# THE CARSON RIVER PROJECT

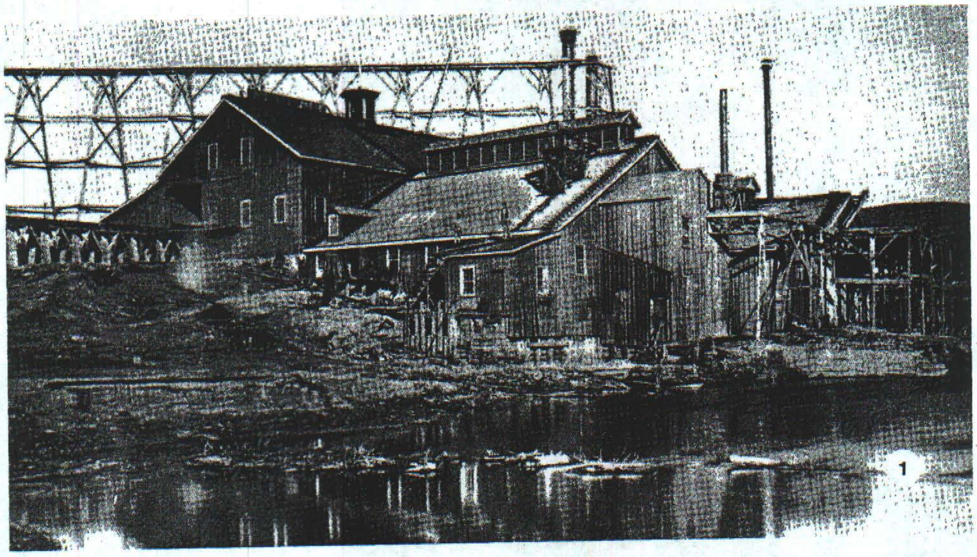
THE CARSON RIVER PROJECT®

# PRELIMINARY PROPOSAL TO THE STATE OF NEVADA

September 1983

The following is a proposal to the Citizenry of Nevada to join in partnership with private enterprise in an attempt to mutually prosper by converting an existing environmental liability into a potential state resource.

THE CARSON RIVER PROJECT ®



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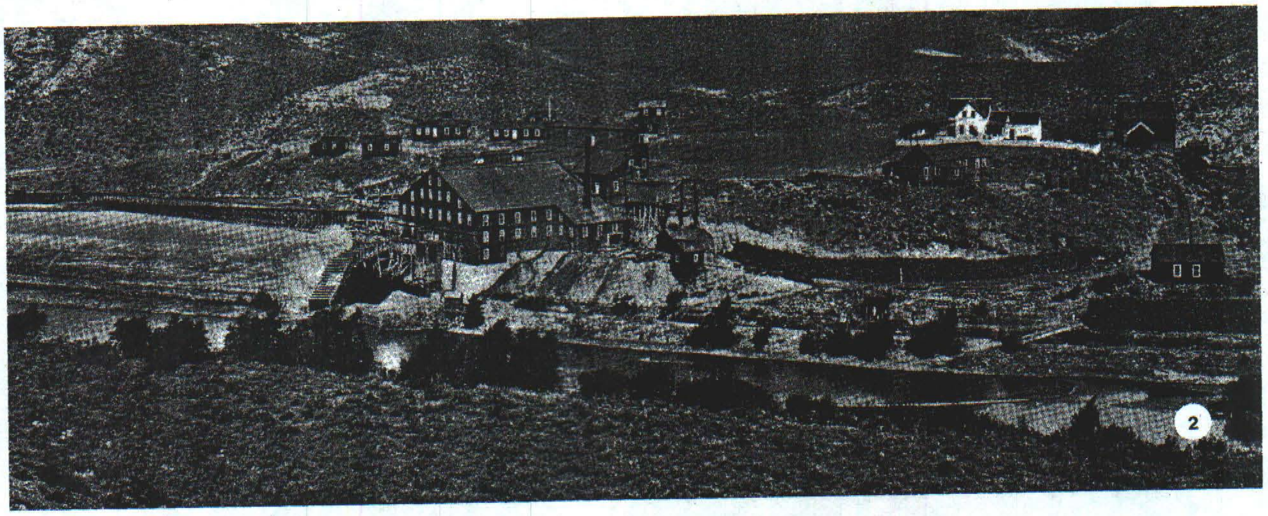

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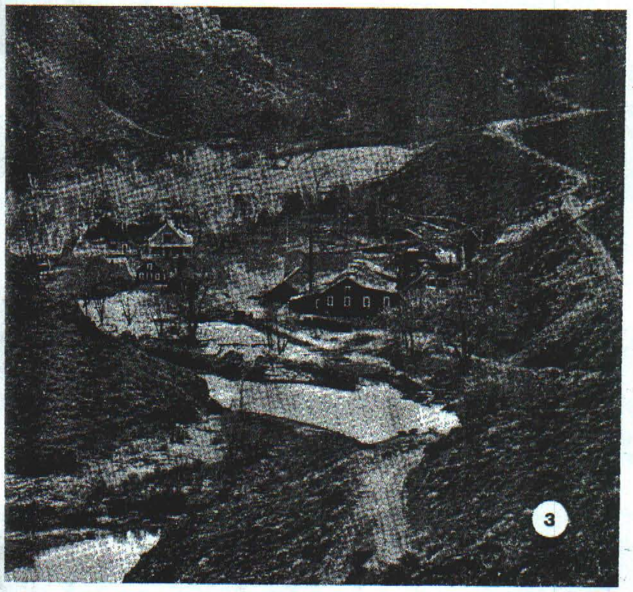
1. Morgan Mill from mill pond side
2. Riverside panorama of Eureka Mill
3. Upstream view of the Santiago Mill
4. Mexican Mill with discharge ditch
5. Downstream view of the Vivian Mill



# THE CARSON RIVER LEGACY
## A Unique History
## An Environmental Hazard

THE CARSON RIVER PROJECT

# THE CARSON RIVER LEGACY

## A Unique History

*The Romance of the Comstock Lode will never die. The story is an epic. It was the last stand of the California pioneers where they rose to the height of their brilliant and adventurous careers. Together with a robust and optimistic people throughout Nevada—many of whom were also pioneers—they shared a partnership that would make unforgettable history.*

### THE COMSTOCK BOOM

The Comstock Lode, discovered in 1859 near Virginia and Silver City, Nevada, was one of the richest single gold and silver bearing ore bodies in the history of mining. Numerous mines operating in the Lode from 1859 to 1882 produced within that time a conservative estimate of some $319,000,000 in gold and silver—when the values were $20 and $1 per ounce, respectively.[27] Many of the mining companies continued to operate even into the turn of this century. It has been estimated that overall the Comstock Lode produced 19,346,296 short tons of lode material with a recorded production of 8,256,179 ounces of gold, 192,010,565 ounces of silver, 76,630 pounds of copper and 55,504 pounds of lead for a total value (then) of approximately $400,000,000.[18]

The Comstock Boom rocked the mining and financial worlds during the last century and contributed substantially and romantically to this country's proud history. The United States was prompted to take emergency action to accept the territory of Nevada as a new state—way ahead of its time—so that the richness of the Comstock Lode's gold and silver could be used to finance and successfully preserve the Union effort during the Civil War.[27]

### THE CARSON RIVER MILLS

So glorified have been the mines and communities of Virginia City, Gold Hill, and Silver City that another appendage of that era has been forgotten. That is the story of the reduction mill operations along the banks of the Carson River which freed a majority of the values from the Comstock ores. Their stories still remain along one of Nevada's most exploited rivers, but the high river canyon walls which once echoed with the repetitive pounding of the mill stamps now keep silent vigil over the ruins of more than a dozen major mills (Map 1 in the Appendix).[27,3,18]

Also forgotten and hidden among the sagebrush and along the precipitous canyon walls is the role played by Nevada's famous Virginia and Truckee Railroad as it rolled through a portion of the Carson River canyons servicing the mills with Comstock ore and necessary mercury. The V & T backhauled the enormous quantities of timber and firewood needed to support the Comstock's mine workings and to power the necessary water pumps in the mining operations in the desert mountains around Virginia City.[27,3]

The rapid development of the many Comstock mines, beginning in 1859–60, created the demand for the immediate construction of mills to extract the values from the ores. The high cost and logistical inconvenience of transporting wood to the desert mine sites for mill power spurred enterprising mine operators to direct their energies to a cheaper source of power—water—which the Carson River offered in abundance just some fifteen miles southward from the location of the Comstock Lode.

## The Mexican Mill—A Pace Setter. . .

The first and uppermost mill was built on the east bank of the Carson River in the Spring of 1860—just some three miles from the present State Capitol building and on what is now the Darling Ranch, near the south side of Empire City. This first mill was soon enlarged and became known as the Mexican Mill (or Silver State Reduction Works).

Unlike other later mills, the terrain allowed this mill to locate some 1,000 feet back from the River, thereby affording more ground-surface area on which to deposit and rework its own mill tailings before flushing its discharge through a mill race (or ditch) into the Carson River.

For its power source, the Mexican Mill diverted water from its own Carson River dam site, four and a half miles upstream, via a well-constructed ditch or flume having a capacity to supply 4,000 cubic feet of water per minute to the mill site with a 22-foot fall. The Mexican Mill's creative diversion of water is still used today for irrigational purposes by the Darling Ranch and others. This oldest water right in the State of Nevada contributed the historic precedence for today's downstream water rights permits from the River.

The Mexican Mill, with its capacity for reducing 120 tons of ore per day, had 44 stamps which ran with an average speed of 75 blows per minute. The crushing and amalgamating part of the mill occupied more than 15,000 square feet of the mill structure. *Kelly's Directory of the Nevada Territory* in 1863 further described the mill as having the largest water wheel on the Pacific Coast with the ability to reduce more than double the ore capacity handled by any other mill in the Nevada Territory. The design, efficiency of recovery, and construction of the Mexican Mill were considered engineering feats for its time and served as a model for subsequently built mills along the River.

