

Water Management in Mining

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Report

Water management in mining: a selection of case studies

Environment
May 2012





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Foreword



Water is a fundamental resource for life. Whether from groundwater or surface water sources, availability of and access to water that meets quality and quantity requirements, is a critical need across the world. We all share responsibility for meeting this need now and in the future.

In mining, water is used within a broad range of activities including mineral processing, dust suppression, slurry transport, and employee requirements. Over the last several decades, the industry has made much progress in developing close-circuit approaches that maximize water conservation. At the same time, operations are often located in areas where there are not only significant competing municipal, agricultural and industrial demands but also very different perspectives on the role of water culturally and spiritually.

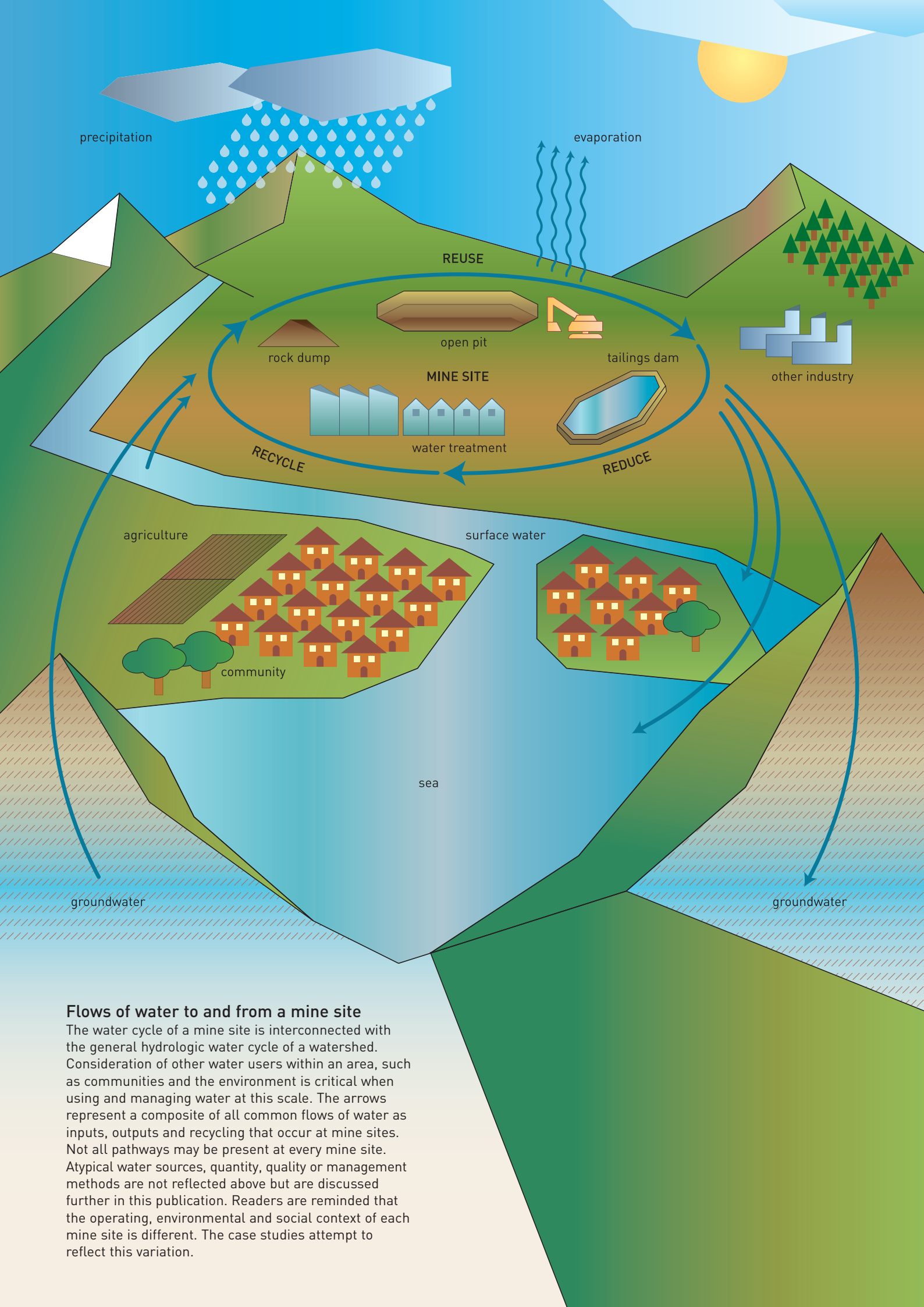
Together, these characteristics lead to tough challenges and there is no simple recipe for water management in mining particularly because the local environments of mines range from extremely low to the highest rainfall areas in the world. Regardless, responsible management of water by mining companies is a key ingredient in ensuring that their contribution to sustainable development is positive over the long term. Not surprisingly, improvement of the industry's water management performance is a high priority for the International Council on Mining and Metals (ICMM).

In 2009, ICMM established a water working group to consider water issues that the sector faces and ways in which the industry can respond. Our members operate in over 62 countries and 800 sites covering many different geographical conditions and remote areas. Each of these sites presents a multitude of water management challenges and opportunities. In the following pages, we feature some examples of how mining companies are managing water responsibly at their operations.

A common theme evident in effective water management is the need for positive and transparent dialogue among the many stakeholders involved. ICMM has compiled this collection of water case studies hoping to promote such dialogue and the sharing of knowledge both within our sector and more broadly with other interested parties. For this reason, we have included contact details in each case study and we invite you to get in touch with the named individuals should you wish to receive more information.

We would welcome your feedback on the publication and look forward to continuing our work to enhance the positive contribution the mining and metals industry can make to good water management.

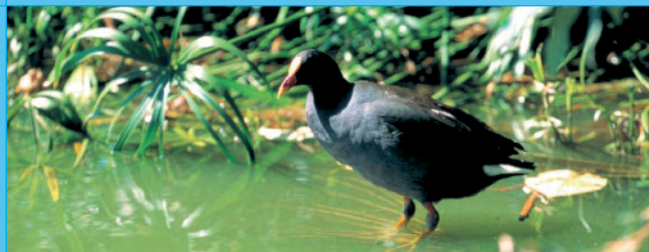
R. Anthony Hodge
President, ICMM



Flows of water to and from a mine site

The water cycle of a mine site is interconnected with the general hydrologic water cycle of a watershed. Consideration of other water users within an area, such as communities and the environment is critical when using and managing water at this scale. The arrows represent a composite of all common flows of water as inputs, outputs and recycling that occur at mine sites. Not all pathways may be present at every mine site. Atypical water sources, quantity, quality or management methods are not reflected above but are discussed further in this publication. Readers are reminded that the operating, environmental and social context of each mine site is different. The case studies attempt to reflect this variation.

Introduction



Water is essential to life on Earth. However, factors such as population growth and economic development mean that its availability is becoming increasingly constrained in many areas. Concomitant with rising concerns about the impact of global climate change and biodiversity loss, the focus on water as a key natural resource has sharpened. Although water issues are important globally, they are first and foremost local issues and always particular to specific areas. Areas where there is not enough water to meet the demand for water are considered to be areas of “water stress”. The availability and demand may be different even within short geographic distances. In 2010, the United Nations declared access to clean water and sanitation a fundamental human right. This illustrates just how important it is to understand the social and human health impacts on people from competing water use in every locality in which a mine operates.

Laws regulating water vary around the world, but it is fair to say that the mining sector can expect to be increasingly required to demonstrate a leadership approach to water use and management. As water plays an essential role in most mining and extractive processes, responsible water use is a critical business issue that affects the ability of individual mines to establish, operate and close.

The mining industry’s use of and impacts on water can result in a range of environmental, social and economic risks. In some cases, perceptions of high water use are sufficient to cause very real tensions and even conflict. Communities close to mine sites may be concerned about availability of water, security of their access to it and, the potential for water contamination. ICMM recognizes that there are many outstanding challenges and that water management needs to continue to improve across the industry.

Now more than ever, special measures are needed to care for and manage this critical resource and to identify options for life-of-mine strategies and initiatives for water conservation and management. The mining sector has developed innovative ways to respond to water issues in differing circumstances and, in some cases, this has illustrated the ability to turn risk into opportunity.

This publication provides a collection of case studies of leading practice on water management by ICMM member companies and other responsible actors in the mining industry. The case studies illustrate a number of innovative approaches to finding sustainable solutions to water issues in this sector. While specific case studies are presented here, many other examples can be found across the sector. These cases are leading the way in helping the mining sector understand and demonstrate responses to changing needs in this area.

A shared resource

Water and the services that it delivers are fundamental for many stakeholders as well as the environment. Water flows across borders and is used by people who may be remote from the immediate source of impact or demand. Understanding and addressing these competing demands is a critical part of water stewardship.

If a mine is regarded by other users as an excessive water consumer or as detrimentally affecting water quality, there can be conflict or discontent. These pressures mean that although governments and local authorities are responsible for the regulation of water, many mining companies consider it necessary to go beyond regulatory compliance, particularly where government capacity is limited. In some instances, however, mining companies have fallen below the level of water management performance that stakeholders expect. Through sharing examples of leading practice, this publication intends to illustrate and support better water management.

