Characterizing, Predicting, and Modeling Water at Mine Sites –
SWRCB Training Academy Short Course, May 18-21, 2009

Field Trip Itinerary, Jamestown Mine, Tuolumne County, CA
Weds. May 20, 2009

8:30 – Depart Marriott Hotel (Rancho Cordova) for Jamestown via Hwys. 16 and 49. (Note: it's about a 2 hour drive so a "pit stop" may be necessary if the bus isn't equipped with a toilet. There is an Indian Casino located near the mine. Portable toilets will be available at the mine.)

10:30 – Arrive at the Jamestown Mine office parking lot which is located off High School Road (not Harvard Mine Road). Meet Mark Adams (Trustee of the Jamestown Trust) and J.C. Isham (Shaw Environmental Inc.). Shaw manages the site for the Trust. We will receive a tailgate safety talk. We will then drive the bus up to the low-grade ore area (Stop 2) and disembark.

10:45 **– STOP 1 – Tailings Impoundment.** Walk over to the tailings impoundment, about 200 meters from where everyone disembarks from the bus. Victor Izzo (Regional Water Quality Control Board) and J.C. Isham will talk about historical and current events concerning the tailings impoundment, followed by discussion led by course instructors regarding characterization and modeling that should be considered for tailings facilities.

11:45 – **Lunch** at the low-grade ore area / Crystalline Pit overlook, adjacent to the Waste Rock Storage Area. A box lunch will be provided by the course organizers ($10 fee). Mineral collectors can try their luck, and class discussion can continue informally. Portable toilets will be placed in this area.

12:30 – **STOP 2 – Low-grade Ore Area / Crystalline Pit Overlook.** Course instructors will talk about the characterization and modeling that should be considered for waste-rock dumps and ore piles.

13:30 – **STOP 3 – Waste Rock Storage Area / Harvard Pit Overlook.** Walk over to the Waste Rock Storage Area (easy walk), which provides a good vantage point to see into the Harvard Pit. Victor Izzo and J.C. Isham will talk about groundwater modeling and pit filling history. Roger Ashley (U.S. Geological Survey) will talk about water quality characterization and geochemical modeling that has been done on the Harvard Pit by Kaye Savage and others.

14:30 – **STOP 4 – Harvard Pit Interior.** The group will walk into the pit to look at primary and secondary minerals in the ore zone and surrounding rocks. To access the pit, walk back toward the bus and continue on into the mine pit (easy downhill walk – access point in NE corner). The bus will take those who prefer to ride to the pit access point *via* Harvard Mine Road.

15:30 – Load bus and depart.

17:30 – Return to Marriott Hotel (Rancho Cordova).

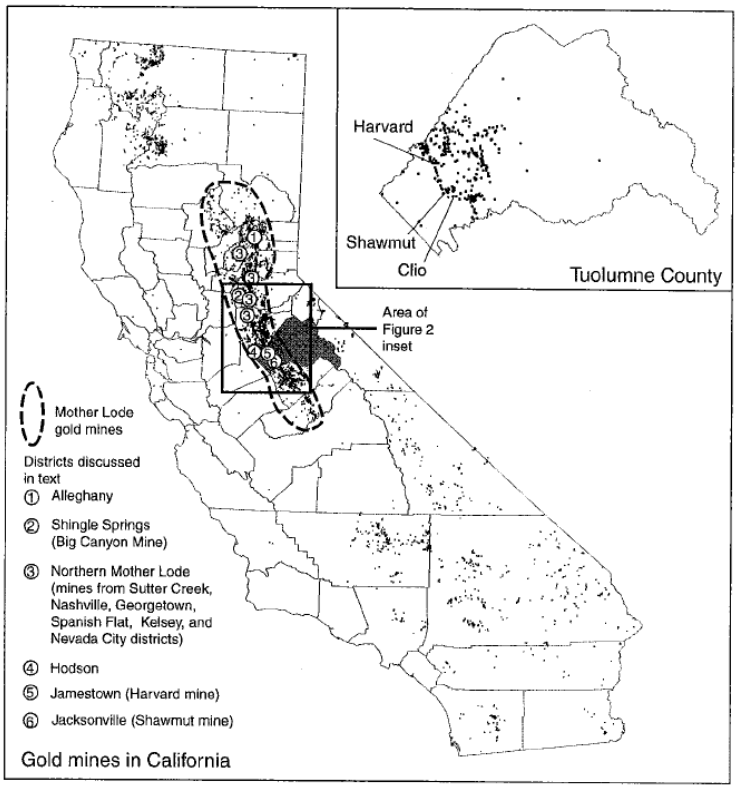

FIG. 1. Locations of gold mines in California; county boundaries are shown for reference (U.S. Geological Survey Computer Resources Information Bank). Mother Lode gold mines are enclosed by the dashed line. Circled numbers represent districts for which analyses are presented. Tuolumne County is shaded. Inset shows locations of gold mines included in this study; Tuolumne County boundary and additional mines shown for reference.

From: Savage et al. (2000) Intl. Geol. Rev., v. 42, p. 385-415.

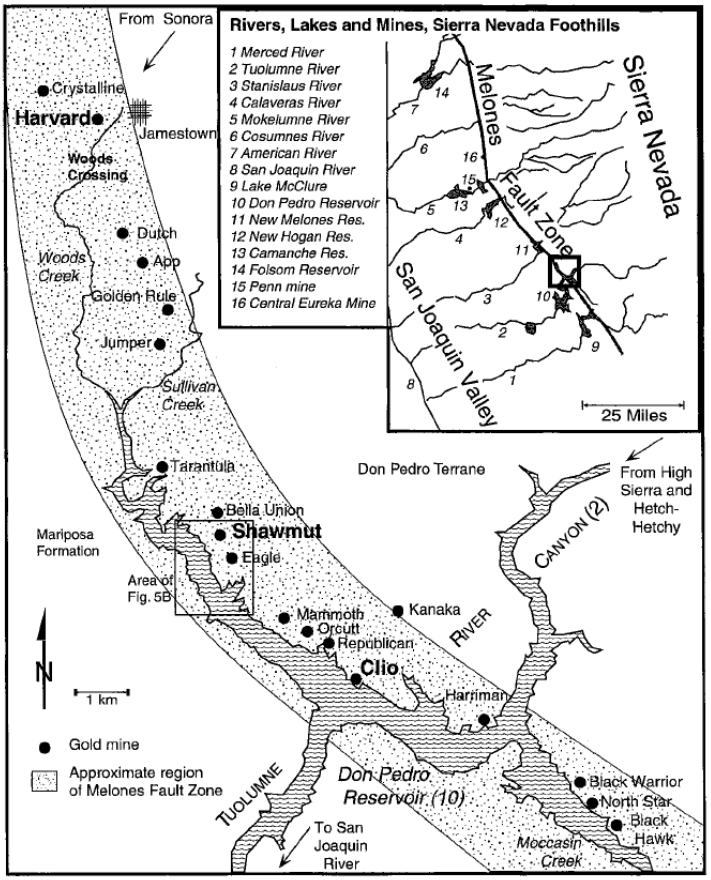

FIG. 2. Location map showing study area in relation to central and southern Mother Lode Gold District and major rivers crossing the Melones fault zone. Mine locations from Parsons (1920) and Knopf (1929). Arrows represent direction of water flow.

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MPortacio 10/2006	JR 10/06	JI 10/06	CONCORD	122170

CALIFORNIA

SCALE: AS SHOWN

SOURCE: GEOMETRIX

Shaw Environmental, Inc.

