Recommendations and Conclusions

At the present market price of mercury, phase one could conceivably pay it's way while phase two offers less promise of being able to repay the loan. The application for exploration under phase one is recommended. Exploration under phase two should be dependent upon the success of phase one, as the added exploration would only be worth the high risk involved if the mine were producing from good ore found as a result of the phase one exploration.

MF-200
(June 1951)
(Revised Feb. 1952)

DOCKET No. DMEA 2448

COMMODITY Mercury

UNITED STATES OF AMERICA
DEPARTMENT OF THE INTERIOR
DEFENSE MINERALS EXPLORATION ADMINISTRATION

Docket Copy
IDM-E 544

EXPLORATION PROJECT CONTRACT [1]

IT IS AGREED this 5th day of June, 1953, between the United States of America, acting through the Department of the Interior, Defense Minerals Exploration Administration, hereinafter called the "Government," and [2] Ronnie B. Smith, Tower Petroleum Bldg., Dallas, Texas, Jene Harper, c/o Franklin Supply Co., Chicago, Illinois, and James F. Dunnigan, Chicago, Illinois - Partners

hereinafter called the "Operator," as follows: and as set forth in Annex I and Annex III.

ARTICLE 1. *Authority for contract.*—This agreement is entered into under the authority of the Defense Production Act of 1950, as amended, pursuant to DMEA Order 1 entitled "Government Aid in Defense Exploration Projects."

ARTICLE 2. *Operator's property rights.*—With respect to that certain land situated in the State of California, County of Contra Costa, described as follows: [3] The S½ of the SE¼ and the S½ of the SW¼ of the NE¼ of Sec. 29, T. 1 N., R. 1 E., Mount Diablo Base and Meridian; Recorded Feb. 1, 1954 (File No. 1060), except for area described in Annex II and shown on map attached hereto, made a part hereof, and entitled "U.S.G.S. Bulletin 922-Plate 6, DMEA-2448."

the Operator represents and undertakes: [4]

~~(a) That the Operator is the owner in possession and entitled to possession and that the property is subject only to the following claims, liens, or encumbrances to each of which the subordination agreement of the holder is attached:~~

(b) That the Operator is a lessee, in possession and entitled to possession, and the Owner's Consent to Lien is attached.

The Operator shall devote the land and all existing improvements, facilities, buildings, installations, and appurtenances to the purposes of the exploration project without any allowance for the use, rental value, depreciation, depletion, or other cost of acquiring, owning, or holding possession thereof.

ARTICLE 3. *Exploration project.*—The Operator, within 45 days from the date of this contract shall commence work on a project of exploration for [5] Mercury

in or upon the described land; and shall bring the project to completion within a period of 18 months from the date of this contract. The work to be performed is more fully described in Exhibit "A" attached hereto, which, with any maps or drawings thereto attached, are made a part of this contract. The Government will contribute to the cost of this work as hereafter provided.

ARTICLE 4. *Performance of the work.*—(a) *Operator's responsibility.* The work shall be performed efficiently, expertly, in a workmanlike manner, in accordance with good mining standards and State regulations for health and safety and for workmens' compensation and employers' liability insurance, with suitable and adequate equipment, materials, and labor, to bring the project to completion within the time fixed. To the extent specified in Exhibit "A," attached hereto, the work may be performed by independent contractor or contractors; and work not specified in Exhibit "A" for performance by independent contractor may nevertheless be so performed upon amendment of Exhibit "A," as agreed to by the parties, to state the work to be so performed and the estimated unit costs thereof, as provided hereafter.

(b) *Independent contracts.*—Any independent contract for the performance of work shall be on a unit-price basis (such as per foot of drilling, per foot of drifting, per hour of bulldozer operations, per cubic yard of material moved), or on some basis that will indicate the amount due for work performed at any stage of the work to be performed under such independent contract. The Government shall not be nor be considered to be a party to any such independent contract, and the Government's right to terminate the exploration project contract under any of its provisions shall not in any manner be affected by reason of any such independent contract. If the reference in Exhibit "A" to any such independent contract states that the Government's approval thereof is required, the Government may refuse to participate in the cost thereof unless and until it has given its written approval of the independent contract.

(c) *Government may inspect.*—The Government shall have the right to enter and observe and inspect the work at all reasonable times, and the Operator shall provide the Government with all available means for doing so. The Government may consult with and advise the Operator on all phases of the work.

ARTICLE 5. *Estimated costs of the project.*—A statement of the estimated cost of the project is set forth in Exhibit "A," attached hereto. Except insofar as any item of requirement or the estimated cost thereof set forth in Exhibit "A" is there or elsewhere designated as an "allowable maximum," such items of requirement and of related cost are estimates only, and may be exceeded to the extent that the Government may from time to time approve for the most economic and beneficial performance of the work within the limitation of the total aggregate estimate of costs. The Government's approval of any such excess over the estimate for an item of requirement or related cost will be signified by its approval and payment of any invoice or voucher for payment which expressly calls attention to such excess. Items expressly designated in Exhibit "A" or elsewhere as "allowable maximum," and the total aggregate estimated cost are limitations, and any excess therein will be for the sole account of the Operator in which the Government will not participate.

ARTICLE 6. *Allowable costs of the project.*—(a) The costs of the project in which the Government will participate are limited to the following:

(1) *Independent contracts.*—Payments to independent contractors under independent contracts listed in Exhibit "A." The estimated cost of any work to be performed under an independent contract is or shall be included in the estimate of costs in Exhibit "A" in terms of the estimated numbers of units of work to be performed, the estimated amount to be paid per unit, and the estimated total amount to be paid to the independent contractor, and such estimates shall be allowable maximums above which the Government will not contribute. Regardless of the provisions of any such independent contract, the Government will participate in the payments to the independent contractor only on account of work actually performed and that conforms with the provisions of the exploration project contract, and only to the extent that the Government deems the unit prices for the work under the independent contract to be reasonable and necessary. No such independent contract shall have the effect of increasing the estimated total cost of the exploration project contract nor the maximum amount which the Government will pay as provided in the exploration project contract.

(2) *Labor, supervision, consultants.*—Labor, supervision and technical services (including engineering and geological consultants), a schedule of which is included in the estimate or costs set forth in Exhibit "A." The requirements and related costs for supervision and technical services are allowable maximums.

(3) *Operating materials and supplies.*—Necessary materials and supplies including items of equipment costing less than $50.00 each, and power, water, and fuel, a schedule of which is included in the estimate of costs in Exhibit "A."

(4) *Operating equipment.*—Any operating equipment to be rented or purchased, or which is owned and will be furnished by the Operator, with the estimated rental, purchase price, or the allowable depreciation, as the case may be, a schedule of which is included in Exhibit "A." Any items listed as owned and to be furnished by the Operator, and related ~~initial~~ allowable depreciation, are allowable maximums.

(5) *Rehabilitation and repairs.*—Any necessary initial rehabilitation or repairs of existing buildings, installations, fixtures, and movable operating equipment, now owned by the Operator and to be devoted to the purposes of the exploration contract, a schedule of which is included in the estimate of costs set forth in Exhibit "A." These [illegible] maximums.

(6) *New buildings, improvements, installations.*—Any necessary buildings, fixed improvements, or installations purchased, installed, or constructed for the purposes of the exploration work, with the estimated cost of each, a schedule of which is included in the estimate of costs in Exhibit "A." All of these items are allowable maximums.

(7) *Miscellaneous.*—Repairs to and maintenance of operating equipment (not including initial rehabilitation or repairs of the Operator's equipment), analytical work, accounting, workmen's compensation and employers' liability insurance and payroll taxes.

(8) *Contingencies.*—Such other necessary, reasonable direct costs of performing the exploration work, within the limit of the total aggregate estimate of costs, whether or not included in any schedule of costs in Exhibit "A," as may be approved by the Government in the course of the work, as indicated by its approval and payment of invoices and vouchers.

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[1] If sufficient space is not provided in any blank, use an extra sheet of paper and refer to it in the blank.
[2] State name, address, and nature of organization if any.
[3] Give legal description or enough to identify the property, particularly excluding any land or interest therein to which the Government's lien is not to attach or the production from which is not to be subject to the Government's percentage royalty.
[4] Strike out the provision not applicable.
[5] Name of mineral or minerals.

16—04323-2

(b) The Government's payment in all cases shall be based on actual, necessary costs (including contract unit prices) incurred not in excess of any "allowance, maximum," and not in excess of the fixed percentage of the total aggregate estimated cost. Costs will be considered to be incurred only as they are or become due and payable.

(c) No items of general overhead, corporate management, interest, taxes (other than payroll and sales taxes) or any other indirect costs, or work performed or costs incurred before the date of this contract, shall be allowed as costs of the project in which the Government will participate.

ARTICLE 7. *Reports, accounts, audits.*—(a) *Progress reports.* The Operators shall provide the Government with monthly reports of work performed and costs (including contract unit prices) incurred under the contract, in quintuplicate (five copies), upon forms provided by the Government. These progress reports shall be certified by the Operator, and shall constitute both the Operator's invoice of costs incurred on the project during the period covered by the report and his voucher for repayment by the Government, unless the Government requires the use of a standard voucher form with invoice attached. Progress reports shall include surface and/or underground engineering-geological maps or sketches showing the progress of the exploration, with assay-reports on samples taken concurrently with the advance in mineralized ground.

(b) *Final report.*—Upon completion of the exploration work or termination of the contract the Operator shall provide the Government with an adequate geological and engineering report, in quintuplicate (five copies), including an estimate of ore reserves resulting from the exploration work.

(c) Compliance with requirements.—If, in the opinion of the Government, any of the Operator's reports are insufficient or incomplete, the Government may procure the making or completion of such reports and attachments as an expense of the exploration work; and the Government may withhold approval and payment of any vouchers depending upon insufficient or incomplete reports.

(d) *Accounts and audits.*—The Operator shall keep suitable records and accounts of operations, which the Government may inspect and audit at any time. The Government may at any time require an audit of the Operator's records and accounts by a certified public accountant, the cost thereof to be treated as a cost of the project. The Operator shall keep and preserve such records and accounts for at least 3 years after the completion of the project or the termination of this contract. Upon the completion of the project or termination of the contract the Operator shall render a final account as provided in Article 12.

ARTICLE 8. *Payments by the Government.*—(a) The Government will pay 75 percent of the allowable costs incurred, as they accrue, in an aggregate total amount not in excess of $56,179.25, which is 75 percent of $73,572.30, the agreed, estimated total cost of the project in which the Government will participate: *Provided*, that until the Operator's final report and final accounting have been rendered to the Government, and any final auditing required by the Government has been made, and a final settlement of the contract has been made, the Government may withhold from the last voucher or vouchers such sums as it sees fit not in excess of ten (10) percent of the maximum total which the Government might have been called upon to pay under the terms of the contract.

(b) The Government may make any payment or payments direct to independent contractors and to suppliers, for the account of the Operator, rather than to the Operator.

ARTICLE 9. *Repayment by Operator.*—(a) If, at any time, the Government considers that a discovery or a development from which production may be made has resulted from the exploration work, the Government, at any time not later than 6 months after the Operator has rendered the required final report and final account, may so certify in writing to the Operator. The certification shall describe broadly or indicate the nature of the discovery or development. In the event of such certification, any minerals mined or produced from the land described in Article 2 within 10 years from the date of this contract, including any mined or produced before the certification, shall be subject to a percentage royalty which the Operator or his successor in interest shall pay to the Government, upon the net smelter returns, the net concentrator returns, or other net amounts realized from the sale or other disposition of any such production, in whatever form disposed of, including ore, concentrates, or metal, until the total amount contributed by the Government, without interest, is fully repaid, or said 10 years have elapsed, whichever occurs first, as follows: See Article 21a, subscribed for what part of 5(a) preceding the colon.

(1) One and one-half (1½) percent of any such net amounts not in excess of eight dollars ($8.00) per ton.

(2) One and one-half (1½) percent of any such net amounts, plus one-half (½) percent of such net amounts for each additional full fifty cents ($0.50) by which such net amounts exceed eight dollars ($8.00) per ton, but not in excess of five (5) percent of such net amounts.

(For instance: The percentage royalty on a net amount of five dollars ($5.00) per ton would be one and one-half (1½) percent; on a net amount of ten dollars ($10.00) per ton, three and one-half (3½) percent.)

(b) As here used, "net smelter returns," "net concentrator returns," and "other net amounts realized from the sale or other disposition," mean gross revenue from sales; or if not sold, the market value of the material after it is mined in the form in which and the place where it is held. In the case of integrated operations in which the material is not disposed of as such, these terms mean what is or would be gross income from mining operations for percentage depletion purposes in income-tax determination.

(c) To secure the payment of its percentage royalty, the Government shall have and is hereby granted a lien upon the land described in Article 2 and upon any production of minerals therefrom, until the royalty claim is extinguished by lapse of time or is fully paid.

(d) This article is not to be construed as imposing any obligation on the Operator or the Operator's successor in interest to engage in any mining or production operations.

ARTICLE 10. *Assignment, transfer, or loss of Operator's interest.*—Without the written consent of the Government, the Operator shall not assign or otherwise transfer or hypothecate this contract or any rights thereunder. The Operator shall not make any voluntary nor permit any involuntary transfer or conveyance of the Operator's rights in the land described in Article 2, without making suitable provision for the preservation of the Government's right to a percentage royalty on production and lien for the payment thereof; *Provided*, that mere failure by the Operator to maintain the Operator's rights in the land, without any consideration running to the Operator other than relief from the cost of maintaining such rights (as by surrender of a leasehold, failure to perform assessment work, or failure to exercise an option), coupled with complete abandonment by the Operator of all interest in or operations on the land for a period of 10 years from the date of this contract, shall not constitute such a transfer or conveyance. Should the Operator make or permit any transfer or conveyance in violation of this provision, the Operator shall be and remain liable for payment to the Government of the same amounts, at the same times, as would have been paid under the terms of the percentage royalty on production. If for any reason the net smelter returns, net concentrator returns, or other net amounts realized from the sale or other disposition of such production are not available as a means of measuring the amount of the Operator's liability, the amount thereof shall be estimated as well as may be, and in the event of dispute as to such estimates, the determination thereof by the Administrator of Defense Minerals Exploration Administration or by his successor shall be final and binding upon the Operator.

ARTICLE 11. *Title to and disposition of property.*—All facilities, buildings, fixtures, equipment, or other items costing more than $50.00 each, paid for or purchased with funds contributed jointly by the Operator and the Government, although title may be taken in the name of the Operator, shall belong to the Operator and the Government jointly, in proportion to their respective contributions, and upon the completion of the work or the termination of the contract shall be disposed of promptly by the Operator for the joint account of the Government and the Operator, either by return to the vendor, by sale to others, or purchase by the Operator at a price at least as high as could otherwise be obtained, as may appear to be for the best interest of the Government, unless the Government, in writing, waives its interest in any such item. If necessary to accomplish such disposition, the Operator shall dismantle, sever from the land, and remove any such item, the cost thereof to be for the joint account of the parties in proportion to their respective interests. If the Operator, within 90 days after the receipt of written notice from the Government, fails, neglects, or refuses to dispose of such property, the Government may itself enter upon the land, take possession of, and remove and dispose of any such property as above provided.

ARTICLE 12. *Termination and completion.*—The Government may, at any time, by written notice to the Operator, terminate this contract: (a) If the Operator fails to provide his share of the money necessary to prosecute operations pursuant to the terms of the contract; (b) if the Operator, in the opinion of the Government, fails to prosecute operations pursuant to the terms of the contract; or (c) if in the opinion of the Government, operations up to the time of the notice have not indicated the probability of making any worth while discovery and in the opinion of the Government further operations are not justified. Upon the completion of the project or any termination of the contract the Operator shall dispose of any remaining materials, supplies, facilities, buildings, fixtures, and equipment in which the Government has an interest, for the joint account of the Operator and the Government in the proportion of their respective interests; shall render to the Government a full and final accounting of his operations under the contract and his expenditures of money; and shall pay to the Government its pro rata share of any money remaining.

ARTICLE 13. *Changes and added provisions.* .....

.....

.....

Executed in sextuplicate the day and year first above written.

THE UNITED STATES OF AMERICA

By .....
Administrator, Defense Minerals Exploration Administration

Partners

.....

.....

.....

I, ...certify that I am the secretary of the corporation named as Operator herein; that .....who signed this contract on behalf of the Operator, was then ..... of said corporation; that said contract was duly signed for and in behalf of said corporation by authority of its governing body, and is within the scope of its corporate powers.

.....

[CORPORATE SEAL]

U. S. GOVERNMENT PRINTING OFFICE 16—60328-1

EXPLORATION PROJECT CONTRACT
RONNIE B. SMITH
DOCKET NO. DMEA-2448

ANNEX I

Materials and Supplies. For the purpose of determining the Government's interest in materials or supplies remaining upon any termination of the work, they shall be considered in groups or categories (such as pipe, or explosives, or rails, or drill steel), and if the original cost of the remaining unexpended portion of any such group or category exceeded $50, the Government shall have an interest therein as provided in Article 11 of the contract form.

Equities in Equipment. Unless expressly permitted by provisions in Exhibit "A", the operator shall not procure equipment or any other item under a rental-purchase agreement, an installment-purchase agreement, any agreement which creates or builds up an equity or interest in the thing procured which can be converted to legal title only by further payment or some other consideration, or any agreement other than for straight rental or cash purchase and delivery.

Preservation of Property. Until the final disposal of any equipment or other property in which the Government has an interest or equity, the operator shall preserve and protect same for the mutual best interests of the parties, any reasonable and necessary cost thereof to be treated as an allowable cost of the exploration work to which the Government will contribute.

EXPLORATION PROJECT CONTRACT
RONNIE B. SMITH
DOCKET NO. DMEA-2448

ANNEX II

The land referred to in Article 2 as exempted from the lease from Mount Diablo Quicksilver Company to Ronnie B. Smith is shown on map "Bulletin 922-Plate 6, DMEA-2448" and is described as follows:

Beginning at the NW corner of the NW¼ of the SE¼ of Sec. 29, T. 1 N., R. 1 E., Mount Diablo Base and Meridian, thence running southerly along the dividing line between the NE¼ of the SW¼ and the NW¼ of the SE¼ of said Sec. 29, a distance of 20 chains to the SW corner of the NW¼ of the SE¼ of Sec. 29; thence running along the southerly line of the NW¼ of the SE¼ of Sec. 29, a distance of 2.924 chains; thence leaving said line and running in a northerly direction a distance of 20.23 chains; thence westerly to the point of beginning.

ANNEX [redacted]

The following provisions are in lieu of all of paragraph (a) of Article [redacted] which precedes the colon:

If at any time the Government considers that a discovery or development from which production may be made has resulted from the exploration work, the Government, at any time not later than six months after the Operator has rendered the final report and final account required by the exploration project contract, may so certify in writing to the Operator. Such certification shall describe broadly or indicate the nature of the discovery or development. The Operator, or his successor in interest, shall pay to the Government a royalty on all minerals mined or produced from the land which is the subject of the exploration project contract, as follows: (1) Regardless of any certification of discovery or development, from the date of the contract until the lapse of the time within which the Government may make such certification of discovery or development, or until the total net amount contributed by the Government, without interest, is fully repaid, whichever occurs first, unless the Government waives its right to a royalty; or (2) if the Government makes a certification of discovery or development, for a period of ten years (or other period fixed by the contract) from the date of the contract, or until the total net amount contributed by the Government, without interest, is fully repaid, whichever occurs first. Said royalty shall be a percentage of the net smelter returns, the net concentrator returns, or other net amounts realized from the sale or other disposition of any such production, in whatever form disposed of, including ore, concentrates, or metal, as follows:

EXPLORATION PROJECT CONTRACT
RONNIE B. SMITH
DOCKET NO. DMEA-2448

EXHIBIT "A"

Description of the Work

The objective of the project is to explore the subject property for mercury ore. The geological details, and the site and purpose of the shaft, are shown on USGS map attached hereto and entitled "Mount Diablo Mine, Contra Costa County, California" dated January 1953. As indicated on the "Bulletin 922-Plate 6, DMEA-2448," the work consists of the following:

1. Level shaft site, erect a headframe with ore pocket, install an electric hoist (including motor, starter, head sheave, and hoisting cable), and build tram from headframe to dump.

2. Sink a 2-compartment timbered shaft (in cross section 4 feet by 8.5 feet in clear of timber) to a depth of 330 feet.

3. At a distance approximately 300 feet below the collar of the said shaft, drive a crosscut approximately 200 feet (in cross section 6 feet by 7.5 feet in clear of timber) in a southerly direction through the vein structure on the hanging wall of the fault; and from the sides of the crosscut, drift (in cross section 6 feet by 7.5 feet in clear of timber) in opposite directions along the strike of the fault for approximately 425 feet.

The total advance of the crosscuts and drifts shall not exceed 625 feet, and the location of shaft, crosscut, and drifts shall be subject to Government approval.

4. Samples of vein material encountered during the exploration shall be cut by the Consulting Engineer and they shall be assayed for mercury content, the place of sampling and assaying being subject to Government approval. The Consulting Engineer must also be approved by the Government, and shall direct the entire exploration program and prepare all reports required under the contract.

Estimated Costs of the Project
(*Indicates allowable maximum)

(1) Independent Contracts

Sinking 2-compartment shaft
330 feet @ $121.20/ft.* 1/ $39,996.00*

Driving crosscut and drifts
625 feet @ $40.00/ft.* 1/ 25,000.00* $64,996.00*

(2) Labor, Supervision, Consultants

1 Consultant @ $500.00/mo.,
7 mos.* 2/ 3,500.00*

(3) Operating Materials and Supplies

None

(4) Operating Equipment

To be furnished by Operator, when needed, at no cost to the project.

3 Sterling trucks

1 International bulldozer

1 Dodge pickup truck

1 Joy Mfg. Co. wagon drill

3/4-yard Northwest power shovel

1 Ingersoll-Rand compressor

Auxiliary buildings, fuel oil and gas tanks, and loose tools

1/ This includes the cost of all necessary timbering, cost of all supplies, and maintenance and repair of all equipment. All equipment shall be furnished by Independent Contractor except that referred to in Item (4).

2/ This consultant shall be required to spend a minimum of two full days each week on the project, and this includes all his transportation costs.

To be purchased

1 only 50 H.P. hoist with motor and starter	$2,250.00*	
1 only 36-inch sheave	125.00*	
750 feet 5/8-inch hoisting cable	200.00*	$2,575.00*

(5) Rehabilitation and Repairs

None

(6) New Buildings, Improvements, Installations

Level shaft site, erect headframe, ore bin, tramway to dump (includes cost of all labor, Workmen's Compensation and Employer's Liability Insurance, and Payroll Taxes)	2,000.00*

(7) Miscellaneous

Assaying 125 samples @ $4.00/sample	500.00

(8) Contingencies

None

* * * * * *

Total Estimated Cost of Project	$73,571.00*
Government Participation @ 75%	$55,178.25*

MF-203

OWNER'S CONSENT TO LIEN

WHEREAS, the undersigned, as owner, co-owner, lessor, or seller has an interest in certain property in the State of CALIFORNIA, County of SIERRA COUNTY described ~~as~~ follows:1/

In a lease dated September 18, 1951, and recorded in book 1048, page 356 official records of said county

which is the subject of a proposed exploration project contract, hereinafter called the "contract", between the United States of America, hereinafter called the "Government", and

2/ Remote Earth, Inc.

hereinafter called the "Operator"; and

WHEREAS, under certain provisions of said contract which are set forth on the reverse side hereof, the Government is entitled to a percentage royalty on production and to certain other rights and equities which do or may conflict with or be adverse to the interest of the undersigned in said property;

NOW THEREFORE, the undersigned, in consideration of said contract and as an inducement to the Government to enter into same, undertakes and agrees as follows:

1. The Government's equity in and right to dismantle, sever, take possession of, and remove and dispose of facilities, buildings, fixtures, equipment, or other items as provided in the contract, or any amendment thereof, shall prevail over and be prior and superior to any conflicting or adverse rights of the undersigned, and the Government is authorized to enter upon the land for such purposes.

2. To secure the payment to the Government of the percentage royalty on production3/ provided for under the terms of said exploration project contract, or any amendment thereof which does not increase the maximum amount of the Government's claim here stated or alter the provisions for repayment, there is hereby granted to the Government a lien upon the land herein described and upon any production of minerals therefrom, until the royalty claim is fully paid in the amount of the Government's contribution, not in excess of 4/$ 135,000.00, or ten years have elapsed from the date of the contract.

3. The undersigned shall commit no act nor assert any claim that may contravene or conflict with the lien, claim, or rights of the Government under the provisions of said contract. This agreement shall be binding upon the heirs, executors, administrators, successors, and assigns of the undersigned.

Dated this 22nd day of April, 1953.

MT. DIABLO QUICKSILVER CO., LTD [Seal]

Vic Blomberg [Seal] President

[Seal] Vice-President

1/ Either (a) insert the legal description of the land, or (b) strike out the words "as follows" and insert "in a lease [or contract, deed, or other document] dated _____, and recorded in book _____ page _____ official records of said county." If (b) is used, the book and page of recordation cannot be dispensed with. If the space provided is insufficient, use an Annex, and refer to the Annex in the space.

2/ Insert the name of the Operator as it will appear in the exploration project contract.

3/ Mining or production from the land is not required, and in the absence of production there is no obligation to repay the Government.

4/ Insert the maximum amount of the Government's contribution.