Over and above managing impacts, mining companies can actually make a significant positive contribution to the provision of safe, clean and adequate supplies of water to neighbouring communities. For example, eMalahleni Water Reclamation Plant in South Africa (operated by Anglo American in partnership with BHP Billiton) treats the contaminated water from its own and other mining operations and delivers treated water directly into the local municipality’s drinking water system (see case study page 10). This arrangement is a good example of a successful public-private partnership.

The role that companies can play in providing water to local communities, whether by working in partnership with non-governmental organization (NGO) providers or by supplying water directly from their own facilities, has the potential to be significant. Yet making sure that such arrangements are sustainable in the long term needs special attention as mines have a finite life.

Water sourcing

Access to a secure and stable water supply is critical to mining operations. Without water, a mine cannot operate. Water sources often need to be shared by multiple users, while leaving enough water for ecosystem functioning. In most mining operations, water is obtained directly from groundwater, streams, rivers and lakes or through commercial water service suppliers. In many countries, water abstraction is highly regulated, and permits specify the amount of water that may be used. Governments therefore play a key role in determining and allocating water among various users. Potable water supply and types of sensitive agriculture and receiving environments require a higher quality of water than others, which imposes a further consideration in water allocation.

Sometimes mines experience a natural and continuous inflow of water, for example in the pit or underground tunnels, and this water needs to be removed (through pumping) so that access to the mine workings stays open. This is known as dewatering. This water is often either released into a receiving water source (if meeting the regulatory and environmental requirements) or used by the mine or within the operation processes. But dewatering can reduce the levels of groundwater or deplete surface water. There may also be issues surrounding the discharge of this water in terms of how its quality and quantity affect the receiving environment. Some of the impacts of discharged water are covered further in the publication.

The mining industry has found many innovative pathways to avoid competing with other users for water. For instance, mining companies sometimes have the capacity to invest in infrastructure to source water that can be of benefit to other users. Also, the mining industry uses some unconventional water supplies. Mining is one of the few industries that is able to use water for various processes, which is of lower quality than that desirable for human consumption. For example, seawater can be used for mineral processing. Hypersaline groundwater and wastewater from other water disposal routes are also potential sources of water for mining operations. At the Minera Esperanza mine in Chile, untreated seawater is being used to meet mine water requirements (see case study page 12).

Desalination plants built for mines may also be used to supply clean drinking water to local communities that may have limited access to potable water. For example, AREVA's Trekkopje uranium mine in Namibia is the first seawater desalination plant to supply both a mine and the local region with water (see case study page 14).

The Freeport-McMoRan Cerro Verde Mine in Peru is constructing a potable water treatment plant to ensure that the city of Arequipa will have access to clean drinking water. It will also build a wastewater treatment plant to divert and treat the town's sewage to meet water requirements for a mine expansion, should the mine expansion proceed (see case study page 16).

“MINING IS ONE OF THE FEW INDUSTRIES THAT IS ABLE TO USE WATER WHICH IS OF LOWER QUALITY THAN THAT DESIRABLE FOR HUMAN CONSUMPTION.”



Water's role in mining processes

In mining operations, the most important use of water is typically in mineral processing. Water is required in hydrometallurgical processes (for example, to recover gold and copper from a solution of chemicals). Water is also required in pyrometallurgical processes (for example, in platinum and copper production) for cooling and other parts of the process.

Significant amounts of water may also be needed for dust control on haul roads and waste dumps. This water can be lower-quality industrial water or mine water, provided there are no contamination risks. In contrast, high-quality potable water is required for domestic purposes in the office and administration buildings and in camps associated with remote mines.

Using pipelines to transport ore in slurry can reduce both costs and energy demands compared with more conventional transport forms such as rail and trucks. This can make remote deposits economically feasible. The use of pipelines does require significant amounts of water to keep the slurry material in liquid form.

Mines operating in regions with extreme seasonal variations in temperature or rainfall face difficult water management challenges. Where seasonal patterns provide very high rainfall for only one or two months, water must be managed to avoid flooding of operations that could lead to water contamination and potential health and safety issues. In these cases, water storage facilities are often constructed for use during extended dry periods.

In other regions, the form of precipitation and the water that a mine relies on can vary. In areas where permafrost conditions occur or where winters are harsh, water may become frozen and not be readily available for use by the mine. These extremes of temperature can also lead to difficult operating conditions. Water supply systems need to be constructed so that pipelines do not freeze, causing the failure of a critical process, such as dewatering or water supplies to heap leaches.

It is important to fully understand the quantities of water that mines use in their operations as well as discharges to the environment. Water accounting is a reporting mechanism that quantifies the mine's water supply, consumption and discharge. Given the many activity streams within a mine site, it can be a challenge to maintain an accurate understanding of the mine's water use. Therefore, mines rely on developing a water balance to manage water and to achieve a sustainable balance among water supply, consumption, and environmental and operational risks. Many companies integrate water management and accounting with other operating tools. For example, Lonmin is using an integrated water balance model to measure and monitor water flows throughout their Marikana operations. This allows them to optimize the reuse of poor-quality process water.

Among the challenges faced by the mining industry is the need to minimize water losses during processing while maximizing water recycling. Today, it is unusual for a mine not to have the potential to recycle process water, which is retained within the mine's closed cycle and stored either in a tailings facility or a dedicated water storage facility. Concerted efforts to save water in this way can have major benefits. For example, when BHP Billiton initiated a water savings project at its Olympic Dam mine in Australia to reduce the volume of water used in its processes, it achieved significant savings (see case study page 18).

Another effective way to save water is by reducing evaporative losses in hot and dry areas. For example, Xstrata's Lomas Bayas mine in the water-scarce Atacama Desert in Chile, which has annual rainfall of approximately 1 millimetre (mm), took steps to reduce evaporative losses in the heap leaching process (see case study page 20).

In areas of water stress, a reduction in water usage across a mining operation benefits the local community and the site (through reducing costs and improving operational efficiencies). A concerted effort in this regard can achieve significant water use reductions. For example, at its Argyle mine in Western Australia, Rio Tinto has achieved an impressive 95% reduction in water use from the ecologically significant Lake Argyle since 2005 (see case study page 22).

Discharges and potential impacts

The use of water in mining affects not just its availability for other users but also the risk of pollution from the disposal of used water. Therefore, companies invest in ensuring that water is not contaminated or where contamination does occur, they invest in treatment or containment within appropriate reservoirs, pipelines, canals or other storage facilities.

Planned water discharges from mines into the receiving environment are normally carefully monitored and controlled to ensure compliance with regulations and to minimize impact to receiving waters. Discharge of treated process water is routinely monitored and must meet certain quality standards and requirements in terms of temperature, pH and conductivity. Other discharges occur due to normal run-off, extreme storm events and discharge from surplus dewatering where water may be contained and discharged appropriately.

In addition to planned discharges, there can sometimes be undesired but anticipated discharges into the receiving environment: e.g. seepage or leakage from storage lagoons, tailings dams and waste dumps; spillage of chemicals and fuels; and other loss of containment due to natural events such as earthquakes or high rainfall events. Any of these occurrences must be controlled to avoid any significant impact on the environment. A lack of management of these events could result in unacceptable consequences.

Some of the industry's most negative impacts have come from unplanned events that resulted in water-related incidents. In 2000, the Baia Mare spill into the Danube River in Romania led to significant downstream fish kills. In South Africa, rising water tables in former mining areas currently threaten to acidify rivers and streams in the Witwatersrand Basin. Elsewhere, seepage of contaminated waters from tailings impoundments and waste facilities are a concern among neighbouring communities and farmers. Technology, regulation, voluntary industry initiatives and best practice guidance exist to reduce risks of such events through good design and management. For example, the International Cyanide Management Code is now widely implemented across the mining sector.

Every case differs, but where water contamination has been a problem, water treatment solutions have sometimes been required. These solutions may need to be implemented long after a mine has closed. In some cases, specific ore types being mined interact with oxygen and water to form acid rock drainage (ARD), a process which can persist long after mine closure and may require on-going management and treatment. ARD management practices have developed a great deal and are being championed by groups such as the International Network for Acid Prevention (INAP). Mining companies now design operations to minimize ARD impacts. However, there are many old sites where water treatment is required. JX Nippon's Toyoha mine in Japan and Barrick's Homestake mine in the United States of America are examples of on-going water treatment and reclamation projects to prevent long-term water issues (see case studies pages 24 and 26).

Local communities will have concerns about the impacts from mine operations and this is exacerbated where communications and engagement processes by the operation are not adequate. To address this, AngloGold Ashanti's Cerro Vanguardia mine in Argentina established a structured stakeholder engagement program, including participation of the community in environmental monitoring (see case study page 28).

**“ENGAGEMENT WITH
STAKEHOLDERS IS
ESSENTIAL.”**



Looking forward

Population growth, continued economic development and climate change are all factors that will drive water stress to increase in some parts of the world. This means demand for water will exceed availability or may further impact on the quality of existing resources. Awareness of this trend has resulted in increased attention to this issue by national and local governments, international organizations and civil society. Leading companies in the mining sector have anticipated this trend and a large body of research is now informing their pragmatic responses. These responses include improved performance in water management through increased efficiency, technological innovation, and sharing of good practice. It is vital that the industry continues to engage effectively with others on sustainable water management and understands the value of water to all users and the environment.