## Other Mills Followed. . .

Using the principal of upstream water diversion from the Carson River for power, the rapid construction of other mills quickly followed. Along with the expansion of the **Mexican Mill** in 1861, the **Mead Mill** (with 16 stamps) was constructed and run by water from the same Mexican water ditch. Another 16-stamp mill, the **Baldwin Mill**, was completed in Empire City in 1863. The **Morgan Mill** with 40 stamps and a capacity to reduce 75 tons of ore per day began operation shortly thereafter near the site of the present Deer Run Bridge. The Morgan Mill, sometimes referred to as the Yellow

Jacket Mill, flumed and elevated water all the way from the Mexican Mill for its principal power.[3]

Capitalizing on the greater fall in elevation of the River through the Carson River Canyon, six additional major mills (located approximately a mile apart) were constructed and expanded to their full capacity in the early 1860's. Surveyor General S. H. Marlette, in 1866, reported on the capacity of these Canyon mills in downstream location order from the Morgan Mill as follows: The **Brunswick** (55 stamps, 155 tons of ore per day capacity); the **Merrimac** (20 stamps, 50 tons per day) with the nearby Yearington Smelter; the **Copper Canyon Mill** (10 stamps, 15 tons); **Vivian Mill** (16 stamps, 40 tons); the **Santiago** (or Zephyr Flat Mill) with 34 stamps and 80 tons per day capacity; and the **Eureka Mill** (20 stamps and 45 tons per day capacity) with its own unique railroad spur.[3]

Below the main Carson River Canyon, nearer the town of Dayton, were found the following mills: the **San Francisco**, **Franklin**, **Island Mill**, the **Ophir Mills**, the **Golden Eagle**, the **Illinois**, and the **Imperial** (or Rock Point) **Mill**—with an overall cumulative ore capacity derived from 160 stamps.[3] Not included in these were a number of much smaller custom mills in the town of Dayton along the Dayton Town Ditch. The total number of stamps pounding out the Comstock ore along the Carson River approached 450. Not to be forgotten, too, were the numerous scattered stamp mills located up the canyons leading into and making up the Carson River watershed. Many of these historic mills alongside the Carson River and within its watershed operated without cessation for nearly thirty years.[27]

### Comstock Mill Tailings. . .

Not having the benefit of today's more modern metallurgical extraction methods, the reduction mills along the Carson River watershed used an inefficient, crude amalgamation process with mercury to free the gold and silver values from the Comstock ores. In this procedure the ore was ground very finely by the stamp mills and was subsequently steamheated in pans or chambers while being charged with mercury (quicksilver).[35] The incentive for efficient mill operations was lessened, since the Comstock ore was most often treated in the mills on a cummulative ore-tonnage payment basis, with the tailings usually belonging to the mill owners.[18]

State Surveyor General S. H. Marlette reported in 1871 from previous mill records that the mills treating Comstock ore recovered not more than 65 percent of the metal values. Numerous other reports and records also support losses from 25 to 35 percent of the assayed gold and silver values. Although some of the mill tailings were impounded alongside the mill sites and later reworked without much success, significant amounts of values were sluiced down the canyons or flushed and deposited directly into the Carson River.

**Substantial Mercury Losses. . .**

The inefficient metallurgical milling procedures lost 1.5 to 2.5 pounds of mercury per ton of Comstock lode ore. When richer gold ores were worked, the loss of mercury (quicksilver) and silver value losses were largely increased due to the grinding of the sulphides into more minute particles which floated off in the water with the mercury and the rest of the tails.[4,5,9,10,19,26,35]

Prior to 1880, according to the 1883 U.S. Geological Survey, the Carson River mills had already milled 6,971,641 tons of the Comstock ore. The 1880 U.S. Geological Survey and U.S. Mint Reports indicated a previous average loss of two pounds of mercury per ton of ore milled. In their prime operations, some of the major mills had to bring in several carloads of mercury per week just to replace the mercury losses in their own milling process.[12] Varying historic reports estimated a total loss of mercury during the years from 1860 to 1895 into the Carson River System from the milling operations to have been between 10,000,000 and 20,000,000 pounds.[4,5,9,10,19,26,35]

**Mercury Input to the Carson River System. . .**

Just what became of all the mercury (quicksilver) used in the reduction works is a question that has never yet been fully and satisfactorily answered. Mercury in great quantities was constantly taken into the mills to replace the mercury lost in the ore milling process. It was used over and over again until it was lost.[35] Whether the mercury was lost as fine droplets in coatings, or momentarily volatilized during the roasting of ores, the properties of elemental mercury (easy condensibility, density, mobility, and tendency for agitated droplets to coalesce) would have caused much of the lost mercury to remain near the mill sites and in the River. This mercury exists somewhere in the Carson River System as a presently undefined threat and environmental hazard.

Other sources of mercury, compared to input from mill tailings, have put relatively small amounts of mercury into the River. Natural sources, such as the normal release of mercury during rock weathering or hot spring fluids, produce aqueous solutions with less than 1 ppb of mercury.[23,31]

The fact that mercury still remains in the Carson River has been securely established by visual observations and by chemical analyses of sediments, from channels cut across the River.[12,16,18]

# THE CARSON RIVER LEGACY
## An Environmental Hazard

*Mercury in the Carson River poses problems. Natural processes which could clear out the mercury eventually—with hundreds of years—are too slow to be depended upon, and the entry of mercury into life material is too fast to ignore in today's society.*

In recent years, mercury has received intense attention around the world because of its proven threat to human health. Hundreds of technical papers have been written on field aspects, experiments, and theoretical approaches pertaining to the nature and forms of mercury, its distribution, impact on life cycles, and environmental rehabilitative methods.

**Redistribution of Mercury. . .**

The vast amount of mercury input (10 to 20 million pounds) to the Carson River System from Comstock ore mill operations has joined the geochemical cycle in nature (Figure 1 in the Appendix) and is subject to the normal processes that operate in the aquatic part of that cycle. River processes disperse mercury on a regional scale, but they are capable of concentrating mercury locally. Evidences support the conclusion that mercury has moved, perhaps to the Carson Sink before 1915 and to Lahonton Reservoir thereafter.[10,25,31] Tailings mixed with sediments are picked up at times of floods, transported in suspension and by saltation (hopping of individual grains on the stream bottom) and re-deposited farther down the River. The high density of mercury, 13.6 $g/cm^3$, compared to density of sediments, about 2.5 $g/cm^3$, insures that mercury would work its way downward in parcels of suspended sediments. Droplets of fine mercury would tend to coalesce and form larger drops, which settle faster. Eventually some of the mercury makes its way to the river bottom to pool behind obstructions and to press into fractures in the bedrock (Figure 2 in the Appendix). For purposes of discussion, the term "Carson River System" refers to: waters in the River and Lahonton Reservoir from Carson City to the Carson Sink; stream and lake sediments recently deposited on bottoms; sediment-tailing mixtures; remnant tailing piles; river-lain terrace materials that interfinger with scree on the uphill sides and with river sediments on the river sides; the bedrock under the water to the depth affected by mercury; and the atmosphere immediately above the water surface (Map 2 in the Appendix).

**Forms of Mercury. . .**

Mercury is capable of existing in many forms and of transforming from one form into another under appropriate conditions.[11,13,14,22,23] Most mercury now in the Carson River System is metallic mercury, $Hg^o$. Small amounts of substances such as HgS, HgO, mercurian ZnS, and organo-mercury are also expected.[10,13,23,31] Much of the non-metallic mercury is absorbed on fine solids, whether organic or inorganic.[8,10,23,31] Naturally occurring mercury-containing substances tend to have low solubilities in water under earth-surface conditions. Many kinds of dissolved species can form such as: $Hg^{\circ}$, $Hg_2^{+}+$, $Hg^{+}+$, $HgCl_2^{\circ}$ and $CH_3Hg^{+}+$.[14,23,33] The number and compositions of mercury-containing phases are set by bulk compositions of the system, temperature, and pressure. Biological processes can accelerate the attainment of equilibrium or they can produce substances not truly stable as transitory phases.[22,23] Both chemical and biologically-mediated reactions proceed at rates strongly influenced by environmental factors. Figure 3 in the Appendix shows a plot of oxidizing conditions (Eh) versus acidity (pH) of earth surface environments, with conditions in the Carson River System emphasized graphically.

Two important kinds of environments in the Carson River System are: (1) an upper zone, in which oxidization by atmospheric-derived oxygen of solids and dissolved constituents can take place; and (2) a lower zone, in which organic solids and some minerals establish and maintain reducing conditions.[16,21,23] Metallic mercury is stable under the reducing conditions but it oxidizes to higher valence forms in the upper environment. Tailings and sediments that are under reducing conditions for much of the year, storing up reaction products, can undergo rapid changes to more oxidizing conditions on being picked up and churned with surface materials, leading to reactions set by the oxidizing zone. Fluxes of mercury consequently pass through life forms and various storage sites fed by the enormous reservoir of liquid mercury.

**A Mercury Hazard. . .**

Workers who have studied mercury distribution in Carson River materials agree that an environmental hazard exists.[10,25,31] High levels of mercury have been measured in water, sediments, invertebrate animals, fish and plants collected at and below the first mill site near Carson City, extending to and beyond Lake Lahonton.[2,10,2,3,5,31] A large part of mercury in living organisms consists of methyl mercury chloride, which is particularly dangerous to humans because of its high mobility and strong biological activity.[7,14,22,23] Methyl mercury passes through the placental barrier of unborn children, leading to permanent crippling or death.[14] Deaths, 50 in all, in Minamata, Japan, plus hundreds affected in deleterious ways, were caused by eating fish and shellfish with high contents of methyl mercury from Minamata Bay, which had become polluted by industrial input of methyl mercury. The threat from mercury in the Carson River, though not as intense as at Minamata, is real and it will persist until remedial measures are taken.

No anomalous levels of mercury were found in well water, even those in areas of nearby pollution.[31] However, so long as metallic mercury is in the River, the possibility cannot be excluded that some unusual effect will mobilize the mercury to contaminate wells in the Carson River System.

Flooding and irrigation of land used for agricultural purposes by Carson River water and deposition of mixed tailings and sediments can potentially contaminate grass and the animals that feed on grass. The presence of mercury in visible droplets[16,18] indicated highly concentrated zones (of mercury) exist in the sands. Sediments could innocently be taken for domestic use, and thereafter act as sources of mercury vapor to the possible harm of humans.

