As a contributor to the economic, social, and environmental future of the Salt Lake Valley, we are committed to integrating sustainable development into everything we do.

Our Approach
At Kennecott Utah Copper, sustainable development is integral to our success as a producer of copper cathode, molybdenum, gold, silver, and sulfuric acid, and to the social and financial investment we have made in our stakeholders and surrounding communities.

Consistent with our sustainable development principles, safety remains one of our core values. We are committed to continually improving health and safety performance in our operations. Currently, our safety record is almost three times better than the industry average, and we aim to continually improve this record with the ultimate goal of achieving a sustained zero incident workplace.

This Sulfuric Acid Environmental Profile is intended to summarize the results of the Life Cycle Assessment of the sulfuric acid originating from Kennecott’s operations. A more detailed profile can also be obtained upon request to help our customers better understand the environmental impacts of their products or services when conducting their own life cycle studies.

What is Sulfuric Acid?
Sulfuric acid is a corrosive, clear, colorless, odorless, oily liquid that is the largest-volume industrial chemical produced in the world and is the most commonly used strong acid. Sulfuric acid plays some part in the production of nearly all manufactured goods. Kennecott Utah Copper produces about one million tons (907 ktonnes) of sulfuric acid (H₂SO₄) each year as a by-product of the smelting process. Salable sulfuric acid products are 93% and 98% sulfuric acid.

Delivery is made in 100-ton (91-tonne) capacity rail cars and 24-ton (22-tonne) or 35-ton (32-tonne) capacity trucks to customers throughout the United States. Customers include gold, copper, uranium, and beryllium metal producers, fertilizer producers, chemical manufacturers, power plants, steel companies, farmers, and companies involved in water treatment.

2006 PRODUCTION DATA
Copper
218,000 metric tonnes
Gold
462,000 troy ounces
Silver
4,152,000 troy ounces
Molybdenum
16,800 metric tonnes
Sulfuric Acid
756,000 metric tonnes

Cover Photo: A key component in fertilizers and pesticides, sulfuric acid is vital to our nation’s agricultural industry and also is used with cornstarch to manufacture biodegradable synthetic polymers for food packaging, carpet and even clothing.
How is it Produced?

Many of the world’s most important metal ore bodies are sulfides— that is, mineral compounds that contain sulfur. The Bingham Canyon Mine contains veins of copper sulfide, so the ore extracted contains sulfur, which needs to be separated from the copper.

Ore from the mine is upgraded using a flotation process to produce copper concentrate. The copper concentrate entering the smelter is about one-third copper, one-third iron, and one-third sulfur, with other trace minerals. The smelting process breaks the elements apart and the sulfur is driven off as sulfur dioxide gas. Early in the 20th century, most of that gas went up the smokestack. Smelters started capturing some of the sulfur in the 1920s. By 1990, Kennecott’s acid plants recovered about 93% of the sulfur.

Kennecott’s new smelter— one of the cleanest in the world— is designed to capture 99.9% of the sulfur dioxide emissions produced. Once the sulfur dioxide gas is cleaned, it is piped to the double contact acid plant where the sulfur dioxide is converted to sulfuric acid. In this way, the acid plant acts as a pollution control device that also produces a high-quality commercial product.

Sulfuric acid is a highly corrosive material, and strict safety guidelines must be followed for handling, storing and working with sulfuric acid.

Life Cycle Assessment

Life Cycle Assessment (LCA) studies involve the collection, assessment and interpretation of data from an environmental perspective over a product’s life cycle (production, use, and end-of-life). Studies can evaluate:

- the entire product life cycle, often referred to as cradle-to-grave or cradle-to-cradle studies, or
- parts of a product life cycle, referred to as cradle-to-gate or gate-to-gate studies.

Figure 1

GOAL AND SCOPE
DEFINITION
LIFE CYCLE INVENTORY (LCI)
LIFE CYCLE IMPACT ASSESSMENT (LCIA)
INTERPRETATION

Inputs

Energy – Consumables – Raw Materials – (ore, water, air)

Figure 2 – Process Flow – Mining to Refining

Other Outputs

Air Emissions
Water Tailings
**Goal and Scope**

The Kennecott LCA project included a complete cradle to gate LCA study for copper cathode, gold, silver, molybdenum oxide and sulfuric acid produced by the mining operation. The methodology used was consistent with ISO 14040 series LCA standards, as shown at a macro level in Figure 1.²

LCA provides Kennecott with a systematic, comprehensive method to evaluate and communicate the environmental impacts of its products and processes. This approach helps the company ensure that a change made in one of its processes will not result in an equal or greater increase elsewhere, including the upstream supply chain. LCA also provides Kennecott with a way to benchmark and improve its operational performance from a sustainable development perspective. Finally, LCA provides Kennecott with a broader view of how its products impact the world, both positively and negatively.

Specifically, the analysis examined how the production of copper, gold, silver, molybdenum and sulfuric acid impacts environmental indicators, such as smog, acid rain, energy, and greenhouse gases from a cradle to gate perspective. Data gathered for the study represents operations at Kennecott’s facilities during the 2006 calendar year. The study was undertaken for internal use by Kennecott and the absolute numbers are only communicated in a confidential, aggregated manner to select customers and LCA database providers. The functional units for the study were 1000 kg each of copper, molybdenum and sulfuric acid, and 1 kg each of gold and silver.

