Mining's Problem with Waste

Safe disposal of mine waste, including **tailings,** is generally recognized as the single largest environmental challenge facing the mining industry worldwide and a major expense for mining companies.

Photo: Catherine Coumans

Tailings from Placer Dome's Marcopper mine in Marinduque entering the sea at Calancan Bay.

Modern open-pit mining has a very high waste-to-product ratio (roughly 99 tonnes of waste to each tonne of copper, and even far more waste in gold mining), making waste the major product of mining. The Canadian mineral industry generates about 650 million tonnes of waste per year.[1] The storage of this waste poses significant engineering challenges. All over the world, tailings-dams are leaking, or breaking, and seeping toxins on a daily basis; but recent environmental and social disasters in Romania, Guyana, Spain, and the Philippines—caused by tailings-dams that burst—have served to focus public attention on this problem.

Mine waste poses an environmental threat not only through its *volume* but also because of its *toxicity*. Mine tailings commonly contain sulfides as well as metals—such as cadmium, copper, iron, lead, manganese, mercury, silver, and zinc—that occur naturally in the ore body. When sulfides in the tailings are exposed to air they oxidize. If oxidized tailings come into contact with water, environmentally toxic sulfuric acid is produced. This process is known as **Acid Mine Drainage** (AMD). The sulfuric acid also accelerates **metal leaching** in tailings. Acid Mine Drainage can have a toxic impact on ground and surface water around mines. According to the United States Environmental Protection Agency, water contamination from mining poses one of the top three ecological-security threats in the world.

Why Do Mining Companies Want to Use Submarine Tailings Disposal?

Submarine Tailings Disposal is dumping mine tailings into the sea through a submerged pipe. In the Western Pacific region, mining companies argue that **Submarine Tailings Disposal (STD)**[2] is the best solution for tailings disposal. They say that storing tailings on the land in this region is risky—because the Western Pacific experiences earthquakes; has many mountainous islands with no place for on-land storage; is an area where land is urgently needed for agriculture; and has high rainfall, making tailings dams vulnerable to collapse. In modern STD systems, mining companies *claim* that the goal is to deposit tailings into deep waters of the sea where there is little oxygen. They say that therefore tailings will be less likely to oxidize and leach out toxic metals. Mining companies also argue that marine life at these depths is not so abundant and it is not important to the human food chain.

By pumping their tailings into the sea, mining companies remove unsightly tailings on land. They "solve" the problems of maintaining tailings **impoundments** and dams, and managing acid mine drainage and metal leaching from tailings impoundments, sometimes "in perpetuity" (forever). And in case of a dam failure, mining companies avoid the risks of social rage and of expensive clean up. Unlike on land, if something goes wrong with an STD system, there is little the company, or anyone else, can do. The public may not even discover a problem, because it is out of sight under the sea. Even if a problem becomes known, it is harder to hold a company legally and financially responsible.

STD is also a relatively cheap mine-waste solution. Placer Dome's Dick Zandee wrote in a 1985 article about their surface disposal system into Calancan Bay in the Philippines that, "operation of the current sea-disposal system costs less than half as much as the operation of the tailings-pond system."[3] For the Kitsault mine in Canada, which was given a special site-specific exemption in 1979 to operate an STD system, it was estimated that STD would save the company $25 million dollars per year in tailings disposal costs relative to the cost of land-disposal. The U.S. Department of the Interior concluded that, on average, STD use resulted in a 17% reduction in capital costs and a 1.6% increase in operating costs.[4]

How is Submarine Tailings Disposal Done?

Mines have a long history of dumping their waste into the sea. Historically this has been into the shallow, near-shore, areas. Even in recent years, shallow surface dumping of tailings, with very damaging consequences, continues to occur, such as at Placer Dome's Marcopper mine in the Philippines (1975-1991). Since the 1970's, there have been Submarine Tailings Disposal systems that have piped tailings further out to sea and deposited them under water into intermediate depths, such as the Island Copper Mine in Canada and the Atlas mine in the Philippines. These systems also caused environmental damage because the tailings did not stay where consultants predicted but came back up into more shallow areas. This toolkit focuses on deep sea dumping to show that there are also serious concerns with this so-called "best practice." It is important to know that even though the industry and its consultants now argue that deep sea disposal is best practice, new shallow depth STD systems are still being built, such as Newmont's Minahasa Raya Mine in Indonesia (started in 1996). And even at a modern deep-sea STD mine, such as Misima in Papua New Guinea, a large amount of waste (50 million tonnes) was dumped onto a near shore coral reef between 1988-1993.

What Mining Companies Say: The following is a generalized description of STD as mining companies and their consultants say it should be implemented in modern STD systems. Note that there may be differences in systems, depending on site-specific characterizations:

First, the tailings are treated to remove at least some of the most harmful chemicals. Then the tailings are piped to a "mixing tank" on the seashore, where they are **de-aerated** and mixed and diluted with seawater. Some companies say that the water should be drawn up from the deeper sea so that the tailings take on the density, temperature, and salinity of the water of that depth and so that the sea creatures in the shallow water are not disturbed by the water intake. The tailings are pumped into the sea through a submerged pipe. Most mining consultants say that 80 to 100 meters deep is sufficient to put the tailings below the **thermocline**, the **euphotic zone**, and the **mixed surface layers.**

When the tailings leave the pipe they should form a "**density current**," a coherent flow that has been described as looking like tooth paste that descends to the deep reaches of the sea. This descending density-current occurs because the tailings are heavier than the surrounding water and because gravity pulls them downwards. A seabed slope of minimally 12% is thought to be needed to move the tailings along the seabed, away from the pipe. When the tailings settle on the sea floor, they are expected to smother the **benthic life** that exists there. Not yet known is whether the **benthic organisms** can regenerate and co-exist with the tailings.

At all STD mines worldwide there have been the following impacts:

1. Pipe breaks
2. Wider than expected dispersal of tailings
3. Smothering of the Benthic organism
4. Increased **turbidity**
5. Introduction of metals and milling agents (chemicals, such as cyanide, used for extraction of the desired metals, and detergents and frothing agents to float out the metals) into the sea.

Where STD is Practiced, and Proposed Sites

The first mines to use STD were the Atlas Mine, in the Philippines, and the Island Copper Mine, in Canada (both in 1971) and the Jordan River Mine, in Canada, and the Black Angel Mine, in Greenland (both in 1972.) In all of these cases, the mines dumped at relatively shallow depths and experienced serious problems with wider than predicted dispersal (spreading out) of tailings, turbidity, and metal leaching. Even after it became well known that these mines were damaging marine environments, the Island Copper Mine, the Black Angel Mine, and the Atlas Mine continued using STD into the 1990s. (The Atlas Mine is still operating.)