## Transport and Transformation of Mercury. . .

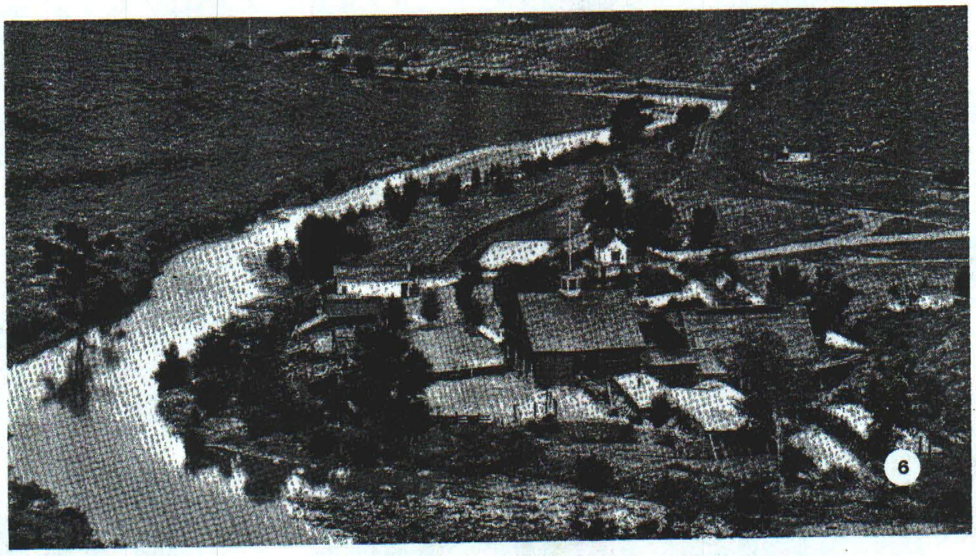
In addition to the physical processes of sediment transport and deposition, mercury is subjected to chemical and biological processes that also transport and transform mercury. Figure 4 in the Appendix shows a hypothetical steady-state in an aquatic system.[23] Mercury initially in the metallic state, $Hg^{\circ}$, dissolves in water in low but important levels (up to 25 ppb) and some volatizes to the air. The liquid mercury and mercury in interstitial waters are acted upon by bacteria to form the relatively soluble and rapidly moving methyl mercury chloride.[7,14,17,22] The $CH_3HgCl$ then may enter the lower portions of the food chain in the microscopic plants and animals. As the mercury ascends in the food chain it becomes higher in concentration (so-called bioamplification) until in fish it may exceed one part per million.[14] The penetration by mercury into the food chain creates a hazard to eaters of fish from the River. A second pathway involves the inorganic or organic conversion of $Hg^{\circ}$ to $CH_3HgCl$ which can transform to $HgCl_2^{\circ}$ or $Hg(OH)_2^{\circ}$ (or other substances) depending on concentrational conditions, and which can also precipitate as insoluble solids and return to the sediments. Biological processes can play sharply different roles. Some bacteria converts $Hg^{\circ}$ to $CH_3HgCl$ under both reducing and oxidizing conditions, but much more rapidly under reducing conditions.[6] Other processes break down $CH_3HgCl$ to methane and $Hg^{\circ}$ especially more rapidly under oxidizing conditions.[30] Each aquatic system represents a complex set of process and reaction products set by boundary conditions, some of which are highly specialized, such as the huge amounts of metallic mercury in the Carson River Systems.

## Rehabilitation of the Sediments. . .

Mercury pollution has been dealt with around the world and these prior experiences can serve as guides. The major approaches that have been used are listed below:

- Control sources of input by industrial activities (i.e., mercury from chlor-alkalai plants[1]) and by agricultural activities such as mercury-compounds in anti-fungus dressings.
- Cover mercury-rich materials in lakes and ponds with layers of clay that block upward migration of mercury.
- Remove all mercury-containing material and put in sites where no hazard is posed.
- Remove all mercury-containing materials and extract mercury to levels low enough to permit special storage of the depleted material or its return to the original site.
- Carry out in-situ chemical reactions, absorptions, and precipitations. These methods provide ways to convert the mercury to separable forms and to recover or isolate them. They fall into the following approaches: co-precipitation on or in other solids; forming mercury-floatation agents; reduction to metal and incorporating in or on other metals; absorption on surfaces of organic and inorganic material; and exchanging mercury onto ion-exchange resins.

Detailed planning of mercury cleanup procedures requires the sampling and analyses of river materials over sufficient time and in reliable number to validate confidence in the data. Only after proper on-site studies and evaluation of the Carson River (which is an intitial major objective of the Carson River Project) can the distribution, forms, and amounts of mercury data be ascertained so as to design the best rehabilitation methods that specifically apply to the Carson River System.



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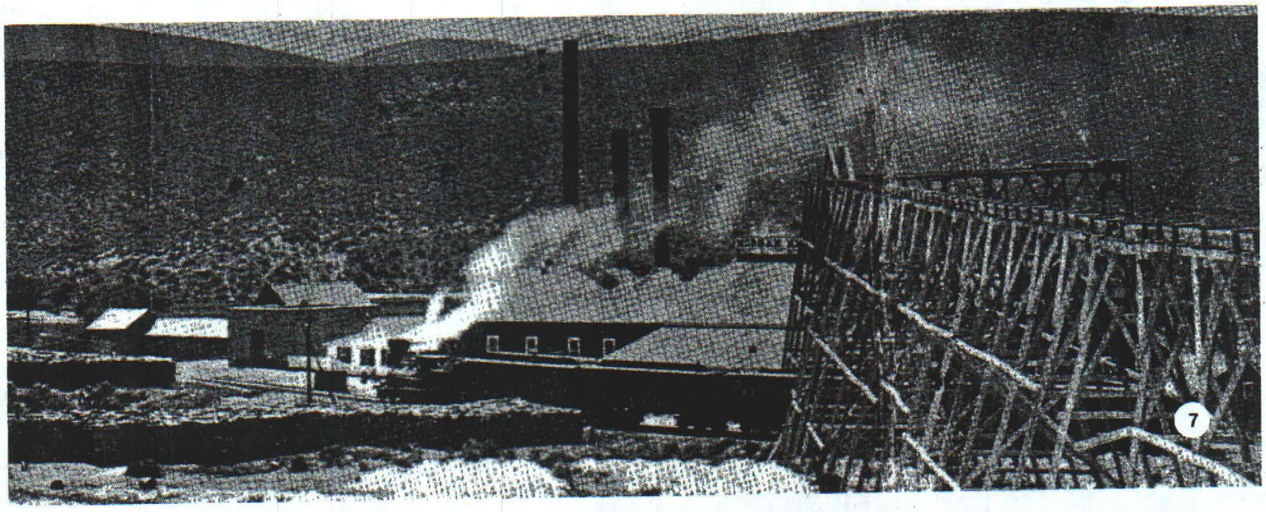

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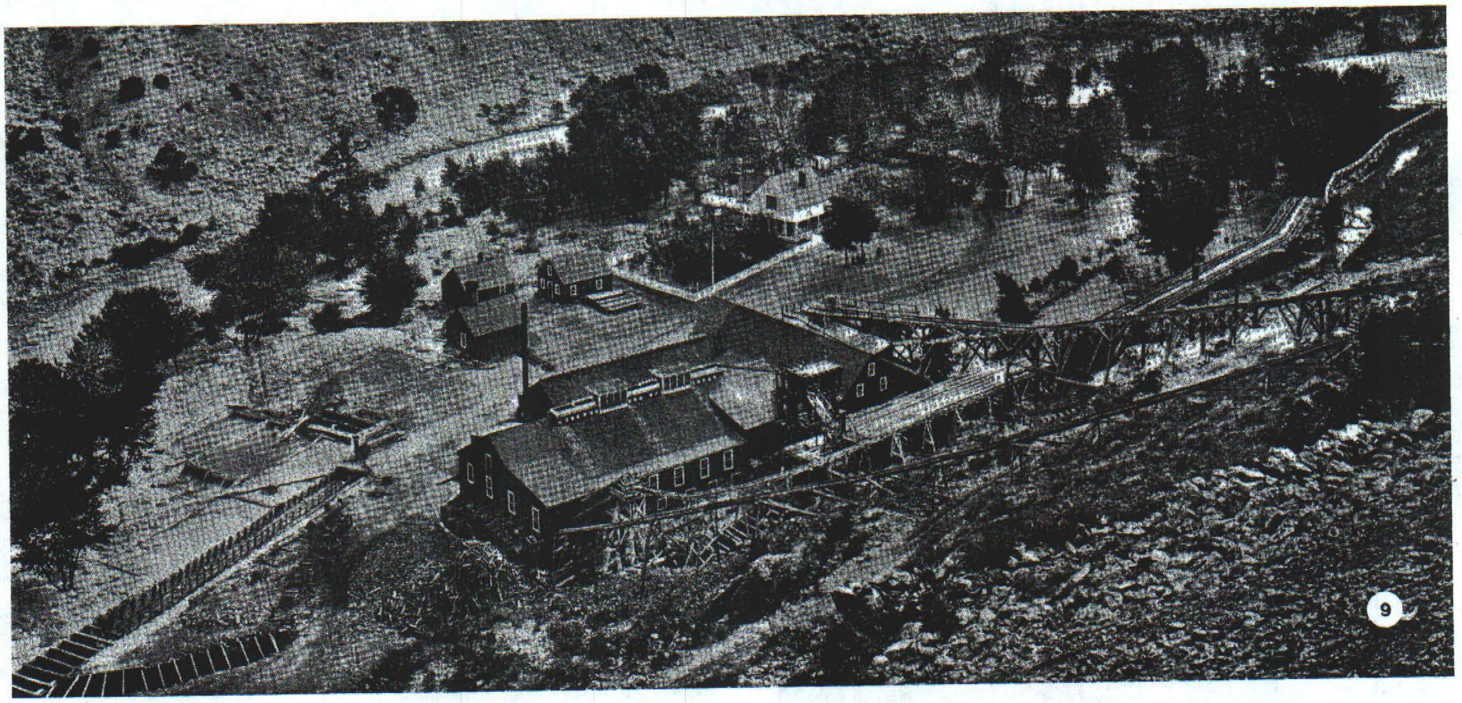

