CENTER for SCIENCE in PUBLIC PARTICIPATION

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"Technical Support for Grassroots Public Interest Groups"

MEMORANDUM Date: November 17, 2004

From: Amy Crook

To: Radhika Sarin
Earthworks
1612 K Street, NW, Suite 808
Washington DC 20009

Re: Evaluation of human health and ecological impacts in Buyat and Totok Bays, Indonesia

At your request I have reviewed the following documents for accuracy and completeness; Environmental Quality Assessment of Buyat Bay and Totok Bay by Kementerian Lingkungen Hidup October 14, 2004, the PT Newmont Minahasa Raya, Environmental Monitoring Study prepared by the Centre for Advanced Analytical Chemistry Energy Technology. August 2004. S.C. Apte, S.L. Simpson, R.F. Jung, G.E. Batley and L.T. Hales Report No: ET/IR729R prepared for PT Newmont Pacific October, 2004; and, Evaluation of the Likelihood that Contamination has Occurred Calculated from Acceptable Daily Intake (ADI) and Quality of the Biota in Buyat Bay, September 2004.

I offer the following comments and observations.

The studies' sampling methods and data analysis do not support their conclusions:

The Centre for Advanced Analytical Chemistry Energy Technology study (CSIRO study) and the Environmental Quality Assessment of Buyat Bay and Totok Bay (Kementerian study) drew the conclusion that Buyat Bay is not a polluted environment. The CSIRO study asserted "The general absence of elevated metal concentrations in fish muscle and liver tissue in this study is therefore a good indicator that metal availability in the waters of Buyat Bay and the surrounding marine waters is not excessive and would not be considered a polluted environment. The concentrations of metals in the water column were also below regulatory standards and provide further evidence to support this conclusion."

This conclusion is flawed for many reasons that are discussed below. The CSIRO sampling and data analysis was not thorough enough to fully assess the impacts from tailings discharges on local residents and the environment. The actual data itself shows elevated levels of metals in the environment and fish, despite their assertion to the contrary.

They underestimated fish contaminant loads, down played metals exceedences in the sediment, did not address metal uptake over time, looked at a very limited number of metals which falsely reduces impacts, did not evaluate cumulative impacts from several metals at once, did not evaluate contamination levels in aquatic organisms that have a much higher exposure rate than fish, based their conclusions on a very limited number of samples, and most importantly, failed to assess risk levels to local residents and wildlife. These studies were not independently conducted, nor were they peer reviewed. Newmont paid for the studies and had a large role in their design and execution. This is an inherent conflict of interest. These reports certainly do not support the claims Newmont is making.

Metal concentrations in seawater are not a good indicator of environmental impacts:

When metals are released into the ocean a complex set of chemical reactions occur. Metals change into dissolved and inorganic states and each metal has different availabilities to aquatic life. Dissolved metals are generally most available to aquatic organisms for uptake. However, dissolved metals can be very chemically active, rapidly bonding with sediment particles in the water and dropping into the sediments below. This ongoing chemical reaction strips the water of available metals making water a poor measure of the amount of metals in the environment. It is not surprising that the CSIRO and Kementerian studies did not measure elevated concentrations of metals in the water column. Metals don't stay in the water column long. Their conclusion that low levels of metals in the water means Buyat and Totok bays are not negatively affected by metals is misleading. The most important place to look for metals effect on the environment is in the sediments and aquatic biota.

Toxic metals in tailings are being released to the environment.

CSIRO collected water samples and compared the levels of toxic metals at several depths above the Buyat Bay sea floor. For example, at Buyat Bay sample site B, CSIRO found that arsenic in seawater 9 meters above the bottom is two-and-a-half times higher than concentrations at a depth 14 meters higher, and Mercury in seawater 9 meters above the bottom is more than 10 times higher than concentrations at a depth 14 meters higher.

There is a striking correlation – the closer samples are taken to the tailings on the sea floor, the higher the level of toxic metals such as arsenic. This is an important finding because Newmont has asserted that the heavy metals in the tailings are not significantly soluble and do not act as a source of metals contamination. CSIRO's data indicates that the millions of tons of Newmont's mine tailings in Buyat Bay are in fact continuously releasing metals into Buyat Bay, a situation which is acknowledged in the first paragraph, page 20 of the CSIRO report.

