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PRINTED: 03/21/2002

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES AZMILS DATA

PRIMARY NAME: MORENCI DUMP LEACH SX-EW

ALTERNATE NAMES:

GREENLEE COUNTY MILS NUMBER: 138

LOCATION: TOWNSHIP 4 S RANGE 29 E SECTION 26 QUARTER N2  
LATITUDE: N 33DEG 03MIN 38SEC LONGITUDE: W 109DEG 19MIN 49SEC  
TOPO MAP NAME: CLIFTON - 15 MIN

CURRENT STATUS: PRODUCER

COMMODITY:  
MILL SX-EW COPPER

BIBLIOGRAPHY:  
ADMMR MORENCI DUMP LEACH SX-EW FILE

06/11/90

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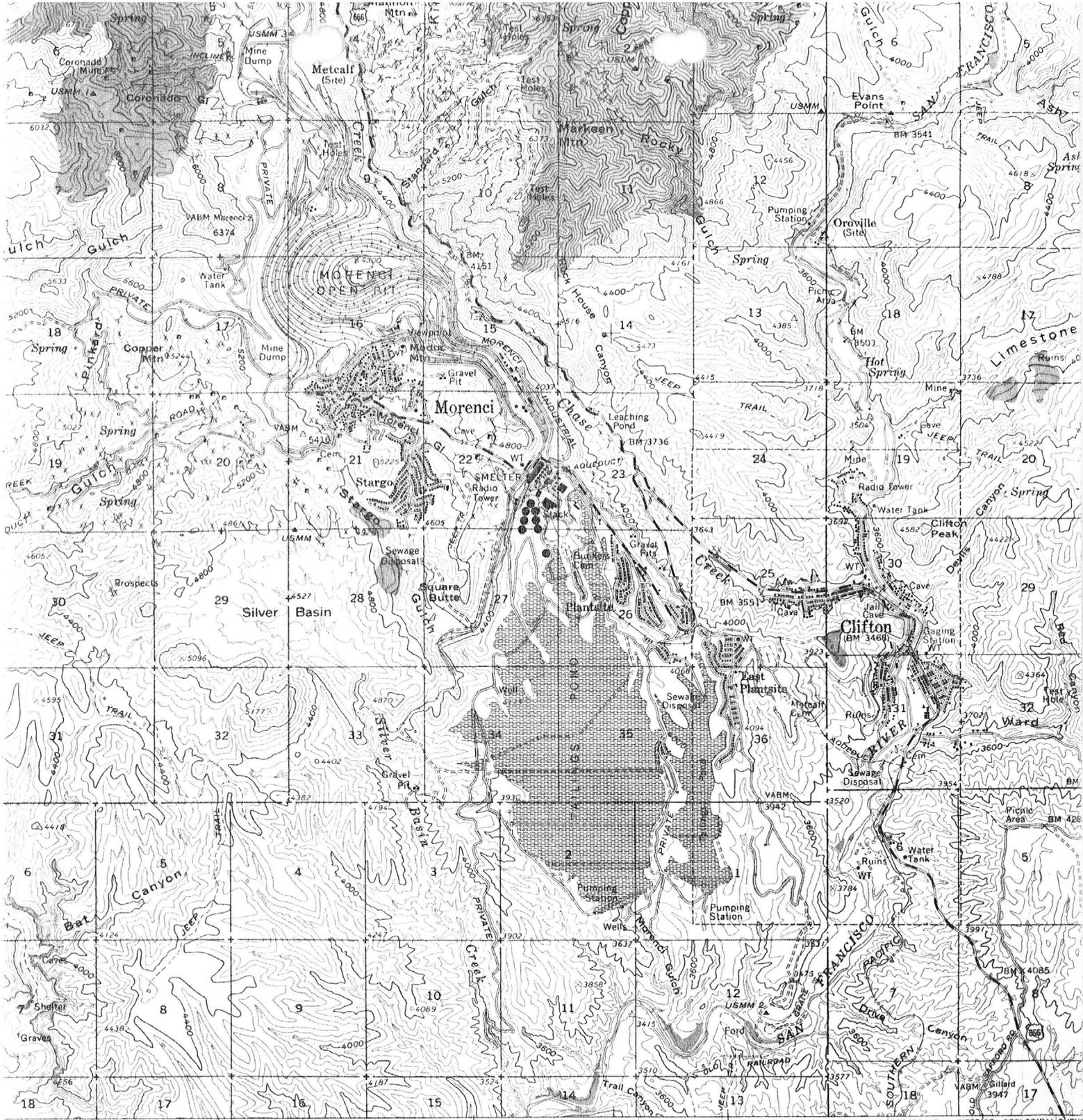
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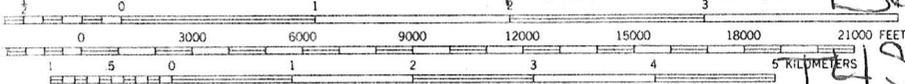
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(GUTHRIE)  
SCALE 1:62500