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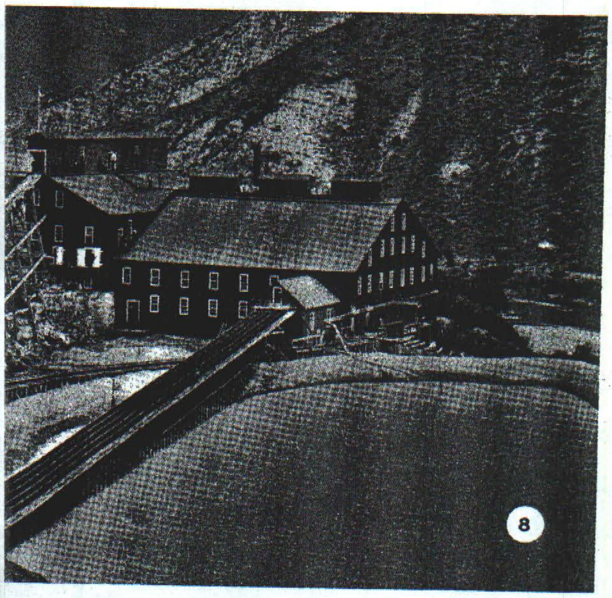
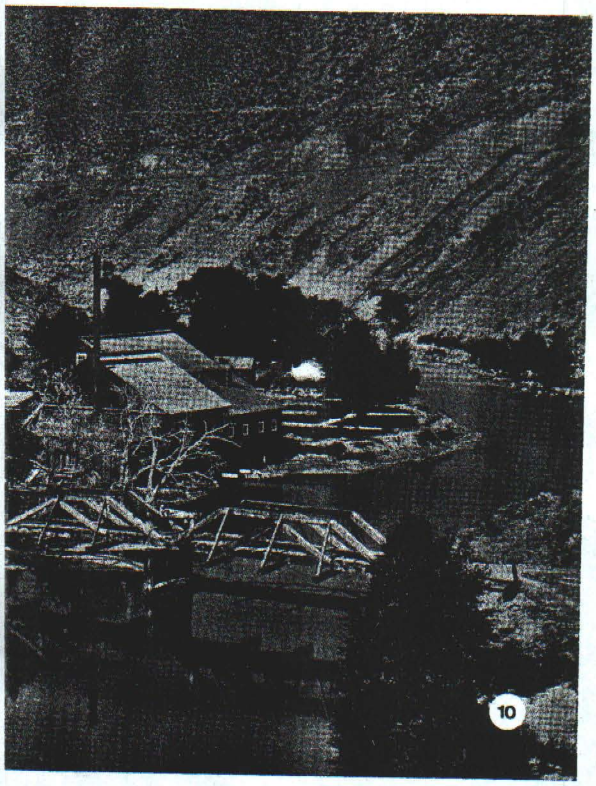
*Merrimac Mill upstream to Brunswick Mill*
*Morgan Mill receiving Comstock ore*
*Eureka Mill with waste pond*
*V&T Railroad view of Santiago Mill*
*Vivian Mill and bridge*




## THE CARSON RIVER LEGACY
## A Responsible Approach

THE CARSON RIVER PROJECT

# THE CARSON RIVER LEGACY

## A Responsible Approach

*Reminiscent of the historic development of the Comstock Lode through the partnership efforts of California pioneers and optimistic Nevadans, a similarly challenging opportunity exists today for the State of Nevada and private enterprise to cooperatively develop a responsible approach toward reducing the problem of continuing contamination by reclaiming mercury and the associated minerals of value from the Carson River System.*

These man-made pollution problems of today were inherited from the historic Comstock era milling and recovery inefficiencies. But hopefully today, modern technology and methodology can contribute to their solution. To do nothing, merely passes to future generations the continuing pollution legacy of the most exploited river in Nevada history; while predicted rises in values of recoverable minerals only promises to invite an increasing number of irresponsible, small-scale operations for the State to police.

### THE CARSON RIVER PROJECT

The Carson River Project was conceived and formulated to be in sharp contrast to past and recently attempted recovery operations. The Project organizers feel a responsible approach toward resolving the mercury pollution problems of the Carson River System is being proposed to the State of Nevada for the first time. A Project operating team has been assembled with the technological and scientific expertise, financial resources, environmental sensitivity, professional capability and management to accomplish the Project objectives.

A project of this anticipated magnitude, scope, and total sensitivity demands—and deserves—a commensurate plan of operation to assure its success. The Carson River Project objectives can be accomplished. Only through carefully planned phases of study and evaluation, with the cooperation, monitoring and approval of the appropriately related agencies of the State of Nevada, can the feasibility of the proposed Carson River Project be determined.

The ultimate objective requires the profitable reclamation of the recoverable mercury and other associated minerals of value from the Carson River System. Although mercury and its related compounds constitute a continuing environmental threat, the combined values of mercury, gold, silver, and other minerals represent a major resource for the State of Nevada. With the ultimate success of this Project, the State of Nevada would fulfill an obligation to environmentally protect its citizenry through the improvement of the quality of water in the Carson River System. Simultaneously, the State of Nevada would financially benefit from its royalty participation in the Project.

The Project organizers feel that the State of Nevada should have foremost confidence in the ability and capability of the Project to perform. After a thorough evaluation of the fundamental strengths of Parker Brothers & Co., Inc.—and their willingness to place their sixty years of performance and integrity on the line—the State of Nevada should be assured that the choice of this company as the Project Operator will provide a credible, responsible, and sensitive effort to methodically accomplish the Project objectives.

## PARKER BROTHERS & CO., INC.
## The Project Operator

In addition to their many essential fundamental strengths, Parker Brothers & Co., Inc.—as the Project Operator—brings to this endeavor years of experience in operational activities that closely parallel the anticipated type of operations that will be needed in the Carson River Project.

### Company Background . . .

Since its founding in 1923 and through sixty years and three generations of single family ownership, Parker Brothers & Co., Inc. has dramatically expanded its market position through its own internal, successful operations. Today, the Company and its consolidated subsidiaries is reported to be one of the largest privately owned construction raw materials producers in the State of Texas and the Southwestern United States.

The Company has proven experience and ability to efficiently recover, process, and transport large amounts of raw materials such as gravel, sand, crushed stone and concrete. The firm presently handles between 17 and 20 million tons of material per year with annual gross sales from these operations exceeding $150,000,000.

Headquartered in Houston, Texas, the parent Company also oversees the activities of its four wholly-owned subsidiaries: Houston Barge Line, Inc., with its manufacturing division, HBL Industries; Kelso Industries, Inc.; Southern Materials, Inc.; and Greens Bayou Machine Co., Inc. Together with these subsidiaries, the Company regularly employs more than 1,700 people in their operations. Many of these employees, like the Company's ownership, are multi-generation employees of the same firm.

Before the Company with its foresight, shifted its attention to meeting the growing demand for limestone in the Texas marketplace, Parker Brothers & Co., Inc. was one of the largest shell dredging operations along the bays of the Gulf of Mexico. In addition to other activities, the Company today operates one of the largest limestone quarries in Texas with more than 100 years proven reserves. Quality-graded crushed limestone from this quarry located in South Central Texas is computer-loaded into some 600 specially designed railcars for efficient and competitive delivery of products to the Company's Texas marketplaces.

Another major operation of Parker Brothers & Co., Inc., is the production and transportation of concrete. The Company owns and operates some 275 ready-mix concrete trucks from 17 concrete plants to strategically serve the demands of its market. To augment the concrete and aggregate business, the Company also owns and operates five stabilization plants, two asphalt plants, a concrete pipe plant, and a concrete block plant.

The Company's headquarters is but a short distance to their shipyard in the Port of Houston Ship Channel, from which Houston Barge Line, Inc. (a subsidiary) is involved in the transportation of materials throughout the inland waterways of North America. Cargoes coordinated from this location include fuel oil, asphalt, and various chemicals for such major customers as Exxon, Shell Oil, and Borge Warner. Overall, Parker Brothers & Co., Inc. owns and operates 53 barges, 17 tugboats, a sand dredge, and a shipyard for construction and repair of marine equipment and special heavy equipment used in the Company's various other operations.

**Project Management and Scientific Expertise . . .**

The principal executives concerned directly with this Project are W. R. Parker, Jr. (Chairman of the Board and President) and W. D. "Bo" Bankston (Vice President). These top Company executives have devoted their personal attention to the proposed Carson River Project, and on numerous occasions they have traveled to Nevada for first-hand evaluations of the Project area. Indicative of their years of management experience, it is apparent that their personalized attention to Project sensitivity will continue to be evident throughout all the phases of the Carson River Project.

The management staff of Parker Brothers & Co., Inc. will be augmented by acknowledged expertise in the various scientific fields of concern applicable to this Project.Two such experts—with particular emphasis on mercury related experience—have been retained in the organization of the Carson River Project. Their respective backgrounds in the scientific areas of exploration geochemistry and exploration geophysics are detailed in the Appendix pocket of this preliminary proposal. As specific and technological needs arise in Project operations, the Carson River Project management staff will enlist the appropriate services of recognized local and national scientific authorities.

## PRELIMINARY PROPOSAL

Upon effecting a mutually satisfactory agreement with the State of Nevada the Carson River Project will implement the following programs to initially determine if the ultimate objective of removing the minerals from the Carson River can be achieved within environmental standards:

**Economic feasibility . . .**

This program will involve sampling and evaluation of river materials to determine if there are economically recoverable amounts of mercury, mercury amalgam, gold, silver and other minerals present in the Carson River. This sampling will be conducted at selected sites deemed by the Project to have the best potential for higher values. Gradually the sampling grid will be expanded to determine the economic extent of these values and to determine the feasibility of conducting a successful economic operation.

This sampling program will be conducted with a special core-sampling device especially designed for this project. If necessary, other mechanical equipment and indirect measurements by geophysical methods may be used to obtain the best possible samples. Every effort will be made to conduct the sampling program with a minimum of disturbance to the River, consistent with the need to obtain good and sufficient samples to determine the feasibility of an operation to reclaim these values from the River.