STD is currently being practiced in the following places:

- In Chile at the Huasco Iron Pelletising Plant operated by Compania Minera del Pacifico
- In Indonesia at Minahasa Raya and Batu Hijau mines both operated by Newmont Corporation
- In Turkey at the Cayeli Bakir Mine operated by Inmet Mining
- In Papua New Guinea at the Lihir Mine operated by Lihir Management Company and Rio Tinto
- In Papua New Guinea at the Misima Mine operated by Placer Dome
- In England at the Boulby Potash Mine operated by Cleveland Potash
- In the Philippines at the Atlas Mine operated by Atlas Consolidated Mining and Development Corporation

Proposed STD Mines

Country	Location	Company
Indonesia	Awak Mas Sulawesi	Mas Mindo Mining
	Toka Tindung Sulawesi	Aurora
	Gag Island	BHP Billiton, PT Gag Nickel
	Central Malaku	Ingold, an associate of Inco
	Halmahara, North Maluku	Weda Bay Minerals and PT Aneka Tambang
	Jember, East Java	PT Jember Metals and PT Banyuwangi Minerals
	Banyuwangi, East Java	PT Jember Metals and PT Banyuwangi Minerals
	East Java	PT Jember Metals and PT Banyuwangi
Papua New Guinea	Simberi Island	Nord Australex
	Woodlark	Highlands Pacific
	Ramu	Highlands Pacific
Philippines	Tampakan, Mindanao	Previously Western Mining Corp.
	Mindoro Oriental	Crew Development Corporation
	Kingking, Mindanao	not available
	Rapu Rapu	Lafayette
Solomon Islands	Bugotu Mine	Bogotu Nickel
Fiji	Namosi Mine	Nittetsu Mining Co. Ltd.
New Caledonia	Boa-Kaine	Iscor
	Nakety	Argosy Minerals Inc.
	Prony	not available
	Koniambo	Falconbridge
Panama	Petaquilla	Irian Resources, Teck & Inmet Mining

***Note**: It appears that public protest has prevented the Rapu Rapu mine from getting a permit to use STD; the permit for the mine in Mindoro Oriental was withdrawn, (See: **The Successful Struggle Against STD in Mindoro, Philippines)**; and the future of Ramu mine is uncertain (see: **Ramu nickel cobalt mine**). Canadian mining giant Inco planned to use STD at its proposed Goro mine in New Caledonia, but they reverted to land based.*

*STD is NOT being practiced, or proposed with any realistic chance of success, in the United States, Canada, and Australia. These three countries are home to most of the mining companies that want to use STD in the Western Pacific. STD is effectively banned in the U.S. and Canada under regulations that protect water and fish. (See: **Canadian Legislation on Submarine Tailings Disposal.**) Australia is considered unsuitable for STD for geological reasons.*[5]

Mining Companies and Consultants Promoting STD

The Mining Companies

The main mining companies pushing for STD in the Western Pacific region are among the biggest multinational mining companies: BHP Billiton, Placer Dome, Newmont (now merged with Franco-Nevada and Normandy), Inco, Falconbridge, and Rio Tinto. Many of these companies are notorious for the trail of disastrous mining projects they have left behind around the globe (Ok Tedi, Marcopper, Grasberg, Bougainville). In February 2001, BHP, Placer Dome, Newmont, Rio Tinto, Western Mining Corporation, Anglo American, and Falconbridge organized a meeting in Vancouver, Canada, with several non-governmental organizations to discuss STD, an indication of the concern that companies have about public opposition. Nonetheless, industry representatives at the meeting insisted that STD should be evaluated on scientific grounds only and that science proves that STD is an acceptable waste-disposal option. They said that they will continue to practice STD.[6] (See: **Science and Submarine Tailings Disposal)**

The Consultants

All of these mining companies make use of small groups of consulting firms that specialize in STD, some since the 1970s. These firms are: Rescan Environmental Services Ltd. (Rescan), Natural Systems Research Environmental Consultants (NSR Consultants), Dames and Moore, and Woodward-Clyde. Less well known, but active, is Lorax Environmental Services (Lorax). Reports from these firms, commissioned by the mining companies, are presented to governments and local communities as impartial, scientific assessments. But these reports are *not* peer reviewed, they are *not* published, and they are frequently not even available to the public upon request. In fact, these consulting companies have never been known to advise *against* STD, and they have a professional and financial interest in promoting STD. These consultants may report on areas of "concern," but they always refer optimistically to "mitigation" or to "technical adaptations" that can be made - or they refer to concerns as "acceptable risk."

Rescan and NSR Consultants have had their hands on almost every STD project to date, as well as many more that are being planned. Rescan was involved from the start in advising at Island Copper, Kitsault, Black Angel, Marcopper, Cayeli Bakir, Misima, Minahasa Raya, and many more. NSR Consultants have been, and currently, are involved in many STD projects and proposals in the Western Pacific (see section: A Look at the Industry). In spite of serious problems at many of the mines that Rescan has been associated with (for example, Black Angel) and is associated with (for example, Minahasa Raya), this company discusses the problems with these STD systems as "learning experiences," turning them into a selling point by arguing Rescan has the longest history with STD.

Importantly, certain individuals in these companies are personally involved in promoting STD as a technology. Most notable of these are Derek Ellis, Clem Pelletier and George Poling of Rescan, Stuart Jones and David Gwyther, of NSR; and Tom Pederson, of Lorax. They give talks at conferences around the globe and interact with the media. Of greater concern, some have presented themselves as "independent experts" to governments trying to decide whether STD is safe for their country. They have done this by presenting themselves as academics, such as Tom Pedeson and Derek Ellis, whom have had appointments at universities, despite their links to consulting firms. Some have even visited communities as independent experts and given advice on whether the community should accept STD. Derek Ellis of Rescan has made STD his career; he was involved in the Island Copper Mine, the very first STD mine. But he has also presented himself as an impartial expert advisor to governments and communities.

The Need for Independent Review of Consultants' Studies

Only recently have independent assessments been made of mining industry consultants' studies. Two recent cases indicate that such independent assessments should be done more frequently. The consultants for Highlands Pacific Ltd. proposed Ramu Nickel Cobalt Mine in Papua New Guinea were NSR Consultants. Two independent reviews have been done of NSR's Environmental Impact Assessment—one in 1999, commissioned by the Mineral Policy Institute of Australia, and the other in 2001, commissioned by the Evangelical Lutheran Church of Papua New Guinea. (See Ramu Case Study.) In 2000, the United States Geological Survey (USGS) completed an independent study on behalf of the people of Marinduque, Philippines who were not comfortable with the assurances of Placer Dome and their consultants, Woodward-Clyde, that STD would be environmentally benign. (See: **The Successful Struggle Against STD in Marinduque, Philippines**)

Written by Catherine Coumans, MiningWatch Canada

1 Environmental Mining Council of British Columbia. *Acid Mine Drainage: Mining and Water Pollution Issues in BC*. 1998. p. 3.

2 Submarine Tailings Disposal is now also being called Managed Submarine Tailings Placement and Deep Sea Tailing Placement. While the industry is trying to imply greater control over the tailings, these terms all cover the same process: dumping mine waste into the sea through a submerged pipe.

3 Zandee, D. "Tailing Disposal at Marcopper Mining Corporation". Asia Mining. p. 35-45. 1985.

4 US Department of the Interior. *Potential for Submarine Tailings Disposal to Affect the Availability of Minerals from United States Coastal Areas.* Bureau of Mines, OFR 101-93. 1993.

5 Jones, Stuart and David Gwyther. *Deep Sea Tailing Placement*. 2000. p. 7.

6 Summary to MiningWatch Canada from NGO participants in a multi-stakeholder meeting called, Deep Sea Tailings Disposal in Vancouver, February 27, 2001.

Science and Submarine Tailings Disposal

Most of the scientific studies on Submarine Tailings Disposal (STD) have been paid for by mining companies wanting to use STD technology to dump mine waste into the ocean. Most of this scientific work has been done by a handful of environmental consulting companies that specialize in STD science and technology. These include Dames and Moore, Woodward-Clyde, Rescan Consultants Inc. (Rescan), Natural Systems Research Consultants (NSR), and Lorax Environmental Services.

Some of these companies offer "cradle to grave" services, meaning they conduct studies mining companies need to get environmental permits from governments, including baseline studies; they conduct monitoring studies during the life of the mine; and when the mine is ready to close down, they conduct closure studies.