RELEVANT CONTRACT PROVISIONS

Repayment by Operator. (a) If, at any time, the Government considers that a discovery or a development from which production may be made has resulted from the exploration work, the Government, at any time not later than six months after the Operator has rendered the required final report and final account, may so certify in writing to the Operator. The certification shall describe broadly or indicate the nature of the discovery or development. In the event of such certification, any minerals mined or produced from the land described in Article 2 within 10 years from the date of this contract, including any mined or produced before the certification, shall be subject to a percentage royalty which the Operator or his successor in interest shall pay to the Government, upon the net smelter returns, the net concentrator returns, or other net amounts realized from the sale or other disposition of any such production, in whatever form disposed of, including ore, concentrates, or metal, until the total amount contributed by the Government, without interest, is fully repaid, or said 10 years have elapsed, whichever occurs first, as follows:

(1) One and one-half (1½) per cent of any such net amounts not in excess of eight dollars ($8.00) per ton.

(2) One and one-half (1½) per cent of any such net amounts, plus one-half (½) per cent such net amounts for each additional full fifty cents ($0.50) by which such net amounts exceed eight dollars ($8.00) per ton, but not in excess of five (5) per cent of such net amounts.

(For instance: the percentage royalty on a net amount of five dollars ($5.00) per ton, would be one and one-half (1½) per cent; on a net amount of ten dollars ($10.00) per ton, three and one-half (3½) per cent.)

(b) As here used, "net smelter returns", "net concentrator returns", and "other net amounts realized from the sale or other disposition", mean gross revenue from sales; or if not sold, the market value, the market value of the material after it is mined in the form in which and the place where it is held. In the case of integrated operations in which the material is not disposed of as such, these terms mean what is or would be gross income from mining operations for percentage depletion purposes in income tax determination.

(c) To secure the payment of its percentage royalty, the Government shall have and is hereby granted a lien upon the land described in Article 2 and upon any production of minerals therefrom, until the royalty claim is extinguished by lapse of time or is fully paid.

(d) This article is not to be construed as imposing any obligation on the Operator or the Operator's successor in interest to engage in any mining or production operations.

Title to and disposition of property. All facilities, buildings, fixtures, equipment, or other items costing more than $50.00 each, paid for or purchased with funds contributed jointly by the Operator and the Government, although title may be taken in the name of the Operator, shall belong to the Operator and the Government jointly, in proportion to their respective contributions, and upon the completion of the work or the termination of the contract shall be disposed of promptly by the Operator for the joint account of the Government and the Operator, either by return to the vendor, by sale to others, or purchase by the Operator at a price at least as high as could otherwise be obtained, as may appear to be for the best interest of the Government, unless the Government, in writing, waives its interest in any such item. If necessary to accomplish such disposition, the Operator shall dismantle, sever from the land, and remove any such item, the cost thereof to be for the joint account of the parties in proportion to their respective interests. If the Operator, within 90 days after the receipt of written notice from the Government, fails, neglects, or refuses to dispose of such property, the Government may itself enter upon the land, take possession of, and remove and dispose of any such property as above provided.

Interior—Duplicating Section, Washington, D. C. 18264

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Bk. 2273
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BOOK 2273 PAGE 191

ASSIGNMENT OF LEASE

RONNIE B. SMITH, Trustee, of Tower Petroleum Building, Dallas, Texas, JENE HARPER, of Chicago, Illinois, and JAMES F. DUNNIGAN, of Chicago, Illinois, hereby assign to JOHN L. JONAS of 166 Los Robles Drive, Burlingame, California, and JOHN E. JOHNSON of 520 South Van Ness Avenue, San Francisco, California, all their right, title and interest in lease dated September 12, 1951, to them from MT. DIABLO QUICKSILVER COMPANY, LTD. a Nevada Corporation for a term of 5 years commencing October 1, 1951.

Dated: ~~December~~ November 1, 1953

Ronnie B. Smith, Trustee

Jene Harper

James F. Dunnigan

MT. DIABLO QUICKSILVER COMPANY, LTD., a Nevada Corporation, hereby consents to the above assignment and releases Ronnie B. Smith, Trustee of all obligation under said lease.

Dated: ~~December~~ January 20th, 1954

MT. DIABLO QUICKSILVER COMPANY, LTD.

By Vice President

By Harold Blumberg Secretary

(Corporate Seal)

In consideration of new lease by MT. DIABLO QUICKSILVER COMPANY, LTD. to JOHN L. JONAS, and JOHN E. JOHNSON executed on November 1, 1953, the above mentioned lease is hereby cancelled.

Dated: ~~December~~ January 20, 1953.

MT. DIABLO QUICKSILVER COMPANY, LTD.

BY Vice President

BY Harold Blumberg Secretary

(Corporate Seal)

John L. Jonas

John E. Johnson

Recorded at request of Grantee
55 min. past 10 A.M. FEB 2 1954
in Book 2273 Contra Costa County Records
Ralph Cunningham, County Recorder.
Recorded as an Assignment and as a
Cancellation of Lease.
Ralph Cunningham-County Recorder
By [illegible] Deputy

MT. DIABLO QUICKSILVER MINE

NARRATIVE REPORT FOR AUGUST 16 - 31 1953.

This report covers the period from August 16th thru August 31st 1953. On August 16th the operation got under way when C. W. Schuette established the collar elevation of the shaft, that is the level to which the shaft site was to be leveled by bulldozer, and laid out the shaft axes.

Leveling the shaft site was done by some drilling and blasting (item of $30.15 for explosives MF-104) to loosen the ground (item of $120.00 for labor of total labor item of $330.20) and by a bulldozer which was rented for one day at a cost of $60.00 (item of $60.00 under rental of operating equipment MF-104). Some additional leveling will have to be done for the 300 feet of dump track for which $216.30 for rails, bolts and track spikes and $27.50 for track ties have been spent. (these last two items are listed under Track and Track ties on MF-104).

Timber for the headframe to the amount of 1400 bd. ft. was on hand, costing $106.97 (under timber on MF-104). The front bent of the headframe was framed and being bolted together at the end of the month and total labor cost was $89.20 (part of total labor cost of $263.20 on MF-104). Nails for the headframe construction came to $25.05 and are so listed on MF-104.

Supervision and technical services are $80.00 for the period.

The original intention was to buy a headframe but as no suitable one could be found it was decided to build one and C.W.S. sketched out a design that could be built from used timber that could be obtained at the time. The headframe was being framed at the end of the month.

The shaft has been sunk 6 feet; a substantial spiler set has been framed over it and the first set below the collar has been concreted with suitable reinforcement by the end of the month.

The hoist was on its way to the camp and the cost of it and of the cable and clamps was $3000.20 and $168.00 respectively, entered under Hoist and cable on MF-104 at $3168.15.

Payroll taxes came to $5.73 as listed on MF-104.

Work was proceeding briskly, the crew was competent and the job is off to a good start.

C. W. Schuette

MT. DIABLO QUICKSILVER MINE.

NARRATIVE REPORT FOR SEPTEMBER 1953.

During September 1953, the headframe was completed and a small bin was built in front of it. On top of the bin a hinged chute was built to swing over the shaft for dumping the sinking bucket. Track for a mine car was laid from the bin to the dump.

The hoist was set on a substantial concrete foundation and was placed in operation.

The power line, which formerely passed over the shaft site, was moved to a new location and the necessary connections for the hoist were made.

The safety crosshead was installed on Sept. 23rd and on the 25th the actual work of sinking was started. At the end of the month the shaft was 28 feet down from the collar. The hoisthouse was being erected at the end of the month.

Costs:

The completion of the headframe cost as follows:

Labor on headframe	$ 984.13
Lumber	60.28
Iron (rods, bolts, angle irons etc)	251.38
Rent of crane to raise headframe	32.50
Total	$1378.29

Note: Of this total, $1290.77 has been entered on Forms MF-104 and MF-104A, as this brings the amount spent for "New Bldgs., etc", to the full allowable total of $2000.00.

The installation of the hoist cost (in part) as follows:

Concrete for Hoist foundation	$ 121.17
Reinforcing iron	18.54
Lumber for concrete form	5.87
Welding gas	9.14
Total	$ 153.72

Note: Of this total, $30.32 has been entered on Forms MF-104 and MF-104A, as this brings the amount spent to the full allowable total of $2350.00

C. J. Schmitt

INTERIM REPORT
Second

Docket No.: DMEA-2448 (Mercury) Sept. 25, 1953

Name and address of operator: Ronnie E. Smith and partners
Tower Petroleum Building
Dallas, Texas

Name and location of property: Mt. Diablo Quicksilver Mine,
SE 1/4 sec. 29, T. 1 N., R. 1 E.,
M. D. B. &M., Contra Costa County, Calif.

Contract No.: DMEA-244

SUMMARY AND CONCLUSIONS

The property was inspected on September 15 and 16, 1953 by an engineer of the U. S. Bureau of Mines accompanied by Mr. C. N. Schuette, consulting engineer, and by Mr. Vic Blomberg, assistant superintendent.

Work was started at the property on August 15, 1953. Work completed included shaft site leveling; and a portion of headframe construction and hoist installation. The shaft was sunk to a depth of 8 feet and concrete was poured for the collar set, hoist foundation, and hoist room floor.

Preliminary work was done efficiently and operating conditions were fair. The operator has not found a solution to water problems at the property described by the previous interim report of July 20, 1953. An independent contract for the shaft sinking operation has not been obtained by the operator.

RECOMMENDATIONS

(a) For improvement of operations: The operator should spend

more time on the property and should delegate either his consultant or superintendent with the authority to pay bills.

(b) Changes in project or target: None.

(c) Amendments to contract: None.

STATEMENT OF WORK COMPLETED

The shaft site was excavated and a 3-compartment shaft, measuring 4'-6" by 8'-6" was sunk to a depth of 8 feet.

A concrete collar set was poured at the shaft, and the construction of a headframe was nearly completed. The collar of the shaft was established at elevation 916 and near the location indicated by the contract.

A hoist with a 50-horsepower induction motor was being installed. A cross head, 750 feet of new 5/8" - 6x19 hoist cable, timber for headframe, 300 feet of 12-pound mine rail and other supplies needed for starting exploration operations were located at the property.

Supplies and equipment not on hand included a sinking bucket, air and water pipe, ventilation equipment and sinking pumps.

COMMENTS ON PROGRESS

Preliminary work was done efficiently by a skilled crew. The operator obtained the services of C. N. Schuette, consulting engineer, and Vic Blomberg, assistant superintendent who was a former operator of the property. The present crew consists of four workmen and includes Mr. Guy Castle, Melvin Bruner and two other shaft men. An independent contract has not been signed.

Excavation work for the shaft site required drilling and blasting to a depth of 3 feet. Equipment used by the operator included one TD-9 International bulldozer with scoop loader, one pickup truck, one portable air compressor with hoses, rock drills and hand tools. A bulldozer with an angle blade was hired for use in leveling the shaft site.

The Mt. Diablo Mining Co. has supplied welding and cutting equipment, hand tools and several small items.

Additional bracing of the headframe was needed. The assistant superintendent installed a 54-inch sheave and the shaft was widened to 8'-6" in clear of timber.

OPERATING CONDITIONS

Present operating conditions are fair. The operator, Ronnie B. Smith, is not in close touch with the exploration operation. The crew were living at Angels Camp, Calif. Mr. C. N. Schuette expressed the opinion that the operator should spend more time at the property and delegate someone to pay bills.

Difficult water problems will be encountered at the property after the shaft reaches the water table.

OPERATOR'S MONTHLY REPORTS

The operator's monthly narrative report was good. The monthly report and voucher for the month of August 1953 lacked copies of the payroll, original invoices or certified copies of equipment and supply purchases.

Geology

The shaft was collared in altered sheared serpentine. No mercury mineralization was encountered.

Sampling

Samples of water were taken from the portal of the 15th-foot level and from an evaporation pond at the property. The analyses will be included with the next interim report.

B. H. Sheahan
Mining Engineer

INTERIM REPORT
(third)

Docket No.: DMEA-2446 (Mercury) November 18, 1953

Name and address of operator: Ronnie B. Smith and partners,
Tower Petroleum Building,
Dallas, Texas.

Name and location of property: Mt. Diablo Quicksilver Mine
SE 1/4 sec. 29, T. 1 N., R. 1 E.,
M.D. B.&M., Contra Costa County,
Calif.

Contract No.: Idm-2944

SUMMARY AND CONCLUSIONS

The property was inspected on Nov. 18, 1953 by an engineer of the Bureau of Mines accompanied by Mr. Vic Blomberg.

The exploratory shaft was sunk and timbered to a depth of 155 feet. No mercury mineralization was found. The rock consisted of sheared black shale and graywacke.

Work progressed at a satisfactory rate. Water problems are expected to be encountered by the work. The shaft was practically dry at its present depth.

The operation was conducted efficiently under the general supervision of Mr. C. N. Schuette, Consulting Engineer. Labor was performed by an independent contract crew of five men, led by Mr. Guy Castle and Melvin Brunor. Mr. Ronnie B. Smith, trustee, has retained financial control of the operation.

RECOMMENDATIONS

a. For improvement of operations:

The operator should spend more time at the property. He should provide his superintendent with financial aid to handle water problems that may be encountered, and other factors involved with the work.

WORK COMPLETED

The two compartment exploratory shaft was sunk to a depth of 155 feet, and timbered with standard shaft sets of 8- by 8-inch timber and 2-inch lagging.

Surface facilities completed included the construction of a head-frame, hoist installation, hoist house, and dump track.

COMMENTS ON PROGRESS

Excellent progress was made on the work. Operations were temporarily stopped from Oct. 20 to Oct. 23 because of a failure of the hoist motor which had to be replaced.

The actual shaft sinking operation was done by independent contract at a price of $50.00 per foot for labor, who furnished explosives. Other material and supplies were purchased by the operator.

OPERATING CONDITIONS

Operating conditions were fair. Water has not yet been encountered in the shaft.

The operation was inspected by Mr. John C. Franz, California

State safety engineer on October 28, 1953. His recommendations for improvements will be carried out as soon as possible according to the operator.

EFFICIENCY OF OPERATIONS

Mr. C. N. Schuette, consulting engineer, has efficiently supervised the work with some assistance from Vic Blomberg, resident and former operator.

The labor employed under the independent contract were skilled in their occupation and included five workmen. The work was conducted on a one shift per day basis. The men worked from 8 to 12 hours per day and six days per week.

OPERATOR'S MONTHLY REPORTS

Expenditures listed by the operator for the month of October showed a total expenditure to date of $19,680.40 when the shaft was 117 feet in depth.

The operator's narrative report prepared by his consulting engineer was good.

UNUSUAL CIRCUMSTANCES

The independent contractors hope to complete the shaft sinking portion of the operation to a depth of 330 feet by January 1954.

Future progress will depend to a large extent upon water problems that will be encountered.

GEOLOGY

Advance was made in sheared black shale and graywacke. No mercury mineralization was observed in the shaft.

SAMPLING

Samples of water taken from the portal of the 165-foot level and from an evaporation pond at the property were analyzed by the Bureau of Mines, Hydrometallurgical and Ore Dressing Branch, Region III.

Sample No.	%. Solids	Remarks
S-240	2.30	Water from 165 level adit.
S-241	4.80	Water from large evaporation pond.

Spectrographic examination of residues from evaporation of water samples S-240 and S-241 detected the presence of Al, Fe, Ca, Mg, Na, and K. Si was not detected in either sample.

Examination with ultra-violet light and fluorescent screen detected Hg in residue S-240 only.

OTHER INFORMATION

According to Mr. Vic Blomberg, the operator may convey his lease on the property to Mr. John Jonas and associates.

B. H. Sheahan
Mining Engineer

MT. DIABLO QUICKSILVER MINE.

NARRATIVE REPORT FOR JANUARY 1954.

The shaft sinking was completed during January 1954.

The shaft is 330 feet deep and timbered to the bottom. At the very bottom a little water is seeping in. At a depth of 300 feet from the collar, a 14 foot station set was placed in the shaft and the crosscut was started to the south, at right angles to the long axis of the shaft. At the end of the month this crosscut was 43 feet long. The crosscut was entirely in the shales thru which the shaft was sunk, it was dry and has not been timbered to date. No provision was made in the contract for a shaft station and no station has been cut out.

Sinking was completed on January 16th and crosscutting started on the 18th using the sinking bucket for hoisting. After the crosscut had been advanced some 20 feet, the shaft was cleaned out and timbering was completed. Then a cage was hung in the shaft to hoist the 20 cu. ft. mine cars which are being loaded by a #12 Eimco mucking machine.

At the shaft collar, tracks were laid from the shaft to a turntable under the bin chute. The dump track was extended north, crossing the road to a new and unlimited dump site.

A supply of transite pipe is on hand for the pump and a supply of peeler logs, some 8'-5" long and some 10" in diameter is on hand for timbering the crosscut.

The Contract No. IDM-E 544, Docket No. DMEA 2442 under which this work is being done, was transferred from:

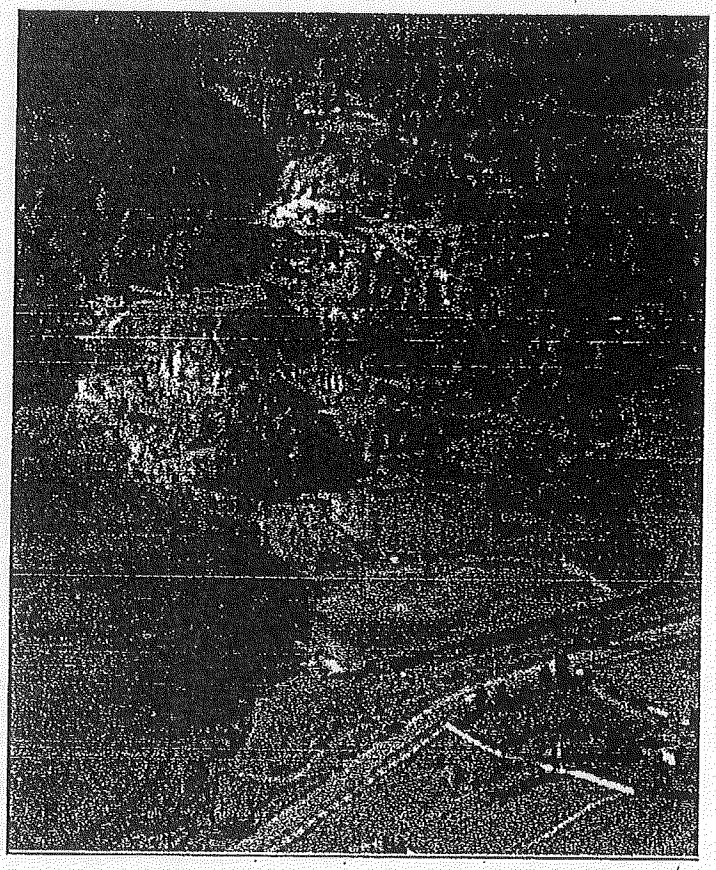
Ronnie Smith, Trustee,
2106 Tower Petroleum Bldg., Dallas 1, Texas. to:

John L. Jonas & John E. Jonnson,
166 Los Robles Drive, Burlingame, California.

Assignment ?

C. H. Schuette.

PRP SEARCH REPORT
SITE CHRONOLOGY AND PROPERTY HISTORY
MT. DIABLO QUICKSILVER MINE
CONTRA COSTA COUNTY, CALIFORNIA



Prepared By:

US Army Corps of Engineers ®

Sacramento District
Geotechnical & Environmental Engineering Branch

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APPENDICES

1.0 INTRODUCTION

1.1 Background

Mount Diablo Mercury Mine consists of a western and an eastern underground mine works, an open-pit mine, and mill works located in Township 1 North, Range 1 East, Section 29, Mount Diablo Baseline and Meridian (Figure 1), three miles from the City of Clayton, Contra Costa County, California. Mining activity began as four cinnabar mining claims; the Powell, Hastings, Welch, and Bendixen claims (Figure 2). The subject properties are Contra Costa County Assessor Parcel Numbers 078-060-034, 078-070-036, and 078-070-034 as well as 078-060-032 (Figure 3).

According to the public record at Contra Costa County, the acid mine drainage first came to the attention of the State of California in March 1939. A County prison farm (Thomas B. Swift Sunshine Preventorium) located downstream of the mine observed iron and sulfuric acid discharge to the creek and contacted the California Bureau of Sanitation, Department of Public Health . Mine drainage also elevated chloride from interception of natural spring water. In response, the mine operator constructed a catch basin that functioned to percolate acid mine drainage into the subsurface during the dry season and overflowed during the rainy season. The result was that sporadic complaints of hard water in downstream wells began to occur. Eventually, the prison farm abandoned its wells.

The United States Public Health Service published the first chemical water quality standards in 1946. After this, regulatory interest in the mine drainage by the Bureau of Sanitation, California Department of Public Health increased as evidenced by an increase in correspondence found in the County records. The focus at this time was on general water quality parameters, not toxicity.

The California Dickey Water Pollution Control Act was passed in 1949. On June 9, 1952, the Water Pollution Control Board #5 (predecessor of the Regional Water Quality Control Board Central Valley Region) issued the first waste discharge requirements for the mine discharge, Order No. 135. The order was written to Mr. Ronnie B. Smith. The Regional Water Pollution Control Board later issued Resolution Number 53-21 on February 27, 1953. Mr. Smith lost interest in the mine shortly after this occurred and the partnership of Jonas and Johnson assumed operation. The most recent order in the record is Order No. 78-114 on September 8, 1978 issued to Jack Wessman.

The original order included a pH neutralization requirement and resulted in the use of lime in the pond during high flow by 1958. Also in 1958 acid mine drainage was found to be polluting the water in the Kings Marsh Creek Springs Resort Swimming Pool.

This report was prepared by the Geotechnical and Environmental Engineering Branch of the Engineering Division, Sacramento District, United States Army Corps of Engineers (USACE).

1.2 Approach

This report follows EPA's guidance document titled PRP Search Manual (USEPA, 2003). A Baseline PRP Search has been conducted. The "Site Chronology and Property History Report" is presented here using the format suggested on Page 212 of the manual. The report does not include a PRP Synopsis Report.

1.3 Key contacts

Position	Name	E-mail	telephone
Program Manager	[redacted]	[redacted]@usace.army.mil	505-342-3435
Project Manager	[redacted]	[redacted]@usace.army.mil	916-557-7455
EPA Region IX Counsel	Larry Bradfish	Bradfish.Larry@epamail.epa.gov	415-972-3934
EPA Region IX RPM	John Hillenbrand	Hillenbrand.John@epamail.epa.gov	415-972-3494
USACE_Counsel	[redacted]	[redacted]@usace.army.mil	916-557-5293
Technical Lead	[redacted]	[redacted]@usace.army.mil	916-557-7903
RWQCB	Victor Izzo	vizzo@waterboards.ca.gov	916-464-4626
RWQCB	Ross Atkinson	ratkinson@waterboards.ca.gov	916-464-4614
Contra Costa County	Edward Turner (GIS)	eturn@pw.cccounty.us	925-313-2015
	Lillian Fujii	LFuji@cc.cccounty.us	925-335-1814
	Linda Wilcox (counsel)	LWilc@cc.cccounty.us	925-335-1800
	Sue Loyd (Hazmat)	sloyd@hsd.cccounty.us	925-250-7912
	Mitch Avalon (PW)	maval@pw.cccounty.us	925-313-2203
CH2MHill	Todd Wang	Todd.Wang@CH2M.com	916-563-2521

1.4 Report Overview

The report is divided into a site history and a property history. The site history discusses operations at the site and the permitting and regulatory history. The property history is a discussion of property ownership evidenced by legal documents such as titles, deeds and liens, and also discusses any environmental studies documenting risk to human health and the environment. All available references cited in the report are found in Chapter 4.0 (References) have been included in Appendix B as a compact disc. The land in Section 29 was patented to individuals by the US General Land Office in the late 1800s. Since then the land has been subdivided. A cross-reference table is included in Table 1 that correlates present day subdivision assessor parcels to original quicksilver (mercury) mining claims filed with Contra Costa County and the United States General Land Office as an aid to the reader.

2.0 SITE HISTORY

Some background information is necessary to understand the early history of the Mount Diablo Mercury Mine. A timeline is included in Appendix A. In the early days of American westward expansion, federal land was not yet surveyed, mining laws were inadequate or non-existent, squatting and sometimes violent disputes over mining claims was common. At Mount Diablo, many mercury mining claims were established years before the United States General Land Office (GLO) established control over public land. The initial mining claims were filed with Contra Costa County and recognized by the GLO only decades later. Subsequently the land was subdivided, consolidated, and subdivided again. In order to understand how the present and past parcel boundaries were drawn and hence which present and past property owners might be Potentially Responsible Parties (PRPs), and to understand the reasons for the sudden commencements and terminations of mining activities according to the market price of quicksilver (mercury) it is helpful to place the past mining activity in historical context.

California gained independence from Mexico on June 14, 1846. After four years as the "Bear Flag Republic", California gained Statehood on September 9, 1850 as part of the Compromise of 1850. William Ryder Powell filed the first recorded mineral claim with Contra Costa County on April 29, 1849 during the tenure of the Bear Flag Republic. His original claim therefore pre-dates federal jurisdiction. The claim was a placer-mining claim for cinnabar in Dunn Creek adjacent to what was to become the Mount Diablo Quicksilver Mine.

Mount Diablo was first established as a baseline and meridian for the United States Public Land Survey in the West in July 1851 by Col. Leander Ransom. R. D. Cutts of the Coast and Geodetic Survey (now the National Geodetic Survey of NOAA) placed a marker there for use in the National Triangulation Survey in 1852. Spanish land grants honored under the Treaty of Guadalupe Hidalgo were surveyed first, which lasted at least through 1859. These grants existed primarily along the California coast and in the

Central Valley. No such grants covered Mount Diablo; it therefore became federal land upon statehood.

Mining claims are difficult to file without cadastral data such as the Public Land Survey. William Brewer, accompanying Josiah Whitney's famous geological survey for the California Geological Survey, established the elevation of Mount Diablo peak in 1862, which established the basis for cadastral survey. The first official federal land patent in the Section was in 1862 to the Western Pacific Railroad, authorized by the Pacific Railway Act of 1862. Prior to this time there was no land record at Mount Diablo. The American Civil War officially began when the Confederacy fired on Fort Sumter on April 12, 1861. Few federal land patents other than those directed by Congress were issued in California until the late 1860s, even though mining operations on federal land were already well underway. Squatting on federal land by miners was encouraged during the Civil War since the Union needed metals for the war effort, but it took decades after the fact to sort out the land claims.