**Mercury Control feasibility . . .**

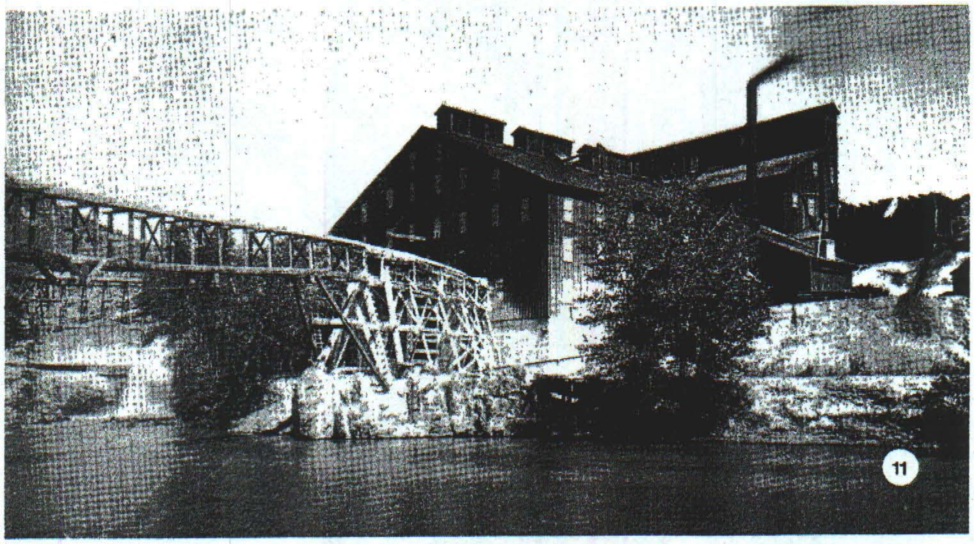
Although the proposed Project may be economically feasible, it is equally important to demonstrate that such an operation in the Carson River would not be creating a larger problem than would otherwise exist. Technical and scientific practicality must be established to ascertain if the Project can be conducted within acceptable environmental standards, with particular attention being given to the control and containment of mercury.

Knowing that in recent years mercury contamination has been successfully dealt with around the world, the Project management is confident that modern technology is available to overcome potential problems that might arise. Since each case of mercury pollution has a number of unknown factors and variables unique to its own environment, it will be necessary for the Project to commence a preliminary sampling program of the water, sediments and biota of the Carson River System to determine if prior proven methods of handling mercury pollution are applicable to this Project. This sampling program will be coordinated by technical experts, retained by the Project, who are professionally experienced in the field of mercury. The information gathered from this preliminary study will be used to determine if the Project will continue and will help formulate the more extensive study and evaluations programs in accordance with Environmental Protection Agency requirements.

**Conclusions . . .**

Upon the determination that the Project is deemed economically viable and the Project Operator is confident of the capability to be in full compliance with all related regulatory standards concerning the specific handling of mercury, the Carson River Project will commence all necessary EPA studies.

The Carson River Project will work closely with all related state agencies in the assurance that the Project will be managed with foresight and concern.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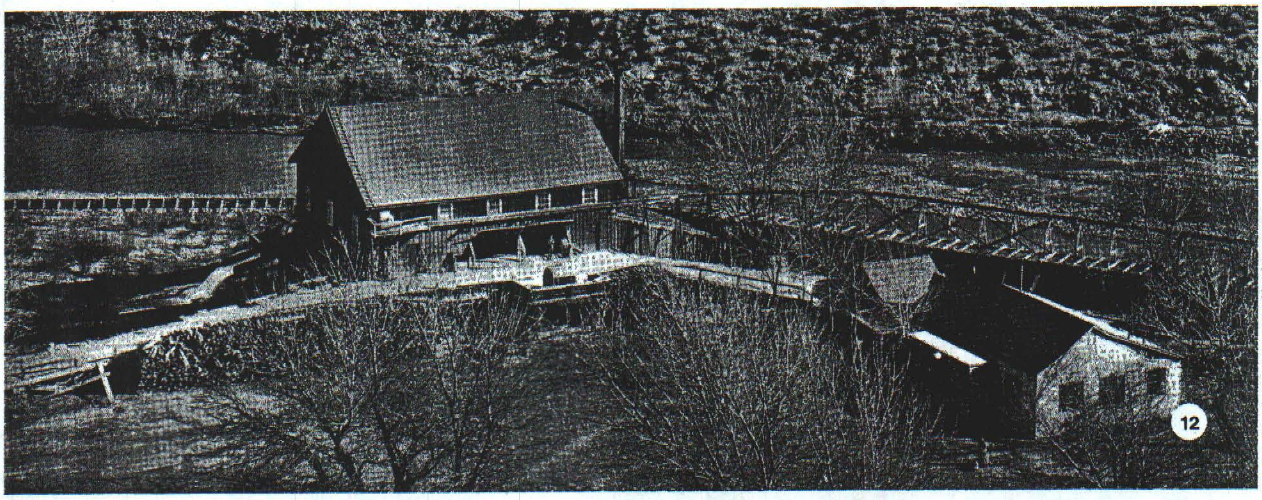
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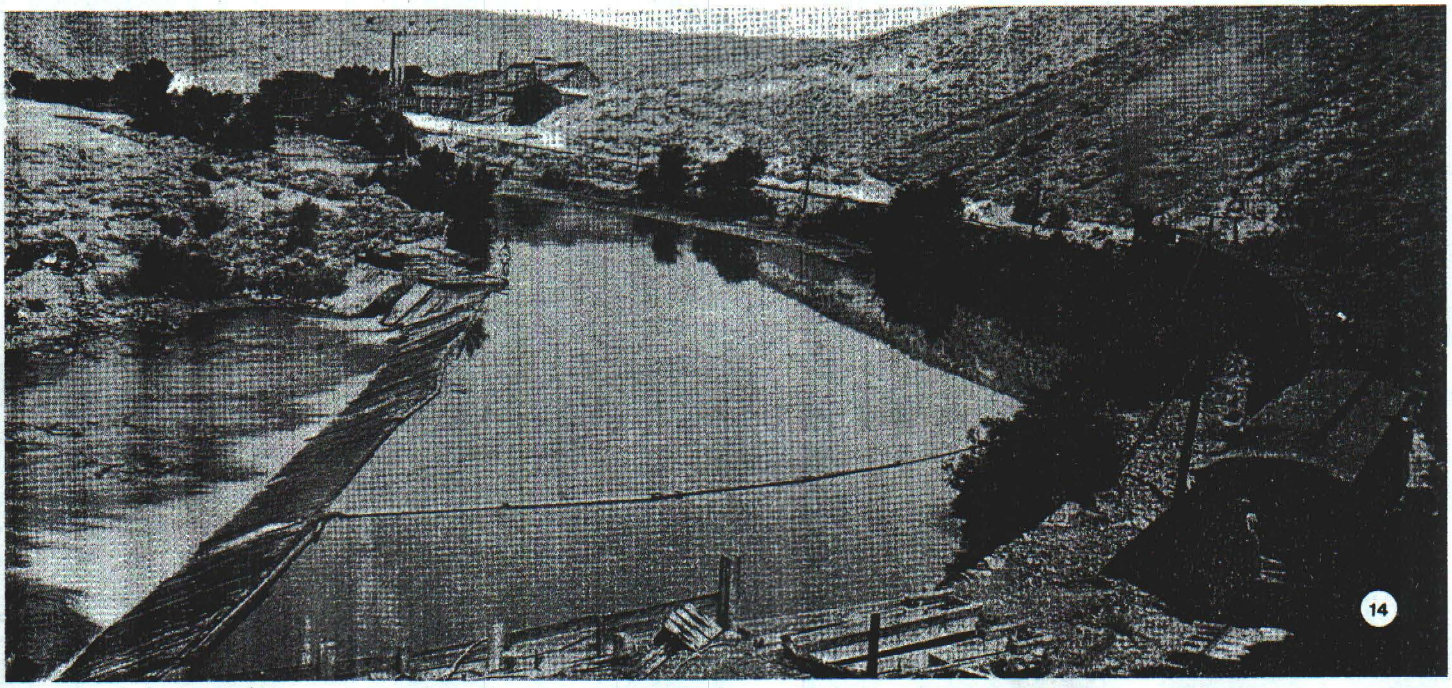
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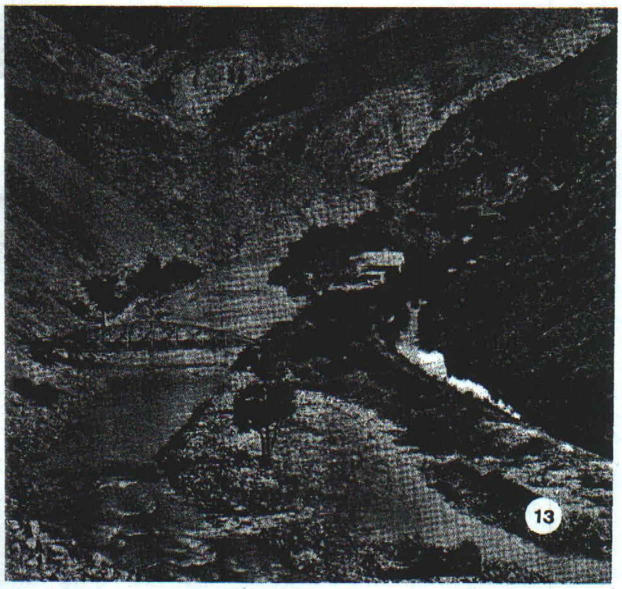
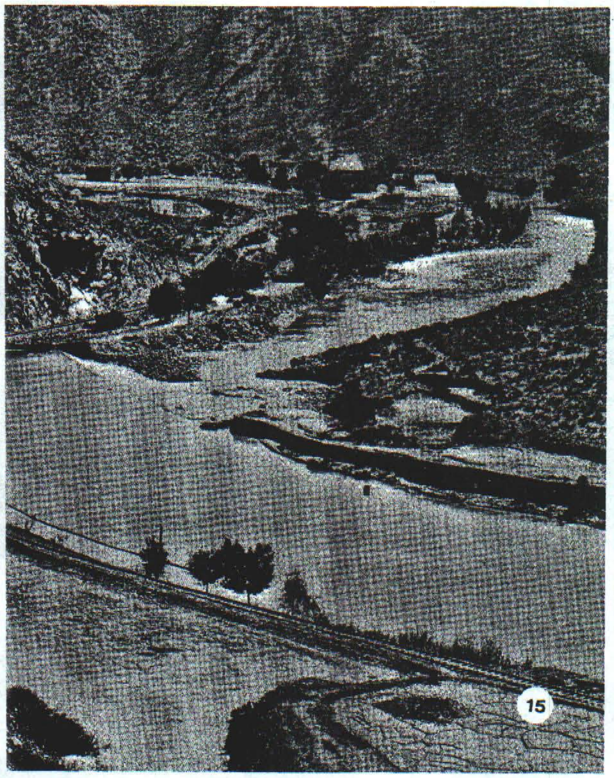
1. *Eureka Mill from River level*
2. *Franklin Mill from nearby hillside*
3. *Water ditch to the Vivian Mill*
4. *Merrimac Dam and Brunswick Mill*
5. *Brunswick tailing pond to Merrimac Mill*