Morenci Dump Leach SX-EW ROAD



CONTOUR INTERVAL 80 FEET  
DATUM IS MEAN SEA LEVEL

43 R 29 E Sec. 27 N 20  
Medium-duty Unimpro



QUADRANGLE LOCATION

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS  
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER 25, COLORADO OR WASHINGTON 25, D. C.  
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

Clifton 15

ABSTRACTED FROM ADMMR ACTIVE MINES DIRECTORY, 1992

*Morenci Dump Leach SX-EW plant  
Granlee County*

**PHELPS DODGE CORPORATION**

**Corporate Headquarters**

2600 N. Central Ave., Phoenix, AZ 85004-3014 - Phone 234-8100.

Chairman of the Board and President D. C. Yearley

Senior Vice President and President Phelps Dodge Mining Company J. S. Whisler

Sr. Vice President and Executive Vice President Phelps Dodge Mining P. J. Ryan

**Phelps Dodge Mining Company**

2600 N. Central Ave., Phoenix, AZ 85004-3014 - Phone 234-8100.

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Vice President Engineering Services R. W. Rice

Controller, Phelps Dodge Mining R. G. Peru

Director, Employee Relations S. L. Marcus

Manager, Employee Relations D. E. Brooks

Assist. Director, Materials Management C. R. Jennings

Traffic Manager J. Sheridan

**Morenci Branch** T4S R29E Secs. 3, 4, 5, 8, 9, 10, 15, 16, 17, 21, 22 & 23

4521 State Hwy. 666, Morenci, AZ 85540 - Phone 865-4521 - Employees: 1950-  
Open pit copper mine - Two concentrators (one with molybdenum circuit) - Total  
capacity 100,000 TPD - 650,000 TPY smelter with 2,400 TPD acid plant  
(inactive) - 340 million pound per year solvent extraction-electrowinning  
plant.

Manager J. G. Clevenger

Assistant Manager W. S. Chen

Superintendent of Mines M. J. Allen

Superintendent of Concentrators R. I. Pennington

Superintendent SX-EW A. J. Broderick, Jr.