These studies are not peer reviewed, not published, and frequently not available to the public. In a clear conflict of interest, these consultants also sometimes act as independent advisors to governments on the science and technology of STD. There are too few independent scientific studies on various aspects of STD and too few independent site specific reviews of the Environmental Impact Assessments produced by mining industry consultants.

Mining companies and their consultants commonly make the following arguments:

1. Science and technology are the only things a community should consider when trying to decide if STD is an acceptable option for mine waste disposal.

2. Mining companies now have the scientific ability to evaluate a site on its environmental acceptability for STD.

3. Mining companies have the technology to implement STD in a way that makes it safe for the marine environment.

These mining industry assertions are not true.

Whether or not STD should be used is simply not a matter of science; it's a matter of *social acceptability*, both at the government and local community level. What level of predicted damage to the marine environment is a community willing to accept? What level of risk of *unpredicted* (and unpredictable) damage are the people who will be immediately affected willing to accept?

Too often, it is impossible for communities to consider these options because information about risks associated with a project are not made available to them. Too often, communities are given a choice between land-based risks and risks of ocean disposal and are not presented with development choices that are alternatives to mining.

In every known case of STD, scientific predictions and "state-of-the art" technology have not been able to protect marine environments from serious predicted impacts (such as the smothering of organisms on the sea bottom), as well as the risks of unpredicted impacts. Every STD system to date has suffered documented, unpredicted environmental damage or system failures.[1]

Limits to Science

STD poses such a high degree of risk for substantial unpredicted and unpredictable long term impacts because little is known about the deep-sea ecosystem. New and unexpected discoveries are being made all the time, such as the discovery of living organisms near hot thermal vents, the discovery of 263 species of fish and 37 species of sharks and rays in the deep sea (230-1,860 meters depth) of New Caledonia of which 40% were new to science[2], and the discovery of "pinnacle" reefs at depths of 80-100 meters.[3] These reefs are believed to play a crucial role as a spawning ground for fish. They are also at a depth at which most mine consultants say it is safe to start discharging tailings.

Because so little is known about deep sea ecosystems, its **benthic** organisms (those on the seafloor) and the role they play in the vertically integrated food chain in the ocean, it is reckless to assume the impact of hundreds of thousands of tons of metal enriched tailings will not be detrimental. Adopting the **Precautionary Principal**, STD should not be considered until the deep-sea ecosystem has been thoroughly studied by independent scientists so that its ecological role and value is better understood.

Technology by which to study the sea is improving, enabling scientists to better assess and recognize unacceptable environmental impacts not previously thought to be detrimental.[4] Current technology still cannot adequately model the deep-sea ecosystem well enough to provide information about impacts of tailings in the sea over many years. For example, scientists recognize that we simply do not have the ability to adequately model water movement and sediment movement sufficiently to be able to forecast exactly how solids will disperse in the sea over time.[5] In addition to scientific deficiencies, there are also technological weaknesses in STD systems. (See: Pipe Breaks below.)

Many impacts of STD have not yet been studied and many questions remain unanswered. For example:

- No research has been done on the effects of tailings on bioluminescence, the ability of some marine organisms to manufacture their own light in order to find food.[6]

- No answer exists to the question of what would happen to tailings on the sea bottom during an earthquake at sea.

- No answer exists to the question of how to control or mitigate damage if an STD system fails, if unexpected upwelling occurs or if a pipe breaks, spreading tailings into shallow, coral-rich areas.

Known Risks Related to STD

In discussions with local communities and governments, mining companies and their consultants make claims about the environmental acceptability of STD and they claim STD, or Deep Sea Tailing Placement "is proven technology."[7] But there are known risks related to STD that mining companies and their consultants either do not discuss with local communities or tend to minimize their severity by speaking of "mitigating measures" that can be taken or good "monitoring systems" that will warn people when a problem does occur. Especially during the pre-permitting phase, there is not enough transparency about the risks associated with STD.

What Mining Companies and Consultants Claim

If **de-aerated** tailings mixed with sea water are deposited by pipe below the **mixed surface layers**, below the **euphotic zone**, and below a **thermocline** onto a sea bed with a "sufficient" slope so that the tailings flow through gravity into the deep waters of the ocean, then tailings will stay together in a density current like toothpaste. Companies and consultants claim that tailings will not be able to come back up above the thermocline, will not significantly leach out metals, will not damage corals and will not negatively affect marine organisms, fish in general or particularly species that make up part of the human food chain.[8]

What we know

Plume Shearing: Tailings do not stay together in a "density current." When tailings leave the pipe to enter the sea, fine tailings particles always break off from the main stream and float away. This is called "plume shearing." These tailings are sometimes caught between ocean layers and can travel this way for many kilometers.[9] If they take on a rotation, tailings may maintain their density for hundreds of kilometers.[10] Plume shearing can also happen when discharged tailings encounter "discontinuities" or places in the ocean where two layers of water meet with different temperature or density. Plume shearing exposes heavy metals to the food chain because fish either ingest tailing particles whole or take up leached metals through their gill membranes.[11] Plume shearing also increases turbidity (makes water less clear), inhibiting photosynthesis by reducing the amount of light that penetrates into the water column. It also drives away some commercially valuable fish species (such as tuna) and poses a threat to fish because tailings contain sharp and pointy particles that may damage fish skin and gills and cause infection.[12]

The Misima Mine, Papua New Guinea: *Owned by Canadian mining company Placer Dome, the Misima mine is often held up as a model of how an "ideal" STD system should work. However, plume shearing at the Misima mine happens at a 112-meter depth, where the tailings leave the pipe and also at depths between 150 and 1,000 meters. Deepwater snapper, an edible species of fish, swim between 100-300 meters depth, so metals in the tailings that shear off may be absorbed by the snapper and passed up the food chain to people.[13] The degree of turbidity is measured by the amount of Total Suspended Solids (TSS) in the plumes. TSS in plumes from the Misima Mine can be as high as 51 milligrams per liter (mg/l). Consultants for Misima (NSR Consultants) minimize this number by saying that the TSS is "only" 51 mg/l,[14] but this is far higher than allowable under Canadian law. (See: Canadian Legislation on Submarine Tailings Disposal.)*

Thermoclines and Upwelling: A thermocline is a layer in the ocean where the temperature changes rapidly. The water above and below the thermocline differs significantly in both temperature and density and acts as a natural barrier between two layers. Mining companies often present the thermocline as a natural and impermeable barrier that will keep tailings out of the mixed surface layers of the ocean. In fact, thermoclines are not necessarily stable barriers. They may become thicker or thinner at different times of the day or year, and they may come and go with seasons. There may be multiple thermoclines in some places while others will not have any. Studies by Professor Rizal Max Rompas from Sam Ratulangi University indicate that there is no thermocline in Buyat Bay, Sulawesi, Indonesia, where Newmont says it is disposing tailings at a depth of 82 meters from its Minahasa Raya mine. Studies show that the thermocline throughout Indonesian waters is deeper than 150 meters.[15] Independent scientists have also shown that there are a lot of sources of energy at work in the sea that can, in fact, push deeper water back up through the thermocline into the more shallow and biologically productive layers of the sea.[16] This is known as "upwelling." In addition to upwelling-favourable surface winds, other sources of energy include internal waves, bottom currents on a sloping seabed, and tidal flows, as well as more unusual events such as earthquakes at sea or tsunamis.

