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WSP Environment & Energy

MANAGING THE RISKS OF MINING AND MINERAL PROCESSING WASTE

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Managing the risks of Mining and Mineral Processing Waste

Catastrophic failures of mining waste ponds capture headlines, and rightfully so. The environmental risks of managing wastes from mining and mineral processing can have costly consequences to corporate reputations, business assets, insurance claims and future policies, and shareholder value.

Mine waste failures have occurred for decades; from Buffalo Creek in 1972 to Hungary in 2010. The types of failures witnessed recently in Hungary and Tennessee threaten lives and the environment while costing billions in property damage. While not as newsworthy, failures of all scale occur all too frequently at these facilities, affecting smaller numbers of people and a smaller portion of the environment, but are no less devastating to those involved.

These risks can be reduced, and in some cases eliminated, using prudent planning, design, operations, and transfer agreements.

Environmental risks from Mining and Mineral Processing Wastes

Environmental risks associated with mining and mineral processing sites range from the headline grabbing catastrophic failures to more routine and systematic failures associated with the design and operation of the facilities.

Catastrophic failures

On October 4, 2010, the western dam of a sludge reservoir belonging to the privately owned company Magyar Aluminum ZRt (Hungarian Aluminum Co) ruptured, releasing approximately 1.5 million cubic yards of "red sludge" and water that inundated 15 square miles. Aquatic life in the streams and rivers near the release was eliminated, the impact to the Danube River from the failure was measured up to 45 miles away, and 7 people were killed. This was avoidable. Leaks in the earthen dams are apparent on satellite photographs taken months and even years before the release occurred; failure to detect seepage during routine inspections or to understand the cause and potential impact of seepage may have contributed to the catastrophe.

In December 2008, a retaining wall at the Tennessee Valley Authority's (TVA) Kingston, Tennessee coal-fired power plant collapsed, allowing approximately 5.4 million cubic yards of fly ash to flow across hundreds of acres near the confluence of the Emory and Clinch Rivers. Homes were destroyed as the fly ash slurry flowed downstream and eventually made its way to the Emory River channel. The root cause of the spill was a very complex set of site conditions that included the presence of a layer of ash and silt at the foundation of the impoundment, a high water content of the fly ash slurry, and the advancement of berms over the wet ash.

A combination of design, construction, and operational factors that could have been understood appears to have led to the failure. The cleanup plan is expected to take about four years at an estimated cost of $268 million, not including work already completed during the time-critical phase when recovered ash was taken to an offsite landfill for disposal, the legal fees, claims and the damage to the TVAs reputation.

Notably, every one of these facilities complied with the legal design requirements and had been "inspected" shortly before failure. Impoundments such as these are the largest man-made structures built in the world and are typical throughout the mining and mineral processing industry. The incremental cost of a comprehensive analysis, site investigations, engineering and operations is a fraction of a percent of the cost of a single failure. Inspections by professionals intimately familiar with the design is however very different than a site walk by people with a checklist.

Environmental contamination

The impact of mining on its surroundings is not always as acute as the catastrophic events, but the long-term effects of wind and water erosion, chemical and acidic drainage, and releases to groundwater can be nearly as crippling to the environment. Mining and minerals processing waste disposal facilities have design lives measured in decades. After closure they will be there forever. The facilities are largely unlined and built on land that may have been previously mined, or used for processing facilities. Huge quantities of water are used to transport the wastes/by-products to the facility. The water is recycled, discharged, trapped within the waste matrix, or seeps into the underlying groundwater systems. Under properly designed conditions, the management of the water poses no significant risk to the environment.

An ongoing example of the impact from these facilities is the mining of Rare Earths[1] in China. In recent months, the press has spotlighted China's state-run and black market Rare Earth mining industry, reporting both the vital nature of these elements and the environmental devastation that exploration and extraction can cause. These impacts include toxic wastelands, lakes of tailings including the world's largest in terms of square mileage, and destruction to soils and vegetation[2]. These unfortunate results of the high-tech mineral rush serve as another reminder of the risks that the mining industry must manage as part of the cost of responsible business operations.

Managing Risks

In light of these cautionary tales, the planning and design of waste impoundment construction should be viewed as the first and best opportunity to manage the risks of failure and environmental contamination. Risk management decisions should be inherent in each stage of the process:

- Site assessment
- Engineering and design
- Site preparation and construction
- Operations & maintenance
- Closure

Site assessment

Site assessment can be routine and provide basic information at a minimum cost or can be designed to provide the geotechnical and environmental data needed to assess the risk posed by the impoundment to property, humans, and the environment for a slightly higher incremental cost. It should be fundamental to the selection of the site for a waste management facility.