Mechanical and Electrical Supt. J. B. McBiles

Chief Engineer A. R. Edwards

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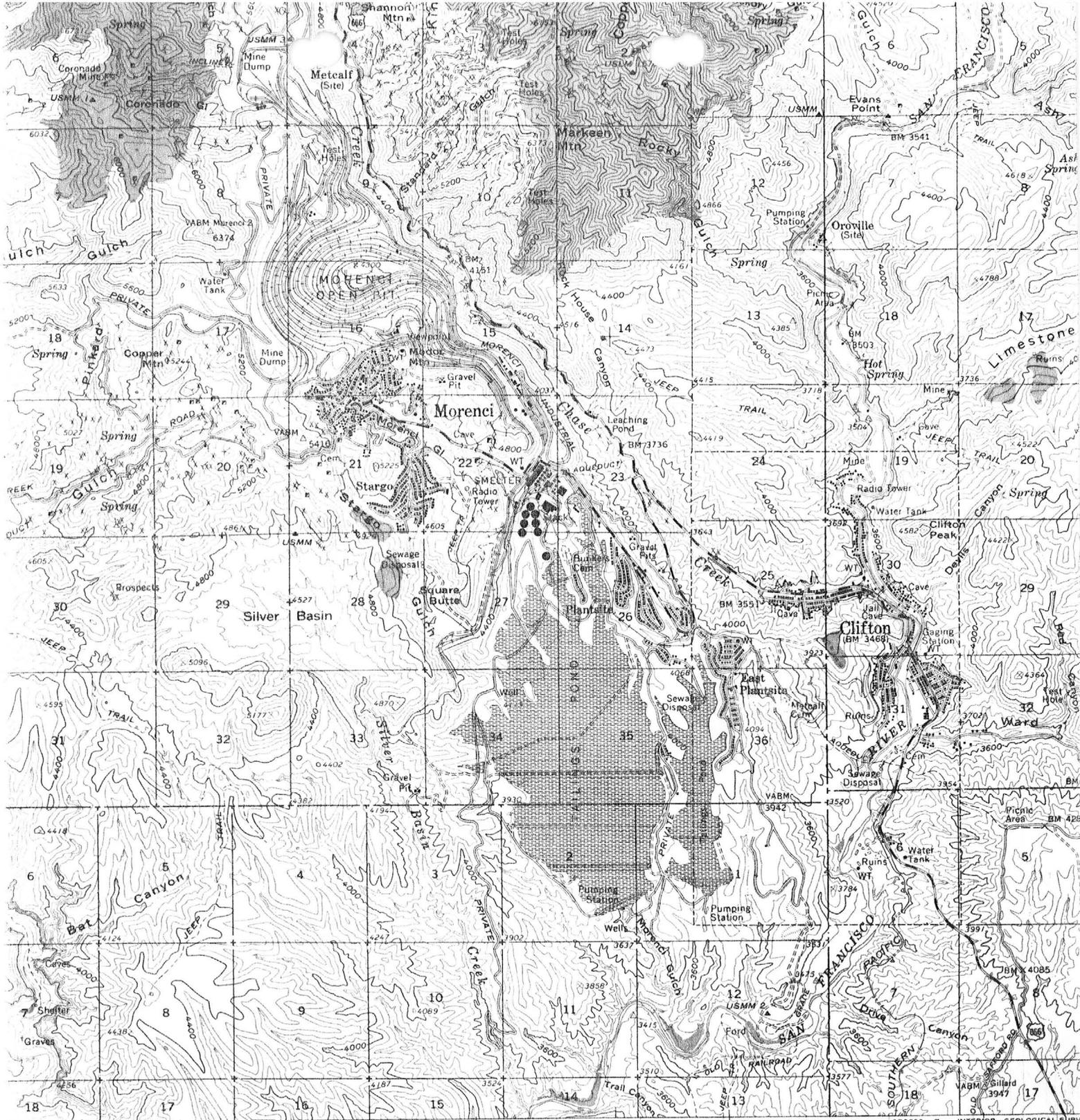
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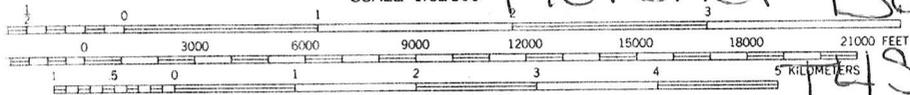
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Morenci Dump Leach SX-EW  
143 Range Sec. 27 Medium-duty Unimpro



CONTOUR INTERVAL 80 FEET  
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*MMS 27*

**phelps  
dodge**  
MORENCI INC.

SOLVENT EXTRACTION  
ELECTROWINNING  
(SX/EW) PLANT (A)

**THE LARGEST SX/EW COMPLEX  
IN THE UNITED STATES**



Phelps Dodge Morenci Inc.  
Morenci, Arizona 85540  
(602) 865-4521 Ext. 206

## Brief History of the Morenci Mining District

The first recorded mineral discoveries in the Clifton-Morenci district were made in about 1865 by volunteer Union soldiers from California who passed through the area. The first prospectors arrived in 1870, looking for gold. They failed to discover significant quantities of gold, but were intrigued by the rich copper deposits they found on both sides of Chase Creek.

The Longfellow Copper Company began operating the Longfellow mine in 1870 in Old Morenci, a site that is now part of the Morenci open pit. Ore mined from the Longfellow mine averaged 20 percent copper — 25 times the copper content of the ore now being mined at Morenci!

