APPENDIX E

Hourly Precipitation Data

Available Precipitation Data

A review of available local hourly rainfall records concluded that no single continuous record set was available. Table 1 summarizes hourly rainfall data sets that were investigated as part of this process. Within the periods of records, each gage is missing significant amounts of information, and in some cases contained erroneous data, which required review, synthesis and adjustment.

Table 1: Hourly Rainfall Data Sets

Gage Name	Latitude	Longitude	Elevation (feet)	Begin (year)	End (year)	Source
Salina AP	36° 39' 49"	121° 36' 29"	74	2001	2006	NCDC
Salinas South	36° 36' 36"	121° 31' 46"	120	1993	2008	CIMIS
Salinas North	36° 43' 00"	121° 41' 27"	61	1993	2008	CIMIS
USDA Salinas	36° 37' 14"	121° 32' 43"	120	1983	1992	CIMIS
Del Monte	36° 36' 00"	121° 52' 00"	45	1948	2005	NCDC

In addition to the above listed gages, there was a Monterey County Water Resources Agency gage at the Salinas Golf & Country Club that recorded hourly rainfall from at least 1971 through 1981 and had at least a 29 year record of either hourly or daily data. However, this data is not available from MCWRA. Mr. James Goodridge (former state climatologist), the Desert Research Institute and Santa Clara Valley Water District were all contacted in unsuccessful attempts to obtain the missing data.

Also, summary data from the CA Climate CD developed by Mr. James Goodridge (former state climatologist) was also obtained. The data is a summary of the maximum rainfall by duration (from 1-60 days) and includes total water year rainfall depths. However, the data does not include a breakdown of daily or monthly totals. Based on a review of the totals depths included on the CA Climate CD and the total depths indicated by this study, there were at least four years when the totals on the CA Climate CD appear to be missing significant information.

The process of synthesizing a continuous, consistent rainfall data set involves using what appears to be the most reasonable data for each period and normalizing the data to be consistent with the daily rainfall record at the location of interest.

A 30-year continuous rainfall data set from October 1978-September 2008 was synthesized from four primary hourly datasets as show in Table 2.

Table 2: Hourly data sets used to create 30-year continuous rainfall data set

Gage Name	Range
Del Monte	1978-1983
USDA Salinas	1983-1992
Salinas South	1993-Jan 31, 1998
Salinas North	Feb 1, 1998-Feb 10, 998
Salinas South	Feb 11, 1998 -2001
Salinas AP	2001-2006
Salinas South	2007-2008

Due to inconsistencies in Salinas South storm gage from February 1, 1998 through February 10, 1998, data from the Salinas North storm gage was used instead.

When values were missing from the indicated rainfall record, hourly rainfall depths were duplicated from the most appropriate gage where data was available. Most values were normalized and made consistent with daily rainfall values recorded at the Salinas Airport. When daily rainfall depths were not available from the Salinas Airport, the hourly values were adjusted using normalization values consistent with the other adjustments used for the data set, ranging from 0.9 to 1.1 depending on the original source of the data.

A comparison of the total water year depths for the synthesized hourly rainfall set, the CA Climate CD, and the Salinas Daily rainfall set are shown in Table 3. The rainfall depths with gray cells are known to be missing values that are found in the hourly data set.

Table 3: Summary of water year rainfall depths.

Water Year	Synthesized Hourly Rainfall Depth (in)	CA Climate CD Rainfall Depth (in)	Salinas Daily Rainfall Depth (in)
1979	10.62	10.62	10.62
1980	12.33	12.33	12.33
1981	9.39	6.39	6.39
1982	18.86	18.86	18.86
1983	22.84	22.84	22.84
1984	8.00	7.96	8.00
1985	8.98	8.98	8.98