Proposed Ramu Mine, Papua New Guinea: *An independent study found that in Astrolabe Bay, in the Madang Province, "a bottom current moving towards the shoreline, with mid-depth currents moving offshore, is suggestive of upwelling, and this can not be ruled out on the available evidence."[17] This study also found that "internal waves could act as periodic pumps to bring some of the STD slurry to much higher levels, where other processes could bring it higher yet."[18] In 1999, an independent study by the Mineral Policy Institute stated that: "If this occurs it will have a significant impact on the productivity and ecology of Astrolabe Bay and the Madang coastline."[19]*

BioAvailability of Dangerous Metals and Chemicals: Tailings that contain sulfides are prone to oxidation, acid drainage, and metal leaching. Metals leaching out of tailings in the sea are a problem because they may become bioavailable, meaning they may be absorbed by marine life and accumulate in the food chain, potentially affecting the health of marine life and of people who rely on food from the sea. Mining consultants argue that putting tailings in seawater largely solves these problems because there is less oxygen available in seawater (so slower oxidation) and seawater is alkaline (which counters acidity). These two factors prohibit acid drainage and metal leaching.[20] Consultants also say that by de-aerating tailings (removing some oxygen), before they are piped into the sea and by depositing them in the deep sea, which has less oxygen than the mixed surface layers, the problem of metal leaching is essentially solved. However, in addition to plume shearing and upwelling (see above), the following describes how STD still does introduce dangerous metals and chemicals into the marine environment.

Readily Available Metals in Tailings Effluent: Dangerous metals that are already dissolved, or otherwise available in tailings, may be introduced to the sea immediately when tailings leave the pipe, such as at the Misima Mine.

Misima Mine, Papua New Guinea: *In the case of Placer Dome's Misima gold mine the tailings contain residual cyanide from the gold extraction process. Before being released into the sea the tailings are first diluted on shore with seven parts of seawater to one part tailing in a "mixing tank" to reduce the concentration of cyanide and other contaminants.[21] Even after this dilution, the tailings contain such high levels of cyanide that they do not meet Papua New Guinea's "water quality criteria for seawater."[22] Therefore, Placer Dome was granted a very large area in the sea around the outfall of the pipe, called a "mixing zone," within which the seawater is polluted with cyanide and other chemicals at levels not otherwise allowed by Papua New Guinea.[23] This "mixing zone" in the sea extends 42 meters above the end of the pipe (which is at a 112 meter depth), and 488 meters below the pipe. The mixing zone is about 2.5 km wide at the top, tapering down to about a kilometer wide at the bottom. In addition to available cyanide, at the boundaries of the mixing zone, copper levels exceeded United States Environmental Protection Agency (USEPA) criteria, and lead levels exceeded Australian and USEPA criteria for* ***total metal analysis***.[24]

Pipe Breaks: Pipes that transport tailings to the sea are notorious for breaking and leaking tailings, both on land and in the sea. Part of the problem is that tailings are very abrasive. At sea, pipes are also vulnerable to landslides, shipping, storms, and tsunamis. When pipes break at sea this can have a serious impact on shallow and coral-rich areas. Pipe breaks are not only a characteristic of old STD systems, but of every STD system. When pipes break at sea the spilled tailings can have a serious impact on marine life in the shallow areas and on coral reefs.

Minahasa Raya, Indonesia: *Pipes have broken in the newest STD systems, such as at Newmont's Minahasa Raya Mine in Indonesia. The pipe broke at sea in 1998, first at 46 meters depth and later at 10 meters depth, seriously impacting coral reefs and marine life. A team of researchers led by Prof. Rizal Max Rompas from Sam Ratulangi University stated, "The mining activities of PT. Newmont Minahasa Raya in Minahasa regency and Bolaan Mongondow need to be reviewed. High levels of several toxic compounds were found at Buyat Bay. The amount of toxic compounds in seawater has reached over the tolerable threshold allowed by government law, PP no 20, 1990. Moreover, the research has found some indication of contamination of the planktons and pelgic fish live in that area… Highly toxic compounds in Buyat Bay include those which are bio-accucumulative and carcinogenic."* [25]

Misima Mine, Papua New Guinea: *Pipes have also broken at what many in the mining industry consider to be a model STD mine, Placer Dome's Misima Mine in Papua New Guinea. The tailings pipe at Misima broke in 1997, at 55 meters depth, and again, in 2001, at 13 meters depth. It took Placer Dome six months before the pipe was fixed in 1997. Placer did not fix the pipe break of December 2001 until February 20, 2002. During each of these pipe breaks at sea, cyanide and metal enriched tailings particles were pumped into the shallow, oxygenated, euphotic zone that is abundant with sea life. Furthermore, by releasing tailings and cyanide at the shallow depths of 55 meters and 13 meters, Placer Dome was no longer in compliance with the conditions of its permit as these shallow areas fall outside of the "mixing zone" Placer was granted.*

Batu Hijau, Indonesia: *This mine started in 1999 and has already had two pipeline breaks because of inadequate pipe materials and quality control.*

Atlas Copper Mine, Philippines: *The pipeline was wiped out by a typhoon.*

Metal Solubility and Availability in Seawater: When exposed to oxygen, sulphides in tailings can oxidize and, in combination with water, produce acids that can leach metals out of tailings. STD proponents[26] argue that these metals will leach out less readily under water, where there is less oxygen. But some metals are actually quite soluble in seawater, even in deep, less oxygenated seawater, as became apparent in the case of the Black Angel Mine. Should metals find their way to the more oxygenated surface layers through upwelling, plume shearing, or pipe breaks, then oxidation and leaching is likely for certain metals, as shown through the research on tailings in the sea at historic copper mines in Newfoundland. Independent scientists also predict metal leaching from tailings in the case of the proposed Ramu Mine.

Black Angel Mine, Greenland: *Golder Associates have noted that even in the case of the Black Angel Mine, where tailings were deposited in a deep fjord, "assumptions about* *the potential solubility of the ore minerals in a marine environment proved to be wrong. Although the sulfide minerals were considered to be insoluble, the soluble hydroxide, carbonate and sulfate phase of Cu [copper], Pb [lead], Zn [zinc], and Cd [cadmium] that formed during the milling process were quickly released to the seawater as tailings were deposited into the nearby fjord."*[27]

Historic Copper Mines in Newfoundland, Canada: *A three year, ongoing study by scientists from Natural Resources Canada, Fisheries and Oceans Canada, and Memorial University of Newfoundland aims to study the chemical and eco-toxicological impacts of tailings that were deposited in the near shore environment by two copper mines in the 1950s and 1960s. A paper presented in 2001*[28] *represents their initial findings, which include the following: That even though oxygen is reduced by a water cover, some sulfide minerals may actually leach out metals more easily in salt water because chemical reactions that produce an electric current are enhanced by the salt. "The extent of weathering [of tailings] in many cases appears to be more intensive in the saline versus fresh water medium, likely because the former is a stronger electrolyte to enhance the electron transfer process. In addition, data clearly show that Pb [lead] leaching is enhanced under saline versus fresh cover. Ni [nickel] leaching also appears to be enhanced under a saline water cover while the data for Cu [copper] and Zn [zinc] are inconclusive." This study also shows that metals from these tailings that were dumped in the sea did appear to bioaccumulate in marine life: "Concentrations of Cu [copper], V [vanadium], Mn [manganese], Co [cobalt], and Fe [iron], were significantly higher in the soft tissue of blue mussels (Mytilus edilis) and soft shelled clams (Myra arenaria) in the vicinity of Little Bay [tailings site] compared to the control site. Significant species effects were also detected with the blue mussels generally having higher concentrations of all metals… Seaweed species Fucus anceps and Ascophyllum nodosum from the Little Bay area displayed similar patterns of enrichment."*