Phelps Dodge entered the Morenci mining picture in 1881 with its purchase of an interest in the Detroit Copper Mining Company, which also was operating underground mines in Old Morenci. Phelps Dodge acquired the remainder of the Detroit Copper Mining Company in 1897. Phelps Dodge and the Arizona Copper Company, a Scottish firm that had purchased the Longfellow Copper Company holdings in 1882, were the dominant companies in the district until 1921, when Phelps Dodge acquired the Arizona Copper Company and became the sole operator in the district.

For the first six decades all mining in the district was by underground methods. During the Great Depression copper prices fell so low that by 1932 all mining had been suspended. The underground mines never reopened.

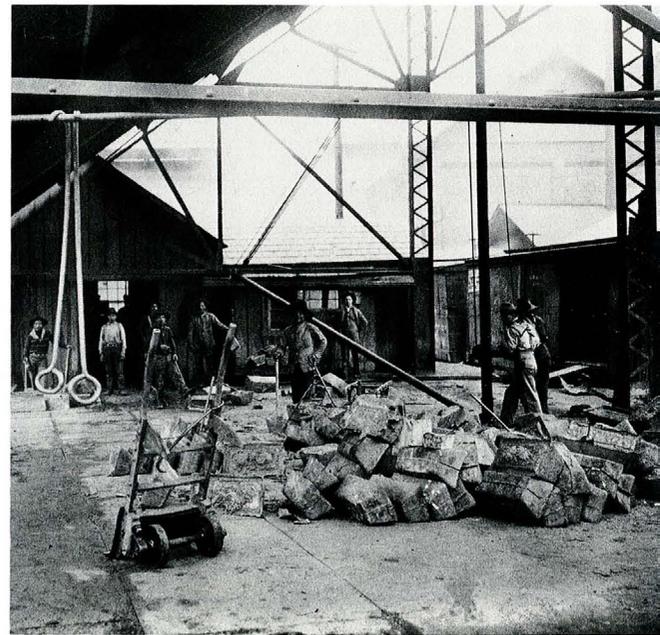
Development of the Morenci open pit began in 1937.

■ **OVER 100 MILLION POUNDS OF COPPER PER YEAR AT A PRODUCTION COST OF LESS THAN 30 CENTS PER POUND.**

■ **A CLEAN PROCESS WITH ENVIRONMENTAL SAFEGUARDS.**

■ **CONSTRUCTION COST: 90 MILLION DOLLARS.**

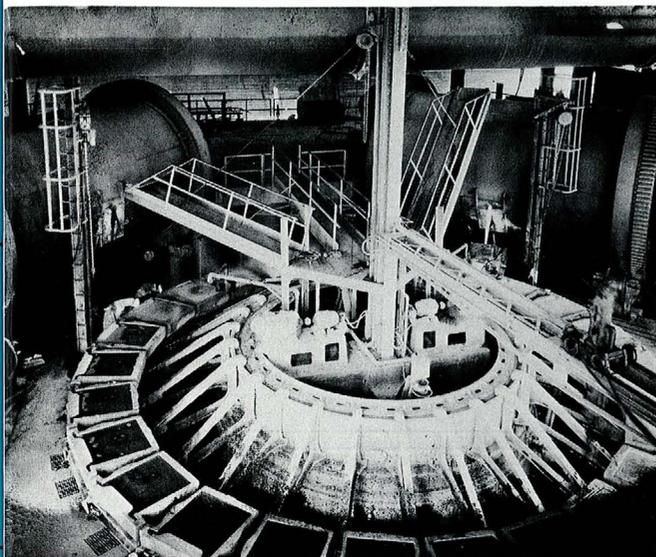
■ **AT PEAK CONSTRUCTION, EMPLOYMENT WAS OVER 800.**



*Copper ingots — about 1900*

Since that time more than 2.6 billion tons of ore and other rock material have been removed from the giant mine.

Over the years, copper has been produced in the Morenci District in several forms: first as ingots from smelters located both in Clifton and Morenci, later as anodes from the Morenci Smelter built in 1942, still later as concentrates and precipitates. Now a part of the copper production is in cathode form.