Water Year	Synthesized Hourly Rainfall Depth (in)	CA Climate CD Rainfall Depth (in)	Salinas Daily Rainfall Depth (in)
1986	11.24	11.24	11.24
1987	8.82	8.82	8.82
1988	6.73	6.56	6.73
1989	8.96	8.96	8.96
1990	8.16	8.01	8.16
1991	10.06	10.06	10.06
1992	11.55	11.55	11.55
1993	16.23	16.23	16.23
1994	9.28	9.28	9.28
1995	21.27	20.87	20.87
1996	18.14	13.71	0.00
1997	20.94	17.75	0.00
1998	31.22	34.74	20.40
1999	12.69	14.15	12.33
2000	14.01	7.96	7.96
2001	19.81	13.48	16.09
2002	3.59	3.59	3.59
2003	7.11	7.11	7.11
2004	9.30	9.99	8.91
2005	19.42	NA	NA
2006	15.34	NA	NA
2007	6.77	NA	NA
2008	5.76	NA	NA

Because of the missing values, not all water years match the CA Climate CD data or the Salinas daily data. The total water year depths of the hourly synthesized data match the Salinas Daily totals where available and determined to be complete; however, the rainfall depths from the CA Climate CD are equal to or exceeded by the synthesized hourly depths in each water year except for 1998. Four months

are missing from the Salinas Daily rainfall for 1998 which account for approximately 11 inches of rain in the hourly data set. To match the CA Climate CD total of 34.74, the 11 inches would need to be increased by about 25 percent, which seemed to be inappropriately high for adjustment of hourly data. The hourly data set for 1998 was not adjusted to match the CA Climate CD total.

The mean annual precipitation for the Salinas Airport gage is 13.40 inches according to the CA Climate CD but only 12.91 inches according to the synthesized hourly values. The rainfall dataset should be adjusted proportionally for locations in the City based away from the airport based on a ratio determined from mean annual precipitation mapping such as that available from SCVWD.

Evaporation Data

An average hourly evaporation value data set was created for the same period of record as the precipitation values to be able to perform long duration simulation, because evaporation data is required for the development of the SalinasHM and may be used in SWMM. Daily evaporation values were available from the Salinas South CIMIS gage for 1992-2008. Monthly average evaporation values were calculated from the available data set. The daily and hourly averages were calculated from the monthly averages and are listed in Table 4.

Table 4: Average evaporation values from the Salinas South gage for a 1992-2008.

	Hourly Average (in)	Daily Average (in)	Monthly Average (in)
January	0.0021	0.0498	1.5433
February	0.0029	0.0700	1.9788
March	0.0048	0.1154	3.5775
April	0.0066	0.1580	4.8993
May	0.0077	0.1840	5.7031
June	0.0090	0.2159	6.6915
July	0.0085	0.2037	6.3144
August	0.0078	0.1872	5.8038
September	0.0064	0.1538	4.7667
October	0.0048	0.1141	3.5365
November	0.0028	0.0670	2.0757
December	0.0066	0.1580	4.8993

A 30-year continuous hourly evaporation data set was created using the average hourly values by month.

Hypothetical 100-Year Rainfall Data

A water-year's worth of hypothetical hourly rainfall data was developed for use as a basis for evaluating a systems ability to mitigate for the potential impacts of increased runoff volume flooding on the Reclamation Ditch. This data set was developed to be consistent with the daily rainfall statistics at the Salinas Airport rain gage from the CA Climate CD and the 100-year 3-day rainfall pattern used for the Zone 9 Operations Study, dated May 1999.

The data set matches the following 100-year depths according to the values in Table 5:

Table 5: 100-year rainfall depths used to create hypothetical rainfall data.

Duration (days)	Depth (inches)
1	3.10
2	4.39
3	5.07
4	5.37
5	5.85
6	6.06
8	6.73
10	7.27
15	8.40
20	9.23
30	10.97
60	16.41

Data Uses

Several methods exist for performing long duration hydrologic simulation and evaluating the effects of hydromodification mitigation measures. These include the EPA models HSPF and SWMM. The SalinasHM was developed by Clear Creek Solutions using the HSPF model to standardize long-duration simulation and to size hydromodification mitigation measures. The SalinasHM model can efficiently model numerous conditions, however, it has some limitations. The SWMM model, or any of a number of proprietary packages that use the SWMM engine with enhanced user interfaces, may be used in any situation, including those that require analysis of complex hydraulic systems and systems where tailwater conditions limit discharges.