4005 Port Chicago Highway
Concord, CA. 94520
Phone (925) 288-9898
Fax. (925) 288-0888

FIGURE 1

SITE LOCATION MAP

JAMESTOWN TRUST
JAMESTOWN MINE
JAMESTOWN, CALIFORNIA

Image File: Site Location Map Fig1.jpg
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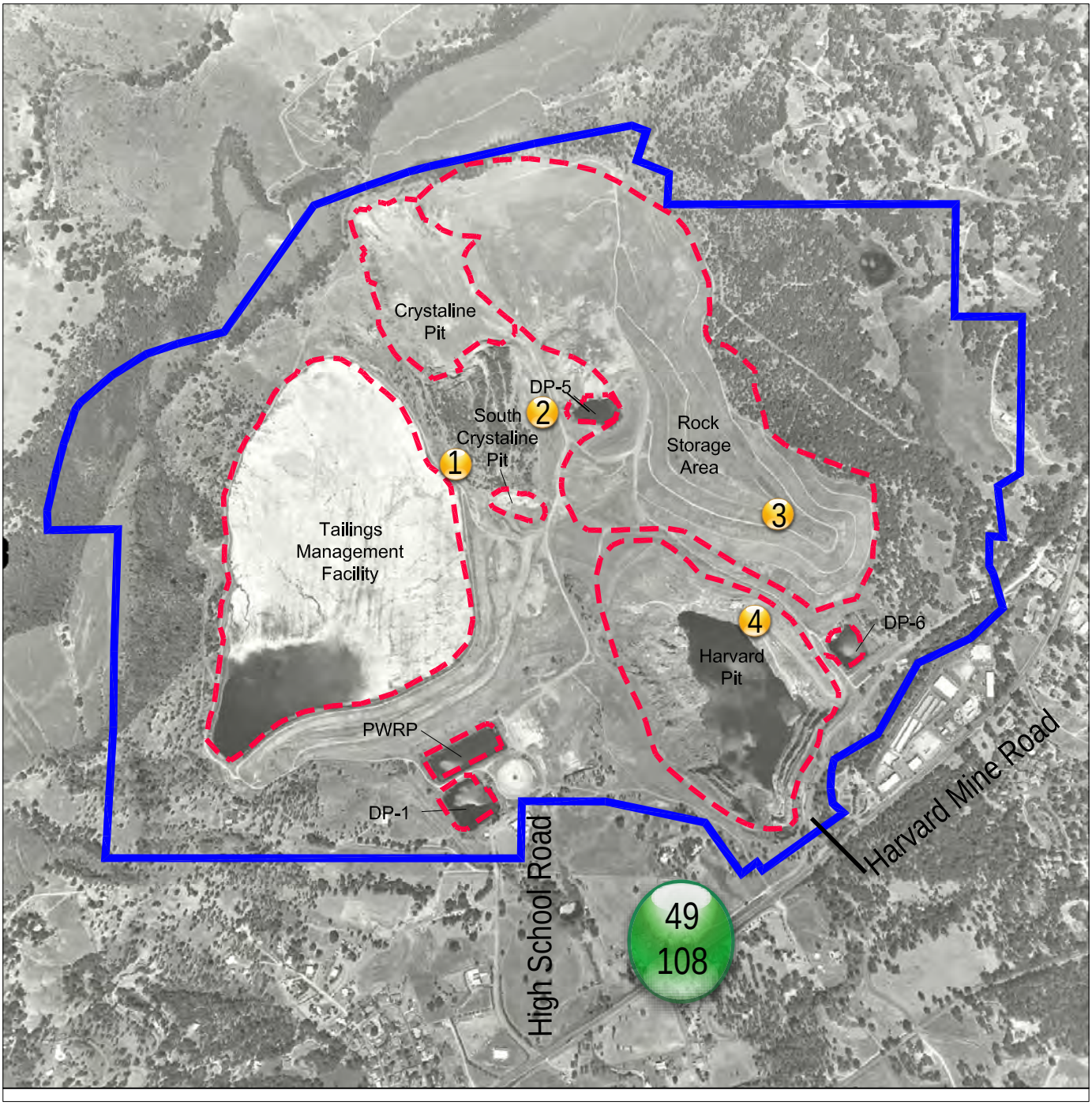

LEGEND:

FORMER MINE FACILITY AREAS

FORMER JAMESTOWN MINE BOUNDARY

1 FIELD TRIP STOP

N

SCALE

0 1200 2400 FEET

SOURCE: GEOMATRIX FIGURE

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FIGURE 2

SITE LAYOUT MAP

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JAMESTOWN, CALIFORNIA

XREF Files: IMAGE Files: BASE PHOTO.bmp
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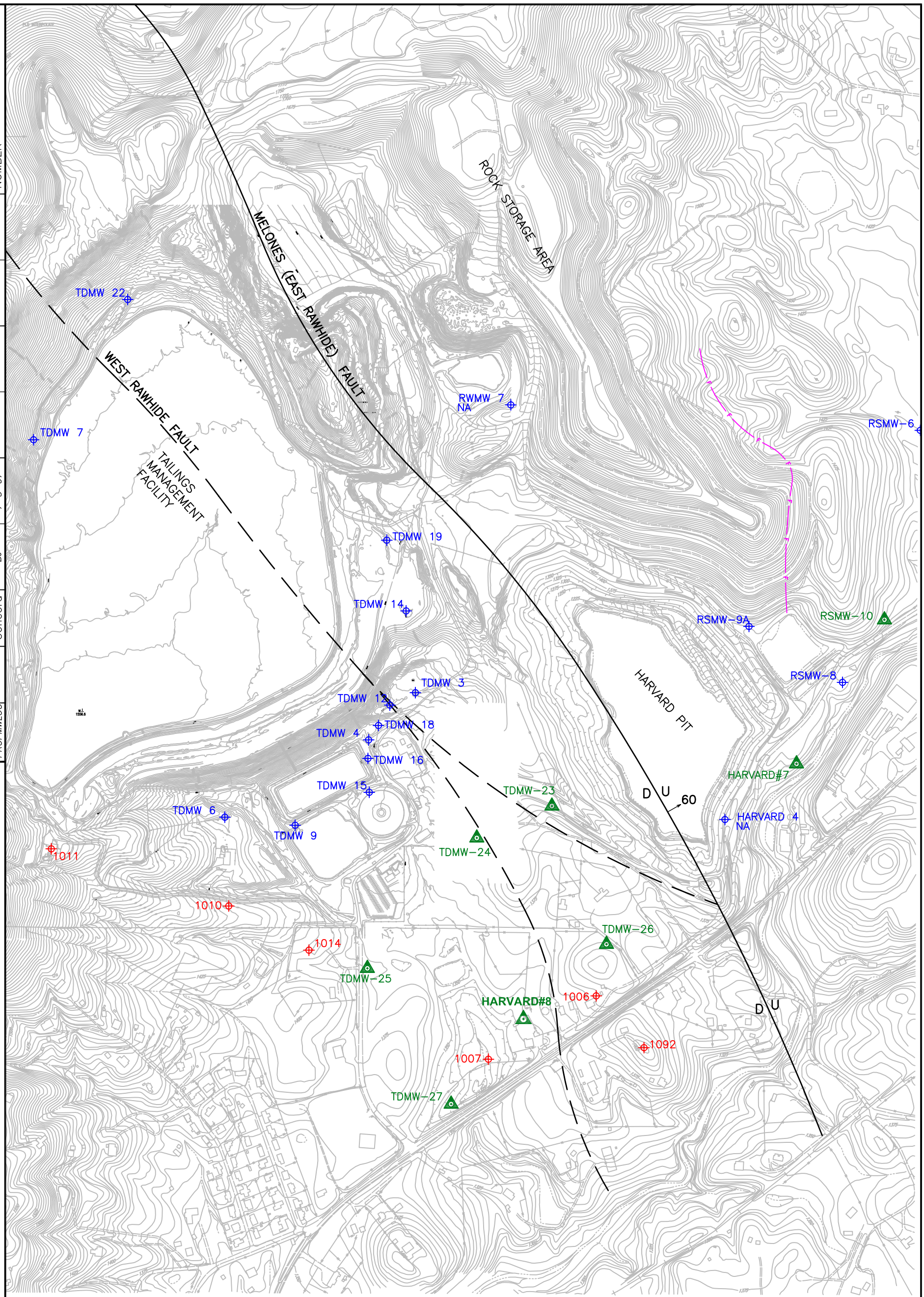

LEGEND

- EXISTING WELL LOCATION
- FAULT, SHOWING RELATIVE DISPLACEMENT (U/D)
- DIRECTION AND ANGLE OF DIP
- GROUNDWATER ELEVATION CONTOUR
- LOCATION OF FRENCH DRAIN (APPROXIMATE LOCATION)
- PROPOSED PHASE I MONITORING WELL LOCATION
- EXISTING PRIVATE WELL (APPROXIMATE LOCATION)

APPROXIMATE SCALE

0 600 1200 FEET

N

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FIGURE 3

WELL LOCATION MAP

REFERENCE: REVISED FROM BROWN & CALDWELL, 2005.