*Anode wheel — about 1950*

## THE SX/EW PROCESS

The solvent extraction/electrowinning plant at Morenci uses a relatively simple process to produce practically pure copper from water that has been percolated through huge dumps of copper-bearing rock called "leach" dumps.

In the past, mining at Morenci was conducted primarily to satisfy the ore requirements of the concentrators. Rock that contained some copper, but too little to be recovered profitably in the normal concentrating-smelting-refining processes, was sent to the leach dumps where it is now available to provide feed to the new plant. In addition, having this new way of making salable copper, Morenci will be able in the future to allocate copper-bearing material between the concentrators and the leach dumps in a way that will maximize the economic return from this mineral resource.

The SX/EW process consists of four steps, as shown on the simple flow sheet on the back of this brochure. Three interdependent process solution streams transfer the copper from one step to the next.

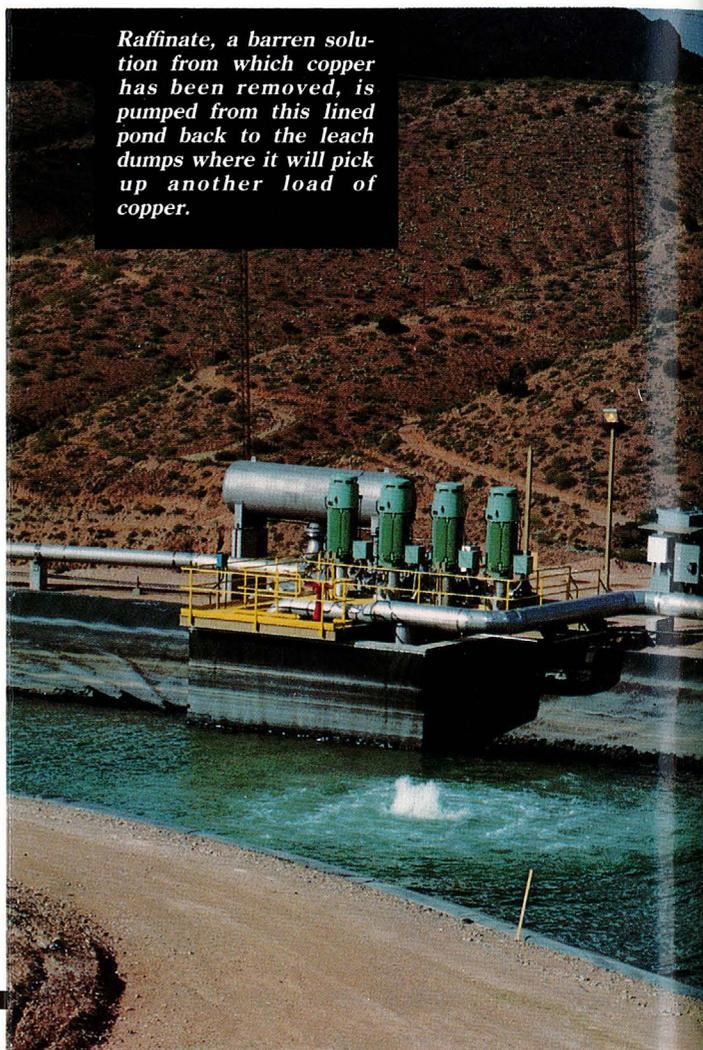
## Leaching

The first step, leaching, starts with the sprinkling of slightly acidic water on one of the leach dumps. The water percolates through the dump, dissolving copper minerals contained in the rock as it descends. The copper-laden water, now called "pregnant leach solution," exits from the bottom of the dump, flows to a collection pond, and is pumped to one of the solvent extraction plants.

## Extraction

In the second step, extraction, the pregnant leach solution is mixed vigorously with an equal volume of kerosene-based solvent that contains an organic chemical specifically designed to extract copper. After the solutions have been mixed for about two minutes the mixture is allowed to settle.

The leach solution, which has given up its copper to the organic chemical, is the heavier of the two solutions and sinks to the bottom. Now called "raffinate," it is pumped back to



*Raffinate, a barren solution from which copper has been removed, is pumped from this lined pond back to the leach dumps where it will pick up another load of copper.*

inking of slightly  
water percolates  
erals contained in  
water, now called  
tom of the dump,  
one of the solvent

the top of the leach dump to begin another cycle. The solvent containing the copper-laden organic chemical, called "loaded organic," floats to the top and is pumped to the next section of the solvent extraction plant.

