U.S. DEPARTMENT OF THE INTERIOR
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MISCELLANEOUS FIELD STUDIES MAP MF-2384
Version 1.0
Sheet 3 of 3

Debris Flows Triggered by the El Niño Rainstorm of February 2-3, 1998, Walpert Ridge and Vicinity, Alameda County, California

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Table 1. Data on debris-flow concentration. See figure 3 for areal extent of concentrations.

Debris-flow concentration (number/0.25 km²)	Map area (km²)	Percent of total map area	Cumulative percent area with debris-flow concentrations greater than or equal to the value in column 1 (km²)	Cumulative percent area with debris-flow concentrations greater than or equal to the value in column 1
0	53.6	61	91.3	100
1	28.6	32	35.7	39
5	6.0	7	7.1	8
10	0.2	0.2	0.2	0.2
15	0.4	0.4	0.9	1
20	0.2	0.2	0.5	0.5
25	0.2	0.2	0.3	0.3
30	0.1	0.1	0.1	0.1

Table 2. Information on documented debris-flow occurrences.

Location	Estimated Time of Occurrence	Source(s) of Information	Comments
30B32 and 30W5b Faircliff St., Hayward	Midnight to 10 am on February 3.	Rex Tolle, owner of 30B32 Faircliff St., and Jose Garcia, owner of 30W5b Faircliff.	Debris flows occurred on hillslope east (behind) and west (adjacent) of Faircliff St. Flooding and/or blockage of v-ditch may have been a contributing factor in triggering some of the flows. Flows are shown in figure 3. According to Rex Tolle, debris flows did not occur at this location in 1995. According to Jose Garcia, debris flows have not occurred at this location in 20 years.
Multiple sites in Niles Canyon including those at mile markers 11.92, 12.48, 12.58, 12.60, and 12.68.	Late night of February 2 and early morning of February 3.	Steve Radcliffe, Caltrans Area Superintendent, Alameda County; Sgt. Steve Drakopoulos, DMV; Hoffman, 1998; Lester, 1998; San Jose Mercury News Staff reports, 1998.	Debris flows in Niles Canyon are shown in figure 6. Debris flows occurred in January, 1998 (Caltrans, 1998) and in January and March, 1995 (San Jose Mercury News Staff, 1995). Debris flows from 1995 debris flows were much larger than those shown in figure 6 (S.D. Ellen, oral commun., 1995).
Neighborhood along Canyon Heights Drive in Fremont, including the following addresses: 840 and 835 Lynn Court; 740 Pickering Ave., and 34310 Canyon Heights Drive.	Late night of February 2 or early morning of February 3.	Lester Wells, owner(?) of 34310 Canyon Heights Drive; Akiraki, 1998; Bailey and others, 1998.	Flows are shown in figure 3. Debris flows also occurred at this location in 1995 (R.C. Wilson, oral commun., 1998).
21780 Eden Canyon Road.	February 3, 2:2:30 am	Mickey Estrerio and Laurine Burns, owners of 21780 Eden Canyon Road.	Debris flow initiated on hillslope on north side of Eden Canyon road, flowed across the road and impacted house at 21780 Eden Canyon Road.
508	February 3, 2:2:30 am	Mickey Estrerio and Laurine Burns, owners of 21780 Eden Canyon Road.	Mostly clayey. Most exposures have a mildly cracked silty clay soil over chert and greenstone. Most exposures are moderately permeable, much too low to very low. Most mantle is severely expansive.

Table 3. Descriptions of geologic materials units in the study area (summarized from Elder and Wentworth, 1995).