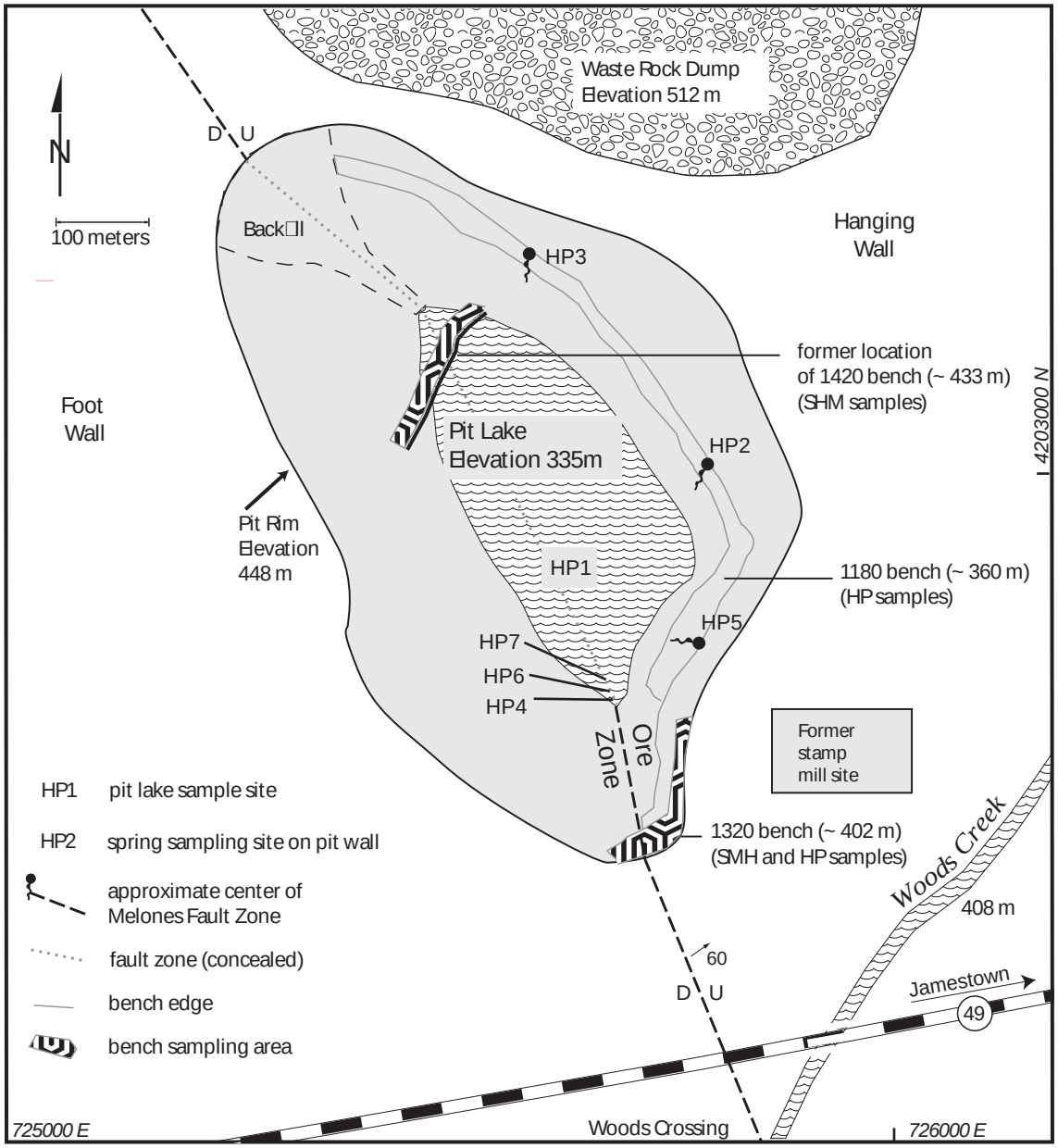

Figure 2. Map of the Harvard open pit at the Jamestown Mine (after Sonora Mining Company, 1994) showing selected geologic and geomorphic features, locations of water sampling sites, and pit wall benches where rocks and their weathering products were sampled.

From: Savage et al. (in press) *Economic Geology*

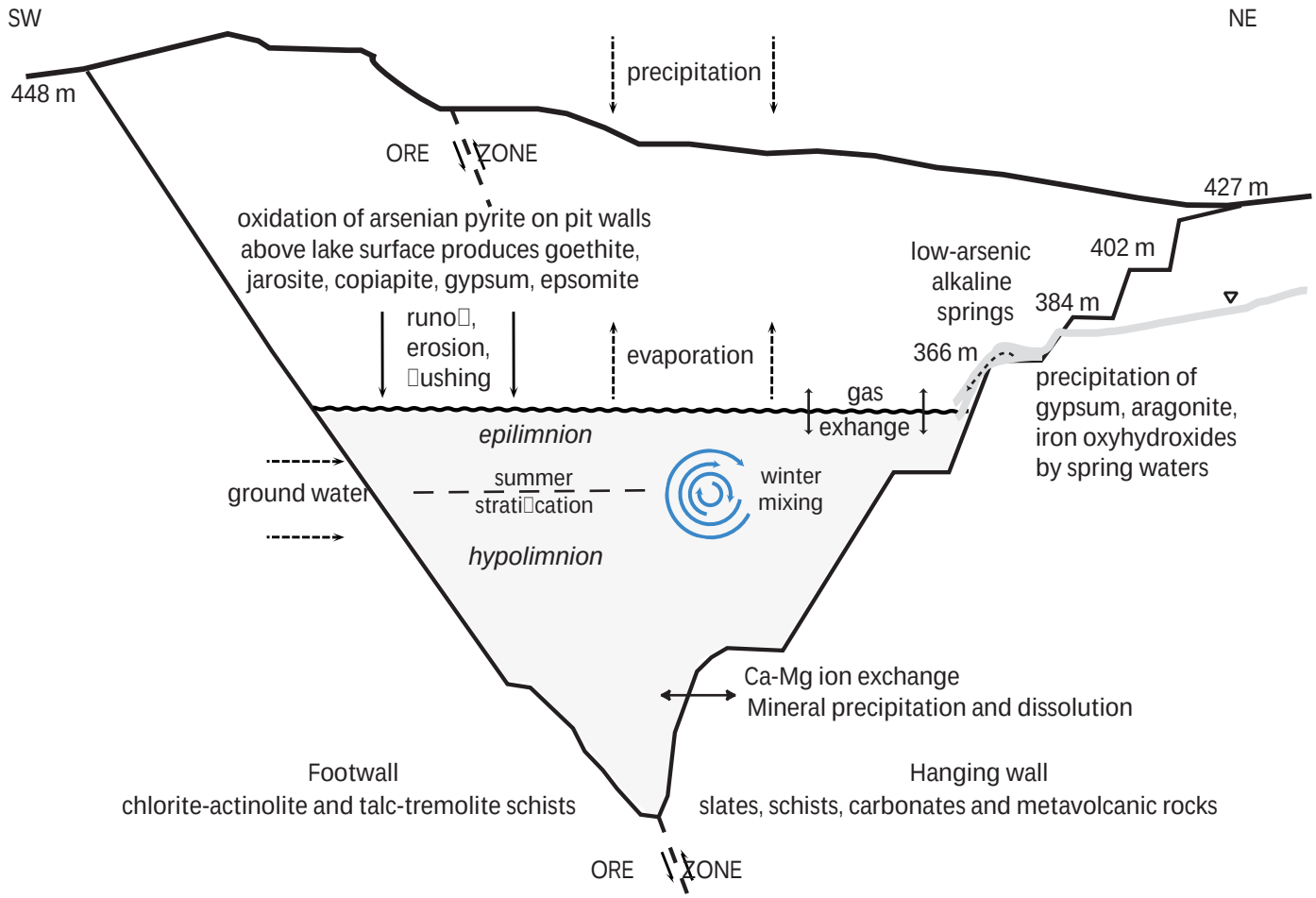

Fig. 14. Schematic showing predominant influences on pit lake chemistry (modified from Savage et al., 2000b).