In the future, it is expected that the following issues will increasingly affect the way mining companies respond to issues related to water:

Water accounting

A consistent approach to water accounting across the mining industry – including both quality and quantity – is a first step to understanding a company's needs and its water footprint. For example, in Australia which has many areas prone to significant water stress, the Water Working Group of the Minerals Council of Australia worked collaboratively with the University of Queensland's Sustainable Minerals Institute to develop a single set of water metrics for the Australian mining industry to enable consistent reporting, benchmarking and the identification of opportunities to improve water management.

Value of water

The value of water will be affected by many factors, including pricing policies, water treatment costs and more broadly the social and environmental value put on water. Furthermore, the increasing interest in an "ecosystem services" approach is highlighting the relationship between industrial activity, such as mining, and the "provisioning services" of the environment, such as the water on which the productivity of ecosystems depend. Also, the monetary value of water will continue to rise and will become a growing consideration in financial planning and feasibility studies for mining operations.

Technological innovation

Technology will continue to be developed to find innovative solutions to the challenges of obtaining water, reducing demand on water for mining processes and designing more efficient and effective means of water management and treatment. This publication presents some examples of current innovative practice throughout the mining life cycle. Many companies are committed to technological research, innovation and development to increase business efficiency and good water practice.

Stakeholder engagement

It is through stakeholder engagement that the mining industry engages in constructive dialogue with others on responsible water management to learn from other perspectives and to contribute to the debate. Engagement with stakeholders is essential to reach consensus and agreement on the many water issues that affect the mining sector and the communities in which it operates. Such engagement provides a means for the sector to contribute to discussions on developing regulations and standards and provides mining companies with the information needed to operate in ways consistent with the human right to clean water. The industry's engagement needs to be undertaken at global, regional and operational levels to ensure that it is a constructive voice in the emerging policy debate.

Anglo American eMalahleni Water Reclamation Plant Republic of South Africa

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Anglo American's eMalahleni Water
Reclamation Plant
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WATER MANAGEMENT OVERVIEW

Anglo American's group-wide water strategy is guided by four principal concerns: water efficiency, water security, water risk and liability, and stakeholder engagement. This strategy is underpinned by a group policy and range of standards. Water standards are specifically divided into focus areas that relate to the range of life cycle stages of any operation.

Anglo American operations have developed site-level water action plans (WAPs). WAPs take local catchment priorities into account and help operations to implement Anglo American policies and water-related standards within the local context. WAPs apply to all stages of the mining cycle and reinforce the need for efficient water management through avoiding, minimizing, reusing and recycling water.

A key feature of WAPs is the importance of continuous stakeholder engagement within the water management program. In this way, WAPs provide links with other operational plans, including community development, social investment and biodiversity programs.

Anglo American's current targets in water management relate to water use efficiency and further development and implementation of standards and guidelines.

Background

The Witbank coalfields, located around the city of eMalahleni, in the northeast of South Africa, contain numerous mines, some of which have reached the end of their working life and others of which are still operating. Anglo American's Thermal Coal workings in the area contain approximately 140,000 megalitres (ML) of ingress groundwater – a figure that is estimated to be rising by over 25ML per day (ML/d). This ingress poses serious challenges to active mines, but more so in closed mines, where without adequate management and resources it can cause the dissolution of metals and salts, leading to contamination of groundwater and, ultimately, surface water.

The region surrounding eMalahleni is in fact a water-stressed area. Long-term climatic modelling indicates that there is a potential for further stress through reduction in annual rainfall. Rainfall events, when they do occur, are also expected to become more severe and to happen over short time periods, introducing short-term flooding risks. As a result, changes in design for water management are required in order to ensure adequate storage for long-term drought or stress periods, where demand exceeds supply and for release in the event of high amounts of rain.

The city of eMalahleni already struggles to meet the water demands of its rapidly expanding population. It is licensed to remove 75ML/d from the local Witbank Dam, but it currently abstracts approximately 120ML/d, with predictions of this increasing to 180ML/d by 2030 to meet increasing needs.

Anglo American's Thermal Coal has invested a decade of research and development into mine water treatment technology. BHP Billiton worked with Anglo American through a joint investigation agreement to commission the eMalahleni Water Reclamation Plant (EWRP) in 2007. The plant was set to treat the water from three Anglo American Thermal Coal operations, and BHP Billiton procured a "right-of-use" of the EWRP to treat water from its South Witbank Colliery on the basis of shared operating costs (the EWRP, however, remains wholly owned and operated by Anglo American). In addition, Anglo American has put in place infrastructure and agreements with the city of eMalahleni to deliver treated water from the plant into the local municipality's drinking water system.



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The EWRP currently treats around 30ML of water a day, providing a safe and secure water source. Some of this treated water is used directly in Anglo American mining operations, but the majority is for social use and meets 12% of eMalahleni's daily water needs. By the end of 2011, the plant had treated 30 billion litres of contaminated mine water and supplied 22 billion litres to eMalahleni Local Municipality. In July 2011, the company approved further investment to increase the treatment capacity to 50ML/d. This second phase is expected to be operational before the end of 2013.

A next phase of the EWRP has been designed to manage both water from Anglo American operations and water from other third-party-owned coal mines, some of which have already reached the end of their operational life cycles.

Stakeholder engagement

During establishment of the EWRP, relevant stakeholders in the regulatory process, at the regional and national levels, were identified and proactively engaged through a pre-consultation process. The consultations considered and discussed regional water challenges and the potential for Anglo American to contribute to long-term solutions. These consultations identified that mine water remediation was fundamental to satisfy the sustainability requirements of the Department of Minerals and Energy (DME), the water security requirements of the community by the Department of Water Affairs (DWA) and the requirements of the Department of Environmental Affairs and Tourism (DEAT) for water to replenish the ecological reserve. To meet these needs, the project integrated the mine water management of several operations with community drinking water resources. Typically, this level of integration is not a legal requirement considered by either the DMR or the DWA.

Through this pre-consultation process, an integrated regulatory process (IRP) was agreed and adopted to manage approvals for the project. The IRP provided a structured approach to identify all critical activities and any dependencies between these activities. An Authorities Steering Committee (ASC), chaired by a member elected by the regulators, was also formed to drive the IRP to facilitate structured engagement with the regulators and to provide a platform to build solid relationships between stakeholders. Nominated representatives from the DWA, DEAT, DME and eMalahleni Local Municipality sat on the ASC. In this way, DME, DWA and DEAT approvals were gained with the support of the municipality, community forums, water usage

agencies and other existing forums. The elevated public profile of the project, through substantial exposure in the local press, also aided the process of obtaining approvals and ensuring good interaction and public participation.

It was anticipated that community acceptance of potable water produced from polluted mine water would be a challenge. However, residents in eMalahleni welcomed the idea of additional water from the mining operations, particularly as there was already a perception of poor quality and unreliable availability from the existing municipal water supply. Nevertheless, a campaign to explain water quality issues was also developed through a public participation process, and water from a demonstration plant was distributed to residents for "taste testing".

Improved relationships have been fostered between Anglo American and eMalahleni Local Municipality through partnering on technical papers and presentations given to professional and scientific bodies and participation at celebratory functions and awards (such as the climate change treaty's Conference of the Parties in Durban in 2011).

Indirectly, a number of other stakeholders in the NGO sector also participated on the project. They registered as interested and affected parties via the public participation process for the environmental authorization application, integrated water use licence and environmental management plan. Where NGOs raised specific problems, Anglo American engaged on an individual basis to address these concerns.

Going forwards, an Operations Liaison Committee has been established with all stakeholders to evaluate performance against targets and planned production. The meetings provide a platform to manage water supply contracts and service-level agreements between stakeholders and to keep the policy of open engagement around this facility and its on-going supply of water for society. This project illustrates how technology has been used to provide a common solution, by addressing mine closure water quality issues and providing water security to operating facilities and the community now and in the long-term.

Minera Esperanza

Minera Esperanza Antofagasta

Chile

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The beginning of the water pumping cycle in the pier sector
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WATER MANAGEMENT OVERVIEW

Minera Esperanza is part of the Antofagasta Minerals group and is guided by group policies and systems for water management. These require efficient and responsible use of water.

Minera Esperanza has a social and environmental strategy built around a set of principles that define how the business generates economic, social and environmental value. Supported by a set of key performance indicators, it covers sustainability priorities and serves as a guide for ensuring long-term sustainable growth.

Background

Minera Esperanza's operation is located 180km from the city of Antofagasta in the Sierra Gorda district in northern Chile. The copper-gold project is a joint venture between Antofagasta Minerals (70%) and Marubeni Corporation (30%). During the first 10 years of operations, Minera Esperanza is expected to produce on average approximately 190,000 tonnes a year of payable copper in concentrate and 230,000 ounces of payable gold. The life of the mine is anticipated to be 15–20 years.