The town of Clayton near the mine was founded by Joel Clayton and Charles Rhine in 1857 which created a logistical base for mining on Mount Diablo. The Civil War created a great demand for strategic minerals, including copper and mercury. A "copper rush" began at Mount Diablo in 1862. Placer deposits of cinnabar were already known and being mined in the area for use in the gold fields. As a result of the search for copper, cinnabar (mercury sulfide) deposits were discovered on federal land at Mount Diablo in 1863.

A number of laws have affected mining in the West that are helpful to keep in mind while reviewing this report including the

- US Chaffee Mining Act of 1866
- US Mining Act of 1870 (placer mining)
- US General Mining Act of 1872
- US Timber & Stone Act of 1878

- Stock Raising Homestead Act of 1916
- US Public Health Service Drinking Water Standards Amendments of 1946
- California Dickey Water Pollution Control Act of 1949
- Defense Production Act of 1950
- US Public Health Service Drinking Water Standards Amendments of 1962
- California Porter Cologne Water Quality Control Act of 1969
- US Water Pollution Control Act Amendments of 1972 (Clean Water Act)
- Safe Drinking Water Act of 1974
- California Surface Mining and Reclamation Act of 1975
- US Surface Mining Control and Reclamation Act of 1977
- California Toxic Pits Cleanup Act of 1984

Demand for mercury for use in the manufacture of mercury fulminate in subsequent wars caused the price of mercury to soar and generated renewed interest in mercury mining at Mount Diablo. The site history shows renewed activity during the Second World War, the Korean War and the Vietnam War. The last known mining activity was by the Guadalupe Mining Company in the early 1970s. Since then demand for mercury has been low as substitutes have been found for many of its former uses. The last operating mercury mine in the United States, the Cordero Mine in Humboldt County, Nevada, shut down in 1981. Since then there has been no interest in re-opening the mercury mine on Mount Diablo.

2.1 Location

The area was once subject to a great deal of mining activity for mercury, copper, coal, and manganese and was referred to by the United States Bureau of Mines as the Mount Diablo Mining District. The site is located in Township 1 North, Range 1 East Section 29 of the Mount Diablo Baseline and Meridian (Figure 1). The western and eastern mine works are located on Contra Costa County Assessor Parcel Number 078-060-034. The settlement pond is located on Parcel Number 078-070-036. Some of the

mine waste is on Parcel Number 078-070-034 immediately to the southeast of the mine properties. Altogether the disturbed land is approximately 100 acres.

Geographically the site is on the northern slope of North Peak north of Mount Diablo, near the intersection of Marsh Creek Road and Morgan Territory Road. The nearest town is the City of Clayton three miles to the northwest. Mine drainage flows to Dunn Creek, a tributary of Marsh Creek. Lower Marsh Creek flows through a flood control project funded by the US Department of Agriculture Soil Conservation Service (now the Natural Resource Conservation Service) under the PL-566 Watershed Protection and Flood Prevention Program. The creek flows through the CalFed Dutch Slough Wetland Restoration Project and eventually flows to Big Break and Dutch Slough and hence to the San Joaquin River (Stockton Deep Water Ship Channel), near the confluence of the San Joaquin and Sacramento Rivers in the Sacramento-San Joaquin Legal Delta.

2.2 Adjoining Properties

The parcel to the immediate north of the mine property (078-070-033) was originally patented by the US General Land Office to the Western Pacific Railroad (See Attachment E) as the first land patent in the Section. The land patent was withdrawn, as the Transcontinental Railroad Act did now allow the railroads to receive land grants with mineral resources, and re-issued as a mineral patent to William Rider Powell of Powell Cinnabar in 1898. Powell had already filed a placer mining claim with Contra Costa County as early as 1849. Powell placer mined Dunn Creek for cinnabar. Today the land is owned by Mount Diablo State Park.

The parcel to the west (078-060-033) was originally part of the George Grutchfield GLO homestead claim and subsequent consolidated Mount Diablo Quicksilver Mine property. The property was used as a rock quarry by the Bradley Mining Company. The property was sold by Robert E. and Dana Dunn on June 11, 1992

to Save Mount Diablo, who in turn sold the property on July 10, 1992 to the California Department of Parks and Recreation (Mount Diablo State Park).

The parcel to the south (078-060-032) was originally a non-patented mineral claim filed by Jacob Bendixen with Contra Costa County on April 28, 1878. According to County records, Mary Ives Crocker and Kate Dillon Winship bought the land from Jacob Bendixen and Paul de Martini on December 23, 1908. The property is owned by Mount Diablo State Park today.

APN 078-060-009 to the south was patented (Patent 312143) by the General Land Office as a homestead claim to Joseph Arraya on January 28, 1937. The property belongs to Mount Diablo State Park today.

Parcel 078-070-034 to the southeast was originally part of the Lyman Hastings cinnabar claim (patent 1494) and the consolidated Mount Diablo Quicksilver Mine. The Morgan Territory Investment Company subsequently acquired it and sold it to The California Department of Parks and Recreation on February 2, 1976.

Land to the east was patented by the GLO as Patent 1494 to a mercury miner named Lyman W. Hastings on May 15, 1869, although his mining claim with the County preceded that. This land patent included 120 acres in Section 28 and 40 acres in Section 29 where the pond, eastern mine works and mill works from the Mount Diablo Mercury Mine are today. Immediately east of this land was the mercury prospect at Sunshine Camp.

Southeast of the property on APN 078-120-041 is the old Perkins Canyon mercury mine that has been attributed to Lyman Hastings. The land is owned today by Mount Diablo State Park.

The record shows there were several mercury mines and prospects in the Mount Diablo Mining District, two near Sunshine Camp, two in Perkins Canyon, two in Long Canyon,

and one at Russelmann Creek. Asbestos, manganese, and copper mines are more numerous in the mining district. No calcines can be found today at any of the other mines. Either the calcines have subsequently been washed away, or more likely, ore was transported to the millworks at the Ryne Mine and later the Mount Diablo Quicksilver mine for processing.

2.3 Site Owners/Operators

The current site owners are Jack and Carolyn Wessman who bought the property from the Guadalupe Mining Company on July 2, 1974. Mr. Wessman was an employee of Security Pacific Real Estate Services at the time. They subsequently subdivided the property and parcel 078-070-036 was deeded to the Mount Diablo Springs Improvement Society (Jack and Carolyn Wessman) on December 30, 2005 and Parcel 078-060-034 was deeded to the Wessman Family Trust on May 10, 2005.

For most of the mine's history, mine operations have been conducted under lease by mine operators and not the property owners. Past mine owners are discussed in the chain-of-title search discussed in Section 3.1

Robert Ogilby, an ownership partner with John Welch, financed and superintended the mine during its early years. Robert Ogilby later became a faculty member of the College of California in Oakland and hence became a charter professor at the University of California in 1869. He went on to found the gold mining town of Ogilby in Imperial County, California after the region was made accessible by the completion of the Southern Pacific Railway. Ogilby listed his profession at the time as surveyor and engineer. Because of his association with government, consideration was given as to whether at any time he might have acted as an agent for the State of California or the United States of America in any of his mining ventures. No evidence was found that Ogilby ever, at any time, acted as an agent for others.

Mr. Ogilby was named in Mining and Scientific Press of San Francisco as a capitalist who built the road to the Welch mine and financed the mill works. He also built the Ogilby Toll Road from "Lake Valley" in what is today South Lake Tahoe to Johnson's Pass along today's Highway 50 route. Ogilby Grade, Ogilby Creek and Ogilby Canyon in El Dorado County were all named for him. The ghost town of Ogilby in Imperial County was a gold mining town beginning around 1884 and was likely named for the same man. Robert Ogilby is also a renowned artist of early California scenes. His painting of Grass Valley during the Gold Rush hangs in the Bancroft Library of the University of California at Berkeley today. According to census records, he was an immigrant who came to California in 1849 or 1850 during the Gold Rush. He lived in Sacramento, Oakland, and is last known to have lived in and probably died in a boarding house in the City of San Francisco leaving behind a wife and two children. He evidently made and lost several fortunes. Mining busts at Mount Diablo and Imperial County probably left him a pauper in old age.

The first known mine operator who was not a mine owner was E.J. Ryan who operated the western mine works from 1875 to 1877. It is estimated that as many as 1,000 flasks or 76,000 lbs of mercury were produced from the western mine in the early years.

Miners named Vic Blomberg and others (Hardy, Moni) began leasing the eastern and western mine properties circa 1930. They produced at least 58 flasks pr 4,408 lbs. of mercury from the western (Ryne) mine works and 9 flasks or 684 lbs. from the eastern mine works.

Vic Blomberg formed Mount Diablo Quicksilver Mining Company, purchased the eastern Hastings mine from E.A. Howard Lumber in 1934 and purchased the western Welch (Ryne) mine from Joseph Tonge at about the same time. This consolidated the mining operations into one unified mining property.

C.W. Ericksen operated the mine from 1933 to 1936 and produced at least 730 flasks or 55,480 lbs of mercury. The archive at the Contra Costa County Historical Society includes a record of sales.

Mr. Ericksen was succeeded as mine operator by the Bradley Mining Company, owned by Worthen Bradley, from 1936 to 1947. According to the records of the US Bureau of Mines, the Bradley Mining Company operations account for most of the mercury production at the mine. They produced 10,329 flasks or 785,000 lbs. of mercury and generated 91,561 tons of calcine waste.

The mine closed in the aftermath of World War II but reopened during the Korean War. In 1951 the mine was leased and operated by a partnership. Ronnie B. Smith, whose office was in the Tower Petroleum Building in downtown Dallas, Texas served as trustee for a partnership formed by Jene Harper, President of Franklin Supply Co of Chicago, Illinois which still exists today, and James Dunnigan, President of Producers Refining which was later taken over by CITGO, which now belongs to PDVSA, the Venezuelan State Oil Company. Contact information given at the time is below:

Ronnie B. Smith, Trustee
2106 Tower Petroleum Building
1907 Elm Street
Dallas, Texas 75201

Gene Harper, President
Alfred J. Mitchell, Treasurer
Franklin Supply Company
624 South Michigan Avenue
Chicago, Illinois

James F. Dunnigan
Producers Refining
Chicago, Illinois

Ronnie B Smith obtained a 75/25 cost-sharing agreement with the United States Department of the Interior Defense Minerals Exploration Administration (DMEA) under the Defense Production Act of 1950. While they operated the mine for a short time, they

may never have done so under the contract with DMEA, which was signed in 1953. Their production is estimated to be 102 flasks of mercury and 1,369 tons of calcines.

By 1954, J.L. Jonas and J.E. Johnson operated the mine under the DMEA cost-sharing agreement. Production was 21 flasks of mercury and 309 tons of calcines. Their addresses were given as:

John L. Jonas

[redacted]

John E. Johnson

[redacted]

Jonas and Johnson arranged to assume the DMEA contract in place of the Smith partnership in 1954 and operated under the cost-sharing arrangement through 1955. The records can be found in DMEA Docket Number 2448, on file with the US Geological Survey office in Spokane, Washington (USGS, 2003). A review of the docket, which numbers several reams of paper, revealed as a condition of the cost-sharing agreement that the DMEA required advance submission of a plan detailing the exact location of planned shafts and drifts. The DMEA claimed 75% ownership of all capital equipment used in expanding the mine, hired an onsite consultant to monitor progress, and conducted detailed audits of expenditures at the mine. Furthermore, when the mine was flooded, the DMEA reviewed the plan to de-water the mine and later to treat acid mine drainage and approved payment for the work. The terms of the contract also gave DMEA a royalty interest in any minerals discovered as a result of the mine expansion performed with the loan.

The mine was flooded in 1955 during the execution of the DMEA loan contract and a miner was killed. The State of California Regional Water Pollution Control Board brought mine de-watering to a halt due to complaints from neighboring properties about

the acid mine discharge. Jonas and Johnson were never able to put the mine back into operation after the disastrous flooding.

Cordero Mining assumed operation of the mine in 1955. Contact information given was

Cordero Mining Co.
131 University Avenue
Palo Alto, California
J.N. Pew, Jr., President
S.H. Williston, Vice-President
John C. Agnew, Secretary-Treasurer

Cordero Mining was created with discovery of the Cordero Mercury Mine in Humboldt County, Nevada. At peak operation, the Cordero Mine was the largest mercury mine in the United States and was the last operating mercury mine in the United States before it closed in 1981. Cordero Mining was bought by Sun Oil Company (Sunoco) in 1941 and was dissolved or sold in 1993. Sun Oil Company is currently cleaning up the Horse Heaven Mine in Jefferson County, Oregon under a Record of Decision. The Horse Heaven Mine is an abandoned mercury mine property that was once owned by Cordero Mining and is now owned by Sunoco.

Cordero Mining declined to use DMEA funds and operated the mine independently, completing the work planned under the DMEA contract by adding several hundred feet of tunnels to the existing underground mine works. Ore was not of sufficient grade to be economic and Cordero dumped the excavated rock and unprocessed metacinnabar ore and ceased operations within a year.

Cordero's participation at Mount Diablo was documented in DMEA Docket #2448, and was also discussed on page 23 of CDMG Special Report 80.

Sometime in 1956, Nevada Scheelite (a subsidiary of Kennametal), a tungsten-mining company from Nevada, operated the mine. Amount of production is unknown. When Nevada Scheelite abandoned operations in 1958, John E. Johnson took over operation of the mine but died shortly thereafter and mine operations ceased.

In 1960, Pacific Gas and Electric sought an easement or right-of-way for high voltage power lines to pass over the Mount Diablo Quicksilver Mine property. More information is found in the mining company records now in the archives of the Contra Costa County Historical Society in Martinez, California. Vic Blomberg, mine superintendent and President of the mining company, demanded a payment of $250,000 as compensation for the easement. PG&E believed this amount to be unreasonable and filed a lawsuit. The court record was not obtained but outcome of that lawsuit is clear since the high voltage power lines now pass directly over mine waste from the western (Ryne) mine works. Site inspection would be required to determine if PG&E disturbed mine waste or mill works when they erected the power lines over the Ryne mine.

On May 11, 1962, Victoria Resources purchased the mining properties from Mount Diablo Quicksilver Mining Company, as determined by title search. The contact information was

Victoria Resources
Boris Gresov
925 Fifth Avenue
New York, New York

Whether they ever actually operated the mine is unknown. They may have been a lumber company like E.A. Howard before them. From 1965 to 1970, Victoria Resources leased the property to mine operator Welty & Randall. Little information was found on this mine operator. Their principle activity was reworking the mine waste to extract additional mercury (RWQCB Memo July 17, 1967).

On December 9, 1969, the Guadalupe Mining Company purchased the mine from Victoria Resources. The contact information given was

Guadalupe Mining Co.
14900 Guadalupe Mine Road
San Jose, California

No record of mine production was found but documents mentioned that mining activity continued until 1971. The Wessmans purchased the property from Guadalupe Mining Company on July 2, 1974 and have not operated the mine. The last marketable recorded production was 21 flasks or 1,596 lbs of mercury produced from 309 tons of ore by Jonas and Johnson during the tenure of the DMEA contract in the early 1950s.

2.4 When Operations Began

The first recorded mercury mining operation at Mount Diablo was reported to be prospector Francis Such in 1850. The first mining claim was filed by Lyman Hastings in nearby Perkins Canyon, date unknown. John Welch discovered cinnabar on the western part of APN 078-060-034 in 1863. The property to the north was a placer mining claim filed by William Ryder Powell in Dunn Creek apparently first filed with the County in 1849. Metacinnabar was discovered on the eastern part of the Wessman property by Frances C. Hastings-Hunsaker, widow of Lyman H. Hastings who had been placer mining Marsh Creek and mining in Perkins Canyon, sometime between 1874 and 1907, probably in 1877. Jacob Bendixen filed a mining claim in the southeast quarter of Section 29 on April 28, 1878. The Welch and Hastings claims were consolidated by Vic Blomberg and the Mount Diablo Quicksilver Mining Company in the early 1930s. Mining operations continued intermittently on the consolidated mine property until 1971. Mercury mining activity therefore spanned over a century.

2.5 Type of Operations

Initially mining at both the Welch (Ryne) Mine and the Hastings mine was conducted as hard rock mining underground. In 1936, the mining method was changed to open-pit mining by the Bradley Mining Company. For milling, ore was crushed and placed in a rotary kiln where it was heated to a temperature of over 500 degrees Centigrade to vaporize mercury, which was recovered by retorting. Low-grade ore and

processed calcines were disposed on-site. There is evidence that mine waste was also sold as aggregate (see Table 2).

2.6 Substances Manufactured, Treated, Stored, or Disposed

Mercury was extracted by mining, crushing, rotary kiln, and retorting of mercury vapors. Calcine waste was disposed onsite and sold (Table 1). Mercury had several historic uses. It was used in gold mines in the Sierra Nevada for separating gold from ore. Mercury was also used for ethyl mercury in vaccine preservation and calomel (Hg_2Cl_2), a sort of predecessor to tincture of iodine as an anti-bacterial treatment, and mercury nitrate, used in felting. But the biggest demand was for the manufacture of mercury fulminate - $Hg(ONC)_2$ - used in percussion caps and blasting caps. The price for mercury skyrocketed with each war, stimulating an increase in mining activity. Mining company records at the Contra Costa County Historical Society indicate that customers included a mercury commodity trader in San Francisco, furriers, major pharmaceutical companies, instrument companies, gold mines, and a rifle cartridge manufacturer.

2.7 Waste

Calcine tailings were the principle waste generated by the mine. The calcines typically contain metal sulfides such as pyrite (FeS), millerite (NiS), chalcocite (CuS), stibnite (SbS), realgar (AsS), alabandite (MnS), and galena (PbS). Acid mine drainage is a biogeochemical process that occurs as a result of the contact of reduced sulfur and metal sulfides with water and oxygen. This process generates sulfuric acid and dissolved metal ions, a self-sustaining process which presents the principle environmental concern from the mining operation.

2.8 Permits

The RWQCB issued Waste Discharge Requirements Order 78-114 on September 8, 1978 which is still in effect. Permits and orders are included in Appendix C.

2.9 Warnings or NOVs issued by regulatory agencies

The Bureau of Sanitation of the California Department of Public Health issued various citations beginning in 1939. The California Regional Water Quality Control Board Central Valley Region issued Resolution 135 on May 15, 1952 and Resolution Number 53-21 on February 27, 1953 to control discharge from acid mine drainage. A Waste Discharge Requirement and Cleanup and Abatement Order were issued on November 20, 1978 to Jack Wessman.

3.0 PROPERTY HISTORY

3.1 Chain-of-Title Search

The search began with the records of the Bureau of Land Management office. General Land Office records were searched to determine to whom the land was originally patented by the United States Government. Contra Costa County was contacted to determine current property ownership. NCO Financial Systems, Inc. performed the chain-of-title search for Environmental Data Resources, Inc. The chain-of-title search report is in Appendix D. The search was complex because the present-day subdivision parcel boundaries are different from the original federal land patent boundaries. Additional property records are found in Appendix E.

Western Parcel (western half of APN 078-060-034)

Copper miner John H, Welch filed a mining claim on April 15, 1863 with Contra Costa County. The claim included the northwest quarter of T1NR1ES29, the northwest quarter of the southeast quarter, and part of the southwest quarter of the northwest quarter (Figure 2). Mr. Welch was searching for copper on behalf of a copper mining company from the Sierra Nevada foothills called Pioneer Copper Mining Co of El Dorado County and discovered cinnabar in a rock outcrop on the subject parcel. The Mining and Scientific Press of San Francisco reported mining operations at this mine beginning in 1863. No records exist with the US Bureau of Mines or California Geological Survey from this time period. On April 17, 1875 Mr. Welch now of Welch Quicksilver Mining Company was granted a federal land patent for 20 acres in T1NR1ES29 referred to as Mineral Lot 37, Welch Quicksilver Mining Claim, and Mineral Lot 38 Welch Consolidated Mine & Mill Site. After the American Civil War, the price of mercury plummeted and there were a number of court cases recorded regarding debts owed by the mine and mining claim infringements in the years after the War.

The earliest production information is available from the reports of the California State Mining Bureau created in April 1880, the first report of mine production appearing in an 1888 report (CSMB, 1888). The source of its information regarding mineral production at Mount Diablo prior to 1888 is unknown. The first mining operations recorded began in 1875, although the mine had been operating since 1863. The production from 1863 to 1875 is therefore unknown. The US Bureau of Mines was created by Public Law 179, the Organic Act of 1916 (and was eliminated in 1995). The Bureau of Mines Mineral Yearbook had its first record of production at Mount Diablo in 1943. There is a gap in the record from 1877 to 1930. It is suspected some unreported production may have occurred during that time period.

The mine reportedly fell into litigation in 1877, probably with the Hastings claim at the eastern mine works or the Jacob Bendixen claim to the south (Mineral Survey 3639 Bendixen Mine, claimed filed with Contra Costa County on April28, 1878), and did not re-open. Perhaps as a consequence of inactivity, on December 10, 1912 the US General Land Office revoked the land patent for Mineral Lot 37, Welch Quicksilver Mine, Mineral Lot 38, Welch Consolidated Mine and Mill Site, and the Bendixen Mine (Mineral Survey 3639) , and restored the land to federal ownership. This made the US General Land Office an abandoned mercury mine owner for a period of about 17 months. On May 11, 1914, George E. Grutchfield was granted a federal land patent for 160 acres that includes the Welch quicksilver mine and the Bendixen Mine (the Hastings claim remained a separate property). The land was purchased from the General Land Office and was recorded as a homestead claim with Contra Costa County.

On April 27, 1915, Agnes Grutchfield inherited sole title as widow of George E. Grutchfield. She promptly leased the property to Joseph Tonge. Agnes sold the property to Joseph Tonge on April 24, 1930. In the meantime, beginning on January 14, 1930, Joseph Tonge subleased the mining property to miners named Blomberg, Hardy and Moni. Sometime between April 24, 1930 and January 17, 1936, Blomberg & Moni bought the property from Tonge, although that title document has not been found.

On January 17, 1936, the property title was transferred from Blomberg and Moni to the Mount Diablo Quicksilver Mining Company with Mr. Blomberg as company president.

Company officers were:

Vic Blomberg, President
Phil W. Cox, Vice-President
Harold Blomberg, Secretary

The eastern mine works dating to the Hastings claim was purchased by Mt. Diablo Quicksilver Mining Co. from E.A Howard of Howard Lumber Co. on February 11, 1934. So the three mining properties, Hastings, Welch, and Bendixen claims, were formally unified as one consolidated mining property on January 17, 1936.

On May 11, 1962, Victoria Resources of New York purchased the property from the Mount Diablo Quicksilver Mining Company. Victoria Resources was run by a man named Boris V. Gresov and the company address traced to a town home facing Manhattan's Central Park at 925 Fifth Avenue, New York, New York

The property was purchased on December 9, 1969 by Guadalupe Mining Company of Santa Clara County. On July 2, 1974, Jack and Carolyn Wessman, the current owners, purchased the property.

California real estate disclosure laws have been around since the Easton v. Strassburger decision of 1984, a case in which a real estate agent failed to disclose a landslide hazard which destroyed the value of a residential property in the city of Diablo (near the Mount Diablo mercury mine). The law now requires that sellers and their agents disclose all known material facts and defects about the property which is for sale. Ten years prior at the time the Wessmans purchased the property, caveat emptor was the law of the land.

On May 10, 2005, the Wessmans transferred title for the property to the Wessman Family Trust.

North Parcel (078-070-033, 078-070-040)

On April 29, 1949, William Ryder Powell filed the first mercury mining claim on record with the County. It was a placer mining claim for Dunn Creek and included Township 1 North Range 1 East Section 29 northeast quarter.

The 160 acre parcel north of the Wessman property (Patent 5 and later 29926), as well as the 80-acre northwest quarter (also Patent 5), were patented by the General Land Office to the Western Pacific Railroad on May 21, 1870 under the Act of Congress that authorized construction of the first Transcontinental Railroad. However the Act prohibited patenting land to the railroad containing mineral resources. Therefore, on April 4, 1898, 160 acres of the railroad patent was revoked by the GLO and re-issued to William Rider Powell of Powell Cinnabar as mining patent 29926 for placer-mining cinnabar from Dunn Creek. Part of the land from that mineral patent is now part of the Wessman property, and part is land now belonging to Mount Diablo State Park, California Department of Parks and Recreation.

East Parcel (078-070-036 and eastern half of 078-060-034)

On May 15, 1869 the eastern portion of the present mine property was patented to Lyman Hastings as a land purchase. There is some evidence that the mining claim was filed with Contra Costa County years before this. The claim was probably originally a placer mining claim for Dunn Creek. According to Seth Adams (Adams, 2000), Lyman Hastings is credited with the first discovery of mercury on Mount Diablo at a mine prospect in Perkins Canyon one mile to the south now on land belonging to Mount Diablo State Park, although it seems that in actuality William Ryder Powell and Francis Such preceded him. This property is also bounded by the Sunshine Camp mercury prospect to the immediate east.

On June 17, 1874, Lyman Hastings died and sole title transferred to his widow, Frances C. Hastings. Sometime shortly thereafter she married a man named Hunsaker and they discovered a metacinnabar (polymorph of cinnabar) deposit on the property. There is some evidence that mining there may have begun around 1875 when the California State Mining Bureau first reported production. Mining apparently ceased due to litigation with the Welch or Bendixen claim around 1877. E.A. Howard of Howard Lumber Company bought the parcel on October 25, 1907. Howard Lumber Company were probably harvesting oak and maple trees from Mount Diablo and sold oak and maple hardwood lumber in San Francisco.