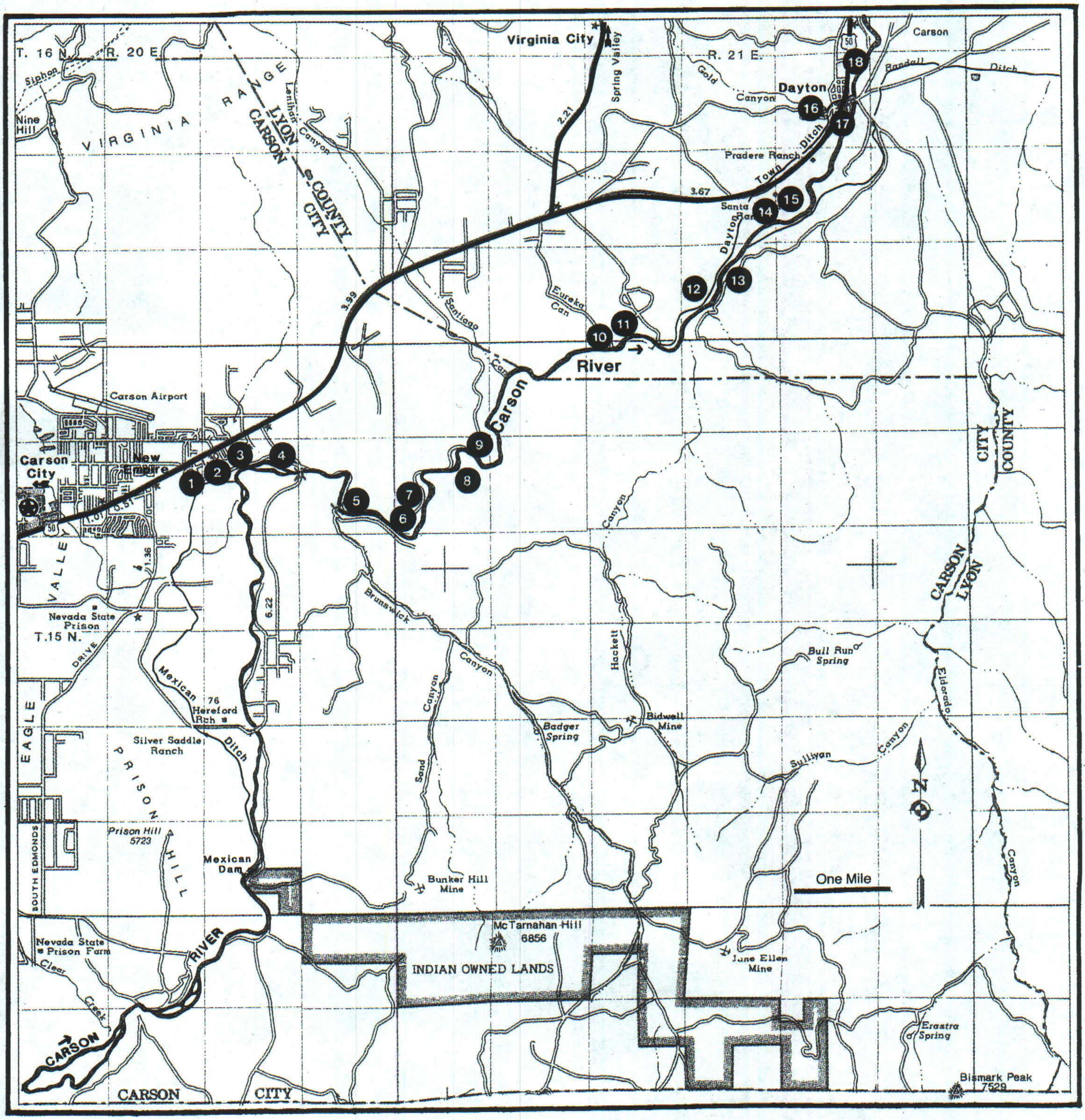



# APPENDIX

THE
CARSON
RIVER
PROJECT

## MAP 1

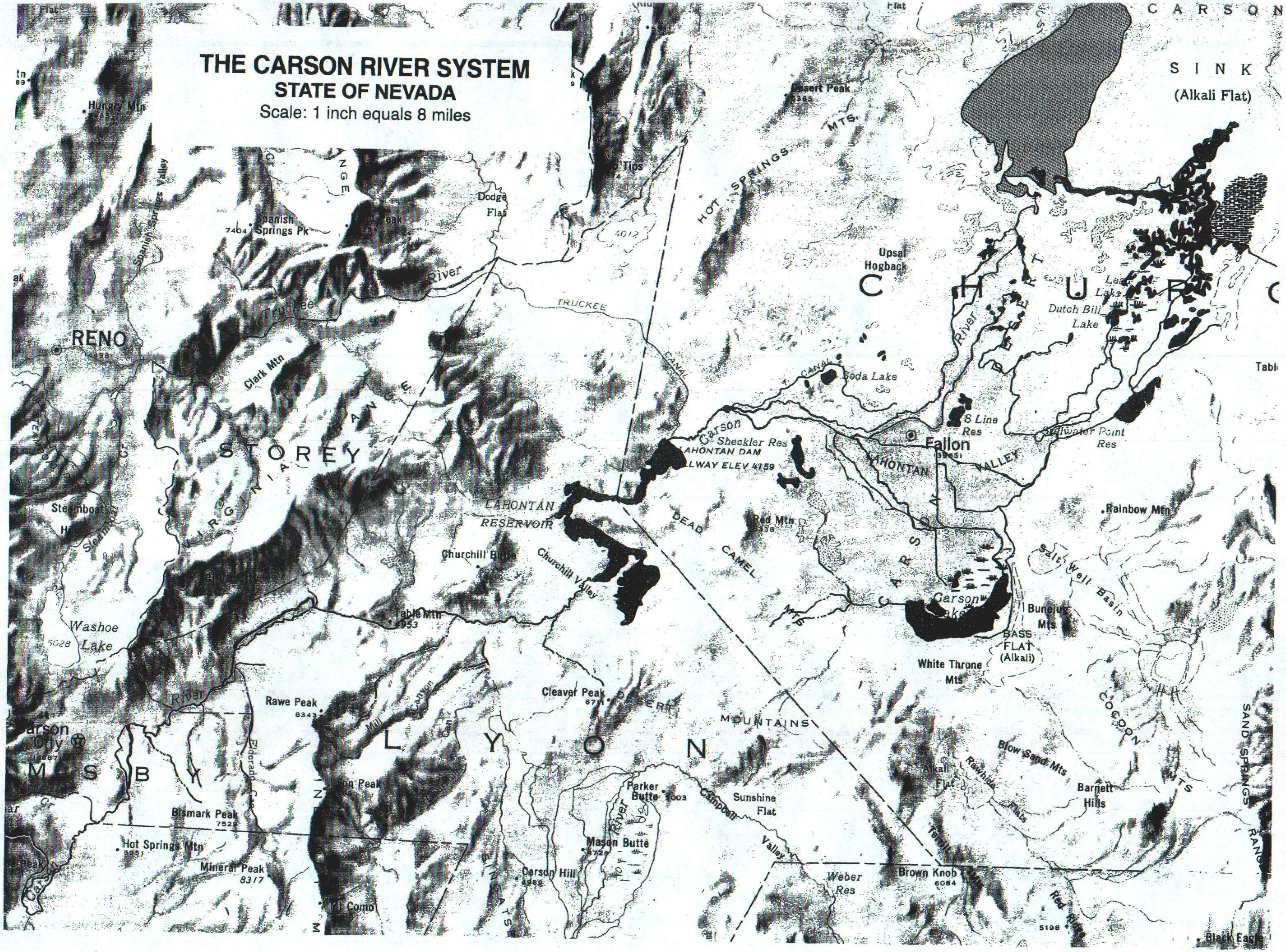



**MAJOR HISTORIC MILL SITES ALONG THE CARSON RIVER**
(1865)

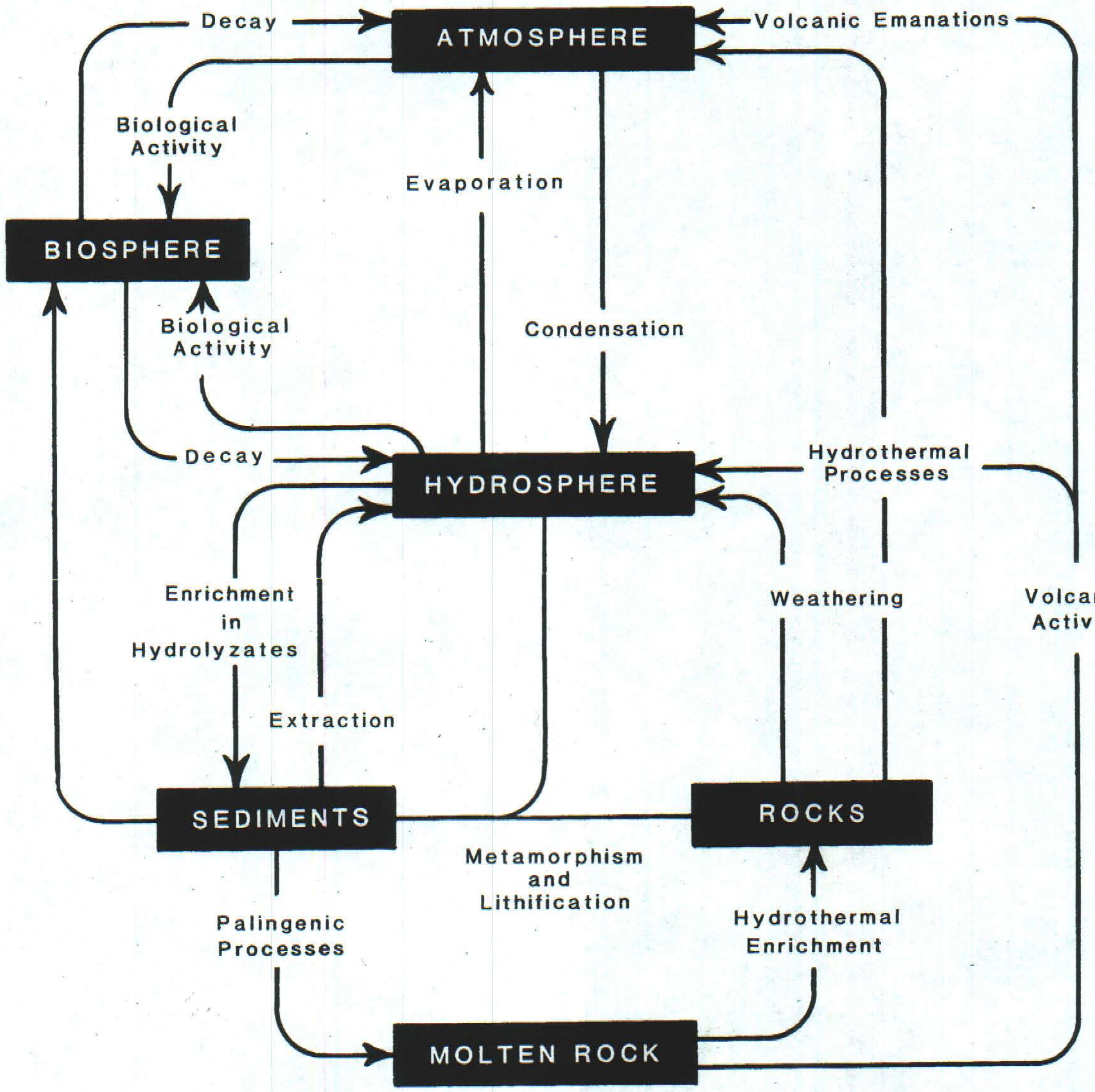
**STATE OF NEVADA**

**MILL SITE LOCATIONS (Shown Above)**

1. Mexican
2. Mead
3. Baldwin
4. Morgan
5. Brunswick
6. Merrimac
7. Copper Canyon
8. Vivian
9. Santiago
10. Eureka
11. San Francisco
12. Franklin
13. Island
14. Old Ophir
15. New Ophir
16. Golden Eagle
17. Illinois
18. Imperial


THE CARSON RIVER SYSTEM
STATE OF NEVADA
Scale: 1 inch equals 8 miles
CARSON
SINK
(Alkali Flat)
Hungry Mtn
RENO
Spanish Springs Pk
7404
Dodge Flat
River
TRUCKEE
CANAL
Clark Mtn
STOREY
Steamboat
Washoe Lake
HOT SPRINGS MTS
Desert Peak
Tips
Upsal Hogback
CHURCHILL
Soda Lake
S Line Res
Fallon
Dutch Bill Lake
Stillwater Point Res
Carson
Sheckler Res
LAHONTAN DAM
LAHONTAN RESERVOIR
LAHONTAN VALLEY
Churchill Butte
Churchill Valley
Table Mtn
Red Mtn
DEAD CAMEL MTS
CARSON
Carson Lake
Rainbow Mtn
Salt Well Basin
Bunejug Mts
BASS FLAT (Alkali)
White Throne Mts
COCOON MTS
SAND SPRINGS RANGE
Cleaver Peak
DESERT MOUNTAINS
LYON
Rawe Peak
8343
Carson City
Bismark Peak
Hot Springs Mtn
Mineral Peak
8317
Mt Como
Parker Butte
Campbell Valley
Sunshine Flat
Mason Butte
Carson Hill
Weber Res
Brown Knob
6084
Alkali Flat
Rawhide Flats
Blow Sand Mts
Barnett Hills
Red Ridge
5198
Black Eagle

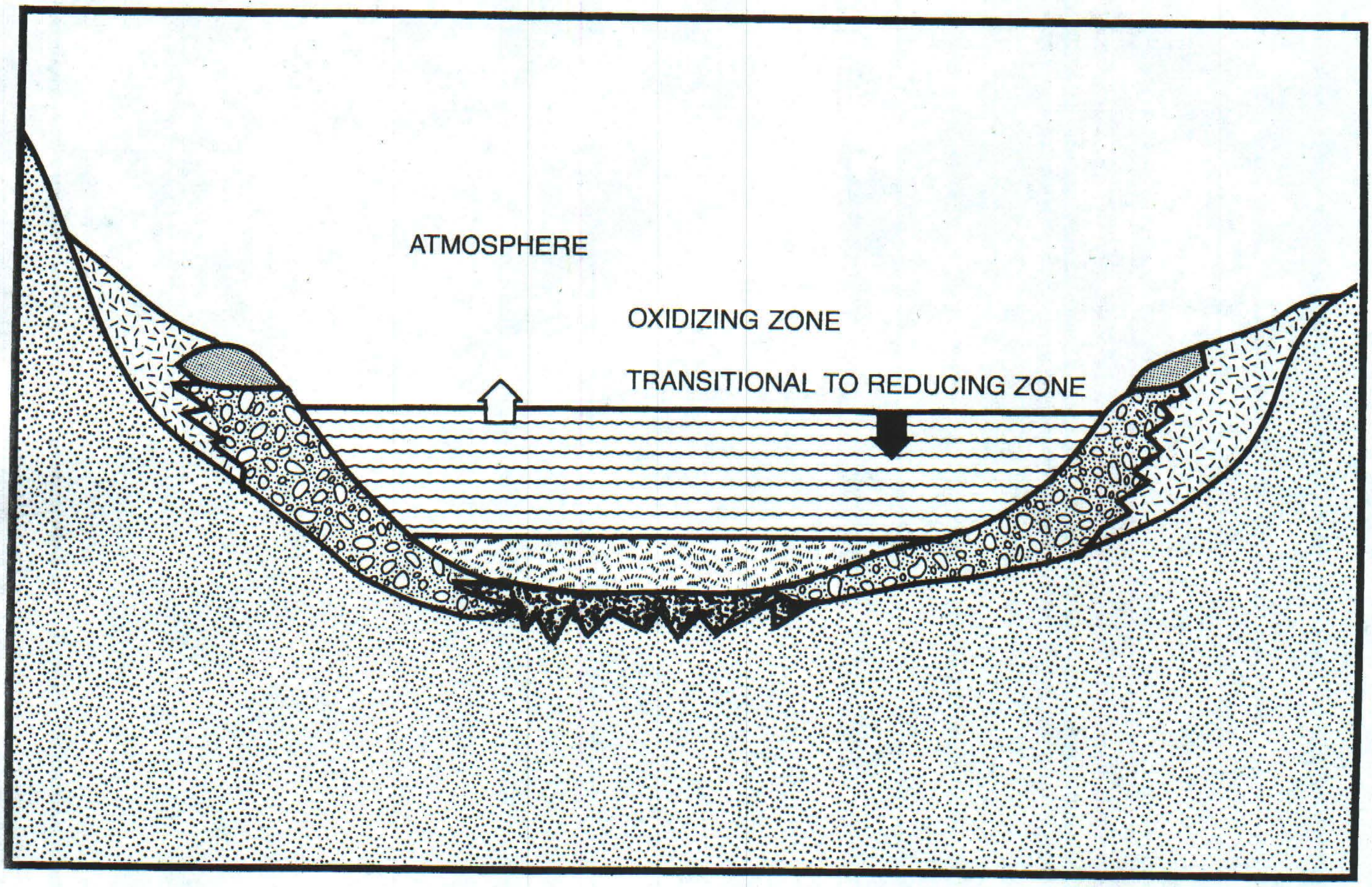