Proposed Ramu Mine, Papua New Guinea: *According to Gregg Brunskill, an independent scientist who has reviewed the studies of NSR Consultants for the proposed Ramu Nickel Cobalt mine, one has to expect a "zone of very unusual seawater chemistry within a radius of about 1 km (landward and seaward) of the pipeline orifice."*[29] *He states, "There will be very high concentrations of ammonia (being oxidized by bacteria to nitrate), sulfate, Mn, and enhanced metal concentrations (Ni, Cr, Co, Hg, and Cd) in the dissolved phase….Of the abundant trace metals in the sediment, Cr (6) may be the most soluble in oxygenated seawater. Ammonia and nitrate are powerful fertilizers in nutrient deficient tropical coastal waters.…"*[30] *Brunskill notes there will be a "very large oxidation power from the high concentrations of MnOOH and FeOOH. Some releases of all trace metals in tailings to* ***oxic*** *and* ***anoxic*** *pore water and oxic overlying sea water can be expected…."*[31] *(idem). Brunskill also notes that the impact of a trend of more frequent El Nino events in the area "suggests cooler surface waters in the Bismarck Sea, and deeper mixing of the surface waters off the north coast of Papua New Guinea" which means the oxygenated layers in which metals more readily leach out will penetrate more deeply than currently modeled by NSR consultants.*

Metal Uptake in Organisms from Undissolved Metals in Tailings: Metals can accumulate in marine organisms even if tailings are not oxidized and leaching metals. If, through a pipe break, upwelling, or plume shearing, tailings end up in shallow areas where marine life is abundant, then metals can be absorbed through absorption of whole tailings, as has apparently been the case at the Marcopper Mine.

Marcopper Mining Corporation, Philippines: *Researcher C.P. David has been able to show that unoxidized tailings entered the near-shore environment because of a tailings spill at Placer Dome's Marcopper mine in 1996. This rapidly led to an increase in concentrations of copper, manganese and iron in Ihatub corals. "The spike in copper concentrations observed in the 1996-1997 growth bands of the Ihatub corals are attributed to the input of mine tailings into the near-shore environment starting in 1996. This increase is quite distinct as it is 5 to 7 times that of the perceived baseline value."*[32]

Reagents and Floating Chemicals: Reagents and flotation chemicals are used to separate desired metals from crushed rock. There are not many studies that show the impact on the marine environment from reagents mixed with tailings. But some of these chemicals are known to increase the solubility of metals in the marine environment.[33]

Metals Moved Biologically by Vertical Migration: Marine scientist Marcus Sheaves has noted that sea creatures do not necessarily confine themselves to one layer or depth of the ocean. Therefore, significant volumes of metals from tailings deposited at great depths may make their way up to higher seawater levels and into the human food chain through the "vertical migration" from the depths to higher layers by plankton and fish that have absorbed tailings or leached metals, and by fish from the higher layers traveling down to the lower levels to feed.[34]

Seabed Slope: STD proponents admit that the slope of the seabed must be steep enough to allow tailings to move away from the pipe to deeper waters.[35] But mining consultants are still promoting STD in places that do not meet these conditions.

Minahasa Raya, Indonesia: *At the Minahasa Raya gold mine, the pipeline into Buyat Bay lays along the floor of the bay and discharges tailings at an 82-meter depth, according to US-based Newmont Corporation, the company that owns and operates the mine. The seabed is so flat that the tailings create* *a mound around the pipe outfall and ejected tailings bubble up creating a volcano-like effect. Consultants for this project were Rescan of Vancouver. It is hard to understand why a modern mine such as Newmont's Minahasa Raya was given permission to be built.*

Proposed Ramu Mine, Papua New Guinea: *The seabed at the proposed Ramu Mine does not have a steep slope in sections. This means that tailings are likely to pile up in places rather than flow together in a density current to the deeper parts of the ocean. "Based on the depth cross-section accumulation seems most likely near the discharge point and at around the 450 m ocean depth contour, where the slope abruptly flattens from 16 degrees to 7 degrees. Massive build-up is significant because of the potential for subsequent tsunamigenic slump."*[36] *Marine scientist John Luick warns that a sudden slump of piled up tailings could cause a tsunami.*[37]

Dispersion of Tailings in the Sea: By dispersion of tailings we mean how widely they are spread in the sea. Consultants have not done a very good job of predicting how large the ecological footprint of tailings in the sea will be. Consulting firm Golder Associates note that "[o]n the basis of Island Copper Mine, Kitsualt Mine and Black Angel Mine, STD's have resulted in dispersal of tailings to a greater extent than predicted. This applies to dispersal in both deep water receiving environment (i.e. bottom of fjord) and in shallow waters."[38] Golder Associates also admits that, "our knowledge of the physics governing solids transport is relatively poor. Many models exist for predicting movement in the marine environment, however, most of these are virtually untested and are indeed based on inappropriate parameterizations [measurable features]…."[39]

Benthic Smothering and Recolonization: We know that in all STD systems benthic (sea bottom) marine life is smothered and wiped out by tailings. There are very few examples of older, discontinued STD systems that we can study to see whether tailings can be "recolonized" with organisms once the dumping stops. What evidence we do have from the Island Copper Mine and the Kitsault Mine indicates that there may be some new creatures that establish themselves on the tailings but that they are not the same as the creatures that were there before and there is a loss of biodiversity.[40] We also know that certain species will avoid settled tailings on the seabed, such as yellowfin sole and tanner crabs.[41]

Sustainability: One of the principles of sustainability is to use and reuse the earth's resources frugally. STD degrades and destroys two resources, the marine environment and earth's metals. Not only do we know that STD smothers life, poisons on the ocean floor and that it puts potentially lethal and sub-lethal metals into the marine environment, it also places potentially useful metals out of our reach. On land, ways are being found to mine tailings for the many useful metals they still contain.

Site Specific Independent Scientific Studies Can Support Struggles against STD

To date, most of the scientific studies on STD in the tropics have been generated by the mining industry and its consultants. This means that local governments and communities have almost no access to impartial information. However, as more tailings find their way into the sea, a growing body of independent scientific work on the physical and geo-chemical effects of tailings in the marine environment is emerging.

There are at least two reasons that independent scientific research should be encouraged.

1. Firstly, independent studies are increasingly showing that the scientific claims in support of STD, made by the industry and its consultants, are based on inadequate and incomplete information. A review of independent scientific research shows that the more independent information that becomes available, the stronger is the overall scientific argument against STD.
2. Secondly, calling for an independent scientific assessment of a mining company's studies can be a very powerful strategic tool in a community's struggle to stop STD.

Independent scientific data can play a very important role in supporting regulatory authorities who find it hard to turn down a permit for STD, especially in cases where this would mean that a mine cannot go ahead for environmental or financial reasons. The United States Geological Survey (USGS) recently completed an independent study on behalf of the people of Marinduque, who have been demanding that Placer Dome not use STD on their island in the Philippines.

The USGS report outlines the extensive information that must be gathered in order to adequately assess whether STD is an acceptable option.[42] The USGS found that it appeared that Placer Dome had not conducted all necessary studies.[43] In fact, gathering this data would likely prohibit many projects from going ahead as the costs and the time it would take to complete this work would be prohibitive for many mining companies. The USGS concluded that the studies it had been able to review did not provide sufficient evidence that STD would be environmentally safe. In fact, they concluded that: "Due to the substantial amounts of soluble salts in the tailings and the strong ability of chloride in sea water to complex metals from tailings, there is considerable potential that a highly acidic, metal enriched , and environmentally detrimental plume would develop in the ocean around the tailings discharge point during tailings disposal."[44] In January of 2001, just months after the USGS report came out, the Philippine Department of Environment and Natural Resources decided not to give a permit for STD and Placer Dome finally backed away from the plan to use STD.