Mount Diablo Quicksilver Mining Company bought the property from E.A. Howard on February 11, 1934 and the property was unified with the purchase and consolidation of the western Welch (Ryne) and southern Bendixen mines on January 17, 1936.

West Parcel (APN 078-060-033)

This parcel contains an old manganese mine prospect and a rock quarry once operated by the Bradley Mining Company. The property now belongs to Mount Diablo State Park. It was originally part of the George Grutchfield GLO homestead claim and subsequent consolidated Mount Diablo Quicksilver Mine property. The property was sold by Robert E. and Dana Dunn on June 11, 1992 to Save Mount Diablo, who in turn sold the property on July 10, 1992 to the California Department of Parks and Recreation (Mount Diablo State Park).

South Parcel(s) (APN 078-060-032, 078-060-009, 078-070-034)

The parcel to the immediate south (078-060-032) was originally a non-patented mineral claim (Mineral Survey 3639) filed by Jacob Bendixen with Contra Costa County on April 28, 1878. It was part of the federal land patent sold by the GLO to George E. Grutchfield as Patent 404717 on May 11, 1914 that included the Welch mercury mine property. According to County records, Mary Ives Crocker (an heiress of the Crocker

banking fortune) and Kate Dillon Winship bought the land from Jacob Bendixen and Paul de Martini on December 23, 1908. The property is owned by Mount Diablo State Park today.

Parcel 078-060-009 was patented to Joseph Arraya (Patent 312143) on January 28, 1913 as a homestead claim and belongs to Mount Diablo State Park today.

Parcel 078-070-034 to the southeast was originally part of the Lyman Hastings cinnabar claim (patent 1494) and the consolidated Mount Diablo Quicksilver Mine. The Morgan Territory Investment Company subsequently acquired it and sold it to The California Department of Parks and Recreation on February 2, 1976. There is mine waste on the property. The Regional Water Quality Control Board cited the State Park for discharge of acid mine drainage from Horse Creek on State Park property to Dunn Creek beginning in March 1989 and as recently as August 18, 2000 (RWQCB, 2000). No enforcement action has been taken.

Northwest Parcels (APN 078-060-003, 078-060-036, 078-060-035)

These properties contain the original mine road built by Mr. Ogilby in the 1860s and are part of John H. Welch's original mining claim with Contra Costa County. 078-060-003 was part of a federal land patent to the Western Pacific Railroad on May 21, 1870. The others were part of the land patent to George E. Grutchfield, who bought the property on May 11, 1914. 078-060-36 belongs to Mount Diablo State Park today, 078-060-035 is private land.

3.2 Environmental hazards

Acid mine drainage and calcine mine waste create many environmental hazards, most of which have not been assessed. Presumably there are environmental hazards at some as yet un-quantified level of risk to human health and the environment due to windblown

dust, exposure to contaminated soil, impact to groundwater, and unauthorized discharge to Marsh Creek. Of these hazards, only the impact to Marsh Creek water quality has been assessed and is of interest to the Army Corps of Engineers under the Restoration of Abandoned Mines Program. At the time of this writing, the public file of the Regional Water Quality Control Board had not yet been obtained and the existing data had not yet been fully assessed, although the Contra Costa County files were made available.

Beginning as early as 1939, the California Department of Public Health has observed discharge of low pH water with sulfuric acid, flocculated iron, high total dissolved solids, chloride, sulfate, and hardness and began enforcement with the passage of US Public Health Service drinking water standards in 1946. Beginning in May 1952, the Regional Water Pollution Control Board issued discharge requirements under the California Dickey Water Pollution Control Act of 1949 for color, precipitate, settleable solids, pH, and undefined "toxic materials". The 1978 Order still in effect added copper, iron, manganese and zinc to the reporting list, but not mercury or nickel, the primary contaminants of concern. The drinking water standard for mercury was set in 1992 as a consequence of the Safe Drinking Water Act of 1974 and therefore post-dated the effective Order. No drinking water standard has been established for nickel but a Preliminary Remediation Goal has been established by EPA.

Aside from regulatory orders discussed in Section 2.9, the first study under modern environmental law and regulation was performed at Marsh Creek Dam in 1980 (CRWQCB, 1980). A fish study was conducted by California Department of Fish and Game and the California Department of Parks and Recreation as part of an environmental impact study for the creation of John Marsh House Park. Largemouth bass were found with 2.7 ppm mercury. Catfish and sunfish had up to 1.8 ppm mercury. The mercury limit in fish set by the Food and Drug Administration is 1 ppm. Fishing was banned in the lake.

In 1987, the Water Board sampled sediment and water in Marsh Creek Reservoir (CRWQCB, 1987). Nickel was in bottom sediment at 118 mg/Kg and mercury averaged 0.46 mg/Kg.

A study was done in nearby Brentwood, California along Marsh Creek for the Sweetwater Ranch development project (Wahler & Associates, 1990) to assess mercury contamination in Marsh Creek. A series of studies by the University of California at Davis were prompted by the recognition that abandoned mercury mines on Mount Diablo have a significant impact on the water quality of Marsh Creek (Slotton *et al.*, 1996, 1997 and 1998). Dr. Slotton concluded that Mount Diablo Mercury Mine discharges over 90% of the mercury in Marsh Creek. According to the production records of the US Bureau of Mines, the western and eastern mine works of Mount Diablo Mercury Mine account for most of the mercury production from the mining district. However, no mill works or calcines have been found at the location of other mining claims and prospects, leading to a suspicion that ore may have been transported from other smaller mining claims to the Mount Diablo Mercury Mine for ore processing. Further historical research would be required to determine where and how mercury was extracted from the other mercury mines in the mining district.

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Mount Diablo Quicksilver Mines - *Mining and Scientific Press*, Vol. 10, No. 21, p. 327 (May 27, 1865)

The Clayton Quicksilver Mine - **Mining Summary: California: Contra Costa, The Clayton Quicksilver Mine,** *Mining and Scientific Press*, Vol. 32, No. 24, p. 373 (June 10, 1876)

TABLE 1
TRACING CURRENT ASSESSOR PARCELS TO ORIGINAL MINING CLAIMS

PLSS SECTION	*ORIGINAL CLAIM*	*SUBSECTION*	*APN*	*Owner*	*Mine or Millworks?*
MDBM T1N R1E S29	William R. Powell	NE ¼	078-070-033	Mt Diablo State Park	
			078-070-040		
			078-060-034 (part)	**Wessman**	**Y**
	John Welch	SE ¼ NW ¼	**078-060-034 (part)**	**Wessman**	**Y**
			078-060-033(part)	Mt Diablo State Park	
		NW ¼	078-060-003	Mt Diablo State Park	
			078-060-035		
			078-060-015		
			078-060-021		
			078-060-036	Mt Diablo State Park	
		SW ¼	078-060-033	Mt Diablo State Park	
	Lyman Hastings	SE ¼ NE ¼	078-060-034 (part)	Wessman	**Y**
MDBM T1N R1E S28		SW ¼ W 1/2	**078-070-036**	**Mt. Diablo Springs Improvement Society**	**Y**
			078-070-035		
			078-070-034	Mt Diablo State Park	
		NW ¼ SW 1/4	078-070-024		
			078-070-021		
			078-070-042		
			078-070-043		

Table 2

Mount Diablo Quicksilver Mine
Production History

			Ryne Mine		Mount Diablo Mine		Ore	Ore	Calcines
	Owner	Operator	(flasks)	(lbs)	(flasks)	(lbs)	(tons)	(%)	$
1863-1875	General Land Office	Pioneer Copper Mining Co.	?	?			?	?	
	Welch	Welch Quicksilver							
1875-1877	Welch	Ryne Mining Co?	1,000	76,000			?	?	
1877-1912	?				?	?			
1912-1913	General Land Office								
1914-1929	George E. Grutchfield	E.A. Howard Lumber?							
1929	Mount Diablo Quicksilver Mining Co.								
1930			58	4,408	9	684	?	?	
1931									
1932									
1933		C.W. Ericksen			730	55,480	?	?	
1934									
1935									
1936									
1937		Bradley Mining Co.			314	23,864	2,911	3%	$40
1938					1,361	103,436	8,850	9%	$6
1939					1,462	111,112	12,000	13%	$42
1940					1,084	82,384	14,400	15%	$263
1941					1,622	123,272	14,400	15%	$827
1942					1,366	103,816	12,000	13%	$375
1943					1,127	85,652	11,000	12%	$2,562
1944					698	53,048	5,500	6%	$1,886
1945					434	32,984	4,500	5%	$3,880
1946					861	65,436	6,000	6%	$11,253
1947					126	9,576	1,000	1%	$32,899
1948					0	0	0		$25,739
1949					0	0	0		$8,640
1950					0	0	0		$9,356
1951-1952		Ronnie B. Smith			102	7,752	1,369	1%	
1953-1954		Jonas & Johnson			21	1,596	309	0%	
1955		Cordero Mining/Sunoco			?	?	?		
1956		Nevada Scheelite/Kennametal			?	?	?		
1958		J.E. Johnson			0	0	0		
1960	Victoria Resources	Welty & Randall			?	?	?		
1970	Guadalupe Mining Co.				?	?	?		
1974	Jack Wessman				0	0	0		
		TOTAL	1,058	80,408	11,317	860,092	94,239		$97,768

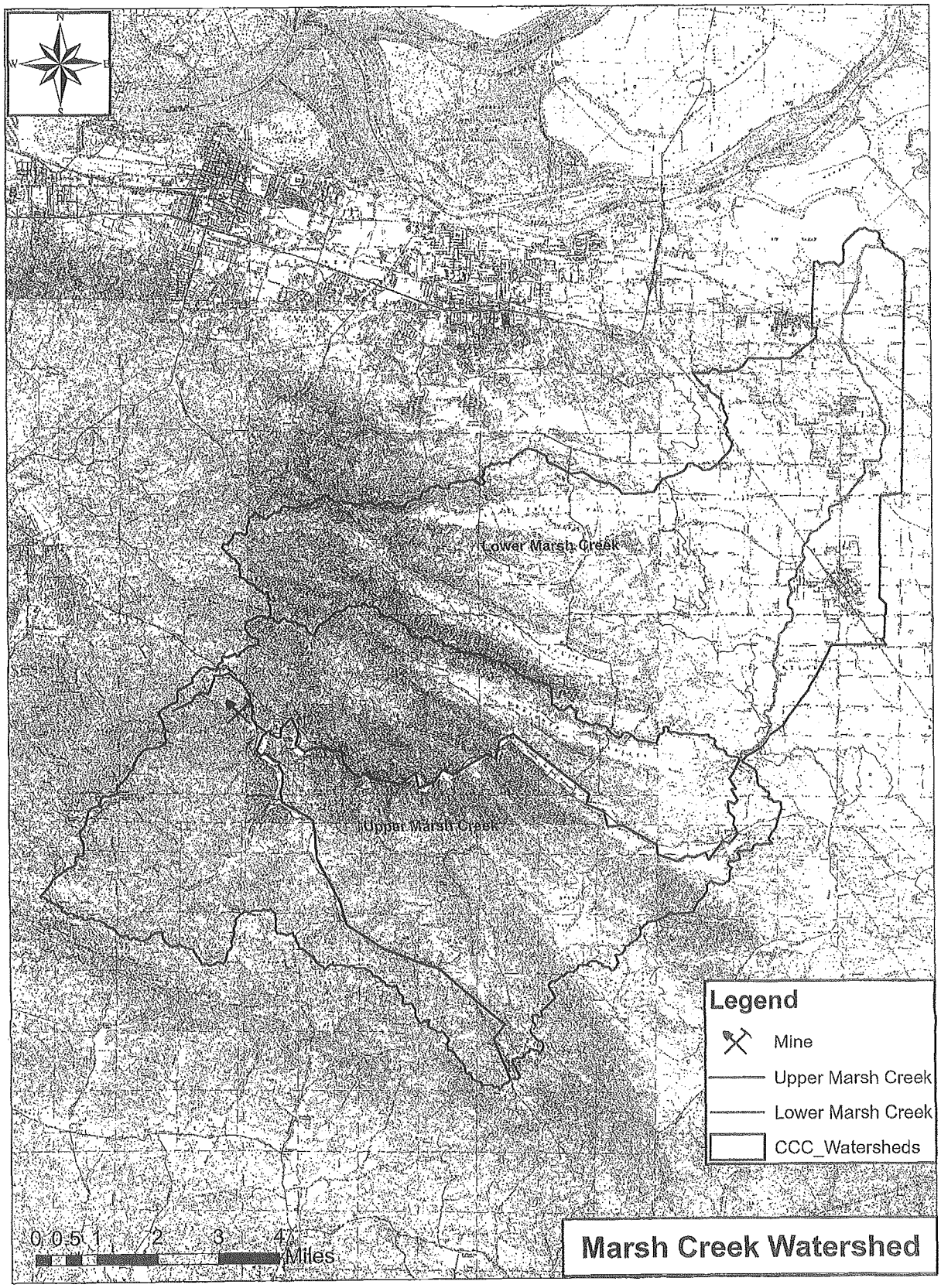

Lower Marsh Creek
Upper Marsh Creek
Legend
Mine
Upper Marsh Creek
Lower Marsh Creek
CCC_Watersheds
0 0.5 1 2 3 4
Miles
Marsh Creek Watershed

Figure 1

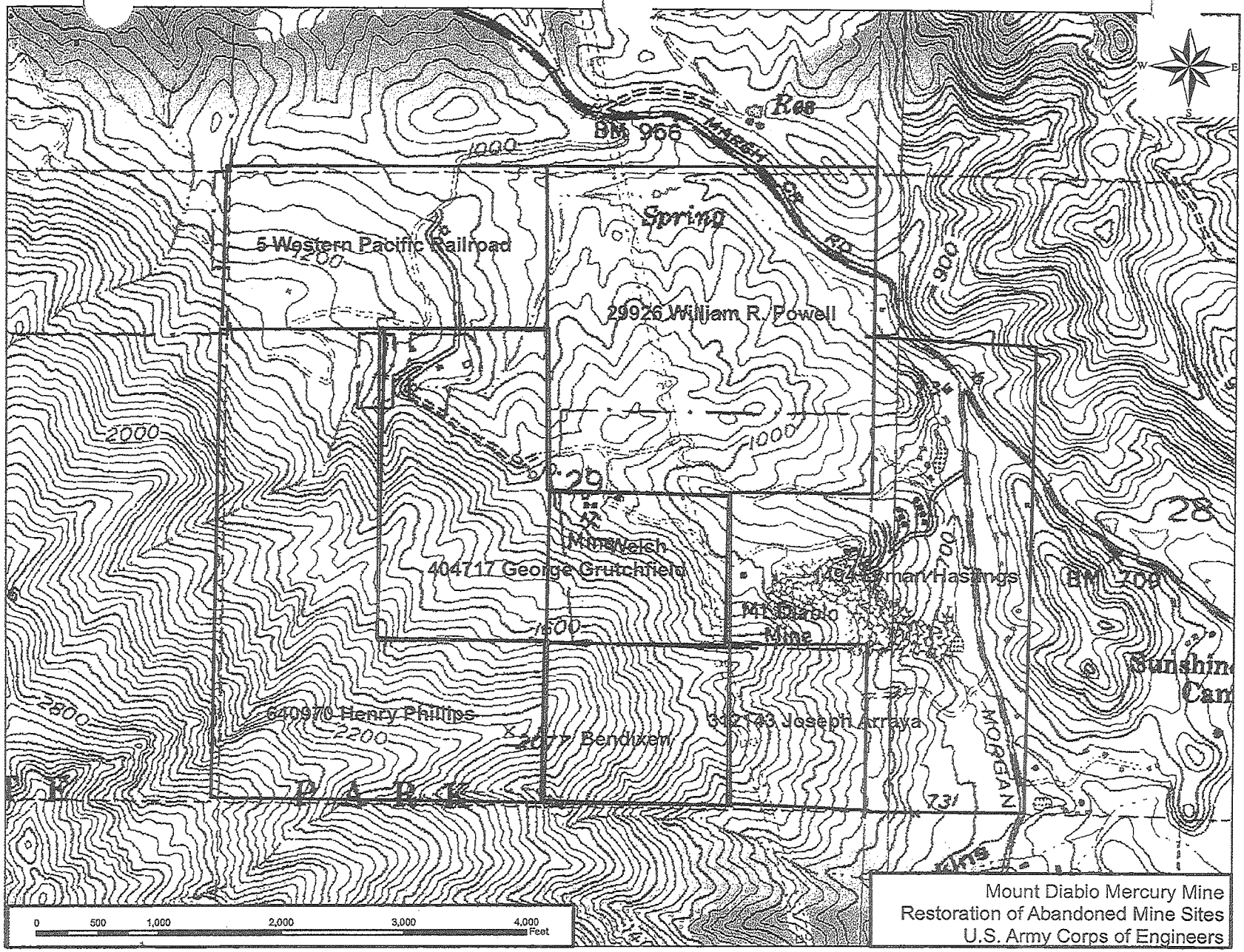
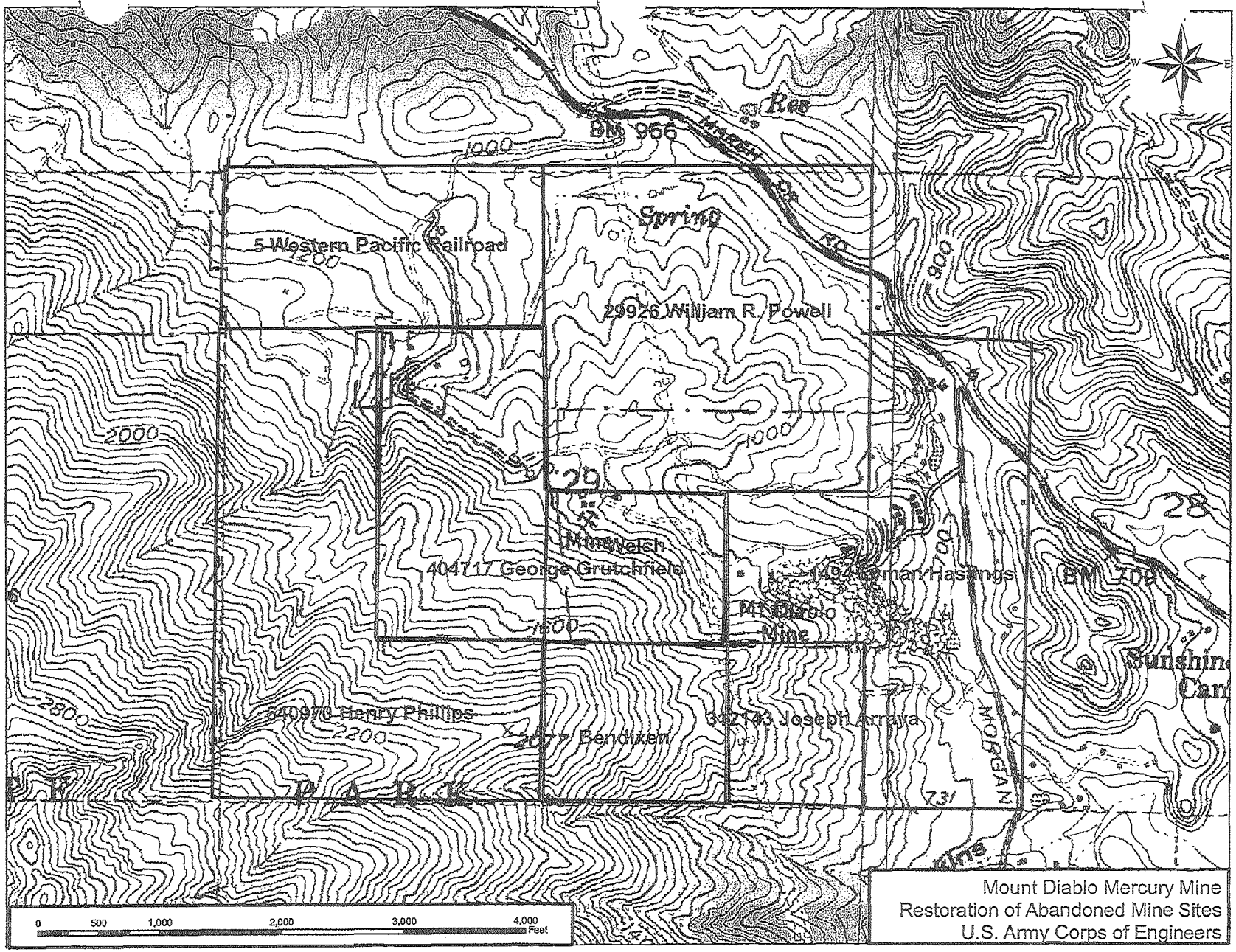

BM 966
Spring
5 Western Pacific Railroad
29926 William R. Powell
404717 George Grutchfield
Mine Welch
1494 Carman Hastings
Mt. Diablo Mine
640970 Henry Phillips
2077 Bendixen
332143 Joseph Arraya
P A P C K
MORGAN
BM 700
Sunshine Cam
28
29
0 500 1,000 2,000 3,000 4,000 Feet
Mount Diablo Mercury Mine
Restoration of Abandoned Mine Sites
U.S. Army Corps of Engineers

Figure 2



Mount Diablo Mercury Mine
Restoration of Abandoned Mine Sites
U.S. Army Corps of Engineers

Figure 2

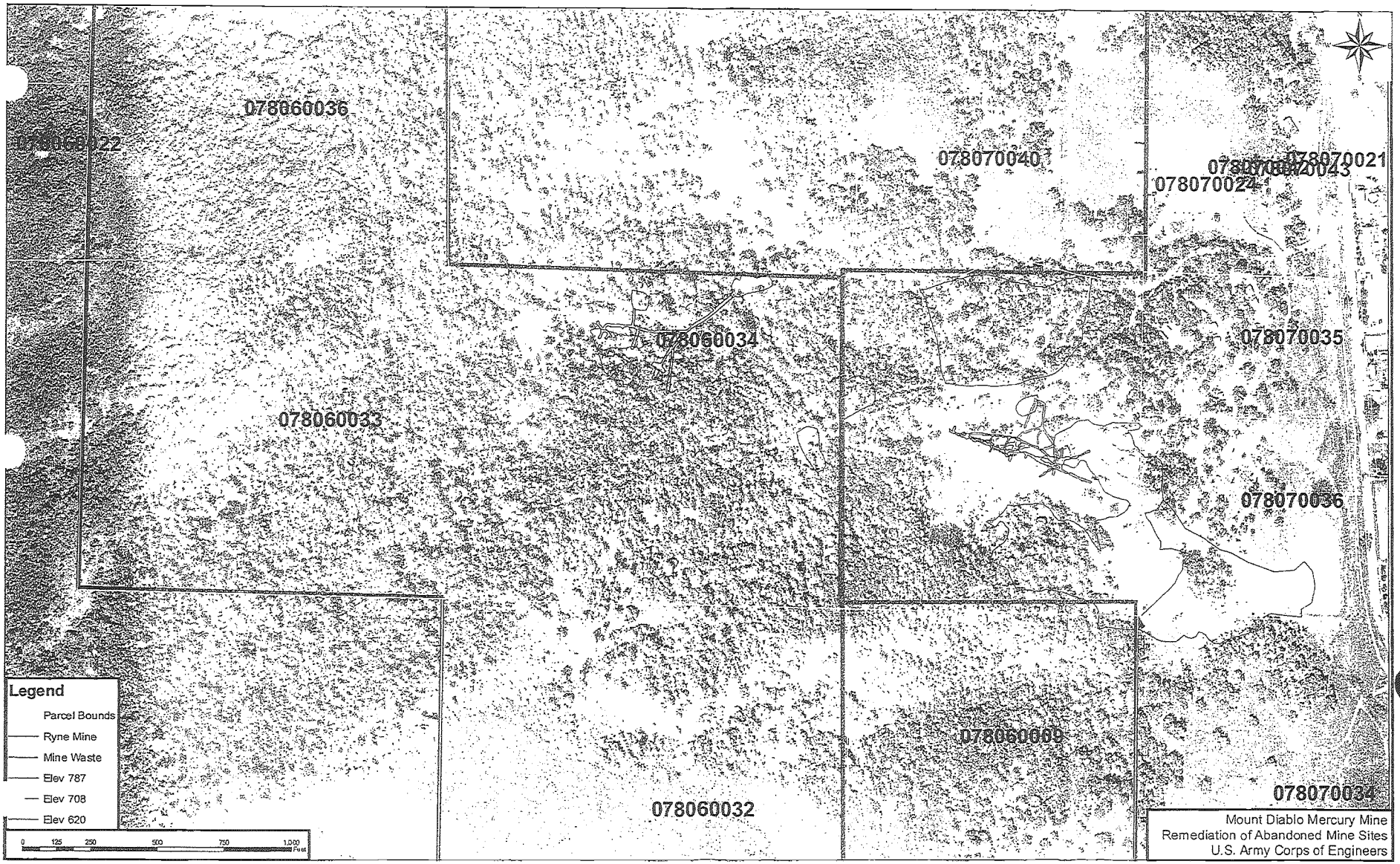

078060036
078060022
078070040
078070021
078070043
078070024-1
078060034
078070035
078060033
078070036
078060009
078070034
078060032
Legend
Parcel Bounds
Ryne Mine
Mine Waste
Elev 787
Elev 708
Elev 620
0 125 250 500 750 1,000 Feet
Mount Diablo Mercury Mine
Remediation of Abandoned Mine Sites
U.S. Army Corps of Engineers

Figure 3

APPENDIX A

TIMELINE

TIMELINE: MOUNT DIABLO QUICKSILVER MINE (8/6/2008)