From: Savage et al. (in press) Economic Geology

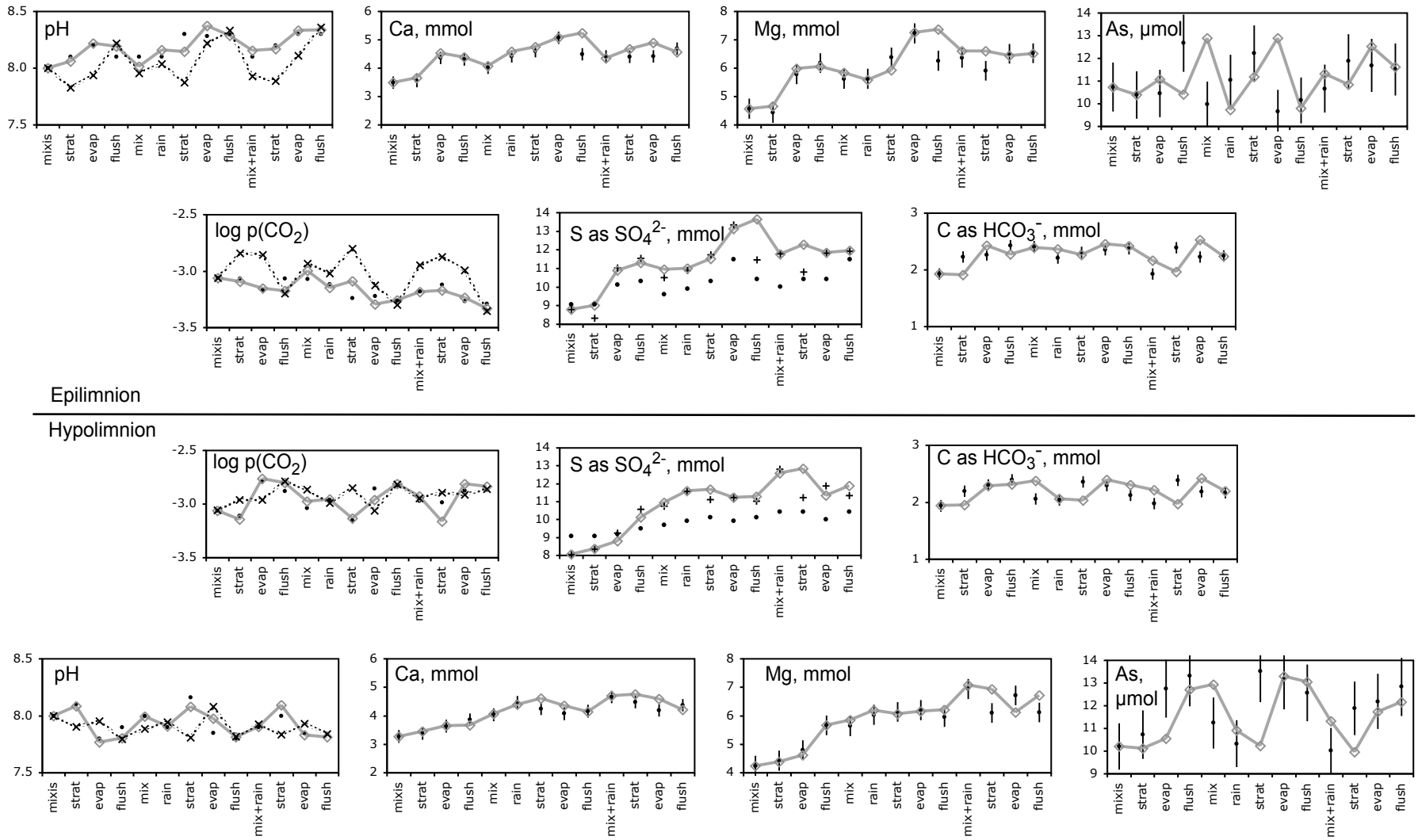

Figure 15. Results of modeling, stage 2: multi-process model for individual seasonal events. Model values were generated by computationally mixing lake waters with rain, spring water, ground water, and evaporative fluxes (Tables 4 and 5), as well as computationally controlling fluxes of CO_2 and wall rock minerals (calcite, magnesite, gypsum, and/or epsomite, see Table 6A). Each forward model for a particular seasonal event used the prior lake water analysis as the starting composition. The upper set of graphs represents the epilimnion and the lower set represents the hypolimnion. Dots represent analyzed values from pit lake and diamonds along grey lines represent modeled values. Vertical error bars represent analytical error (see text). On pH and CO_2 graphs, 'x' symbols along stippled lines show results of Stage 1 modeling with no CO_2 evasion. On sulfate graphs, '+' symbols represent adjusted concentrations after charge balance calculations (see text).

Source: Savage et al. (in press) Economic Geology

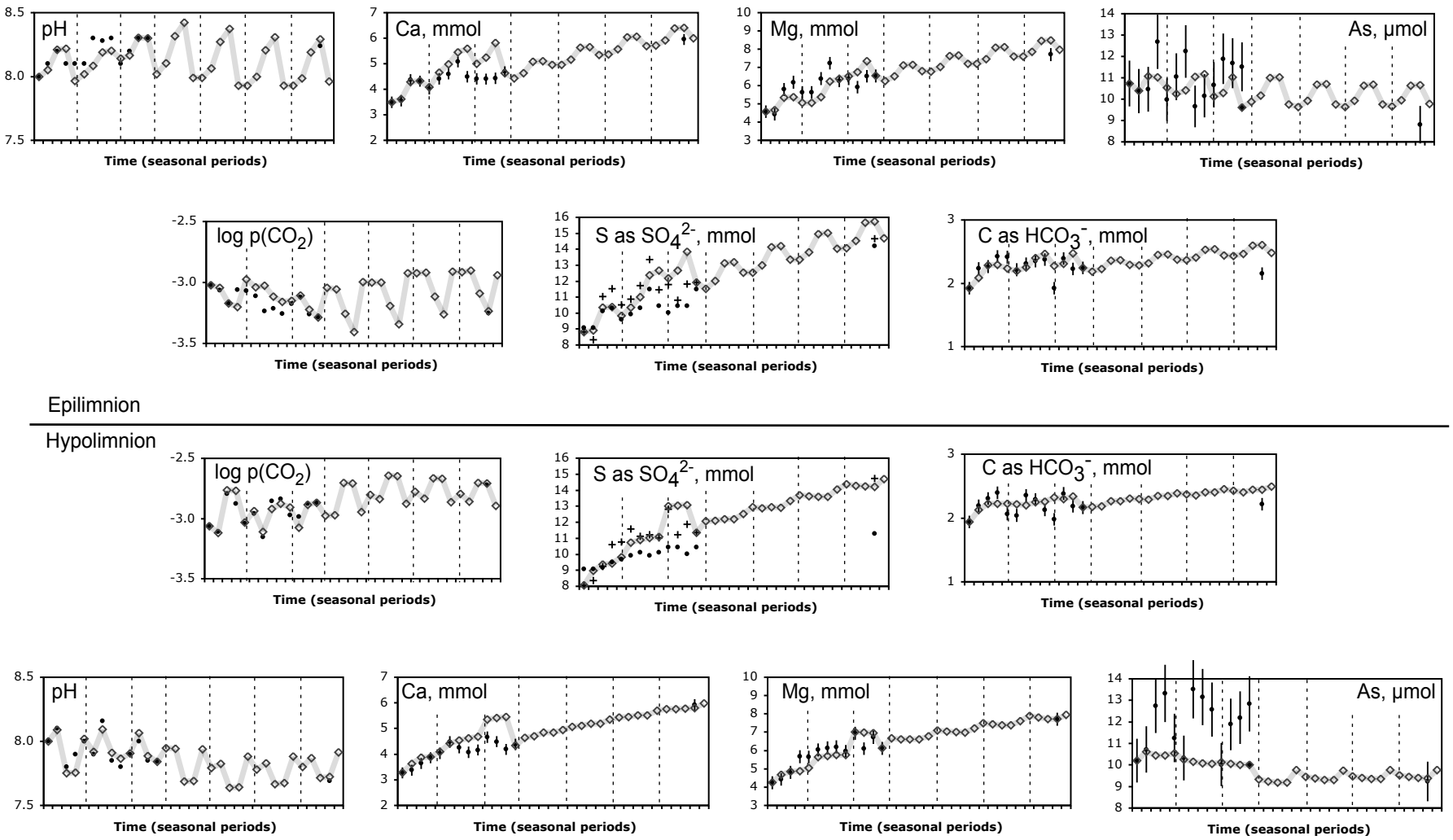

Figure 16. Results of modeling, stage 3: multi-process continuous models. Dashed lines separate years, each of which includes five model events: spring stratification, summer evaporation, autumn flush, onset of mixis, and winter/spring rains. The final data point represents October 2004. Dots represent analyzed values from the pit lake, vertical error bars represent analytical error (see text), and diamonds along solid lines represent modeled values. On sulfate graphs, '+' symbols represent adjusted concentrations after charge balance calculations. Modeled concentration values were generated by computationally mixing lake waters with rain, spring water, ground water, and evaporative fluxes, as well as computationally controlling seasonal fluxes of CO_2 and wall rock minerals (gypsum and epsomite) as indicated in Table 6B. Each forward model step used the results of the prior step as the starting point, except that constituent concentrations were reset at the final Year 3 event to their measured values. Arsenic was reset to values indicated by solid diamonds (see text).