Copper concentrate containing gold and silver by-products is processed by a conventional milling and flotation process. The process plant capacity is approximately 97,000 tonnes of ore per day, with tailings being disposed of in an innovative thickened-tailings facility. The mine, which is located in an area of the Atacama Desert, one of the driest places in the world, requires approximately 20 million cubic metres (Mm³) of water a year to operate. Securing a long-term supply of useable water and optimizing the use of that water in the processes was important for the mine development. Thus, the use of seawater solves one of the major constraints for mine development in the north of Chile: access to water resources.

“THE USE OF SEAWATER
SOLVES ONE OF THE
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IN THE NORTH OF CHILE:
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Use of untreated seawater

To meet the water demands of the mine, the processing plant was designed to use untreated seawater. Studies were carried out in laboratory conditions and then through a pilot project to determine optimum operating conditions for the primary flotation process using seawater. Once the process was proved, a supply pipe network was constructed to transport seawater 145km from the Pacific coast to the mine site.

The seawater intake is located at Caleta Michilla in Mejillones at the site of Minera Esperanza's port facilities. At the beginning of the water pumping cycle, the seawater is conditioned by filtering to remove suspended solids, and a corrosion inhibitor reagent is added to ensure a longer working life of the pipelines. The seawater is then transported to the mine via a pipeline that climbs 2,300 metres (m) and passes through four intermediate pumping stations to reach the concentrator plant. The power consumption of the pumping system is on the order of 20 megawatt-hours, which comes from the regional electric grid.

The greatest demand for seawater in the operation is the concentrator plant, which requires around 600 litres per second (L/s) of the total mine consumption of approximately 630 L/s. Some processes both at the port facility and at the mine site require fresh water for drinking, sanitation, cooling and concentrate washing. This is obtained from seawater desalination plants using reverse osmosis at both locations. This accounts for approximately 8% of the total seawater usage.

Thickened tailings

This technology thickens tailings using high-torque thickeners that produce up to 67% solids. The thickened tailings are pumped through a pipeline system that distributes it in sectors inside the tailings deposit. Once the mix is solidified, it is possible to continue depositing more tailings in the same area.

Stakeholder engagement

From an early design stage, Minera Esperanza considered the expectations of surrounding communities. To do this, the company developed a community relations plan that focused on its areas of influence – namely Sierra Gorda, Baquedano, Mejillones and Caleta Michilla.

The plan follows the sustainability principles of Antofagasta Minerals, Minera Esperanza's parent holding, which calls for consideration of people, the environment and applicable legal regulations.

Minera Esperanza chose to recruit a significant part of its staff from neighbouring communities. Therefore, a major feature of the community plan was a program to enhance the job skills (both for construction and mine workers) of the residents of the Antofagasta Region, particularly those living closer to Minera Esperanza's facilities. The challenge was to train people with no previous mining experience and in some cases no work experience at all.

Almost 1,500 local people have received training supported by Minera Esperanza. This includes 500 people who participated in foundation courses for mine operators and mine plant maintenance between 2009 and 2011; today, 370 local people are employees of the company. In its drive to provide equal opportunities, Minera Esperanza focused on attracting women to participate in the scheme. In 2010, Minera Esperanza had 12% women workers, compared with a country average for the mining industry of 6%.

As part of its priority to maintain respect and mutual trust with its neighbours, Minera Esperanza began a cycle of workshops named *Mi Vida, Mi Esperanza* (My life, my hope) in 2008. This initiative facilitates social dialogue and addresses local social issues such as sexual responsibility and the prevention and management of alcoholism and drug addiction. The company also supports initiatives on education in road safety.

AREVA

Trekkopje uranium mine

Namibia

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View of Erondo Desalination Plant in the Namib Desert

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WATER MANAGEMENT OVERVIEW

AREVA has made a commitment to minimize its environmental footprint and to reduce water consumption. The strategy for water is to develop programs to meet the following objectives:

- work towards a global target of the AREVA group to reduce overall water consumption by 35% (from 2008 levels) by improving water efficiency at all operations
- implement water standards for each operation that set the minimum expectations when managing water
- characterize surface and groundwater resource availability, quality, use and sustainability
- identify and estimate present and future water use by area and types of user groups
- make recommendations for the sustainable use of water resources and make eco-design studies to reduce water needs for new projects.

AREVA mining sites are often located in areas where access to drinking water is a major issue; therefore, the company's approach to water management takes into account local social, regulatory and economic issues. At water-stress sites this has been done through establishment of interdisciplinary water committees.

Background

The Trekkopje uranium mine is located approximately 65km northeast of Swakopmund in western Namibia. The mining licence was obtained from the Namibian government in 2008, and the mine is currently entering its final phase of construction. The mine will be one of the largest in Southern Africa and the 10th largest in the world. The estimated mine life is 12 years.

The Trekkopje ore body covers a surface area of approximately 42 square kilometres, with the main ore-bearing content being present within the upper 15m of the deposit. The mine will be an open cast operation. Once the ore is extracted it will be crushed and processed using alkali heap leaching. Both mining and the processing technique require significant volumes of high-quality water, 14 million cubic metres per annum (Mm³/a), in a water-scarce area.

During exploration and the pilot testing phases at the mine site, water was supplied by the national water supplier, NamWater, from aquifers along the coast. Yield from these aquifers is limited, and regulation restricts the amount of water that may be extracted. Groundwater on the mine site itself is saline and used mainly for dust suppression. Neither seawater nor saline groundwater can be used directly in ore processing, as chlorides present in the saline water would disrupt the ion exchange process used in heap leaching.

Because the freshwater aquifers do not yield sufficient water to supply all of the mines and communities in the area, it was apparent that another solution had to be developed. Seawater desalination was the only clear option, and AREVA constructed a desalination plant, the first one for the country, to meet the water needs of the mine.

The Erongo Desalination Plant (EDP) was built between 2009 and 2010 on the Namibian coast approximately 50km from the mine and was officially inaugurated on 16 April 2010. Desalinated water is obtained by a combination of a reverse osmosis process and extreme filtration. A pipeline network and system of booster pumps transports the desalinated water to the mine. Along this pipeline, an electrical line of 132 kilovolts was built to feed the plant.



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The EDP is capable of producing 20Mm³/a of water (the mine requires only 70% of the total capacity). The excess water is enough to meet nearly half the water requirements of the Erongo Region. This estimate includes the needs of other industrial sites as well as communities. AREVA and NamWater are developing an agreement on how to manage the distribution of this water. A connection will be built between the desalination plant pipeline and NamWater's pipeline. NamWater can decide which source to use depending on the status of its water-well field and users' consumption demand. The two water types will be mixed in reservoirs prior to distribution.

AREVA has also succeeded in reducing its expected annual water consumption requirement to 14Mm³ from an original prediction of 20Mm³. This was achieved primarily by building a small on-site water treatment plant and developing infrastructure so that water can be reused.

An environmental and social impact assessment (ESIA) was prepared as part of the planning and design process prior to construction of the EDP. Monitoring that started as part of the ESIA continues in order to assess the environmental impact of the plant. At a minimum of 30 years, the expected operational life of the plant is longer than the planned life of the mine. NamWater will take over the plant as part of the mine closure plan.

Stakeholder engagement

Stakeholder engagement and public participation were a focus of the early stages of the ESIA. The objectives of the public participation were to:

- identify and address concerns, issues and questions of interested and affected parties
- provide information to stakeholders on the project on an on-going basis
- identify opportunities, issues, constraints and alternatives
- identify additional interested and affected parties
- ensure and facilitate opportunities for affected communities and marginalized groups to discuss their concerns
- obtain, verify and update relevant data
- provide feedback on the findings of the assessment and request comments on the findings.

Prior to the distribution of the draft ESIA for public review, the engagement process included two focus group meetings, a public meeting, one-on-one meetings with government officials and specialists, a presentation to a joint ministerial management committee meeting, the production and circulation of a third-party public information document and an announcement of the ESIA, calling for comments and issues to be submitted.

A three-week period for public review was set aside, and interested and affected parties commented on the draft ESIA report. At the same time, the report was reviewed by an independent ESIA reviewer. Public meetings were held in Swakopmund and Windhoek to obtain feedback from the public. Written comments from experts were also received. The final report addressed all issues raised both at the public meetings and in written submissions, including specialist study reports.

The Wlotzkasbaken Residents Association (WRA) was initially opposed to the location of the plant near their holiday resort due to concerns of noise pollution (especially during construction) and changes to the character of the area. The plant buildings were designed to fit into the landscape, and the desalination plant supplier ensured low noise levels outside the plant. The seawater intake contractor communicated closely with the WRA and informed it in advance about noisy events such as blasting.

Ecologists were concerned about the impact of the plant and pipeline on the Wlotzkasbaken lichen field, which has a globally unique species richness and density. An 8km section of the pipeline route was therefore shifted south to avoid crossing the lichen field. The pipeline now forms the southern boundary of the lichen field and prevents access. During construction of this pipeline, all contractors were informed about the importance of the area, and off-road driving in the area was banned to prevent dust and vehicle damage to the lichen. AREVA has also constructed an information centre about the desalination plant and the importance of lichen fields and has built a cable fence to protect the other three sides of the main field.

Freeport-McMoRan Copper & Gold

Sociedad Minera Cerro Verde copper mine

Peru

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Construction in process at the Arequipa water treatment plant funded by Cerro Verde

WATER MANAGEMENT OVERVIEW

Freeport-McMoRan Copper & Gold uses a formal management system to identify material sustainability issues at its operations. Through this process, both the certainty and the quality of water sources are identified as key sustainability challenges for Freeport-McMoRan business.