Date	APN 078-060-034 (West)	APN 078-070-034 (East)	APN 078-070-036	APN 078-070-034
January 24, 1848	Gold discovered in California			
April 29, 1849	William Ryder Powell files first placer mining claim on Dunn Creek incl. part of -034			Need 3 dates, patent, sale and Park purchase
September 9, 1850	California becomes a State			
1850	Francis Such discovers gold, quicksilver and copper near Mount Diablo (Clayton Historical Society) – placer deposits?			
1857	City of Clayton founded			
April 12,1861	War Between the States begins, demand for mercury fulminate skyrockets			
April 15, 1863	John Welch discovers cinnabar mineral deposit, files mining claim with Contra Costa County, mining operation commences			
April 26, 1865	Civil War ends, mercury demand plummets			
July 26, 1866	US Chaffee Mining Law passes			
May 15, 1869		Lyman Hastings receives federal mineral patent		
May 21, 1870	US Placer mining law passed			
May 10, 1872	US General Mining Act passed			
April 17, 1875	J. Welch receives federal land patent			
June 17, 1874		Lyman H Hastings dies		
1875?		Widow Frances C Hastings Hunsaker discovers metacinnabar		
1875-1877	First production record with US Bureau of Mines, Ryne Mining Co. operates the (western?) mine	Mining must have occurred		
1877	Litigation closes the mines, likely a dispute between the two mining properties			
1878	US Timber & Stone Act passed			
April 4, 1898	US GLO recognizes Powell's placer mining claim (APN 078-070-033, -040, part of -034)			
July 27, 1905	E.A. Howard buys part of property from Powell.			
October 25, 1907		E.A. Howard buys property (Howard Lumber Co.)		
December 10, 1912	US GLO revokes Welch mineral patent			
May 11, 1914	George Grutchfield purchases land from GLO			
July 1914	World War I begins			
April 27, 1915	Agnes Grutchfield granted sole title (widow)			
November 11, 1918	World War I end			
January 14, 1930	Joseph Tonge leases interest to Blomberg, Hardy & Moni?			
March 8,1930	Hardy leases interest to Blomberg & Moni			
April 24, 1930	Joseph Tonge purchases land from Agnes Grutchfield			
1931	Japan invades Manchuria			
1931	Mount Diablo State Park, created in 1921, begins acquiring land			
1933-1936	C.W. Erickson operates the mine			
February 11, 1934		Mt Diablo Quicksilver Mining Co buys property from E.A. Howard (Howard Lumber Co.)		
January 17, 1936	Title transfer from Blomberg & Moni to Mt Diablo Quicksilver Mining Co.			
1936	Bradley Mining Co. operates the mine			
September 3, 1939	World War II begins			
September 2, 1945	World War II ends, Cold War begins			
1946	Public Health Service Drinking Water Standard Amendments			
1947	Bradley Mining Co. ceases operation at the mine			
October 1, 1949	California Dickey Water Pollution Control Act			
June 25, 1950	Korean War begins			
1951	Ronnie B Smith, Producers Refining & Franklin Supply Co. partnership operate mine			
1953	US DoI Defense Minerals Exploration Administration loan contract signed			
February 27, 1953	RWQCB Resolution No. 53-21 (water pollution abatement order)			
July 27, 1953	Korean ceasefire			
1954	Jonas & Johnson operate mine, miner killed, mining operation halted, DMEA contract ends			
1955	Cordero Mining Co. operates mine (Sunoco)			
1956	Nevada Scheelite operates mine (Kennametal)			
1958	John E. Johnson operates mine, Johnson dies, mining halts			
1960	PG&E sues for easement/right-of-way through mine property			
1962	Public Health Service Drinking Water Standard Amendments			
May 11, 1962	Victoria Resources purchases mine from Vic Blomberg			
March 8, 1965	9th Marine Expeditionary Brigade lands at Da Nang, Republic of Vietnam. US involvement escalates through 1968			
1965-1970	Welty & Randall operate mine, rework the calcine mine tailings			
1969	California Porter-Cologne Water Quality Control Act passed			
December 9, 1969	Guadalupe Mining Co. purchases mine from Victoria Resources			
1971	Pace of land purchase by Mount Diablo State Park increases, park boundary approaches mine property			
1974	Safe Drinking Water Act			
July 2, 1974	John and Carolyn Wessman purchase mine property from Guadalupe Mining Co.			
1975	California Surface Mining & Reclamation Act (SMARA)			
February 2, 1976				Mt Diablo State Park purchases from Morgan Territory Investment Co.
August 3, 1977	US Surface Mining Control & Reclamation Act			
September 8, 1978		CRWQCB WDR 78-114		
November 20, 1978		CRWQCB CAO		
August 1, 1979		CRWQCB MRP 78-114		
1984	California real estate disclosure law established (Easton v. Strassburger)			
May 10, 2005	Title transferred to Wessman Family Trust			
December 30, 2005			Title transferred to Mt. Diablo Springs Improvement Society	

APPENDIX B

REFERENCES CD

APPENDIX C

PERMITS & ORDERS

RECEIVED

JUN 9 1952

Mt. Diablo Mine

Resolution No. 1435 ... Department

Resolved that the following requirements govern the nature of the discharge from the Mt. Diablo Mine to Marsh Creek by way of Dunn Creek:

1. Maximum quantity of settleable solids in the pond effluent shall not exceed 0.5 ml/liter after one hour of quiescent settling in a standard Imhoff cone.

2. The pond effluent shall not produce noticeable color or precipitate after 15 minutes aeration.

3. The pond effluent shall not produce noticeable color or precipitates when pH is adjusted to neutrality (7.0).

4. The pond effluent leaving the mine property shall have a pH between 6.5-8.5.

5. The pond effluent shall not produce excessive color in Marsh Creek.

6. The pond effluent shall not contain any toxic materials in such quantity or of such character as to be hazardous to the public health or to plant or animal life.

If, in the future, there is a change in the conditions or use of the disposal area or in Marsh Creek, it may be necessary for the Central Valley Regional Water Pollution Control Board to revise the requirements to conform to the new conditions or use.

Regional Water Pollution Control Board — Central Valley Region — State of California

Carl M. Hoskinson
Chairman

Attest:

Joseph S. Gorlinski
Executive Officer

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

ORDER NO. 78-114

WASTE DISCHARGE REQUIREMENTS
FOR
MOUNT DIABLO QUICKSILVER MINE
CONTRA COSTA COUNTY

The California Regional Water Quality Control Board, Central Valley Region, (hereafter Board), finds that:

1. The Board on 27 February 1953 adopted Resolution No. 53-21 which prescribed requirements for a discharge from Mount Diablo Quicksilver Mine to Dunn Creek.

2. Surface and mineral rights of the mine are presently owned by Jack and Carolyn Wessman.

3. Present waste discharge requirements established by Resolution No. 53-21 are not adequate nor consistent with present plans and policies of the Board.

4. Mount Diablo Quicksilver Mine discharges mine drainage from the mine tailings and overburden to Dunn Creek near its confluence with Marsh Creek a tributary of the San Joaquin River a water of the State.

5. Mount Diablo Quicksilver Mine is located in the NE 1/4, SE 1/4 of Section 29, T1N, R1E, MDB&M (assors parcel #78060008-6) with surface water drainage to Dunn Creek.

6. The beneficial uses of Marsh Creek and Marsh Creek reservoir are: water-contact recreation, non-water contact recreation, freshwater habitat, wildlife habitat, and the preservation of rare and endangered species.

7. The beneficial uses of the groundwater are: domestic supply, irrigation, and stockwatering.

8. The Board, on 25 July 1975, adopted a Water Quality Control Plan for the Sacramento-San Joaquin Delta Basin.

9. Mining operations ceased in 1971, however, the mine area continues to discharge mineralized water and sediment to Dunn Creek.

10. The action to revise waste discharge requirements for this facility is exempt from an environmental review in accordance with Sections 15101, 15107, and 15108 of the CEQA regulations.

11. The Board has notified the discharger and interested agencies and persons of its intent to prescribe waste discharge requirements for this discharge.

12. The Board in a public meeting heard and considered all comments pertaining to the discharge.

WASTE DISCHARGE REQUIREMENTS
MOUNT DIABLO QUICKSILVER MINE
CONTRA COSTA COUNTY

IT IS HEREBY ORDERED, that Resolution No. 53-21, be rescinded and Jack and Carolyn Wessman shall comply with the following:

A. Discharge Prohibitions:

1. The direct discharge of wastes to surface waters or surface water drainage courses is prohibited.

2. Previously deposited sediment in the reservoir shall not be discharged.

B. Discharge Specifications:

1. The discharge shall not cause a pollution or nuisance as defined by the California Water Code.

2. The discharge shall not cause degradation of any water supply.

3. The discharge shall remain within the designated disposal area at all times.

4. The discharger shall implement erosion control practices to minimize erosion of mine overburden and worked areas.

C. Provisions:

1. The discharger may be required to submit technical or monitoring reports as directed by the Executive Officer.

2. The discharger shall follow the following time schedule to comply with discharge prohibition A1:

Action	Compliance Date	Compliance Report Due
Conceptual Plan	1 Nov 1978	15 Nov 1978
Complete Construction Plan	1 Jan 1979	15 Jan 1979
Begin Construction	1 Apr 1979	15 Apr 1979
Progress Construction Report	1 Jun 1979	15 Jun 1979
Full Compliance	1 Jul 1979	15 Jul 1979

3. The discharger shall follow the following time schedule to comply with Provision A.2:

	Due
Submit Conceptual Plan	15 Sept 1978
Complete Construction	1 Nov 1978

4. The discharger shall report promptly to the Board any material change or proposed change in the character, location, or volume of the discharge.

5. In the event of any change in control or ownership of land or waste discharge facilities presently owned or controlled by the discharger, the discharger shall notify the succeeding owner or operator of the existence of this Order by letter, a copy of which shall be forwarded to this office.

6. Any diversion from or bypass of facilities necessary to maintain compliance with the terms and conditions of this Order is prohibited, except (a) where unavoidable to prevent loss of life or severe property damage, or (b) where excessive storm drainage or runoff from any event having a return frequency greater than one in twenty-five years (≥ 3.9 inches/day [9.9 cm/day]) would damage any facilities necessary for compliance with effluent limitations and prohibitions of this Order. The discharger shall notify the Board in writing within two weeks of each such diversion or bypass including documentation of the storm intensity.

7. The Board will review this Order periodically and may revise requirements when necessary.

I, JAMES A. ROBERTSON, Executive Officer, do hereby certify the foregoing is a full, true, and correct copy of an order adopted by the California Regional Water Quality Control Board, Central Valley Region, on 8 September 1978

Original signed by
James A. Robertson

JAMES A. ROBERTSON, Executive Officer

CH/ap 7/25/78

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

MONITORING AND REPORTING PROGRAM NO. 78-114
FOR
MOUNT DIABLO QUICKSILVER MINE
CONTRA COSTA COUNTY

RESERVOIR MONITORING

A grab sample of the impounded water shall be collected during November of each year. The sample shall be collected at a point where a representative sample can be obtained. The sample shall be analyzed for the following:

Constituents	Units
Specific Conductivity	µmhos/cm
pH	units
Copper	mg/l
Iron	mg/l
Manganese	mg/l
Zinc	mg/l

In addition, a monthly report shall be submitted for the months November through March inclusive detailing:

1. The distance from the water surface to the spillway (freeboard).
2. The condition of the containment dikes.
3. The condition of the up watershed diversion berms.

REPORTING

In reporting the monitoring data, the discharger shall arrange the data in tabular form so that the date, the constituents, and the concentrations are readily discernible. The data shall be summarized in such a manner to illustrate clearly the compliance with waste discharge requirements. Monitoring shall commence not later than 30 November 1979, unless otherwise specified.

Monthly monitoring reports shall be submitted to the Regional Board by the 15th day of the following months: December through April.

MONITORING AND REPORTING PROGRAM
MOUNT DIABLO QUICKSILVER MINE
CONTRA COSTA COUNTY

If the discharger monitors any pollutant at the locations designated herein more frequently than is required by this order, he shall include the results of such monitoring in the calculation and reporting of the values required in the Discharge Monitoring Report Form. Such increased frequency shall be indicated on the Discharge Monitoring Report Form.

Ordered by W. H. Crooks for
JAMES A. ROBERTSON, Executive Officer

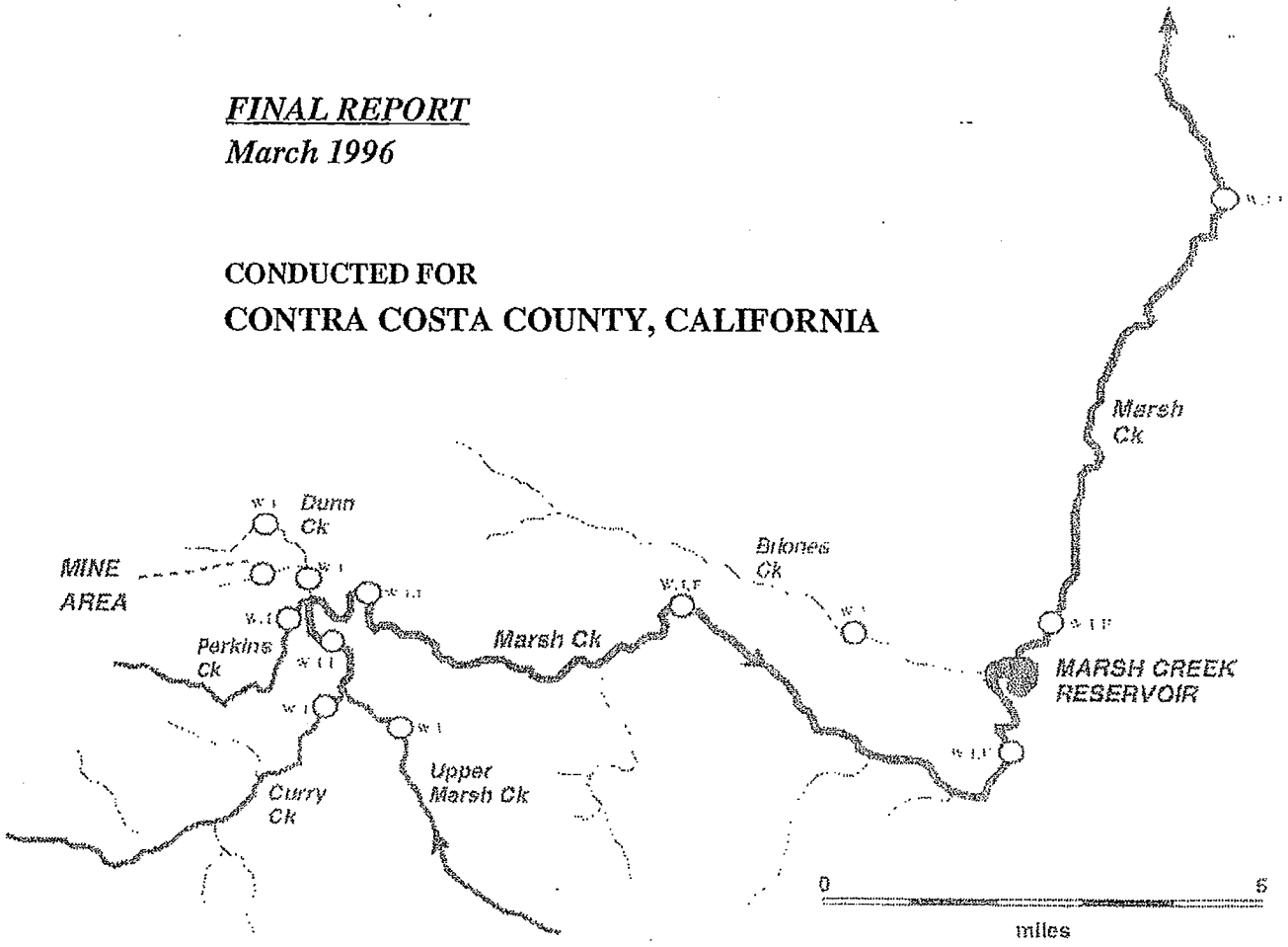
1 August 1979
(Date)

CAH/gs 2/23/79

MARSH CREEK WATERSHED
1995 MERCURY ASSESSMENT PROJECT

FINAL REPORT
March 1996

CONDUCTED FOR
CONTRA COSTA COUNTY, CALIFORNIA



STUDY AND REPORT BY

Darell G. Slotton, Ph.D.
Shaun M. Ayers
John E. Reuter, Ph.D

MARSH CREEK WATERSHED
1995 MERCURY ASSESSMENT PROJECT

FINAL REPORT
March 1996

CONDUCTED FOR
CONTRA COSTA COUNTY, CALIFORNIA

STUDY AND REPORT BY

Darell G. Slotton, Ph.D.
Shaun M. Ayers
John E. Reuter, Ph.D.

1624 Pacific Drive, Davis, California 95616
(916) 756-1001 dgslotton@ucdavis.edu

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ACKNOWLEDGEMENTS

I would like to thank Phil Harrington of the Contra Costa County Department of Public Works and Sue Loyd of the County Health Services Department for their help and support throughout this project. The Wessmans graciously provided access to the mine area on their property, provided helpful background information, and consistently exhibited a willingness and desire to help find a solution to the mercury problem on Mt. Diablo. Thanks also to the public and agency participants in the Marsh Creek Watershed Mercury Task Force for helping to move this process along.

DGS

EXECUTIVE SUMMARY

- Before this comprehensive 1995 study, the Mt. Diablo Mercury Mine was generally assumed to be the main source of mercury to the Marsh Creek watershed in Contra Costa County. However, data was not available to quantify this input, rank the mine against other potential mercury sources, or rule out the possibility of a generalized source of mercury in this mercury-enriched watershed.

- In the project reported here, water, suspended sediments, and flow were analyzed at 18 key sites throughout the Marsh Creek watershed during a high flow-period. State-of-the-art collection and analytical procedures were utilized for the 48 individual water mercury analyses, producing above-detection concentration information for each of the major tributaries and potential source regions. Combining concentrations with the flow data, relative mass balances were calculated, ranking each of the tributaries as to mercury contribution to the watershed. This aqueous watershed information was supplemented by mercury analytical collections from multiple groups of aquatic invertebrate indicator species at the 12 stream sites where they were present (41 samples), and stream fish at the 6 sites where they were present (28 samples).

- The 1995 watershed-wide mercury information assembled here establishes that the mine site does indeed represent the overwhelming, ongoing source of mercury to the watershed. Mercury data from water collections and invertebrate bioindicator organisms strongly implicate the mine region as the dominant source of mercury. Mass balance calculations indicate that approximately 95% of the total input of mercury to the upper watershed derives from Dunn Creek, with an estimated 88% traceable specifically to the current exposed tailings piles of the Mt. Diablo Mercury Mine. This is a remarkably high percentage, particularly in light of the geologically mercury-rich nature of the watershed in general, and indicates that the mercury in exposed, processed, cinnabar tailings material is exceptionally available for downstream transport in water.

- The data indicates that the great majority of the mercury load emanating from the tailings is initially mobilized in the dissolved state. This dissolved mercury rapidly partitions onto particles as it moves downstream. The bulk of downstream mercury transport is thus particle-associated.

- Though Dunn Creek carried the bulk of the watershed's source mercury, this small tributary delivered less than 7% of the total water volume and less than 4% of the suspended solids load. With 95% of the mercury originating from the Mt. Diablo Mine area, but 95% of the watershed's suspended sediment load deriving from non-mine, low mercury source regions, any significant decrease in the export of mercury from the immediate mine site should result in a corresponding decline in depositional sediment mercury concentrations downstream and in Marsh Creek Reservoir. This would almost certainly help to drive down the mercury concentrations in water and the flux of mercury into aquatic organisms. With an estimated 88% of the currently exported mercury linked directly to the mine site tailings piles, mercury source mitigation work within the watershed would clearly be best directed toward this localized source.

- Though mitigation recommendations were not a part of our scope of work, we provide input on the subject at the end of this report, based on the data collected in this study, that may help to both clarify the task and direct the planning process.

- Fishes in Marsh Creek Reservoir were found to consist in 1995 of populations of small mosquito fish, native planktivorous hitch, stunted bluegill, and largemouth black bass.

The reservoir was uniformly shallow at this time, with depths averaging 5 feet. The water was organic-stained and very turbid, with heavy growths of aquatic weeds. Lack of oxygen was indicated to be a limiting factor for fish in the bottom waters during the warm season. Adult largemouth bass and possibly bluegill represent the only potential angling opportunities in the reservoir at this time.

- Marsh Creek Reservoir mercury levels were characterized in 1995 with 26 individual sediment mercury samples from surface sediment as well as deep core sections, 25 muscle mercury samples from individual adult fish, 21 muscle and 8 whole composite samples of juvenile fish, and 4 composites of reservoir invertebrates.

- Approximately 5 feet of depositional sediment had accumulated on the reservoir bottom. Reservoir sediment mercury concentrations were found to be quite uniform across the bottom and throughout the reservoir's 30+ year depositional sediment record, with the great majority of samples falling within the range of 0.36-0.80 parts per million mercury, and all sediment samples having less than 1.50 ppm mercury.

- Mercury in Marsh Creek Reservoir edible fish flesh was above the health standard concentration of 0.5 ppm in all samples of "keeper" sized bass and bluegill, with the larger bass ranging up to and slightly over 1.0 ppm muscle mercury. These levels are of concern but are not exceptional for this region of California. They are near enough to the health guidelines that a decline to levels below the guidelines may be realistically attainable, through potential mercury mitigation work in the watershed. Mercury concentrations in adult fish will likely take a number of years to change significantly, even in conjunction with a major reduction in transported watershed mercury. This is because their mercury levels are a composite of accumulations across their multi-year lives. However, mercury levels in a number of the short-lived, alternate indicator organisms utilized in this project should respond to changes in source mercury very quickly.

- With this 1995 watershed mercury assessment, a comprehensive, accurate data base has been initiated for the County, describing mercury conditions throughout the major components of the Marsh Creek watershed. This includes mercury concentration, loading, and relative mass balance data for water and suspended sediment from all major tributaries, mercury levels from aquatic biota throughout the watershed; and depositional sediment and biota mercury concentrations from Marsh Creek Reservoir. The utility of these data for use as a general baseline could be substantially increased with the sampling of selected parameters in the current water year (1996), prior to any mitigation work, to help account for natural inter-annual variability. We note that 1995 was an extremely wet, high-runoff year, while 1996 is more of an average water year. It is our strong recommendation that the County obtain as extensive and varied a baseline data record as possible prior to mitigation, and maintain selective monitoring of key sites and parameters throughout and following mitigation work. Ongoing monitoring of carefully chosen indicator samples will play an integral role in guiding and assessing the effectiveness of any mitigation efforts.

1. INTRODUCTION

The Marsh Creek watershed, in eastern Contra Costa County, is fed primarily by seasonal tributaries from the eastern slope of Mt. Diablo. Flows in the watershed range from zero in many upstream tributaries during the dry season to hundreds of cubic feet per second in downstream Marsh Creek during winter storm runoff. Marsh Creek flows through the towns of Brentwood and Oakley, ultimately emptying into the San Joaquin Delta east of Antioch.

A flood control dam was built on Marsh Creek in 1963, approximately five miles upstream of Brentwood. The resulting Marsh Creek Reservoir is now a shallow water body with extensive riparian, marsh, and aquatic weed growth, providing habitat for a variety of wildlife including resident populations of fish. The surrounding land is currently used for cattle grazing. The primary function of the reservoir is flood control. Operated by the Contra Costa Department of Public Works, it has been closed to the public throughout recent years.

An extensive residential development is planned for the area surrounding Marsh Creek Reservoir. As the existing reservoir may be incorporated into these development plans, information regarding its water quality and that of the watershed in general is of particular current interest. One potential area of concern involves mercury. The California Department of Fish and Game analyzed fish from the reservoir in 1980. These fish were found to be above existing health standards for mercury (Contra Costa County 1994).

A large, abandoned mercury mine site is present on the northeast slope of Mt. Diablo. The Mt. Diablo Mercury Mine is located within the Marsh Creek watershed, adjacent to Dunn Creek, which is a small tributary to Marsh Creek. A substantial area of exposed tailings is present at the site and, while this region contributes only a small fraction of the total flow in the watershed, it has been assumed for many years to be a major contributor to the downstream mercury accumulations. A series of sediment settling ponds were constructed in ~1980 to intercept suspended sediment from the tailings and related springs. Water collections made in the vicinity of the mine by the Central Valley Regional Water Quality Control Board demonstrated significantly elevated mercury concentrations (CVRWQCB 1994). However, these tests did not include the entire watershed and did not have a low enough level of analytical detection to obtain useful data from any but the most extremely contaminated samples. Consequently, this earlier work could not determine the relative loading of mercury to the watershed from the mine on a mass balance basis.

In early 1995, our mercury biogeochemistry research group was contracted by the Contra Costa County Department of Public Works to undertake a comprehensive

assessment of mercury throughout the Marsh Creek watershed. It was our strong recommendation that a relatively thorough and up-to-date understanding of mercury dynamics throughout the watershed as a whole be obtained before mitigation plans were made. We felt that it was critical to determine the relative importance of the exposed mine site to the watershed's total mercury loading.

Mercury is naturally enriched throughout extensive areas of the Mt. Diablo region, which is why mercury was historically mined here (Ross 1940). Mercury is similarly enriched throughout much of the California Coast Range. As the majority of the water flow and associated transported material in the Marsh Creek watershed appeared to derive from tributaries other than the one containing the Mt. Diablo mine, it was quite conceivable that a significant proportion of the total mercury budget might come from more generalized watershed sources. Despite the locally contaminated nature of the mine vicinity itself, if the majority of total mercury loading came from elsewhere in the watershed, mitigation work at the mine could be relatively ineffectual.