Source: Savage et al. (in press) Economic Geology

SELECTED REFERENCES FOR HARVARD MINE PIT LAKE, GEOLOGY AND GEOCHEMICAL MODELING

compiled by Roger P. Ashley, U.S. Geological Survey

Allgood, G. M., 1990, Geology and operations at the Jamestown Mine, Sonora Mining Corporation, California, in Landefeld, L. A., and Snow, G. G., eds., Yosemite and the Mother Lode Gold Belt: Santa Fe Springs, CA, Pacific Section, AAPG, p. 147-154.

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Shevenell, L., Connors, K. A., and Henry, C. D., 1999, Controls on pit lake water quality at sixteen open-pit mines in Nevada: Applied Geochemistry, v. 14, p. 669-687.

Tempel, R. N., Shevenell, L. A., Lechler, P., and Price, J., 2000, Geochemical modeling approach to predicting arsenic concentrations in a mine pit lake: Applied Geochemistry v. 15, p. 475-492.

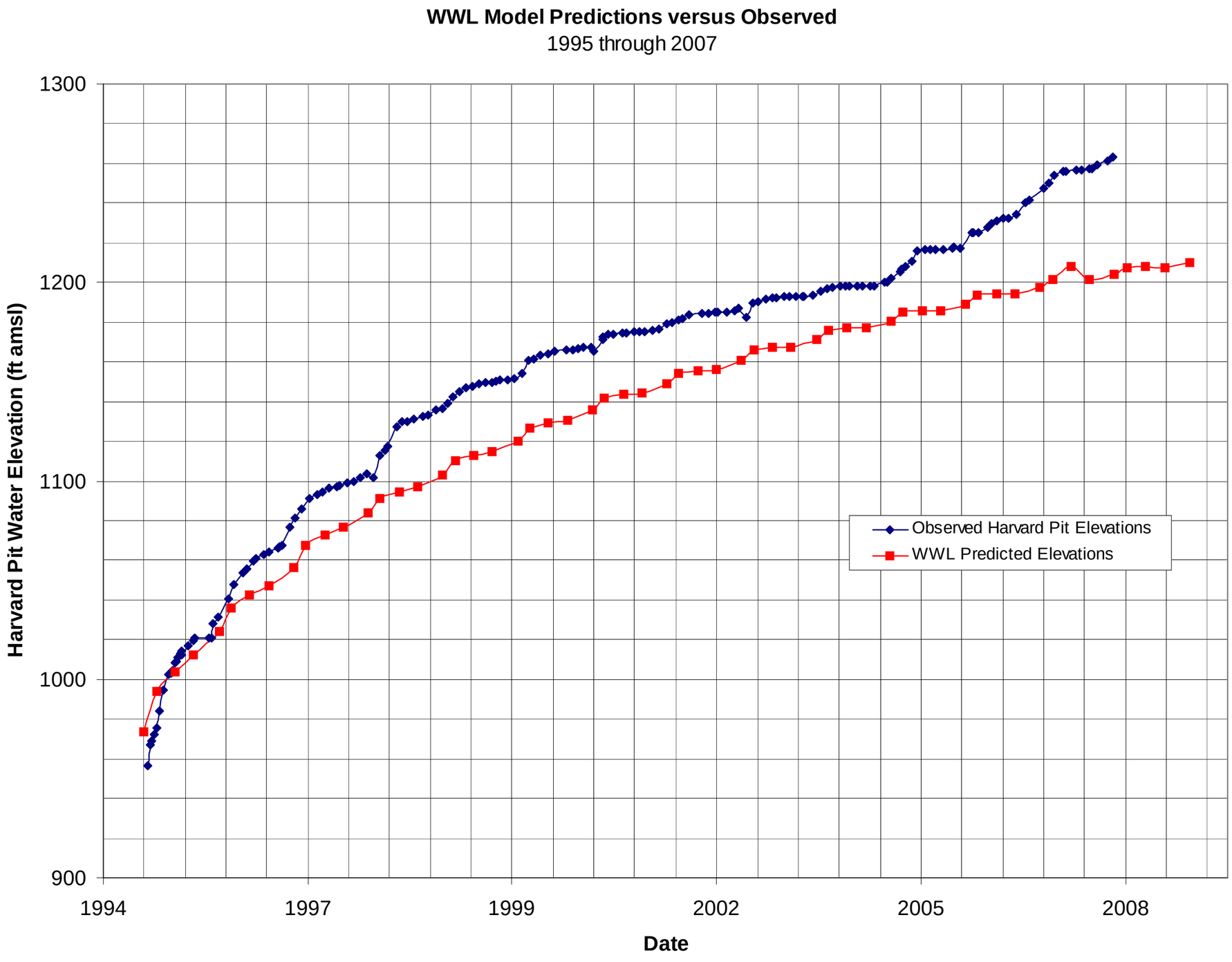

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FIGURE 3-3
WWL MODEL PREDICTIONS vs. OBSERVED
COUNTY OF TUOLUMNE
FORMER JAMESTOWN MINE
JAMESTOWN, CALIFORNIA

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
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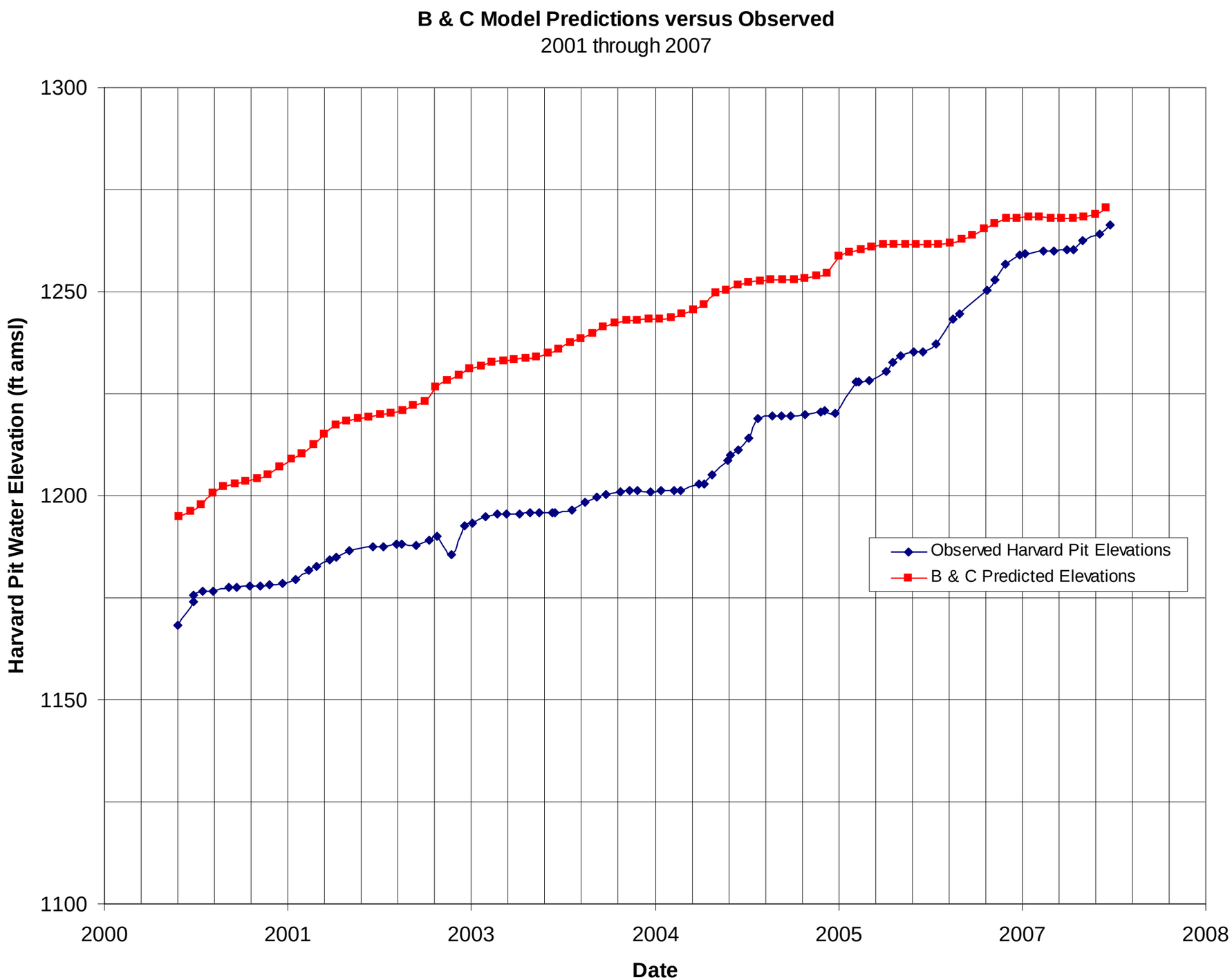