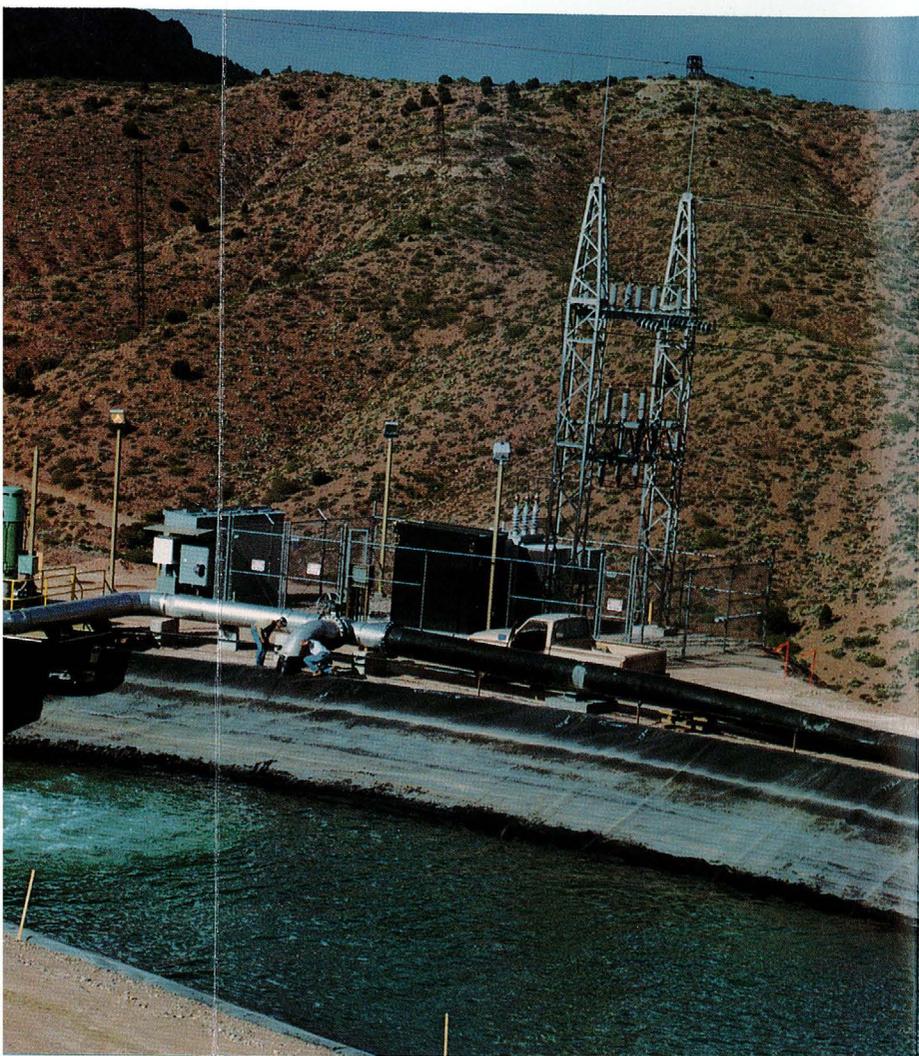
The solvent extraction plants at Morenci are capable of processing 30,000 gallons of pregnant leach solution per minute.

### Stripping

t leach solution is  
f kerosene-based  
pecifically designed  
e been mixed for  
o settle.

its copper to the  
olutions and sinks  
pumped back to

In the third step, stripping, the loaded organic is mixed with a copper-bearing sulfuric acid solution, called "electrolyte," and the copper migrates from the organic to the electrolyte. The mixed solutions then are allowed to settle; the solvent that has been stripped of its copper, called "barren organic," floats to the top and is sent back to the extraction step to pick up another load of copper. The electrolyte containing the copper, called "rich electrolyte," settles to the bottom and is pumped to the electrowinning tankhouse.