In the first phase of our mercury assessment, we developed a sampling plan that accounted for all important watershed tributaries, major source flows at the mine site, and included stations along downstream Marsh Creek to the reservoir and well beyond. We waited for a period of high but relatively steady flows following a major storm series, when suspended material was being transported in abundance and the sites could be inter-calibrated. These conditions occurred in late March 1995 and we were able to successfully collect samples throughout the watershed within a short period of consistent flow. At each of the 18 sites, water samples were taken for analysis of mercury in both raw and filtered fractions, as well as for suspended solids concentration. The mercury samples were taken using ultra-clean techniques and were analyzed by the foremost aqueous mercury analytical laboratory in the world, providing above-detection mercury concentration data for all samples. At each site, the water flow was determined as well. With concentration and flow data for each site, it was then possible for us to calculate the total loads of mercury moving through each stretch and to compare the tributaries on a relative basis.

To supplement these water-based mercury measurements, we looked at bioindicator organisms within the watershed. At 12 collection sites, we sampled localized benthic invertebrates of several types. These invertebrates integrate the bioavailable fraction of mercury that they are exposed to over their lifetimes. In-stream fish were collected at the 6 stations where they were present. All of these samples were analyzed for mercury, to provide time-integrated information on the relative mercury trends among the different tributaries.

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A second piece of essential information was the determination of current mercury conditions in Marsh Creek Reservoir, particularly within the fish populations. As the only data to have been collected there had been taken 15 years earlier, in 1980, and the actual data themselves were apparently unavailable (Contra Costa County 1994), a new survey of the reservoir was warranted.

Therefore, in a second phase of our assessment, we conducted a study of mercury in Marsh Creek Reservoir sediments and biota in September 1995. We collected surficial sediments from throughout the reservoir and obtained a record of historical sediment mercury deposition over the 30+ year history of the reservoir through sediment core samples. The reservoir's current fish populations were assessed, with tissue mercury analyses conducted on extensive samples from all types with significant representation at this time.

Table 1 summarizes the mercury analytical samples collected for both phases of this project. A total of 48 aqueous mercury analyses were made, half in raw water and half in corresponding filtered water. Total mercury was analyzed in 170 individual biotic and sediment samples, including 46 individual fish analyzed for muscle mercury from Marsh Creek Reservoir. Additional analytical samples for the project included suspended solids samples from all stream sites (22, including duplicate samples), and moisture and organic percentage analyses in 30 reservoir bottom sediment samples.

Throughout this report, the data for each major watershed parameter is generally presented both in tabular and graphic form. Map figures of each of the major data parameters are included for the watershed as a whole, as well as for the immediate mine vicinity where appropriate.

With the data collected in the two phases of the study, this report provides the County with information on current mercury levels throughout the Marsh Creek watershed and Marsh Creek Reservoir. Further, the relative importance of the various upstream source regions to the overall mercury loading in the system can be estimated. Finally, in the event that new mercury mitigation work is initiated within the watershed, a comprehensive, accurate data base has been initiated, describing mercury conditions throughout the major components of the system, including water, suspended sediment, and aquatic biota from the entire watershed and depositional sediment and biota from Marsh Creek Reservoir. Baseline data, taking into account natural inter-annual variability, can be compared to mercury levels in future collections to guide and assess the effectiveness of mitigation efforts.

Table 1. Summary of all Samples Analyzed for Mercury in This Project

	Raw Water	Filtered
Aqueous Total Mercury:	22	22
Aqueous Methyl Mercury:	2	2
TOTAL AQUEOUS SAMPLES (48 total):	24	24

	Stream	Reservoir
Invertebrate Composites:	41	4
Small Fish Whole Fish Composites:	18	8
Individual Fish Muscle Samples:	20	46
Adult Largemouth Bass:		*10*
Juvenile Largemouth Bass:		*10*
Adult Bluegill:		*1*
Juvenile Bluegill:	*4*	*11*
Hitch:	*8*	*14*
Juvenile Salmon:	*5*	
Crayfish Tail Muscle:	*3*	
Individual Fish Liver Samples:		7
Sediment:	—	26
TOTAL SOLID SAMPLES (170 total):	79	91

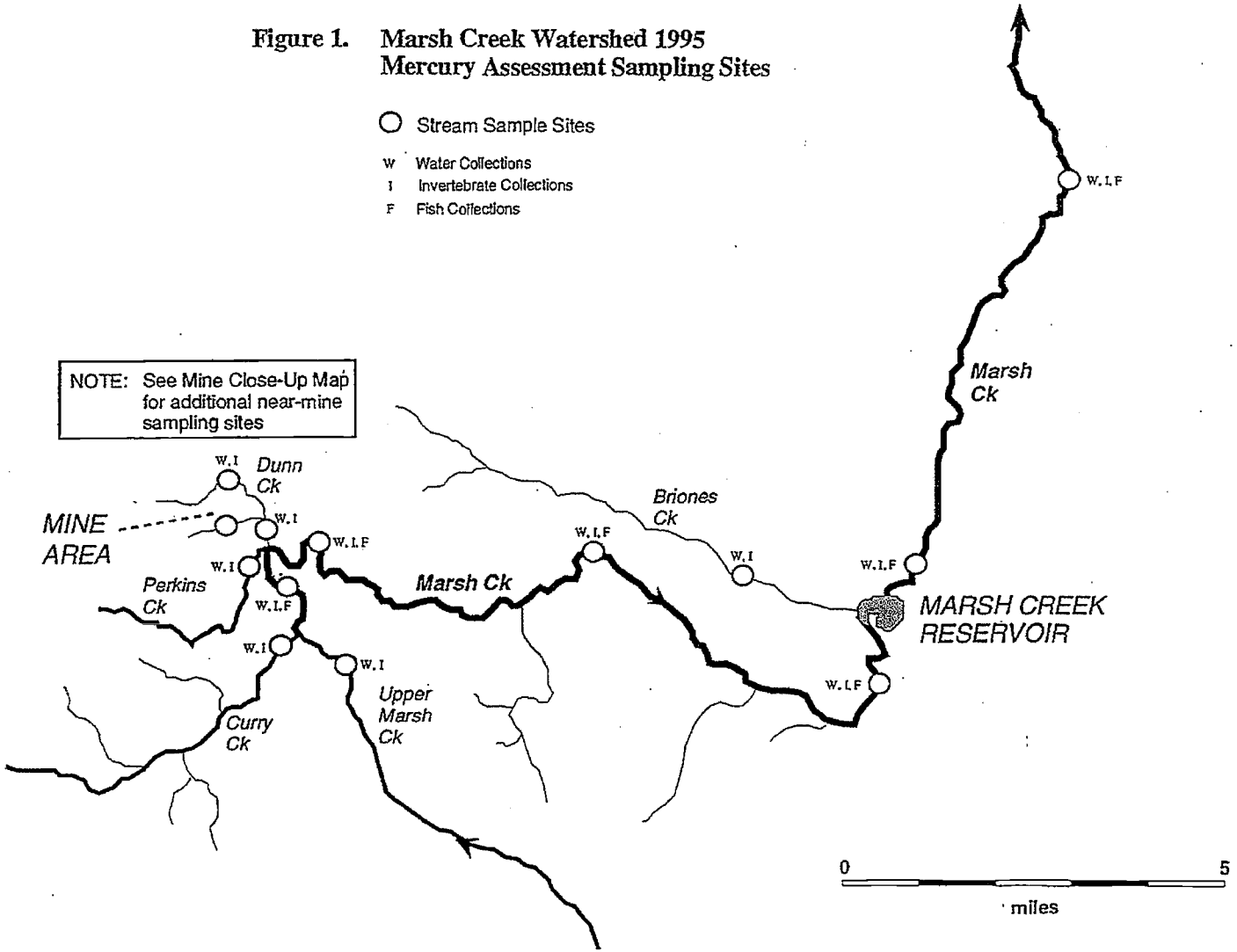
2. METHODS

2.1 Site Selection

The sampling sites utilized for the watershed portion of this project are shown in Figures 1 and 2. Sampling sites within Marsh Creek Reservoir are displayed in section 3.2 (Fig. 18).

In the watershed component of this work, our plan was to sample all significant tributaries of the Marsh Creek watershed, immediately following heavy rains. We sampled water and invertebrates from the upper section of Marsh Creek (above Curry Creek), from Curry Creek, Perkins Creek, Dunn Creek both above and below the Mt. Diablo Mercury Mine area, "My" Creek (a tributary to Dunn Creek that runs along the northern edge of the mine area), and Briones Creek. We were unable to sample two streams which enter Marsh Creek from the south along the mid section of the creek. This was because the landowners repeatedly refused us permission to make collections. However, these were relatively small creeks and their contributions to the downstream mercury load could be estimated by

Figure 1. Marsh Creek Watershed 1995 Mercury Assessment Sampling Sites



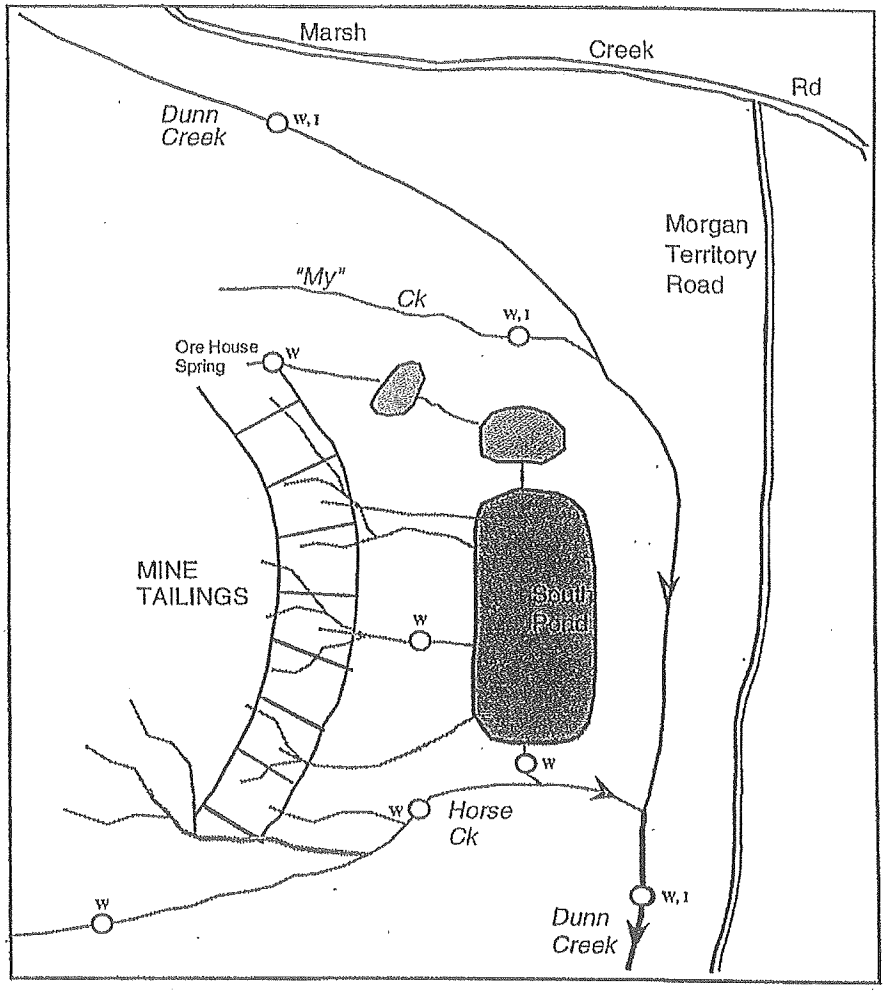


Figure 2. **1995 Mercury Assessment Sampling Sites in the Vicinity of the Mt. Diablo Mine**

○ Sample Sites

W Water Collections
I Invertebrate Collections

noting the changes or lack thereof in the various parameters at sites on Marsh Creek both above and below their inflows. As it turned out, they were insignificant to the regional mercury picture.

In addition to the tributaries, we sampled water, invertebrates, and fish from six additional sites along the length of Marsh Creek, including a site between Curry and Perkins Creeks, a site ~1 mile downstream of the Dunn Creek inflow, another ~5 miles downstream, one ~10 miles downstream just above the reservoir, one just below the reservoir, and a final Marsh Creek site well downstream at Delta Rd, between Brentwood and Oakley. In addition to these main stream sites, we collected water from five additional sites in the vicinity of the mine itself. These included samples from Horse Creek, which flows along the south edge of the tailings, both above the tailings influence and below, just before entering Dunn Creek. Other mine area water samples included outflow from the lower settling pond, representative inflow to that pond through the tailings, and the Orehouse spring which flows into the north settling pond.

In summary: at a total of 18 sites, flows were determined and we sampled for suspended solids and for total mercury in raw and filtered water immediately after a major storm cycle. Methyl mercury was additionally analyzed from duplicate samples taken from Marsh Creek directly above the reservoir. Benthic invertebrate bioindicators were sampled at all sites containing sufficient concentrations of organisms for analysis (12 sites) and fish were taken at those stream sites where they were present (6 sites).

In Marsh Creek Reservoir, surficial sediment was collected from 8 different locations in the reservoir (Fig. 16). These were spaced so as to sample all major depositional areas. Sediment cores were taken at the centers of each of the two main basins. Fish were taken from throughout the reservoir.

2.2 Collection Techniques

2.2.1 Water

Water collections for mercury analysis were made in conjunction with Frontier Geosciences Laboratory, which is the most highly esteemed aqueous mercury laboratory in the world. Ultra-clean 250 ml teflon collection bottles were shipped to us, individually packaged in double zip-lock bags. Two person clean collecting protocol was used, in which the actual sample bottle was touched only by one researcher who handled nothing else and wore sterile gloves. Samples were taken in flowing water by standing mid-stream and, facing upstream, submerging the bottle in the middle of the flow. The cap was

removed underwater, allowing the bottle to fill without coming into contact with potential surface film material, and then resealed before bringing to the surface. The bottle was then placed into the waiting isolation bags, held by the co-worker. Bagged ice packs kept the bottles cool and samples were shipped by overnight mail to Frontier Geosciences. Water samples were filtered and preserved in a trace metal clean room within 24 hours of collection, and later analyzed within standard holding times.

In conjunction with each set of aqueous mercury samples, we collected identical water into 1 liter bottles for analysis of suspended solids. These bottles were held in a separate ice chest, on ice, and were returned to our laboratory in Davis for processing within 48 hours of collection.

Flow at each of the stream sites was determined by measuring the cross sectional area of the channel along a relatively uniform stretch. A known number of meters was marked off alongside. A current float of near-neutral buoyancy was then passed through this course three to ten times. Time to the nearest 0.01 seconds was recorded for each pass.

2.2.2 Invertebrates

Stream invertebrates were taken from riffle habitat at each of the sites where they were present, i.e. from rapids or cobble bottomed stretches with maximal flow, where aquatic insects tend to be most concentrated among the rock interstices. Stream invertebrates were collected primarily with the use of a research kick screen. At each site, one researcher spread and positioned the screen perpendicular to the flow, bracing the side dowels against the bottom, while the other researcher overturned boulders and cobble directly upstream of the screen. These rocks were hand scrubbed into the flow, dislodging any clinging biota. Following the removal of the larger rocks to the side of the stretch, the underlying cobble/pebble/gravel substrate was disrupted by shuffling the boots repeatedly. Invertebrates were washed into the screen by the current. The screen was then lifted out of the current and taken to the shore, where forceps were used to pick macro-invertebrates from the screen into collection jars. This process was repeated at each site until a sufficient sample size of each taxon of interest was accumulated to permit analysis for mercury. At Marsh Creek Reservoir, samples of adult dragonflies and damselflies were taken with insect nets.

Samples were maintained in their collection jars on ice, and then cleaned in fresh water within 24 hours of collection. Cleaning was accomplished by suspending sample organisms in fresh water and, as necessary, shaking individuals in the water with teflon-coated forceps to remove any significant clinging surficial material. Cleaned organisms

were stored in pre-cleaned jars with teflon-lined caps, which were frozen and then dried at 50-60 °C. The dried sample was homogenized to a fine powder with teflon-coated instruments and a glass laboratory mortar and pestle. All of these techniques have been well established and tested in extensive prior mercury research work throughout California (Slotton et al. 1995a).

2.2.3 Fish

Fish were taken from selected stream sites, where present, with baited minnow traps which were left overnight. Stream fish were also taken with seines which were pulled through certain stretches to trap fish. In Marsh Creek Reservoir, fish were collected using a boat with a variety of experimental gillnets, as well as by set line, angling, and with dip nets. Small individuals to be analyzed for mercury from both stream and reservoir were held on ice in sealed bags. They were later weighed and measured in the laboratory and homogenized into appropriate composite samples with a laboratory homogenizer. Larger fish to be analyzed were weighed and measured on site. Tissue samples for mercury analysis were excised directly in the field, using clean technique, with stainless steel scalpels. Muscle samples were taken from the dorso-lateral ("shoulder") region, as done by the California Department of Fish and Game. Tissue samples were placed directly into pre-weighed laboratory digestion tubes, which were capped with teflon liners and maintained in sealed bags. The precise weight of each tissue sample was determined by weighing the tubes containing samples (together with pre-weighed blanks) and subtracting the initial empty weights. We have utilized these techniques with great success in similar work over the past 11 years (Reuter et al. 1989, Slotton 1991, Slotton et al. 1995a, Slotton et al. 1995b)

2.2.4 Sediment

Sediment samples were taken in Marsh Creek Reservoir both from the surficial sediment at the sediment/water interface and in extended cores which penetrated deep into the sediment. Surficial sediment samples were collected with an Ekman dredge and were spooned into pre-cleaned glass jars with teflon-lined caps. Sediment cores were taken by hand with a custom-made non-metallic coring device which was driven into the bottom from the boat and then carefully pulled out and transported to shore. There, the core was extruded and sectioned, with samples retained in pre-cleaned glass jars with teflon-lined

caps. Sediment samples were maintained refrigerated but unfrozen (so as to not alter mineral structure) until they were analyzed for mercury within 18 days of collection.

2.3 Analytical Methodology

2.3.1 Water

Total mercury in water was analyzed by dual amalgamation/cold vapor atomic fluorescence spectrometry, as developed by Bloom and Crecelius (1983). Methyl mercury was analyzed utilizing aqueous phase ethylation, followed by cryogenic gas chromatography with cold vapor atomic fluorescence detection, as developed by Bloom (1989). The detection levels for these extremely sensitive analyses are approximately 0.01 ng L^{-1} (parts per trillion), well below any environmental aqueous mercury levels present throughout Northern California.

Current speed was estimated by taking the average time of the near-neutral buoyancy current float to traverse the uniform test stretch of stream and dividing by the length of the stretch. The speed of the flow was then multiplied by the cross sectional area to obtain the flow volume per second.

The bulk load of total mercury moving through each stream site per day was determined by multiplying the measured aqueous mercury concentration by the corresponding measured flow (volume per second) and finally by the number of seconds in a day.

The relative mass balance contributions of bulk mercury from individual upstream source areas to downstream receiving waters were determined by assessing the proportional contributions of bulk mercury among the source flows immediately upstream at each major fork in the sampled streams. This was done by working upstream from the Marsh Creek site 1 mile below the Dunn Creek inflow. Based on the data, all significant mercury inputs occurred above this point. The calculated bulk flows of mercury of the streams contributing to this portion of Marsh Creek (Marsh Creek above Perkins Creek, Perkins Creek, and Dunn Creek) were assessed relative percentage contributions by dividing each mercury load value by the sum of the three. The total mercury input at this point was considered to be 100%. The relative contributions of tributaries upstream of these 3 stem flows were determined by successively following this procedure and multiplying the percentage bulk mercury load proportions of contributing flows by the previously calculated percent contribution of the stem flow immediately downstream (Table 6).

2.3.2 Suspended Solids

Suspended solids concentration at each site was determined by filtering a given volume of well mixed sample water through a pre-weighed glass fiber filter. The solids were retained on the filter, which was then dried at 105 °C for 24 hours. After cooling the filter in a dessicator, it was re-weighed to the nearest 0.0001 g. The weight of solids was obtained by subtracting the initial, clean weight of the filter from the weight with solids. This amount was divided by the volume of water filtered to derive the solids concentration on a milligram per liter basis. To obtain bulk loading quantities of suspended solids, the concentration data were weighted by the accompanying flows, as described for aqueous mercury.

Dry weight mercury concentration of the particulates themselves was estimated by first determining the aqueous mercury concentration attributable to the suspended solids. This was done by subtracting the aqueous mercury concentration in filtered water from the corresponding mercury concentration in raw water. This aqueous concentration, attributable to the entrained particulates, was then divided by the concentration of suspended solids in the water.

2.3.3 Fish, Invertebrate, and Sediment Total Mercury

Solid samples for mercury were analyzed using homogeneous portions. Sediment was subsampled from homogenized, wet (liquefied) samples. Identical subsamples were used to determine moisture content for dry weight conversions. Fish tissue was also analyzed on wet (fresh) samples, as is the standard procedure for governmental agencies. Mercury analyses of invertebrate samples were conducted with dried and powdered samples for uniformity, as described in Slotton et al. (1995a).

Solid samples of all types were processed by first digesting in concentrated sulfuric and nitric acids and potassium permanganate, under pressure, at 80-100 °C for three hours. They were subsequently analyzed for total mercury using a well-established modified cold vapor atomic absorption (CVAA) micro-technique, described in Slotton et al. (1995b). The level of detection for this technique is approximately 0.01 mg kg^{-1} (ppm), sufficient to provide above-detection results for nearly all aquatic sediment and biota samples in this region.

2.3.4 Sediment Water and Organic Content

Moisture content of sediment samples was determined by weight difference between fresh, homogenized sample (10-2560 g) and the sample after drying at 105 °C to constant weight (generally 24 hours), subtracting out the weight of the weighing container. Weights were accurate to ± 0.001 g. To obtain the Loss On Ignition (LOI) estimate of organic content, the dried sample was subsequently placed in a 475 °C muffle furnace for 2 hours in order to burn off any organic matter. After cooling, the mineral moisture of hydration was returned by re-wetting the sample. The sample was again dried at 105 °C to constant weight, cooled in a dessicator, and weighed again to ± 0.001 g. The loss in weight between the initial dry sample and the sample after the muffle furnace treatment is attributed to organic matter.

2.4 Quality Assurance/Quality Control (QA/QC)

2.4.1 Water

The water samples for mercury were analyzed at Frontier Geosciences Laboratory in a single, large analytical run, accompanied by a good number of QA/QC samples. QA/QC was excellent, as summarized below in Table 2.

Table 2. Frontier Geosciences Laboratory Aqueous Mercury QA/QC (from 1 analytical run)

	Spike Recoveries (%)	Duplicate RPD (%)	Reagent Blanks (ng/L)	Filter Blanks (ng/L)	NRCC Dogfish (ppm)
Certified Level					4.57
Ideal Recovery	(100%)	(0%)	(0.00)	(0.00)	(100%)
Control Range (%)	75-125%	≤25%			75-125%
Control Range (concentration)			≤0.20 ng/L	≤0.20 ng/L	3.43 - 5.71
Recoveries (%)	100-113%	1-20%			97-107%
Recoveries (concentration)			0.10	0.12	4.42 - 4.89
(n)	n=3	n=11	n=1	n=1	n=7
Mean Recoveries (%)	105%	8%			101%
Mean Recoveries (concentration)			0.10	0.12	4.63

2.4.2 Fish, Invertebrates, and Sediment

Extensive QA/QC accompanied all of our total mercury analyses of aquatic biota and sediment samples. For each sample batch of approximately 24 samples, a large number of QA/QC samples were included through all phases of the digestion and analysis procedures (16 total). These included 1 blank and 7 aqueous mercury standards, 2 pairs of samples of standard reference materials (4 total) with known mercury concentrations, 2 duplicates of analytical samples, and 2 spiked analytical samples. These 16 additional samples per analytical run were used, as always, to ensure the reliability of the data generated. The QA/QC results for this portion of the work are summarized in Table 3.

Table 3. D.G. Slotton Laboratory Total Mercury QA/QC Summary (from 8 analytical runs)

	Std Curve R^2	Spike Recoveries	Duplicate RPD	NBS Tuna	IAEA Tuna	NBS Sediment	BCR Sediment
Certified Level (ppm)				0.95	4.70	1.47	0.67
Ideal Recovery	1.000	(100%)	(0%)	(100%)	(100%)	(100%)	(100%)
Control Range (%)	≥0.975	75-125%	≤25%	75-125%	75-125%	75-125%	75-125%
Control Range (ppm)				0.71-1.19	3.60-6.00	1.10-1.84	0.50-0.84
Recoveries (%)	0.998-1.000	87-108%	0.2-18.8%	88-120%	93-104%	97%	90-100%
Recoveries (ppm)				0.84-1.14	4.37-4.87	1.42-1.43	0.60-0.67
(n)	n=8	n=18	n=21	n=16	n=15	n=2	n=6
Mean Recoveries (%)	0.999	98%	5%	106%	98%	97%	96%
Mean Recoveries (ppm)				1.01	4.61	1.43	0.64

The extensive set of aqueous standards was used to construct an accurate curve of mercury concentration vs atomic absorbence for each analytical run. The standard curve R^2 values for the mercury runs utilized in this project all fell between 0.998 and 1.000, well above the control range of ≥ 0.975. The standard reference material samples included two fish standards and two sediment standards. All recoveries were within the 75% - 125% control levels, at 88-120%. Sample duplication was excellent, with relative % difference (RPD) having a mean value of 5% among 21 total paired samples. Spike recoveries were also consistently good, with recoveries of 87% - 108%, as compared to the 75% - 125% control levels.