## FIGURE 1




## THE MERCURY CYCLE IN NATURE

The **mercury cycle in nature** is the world wide distribution of mercury in rocks, molten rocks (magma), water-deposited sediments, waters in the ocean, lakes, rivers and groundwater (hydrosphere), the sum total of plants and animals (biosphere) and the atmosphere, and the processes whereby mercury is mobilized, moved and retained in the different materials. Figure 1 is a diagram showing the important reservoirs of mercury, starting with mercury in a primitive source (molten rock) that is transported away in watery solutions and deposited in crustal rocks as mercury ore deposits and impregnations (hydrothermal enrichments). Mercury is transported in river sediments produced by rock weathering and erosion, to depositional basins where it may return to magma by deep burial and heat (palingenic processes), or it may be released by dissolving in watery solutions (extraction) that discharge into the hydrosphere. Mercury in the hydrosphere can volatilize to the atmoshere (evaporation), it can be incorporated in life forms (biosphere) by biological activity, or it can return to the sediments by formation of lowly soluble mercury compounds (enrichment in hydrolyzates). Mercury can also go directly from sediments to the biosphere or hydrosphere by decay or dead mercury-containing life forms. Mercury in the atmosphere can be delivered back to the hydrosphere by rainfall (condensation), thereon to join the mercury cycle of the hydrosphere. Another mode of input of mercury to the hydrosphere is discharge in gases given off by undersea volcanoes to the hydrospere (hydrothermal processes) or by surface volcanoes to the atmosphere (volcanic emanations). The grand cycle of mercury involves moving from the primitive source to various storage sites, with some mercury cycling around shorter paths.