This case and others indicate that a critical scientific assessment of studies conducted by mining industry consultants will likely show that not all necessary data has been gathered, faulty methodology has been used, contradictory models have been used, and overly optimistic conclusions have been drawn from the available data.[45]

By Catherine Coumans, MiningWatch Canada

Reviewed by John Luick, National Tidal Facility, Australia, The Flinders University of South Australia

1 This is true for the original STD systems that go back to the 1970s, as well as for the most recent systems. It is true for Island Copper, Kitsault, the Black Angel Mine, Misima, Minahasa Raya, and Batu Hijau etc. See, for example, U.S. Department of the Interior "Case Studies of Submarine Tailings Disposal: Volume II- Worldwide Case Histories and Screening Criteria" OFR 37-94, 1994; Golder Associates, 1996. Assessment of Metal Mine Submarine Tailings Discharge to Marine Environments; Review of the Coral Reef and Nearshore Environment, Misima Mine, Papua New Guinea, NSR Consultants, Oct. 1999.

2 Sheaves. M. 2001. *In* Mineral Policy Institute, A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. P.64.

3 http://geology.cr.usgs.gov/pub/open-file-reports/ofr-00-0397/ p.36

4 http://geology.cr.usgs.gov/pub/open-file-reports/ofr-00-0397/ p.36

5 Golder Associates, 1996. Assessment of Metal Mine Submarine Tailings Discharge to Marine Environments. p.43.

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7 NSR Consultants, January 2000. Deep Sea Tailing Placement. . 1.

8 See, for example, the claims made by NSR Consultants, January 2000. Deep Sea Tailing Placement. p. 2.

9 Mineral Policy Institute, February 1999. Environmental Risks Associated with Submarine Tailings Discharge in Astrolabe Bay, Madang Province, Papua New Guinea. p. 5.

10 Luick, J. 2001. *In* Mineral Policy Institute, A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. p. 45.

11 Sheaves, M. 2001. *In* Mineral Policy Institute, A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. p. 75.

12 Sheaves, M. 2001. *In* Mineral Policy Institute, A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. p. 75.

13 NSR Consultants, April 1997. Review of Submarine Tailings Disposal: Misima Mine, Papua New Guinea. p. 10.

14 NSR Consultants, April 1997. Review of Submarine Tailings Disposal: Misima Mine, Papua New Guinea. p.13.

15 Pariwono, John. August 2, 1999. Suara Pembaruam.

16 Luick, J. 2001. *In* Mineral Policy Institute, A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. p. 37.

17 Luick, J. 2001. *In* Mineral Policy Institute, A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. p.40.

18 Luick, J. 2001. *In* Mineral Policy Institute, A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. p. 42.

19 Mineral Policy Institute, February 1999. Environmental Risks Associated with Submarine Tailings Discharge in Astrolabe Bay, Madang Province, Papua New Guinea. p. 8.

20 NSR Consultants, January 2000. Deep Sea Tailing Placement. p. 2.

21 NSR Consultants, April 1997. Review of Submarine Tailings Disposal: Misima Mine, Papua New Guinea. p. 8.

22 NSR Consultants, April 1997. Review of Submarine Tailings Disposal: Misima Mine, Papua New Guinea. p.18.

23 NSR Consultants, April 1997. Review of Submarine Tailings Disposal: Misima Mine, Papua New Guinea. p.21.

24 NSR Consultants, April 1997. Review of Submarine Tailings Disposal: Misima Mine, Papua New Guinea. p.21.

25 Quoted on Jatam Home page: www.jatam.org April 2001.

26 NSR Consultants, January 2000. Deep Sea Tailing Placement. p. 2.

27 Golder Associates, 1996. Assessment of Metal Mine Submarine Tailings Discharge to Marine Environments. p.54.

28 Blanchette, M.C., et al, 2001—A Chemical and Ecotoxicological Assessment of the Impact of Marine Tailings Disposal. Published in Proceedings from the Fort Collins Tailings and Mine Waste conference by Balkema.

29 Brunskill, Gregg J. 2001. *In* Mineral Policy Institute, A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. p. 52.

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31 Brunskill, Gregg J. 2001. *In* Mineral Policy Institute, A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. p. 52.

32 C.P. David, 2000, Tracing a Mine Tailings Spill Using Heavy Metal Concentrations in Coral Growth Bands: Preliminary Results and Interpretation. Coral Reef Symposium Proceedings, Bali, Indonesia.

33 Golder Associates, 1996. Assessment of Metal Mine Submarine Tailings Discharge to Marine Environments. p.54.

34 Sheaves, M. 2001. *In* Mineral Policy Institute, A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. p. 73.

35 NSR Consultants, January 2000. Deep Sea Tailing Placement. p. 3.

36 Luick, J. 2001. *In* Mineral Policy Institute, A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. p. 44.

37 Luick, J. 2001. *In* Mineral Policy Institute, A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. p. 46.

38 Golder Associates, 1996. Assessment of Metal Mine Submarine Tailings Discharge to Marine Environments. p. 106.

39 Golder Associates, 1996. Assessment of Metal Mine Submarine Tailings Discharge to Marine Environments. p. 43.

40 Golder Associates, 1996. Assessment of Metal Mine Submarine Tailings Discharge to Marine Environments. p. 110.

41 Sheaves, M. 2001. *In* Mineral Policy Institute, A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. p. 75.

42 http://geology.cr.usgs.gov/pub/open-file-reports/ofr-00-0397/ p. 34-36.

43 http://geology.cr.usgs.gov/pub/open-file-reports/ofr-00-0397/ p. 36.

44 The USGS report can be found at: http://geology.cr.usgs.gov/pub/open-file-reports/ofr-00-0397/ p. 2.

45 Mineral Policy Institute, 2001. A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. p. 7.

American Legislation Pertaining to STD

STD Effectively Banned in the US

Mining companies often say that STD is legal in the United States. But the way the *Clean Water Act* is written, it effectively rules out STD as an option for **tailings** disposal. Although several companies have applied for exemptions to the regulations**,** no proposed mining companies in the U.S. have ever approved a final plan for submarine tailings disposal. And currently, there are no mines operating in the U.S. using STD.

A statement from the Environmental Protection Agency (EPA)[1] says, "Pursuant to provisions of the Clean Water Act (CWA), discharges of pollutants into waters of the U.S. require a National Pollutant Discharge Elimination System (NPDES) permit. **Effluent** limitation guidelines established under the CWA prohibit the discharge of process water from new mills into waters of the U.S. (including process water contained in tailings). The 'no discharge' effluent limitation guidelines are what effectively prohibits the use of STD."

"No mines in the United States currently use STD, as the practice is prohibited by regulation," says an EPA official.[2]

The Clean Water Act: A Summary

The *Clean Water Act* (CWA) was enacted in 1948 as the *Federal Water Pollution Control Act*. In 1977, the act was renamed the *Clean Water Act* and in 1991 it was reauthorized.[3] It aimed to reduce or eliminate the pollution of interstate waters and tributaries and clean up surface and underground waters. Currently the CWA covers water quality programs, standards and procedures that govern allowable discharges and other aspects of water management.

"The *Clean Water Act* strives to restore and maintain the chemical, physical, and biological integrity of the nation's water. The act sets up a system of water quality standards, discharge limitations, and permits**.**"[4] The CWA aimed to attain a level of water quality that "provides for the protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water" and eventually to eliminate pollutants in navigable waters.

Before discharging substances into U.S. waters, a permit must first be issued through the National Pollution Discharge Elimination System (NPDES), which is run under the EPA. To get the permit, the EPA must be assured that proposed discharge "complies with all applicable effluent limitations and water quality standards."[5] Submarine tailings are comprised of effluent waste water and extraction **reagents** (see: **Introduction**). This process typically contains **suspended solids** in the range of 200,000 to 600,000 mg/l—over 10,000 times the maximum allowed by law.