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FIGURE 3-4
B&C MODEL PREDICTIONS vs. OBSERVED
COUNTY OF TUOLUMNE
FORMER JAMESTOWN MINE
JAMESTOWN, CALIFORNIA

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
--		CONCORD	NJS 5/20/08	GM 05/21/08	JCI 5/28/08	122170-N17B

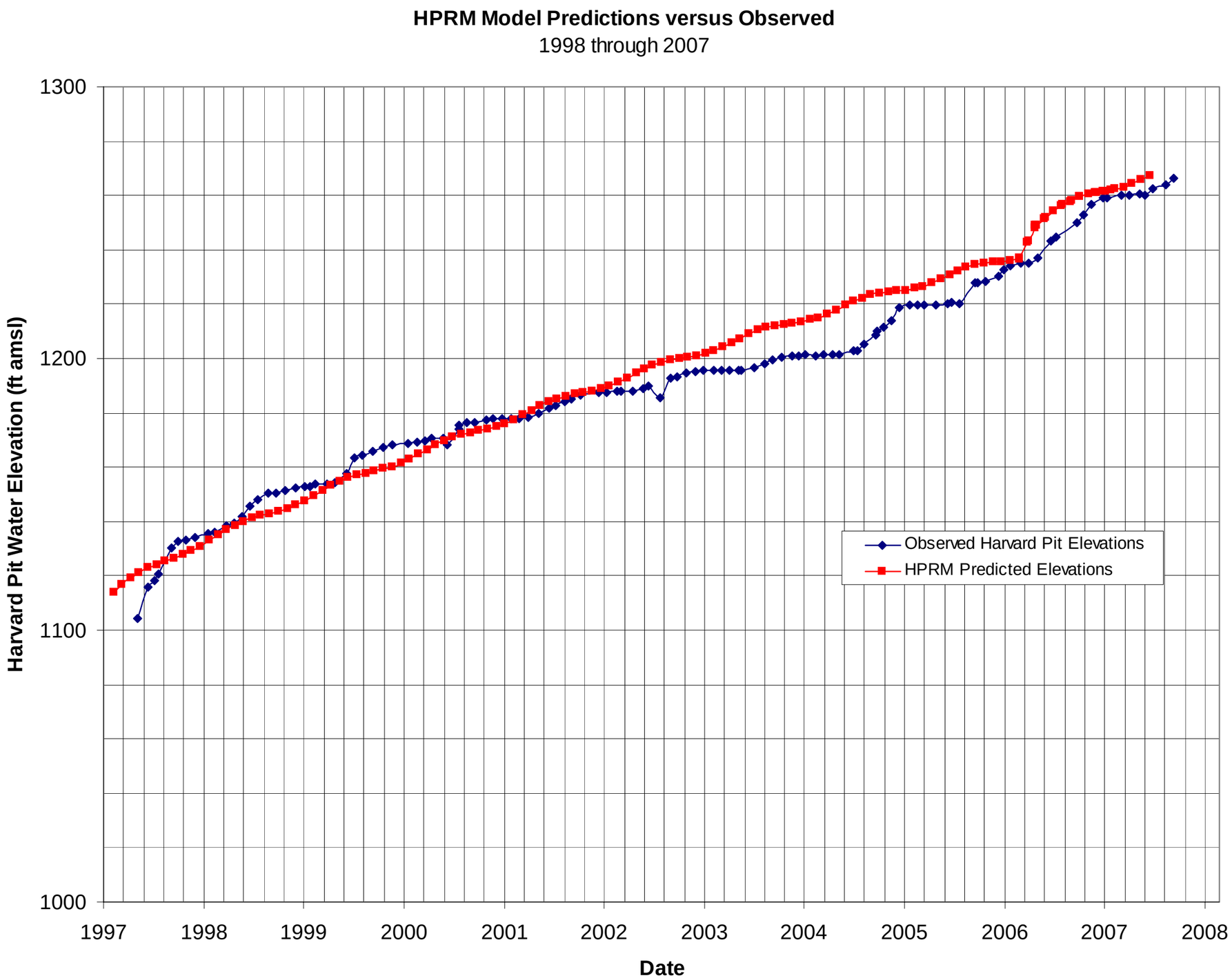

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FIGURE 3-8
HPRM MODEL PREDICTIONS vs. OBSERVED
COUNTY OF TUOLUMNE
FORMER JAMESTOWN MINE
JAMESTOWN, CALIFORNIA

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
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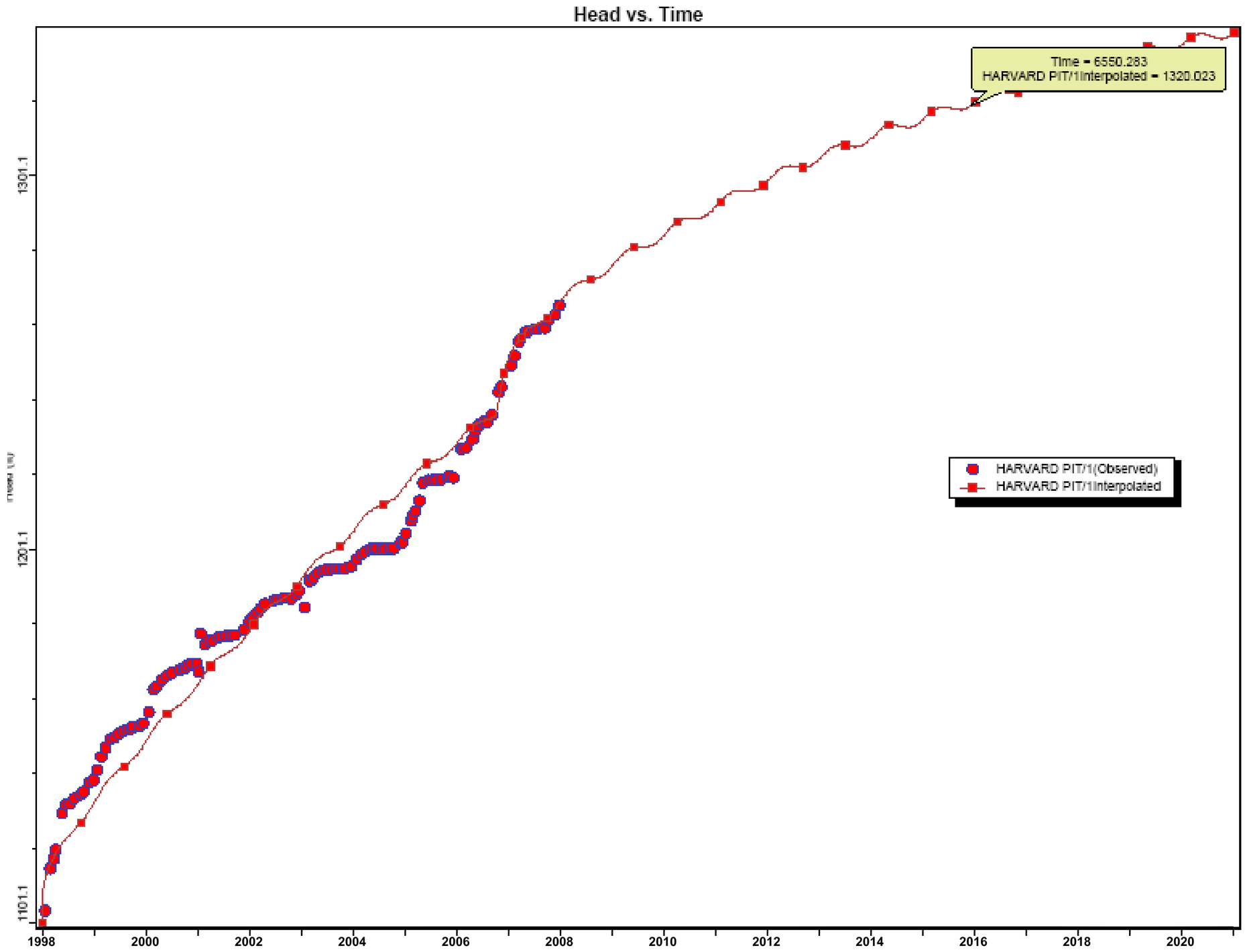