Geologic materials unit number	Geologic unit, age, and summary description	Properties of soil mantle
133	Orinda Formation. Tertiary. Interbedded sandstone and mudstone. Sandstone that grades to siltstone. Intergranular permeability of most bedrock is low to very low, but minor moderate to shallow low, some moderate below shallow rock. Local fracture permeability.	Probably mostly clayey, some granular. Most mantle has moderate permeability, much too low to very low permeability, with some moderate. Probably much to most mantle is severely expansive.
215	Leona Rhyolite. Tertiary (?). Hard to firm, massive, fine-grained rhyolite. Most is very low intergranular permeability, low to possibly moderate fracture permeability to depth.	Mostly granular, some to much clayey. Most mantle has moderate permeability, much too low to very low permeability. Most mantle is stony, silty, some to much clayey, some to expansive. Soil is generally absent or less than 18 in. thick.
355	Briones Sandstone. Tertiary. Largely sandstone: some is hard and calcite-cemented, some is soft and friable; associated with shell breccia; some is dirty and clayey and grades to fine sandy mudstone; and most is uncemented, firm weathered sandstone. Most of the unit has low intergranular permeability, very low where calcite cemented. Moderate permeability with fractures in shallow rock.	Mostly mostly granular, some clayey. Most mantle has moderate permeability, much too low to very low permeability, with some moderate. Probably mostly expansive, some to much unexpansive.
375	Tolman Formation. Tertiary. Probably mostly sandstone, some is hard and calcite-cemented/brecciatic sandstone, some conglomerate, and some clayey rock. Bedrock probably has mostly low intergranular permeability, probably some moderate and very low. Cemented and clayey rock probably has low fracture permeability, some moderate.	Mostly mostly granular, some clayey. Most mantle has moderate permeability, much too low to very low permeability. Most mantle unexpansive, some expansive.
386	Hambre Sandstone of the Monterey Group. Tertiary. Sandstone, hard to firm where weathered, interbedded with firm clayey sandstone to siltstone. North of Mission Pass (most of study area), relatively clean sandstone and clayey rock are equally abundant, with sandstone more abundant. Clayey rock, North of Mission Pass, shallow bedrock has mostly low intergranular permeability. South of Mission Pass, bedrock probably has low to very low intergranular permeability.	Probably mostly clayey, some granular. Most mantle has moderate permeability, much too low to very low permeability, with some to much moderate. Probably much mantle has low to very low permeability; some to much moderate. Probably much to most mantle is expansive.
389	Oursan Sandstone of the Monterey Group. Tertiary. Mostly clayey sandstone, grained sandstone grading to sandy mudstone. Most is uncemented, poorly bedded, mostly separated. Minor to some hard calcite-cemented sandstone. In shallow bedrock, low to very low intergranular permeability and low fracture permeability.	Probably mostly clayey, some granular. Most mantle has moderate permeability, much too low to very low permeability, with some to much moderate. Some mantle is severely expansive.
508	Claremont Shale of the Monterey Group. Tertiary. Mostly hard chert and siliceous mudstone, interbedded with firm shale and mudstone; including some firm and hard sandstone, shale and mudstone. Most exposures have very low intergranular permeability except firm sandstone, which has low intergranular permeability. Most of the unit has low to moderate fracture permeability in shallow bedrock.	Mostly clayey. Most exposures have a mildly cracked silty clay soil over chert and greenstone. Most exposures are moderately permeable, much to most very low. Most mantle is severely expansive.
532	Tice Shale of the Monterey Group. Tertiary. Consists of both hard siliceous shale and mudstone that grades to clayey very fine-grained sandstone, in variable proportions. Very low intergranular permeability in all unit except some clayey sandstone, which has very low to low permeability. Most is low to very low fracture permeability, some to moderate fracture permeability.	Probably mostly clayey, some to much granular (silty). Probably most mantle has moderate permeability, much to very low permeability, with some moderate. Some to much mantle is severely expansive.
616	Conglomerate. Cretaceous and (or) Jurassic. Probably much conglomerate, much sandstone, minor shale. Intergranular permeability of bedrock low to very low where fresh, mostly low where weathered. Low fracture permeability in bedrock.	Mostly granular. Typical soil consists of sand, silt, and pebbles; some is clayey sand or sandy clay. Most mantle unexpansive to significantly expansive.
635	Lower part of Knoxville Formation, and part of unnamed shale unit. Cretaceous and (or) Jurassic. Mostly sandstone similar to Franciscan sandstone, some to much mudstone and shale, minor conglomerate. Intergranular permeability is low to very low. Much shallow mudstone and sandstone has low to locally moderate fracture permeability.	Mostly granular. Typical soil consists of sand, silt, and pebbles; some is clayey sand or sandy clay. Most mantle unexpansive to significantly expansive.
644	Great Valley sequence, sandstone and shale unit. Cretaceous. About two-thirds fine/soft, one-third dominant sandstone in beds as thick as 25 ft and intervals as thick as 200 ft or more. Intergranular permeability of most bedrock very low where fresh; where weathered, much low, much very low, some moderate. Low fracture permeability in much shallow bedrock.	Mostly mostly clayey, some to much granular. Probably most mantle has low to very low permeability, some moderate. Most mantle is unexpansive to significantly expansive.
685	Upper part of Knoxville Formation, and part of unnamed shale unit. Cretaceous and (or) Jurassic. Most is shale, mudstone, and siltstone; minor to some sandstone; minor limestone. Some to much bedrock is soft to firm clayey shared material, remainder hard. Most bedrock has very low intergranular permeability, minor to some low. Most shallow bedrock has low fracture permeability.	Most to almost all clayey. Unscratched to lightly mildly cracked silty and sandy clay soil over unscratched to lesser mildly cracked clayey subsoil. Most to almost all mantle has low to very low permeability. Probably much mantle is severely expansive.
688	Shale unit. Cretaceous and (or) Jurassic. Probably mostly shale and mudstone as described for unit 685. Includes some to possibly equally abundant sandstone, and lesser but possibly some conglomerate. Probably some clayey sheared rock. Intergranular permeability of bedrock mostly very low, minor to some low. Most shallow rock has low to locally moderate fracture permeability.	Mostly clayey. Most mantle has low to very low permeability. Most mantle unexpansive; probably much to severely expansive.
805	Franciscan complex. At least parts are Jurassic in age. Most is severely sheared serpentinite that contains abundant blocks of serpentinite, ultramafic rock, and other rock types; borders are clayey gouge. In places contains relict sedimentary rock. Very low intergranular permeability, except minor sandstone blocks and some sheared silica-carbonate rock. Fracture permeability in shallow rock is mostly low, some moderate, some very low (in gouge borders).	Mostly granular and rocky, much clayey (probably over gouge borders). Most mantle has moderate permeability, much low to very low. Some to much mantle is expansive.