## FIGURE 2




### SCHEMATIC CROSS-SECTION OF THE CARSON RIVER SYSTEM

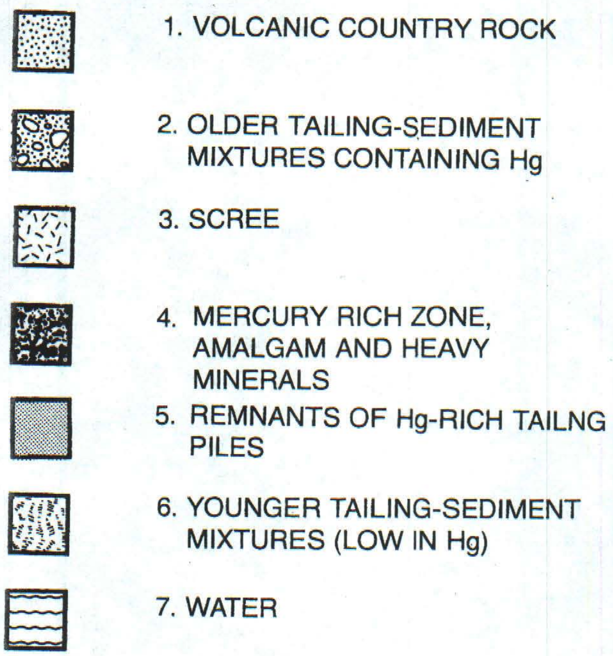
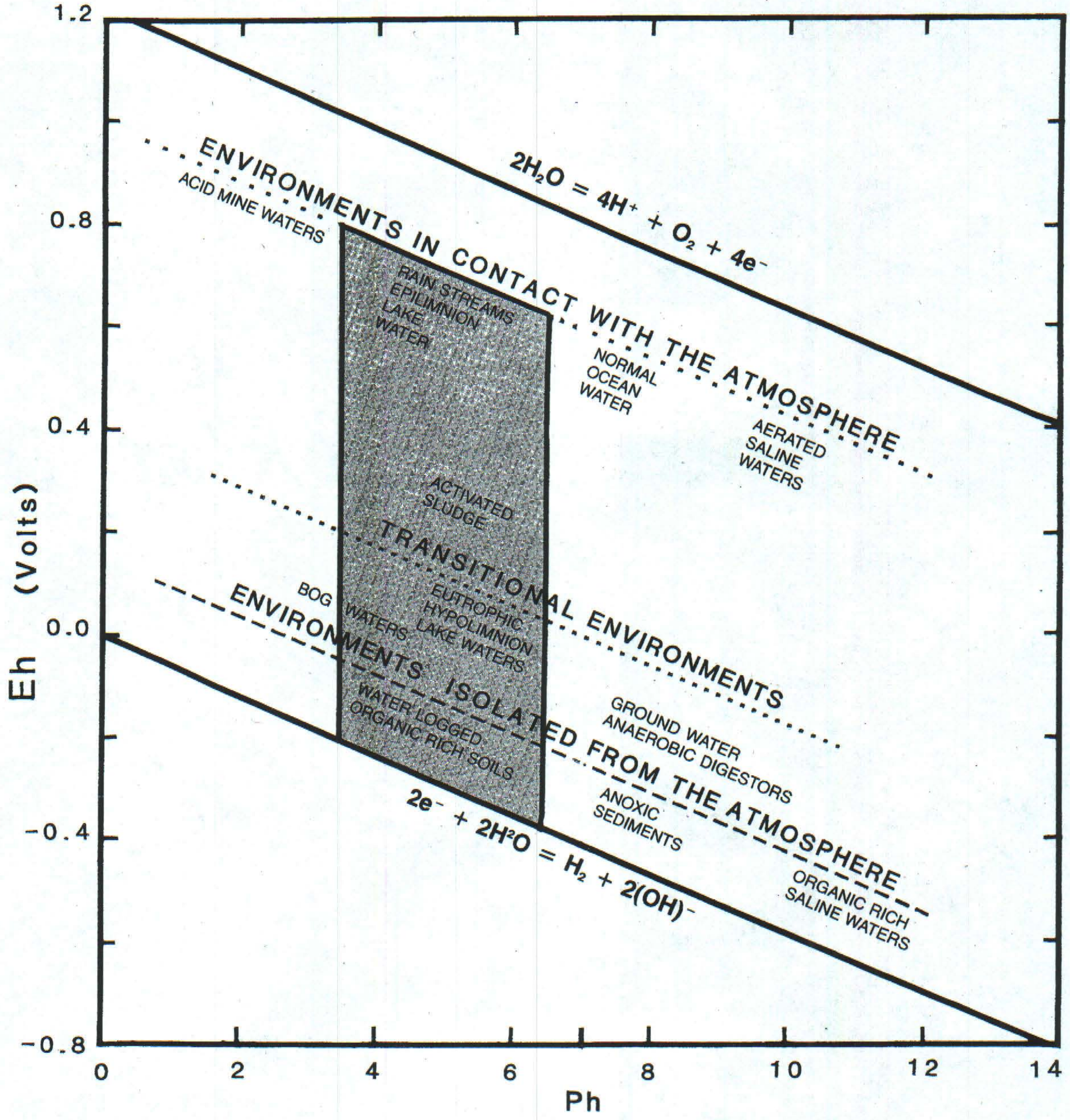



**Figure 2** is a schematic representation of one possible distribution of materials in the Carson River System as viewed in a cross-section taken at a right angle to the River between the uppermost mill and Lahontan Reservoir. The water (7) in the River is shown flowing on recently deposited tailing-sediment mixtures (6) and on somewhat older mercury-containing tailings (2) mixed with the sediments. The lower-most material refers to rich mercury, amalgam and heavy minerals (4) that have worked their way to the bottom of the sediments and into fractures and cracks in the volcanic bedrock (1). Laterally, the mercury-rich heavy material interfingers with rock debris, scree, shed from the hillsides (3). The most recently deposited younger tailing-sediment mixtures also overlay the older tailing-sediment mixtures containing mercury (2). Remnants of tailing piles are on river-cut terrace surfaces (5).

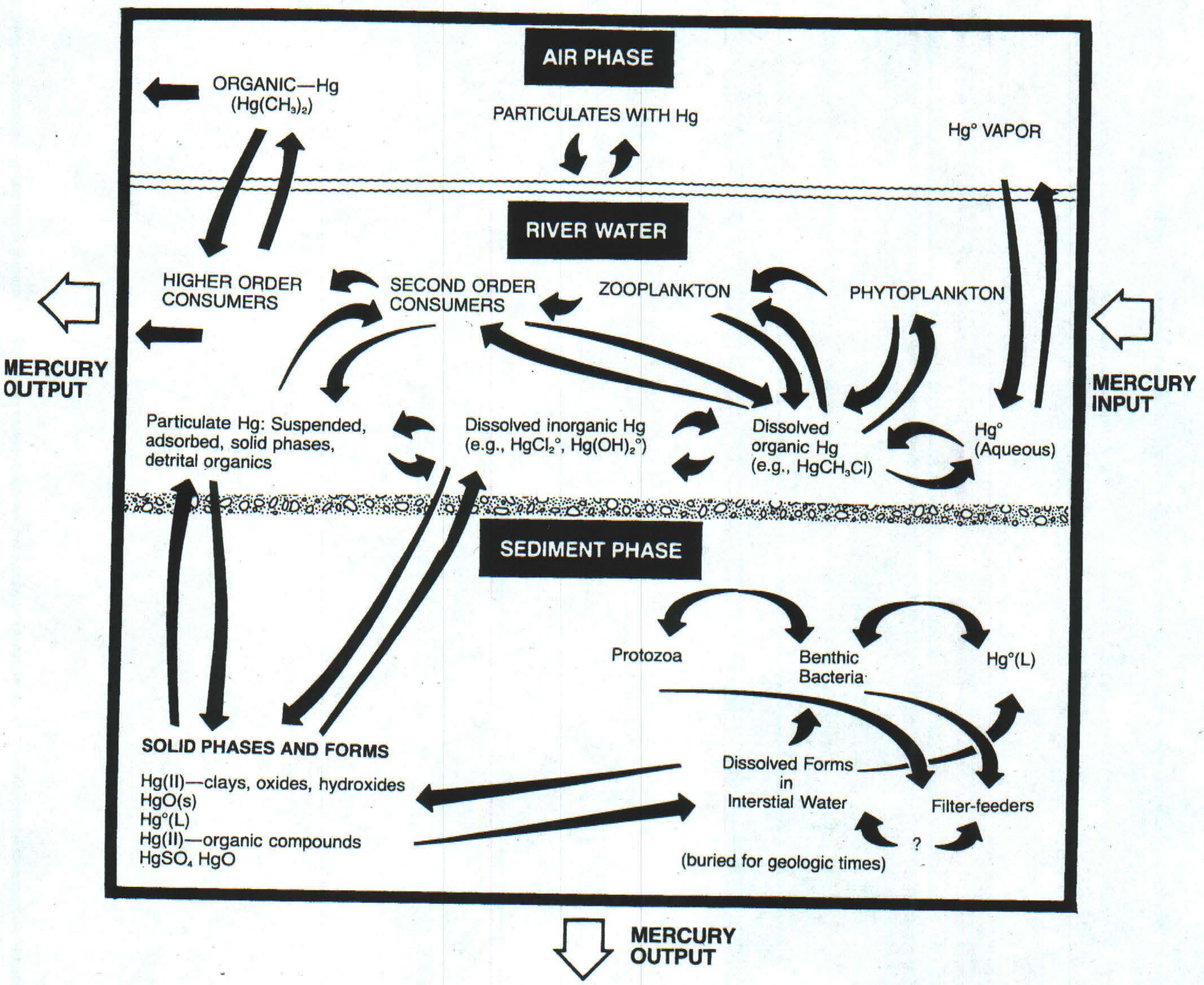
## FIGURE 3




**RELATIVE POSITIONS OF VARIOUS ENVIRONMENTS AS CHARACTERIZED BY Eh AND Ph**

**Figure 3** is an Eh-pH diagram showing ranges found in materials of surface environments, with the probable range expected in Carson River materials shown graphically by special shading. The Eh is a measure of oxidizing capability, with more powerful oxidation with higher positive values. The pH is a measure of hydrogen ion strength, with stronger acidity at lower pH values. The Eh-pH ranges in the Carson River System depend on (are set by) the amounts of oxygen as compared to reducing substances (organic substances, ferrous iron), successively deeper in the water and sediments. The presence of organic compounds in the sediment, contributed by sewage effluents, leads to low oxidizing (high reducing) conditions. Acidity in the dilute river waters is set by dissolved atmospheric carbon dioxide and the presence of carbonate-bicarbonate solution buffers, or effects of dissolved sulfide and organic matter. Deep in the sediments the Eh is negative (reducing) and the pH is acidic (3.5–6.5); overturning the sediments would sharply change Eh and pH to more oxidizing conditions.

## FIGURE 4




### CONCEPTUAL MODEL FOR THE TRANSPORT AND TRANSFORMATIONS OF MERCURY (Hg) IN AQUATIC ENVIRONMENTS

**Figure 4*** should be regarded as representing the three major parts of a river environment, river water, sediments and air above the river, with lists of mercury compounds and mercury-containing materials that may occur in each part. The interface between the sediment and river water is particularly important and it is emphasized graphically. Mercury that is input to river water, represented by an arrow, can dissolve to form soluble mercury, Hg° (aqueous), which may volatize to the air or be absorbed onto sediments, both suspended in the water and on the river bottom. Once in the sediments, the Hg° can be buried and effectively removed, or it can be metabolized by life forms to methylmercury compounds. The methylmercury may dissolve in the river water and be taken up by life forms or arranged in the food chain sequence, or it may volatize to the atmosphere. On death and decay of organisms, some of the mercury compounds settle to the bottom of the river to be acted on by organisms or be converted to solid compounds dispersed through the sediment. Each river has its own set of materials and reactions.

**This type of model assumes a dynamic system at steady-state.*

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