IMAGE	X-REF	OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
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FIGURE 3-9
MODEL PREDICTIONS

COUNTY OF TUOLUMNE
FORMER JAMESTOWN MINE
JAMESTOWN, CALIFORNIA

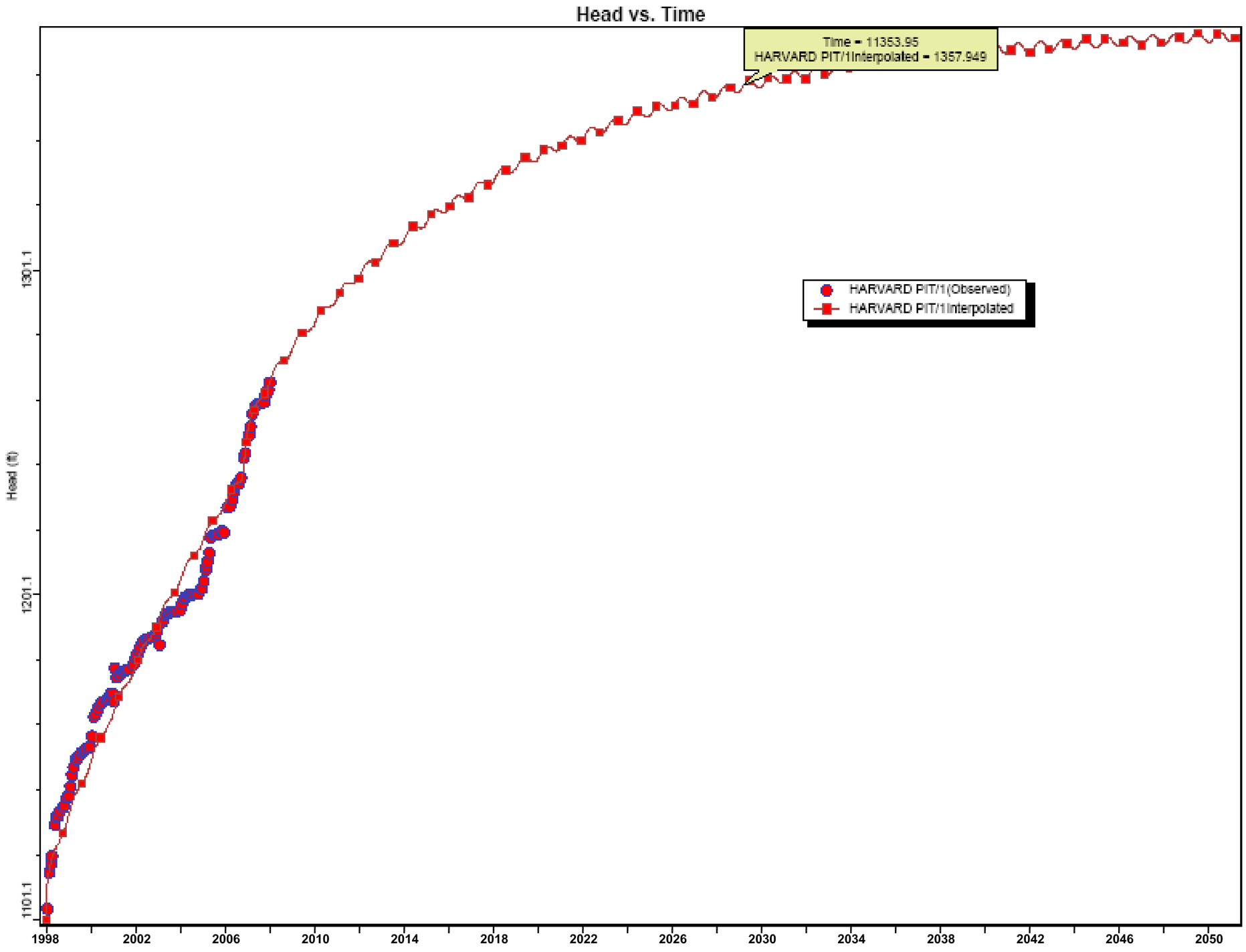

IMAGE	X-REF	OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
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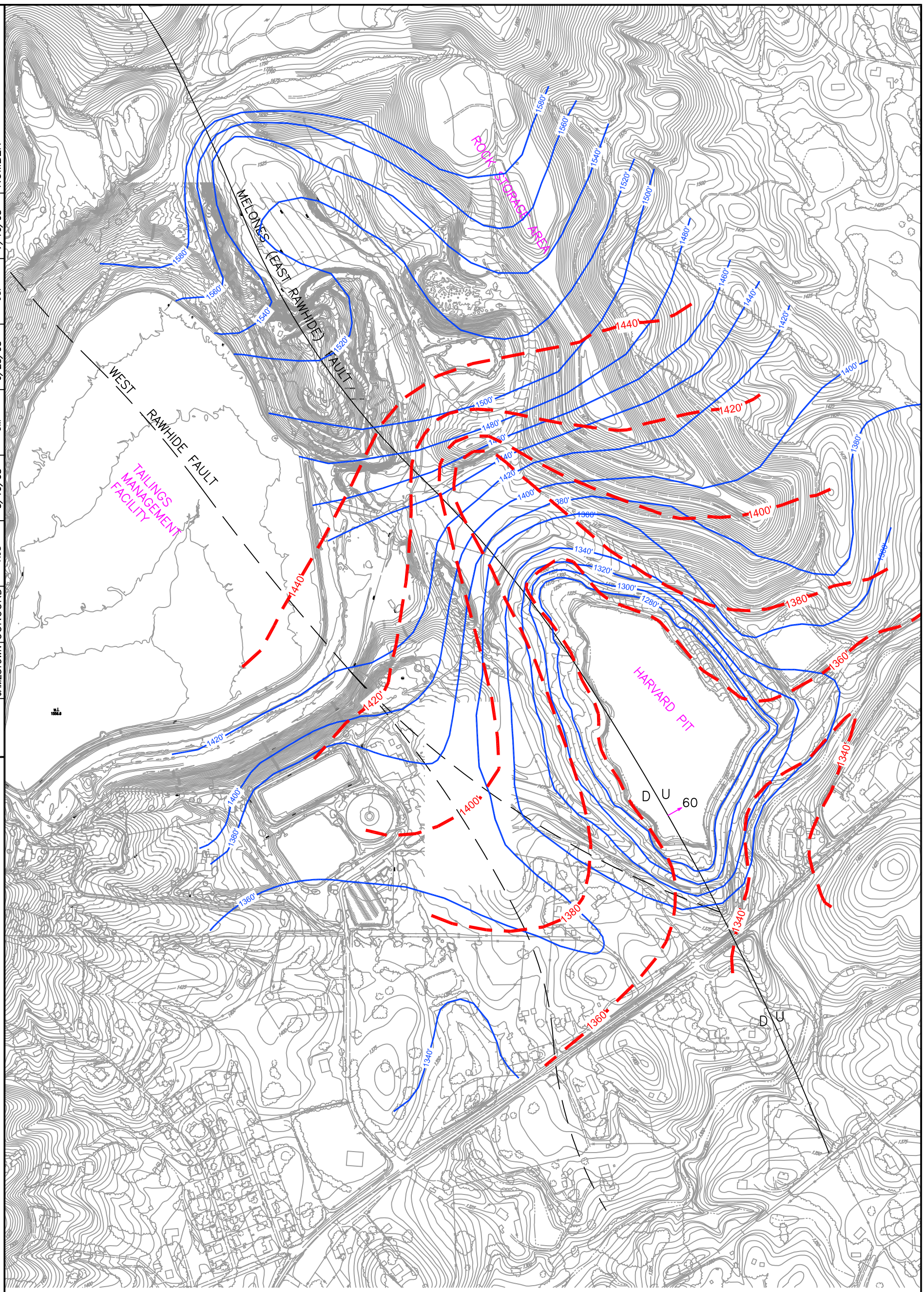
FIGURE 3-10
EXTENDED MODEL PREDICTIONS

COUNTY OF TUOLUMNE
FORMER JAMESTOWN MINE
JAMESTOWN, CALIFORNIA



LEGEND

U/D FAULT, SHOWING RELATIVE DISPLACEMENT (U/D)