Table 4. Summary of debris-flow data for each geologic materials unit. See appendix for complete data. NA, not applicable.

Hillslide materials unit	Map area (km²)	Percent of total	Number of debris flows	Number of debris flows per km²	Mean travel distance (m)	Median travel distance (m)	Mean gradient (degrees)	Median gradient (degrees)	Mean contributing area (m²)	Median contributing area (m²)	Mean total curvature (1/m)	Median total curvature (1/m)
All	91.3	100	531	5.8	53.4	39.1	26.2	24.6	925	579	-0.001	-0.001
133	0.8	0.8	2	2.4	40.0	62.2	20.7	24.9	549	654	-0.005	-0.003
215	1.9	2.1	25	13.2	80.9	56.8	21.5	754	653	0.001	-0.001
355	4.8	5.3	20	4.2	44.6	37.0	22.1	23.9	823	492	-0.003	0.000
375	1.1	1.2	6	5.5	40.0	32.3	20.6	21.9	823	490	-0.006	0.000
386	1.2	1.4	5	4.2	67.4	52.7	25.0	24.9	549	654	-0.005	-0.003
389	2.8	3.1	2	0.7	34.9	NA	18.8	NA	1774	NA	-0.001	NA
508	6.2	6.8	14	2.3	53.6	35.7	23.5	21.7	1016	543	-0.002	-0.001
532	2.9	3.2	15	5.2	43.4	35.4	23.3	21.9	888	917	0.002	0.001
616	1.8	1.9	8	4.4	80.7	78.6	33.6	32.2	1009	740	0.015	0.000
635	2.4	2.6	5	2.1	79.8	59.5	22.5	21.0	1448	786	-0.009	-0.003
644	53.2	58.3	362	6.8	49.1	35.2	26.2	27.0	805	535	-0.002	-0.001
685	2.6	2.9	21	8.1	63.7	61.2	21.9	22.8	2329	802	0.000	0.001
688	3.1	3.4	15	4.8	75.4	49.7	18.8	17.2	1112	1037	-0.003	-0.001
805	1.2	1.3	1	0.8	NA	NA	NA	NA	NA	NA	NA	NA
253, 612, 623, water, Holocene and late Pleistocene alluvium, undivided Pleistocene and Quaternary deposits	5.3	5.7	0	0	NA	NA	NA	NA	NA	NA	NA	NA

Table 5. Summary of apparent relative susceptibility to debris flows (derived from number of debris flows/km² in table 4 and geologic materials units in the study area (derived descriptions in table 3). For example, unit 389, has low relative susceptibility to debris flows, low susceptibility to shallow and bedrock permeability, and high clay content and expansivity.