3. RESULTS

3.1 Watershed

3.1.1 Water

We determined flows and collected water samples for mercury and suspended solids at 18 individual sampling sites distributed throughout the Marsh Creek watershed. These collections were made within a 48 hour period during high runoff flow conditions in late March 1995, following an extensive series of storms. A considerable effort was made to obtain these samples within as close a time period as possible, during high but relatively stabilized flow conditions. Flow values are presented in Table 4 and Figures 3 and 4. Concentration data for suspended solids and aqueous mercury are presented in Table 4 and Figures 5 and 6. Calculated bulk mercury loads, on a grams per day basis for each site, can be found in Table 5 and Figures 7 and 8. Mass balance data quantifying the overall proportional mercury contributions of the various source tributaries to downstream receiving waters are presented in Table 6 and Figures 9 and 10.

Table 4. Watershed Flow; Aqueous Mercury and Suspended Solids Concentration Data

Site	Flow (cfs)	*Aqueous Total Mercury* Raw (ng/L)	Filtered (ng/L)	*Suspended Solids* All (TSS) (mg/L)	Solids Hg (dry ppm)
Upper Marsh Creek	28.30	3.24	1.29	16.10	0.10
Curry Creek	33.70	5.18	1.49	32.00	0.12
Marsh Ck above Perkins Ck	65.60	4.69	1.34	32.10	0.10
Perkins Creek	13.90	8.89	4.11	3.00	1.59
Upper Dunn Creek	5.20	3.60	2.73	1.50	0.60
Upper Horse Creek	0.08	25.50	16.00	1.10	8.64
"My" Creek	2.10	381.00	28.40	10.90	32.41
OreHouse Spring	0.01	1,940.00	71.00	11.40	164.00
Trickle coming from tailings	0.03	58,400.00	54,100.00	77.20	56.37
South Pond outlet	0.05	59,100.00	59,100.00	26.10	0.00
Horse Creek @ tailings	0.32	25,000.00	21,900.00	104.00	29.8
Dunn Ck below mine confluence	7.80	949.00	226.00	13.50	53.60
Marsh Ck below Dunn Ck conf.	83.60	79.30	21.40	19.40	2.99
Mid Marsh Ck @ rd. crossing	101.00	52.80	10.10	24.60	1.74
Marsh Ck above Reservoir	111.00	37.67	8.80	23.10	1.25
Briones Ck @ Deer Valley Rd.	4.10	5.84	2.03	61.20	0.06
Marsh Ck below Reservoir	116.00	43.70	7.47	34.60	1.05
Marsh Ck @ Delta Rd.	107.00	37.80	6.44	53.80	0.58
		Aqueous Methyl Mercury Raw (ng/L)	Filtered (ng/L)		
Marsh Ck above Reservoir		0.204	0.112		

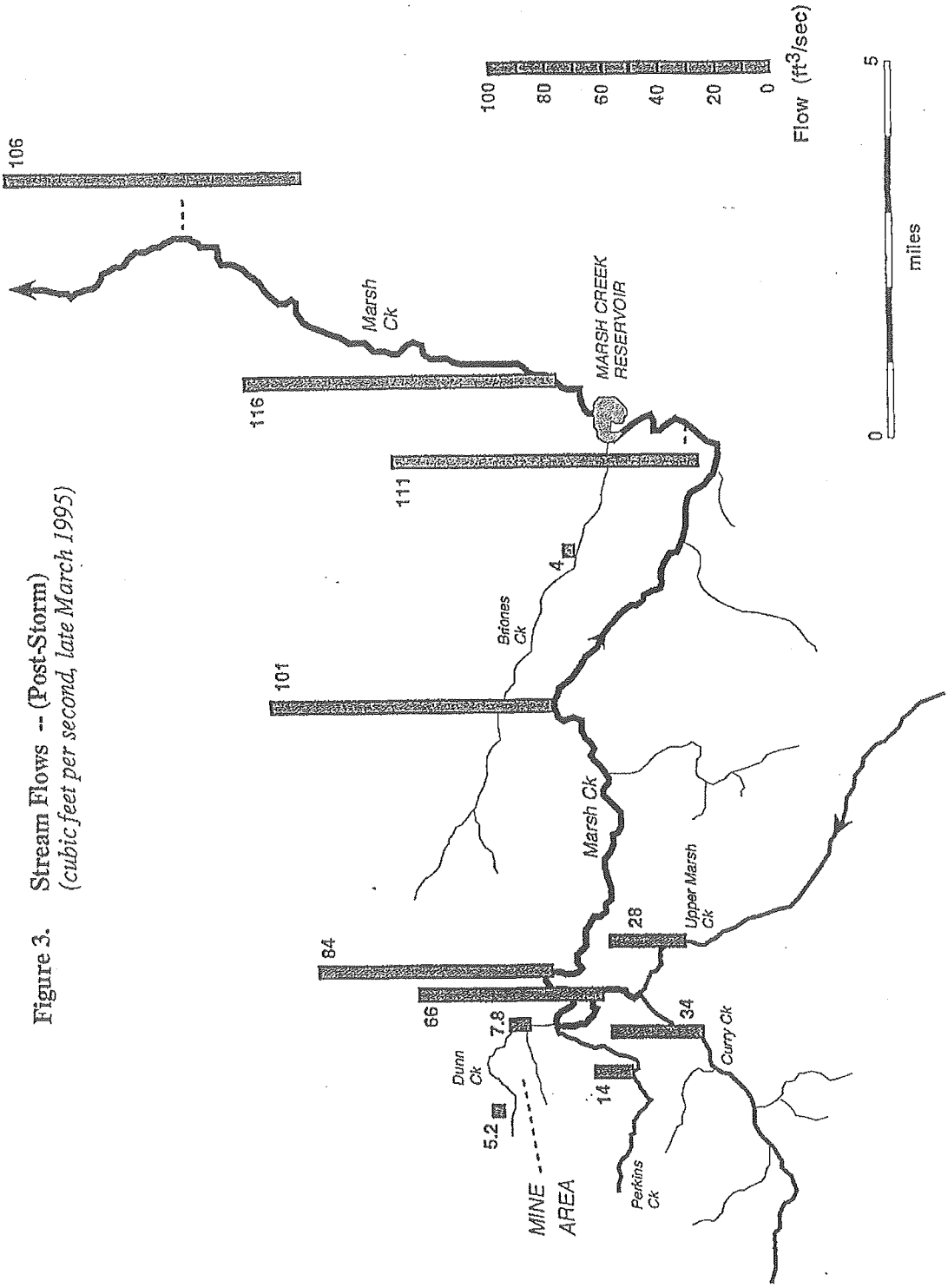
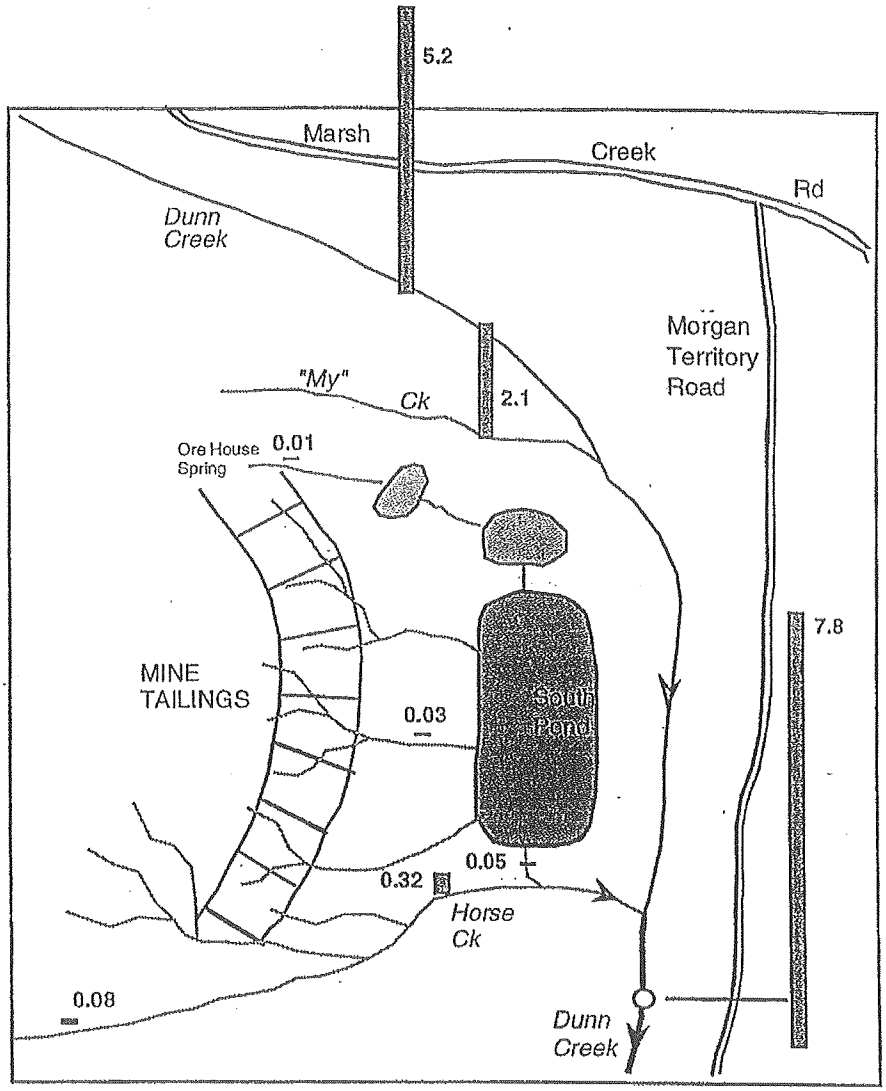
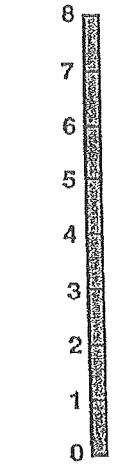


Figure 3. Stream Flows -- (Post-Storm)
(cubic feet per second, late March 1995)





Note scale (vs 100 ft³/sec scale used in whole watershed map)

Figure 4. **Stream Flows in the Vicinity of the Mt. Diablo Mine** *(Late March 1995)*

3.1.1.1 *Relative Flows*

Flow values, in units of cubic feet per second (cfs), are presented in Table 4 and Figures 3 and 4. Flow data were collected as a key parameter for bulk load and mass balance calculations. At the time of these samplings, major tributary streams in the Marsh Creek watershed each contributed flows of between 4 and 34 cubic feet per second to Marsh Creek. The flows measured in Marsh Creek itself demonstrated a characteristic, steady increase moving downstream, incorporating the inputs of the various tributaries as well as groundwater inflows. Flow was estimated at approximately 100 cfs at a site halfway between the Dunn Creek confluence with Marsh Creek and the downstream reservoir. Flows at and below the reservoir were an additional 5-15% higher.

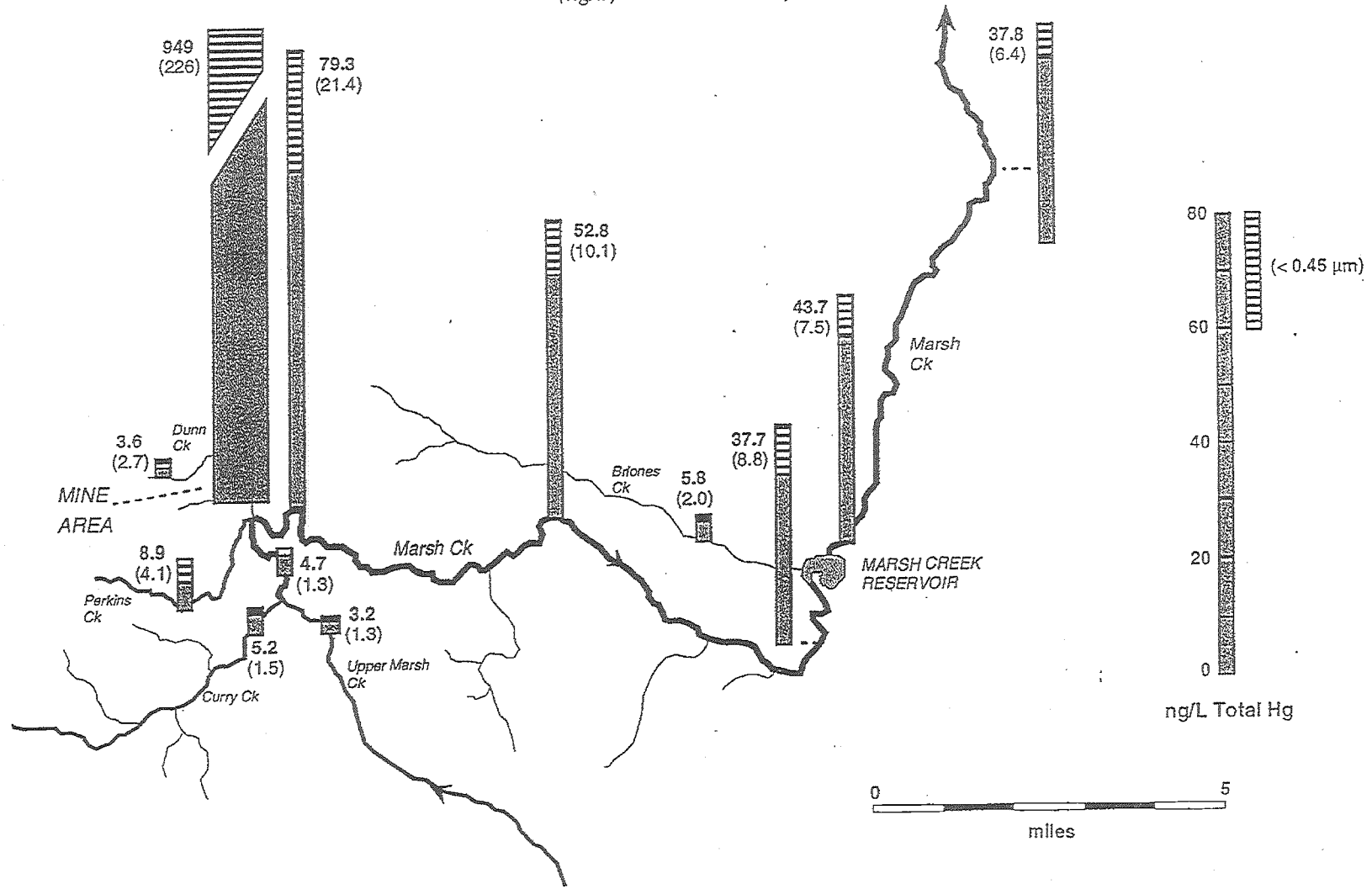
Of the ~115 cfs flow noted immediately above and below the reservoir in this sampling, three major upstream tributaries together accounted for 69% (~80 cfs) of the total. These were upper Marsh Creek, Curry Creek, and Perkins Creek. The water volume measured in Dunn Creek (7.8 cfs), which includes all flows derived from the Mt. Diablo mine area, amounted to less than 7% of the downstream flow. Further, the great majority of this water was derived from regions away from the mine, including the upper portions of Dunn Creek (5.2 cfs) and Horse Creek (0.08 cfs). "My" Creek, which is north of and relatively peripheral to the main tailings region, accounted for a further 2.1 cfs. Flows emanating specifically from the area of exposed tailings were estimated at only 0.28 cfs at the time of this sampling (lower Horse Creek minus upper Horse Creek, South Pond outflow minus Orehouse spring flow). This tailings-specific flow, at 0.24%, was less than one quarter of 1% of the total downstream water flow noted at the reservoir.

3.1.1.2 *Aqueous Mercury Concentrations*

Mercury was analyzed in homogenized, representative water samples taken from each of the 18 sites throughout the Marsh Creek watershed. Each sample was further divided into a filtered (≤ 0.45 µm) and raw water sample, each of which was analyzed for total mercury. Duplicate samples taken at the inflow to Marsh Creek Reservoir were also analyzed for methyl mercury. Aqueous mercury concentrations, in units of nanograms per liter (ng L^{-1}, = parts per trillion), are presented in Table 4 and Figures 5 and 6 Mercury measured in the filtered fraction is displayed superimposed on the total mercury data bars in the figures, and in parentheses in the figure data.

It is apparent in Figure 5 that; on a concentration basis, aqueous mercury levels in Dunn Creek downstream of the Mt. Diablo mine were significantly higher than the concentrations seen in all other tributaries to Marsh Creek, as well as upstream of the mine.

Figure 5. Marsh Creek Watershed
Aqueous Mercury Concentrations
(ng/L, late March 1995)



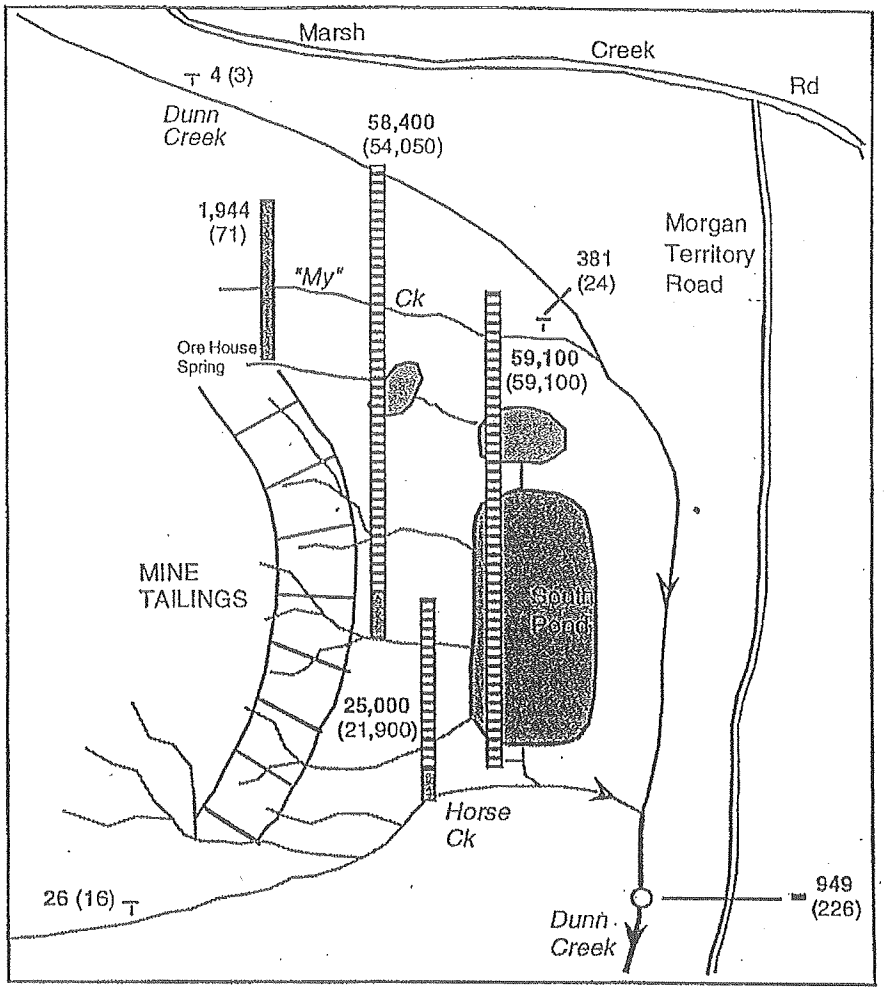


Figure 6. **Aqueous Mercury Concentrations in the Vicinity of the Mt. Diablo Mine** *(Late March 1995)*

The mercury concentrations found in the other main tributaries, at 3.2-8.9 ng L^{-1}, were two orders of magnitude lower than the 949 ng L^{-1} concentration found in Dunn Creek below the mine. The great impact of the mine-region Dunn Creek flows to Marsh Creek is apparent in the large increase in Marsh Creek aqueous mercury concentrations below the Dunn Creek confluence. Upstream levels of 3.2-8.9 ng L^{-1} increased to 79.3 ng L^{-1}, measured one mile below the confluence. Aqueous mercury concentrations remained elevated below this point in the watershed, at > 37 ng L^{-1} as far downstream as the town of Oakley.

The close-up map of aqueous mercury concentrations in the immediate vicinity of the Mt. Diablo mine (Fig. 6) demonstrates that the very high mercury levels seen in Dunn Creek are clearly derived from the mine itself. The stream "My" Creek, which borders the north extent of the tailings region, was quite high in mercury at 381 ng L^{-1}, while flows emanating from the tailings themselves were massively contaminated, with levels ranging from 25,000 - 60,000 ng L^{-1}. The Orehouse spring was also quite high, though far lower in mercury than the downslope tailings flows, at 1,944 ng L^{-1}. This small spring, however, contributed very little to the overall water volume from the site, with its flow at this time measured at just 0.01 cubic feet per second (Fig. 4).

Previous water sampling in the region by the Central Valley Regional Water Quality Control Board utilized less sensitive analytical techniques that placed most watershed samples below the 0.00002 mg L^{-1} (20 ng L^{-1}) level of detection (CVRWQCB 1994). However, above detection results were obtained from 4 of the earlier samples, including a Dunn Creek sample directly below the mine inflows (600 ng L^{-1}) and 3 sites in the direct vicinity of the tailings and settling pond (16,000 - 70,000 ng L^{-1}). These December 1994 levels were quite similar to the corresponding concentrations we found in our 1995 work.

In addition to the maximally contaminated flows from the mine tailings themselves, it is notable that all of the Marsh Creek watershed tributaries which showed any significant elevation in mercury concentration, relative to the entire data base, derived from the same slope of Mt. Diablo; i.e. the region between Perkins Creek and "My" Creek.

It is a very important observation that nearly all of the mercury detected in the heavily contaminated, near-tailings flows was found to be in the *filtered* fraction; i.e. the "dissolved" state. The sample of representative tailings seepage moving into the settling pond was found to contain 58,400 ng L^{-1} total mercury, with 54,050 ng L^{-1} (93%) measured in the filtered fraction. Water leaving the settling pond had 59,100 ng L^{-1} total mercury, with an identical concentration (a full 100%) measured in the filtered fraction. The somewhat diluted but higher volume flow in Horse Creek had a total mercury concentration of 25,000 ng L^{-1}, with 21,900 ng L^{-1} (88%) accounted for by the filtered

fraction. These collections were in marked contrast to samples from all other sites throughout the watershed, where the majority of the total aqueous mercury was in the particulate fraction. In downstream Dunn Creek and Marsh Creek, the filtered fraction accounted for only 17-27% of the total aqueous mercury. Further, it is likely that much of the downstream "filtered" mercury fraction was not truly "dissolved", but was associated with particulates and colloids that were simply smaller than the 0.45 µm standard pore size used in filtration. In contrast, the filtered mercury fraction that constituted virtually the entire mercury load in flows sampled at the tailings themselves likely originated from truly dissolved mercury, as suggested by the acidity (low pH) in the immediate vicinity of the ore body and settling pond.

This data indicates that the extremely high mercury concentrations in the tailings flows are derived specifically from the dissolution of mercury from the tailings. The tailings of this historic mercury mine are by definition rich in mercury. Once in the dissolved state, this mercury can become highly mobile. Mercury presumably dissolves readily into water in the immediate vicinity of the tailings due to the characteristic presence of sulfides in the ore. This sulfur, when exposed to rainwater, promotes the formation of sulfuric acid. The acid dissolves ore constituents that would otherwise remain in solid form, including the metals iron and mercury. The iron creates the orange stain characteristic of much acid mine drainage. This happens as the low pH is subsequently neutralized by dilution with other water and the dissolved metal begins to precipitate out of solution. Mercury likely precipitates fairly rapidly as well, as evidenced by the decline in the proportion of filtered mercury seen downstream of the immediate mine area. However, we note that the freshly formed, tiny, flocculent particles that result from the precipitation of formerly dissolved metals are themselves extremely susceptible to downstream transport, if exposed to significant flow energy. Therefore, it is our interpretation that this process of the tailings mercury dissolving into runoff seepage water is, either directly or indirectly, supplying much of the greatly elevated mercury concentrations seen in the downstream watershed.

The downstream shift in aqueous mercury partitioning, from dissolved mercury in the immediate vicinity of the tailings to particulate mercury dominating the remainder of the downstream watershed, indicates that the tailings-based dissolved mercury rapidly adsorbs to particulate material upon leaving the mine site.

An additional finding brought out by this data involves the main settling pond at the mine site, which captures much of the overland and through-flow from the tailings. The mercury measured in the outflow from this pond was entirely in the dissolved state. It was also essentially identical to representative tailings seepage that was flowing *into* the pond, both in character and mercury concentration. We conclude that, in its current configuration

and pH, the settling basin may not be effectively "settling out" a significant proportion, if any, of the aqueous mercury flowing into it. This is particularly the case under storm-related, elevated flow conditions, when the great majority of overall transport in the watershed occurs.

