Evidence Supporting **12.42 Inches** of Precipitation Reported in **Example No. 4 of Exhibit A**

A. List of Reports:

1. Sacramento Daily Union, January 8, 1862: RAIN and SNOW SOUTH—In Sonora, it rained all day on Friday, January 3rd and snowed hard all night.

2. Sacramento Union- January 5, 1862—8PM Placerville: It has been raining here all day and turned to snowing tonight. It is snowing hard at Strawberry and in Carson Valley. It was very cold here yesterday, the ground being frozen hard. At Strawberry (near the summit) the thermometer stood at 16 below zero.

3. Rainfall amounts and time rain or snow started to fall in January 1862.
   a. Antioch: According to David J. West's Diary, January 4th was a cold raw day. Ice froze last night. Rained hard all day and night of the 5th.
   b. Sacramento: Precipitation started around 10AM the 5th.
   c. Grass Valley: Started snowing about noon on the 5th
   d. San Francisco: No rain from the 1st through the 4th of January. Then 2.67 inches fell on the 5th followed by 1.49 inches on the 6th with nothing on the 7th.
   e. According to the Taylor brother's book: "The Great California Flood of 1862", light rain started to fall in the Los Angeles basin on Christmas day. The rainfall intensity increased noticeably around New Years and continued that way until a downpour began on or near the 15th and lasted 24 hours or longer.
4. Early January 1862 cold outbreak temperature information for Sacramento and Nevada City can be found in "Lake Sacramento" on figure 3 and page 85. More temperature information is located on Microfilm Roll "B" of Logan's Sacramento weather observations.

Note : The mean temperature dropped 7 degrees at Sacramento between the 2nd and 3rd, with a minimum temperature drop in

Nevada City of the same amount. An additional 7 degree drop in the 7AM temperature at Sacramento occurred between the 3rd and 4th.

5. Wind information during the first week of January 1862.
   a. From Microfilm Roll "B" of Dr. Logan's Sacramento weather observations shows the winds generally light to moderate Northerly the 5th and 6th becoming Southerly the 7th. Earlier it was Northerly and stronger on the 3rd and 4th.
   b. Reports from David J. West's Diary for Antioch
      1). January 2: Strong West wind—cool nights
      2). January 3: Cool North wind—looks like a front
      3). January 4: Cold raw day—ice froze last night
      4). January 5: Rained hard all day. Wind Southeast changed to North at night.
      5). January 6: Rained hard all last night and all forenoon. Wind came (a)round to the West at sundown to a pleasant breeze. Monte Diablo white with snow.
      6). January 7: Wind Nortwest and North
      7). January 8: Rained hard all day. Commenced blowing a gale afternoon

6. The United States Geological Survey has prepared a new emergency-preparedness scenario, called ARKStorm. It is patterned after the 1861-62 historical events but uses modern modeling methods and data from large storms in 1969 and 1986. *This information was taken from the abstract of Dale Alan Cox's article ARKStorm: A West Coast Storm Scenario contained in the Proceedings of 2010 California Extreme Precipitation Symposium.*

B. List of Statements With Guidance From Above Reports

1. On January 1, 1862 the first surge of arctic air slid southward just inland from the Canadian Coast and arrived in Northern California late the 2nd. Between the 2nd and the 3rd, there was a 7 degree drop in the 7AM temperature at Sacramento and a 7 degree drop in the minimum temperature at Nevada City. Between the 3rd and 4th the 7AM temperature dropped an an additional 7 degrees at Sacramento---down to a chilly reading of 35 degrees. Early the 4th: There was ice at Antioch, ice a half

inch thick in Napa, a low temperature in Nevada City of 17 degrees, ground frozen hard in Placerville and 16 below zero in Strawberry.

2. In our opinion a Jet Stream linkup was established between the first arctic disturbance and the disturbance that was causing light rain to fall in the Los Angeles basin. Our best estimate (using the Taylor Brother's report as a guide) as to when the linkup occurred was New Year's day. The reaction to the linkup was strong enough to cause the intensity of the rain falling in the Los Angeles basin to increase and the rainfall pattern to expand as far north as Sonora by early the 3rd of January.

3. On the 3rd it rained all day in Sonora and snowed hard all night. This indicates arctic air had spread southward beyond Sonora. It also suggests that overrunning saturated air from the subtropics was receiving extra lift and cooling which would produce heavier than usual amounts of precipitation in Sonora. The same thing would be true along the front face of the Sierra south of Sonora. How far south would depend upon the extent of the southerly penetration of the more dense modified arctic air.

4. Since no rain was reported on the 3rd or 4th in San Francisco and Antioch with only .02 of an inch having fallen in Sacramento, it appears safe to conclude that the northward spread of the rain into the Sacramento Valley had stopped. The rise in barometric pressure at Sacramento from 29.70 inches on 7AM the 2nd to 30.17 inches at 9PM the 4th supports this conclusion.