Geologic Materials Unit	Apparent Relative Susceptibility	Soil Mantle Permeability	Shallow Bedrock Permeability	Soil Mantle Clay Content	Soil Mantle Expansivity
133	low	low	low	high	high
805	low	moderate	low	low	moderate
215	low	moderate	low-moderate	moderate	moderate
508	low	low	low-moderate	high	high
355	low	moderate	moderate	low	moderate
375	low	moderate	low	low	low-moderate
616	low	low	low-moderate	high	moderate-high
635	low	moderate	moderate	low	low
644	low	low	low	high	low-moderate
685	moderate	low	low	high	high
688	moderate	low	moderate	low-moderate	low-moderate
133	high	low	low-moderate	high	high

Table 6. Rain gage and rainfall data from ALERT gages relevant to the February 2-3 storm. Gages are part of the National Weather Service ALERT gage network described by Wilson (1997) and all are 60-pulse-bucket type. Gage location, mean annual rainfall, hourly rainfall data, maximum rainfall, and time of maximum rainfall (in 10-minute increments) provided by Andreas Godfrey of the Alameda County Public Works Agency. Estimates of recurrence intervals are based on Rantz (1971a, 1971b). *, exceeds debris-flow triggering threshold of Cannon (1988), applies to 6-, 12-, 18-, and 24-hour durations only; **, exceeds threshold of Wilson and Jayko (1997), applies to 6- and 24-hour durations only; GM, gage malfunctioned; NA, data not available. See figure 2 for diagram of cumulative rainfall.