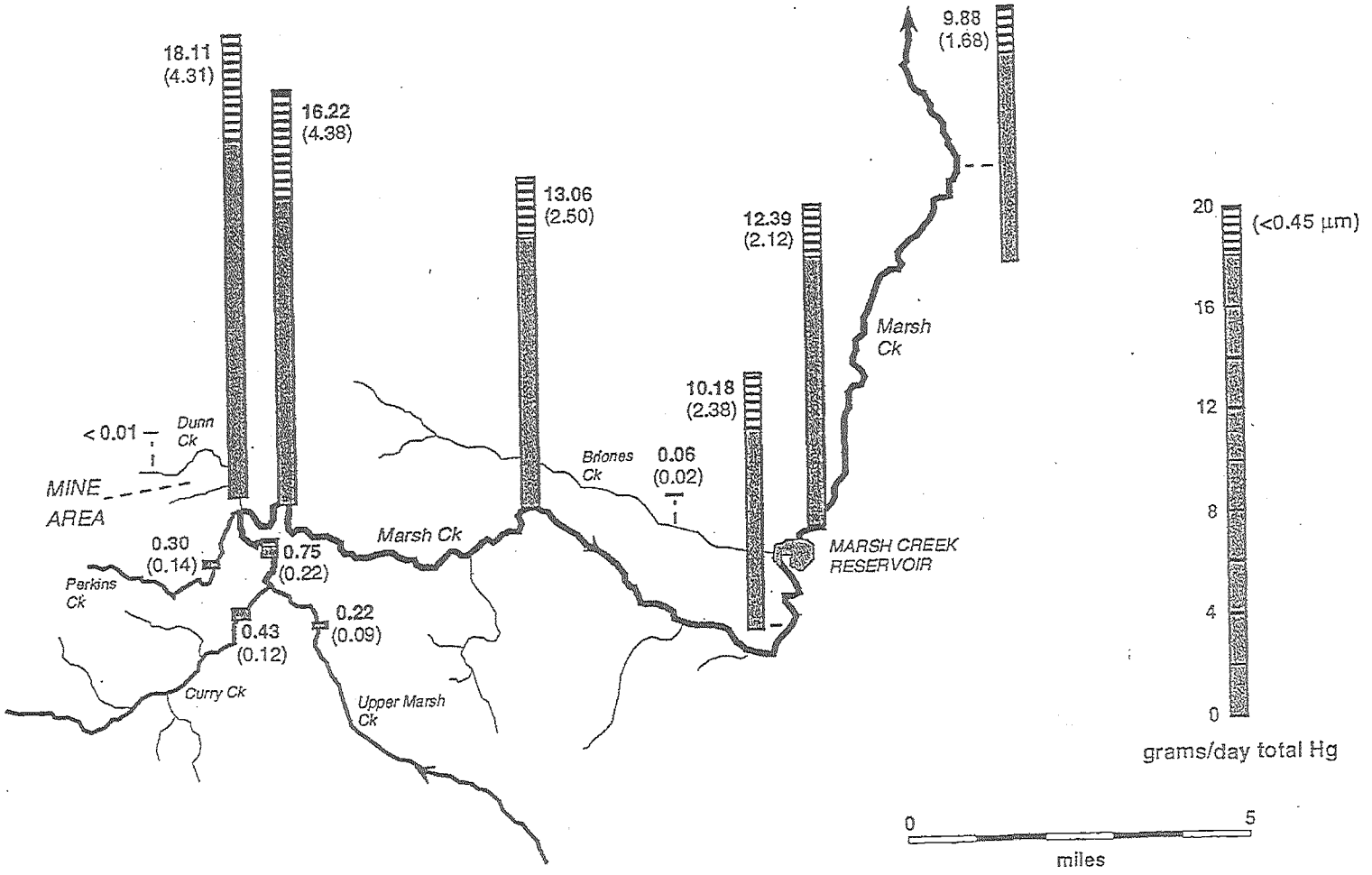
3.1.1.3 *Bulk Loads*

The mercury concentration data describe the local water quality conditions present at each of the sampling sites at the time of these collections. Aqueous mercury concentration is also a critical parameter with regard to localized biological uptake in the stream ecosystem. However, for considerations of overall mercury loading from the watershed to the downstream reservoir and beyond, we needed to determine the actual quantities of mercury that move through each of the stretches. This was accomplished by weighting the concentration information at each of the sites by the corresponding flow values that we determined at the time of sampling. In this way, we have been able to estimate the mercury *loads* deriving from the various tributaries, on a grams mercury per day basis. This data is presented in Table 5 and in Figures 7 and 8.

Clearly, Dunn Creek below the mine region is contributing the vast majority of mercury to the downstream reaches of Marsh Creek. All of the other tributaries, combined, accounted for approximately 1 gram of daily high flow mercury load at the time of this assessment, as compared to over 18 grams per day calculated to be moving concurrently through lower Dunn Creek toward Marsh Creek. Loads in Marsh Creek below the Dunn Creek confluence, at 10-16 grams per day as far downstream as Oakley, were dramatically greater than levels seen upstream of this confluence and in other tributaries away from mine influence. The mine inset map (Fig. 8) demonstrates that the great majority of the Dunn Creek mercury load derives specifically from the tailings piles. The greater proportion of this tailings-derived load enters lower Horse Creek without moving through the settling pond. A load of 19.6 grams of mercury per day was calculated for lower Horse Creek above the settling pond outlet, while the corresponding mercury load moving out of that pond was calculated at 7.2 grams per day.

At the time of this sampling, the data indicates that a portion of the upstream mercury load was actively sedimenting out of the water column in the course of moving downstream. Total aqueous mercury loads generally declined, moving downstream from the mine area. This occurred near the mine (Fig. 8) as well as along the length of Marsh Creek below the Dunn Creek confluence (Fig. 7). The combined mercury loads from Horse Creek (19.6 g/day), the settling pond (7.2 g/day), "My" Creek (2.0 g/day), and

Figure 7. Marsh Creek Watershed
Aqueous Mercury Bulk Loads
(grams mercury per day; late March 1995)



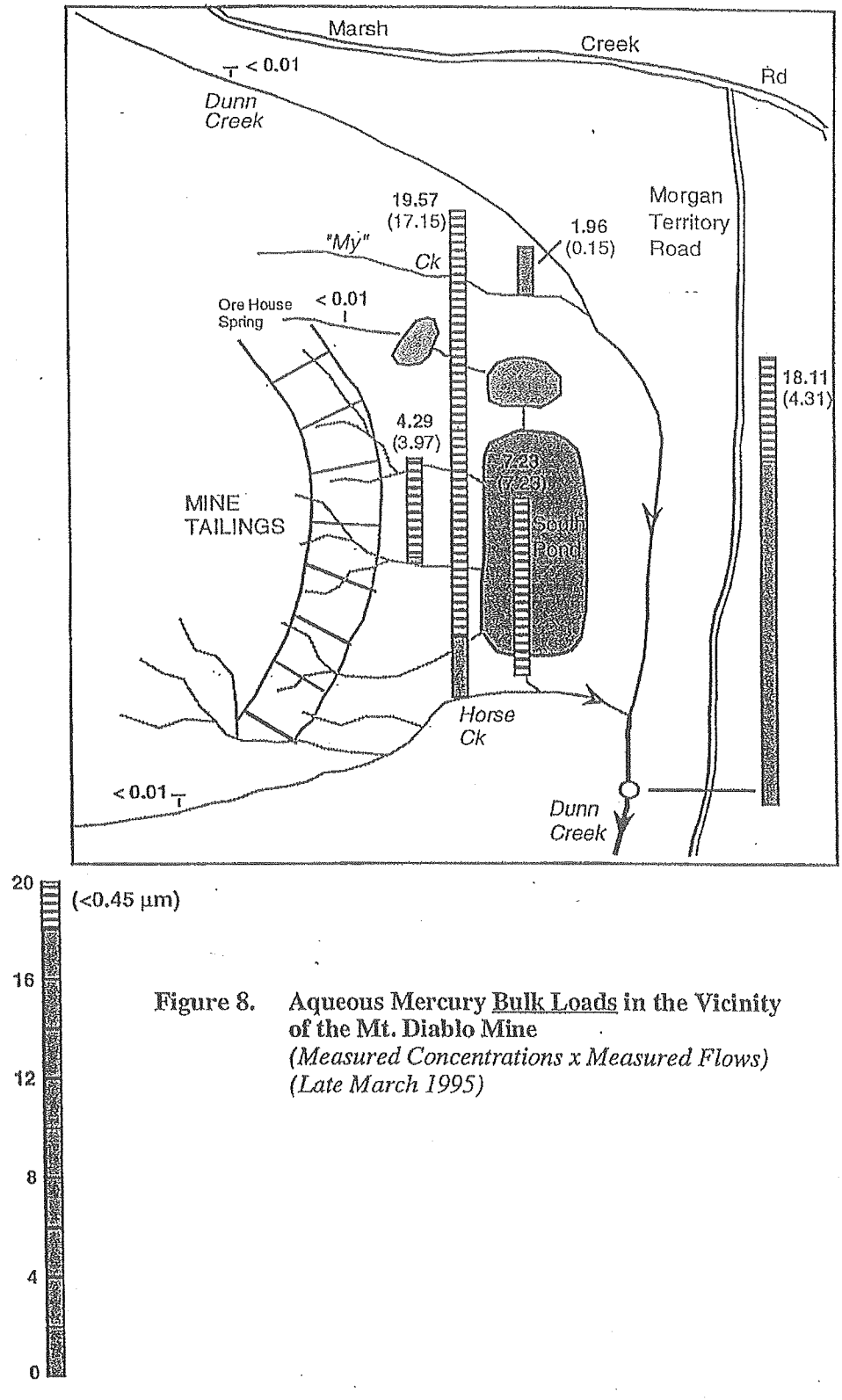


Figure 8. **Aqueous Mercury Bulk Loads in the Vicinity of the Mt. Diablo Mine**
(Measured Concentrations x Measured Flows)
(Late March 1995)

Table 5. Watershed Aqueous Mercury and Suspended Solids Bulk Loading Data

Site	*Aqueous Total Hg* Raw	Filtered	*Suspended Solids* (TSS)
	(grams/day)		*(kilograms/day)*
Upper Marsh Creek	0.224	0.089	1,110.0
Curry Creek	0.427	0.123	2,640.0
Marsh Ck above Perkins Ck	0.753	0.215	5,160.0
Perkins Creek	0.302	0.140	102.0
Upper Dunn Creek	0.046	0.035	18.4
Upper Horse Creek	0.005	0.003	0.2
"My" Creek	1.960	0.146	55.9
OreHouse Spring	0.048	0.002	0.3
Trickle coming from tailings	4.290	3.970	5.7
South Pond outlet	7.230	7.230	3.2
Horse Creek @ tailings	19.600	17.100	81.2
Dunn Ck below mine confluence	18.100	4.310	257.0
Marsh Ck below Dunn Ck conf.	16.200	4.380	3,960.0
Mid Marsh Ck @ rd. crossing	13.100	2.500	6,070.0
Marsh Ck above Reservoir	10.200	2.380	6,250.0
Briones Ck @ Deer Valley Rd.	0.059	0.020	614.0
Marsh Ck below Reservoir	12.390	2.120	9,800.0
Marsh Ck @ Delta Rd.	9.880	1.680	14,100.0
	Aqueous Methyl Hg Raw	Filtered	
	(grams/day)		
Marsh Ck above Reservoir	0.055	0.030	

upper Dunn Creek (0.05 g/day) totaled 28.8 grams per day, while the load measured in Dunn Creek just below the mine site was considerably lower at 18.1 grams per day. The load in downstream Marsh Creek one mile below the Dunn Creek confluence was still lower at 16.2 grams per day. The decline in the mercury load suspended in the water column continued, moving downstream, with 13.1 g/day measured at the site halfway down to the reservoir and 10.2 g/day measured just above the reservoir. This consistent pattern indicates that a portion of the mercury load was falling out of the current along with sedimenting particulates. However, we note that much or all of the previously suspended sediment that settles out within the channel itself during post-storm and lower flow conditions may ultimately be transported downstream to the reservoir and beyond under higher flow conditions, particularly with the spike increases in flow typical during large storm events.

The bulk load data additionally indicates that all significant mercury loading to the Marsh Creek watershed is accounted for by the upper watershed tributaries. The steady drop in aqueous mercury loads measured in Marsh Creek, from the Dunn Creek confluence

down to the reservoir, precludes the possibility of any important additional inputs of mercury from other sources along that stretch.

3.1.1.4 *Mercury Mass Balance*

Table 6. Calculated Relative Mercury Mass Balance Contributions of Upper Watershed Sources

Site	Raw Total Hg (grams/day)	%	Filtered Total Hg (grams/day)	%
Perkins Creek	0.30	1.6%	0.14	3.0%
Marsh Creek above Perkins Creek	0.75	3.9%	0.22	4.6%
Dunn Creek below mine confluence	18.11	94.5%	4.31	92.4%
	(19.17)	(100.0%)	(4.67)	(100.0%)
Marsh Creek above Perkins Creek	0.75	(3.9%)	0.22	(4.6%)
Upper Marsh Creek	0.22	1.4%	0.09	1.9%
Curry Creek	0.43	2.6%	0.12	2.7%
	(0.65)	(3.9%)	(0.21)	(4.6%)
Dunn Creek below mine confluence	18.11	(94.5%)	4.31	(92.4%)
Upper Dunn Creek	0.05	0.2%	0.03	0.1%
"My" Creek	1.96	6.4%	0.15	0.5%
South Pond Outlet	7.23	23.7%	7.23	27.2%
Horse Creek at Tailings	19.57	64.2%	17.15	64.5%
	(28.81)	(94.5%)	(24.56)	(92.4%)
TAILINGS ALONE				
Horse Creek at Tailings	19.573	64.21%	17.146	64.51%
(- Upper Horse Creek)	- 0.005	- 0.02%	- 0.003	- 0.01%
	19.568	64.19%	17.143	64.50%
		(+)		(+)
South Pond Outlet	7.230	23.72%	7.230	27.20%
(- OreHouse Spring)	- 0.048	- 0.16%	- 0.002	- 0.01%
	7.182	23.56%	7.228	27.20%
TAILINGS ALONE	26.75	87.8%	24.37	91.7%

Based on the data collected during this representative post-storm, elevated flow sampling, we have constructed a mass balance of the relative contributions of mercury to the watershed from the various upstream tributaries. These tributaries have been

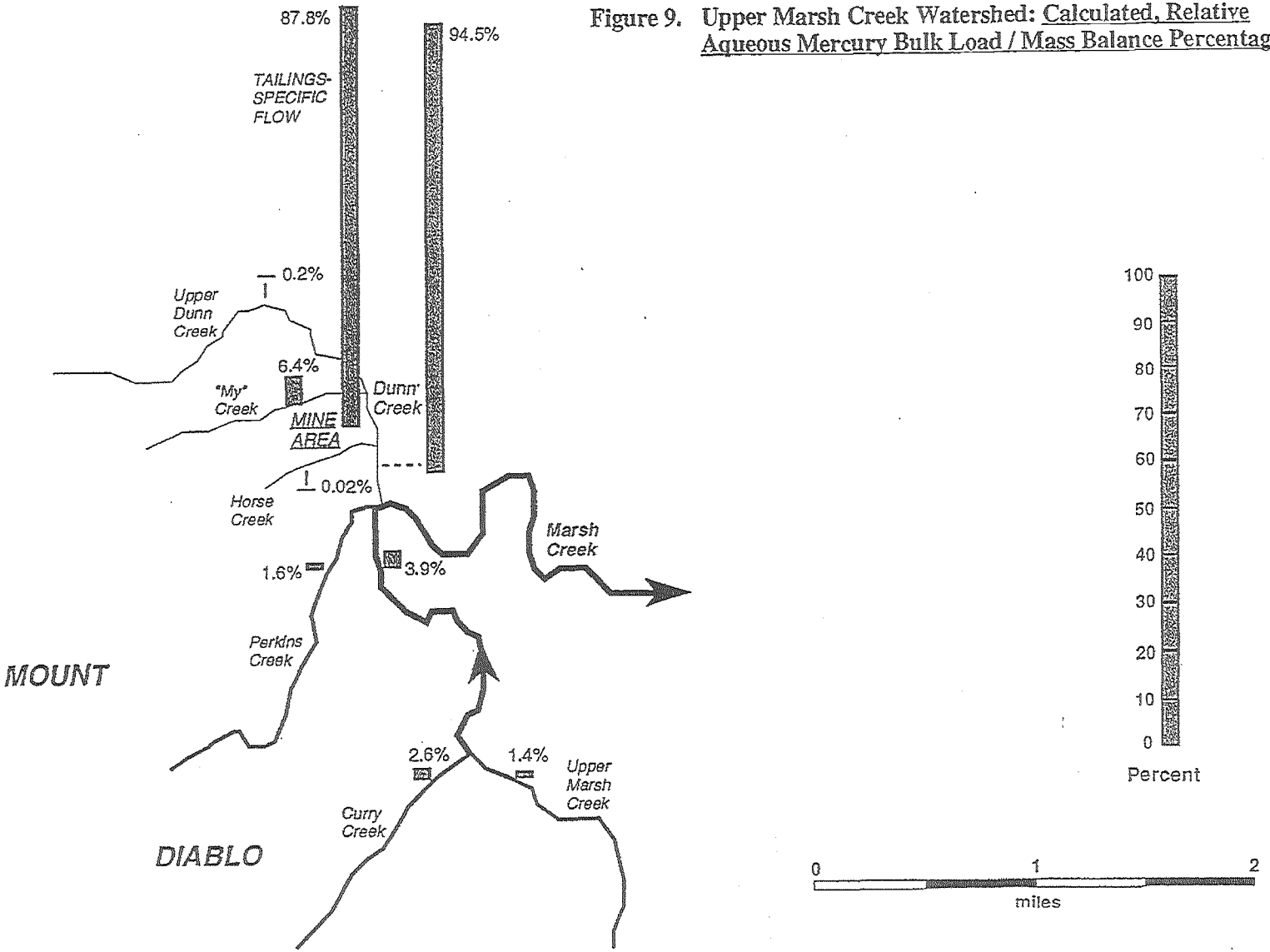


Figure 9. Upper Marsh Creek Watershed: Calculated, Relative Aqueous Mercury Bulk Load / Mass Balance Percentages

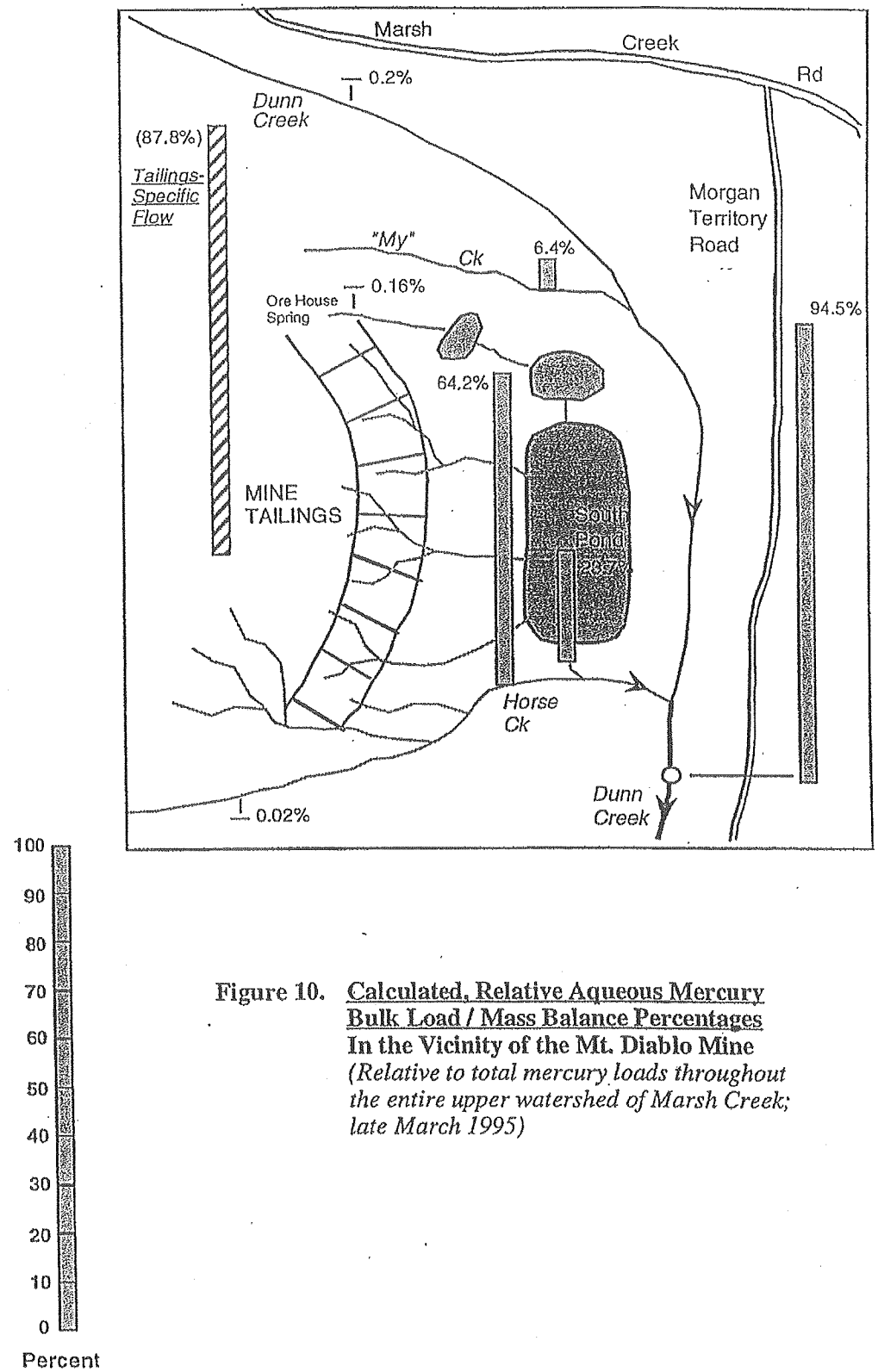


Figure 10. **Calculated, Relative Aqueous Mercury Bulk Load / Mass Balance Percentages In the Vicinity of the Mt. Diablo Mine** *(Relative to total mercury loads throughout the entire upper watershed of Marsh Creek; late March 1995)*

demonstrated to provide essentially all of the watershed's mercury loading. The data are presented in Table 6 and in Figures 9 and 10. The technique used to arrive at these values is described in section 2.3.1. These are our best estimates of the true proportional inputs of mercury from the different source regions to the Marsh Creek watershed.

In this analysis, the Dunn Creek inflow to Marsh Creek represents 94.5% of the total mercury loading to the upper watershed. Though the bulk of the water and transported sediment derive from upper Marsh Creek, Curry Creek, and Perkins Creek, these major tributaries accounted for only 5.5% of the watershed's mercury.

Of the 94.5% of the watershed mercury estimated to derive from Dunn Creek, it is apparent that the overwhelming majority comes from the Mt. Diablo mine. The upper stretches of Dunn Creek and Horse Creek, above the influence of the mine, together with the Orehouse spring flow, accounted for less than 0.4% of the total mercury (Fig. 10). "My" Creek contributed a moderate load of 6.4%. We are not clear at this time whether this particular stream is amenable to straightforward mitigation options.

Our major interest is in the flows emanating from the tailings themselves, as they are a very localized source that represent the County's best and most cost-effective mitigation focus for watershed mercury cleanup, if they in fact constitute the majority of the source. The data indicate that this is indeed the case. Subtracting out the small mercury loads of the Orehouse spring and upper Horse Creek, the relative mercury loading to the entire watershed derived specifically from this comparatively small region of mine tailings is estimated to be approximately 88%. The majority of this tailings-based load (64.2% in this analysis) enters lower Horse Creek without passing through the settling basin.

This information suggests that mitigation work directed specifically at the mine tailings, in order to lessen the export of mercury, may be a very sensible and cost-effective approach.

3.1.1.5 *Suspended Solids*

Suspended solids (TSS) data for the 18 stream sites are presented on a concentration basis (mg L^{-1}, = parts per million) in Table 4. This is a measure of particulate matter, primarily sediment, in the water. Suspended solids are of importance to mercury dynamics as they generally constitute the major vector of downstream mercury transport in running water. Mercury can be incorporated into the mineral matrix of particles as well as surface-adsorbed. Upon loosing velocity in the downstream reservoir and delta, these particulates deposit at the bottom as sediments and constitute the bulk of the total mercury in those systems.

Highest concentrations of TSS were seen in the flows on and around the tailings (to 104 mg L^{-1}), where iron and other metals were actively precipitating. The small Briones Creek, which drains farmland, was relatively very turbid as well (61 mg L^{-1}). Upper Marsh Creek and Curry Creek (~32 mg L^{-1}), the dominant sources of flow to the watershed, were quite turbid with suspended solids during this post-storm sampling period, while Perkins Creek (3 mg L^{-1}), "My" Creek (11 mg L^{-1}), upper Horse Creek (1 mg L^{-1}), and upper Dunn Creek (1.5 mg L^{-1}) were flowing quite clear. Below the Dunn Creek confluence, suspended solids concentrations in Marsh Creek generally increased steadily, moving downstream toward the reservoir and below (19 mg L^{-1} below the Dunn Creek confluence, increasing to 54 mg L^{-1} near Oakley).

As described above for mercury, the actual bulk loads of suspended solids moving through the different stream sections at the time of this sampling can be calculated by weighting the measured concentrations of TSS by the corresponding flows. These data are presented in Table 5 in units of kilograms per day and, Figure 11, as metric tons (1,000 kilograms, = 2,200 pounds) per day. The pattern is in sharp contrast to the mercury findings. Whereas the Dunn Creek mercury load overwhelmingly dominated that of the entire watershed, the suspended solids entering Marsh Creek from Dunn Creek represented only a very small fraction of the overall suspended solids load measured in downstream Marsh Creek. The Dunn Creek suspended solids load was calculated to be 0.26 metric tons/day, as compared to a combined 6.86 metric tons/day measured at the reservoir inflows. The Dunn Creek contribution of suspended solids therefore represented less than 4% of the total load measured entering the reservoir. While approximately 88% of the watershed's mercury was calculated to derive from the tailings piles at the Mt. Diablo mine, these suspended solids data indicate that an estimated 95% of the drainage's suspended solids load comes from tributaries which were found to be relatively very low in mercury--i.e. those tributaries other than Dunn Creek (including "My" Creek) and Perkins Creek.

In Table 4 and Figure 12 we have estimated the mercury concentration of the suspended particulates at the different sites, in consistent units of dry weight milligrams of mercury per kilogram suspended sediment (mg kg^{-1}, = parts per million). We note that the dominant sources of suspended sediment to the watershed--upper Marsh Creek, Curry Creek, and the small tributaries entering Marsh Creek along its lower length--were measured or demonstrated to be very low in suspended sediment mercury concentration, on the order of 0.1 ppm. This is in comparison with Marsh Creek TSS mercury levels between the Dunn Creek confluence and the reservoir of 1.3-3.0 ppm. Clearly, if the load of mercury emanating from the Mt. Diablo mine site can be significantly lessened, the natural suspended sediment loads transported through the Marsh Creek watershed in future