Metals levels in the sediments are harmful:

The number of sediment samples collected in the PT NMR studies was inadequate to account for spatial variation or to fully characterize the extent of elevated metals levels in the tailings. Taking only one sample at each of the rivers and reference sites is an inadequate measure and cannot legitimately be used for comparison or statistical analysis. Sediment sampling should be conducted following an accepted protocol using approved analytical methods. Good examples can be found in various publications: http://www.epa.gov/hudson/sediment_sampling.htm, Contaminated Sediment Web Site Links -- U.S. EPA http://www.epa.gov/waterscience/cs/links.htm. A complete assessment of sediment contamination needs to be done using independent contractors with peer review and full public participation through out the study.

In general, considerations of metal bioavailability and bioaccumulation in aquatic media can be split into direct and indirect exposure and impacts. Direct exposure occurs via the water column where biotic and abiotic factors can influence metal bioavailability, and bioaccumulation may lead to toxic impacts. Indirect exposure occurs as dietary exposure when consumer organisms subsequently ingest metals bioaccumulated in organisms at a lower trophic level with the potential for effects or bioaccumulation. Even though direct and indirect exposure of bioavailability and bioaccumulation are considered separately, this has only been done for practical reasons, because, in natural systems, these occur in unison (Drexler, et. al. 2003).

Concentrations of arsenic, copper, and mercury in the sediment at many of the sampling sites in the CSIRO report exceeded Washington State (Washington State Sediment Management Standards, Chapter 173-204 WAC) and Canadian sediment standards (Canadian Sediment Quality Guidelines. http://www.ec.gc.ca/CEQG-RCQE/English/Ceqg/Sediment/default.cfm) and the National Oceanographic and Atmospheric Administration's guidelines for probable effects (NOAA http://response.restoration.noaa.gov/cpr/sediment/SQGs.html). Both the Washington State and Canadian sediment standards are more stringent than the Australian and New Zealand standards used as a comparison by CSIRO. By using less stringent standards as their basis of comparison, CSIRO does not disclose the fact that the sediments in Buyat and Totok Bays are contaminated at levels known to cause toxic effects in marine organisms.

Neither the CSIRO nor the Kementerian study assessed all the metals in the tailings discharge. The studies did not evaluate levels of cadmium, chromium, lead, nickel and zinc in the environment or in fish. Neither study gave any explanation about why these metals were ignored when they are likely contained in the ore body and are thus discharged with the tailings. Cadmium, chromium, lead, nickel and zinc can all accumulate in the environment and cause adverse effects. The assessment of human health and environmental impacts is incomplete without a full characterization of metal contamination in all water, soil, and groundwater areas surrounding the mine sites and in drinking water, fish, shellfish and wildlife consumed by local residents. The full exposure to local residents needs to be evaluated by adding all exposure routes; dermal, dietary, and inhalation.

The measured arsenic levels are dangerous to fish and wildlife:

Sampling stations closest to the tailings disposal site showed the highest concentrations of arsenic in the sediment. The CSIRO study states "the concentrations of arsenic and antimony are elevated in sediment collected in Buyat Bay, particularly over the area of tailings discharge" (page 27). All sampling sites had concentrations of arsenic that exceeded National Oceanographic and Atmospheric Administrations probable effects guidelines for effects range-low (ERL) of 8.2 ppm dry weight and almost 50% of the sampling sites exceeded the effects range-median (ERM) of 70 ppm dry weight. When contaminant concentrations in sediment exceed the ERL level, 20-30 % of the organisms exposed to these sediments show an adverse impact. When the contaminant concentrations exceed the ERM level, 60-90% of the organisms exposed to these concentrations of arsenic will show adverse effects (NOAA). Several sample sites in Buyat Bay had concentrations of arsenic an order of magnitude above the ERM level meaning that organisms exposed to these sediments will be severely impacted in their ability to live, grow, feed and reproduce.

Mercury contamination needs to be assessed in area soils:

Newmont used a roaster to remove metal from the ore at the Minahasa mine. A significant amount of airborne mercury could have been released if mercury collection systems were not installed and properly used. Airborne mercury releases have been a problem at mines elsewhere that operate roasting facilities.

Newmont needs to provide information on how mercury was captured from the roasters, and how was it handled. Was it sold as a by-product, or otherwise disposed, and where? How much mercury was emitted into the atmosphere? How much mercury was recovered from the cyanide circuit? How was this mercury managed- sold as by-product or otherwise disposed, and where? What is the total amount of mercury by-product sold from the mine? Did they do a mass balance with the amount of mercury that came into the processing facility, compared to the mercury that was captured or otherwise released?