Note: This suggests that while moderate to heavy precipitation was likely falling from the vicinity of Sonora southward (on the 3rd and a portion of the 4th), it was still dry in the Sacramento Valley.

5. Early the 4th of January a second arctic disturbance dropped into the Eastern Gulf of Alaska and continued moving rapidly southward. On the night of the 4th, a foot of snow fell at Shasta. In Red Bluff it started snowing at 1AM the 5th and by daybreak 8 inches of snow had fallen. From there the precipitation spread southward and by midmorning rain or rain and snow mixed was falling in Antioch and Sacramento. It began to snow in Grass Valley around noon and by midnight 12-15

inches had fallen. *Source: Lake Sacramento, page 82.*

Note: The barometric pressure reading in Sacramento at 9PM on the 4th of January was 30.17 inches. This was followed by a low point reading of 29.66 inches at 2PM on January 6, 1862. During much of this time period a South to Southeast wind was blowing in Antioch. In Sacramento Dr. Logan's three daily wind observatioins (7AM, 2PM and 9PM) all indicated light to moderate Northerly Winds. But a Sacramento Union report onTuesday January 7, 1862 paints an entirely different picture. The total amount of rain which fell during Sunday, Sunday night and yesterday forenoon was 2.69 inches. This storm was quite extraordinary, from the fact that a violent Northwest wind prevailed throughout. We have seldom had rain from the northwest and never so large a quantity. The mean temperature in Sacramento on both the 5th and 6th was 42 degrees. Then on the 7th the winds became Southerly and by 2PM the temperature in Sacramento had warmed up to 50 degrees and the barometric pressure remained almost steady.

6. Evidence of overrunning subtropical air
    a. Storm snowfall amounts:
        12 inches in Shasta
        8 inches in Red Bluff
        6 inches in Chico
        12-15 inches in Grass Valley
        36 inches at Eureka Mine (vicinity of Graniteville)
        28 inches fell 4 miles west of summit on Big Tree Rd.
        7 inches in Cacheville
        12 inches in Yolo County, near the western foothills.
        24 inches at Mt. St. Helena (north of Santa Rosa)
    b. Storm rainfall amounts:
        4.14 inches in San Francisco (on the 5th and 6th) with 2.67 inches on the 5th.
        2.69 inches in Sacramento (on the 5th and 6th) with 2.08 inches on the 5th.
        * 1.75 inches in Grass Valley (on the 5th and 6th) with 1.55 inches noon the 5th to noon the 6th.

*Note: Water content of snow plus any rain.

C. Discussion of Results:

1 Evidence indicates the use of the word violent, in the Sacramento Union report to describe the persistent Northwest wind, gives the most accurate description of the weather that prevailed on the 5th through the morning of the 6th. Inspite of the heavy rain the daily mean temperature remained the same--42 degrees both days. We are satisfied this would have produced overrunning that extended southward as far as Sonora and beyond.

2. An examination of the above rainfall and snowfall data for the storm of January 5th and 6th, 1862, proves the precipitation amounts were heavier in the south. Two reports really standout. On the 5th, 2.67 inches of rain fell in San Francisco and Sacramento recorded 2.08 inches. Undoubtedly this was due to overrunning subtropical air which started not long after the the second arctic disturbance dropped into the Gulf of Alaska. This caused the large upper level trough of low pressure lingering off the Central and Southern California coast to move in an easterly direction pushing increasing amounts of rain bearing clouds from the subtropics into California. *See figure 1.* A drop in barometric pressure at Sacramento during the period 9PM January 4th (30.17 inches) down to (29.66 inches) at 2PM the 6th, lends strong support to this view.

3. *Figure 1* is a Jet Stream Weather Map depiction of the official 500 mb. chart for the morning of January 24, 1969. This is a segment of one of the two large storms selected by ARKStorm as an aid in preparing their new emergency-preparedness scenario. According to our research, the 24th of January 1969 is also the start of a sequence of weather events similar to the one beginning on January 4, 1862. In both cases moderate to heavy amounts of snow fell in the mountains of California but the snow from the 1862 storm fell at a much lower elevation---at or near the valley floor across much of Northern California. Why did the snow fall at such low elevations compared with the storm of January 1969? To begin with in early January 1862 a cold wave filled most of the Central Valley of California with unseasonably cold air. On the

morning of January 4th, there was ice in San Francisco and Antioch, ice a half inch thick in Napa and the ground was frozen hard in Placerville. This event was followed closely by the second arctic outbreak that was cold enough and had enougth moisture to produce a foot of snow at Shasta (~ 8 miles west-northwest of Redding-- elevation 1,026 feet) on the night of the 4th.