Gage	Mean annual precipitation (in/mm)	Elevation (ft/m)	Latitude	Longitude	Cumulative rainfall from January 1 - February 1 1998 (in/mm)	Cumulative rainfall from February 2-3 storm (date, time)	Approximate end of February 2-3 storm (date, time)	Cumulative rainfall from February 2-3 storm (in/mm)	Normalized storm rainfall (cumulative rainfall divided by mean annual precipitation)	Maximum rainfall during a 1-hour period (in/mm)	Time of maximum rainfall for 1-hour period (date, time)	1-hour rainfall recurrence interval exceeded (2, 5, 10, 25, 50, or 100 years)	Maximum rainfall during a 6-hour period (in/mm)	6-hour rainfall recurrence interval exceeded by previous storm (2, 5, 10, 25, 50, or 100 years)	Maximum rainfall during any 6-hour period (in/mm)	Time of maximum rainfall for 6-hour period (date, time)	Rainfall recurrence interval exceeded by maximum 6-hour period rainfall (2, 5, 10, 25, 50, or 100 years)	12-hour rainfall total measured from the beginning of the storm (in/mm)	12-hour rainfall recurrence interval exceeded by previous storm (2, 5, 10, 25, 50, or 100 years)	Maximum rainfall during a 12-hour period (in/mm)	Time of maximum rainfall for 12-hour period (date, time)	Rainfall recurrence interval exceeded by maximum 12-hour period rainfall (2, 5, 10, 25, 50, or 100 years)	18-hour rainfall total measured from the beginning of the storm (in/mm)	18-hour rainfall recurrence interval exceeded by previous storm (2, 5, 10, 25, 50, or 100 years)	Maximum rainfall during an 18-hour period (in/mm)	Time of maximum rainfall for 18-hour period (date/time)	24-hour rainfall total measured from the beginning of the storm (in/mm)	24-hour rainfall recurrence interval exceeded by previous storm (2, 5, 10, 25, 50, or 100 years)	Maximum rainfall during a 24-hour period (in/mm)	Time of maximum rainfall for 24-hour period (date/time)	24-hour rainfall recurrence interval exceeded by maximum 24-hour period rainfall (2, 5, 10, 25, 50, or 100 years)
1930	27/686	980/298.7	37.18 N/ 122.05 W	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM
1932	24/610	575/175.3	37.41 N/ 10.38/264	122.04 W	2/2, 04:00	2/3, 10:00	4.64/118	0.19	0.79/20	2/2, 22:40-23:40	5	1932	0.62/16	<2	2.21/56	2/2-2/3, 20:50-02:50	5	1932	2.30/58	2	3.59/91	2/2-2/3, 09:00-03:00	10	4.09/104	10	4.14/105*	2/2-2/3, 02:50-07:40	10	4.14/105*	2/2-2/3, 02:50-07:40	10
1934	25/635	1019/307.8	37.41N/ 122.01 W	8.78/223	2/2, 04:00	2/3, 10:00	3.58/91	0.14	0.71/18	2/2-2/3, 23:00-00:00	5	1934	0.39/10	<2	1.77/45	2/2-2/3, 19:40-01:40	2	1.28/33	<2	2.52/64	2/2-2/3, 13:10-01:10	5	1.75/44	<2	2.96/75	2/2-2/3, 00:00-03:00	5	3.21/83	2	3.31/84	2/2-2/3, 02:40-02:40	5
1936	21/533	100/30.5	37.41 N/ 122.08 W	8.74/222	2/2, 05:00	2/3, 10:00	4.21/107	0.20	0.67/17	2/2, 22:50-23:50	5	1936	0.43/11	<2	1.97/50	2/2-2/3, 19:50-01:50	5	1.29/33	<2	2.04/52	2/2-2/3, 13:10-01:10	2	1.93/6	2/2-2/3, 19:50-01:50	5	3.55/90	2/2-2/3, 00:00-03:00	5	3.82/97	10	3.62/92	2/2-2/3, 00:00-03:00	10
1938	22/559	710/216.4	37.37 N/ 122.04 W	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM	GM
1940	18/457	60/18.3	37.36 N/ 122.09 W	6.98/177	2/2, 03:00	2/3, 10:00	3.74/95	0.21	0.87/22	2/2-2/3, 23:20-00:20	25	1940	0.27/7	<2	1.81/46	2/2-2/3, 19:50-01:50	10	0.94/24	<2	2.36/60	2/2-2/3, 13:10-01:10	5	1.33/34	<2	3.01/76	2/2-2/3, 00:00-03:00	10	3.28/83	10	3.23/82	2/2-2/3, 02:40-03:30	10
1942	20/513	1500/481.6	37.38 N/ 122.53 W	NA	2/2, 05:00	2/3, 10:00	2.28/57	0.11	0.71/18	2/2, 00:10-01:10	2	1942	0.39/10	<2	1.42/36	2/2-2/3, 19:50-21:20-03:20	<2	1.92/49	2/2-2/3, 13:00-01:00	<2	1.60/41	2/2-2/3, 17:00-10:00	<2	2.03/51	2/2-2/3, 00:00-03:00	<2	2.08/53	2/2-2/3, 03:20-03:20	<2
1950	18/457	10/3.0	37.42 N/ 122.12 W	NA	2/2, 05:00	2/3, 10:00	3.51/89	0.20	0.43/11	2/2, 13:20-14:20	2	1950	0.32/8	<2	1.62/41	2/2-2/3, 20:50-02:50	5	1.25/32	<2	2.21/56	2/2-2/3, 13:00-01:00	5	2.35/59	5	2.81/71	2/2-2/3, 00:00-03:00	5	3.24/83*	10	3.27/83*	2/2-2/3, 04:30/04:30	10
2102	18/457	10/3.0	37.38 N/ 122.08 W	6.01/153	2/2, 05:00	2/3, 10:00	4.21/107	0.23	0.89/23	2/2, 22:50-23:50	5	2102	0.35/9	<2	2.34/59**	2/2-2/3, 20:50-02:50	100	1.05/27	<2	3.01/76*	2/2-2/3, 13:20-01:20	50	2.02/	2/2-2/3, 00:00-03:00	5	3.74/95**	5*	3.80/96**	2/2-2/3, 00:00-00:00	25
2104	18/457	60/18.3	37.39 N/ 122.06 W	8.35/212	2/2, 05:00	2/3, 10:00	4.68/119	0.26	0.89/23	2/2, 22:40-23:40	50	2104	0.43/11	<2	2.44/62**	2/2-2/3, 20:40-2:40	100	1.36/35	<2	3.27/83*	2/2-2/3, 13:10-01:10	50	2.04	2/2-2/3, 00:00-03:00	5	3.82/97*	5*	4.17/106**	2/2-2/3, 00:50-02:50	50
2110	18/457	25/7.6	37.39 N/ 122.08 W	8.54/217	2/2 05:00	2/3, 10:00	3.86/98	0.21	0.63/16	2/2, 22:50-23:50	2	2110	0.47/12	<2	1.97/50*	2/2-2/3, 19:50-01:50	50	1.21/31	<2	2.60/66	2/2-2/3, 13:10-01:10	2	2.10	2/2-2/3, 00:00-03:00	5	3.12/79	2/2-2/3, 00:00-03:00	5	3.48/88	10	3.61/92**	2/2-2/3, 03:00-03:00	10

Table 7. Quantitative comparison of cumulative and hourly rainfall data from ALERT gages and NEXRAD. RMSE, root mean squared errors; SE, systematic errors.