Further Regulations Relevant to STD

The EPA designs discharge standards based on the best pollution-control technology that exists for each industry. Existing mines are required to conform to best practicable technology (BPT) or best available technology (BAT) as defined by the EPA. In addition, all new mines must conform to the New Source Performance Standards (NSPS), which essentially eliminate discharge altogether.[6]

Discharges that come from a localized source (like a pipe) or "point source discharges," must conform to the stricter of two standards: Technology-based effluent guidelines contained in Code of Federal Regulations Title 40 (*Protection of Environment*) or state-regulated water quality standards.

The total amounts of various substances that may be discharged in effluent are listed within the Code of Federal Regulations, Part 440, known as the *Ore Mining and Dressing Point Source Category, Subpart J.*

To achieve its objectives, the CWA embodies the concept of all discharges into United States waters being unlawful, unless specifically authorized by a permit from the NPDES. The law has civil, criminal, and administrative enforcement provisions—and also "citizen suit enforcement," meaning that community members can file lawsuits against an operation.[7] If granted, "[t]he permit will contain limits on what you can discharge, monitoring and reporting requirements, and other provisions to ensure that the discharge does not hurt water quality or people's health. In essence, the permit translates general requirements of the CWA into specific provisions tailored to the operations of each person discharging pollutants." [8]

By Kevin Dixon, PhD Candidate, Department of South and Southeast Asian Studies, U.C. Berkeley

1 United States Environmental Protection Agency, Region 10, *Final Summary Report of Submarine Tailings Disposal, Submarine Tailings Disposal Studies for the Alaska Juneau Gold Mine Project*, Seattle, Washington, January 22 1999, p. 10.

2 McGrath, Patricia, United States Environmental Protection Agency Region 10. "Discharge Permitting and Environmental Assessment Issues Associated with Submarine Tailings Disposal for the Alaska-Juneau Mine Project," February, 1998, p. 1.

3 United States Bureau of Reclamation, *Federal Water Pollution Control Act of 1948 (Clean Water Act).* Online. www.usbr.gov/laws/cleanwat.html, April 15, 2002.

4 Ibid.

5 Ibid.

6 United States Code of Federal Regulations Title 40, Protection of the Environment, Subchapter N, Part 440: *Effluent Guidelines and Standards, Amendment to Ore Mining and Dressing Point Source Category; Effluent Limitations Guidelines and New Source Performance Standards*; Environmental Protection Agency 40 CFR Part 440. US GPO via GPO Access. Online: http://www.access.gpo.gov/nara/cfr/cfrhtml_00/Title_40/40cfr440_00.html, April 14, 2001.

7 Copeland, Claudia (Specialist in Environmental Policy, Environment and Natural Resources Policy Division, January 20, 1999; made available by The Committee for the National Institute for the Environment). Congressional Research Service Report for Congress: *Clean Water Act: A Summary of the Law*. Online: http://cnie.org/NLE/CRSreports/water/h2o-32.cfm, April 15, 2002.

8 United States Environmental Protection Agency, Office of Wastewater Management. *Permit Issuance Process Frequently Asked Questions*: "What is an NPDES Permit". Online: http://cfpub.epa.gov/npdes/faqs.cfm?program_id=1, April 15, 2002.

Canadian Legislation on Submarine Tailings Disposal

STD Effectively Banned in Canada Since 1977

"Under the Canadian federal Metal Mining Liquid Effluent Regulations (MMLER) coastal metal mine operations are not permitted to discharge **tailings** to submarine receiving environments…."[1] Canada's Fisheries Act contains prohibitions against the destruction of fish habitat under Section 35, while Section 36 contains prohibitions against the release of "deleterious substances," (meaning harmful substances), into "waters frequented by fish" (meaning where fish live).

In 1977, the Metal Mining Liquid Effluent Regulations (MMLER) were enacted under the Fisheries Act and they set limits on the percentage of certain metals allowed in mine **effluent** (liquid waste generated from the mine) dumped into the environment.

These regulations mandate that the amount of **Total Suspended Solids** (TSS) released in mine effluent per month may not exceed an average of 25 milligrams per litre. This effectively prohibits the release of tailings into water "frequented by fish," as tailings usually have a TSS measure of at least 200,000 to 600,000 mg/l.

The Island Copper Mine on Vancouver Island in Canada started dumping its tailings into the sea in 1971, as one of the first STD mines in the world. Because it was already operating when the MMLER regulations were enacted, it fell under conditions set out in MMLER that exempted existing operations from the MMLER requirements. Island Copper was allowed to continue using STD until it closed in 1996.

Even Tougher Regulation Seals STD's Fate

New legislation set to go into effect in 2002, called the Metal Mining Effluent Regulation (MMER), is a modernization and strengthening of the old MMLER regulations. These new regulations uphold and strengthen legislation banning the release of tailings into waters frequented by fish. When they go into effect the allowable limit of TSS will become just 15 milligrams per liter per month.

New MMER legislation makes it even more difficult to get an exemption for STD. In order to get one, a company will have to ask for the MMER regulation itself to be amended, which requires approval from the Governor in Council and Cabinet. Such a request will also trigger the Canadian Environmental Assessment Act and provincial environmental regulations, making a request for an exemption transparent and open to public comment.

The Kitsault Mine: Canada's Only Exception under the old regulations

Under the old MMLER, if a mining company wanted to dump tailings into the sea it had to ask for a unique site-specific exemption from the Fisheries Act and the MMLERs. Only one exemption has ever been given since the MMLERs came into effect in 1977 and that was to the Kitsault Mine, in British Columbia, Canada. The Kitsualt Mine, managed by a subsidiary of Cyprus Amax Metals Company from the US, was exempted and allowed to dump tailings into a marine fjord called Alice Arm.

The Canadian government had to enact special regulations known as the Alice Arm Tailings Deposit Regulations to grant the exemption. The mine only operated between 1981 and 1982, but the exemption caused a national controversy and raised difficulties for the government. Although the mining industry has repeatedly asked for other exceptions to be made, there have been none and as a part of the new MMER legislation, Environment Canada (Canada's Environment Ministry) has formally repealed the Alice Arm Tailings Deposit Regulations.

Environmental Consequences of Kitsault and Island Copper

Both in the case of the Island Copper Mine and the Kitsault Mine, scientific studies have shown that the tailings did not behave as the consultant scientists predicted. Tailings from both mines spread more widely than predicted and moved into shallower and more biologically productive areas. They created more **turbidity** than predicted, driving away mobile species, smothering native species, and creating loss of rare organisms and reduced biodiversity. In the case of Island Copper, studies also show increased bioavailability of metals and bioaccumulation of metals in local biota.[2]

By Catherine Coumans, MiningWatch Canada

[1] Golder Associates Ltd. April 4, 1996. Report on Assessment of Metal Mine Submarine Tailings Discharge to Marine Environments. p. 1.

[2] Golder Associates Ltd. April 4, 1996. Report on Assessment of Metal Mine Submarine Tailings Discharge to Marine Environments. p. 109.

A Look at the Industry

An analysis of Natural Systems Research Consultants[1]

Over a period of 26 years NSR has worked on more than 400 projects. In particular, NSR has carved out a niche working on mining projects involving the dumping of **tailings** into rivers and oceans. Since 1982, NSR has advised companies on 24 ocean disposal projects which have been clustered in nine countries—Indonesia (6), Papua New Guinea (5), New Caledonia (5), the Philippines (3), Chile (1), Fiji (1), the Solomon Islands (1), Cuba (1) and Canada (1).