Freeport-McMoRan takes a long-term view on securing water supplies to address changing user patterns, multiple source options and synergies with local community needs over time. Part of this strategy requires a review of water management practices to determine if opportunities exist to optimize current water use. To facilitate this review, Freeport-McMoRan established a multi-disciplined task force to monitor regulatory and business issues associated with water, as well as to evaluate and propose options to address water management and conservation.

The Freeport-McMoRan Water Management and Conservation Task Force developed an initial company-wide program that requires improved measurements, water balance modelling and prioritization of water management projects. All active Freeport-McMoRan operations are required to design and implement a water management/conservation plan. In 2010, the Cerro Verde operation was selected by the task force as a pilot project to develop standards for company-wide implementation.

Background

The Cerro Verde operation is an open pit copper and molybdenum mining complex located approximately 20 miles southwest of Arequipa in Peru. Freeport-McMoRan Copper & Gold, through its predecessor companies, began operating Cerro Verde in 1994. The mining operation is conducted in two pits; the Cerro Verde pit is now approximately 330m deep, and the Santa Rosa pit currently has a depth of 150m. Cerro Verde is planning a large-scale expansion to its operations that would triple the capacity of its concentrator and extend the lifetime of the solvent extraction and electrowinning facilities. The expansion, if implemented, will require access to additional water supplies.

In Arequipa Province, access to clean water is a major challenge due to population growth and limited water resources associated with the arid environment. The main source of water in the region is precipitation in the Rio Chili watershed high in the Andes, and seven dams and reservoirs have been developed to use this water resource. The Rio Chili meets the drinking water needs of Arequipa, as well as the needs of agriculture, industry and mining. The Cerro Verde operation uses surface water from the Rio Chili as its primary supply for current operations.

Development of clean water solutions through stakeholder engagement

In 2005, after consultation with the local communities as part of Cerro Verde's sustainable development program, Freeport-McMoRan identified clean water as the area's most important need. Currently, there is insufficient wastewater treatment capacity in Arequipa Province, and the Rio Chili has become contaminated because of untreated residential and industrial sewage discharges to the river. These discharges also affect water quality in agricultural areas downstream of the city of Arequipa. Treating this wastewater for use at the expanded Cerro Verde operations would be a long-term source of treated water for mining operations. It would also improve the river's water quality, enhance agriculture products grown in the area and reduce water-borne illnesses. Furthermore, the reuse of effluent is being promoted by the Peruvian government as a sustainable water supply for the mining sector.



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In 2006, following discussions with the regional and local governments, civil leaders and development agencies, Freeport-McMoRan committed to support the costs for new potable water and wastewater treatment plants to serve the Arequipa population. According to agreements with the government of Peru, the mayors in the Arequipa Region and community leaders, the total costs of building the two plants are to be shared equally by Cerro Verde and the municipalities. These facilities would supply clean drinking water to the population and would also allow wastewater generated by the population to be treated to reduce the environmental and human health impacts of dumping untreated water into the Rio Chili. Cerro Verde's support for the water and wastewater treatment facilities is aligned with its efforts to assist with the social needs of communities near the mine. None of the potable water generated by the water treatment plant is intended for use in Cerro Verde's mining operations.

Potable water treatment plant for Arequipa

Between 2007 and 2008, an engineering feasibility study was undertaken by Cerro Verde to determine the most sustainable options for constructing the new potable water treatment facility. The study determined that the facility could be built using a modular system, which would allow expansion of the plant over 30 years as the population grows. In early 2010, the process of designing and commissioning the potable water treatment plant was initiated, with construction beginning later that year. At the end of 2011, construction was 98% complete. In addition, an agreement has been reached with the Peruvian government for development of a water storage and distribution network in the city of Arequipa, which is being financed by the Cerro Verde Association. The association manages Cerro Verde's voluntary contributions made for projects in Arequipa that focus on education and training, health, cultural preservation, basic infrastructure and sustainable development, among others. The project was about 70% complete at the end of 2011 and is expected to be completed in 2012.

Wastewater treatment plant for Arequipa – Cerro Verde expansion

During 2011, Cerro Verde conducted feasibility studies to evaluate the possibility of constructing a wastewater treatment plant. This plant would treat wastewater from the city of Arequipa and deliver 1 cubic metre per second of the treated water to the mine to support the expanded mining operations.

Discussions have taken place between Cerro Verde and the Regional Government of Arequipa, the national government, SEDAPAR (the local utility) and other local institutions to allow Cerro Verde to finance the engineering and construction of this treatment plant should the mine expansion proceed. The plant would be operated by SEDAPAR and would improve the water quality of the Rio Chili and provide a clean supply of water for the agricultural sector in the region.

On-going stakeholder engagement

Cerro Verde's key stakeholders for the potable water and wastewater treatment plants fall into two main groups: those in areas of direct influence (defined, among other factors, as having some form of environmental impact from the mining operations – currently the districts of Uchumayo, Tiabaya, Yarabamba and Ilay, amounting to approximately 55,000 inhabitants) and those in areas of indirect influence (all the other districts of the province of Arequipa, amounting to approximately 900,000 inhabitants).

Cerro Verde operates a community relations program that works with municipalities and social leaders. Using the results of its social baseline studies, Cerro Verde has been able to define the primary social problems in the areas of influence, which, in addition to water quality, were identified as insufficient employment and educational opportunities.

BHP Billiton Olympic Dam Australia

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Olympic Dam in South Australia is a multi-mineral orebody producing copper, gold, silver and uranium
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WATER MANAGEMENT OVERVIEW

BHP Billiton policies and strategies include considering strategic water planning, improving operational performance through effective water management, identifying conservation opportunities and promoting industry projects.

In accordance with its environment group-level document, BHP Billiton is implementing water management plans at all of its operations, including controls to mitigate the impacts of water use and discharge.

BHP Billiton focuses on addressing water stress and quality, which allows the company to reduce use of water that is most likely to compete with human or environmental needs. Material sites are identified where high-quality water use exceeds, or is anticipated to exceed, 3,000 megalitres per annum for an operation or project or where water management may be a material risk issue. Water reduction cost curves are developed at the most material sites, which help the company to identify opportunities, including water substitution and water stewardship.

BHP Billiton has an aggregate group target of a 10% improvement in the ratio of water recycled/reused to high-quality water consumed from a base year of 2006/7.

Background

Located 560km north of Adelaide, South Australia, Olympic Dam is the world's fourth largest remaining copper and gold resource and the largest uranium resource. It also contains significant quantities of silver. Olympic Dam is Australia's largest underground mine. The ore body was discovered in 1975 and went into production in 1988. The operation comprises a fully vertically integrated underground mine and metallurgical complex of milling, flotation, leaching, smelting, electro refining and solvent extraction.

All water used at Olympic Dam is sourced from the Great Artesian Basin (GAB), one of the largest groundwater aquifers in the world. Abstraction of water from this source must not affect the groundwater boreholes of other land users or GAB natural springs. These springs feature nationally and internationally recognized rare or endangered species such as the salt pipewort, the thick-billed grasswren, plains rats and the banded stilt.

“BHP BILLITON
CONTRIBUTED TO
THE GREAT ARTESIAN
BASIN SUSTAINABILITY
INITIATIVE (GABSI), A
PROGRAM INITIATED
BY THE AUSTRALIAN
GOVERNMENT TO
HELP LANDHOLDERS
REHABILITATE
FLOWING BORES.”



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The water savings project

BHP Billiton operates a water savings project to reduce the volume of water used at the Olympic Dam site. The project has been developed to reduce the consumption of GAB water by optimizing water recovery and recycling and by substituting poor-quality local groundwater in some areas.

Initially, several projects were implemented to improve understanding of the GAB. These projects included reinterpreting existing data to assess how water transmits to the GAB's springs. Supporting these projects were water conservation and recycling activities designed to improve water use efficiency. Activities included replacing high-quality water with hypersaline groundwater for dust suppression on roads, implementing a lockout system for water valves to ensure water is recycled from storage ponds and implementing advanced process controls to reduce water losses to tailings dams that store waste. Additional projects have been implemented to monitor and preserve natural spring flows along the margin of the GAB that are hosts to unique ecological communities, including installing four new monitoring bores with solar-powered measuring instruments. Collectively, the initiatives resulted in an improvement in industrial water efficiency of 15% between July 2004 and June 2009, from 1.27 kilolitres to 1.07 kilolitres per tonne of material milled.

In 2011, the Olympic Dam team undertook a water use reduction cost curve process that identified additional GAB water reduction opportunities; these include covering open site water storages to eliminate evaporation, increasing the volume of wastewater reused in the metallurgical plant and replacing more high-quality water with hypersaline groundwater in the mine vehicle wheel wash. The total additional reduction in GAB water use expected from all reduction opportunities is 450 megalitres per year, or 0.04 kilolitres per tonne of material milled.