Mercury concentrations in Buyat and Totok Bays sediments exceed safe levels:

The data in the CSIRO report clearly show that mercury concentrations in the sediment are elevated in many areas of Buyat and Totok Bays, yet the report never states that. They only discuss the mercury values relative to locations around the world and never discuss the human health and environmental implications of mercury exposure to local residents.

The CSIRO study presents their findings compared to the Australian and New Zealand sediment standards, both of which are higher than the Canadian and Washington state sediment standards (Table 16 in CSIRO report). Mercury sediment standards vary quite a bit by jurisdiction, but both the Canadian sediment standard of 0.13 ppm and the Washington State standard of 0.41 are much, much lower than most of the concentrations found in Buyat and Totok bays (Table 13, values from 0.03 at the Buyat river mouth to 14.5 in Totok Bay of total mercury ug/g dry weight).

The results are clear. There are high mercury concentrations in Buyat and Totok bay sediments that exceed Washington State, Canadian sediment standards and the National Oceanographic and Atmospheric Administration's guidelines for probable effects, sometimes by an order of magnitude. This is a very serious finding and influences mercury contamination levels in aquatic organisms.

Local residents are at risk from mercury exposure:

The CSIRO report documents mercury levels in fish range between 0.012 and 0.359 ug/g wet weight, with five fish above 0.26 mg/kg. These levels are comparable with mercury concentrations reported for fish in North America (USEPA 2001a). The CSIRO report gives the impression that local residents are not at risk from their current fish consumption habits. This impression is misleading because the CSIRO report did not discuss several factors that increase risk to local residents.

Risks to Sulawesi residents from eating local fish comes from three factors; some fish have elevated mercury levels, local residents eat a lot of fish so their exposure rate to contaminants is large, and residents eat many types of seafood that concentrate contaminants more than fish muscle tissue. When these factors are combined it results in significant risks to residents from eating local seafood, and shows that risks have been greatly underestimated. All of these factors are discussed below.

Consumption of seafood that contains inorganic and organic mercury (mostly as methylmercury) is a very serious health threat. USEPA and many international governments have initiated a worldwide effort to reduce and eliminate mercury discharges. Neurotoxicity is the health effect of greatest concern with mercury exposure, although many different health problems have been attributed to mercury exposure. Both inorganic and methylmercury cause a variety of health impacts to humans and animals, and exposure to both organic and inorganic mercury should be factored into any health affects assessment (USEPA 1997). Ingested methylmercury is almost completely absorbed into the blood and distributed to all tissues (including the brain). It also readily passes through the placenta to the fetus and fetal brain. The developing fetus is considered the most sensitive to the effects of mercury; therefore, women of childbearing age are the population of greatest concern.

Recent research on methylmercury demonstrates that women exposed to this chemical may transfer sufficient amounts in utero or through breast feeding to induce pre- or postnatal developmental damage in their offspring. Children born of women exposed to relatively high levels of methylmercury during pregnancy have exhibited a variety of developmental neurological abnormalities, including delayed onset of walking and talking, cerebral palsy, and reduced neurological test scores. Far lower exposures during pregnancy have resulted in delays and deficits in learning abilities in the children (EPA Mercury White Paper).

EPA and other world health organizations have attempted to estimate how much seafood containing mercury pregnant and nursing mothers and infants can safely eat. The determining factors are the mercury concentrations in the food and how much seafood is consumed. The results show two groups of women of childbearing age are particularly of concern: (1) those who eat more than 10 grams of fish a day and (2) those who eat fish with higher methylmercury levels. Ten grams of fish a day is a little over one-quarter cup of fish per week (USEPA 2001a). The local residents of Buyat and Totok Bays eat an ***average*** of 25 times the amount of fish per day than is used by the USEPA as an average consumption level (ADI paper).

The second group of concern is women and infants who eat fish with higher mercury concentrations (0.5 ppm and higher). Even women eating average amounts of fish (<10 grams/day) have mercury exposures that should cause concern, if the mercury concentration in the fish is 0.5 ppm. If women eat fish containing mercury concentrations of 0.5 ppm or greater and their average fish intake is between 40 and 70 grams/day (or about a quarter cup per day), their mercury exposures would range from three to six times the safe dose. Consumers who eat fish with 1 ppm mercury at the level of 40 to 70 grams/day have intakes that range from 6 to nearly 12 times the safe dose. If the fish have average mercury concentrations of 0.1 to 0.15 ppm, the women's mercury exposures range from near or slightly over the safe level to about twice the safe level (USEPA 2001b). The CSIRO report documented that 18 out of 64 fish samples (28%) had mercury concentrations in excess of 0.1 ppm.