D. Conclusions:

1. There were two episodes when overrunning caused moderate to heavy precipitation to fall in Sonora. The first episode lasted (~ 24-30 hours) during the two day span of the 3rd and 4th of January. It was caused by a Jet Stream linkup, that occurred a couple of days earlier, between the first arctic disturbance and the disturbance which produced the light rain in the Los Angeles basin during the Christmas Holidays. *For more details refer to Section B-2 and 3 of this report.*

2. The second episode lasted (~ 30-36 hours) and occurred on the 5th and 6th. It was triggered by the second arctic disturbance when it dropped southward into the Eastern Gulf of Alaska early the 4th of January. *For more details refer to Section C-1 above.*

3. In both episodes moisture laden air from the subtropics was overrunning modified arctic air. This scenario would have produced substantial amounts of precipitation in Sonora during the four day period January 3rd through the 6th.

4. The material presented in this report indicates that the two episodes of overrunning caused an extended period of moderate to heavy precipitation to fall at Sonora. This supports our conclusion that the amount of precipitation that fell in Sonora during this four day period was close enough to the estimate of 12.42 inches stated in Example No. 4 of EXHIBIT A to verify.

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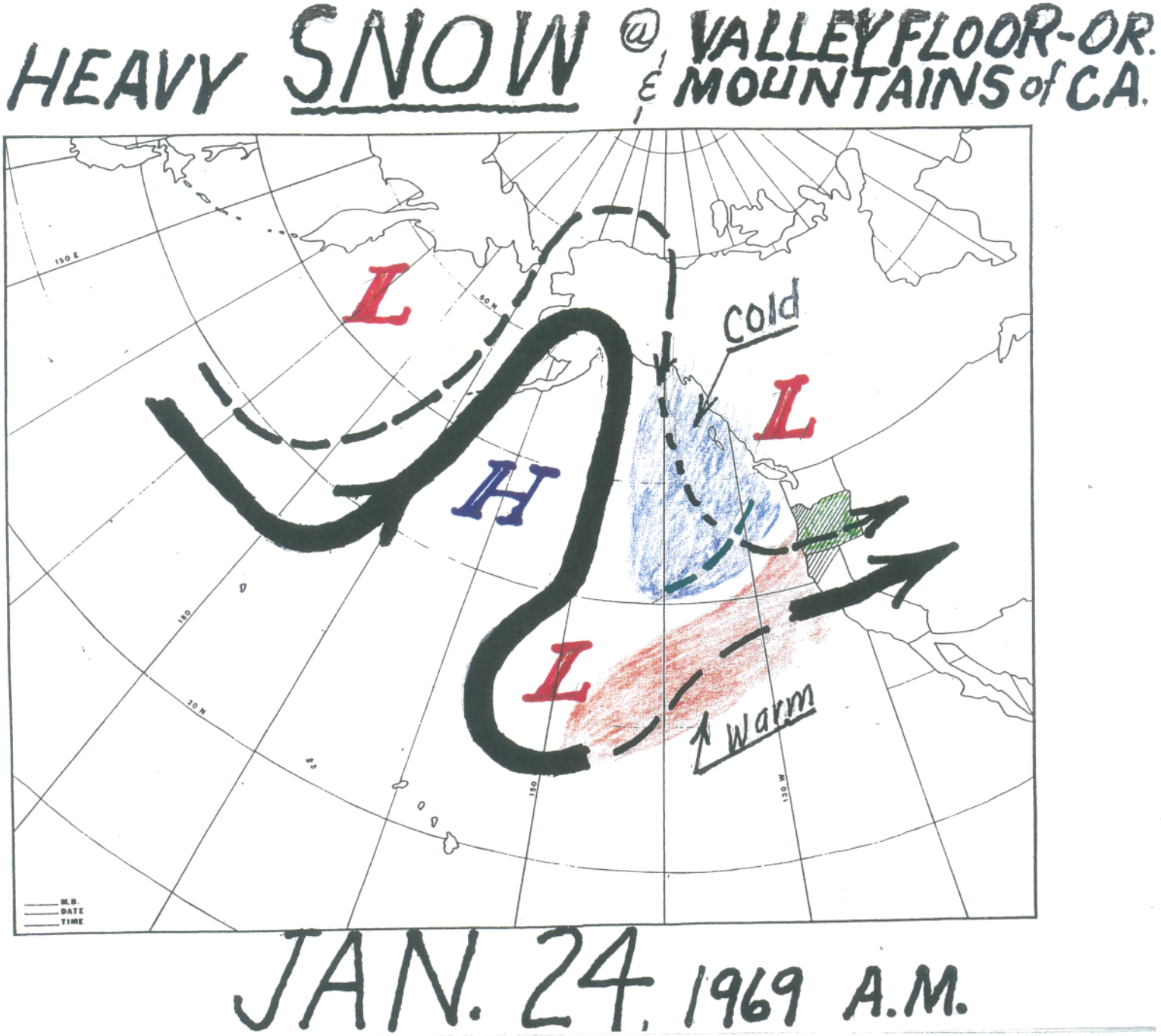
May 10, 2015

FIGURE 1


HEAVY SNOW @ VALLEY FLOOR-OR. & MOUNTAINS of CA.
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DATE
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