BHP Billiton has also undertaken projects that result in direct water savings within the GAB. Between 2000 and 2004, AUS\$2.2 million was contributed to the Great Artesian Basin Sustainability Initiative (GABSI), a program initiated by the Australian Government to help landholders rehabilitate flowing bores and replace open bore drains with piped delivery networks. This has resulted in savings of around 37 megalitres per day since 2004 in the vicinity of the Olympic Dam wellfields. In 2009 BHP Billiton purchased two pastoral properties in the north of the wellfield area and shut down several free-flowing bores, resulting in further savings of around 5 megalitres per day.

Stakeholder engagement

By continuing to identify opportunities to minimize water use, Olympic Dam is contributing to the sustainability of the GAB in South Australia and the ability of future generations and the environment to obtain groundwater from it. The use of water at the site is communicated to the local community through a key performance indicator board near the site entrance that shows daily water demand. In addition, articles are produced for local newspapers that aim at informing the community about the GAB and the use of water at the Olympic Dam site.

Xstrata Copper

Lomas Bayas mine

Chile

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Installation of drip irrigation system for leach pads in Lomas Bayas
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WATER MANAGEMENT OVERVIEW

Xstrata's endorsement of the UN CEO Water Mandate reflects the priority the company places on water conservation and management. Xstrata's operations aim to be as efficient as possible in their water use and to avoid any negative impacts on water quality in the environments in which they operate.

As water availability varies considerably between the regions in which Xstrata operates, its commodity businesses work on a regional basis with local communities, authorities and agricultural and other industry users to develop and implement water management plans that ensure the sustainable and equitable management of water resources between stakeholders in the catchment area.

Xstrata aims progressively to increase the amount of water recycled and reused within its operations, and in water-scarce regions sites are required to implement water conservation plans, set water intensity targets and implement water efficiency measures.

Background

Xstrata Copper's Lomas Bayas copper mine is located 120km northeast of the port of Antofagasta in the San Cristobel mountains of the Atacama Desert. The Lomas Bayas open pit copper mine uses heap leach pads and electrowinning recovery processes to produce copper cathodes (99.99% refined copper). The copper cathodes are then transported by trucks to Antofagasta Port for shipment to overseas customers.

As the mine is located in a desert environment with very low annual rainfall of approximately 1mm, access to and management of water is a major issue in the region and a key operational focus for the mine.

Due to the unavailability of water close to the mine, water is sourced from the Loa River in the municipality of Calama, approximately 100km northeast of the Lomas Bayas operations. Efficient water use is thus essential to avoid potential negative impacts on the environment and local communities that also rely on this water source. Xstrata Copper has therefore investigated how the mine water supply can be managed more effectively to allow expansion activities without sourcing greater quantities of fresh water.

In 2009, Xstrata Copper undertook a detailed study in collaboration with the University of Antofagasta, the Northern Catholic University and two research centres based in Antofagasta. The aim of the study was to identify and evaluate the areas within the operation that consumed the largest percentage of water, including water losses due to evaporation.



Aerial View of Lomas Bayas leach pads
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Focus on reducing water evaporation

Water evaporation from the mine's solution ponds and leach pads were identified as critical areas, contributing to more than 40% of the total water lost on-site. As such, these areas became the main focus for the site's water efficiency project.

The most water-intensive of these processes is the Lomas Bayas heap leaching operation, where mildly acidic solution is sprayed over crushed ore to leach out the copper. Key areas of evaporative water loss were found to be associated with the sprinkler distribution system and the irrigated areas of the leach pads. Following engineering feasibility studies, the existing sprinkler system was replaced with a more advanced and water-efficient drip-feed system. Impermeable plastic covers were also installed over the areas of the leach pads being irrigated to reduce evaporation. By taking these steps, Lomas Bayas reduced the evaporation rate in the leaching process by approximately 54% – from 9.8 to 4.5 litres of water per square metre per day.

These improvements allowed Lomas Bayas to increase the area irrigated with leaching solutions by almost 70% – from 540,000m² in 2008 to 916,000m² in 2011 – enabling the mine to expand production without placing additional stress on local water resources.

Stakeholder dialogue roundtables

In 2009, Lomas Bayas established a dialogue roundtable involving senior management representatives and local stakeholders, including farmers operating in the Calama catchment area, the community of Baquedano (the one closest to the mine) and other communities within the Loa River catchment area. Through these discussions, Lomas Bayas has been able to identify the needs and concerns of its stakeholders and keep them informed on the initiatives being implemented at the site to improve water efficiency. Following an evaluation of the dialogue process in 2010, individual meetings were held with each stakeholder group due to differing priorities and interests.

The roundtables consist of three distinct phases, the first of which involves the participation of the local stakeholders in identifying risks and opportunities relating to the sustainable and equitable management of water resources in the catchment area. In the second phase, stakeholders are engaged to co-design solutions for the identified risks and opportunities. During the final phase, roundtable stakeholders evaluate the effectiveness of the initiatives implemented to ensure that the original risks and opportunities have been successfully mitigated or pursued. This process is facilitated and evaluated by an independent third party selected by both groups to ensure transparency.

Through the dialogue roundtables, Lomas Bayas has been able to work with local stakeholders to improve water management and agricultural activities in the Calama catchment area. A wide range of initiatives has been implemented, including legal support to help local farmers formalize their water rights in accordance with Chilean regulatory requirements, annual clearing of irrigation canals, installation of potable water systems for local families and the installation of treatment systems to remove naturally occurring heavy metals from water used for irrigation.

“THROUGH THE DIALOGUE
ROUNDTABLES, LOMAS
BAYAS HAS BEEN ABLE
TO WORK WITH LOCAL
STAKEHOLDERS TO
IMPROVE WATER
MANAGEMENT AND
AGRICULTURAL ACTIVITIES
IN THE CALAMA
CATCHMENT AREA.”

Rio Tinto

Argyle Diamond Mine

Western Australia



Lake Argyle, Western Australia
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WATER MANAGEMENT OVERVIEW

The Rio Tinto water strategy takes a long-term view on water in terms of social, environmental and economic values. The strategy has three key elements: improving water performance, understanding the value of water and engaging with stakeholders.

Each of Rio Tinto's operations implements the water strategy in its own way, reflecting local and regional water risks.

To support improved performance, Rio Tinto developed a water standard in 2003 that sets out minimum expectations for water management at each of its operations. To meet this water standard, each operation is required to develop a water balance and water management plan, employ skilled personnel to deal with the different aspects of water management and design appropriate water infrastructure that reflects leading practice. Rio Tinto uses a "catchment approach" to water management, which considers all water flows and uses for the areas surrounding an operation. Rio Tinto has a group-wide water efficiency target of 6% reduction in fresh water used per tonne of product between 2008 and 2013, which each operation is required to contribute to and support.

Background

Argyle Diamond Mine is located in northwest Australia in the Kimberley region, which is remote, arid and hot – with temperatures reaching 40°C in the wet season and with an annual rainfall of 750mm. The mine lease area is located in the traditional country of the Miriwung, Gidja, Malgnin and Woolah peoples.

The mine is the world's largest single producer of diamonds, producing approximately 30 million carats each year – one-fifth of the world's natural diamond production. Production began in 1985 with an open pit operation. With the planned development of an underground mine in 2013, the life of the mine has been extended to at least 2019.

Water is a sensitive issue at the Argyle mine, both in terms of a limited supply and the impact the operation could have on local groundwater. The water for the mine is sourced from the Gap Dam, Jacko's Dam and Lake Argyle. Lake Argyle is a Ramsar-protected wetland site and the mine has been working to reduce and eventually eliminate its use of water from this source in its routine operations.

Argyle Diamond mine's water management activities focus on monitoring potential impacts on groundwater, engaging stakeholders and managing water use.

“BY INTRODUCING THESE CHANGES TO WATER USAGE IN THE MINE, ARGYLE HAS ACHIEVED A 95% DROP IN WATER TAKEN FROM LAKE ARGYLE SINCE 2005.”



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Water usage, reduction and recycling

Argyle Diamond Mine used more than 3,500 megalitres from Lake Argyle to run its operations in 2005. The mine has set a target of reducing this use to zero in its operations. There will be an on-going requirement to draw water from Lake Argyle for the testing of the mine's pipeline in the future, but this will be minimal.