NSR goes beyond scientific advice to engage in corporate public relations work. In a promotional brochure NSR advertises that it "*provides advocacy support and strategic advice to clients and offers environmental services for the planning and permitting of new resource development projects, principally for the mining and petroleum industries.*" This includes education of stakeholders with an introductory video on DSTP, strategic advice on stakeholder involvement and the negotiation of regulatory/permit conditions. The type of NSR's work can be seen in the following portfolio of recent contracts:

- When BHP was desperately seeking to defeat legal action by PNG landowners over the impact of tailings dumped in the Fly River, NSR was hired to provide assistance.
- NSR advised Placer Pacific on river dumping of tailings in the Strickland River from the Porgera mine in Papua New Guinea.[2]
- When NSR was contracted by Minorco Services to advise on the proposed Weda Bay Nickel Project on Halmahera Island in Indonesia's Maluku province in 1998, it advised on the ocean disposal of mine wastes as well as on "non-technical issues i.e., permitting/public opinion/NGOs."[3]
- When Placer Pacific was seeking Fijian government approval for the Namosi project, NSR was brought in to do presentations on ocean disposal of mine wastes to government officials.[4]
- NSR was also hired in 1999 by the Philippine Department of Environment and Natural Resources to provide advice "to the Mines and Geoscience Bureau on the formulation of a DSTP policy for the Philippines."[5]
- Two years earlier, Western Mining Corporation (WMC) had hired NSR to advise it of the prospects of ocean disposal of mine wastes being used at WMC's controversial Tampakan project and the implications on the 1972 London Dumping Convention.[6]
- In 1998 Rio Tinto hired NSR to evaluate environmental issues in reopening the Bougainville copper mine.[7]

NSR is actively involved in the promotion of STD to the mining industry.

In a letter from the Director of NSR, Stuart Jones, to the Senior Vice President of the giant mining house Anglo American Plc in June 2000, this point is made clear:

"You mentioned that there is resistance to the concept of DSTP [STD] from your CEO. In my experience we find the same reaction in just about every person who has had no prior exposure to the concept. The senior management and the Board of Directors of two of NSR's new clients (Falconbridge and Sherrit International) had similar concerns. The approach adopted in both cases was for NSR to prepare a short briefing paper and then make a detailed presentation to senior management (two hours) and a short presentation to the Board of Directors (one hour). I did the presentation to Sherritt in February this year and both myself and our senior marine biologist (Dr David Gwyther) made the presentations to Falconbridge in March of this year (both in Toronto). We were told that the effect of the presentation was in both cases, that senior management and the Board of Directors felt comfortable with the concept of DSTP and were happy for DSTP to be considered…If you think it would help we would be pleased make a presentation to your CEO on the subject."[8]

It is an issue of legitimate public concern to ensure that scientific consultancy firms engaged to provide analysis in the mining industry continue to maintain an independence and detachment from their clients in the mining industry. It is only when these conditions are met that governments, stakeholders and the community generally can have complete confidence that scientific analysis and reports are provided on a truly independent basis.

Written by Philip Shearman, PhD Candidate

1 See also: *A review of risks presented by the Ramu Nickel Project to the ecology of Astrolabe Bay,* Mineral Policy Institute. pgs. 32—35, 2001.

2 NSR, Mining in High Rainfall Tropical environments: Project Listing, www.nsrenv.com.au, 15 November 1999, page 9.

3 NSR , Mining: Deep Sea Tailing Placement (DSTP) Project Listing, www.nsrenv.com.au, undated

4 NSR, Deep Sea Tailing Placement: Project Listing, op cit, page 1.

5 NSR, Deep Sea Tailing Placement: Project Listing, op cit, page 5.

6 NSR, Deep Sea Tailing Placement: Project Listing, op cit, page 5.

7 Natural Systems Research Environmental Consultants, *Mining in High Rainfall Tropical Environments: Project Listing*, Online: www.nsrnv.co.au, 15 November, 1999, page 9.

8 Letter from Stuart Jones, Director, NSR to Dr John Groom, Senior Vice President, Safety, Health and Environment, Anglo American plc, London, UK; dated 7 June, 2000.

Submarine Tailings Disposal Literature Review

Overview Texts

The following texts provide information about Submarine Tailings Disposal (STD) in general. They provide examples and case studies of particular sites, information about the political, social and environmental context in which STD takes place, and scientific information about STD.

Briefing Document, Environment Canada Meeting on Metal Mine Submarine Tailings Disposal, Briefing Document, 952-1928, Simon Fraser University-Harbour Centre, Vancouver, B.C., March 22nd 1996. *[This is a Canadian government text.]*

Moody, R. Into the Unknown Regions: The Hazards of STD. April 2001. International Books, Utrecht, Netherlands. *[This is an excellent critical overview of the current status of STD, its politics and players.]*

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Proceedings from the International Conference on Submarine Tailings Disposal, April 23-30, 2001, Manado, Indonesia, forthcoming from JATAM, Jakarta, Indonesia. *[This forthcoming volume of proceedings will cover social, scientific, legislative and global political and economic aspects of STD.]*

Salomons, W. and U. Forster (eds). 1988. Chemistry and Biology of Solid Waste, Dredged Material and Mine Tailings. Springer-Verlag, Germany. *[This volume is a frequently referred to source of papers on STD. Some are by authors who also make their living as mining industry consultants on STD, for example, Ellis, D. Case Histories of Coastal and Marine Mines.]*

The Rawson Academy of Aquatic Science, July 21, 1992. A Critical Review of MEND Studies Conducted to 1991 on Subaqueous Disposal of Tailings. *[Some of these studies were conducted by mining industry consultants who make their living preparing studies for STD systems. For example Rescan Environmental Services Ltd.]*

U.S. Department of the Interior 1993. Case Studies of Submarine Tailings Disposal: Volume 1-North American Examples, OFR 89-93. *[This text is a useful overview of STD mines. It has the appearance of being an impartial review, but it has a lot of input from the mining industry and the consultants they hire for STD systems and this is reflected in the text.]*

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Independent Scientific Studies

A major problem at the moment is that there are not enough independent scientific and social studies that have been done on the actual and potential impacts of STD. Most STD studies are still being done by mining industry consultants who are being paid by the industry. Many of these consultants have made careers by promoting STD. These studies are not peer reviewed, they are not always published, and sometimes mining companies refuse to provide them to the public.

The following documents represent some of the important independent studies that do exist. Not surprisingly, they raise numerous serious concerns about the actual and potential physical, biological and chemical effects of STD.

On Island Copper, Canada (closed)

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On Ramu, Papua New Guinea (proposed)

Brunskill, G.J. Critique of geochemical and sedimentation aspects of the Ramu Nickel Joint Venture proposal for deep sea tailings disposal in Astrolabe bey and the Vitiaz Basin, Papua New Guinea. In, Mineral Policy Institute, A review of risks presented by the Ramu Nickel Project to the ecology of Astrolabe Bay, 2001.

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Some Studies by the Mining Industry & their Consultants on STD

There are a handful of consulting firms that conduct the majority of studies on STD on behalf of the mining industry. Among these are: Dames and Moore, Woodward-Clyde, Rescan Consultants Inc., Lorax Environmental Services Ltd., and Natural Systems Research Consultants (NSR). There are also individuals associated with these companies, some of who also hold academic positions at universities, who publish and speak on STD separately from their consulting firms, but who primarily support STD as a technology. These are, for example, Derek Ellis, associated with Rescan, Stuart Jones and David Gwyther, associated with NSR, and Tom Pederson, associated with Lorax.

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** An extended bibliography is available at www.miningwatch.ca and www.moles.org*

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