Cumulative Rainfall

NEXRAD time: 1/31/098, 4:10 - 2/3/98, 17:46 GMT
Gage Time: 1/30/98, 20:00 - 2/3/98, 10:00 PST

Location	Rainfall measured by NEXRAD (in., mm)	Rainfall measured By rain gage (in., mm)	Difference between gage and NEXRAD rainfall (in., mm)
1932	5.0, 127	6.16, 156	-1.16, -29
1934	3.70, 94	4.70, 119	-1.00, -25
1936	5.0, 127	5.56, 141	+0.44, +11
1940	3.0, 76	4.13, 105	-1.13, -29
1942	4.0, 102	2.26, -62	+1.74, +44
1950	5.0, 127	4.13, 105	+0.87, +22
2102	3.0, 76	4.53, 115	-1.53, -39
2104	5.0, 127	4.95, 126	+0.05, +1
2110	5.0, 127	3.13, 80	+0.87, +17

RMSE = 0.99, 25
SE = -0.02, -0

NEXRAD time: 2/3/98, 5:00-6:00 GMT
Gage Time: 2/2/98, 21:00-22:00 PST

Location	Rainfall measured By NEXRAD (in., mm)	Rainfall measured by rain gage (in., mm)	Difference between NEXRAD and gage rainfall (in., mm)
1932	0.30, 8	0.47, 12	-0.17, -4
1934	0.30, 8	0.30, 8	0.00, 0
1936	0.30, 8	0.51, 13	-0.21, -5
1940	0.00, 0	0.21, 5	-0.21, -5
1942	0.00, 0	0.16, 4	-0.16, -4
1950	0.20, 5	0.27, 7	-0.07, -2
2102	0.25, 6	0.39, 10	-0.14, -4
2104	0.30, 8	0.51, 13	-0.21, -5
2110	0.25, 6	0.35, 9	-0.10, -3

RMSE = 0.24, 6
SE = -0.05, 0

NEXRAD Time: 2/3/98, 6:00-9:00 GMT
Gage Time: 2/3/98, 0:00-1:00 PST

Location	Rainfall measured By NEXRAD (in., mm)	Rainfall measured By rain gage (in., mm)	Difference between NEXRAD and gage rainfall (in., mm)
1932	0.30, 8	0.28, 7	+0.08, +2
1934	0.30, 8	0.30, 8	0.00, 0
1936	0.30, 8	0.20, 5	+0.10, +3
1940	0.00, 0	0.39, 10	-0.39, -10
1942	0.70, 18	0.16, 4	+0.54, +14
1950	0.40, 10	0.12, 3	+0.28, +7
2102	0.80, 20	0.20, 5	+0.60, +15
2104	0.40, 10	0.24, 6	+0.16, +4
2110	0.50, 13	0.15, 4	+0.35, +9

RMSE = 0.28, 7
SE = +0.13, +3

Hourly Rainfall

NEXRAD Time: 2/3/98, 2:57-3:57 GMT
Gage Time: 2/3/98, 19:00-20:00 PST

Location	Rainfall measured By NEXRAD (in., mm)	Rainfall measured by rain gage (in., mm)	Difference between NEXRAD and gage rainfall (in., mm)
1932	0.10, 3	0.20, 5	-0.10, -2
1934	0.05, 1	0.12, 3	-0.07, -2
1936	0.10, 3	0.12, 3	-0.02, 0
1940	0.00, 0	0.08, 2	-0.08, -2
1942	0.05, 1	0.04, 1	+0.01, 0
1950	0.20, 5	0.15, 4	+0.05, +1
2102	0.10, 3	0.16, 4	-0.06, -1
2104	0.10, 3	0.15, 4	-0.05, -1
2110	0.10, 3	0.16, 4	-0.06, -1