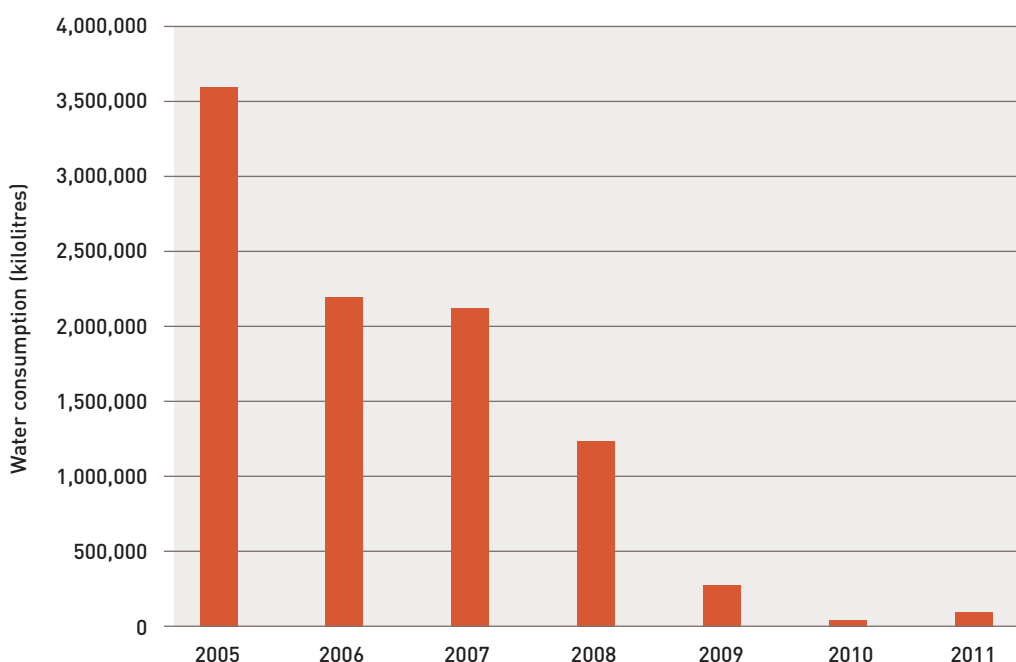
The biggest user of water at the site is the processing plant, where water is needed to wash and separate the diamonds. Instead of being discharged to the environment, since 2005 this water has been captured and recycled back through the processing plant, achieving a recycling rate of almost 40%. Water seepage from tailings is also captured and recycled for use in the process. Dewatering of the underground mine and from the surface pit operation provides additional water that is collected and stored in the two dams for drinking and operational use.

By introducing these changes to water usage in the mine, Argyle has achieved a 95% drop in water taken from Lake Argyle since 2005, and by 2009 the use of water from the lake was reduced to 300 megalitres.

Stakeholder engagement

The key stakeholders for Argyle around water management are Traditional Owners. There is an on-going liaison with these Traditional Owners, with much of the discussion being around ensuring sites of cultural significance are not affected by changes in water flow or quality. Argyle monitors a number of important traditional cultural sites that are water-dependent and are located within the lease area. In the early 1990s, mining operations had an impact on one of the springs that was of concern to Traditional Owners. Subsequently, a resolution was reached on the issues. Inspections of the operations are now carried out to provide assurance to Traditional Owners that water efficiency and water quality at the site are being maintained. Engagement with government stakeholders has a major focus on ensuring compliance with regulations and licences.

Lake Argyle water consumption



JX Nippon Mining & Metals

Toyoha mine

Japan

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Interior of Oshidori Water Treatment Plant
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JX Nippon Mining and Metals

WATER MANAGEMENT OVERVIEW

JX Nippon Mining & Metals policy on water management is embodied in its basic environmental policy, which requires:

- promotion of technology development that will improve productivity of resources and materials
- active engagement in environmental conservation
- elimination of waste in operations
- enhancement of employees' awareness of environmental conservation
- disclosure of information.

JX Nippon Mining & Metals has developed voluntary standards to monitor water emissions, and it conducts internal and external audits at each operating site.

Background

The Toyoha mine is located 40km southwest of Sapporo, Hokkaido, Japan. The mine mainly worked the Tajima, Izumo, Soya and Shinano mineral veins associated with an active hydrothermal system (where hot water has passed through the earth's crust and deposited minerals). Some areas of the workings reached rock temperatures of more than 160°C. The mine produced zinc, lead, silver and indium from 1914 and until recently was the world's largest indium producer (30 tonnes per year). In March 2006, the mine closed; surface restoration is due to be completed in 2014.

The mining operation left a legacy of closed underground openings and tailings dam facilities that could potentially generate metals that contain acidic wastewater.

Wastewater is permanently processed under regulatory requirements to prevent water contamination of the surrounding rivers. The treated water is discharged into the nearby Shirai River, which flows into the Toyohira River. Toyohira River water is subsequently used for the Sapporo city water supply, so plant integrity and reliability are essential. Mine closure is regulated under mining law by the national government authority. The mine water discharge treatment point is located upstream of a municipal drinking water treatment plant, however, additional criteria for discharge were stipulated by the municipal office.

“MONITORING RESULTS
ARE SHARED WITH ALL
STAKEHOLDERS TO INDICATE
THE CONCENTRATION OF
ORGANIC COMPOUNDS
IN WATER SAMPLES AND
BRIEFING SESSIONS
WITH LOCAL RESIDENTS
ARE HELD TO EXPLAIN
RESULTS IF REQUIRED.”



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Effluent treatment facilities

The wastewater processing facility is provided by two effluent treatment plants constructed at the Toyoha mine. The first started operating in October 2008 to treat the permeated wastewater from the tailings dam; the second started operating in October 2011 for the water from the underground mine. The water is treated using a high-density sludge formation system that neutralizes lime, using recycled sludge.

These facilities were designed and constructed in close cooperation with the Hokkaido government's Industrial Safety and Inspection Department and Sapporo City. The main features of these facilities are as follows:

- All facilities are set indoors so that they can operate throughout the year, in particular during the winter months, when there is heavy snow. Temperatures in the region regularly reach 10°C–20°C below zero with over 6m of snow between December and March.
- The pipes between the tailing storage facilities and the treatment plant are contained within a concrete culvert to prevent leakage of wastewater.
- The two treatment plants are equipped with a standby power generator to ensure continuity of operation in the event of a power cut. Emergency wastewater storage tanks below ground are also provided to ensure containment in the event of a plant malfunction.
- Under ordinary conditions, only one treatment line operates in each plant. However, both facilities are equipped with a duplicate treatment line. This allows additional wastewater to be treated when the volume flows are high and ensures continuous operation in the event that one of the two treatment lines malfunctions.

During a one-year test run, the facility for the permeated wastewater from the tailings dam produced high-quality processed water to the specification set by Sapporo City environmental pollution control.

JX Nippon Mining & Metals routinely monitors water discharge in accordance with laws, regulations and other ordinances, as well as voluntary standards, to ensure that safe standards of water are maintained. Concentrations of manganese, zinc and other heavy metals are monitored. Levels of manganese and zinc are less than 7 ppm and 3 ppm, respectively, at the Sapporo municipal office compliance point.

Stakeholder engagement

JX Nippon Mining & Metals liaised with the Sapporo Environmental Preservation and Pollution Control Department and the Sapporo Water Supply Department of the Sapporo municipal office throughout the process of designing and constructing the water treatment plants. At the completion ceremony, various key stakeholders, including governmental officers, local community representatives and members of academia were invited, and the company explained the design and operation of the wastewater treatment facilities. A guided tour of the facilities was held in December 2011.

As part of their continuing commitment to stakeholder engagement, JX Nippon Mining & Metals issues performance and monitoring results to all stakeholders to indicate the concentration of organic compounds in water samples and provides briefing sessions with local residents to explain results if required.



Exterior view of Oshidori Water Treatment Plant
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Barrick

Homestake mine

United States of America

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Reclaimed mine process plant area, which is currently being used as city's historical interpretive park
Copyright © 2012 Barrick

WATER MANAGEMENT OVERVIEW

The Barrick environmental policy and the Water Conservation Standard aim to protect natural water resources and manage physical, social/regulatory and reputational risks. The policy outlines a commitment to pollution prevention, safeguarding the environment, educating employees and communities about environmental commitments and applying proven management practices to prevent or mitigate negative environmental impacts.

In 2008, Barrick introduced a new global Water Conservation Standard to increase focus on responsible water use. Building on the company's existing monitoring programs, the standard has established water conservation criteria and regular management review procedures for sites. The standard recognizes that water management activities need to be site-specific. At a minimum, the standard requires operations to conduct risk assessments related to water; to implement systematic monitoring programs of water supply, storage, usage and discharge; to develop and maintain site-wide water balances; and to institute water conservation programs that address significant risks at all stages of the mine life cycle.

Background

The Homestake mine is located in the northern Black Hills near the city of Lead, South Dakota. The mine has been operational since 1876, with Barrick acquiring the site in 2001 when it purchased the Homestake Mining Company that historically operated the site. Over the life of the mine, more than 1,250 metric tonnes of gold was produced. The majority of mining was from underground methods, but starting in the early 1980s a significant open pit was developed in the area of the original discovery. With the long history of the mine, processing included various methods, including gravity concentration, amalgamation and cyanidation. This resulted in processing facilities occurring over a large area. When the mine closed in 2001, it consisted of an extensive mine with between 300 and 400 miles of underground workings, a single open pit, three waste rock facilities, a tailings disposal facility, a mill site, a gold refinery and numerous other facilities and historical structures.

Reclamation began in 2000 and is continuing through the present time. The western portion of South Dakota, where the Homestake mine is located, is a semi-arid environment where high-quality water is at a premium. Water has therefore been a key focus in the closure and post-closure reclamation strategies. Since the mine closure, Barrick has completed several rehabilitation endeavours and invested over US\$100 million on local sustainable development and reclamation. These projects have included closure of more than 200 historical mine sites, reclamation of the underground mine, reclamation of the former mill site, closure of three solid waste landfills, reclamation of three waste rock facilities, construction of two water treatment plants (along with the associated collections systems, pipelines, storage ponds and discharge structures) and continuing reclamation of the tailings storage.