### Electrowinning

In the final step, electrowinning, the rich electrolyte is pumped through a series of tanks or "cells." Hanging in the tanks are insoluble lead plates alternating with sheets of copper. Each lead plate serves as the anode pole of an electric circuit; each cathode pole begins as a thin "starter sheet" of pure copper. A direct current is passed through the electrolyte, reducing some of the copper ions to copper metal, which accumulates on the starter sheet.

After seven days in the cell a starter sheet has grown to a slab of virtually pure copper weighing about 200 pounds. At that point it is removed from the cell and replaced with a new starter sheet. The harvested cathodes are ready for sale or for further processing into other copper products. The electrolyte that has passed through the tankhouse, partially depleted of its copper and thus called "lean electrolyte," is returned to the stripping step to have its copper content upgraded once again.

The Morenci solvent extraction/electrowinning plant will produce over 100 million pounds of electrowon copper per year.

### An Environmentally Clean Process

In the Morenci solvent extraction/electrowinning operation there are no discharges of any process liquids to the environment. The leach solutions continually circulate between the leach dumps and the extraction section; the organic circulates between the extraction section and the stripping section; and the electrolyte circulates between the stripping section and the electrowinning tankhouse.

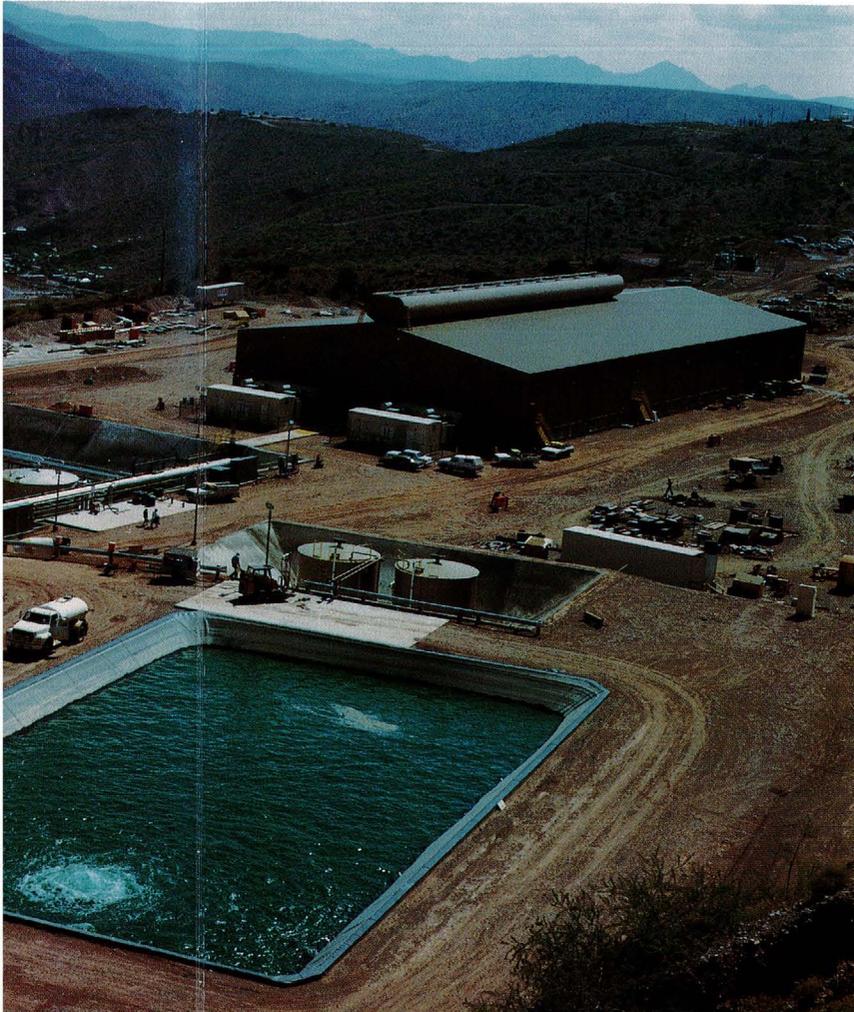
Surface water quality and groundwater quality are protected by a \$9 million flood control system that includes a \$2 million dam that cuts off both surface and alluvial subsurface flows in Chase Creek. Groundwater quality downstream of the dam is checked in a series of monitor wells.