Geotechnical investigation provides the data needed to perform the engineering analysis of the impoundment foundation, earthen materials proposed for berm construction, and tailings or other waste to be placed in the impoundment.

Attention to the environmental as well as the geotechnical mechanisms from the initial site investigations can provide opportunities to minimize risk early and at a fraction of the cost required after design or construction.

Engineering and design

The design of any waste management impoundment requires an expert level understanding of geotechnical engineering and hydrology to provide an appropriate factor of safety against typical failure modes. These facilities combine the complexity of dam design with the risks associated with geochemical impacts. There are a myriad of texts and requirements that define the minimum requirements for engineering of these structures. In addition to geotechnical and hydrologic expertise, today's impoundment design also requires an expert level understanding of geochemistry, material sciences, hydrogeology, and hydraulics to reduce environmental risk. These skills are critical in order to understand and reduce the potential for environmental impact during operation and over the years following closure.

Site preparation and construction

Site investigations using test pits and borings allow the engineers to see small examples of what exists at a site. During site preparation, the whole surface of the foundation is often exposed for a period of time. This is the best opportunity to identify unique features that could lead to failure. No company should waste this opportunity by relegating the site preparation oversight to a third party inspector or contractor. The designer knows what was assumed and will recognize variations better than anyone else.

The construction of these facilities often occurs over decades. Many of these facilities use the wastes and by-products in their construction. This is an efficient use of natural resources, but also means that the people who design the facility, the people who first construct the initial impoundments and the knowledge they hold may be long gone before the facility reaches its ultimate capacity. Interestingly, the examples given of catastrophic failures occurred late in the lives of the operating facilities. Recognizing this provides an understanding of how the facility must be designed and how the operating and construction specifications and manuals must tie together.

Operations and maintenance

The operating period of an impoundment is the time of greatest risk of catastrophic failure, and therefore presents the greatest opportunity for risk management. It is the understanding of the interrelationship of the environment, impounding structure(s), and the surrounding environment that provides the basis for controlling risk.

A properly prepared and implemented operations manual will provide guidelines for operation, maintenance, inspection, response to inspection findings, environmental performance monitoring, and training of new personnel. The operations manual cannot be an afterthought, something the designer pulls together after the budget is expended. It must demonstrate the degree of due diligence the owner/operator intends to follow, and reassure regulators that fundamental practices are in place. As may have been the case in Hungary, an inspection is not sufficient unless it is performed by personnel familiar with failure modes and who understand the signs of potential failure.

An understanding of closure liabilities may present opportunities to reduce the risk or liability of closure during operations. For example, an impoundment will continue to produce water or leachate for many years after closure, often requiring management of water after opportunities for recycling to the mineral processing operations. Phosphogypsum stacks may take 20 years or longer to drain. By recognizing the long term risk, steps can be taken to accelerate the dewatering process and thereby accelerate the strength gain that comes from dewatering and reduce the water treatment requirements after closure.

Closure

Once an impoundment has reached its operating life the risk of catastrophic failure may begin to decline but the risk of environmental liability is at its highest. These facilities will last forever. Natural processes; erosion, both by wind and water, runoff to surface water bodies, and seepage to groundwater and surface water begin before the closure is complete and also act on the closed facility forever. Using sustainable techniques, the closure can be designed and implemented to minimize the risk of environmental contamination.

WSP and waste management

WSP Environment & Energy is an environmental consulting firm that has earned its position as a leading environmental, health, and safety services organization by providing business and industry with creative environmental solutions of the highest quality that address the most fundamental needs of any business, the bottom line.

Our objectives are straightforward: identify the problem and resolve it so that clients can focus on their businesses. It is that focus on the business aspects affecting our clients that has made us a leading private-industry focused consulting firm. We are constantly looking at the process required to extinguish or minimize risk while recognizing the cost of achieving that goal can be controlled.

We help our clients manage the remnants of past mineral and metals mining activities by providing the following services related to management of mining wastes:

- Environmental Site Assessments
- Natural Resource Damages Assessments
- Ecological and Human Health Risk Assessments
- Regulatory Compliance and Permitting Services
- Environmental Management Plans and Programs
- Engineering and Design
- Reclamation, Rehabilitation and Closure Services
- Information Management
- Environmental Liability Solutions

WSP's understanding of the entire life cycle of a waste management facility can result in providing expert advice on all aspects of risk management, investigation, design, construction and closure to minimize the cost of a facility; the true cost of the entire life cycle.