**Life Cycle Inventory: LCI**

Life cycle inventory (LCI) is a key step in the LCA process. The LCI catalogs all the environmental inputs and outputs of a product system. Data may be collected first-hand from measurements and estimates of key activities, or the data will be based on information drawn from existing LCA databases. At Kennecott, the majority of inventory data was collected on-site and modeled using GaBi 4.0™ LCA software. Data included or excluded from the study was dependent on the system boundaries identified during the goal and scope definition. The LCA system boundaries for the study are described in Table 1 and Figure 3.

An allocation was performed in the smelter model in order to assign inputs and outputs to the sulfuric acid profile. The acid plant removes the majority of sulfur emissions at the smelter and thus functions as a pollution control technology. As a result, no upstream impacts were allocated to the sulfur at the smelter, and the sulfuric acid begins accruing environmental burden at the acid plant.

A critical review, or independent verification, was not carried out for this study given the goal definition outlined previously and the requirements of ISO 14040. However, internal reviews were carried out by project team members at both Kennecott and PE Americas. The PE Americas reviewers included Johannes Gediga and Marc Binder, internationally recognized experts in the field of LCA.
## Sulfuric Acid Environmental Profile

**Life Cycle Assessment**

**Included Excluded**

- Maintenance and operation of acid plant equipment
- Internal transportation of materials
- Beneficiation and processing of materials
- Manufacture of raw and processing materials
- Transportation of raw and processing materials to Kennecott
- Packaging of products
- Manufacture and transport of packaging materials for sulfuric acid
- On and off-site power generation
- On and off-site waste management and disposal
- Overhead (heating, lighting) of on-site administrative and manufacturing facilities

*LCI data was included for process materials from the GaBi 4 Software database*

### Table 1 – LCA System Boundary

<table>
<thead>
<tr>
<th>INCLUDED</th>
<th>EXCLUDED</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Maintenance and operation of acid plant equipment</td>
<td>• Capital equipment and maintenance, with the exception of mining equipment</td>
</tr>
<tr>
<td>• Internal transportation of materials</td>
<td></td>
</tr>
<tr>
<td>• Beneficiation and processing of materials</td>
<td>• Overhead (heating, lighting) of off-site administrative facilities</td>
</tr>
<tr>
<td>• Manufacture of raw and processing materials*</td>
<td>• Transportation of finished product from the Kennecott site</td>
</tr>
<tr>
<td>• Transportation of raw and processing materials to Kennecott</td>
<td></td>
</tr>
<tr>
<td>• Packaging of products</td>
<td></td>
</tr>
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*LCI data was included for process materials from the GaBi 4 Software database*
Life Cycle Impact Assessment

Following the LCI, a life cycle impact assessment (LCIA) was completed to help Kennecott determine which process or processes have the greatest adverse environmental impact. LCIA helps Kennecott pinpoint opportunities for improvement within its operations.

Estimates for potential environmental impacts are organized under four main impact categories (shown below in Table 2). These impact categories were selected based on:

- the geographical location of Kennecott’s operations, or
- issues Kennecott currently addresses either through its internal reporting or its Environmental Management System.

<table>
<thead>
<tr>
<th>IMPACT CATEGORY</th>
<th>DESCRIPTION</th>
</tr>
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<tbody>
<tr>
<td>Primary Energy Demand</td>
<td>A measure of the total amount of primary energy extracted from the earth, including petroleum, hydropower and other sources, taking into account the efficiency of electric power and heating processes.</td>
</tr>
<tr>
<td>Global Warming Potential</td>
<td>A measure of greenhouse gas emissions, such as CO₂ and methane, calculated using the IPCC 2001 Global Warming Potential Index (GWP100).</td>
</tr>
<tr>
<td>Acidification Potential</td>
<td>A measure of emissions to air known to contribute to atmospheric acid deposition (acid rain).</td>
</tr>
<tr>
<td>Photochemical Oxidant</td>
<td>A measure of emissions of precursors that contribute to low level smog, produced by the reaction of nitrogen potential oxides and VOCs under the influence of UV light.</td>
</tr>
</tbody>
</table>

TABLE 2 – LCIA CATEGORIES
**Acidification Potential (AP)**

Emissions contributing to Acidification Potential are a result of SOx remaining after processing by pollution control equipment, and the production of electricity.

**Global Warming Potential (GWP)**

The majority of Global Warming Potential is created by the combustion on fossil fuels to generate electricity on-site and off-site.

**Photochemical Oxidant Creation Potential (POCP)**

The majority of the POCP generated is from direct emissions from the acid plant.
Disclaimer: The data reported in this Sulfuric Acid Environmental Profile includes off-site impacts as appropriate for LCA. Consequently, the inclusion of such aspects must be considered when comparing the information included in this Profile to other reported data from Kennecott's operations that do not include off-site life cycle impacts. For more information, please see Table 1 – LCA SYSTEM BOUNDARY on page 5 of this Profile.

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