Recently, the USEPA revised their safe dose to 0.3 μg methylmercury/g fish based on a total consumption rate of 0.0175 kg fish/day (USEPA 2001b). A total consumption rate of 0.0175 kg fish/day is equal to a little more than a quarter of a cup of fish a week. The CSIRO report (page 48) claims that fish are safe to eat because "Only two fish muscle samples (TC1, BB6) out of 64 fish samples in the current study exceeded this very stringent guideline". Their rational is deeply flawed because they base their conclusion on a fish consumption rate (0.0175 kg fish/day), which is far below that of the local Sulawesi fish consumption rate.

The paper titled Evaluation of the Likelihood that Contamination has Occurred Calculated from Acceptable Daily Intake (ADI) provides some information on the local fish consumption levels by the people of North Sulawesi through field interviews. This paper reports that local people eat around 4.5 fish per day, with the average weight of the fish at around 0.095kg, for a total of 0.45 kg/day. This means that the ***average*** local resident eats about ***25 times*** more fish than the levels used to predict safe consumption levels. This puts local residents, especially pregnant and nursing mothers and infants, at risk from consuming unsafe amounts of mercury.

A well-executed study completed by the Columbia River Intertribal Fish Commission corroborates the level of fish consumption by Sulawesi residents (CRITFC, 1994, USEPA 2000b). The CRITFC conducted a comprehensive survey of fish consumption by members of the Nez Perce, Umatilla, Yakima, and Warm Springs Tribes that possess fishing rights to harvest anadromous fish and resident fish species originating in streams and lakes flowing throughout the Columbia River Basin. Information obtained in this survey included age-specific fish consumption rates, the fish species and parts of the fish consumed, and the methods used to prepare the fish for consumption. The fish consumption survey showed that member tribes consume considerably more fish than the general public. The average and 99th percentile fish consumption rates for adults in CRITFC's member tribes are higher by factors of 8.4 and 2.7, respectively, than the corresponding per capita fish consumption rates reported for the general public by

EPA (USEPA, 2000a). A fish consumption rate of 540 g/day represents a reasonable subsistence fish consumption rate for CRITFC's member tribes who pursue a traditional lifestyle. This value is very similar to the value calculated in the Evaluation of the Likelihood that Contamination has Occurred Calculated from Acceptable Daily Intake (ADI) paper of 0.45 kg/day (450 g/day).

Another useful study was conducted by USEPA in 1999 on Asian and Pacific Islander Seafood Consumption (USEPA 1999). Analyses similar to this need to be included within a full risk assessment for residents in Buyat and Totok Bays before any conclusions about health effects can be drawn.

Underestimation of contaminants in fish:

The CSIRO report just analyzed fish fillets, not the whole fish, so their analysis inadequately quantifies resident's full exposure to metal contamination. Some local residents eat more of the fish than skinned fillets, and wildlife (birds, predatory fish, etc.) consumes the whole fish. Whole fish bodies should be analyzed for metal content to fully assess metal exposure. The CSIRO study also falls short because it did not sample metal concentrations in other seafood eaten by local residents. Shellfish and other aquatic organisms are a large part of local resident diets and their contribution to dietary contaminant load must be fully assessed.

Chemical contaminant concentrations in fish tissue are influenced by the specific species and age (size) class of the fish sampled, the chemical properties of the chemical contaminant (e.g., degradation rate, solubility, bioconcentration potential), and the contaminant level in the waterbody. Metals concentrate at different rates in different parts of the body, i.e. in the internal organs, bones, muscle and skin of the fish. An EPA study of contaminant levels in fish documented that on the average concentrations of cadmium, chromium, cobalt, copper, lead, manganese, nickel, vanadium, and zinc were higher when whole body samples were used instead of fillets (USEPA 2000a). In particular whole body concentrations of arsenic were uniformly higher than the fillet concentrations. Research conducted on various types of fish tissues shows that blood, spleen, and kidney accumulates methylmercury more rapidly than other tissues and contained the highest concentration of mercury. Other tissues in order of decreasing mercury residues were liver, gill, brain, gonad and muscle (Rand and Petrocelli 1985). Thus the CSIRO study analyzed only fish muscle tissue, the type of tissue least likely to accumulate and store metals. This will result in underestimating exposure to heavy metals for local residents and wildlife.