The reclamation has had four key water management goals:

- 1. The rehabilitation of historical waste rock facilities and ancillary mine facilities to improve water management.** Initial reclamation concentrated on the removal of affected materials from the former mill site, to allow natural precipitation onto the site to flow to the surrounding streams without water diversion or treatment. Subsequent reclamation of the waste rock facilities has concentrated on the establishment of vegetation to minimize sediment transport into streams, thereby protecting water quality. Finally, regrading of the waste rock facilities has restored over 500 metres of streams that now flow in open channels and serve as wildlife habitats.



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2. **The development of a network of capture systems to collect all seepage while diverting clean surface water into surrounding streams.** This work had two phases. First, storm water diversion structures were built on the waste rock facilities to minimize the amount of precipitation seeping into the water rock facilities while protecting the surrounding environment due to excessive sedimentation. Second, multiple collection systems were built to capture seepage and surface drainage and pump it to the site water treatment plant.
3. **The management and treatment of collected affected seepage to ensure discharged water meets water quality standards.** Homestake undertook a multiple-year study to determine the most effective way to manage and treat this affected seepage. A water treatment plant, using reverse osmosis and the biological reduction of selenium to less soluble state, was constructed and integrated within the seepage collection system. Water quality monitoring in nearby streams is demonstrating that all water quality standards are met and that the receiving waters are being protected as cold-water fisheries.
4. **The maintenance of freshwater collection systems from the area's natural springs, which supply process and potable water to surrounding communities.** During early operation of the mine, Homestake developed an extensive system to collect water from a number of the area's natural springs. This freshwater collection system supplied process water and potable water to the surrounding communities. Due to the arid nature of the area, access to a high-quality water source increases the incentive for development in the area. Homestake worked with the surrounding communities and the Lead-Deadwood Sanitary District for the transfer of this historic water-gathering system to these entities. The excess water formerly used by the milling process can now be used by the district and be sold to surrounding housing developments as an additional source of income.

The results of pursuing these goals have been the expansion of local cold-water fisheries and the associated wildlife habitat, sustainable high water quality in surrounding streams, a clean water supply system and the long-term economic development of the area.

Stakeholder engagement

The main stakeholders involved in this project have been the state of South Dakota, the Lead-Deadwood Sanitary District and the cities of Lead and Deadwood. Numerous meetings and discussions were held with each of these entities to ensure that the goals of the reclamation plan met the stated objectives. The collaboration with the Lead-Deadwood Sanitary District aimed to ensure that the operation of the water-gathering system could be done economically, while collaborations with the state of South Dakota were primarily focused on guaranteeing that all water quality standards would be met. The state of South Dakota was kept informed of all test work prior to the development of the innovative water treatment system. Collaboration with the cities of Lead and Deadwood has concentrated on future economic development opportunities. This has included conversion of the underground mine into the deepest underground science facility in the world, which has become a hub of groundbreaking scientific research. Barrick also worked with local stakeholders on conversion of one of the former process buildings into a gaming, entertainment and hotel facility and on donation of the Homestake mine records, along with financial contributions, to establish a research centre for the preservation of the local history and mining heritage for future generations.

“THE EXCESS WATER FORMERLY USED BY THE MILLING PROCESS CAN NOW BE USED BY THE DISTRICT AND BE SOLD TO SURROUNDING HOUSING DEVELOPMENTS AS AN ADDITIONAL SOURCE OF INCOME.”



Collection of a groundwater sample adjacent to the CVSA Tailings Storage facility by members of the community
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WATER MANAGEMENT OVERVIEW

Water is one of AngloGold Ashanti's sustainability focus areas and is covered in the AngloGold Ashanti overarching environmental policy. While AngloGold Ashanti's commitments to water performance and security are derived at the corporate level, individual operations are required to develop site-based targets and action plans to manage their unique water challenges.

The AngloGold Ashanti Water Management Standard sets out good practice requirements for monitoring and managing surface and groundwater quality as well as its consumption. These management plans seek to embed integrated water management at all sites in a systematic manner, and since the standard's launch in 2009, operations have been working to address deficiencies in specified requirements. Internal reviews of compliance with this and other approved standards are carried out under the Community and Environment Review Program.

Background

Cerro Vanguardia S.A. (CVSA) is the biggest gold and silver mine in size and production in the Patagonia region of Argentina. It is situated in the region of the Deseado Massif, 200m above sea level and 150km northwest of Puerto San Julián in the province of Santa Cruz. The site includes an extensive area of quartz veins, located in a sequence of volcanic rocks.

The exploration at CVSA began in 1990, when mining was relatively unknown in Argentina. There were concerns in the local community regarding potential pollution from the mining operations, and CVSA recognized a need to improve and develop its engagement process. The mine therefore implemented an open-door policy with the local community to improve dialogue and to share information. Surveys are now conducted each year by external consultants to obtain the views of the community and to assess their level of acceptance of CVSA. In 2009 and 2010, the surveys concluded that CVSA was accepted by 54% of the community; in 2011, this increased to 71%.

Environmental monitoring program

The operation includes a tailings storage facility (TSF), where the processed mine residue is continually deposited in a slurry form containing water and tailings/residue. The slurry separates in the TSF, and the water, which has traces of residual cyanide, is continually reclaimed for reuse in the gold recovery process. CVSA recycles and reuses up to 95% of its cyanide through a Cyanisorb plant before it goes to the TSF. There is a residual risk of seepage of water into the soils and groundwater system beneath the TSF that needs to be prevented and continuously monitored.

The TSF is surrounded by a network of monitoring wells from which water samples are obtained and analysed for quality in order to verify if the tailings from the process are affecting the groundwater. The monitoring has been carried out since the commencement of mining to provide baseline groundwater data against which potential impact can be assessed. The on-going routine groundwater monitoring is essential in enabling CVSA to assess its impact on the water environment against the baseline conditions. The monitoring program assesses the presence of heavy metals and cyanides and includes analysis of the physical and chemical characteristics of the water, verifying that the parameters



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are within the limits prescribed by law in Argentina. Samples are collected and stored under carefully controlled conditions and sent to a certified external laboratory for analysis.

Monitoring of the groundwater wells immediately adjacent to the TSF shows consistent results below the analytical instrument's detection limit of 0.02 milligrams per litre of cyanide. Results are reviewed by the company on an on-going basis, shared with the authorities during official inspections and reported annually to the provincial ministry of mining.

The results of the analysis are used to assess if the preventive measures are effective and to provide management with an early warning of any potential problem so that appropriate corrective and mitigating actions can be taken. In 2003, this routine water monitoring identified an isolated peak in cyanide levels in one borehole in the TSF. Tailings discharge to the area was immediately stopped, and investigations were begun to identify the source of the cyanide leak to groundwater. The investigations included the installation of additional monitoring wells and geophysical studies. These studies identified a quartz vein in the bedrock that was acting as a conduit, allowing cyanide to enter the groundwater. A major earthworks operation was started to expose the vein under the tailings dam and cover it with a thick high-density polyethylene (HDPE) liner to prevent the downwards seepage of water. This HDPE liner was two layers thick, with a series of electronic sensors installed between the layers to detect seeps through the liners. On-going monitoring of groundwater undertaken since the HDPE was installed indicates that the liner is successfully preventing further ingress of cyanide into groundwater.

“TRANSPARENCY IS GUARANTEED TO SUCH AN EXTENT THAT IN SOME CASES THE PARTICIPANTS TRAVEL WITH THE SAMPLES TO BUENOS AIRES TO DELIVER THEM TO THE LABORATORY.”

Community participation

Engagement between CVSA and the community was limited until 2008, and CVSA recognized the need for improvement. In an effort to overcome this, the company decided to transform its relationships with the community, implementing a new open-door program called “Puertas Abiertas”. Under the new program, community members were invited to become more acquainted with the mine. CVSA's operational procedures, environmental monitoring program and safety management programs were communicated through this program of engagement.

In 2009, a participatory environmental monitoring program was established, in which the community was invited to become involved in monitoring to verify that the groundwater quality around the TSF remains safe. The invitations were publicized through advertisements on radio, television and newspapers. Students, teachers, public institutions, centres that bring together retired people and the media were also invited to participate. Volunteers are given introductory training to explain the objective and method for monitoring, and they can then participate in the monthly sampling that is carried out jointly with the environmental staff of CVSA. Questions and concerns are answered before and during the field activities. Transparency is guaranteed to such an extent that in some cases the participants travel with the samples to Buenos Aires to deliver them to the laboratory.

The results of the monitoring and laboratory analysis are sent to the Rural Society of Puerto San Julián, giving the public access to them. Frequent meetings are held between CVSA and the community at which the results are presented and explained, and the community is invited to participate in on-going discussions and consultation.

Community participation in the monitoring process has led to a greater transparency of CVSA's operations and has provided community confidence in CVSA applying appropriate controls to prevent pollution. By being able to demonstrate the application of higher standards than those required by law and a compliance with the International Cyanide Management Code and the ISO 14001 standard, the company has benefited from this community interaction by a positive change of perception towards the mining industry in general and towards CVSA in particular.

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Page 7 – Sampling of groundwater emanating into the Potrero open pit which is located nearby the CVSA Tailings Storage facility by a community member *Copyright © 2012 AngloGold Ashanti*

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