We have been retained by PRP Groups to perform remedial design and remediation such as the lead mining area reclamation project at the Cherokee County Superfund Site in Kansas. We are the site remediation manager for investigation and remediation of the Coronet Industries Superfund Site, a former phosphate mining site in Florida, and are providing soil and groundwater characterization and closure planning for phosphoric acid production facilities in Idaho.

Notes:

[1]Rare Earths are the seventeen metals fueling the growth of green technologies such as batteries for hybrid cars; lightweight, malleable elements with high electrical conductivities, properties imperative to high-demand industries. An estimated $1 billion in goods sold in the US in 2010 contained Rare Earths, nearly all of which were mined in China.

[2]One estimate from China states that for every pound of rare earth minerals which are produced, one square foot of vegetation and 1.5 square feet of soil will be sterilized.

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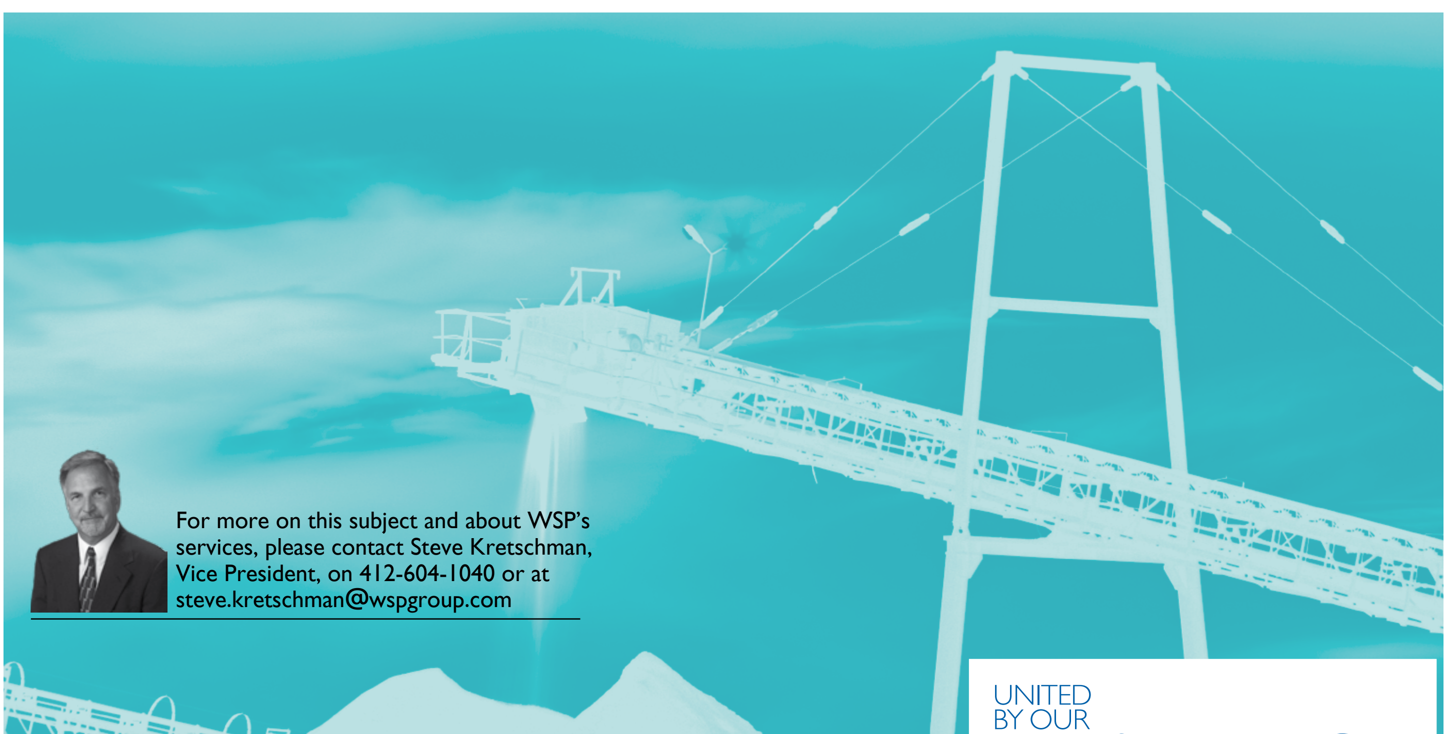

For more on this subject and about WSP's services, please contact Steve Kretschman, Vice President, on 412-604-1040 or at steve.kretschman@wspgroup.com

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