organasasi Papua Merdeka (Free Papua Movement)
MIGA	–	Multilateral Investments Guarantee Agency (World Bank)
PTFI	–	P.T. Freeport Indonesia
PWT2	–	Pengembangan Wilayah Timika Terpadu, that later became the FFIJD
WWF	–	Worldwide Fund for Nature
WALHI	–	Indonesian Forum for the Environment

Annex J1. Summary of Grasberg's Operations

1963	Exploration at Ertsberg (ore body adjacent to Grasberg).
1973	Mining production begins at Ertsberg, ore production is 7,500 tonnes/day. 30 year contract of work signed.
1981–1988	Ore production at Ertsberg increases to 20,000 t/d.
1988	Grasberg reserves are discovered.
1989	Production at Grasberg is 32,000 t/d
1991	New reserves are discovered, total reserves are now estimated at 483 million tonnes Cu. Production reaches 57,000 t/d, capacity reaches 118,000 t/d. PTFI and the Indonesian Ministry of Mines agree on a 30 year contract term with provisions for two 10 year extensions.
1995	An alliance with Rio Tinto is announced and reserves are estimated at 1.9 billion tonnes.
1996	An environmental audit (Dames & Moore) as well as a social audit (LABAT-Anderson) are undertaken by independent consultants.
1997	Approval for the expansion to 300,000 t/d capacity is received after an environmental impact assessment. A fund is established to promote community development (FFIJD)
1999	Ore production is 220,700 tonnes ore/day

Source: http://www.fcx.com/fmcg/#PT-FI

Annex J2. Geology at Grasberg

The Grasberg porphyry copper and gold deposit is 'an igneous complex confined to intrusive rocks emplaced in tightly folded carbonate strata of Tertiary age.' 'Mineralisation extends from the surface at 4200m to 2700m elevation.' (MacDonald *et al.*, 1994). Mineralisation from the earliest intrusive stage (Dalam Diatreme) is chalcopyrite. The Main Grasberg stock in the middle intrusive stage is an intensely developed quartz-magnetite dilational stockwork. The intrusive rocks have been dated at 2.7–3.3 million years old (MacDonald *et al.*, 1994).

Annex J3. Shrimp and Catfish Tissue Analysis

Trace element concentrations (mg/kg wet wt.) in edible shrimp and catfish tissue (Ortman and Subra, 2000).

Element	Shrimp	Catfish	
	November 1995	November 1995	Values for 1993, 1994, 1995
Copper	6.8–15.5	1.2–2.0	0.03–4.6★ (typically 1–3 ppm)
Arsenic	<0.04–0.13	0.67–2.57	0.17–7.72★ (typically <2 ppm)
Mercury	0.02	0.04–0.09	–
Selenium	0.18–0.29	<0.04–0.15	–

★The higher value was from the Mawati River in September 1993 for copper and November 1994 for arsenic.