RMSE = 0.06, 1
SE = -0.04, -1

NEXRAD Time: 2/3/98, 4:10-7:10 GMT
Gage Time: 2/2/98, 22:00-23:00 PST

Location	Rainfall measured By NEXRAD (in., mm)	Rainfall measured by rain gage (in., mm)	Difference between NEXRAD and gage rainfall (in., mm)
1932	0.20, 5	0.60, 15	-0.40, -10
1934	0.10, 3	0.30, 8	-0.20, -5
1936	0.10, 3	0.66, 17	-0.56, -14
1940	0.00, 0	0.20, 5	-0.20, -5
1942	0.10, 3	0.26, 7	-0.16, -4
1950	0.40, 10	0.35, 9	+0.05,+1
2102	0.30, 8	0.66, 22	-0.36, -9
2104	0.30, 8	0.74, 19	-0.44, -11
2110	0.40, 10	0.54, 14	-0.14, -4

RMSE = 0.44, 11
SE = -0.34, -8

NEXRAD Time: 2/3/98, 8:59-9:59 GMT
Gage Time: 2/3/98, 1:00 - 2:00 PST

Location	Rainfall measured By NEXRAD (in., mm)	Rainfall measured by rain gage (in., mm)	Difference between gage and NEXRAD rainfall (in., mm)
1932	0.30, 8	0.15, 4	+0.15, +4
1934	0.05, 1	0.08, 2	-0.03, -1
1936	0.55, 14	0.18, 5	+0.36, +9
1940	0.00, 0	0.00, 0	0.00, 0
1942	0.30, 8	0.12, 3	+0.18, +5
1950	0.15, 4	0.05, 1	+0.10, +3
2102	0.30, 8	0.15, 4	+0.15, +4
2104	0.50, 13	0.15, 4	+0.35, +9
2110	0.30, 8	0.20, 5	+0.10, +3

RMSE = 0.27, 7
SE = +0.15, +4

NEXRAD Time: 2/3/98, 4:57-5:07 GMT
Gage Time: 2/2/98, 20:00-21:00 PST

Location	Rainfall measured By NEXRAD (in., mm)	Rainfall measured by rain gage (in., mm)	Difference between NEXRAD and gage rainfall (in., mm)
1932	0.30, 8	0.31, 8	-0.01, -0
1934	0.25, 6	0.15, 4	+0.10, +3
1936	0.30, 8	0.35, 9	-0.05, -1
1940	0.00, 0	0.00, 0	0.00, 0
1942	0.20, 5	0.25, 6	-0.05, -1
1950	0.20, 5	0.25, 6	-0.05, -1
2102	0.25, 6	0.27, 7	-0.02, -1
2104	0.30, 8	0.35, 9	-0.05, -1
2110	0.15, 4	0.28, 7	-0.13, -3

RMSE = 0.13, 3
SE = -0.09, -2

NEXRAD Time: 2/3/98, 6:56-7:56 GMT
Gage Time: 2/2/98, 21:00-22:00 PST

Location	Rainfall measured By NEXRAD (in., mm)	Rainfall measured by rain gage (in., mm)	Difference between NEXRAD and gage rainfall (in., mm)
1932	0.30, 8	0.27, 7	+0.03, +1
1934	0.20, 5	0.35, 9	-0.15, -4
1936	0.30, 8	0.35, 9	-0.05, -1
1940	0.00, 0	0.00, 0	0.00, 0
1942	0.40, 10	0.66, 17	-0.26, -7
1950	0.10, 3	0.27, 7	-0.17, -4
2102	0.25, 6	0.27, 7	-0.02, -1
2104	0.30, 8	0.35, 9	-0.05, -1
2110	0.15, 4	0.28, 7	-0.13, -3

RMSE = 0.13, 3
SE = -0.09, -2

NEXRAD Time: 2/3/98, 10:09-11:09 GMT
Gage Time: 2:00 - 3:00 PST

Location	Rainfall measured By NEXRAD (in., mm)	Rainfall measured by rain gage (in., mm)	Difference between gage and NEXRAD rainfall (in., mm)
1932	0.00, 0	0.00, 0	0.00, 0
1934	0.00, 0	0.00, 0	0.00, 0
1936	0.00, 0	0.00, 0	0.00, 0
1940	0.00, 0	0.01, 1	-0.01, -1
1950	0.00, 0	0.00, 0	0.00, 0
2102	0.10, 3	0.00, 0	+0.10, +3
2104	0.10, 3	0.00, 0	+0.10, +3
2110	0.05, 1	0.00, 0	+0.05, +1

RMSE = 0.05, 1
SE = +0.02, +1

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