Even before there was any mining in the Morenci District, the Chase Creek waters that flowed into the San Francisco river contained appreciable amounts of copper and other metals that had been dissolved as the waters flowed through the mineralized district that comprises today's Morenci mine.

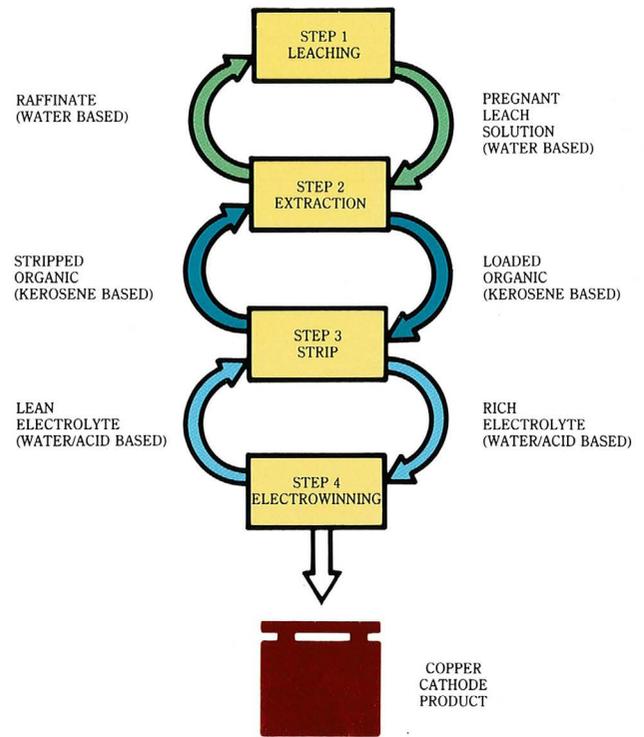
One of the new water quality protection features associated with the Morenci SX/EW project is a clean water bypass system that collects Chase Creek flows upstream of the mineralized area, pipes them completely around the mining and leaching operations, and discharges them back into Chase Creek downstream of the flood control dam. Thus from now on the Chase Creek waters that enter the San Francisco River will actually be purer than at any previous time in history!

*Finished copper cathodes that are removed from the cells measure about three feet square and about 3/4" thick. They weigh about 200 pounds each and are very pure, ready for direct sale or further processing to other copper products.*

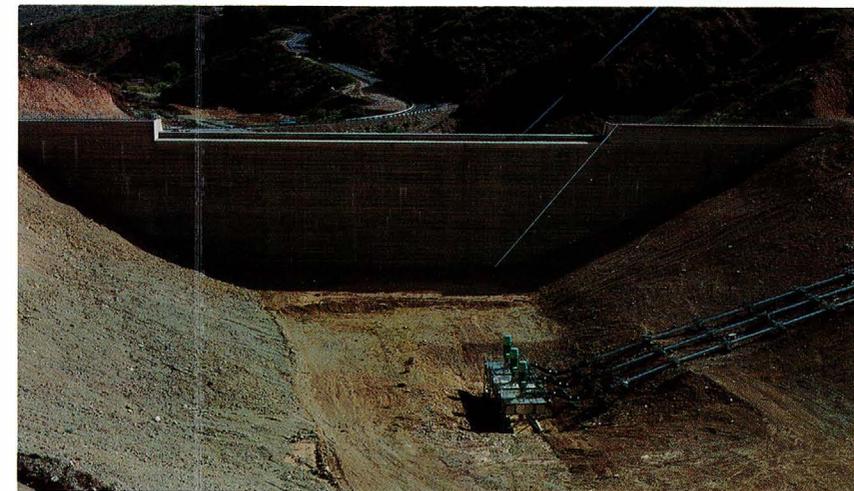




## SX/EW PROCESS FLOW DIAGRAM



As can be seen, this operation bypasses the smelting and refining steps of the pyrometallurgical process. The cathode copper is transported to Phelps Dodge's El Paso rod mill to be cast into copper rod.



**Carl J. Forstrom**  
1939–1987

Construction of the Morenci SX/EW complex stands as a monument to Carl J. Forstrom, whose dedicated pursuit of improved productivity and technological advancement were hallmarks of his tenure as Manager.