60 DIRECTION AND ANGLE OF DIP

2008 GROUNDWATER ELEVATION CONTOUR LINE

HARVARD PIT REFILLING MODEL PREDICTED 2029 GROUNDWATER ELEVATION

APPROXIMATE SCALE

0 600 1200 FEET

N

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FIGURE 3-11

MAY 2008 GW CONTOURS VERSUS PREDICTED 2029 GW CONTOURS

COUNTY OF TUOLUMNE
FORMER JAMESTOWN MINE
JAMESTOWN, CALIFORNIA

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NJS 5/19/08	GM 6/25/08	JCI 7/16/08	122170-N22

IMAGE	X-REF	OFFICE
8:57am	JAMESTOWN	CONCORD

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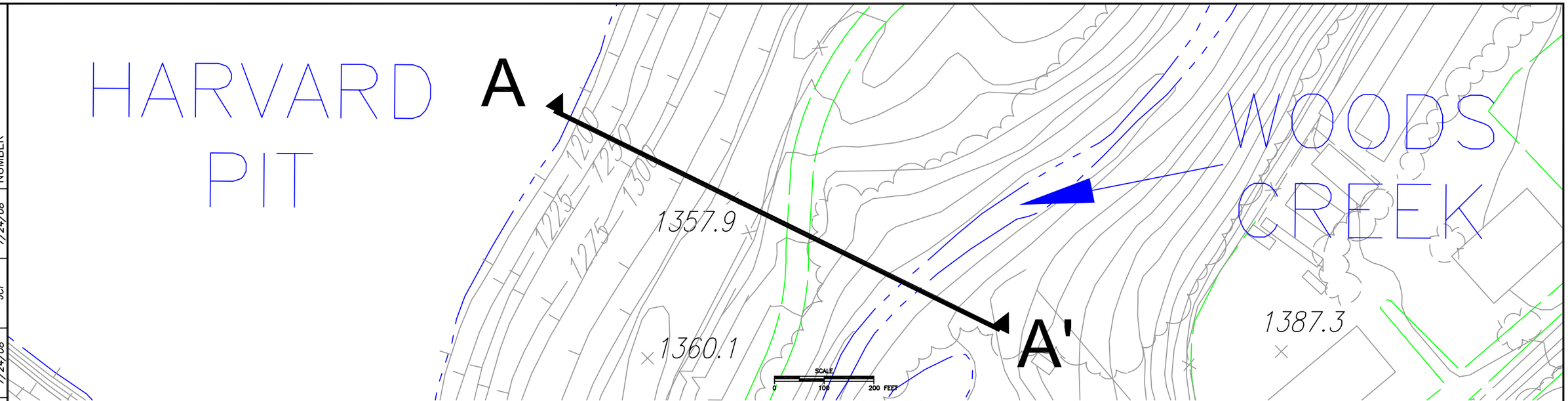
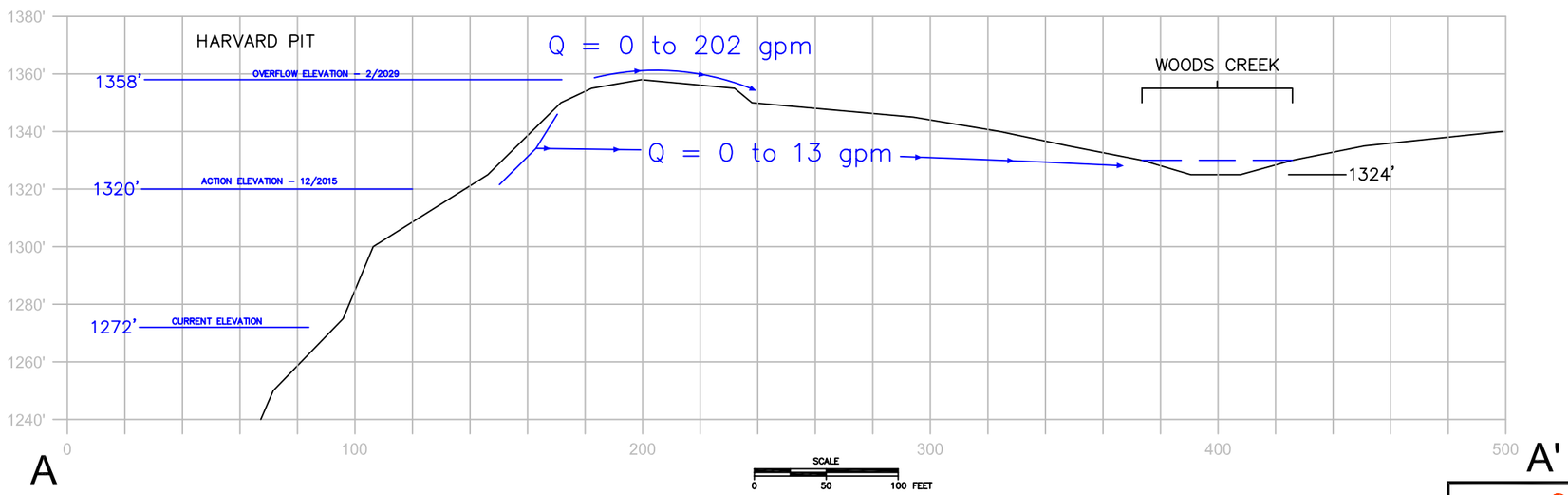


PLAN VIEW



CROSS-SECTION A-A'

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FIGURE 3-12

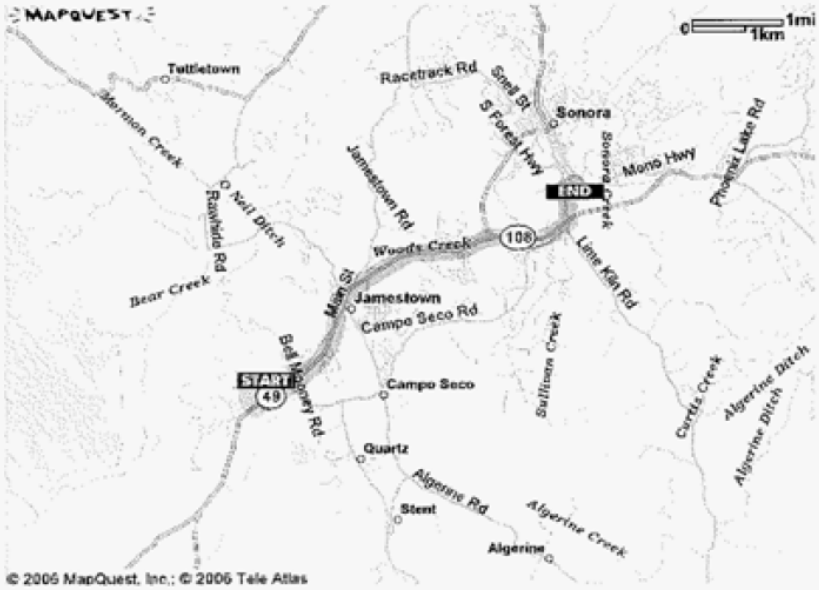
HARVARD PIT OVERFLOW POINT
PLAN VIEW AND CROSS-SECTION

COUNTY OF TUOLUMNE
FORMER JAMESTOWN MINE
JAMESTOWN, CALIFORNIA

DRAWING NUMBER	APPROVED BY		CHECKED BY		DRAWN BY		OFFICE	X-REF	IMAGE
122170-N23	JCI	7/24/08	GM	7/24/08	NJS	7/18/08	CONCORD	JAMESTOWN	--

In case of medical emergency, the closest hospital to the Jamestown Mine site is Tuolumne General Hospital in Sonora. Phone is 209-533-7100, See driving directions, below.

Driving Directions from [17753-17987] High School Rd, Jamestown, CA to 101 Hospital... Page 2 of 2



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These directions are informational only. No representation is made or warranty given as to their content, road conditions or route usability or expeditiousness. User assumes all risk of use. MapQuest and its suppliers assume no responsibility for any loss or delay resulting from such use.

Directions The closest off-site medical facility is Tuolumne General Hospital, 101 Hospital Rd., Sonora, CA. Tel No 209-533-7100. Take State Highway 108/49 north for approximately 1 mi to Jamestown. Continue on CA 108 for approximately 2.75 mi. Turn **L** on S Washington Rd for 0.3 mi. Turn **R** onto Calaveras St. for 0.1 mi. Stay straight to go to Nevada St. and end at 101 Hospital Rd. Anticipated travel time is approximately 10 minutes.

Field trip guide compiled by Charlie Alpers (USGS) with assistance from Mark Adams (Point Environmental), Roger Ashley (USGS), Ross Atkinson (RWQCB), Ross Grunwald (GeoResource Management), Rick Humpheys (SWRCB), Victor Izzo (RWQCB), and J.C. Isham (Shaw Environmental).