Another omission of the CSIRO report is that they did not do an assessment of the health of the benthic community. Healthy fish populations depend on a thriving benthic community, which is the major food source for many of the local fish stocks. Without a healthy benthic community, fish populations will not be able to sustain themselves.

The reports do not assess risk to local residents:

Both reports stopped short of evaluating a very critical issue- the risk to local residents from eating seafood from Buyat and Totok Bays. The studies assessed metals levels in fish, but did not take the very important next step of using that information to calculate how eating local fish effects human health and wildlife. The studies took a one time "snap shot" view and didn't use the information appropriately to answer two of several key questions "Are the fish in Buyat and Totok bays safe to eat?" and "Have the residents in the area been harmed by releases from the mine?". Harm from eating food containing metals occurs over time because some metals build up in the body to toxic levels. The risk to the local population should be assessed over their lifetime-a very standard requirement. A thorough human health and ecological risk assessment should be conducted to fully determine the impacts from mine wastes.

To adequately evaluate risks to residents from mine waste, the risk assessment must be based on accurate local fish consumption rates. Using values based on sport fishing or average non-indigenous consumption rates will underestimate risks to local residents dependent on fish as their economic and dietary mainstay. Realistic consumption rates would include several daily meals of local fish. Toxic impacts can occur when residents eat large amounts of local fish with moderately elevated metals levels. The more frequent the meals, (exposure), the lower the contaminant concentration needs to be to affect human health (see http://www.epa.gov/waterscience/fishadvice/volume2/v2ch3.pdf, table 3.3 for an example of how to calculate acceptable exposure based on fish consumption levels).

Based on the local fish consumption levels by the people of North Sulawesi presented in the paper titled Evaluation of the Likelihood that Contamination has Occurred Calculated from Acceptable Daily Intake (ADI), there is a documented health threat to the local people from eating fish contaminated with arsenic. This is a very significant finding. The CSIRO and Kementerian studies provide information on metal levels in water, sediment and fish, but don't use the data to assess human health and environmental effects. They have evidence that shows impacts to local residents, but do not take the important step of addressing this issue. The full risk from consumption of seafood and exposure to metals needs to be assessed.

The ADI paper only looked at health impacts from arsenic. It is critical that all contaminants be assessed and risks calculated for additive exposure of all metals and any other contaminants in the waterbody. It is also critical that the risk assessment specifically evaluate risks to children separately from adults due to their lower body weight and higher susceptibility to developmental health problems from exposure to heavy metals. The risk assessment should include all an assessment of all contaminants in the area (not just heavy metals), exposure pathways; eating local fish, drinking water, swimming, and dermal contact with sediments and soils.

Contamination from heavy metals have not been fully evaluated:

The CSIRO and Kementerian studies did not evaluate all the heavy metals contained in Newmont's tailings that have been discharged into the environment, nor did they evaluate cumulative and additive toxicity of combined heavy metals. This will result in underestimating impacts to local residents and the environment.

Multiple Chemical Exposures: Interactive Effects

Local Sulawesi residents are simultaneously exposed to a number of heavy metals from Newmont's tailings discharge and airborne environmental contaminants from the mine site. Local residents who ingest chemically contaminated fish, drink metal laden water, swim in local waterbodies and live near the mine site may be exposed to a number of different chemicals simultaneously. Often chemicals interact with each other to create a stronger toxic effect. Experiencing many chemical exposures at the same time can further compromise a person's immune system and additively impact local environmental health.

It is important that all chemical exposures be evaluated and that the individual exposures and/or risks are then summed to estimate cumulative risks. Safe exposure levels for all chemicals combined must be calculated based on information particular to local Sulawesi residents, not generic information from another location. Monthly meal consumption limits for noncarcinogenic and carcinogenic contaminants need to be calculated to get the total dose. Cumulative exposure to all contaminants needs to be assessed to fully evaluate health effects.

EPA provides guidance on chemical mixtures in risk assessments in *Guidelines for the Health Risk Assessment of Chemical Mixtures* (U.S. EPA, 1986). EPA has recently published a supplement to the 1986 guidelines (USEPA, 2000d). EPA recommends that a cumulative risk assessment be conducted at sites where a mixture of chemicals has been released. Their recent publication outlines the methods for this procedure (UDEPA 2000c).

Please contact me with any questions on this memo.

Sincerely,

Amy Crook

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