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TECHNICAL MEMORANDUM

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DATE: December 5, 2007

SUBJECT: Comfort Lake Forest Lake Watershed District
 Modified Water Years

This memorandum summarizes the methodology to be used to calculate the data used in the Water Budgets to represent a Modified Water Year.

The adjusted rating curves (Appendix B) were used to re-calculate discharge rates from monitored stage levels for the data collected by Washington Conservation District (WCD) in 2003, 2004, 2005, and 2006.

The following table summarizes the start and end dates of the monitoring periods.

Station	Year	Type of Monitoring		Station Monitoring Period	
		Streamflow	Precipitation	Start Date	End Date
SM1	2003	+	+	5/27/03	- 10/30/03
SM2	"	+	+	5/27/03	- 10/30/03
SM6	"	+	SM8	5/29/03	- 10/28/03
SM8	"	+	+	5/29/03	- 11/3/03
SM1	2004	+	+	3/24/04	- 11/2/04
SM4	"	+	+	5/4/04	- 11/2/04
SM6	"	+	SM7	3/31/04	- 11/2/04
SM7	"	+	+	4/5/04	- 11/2/04
SM8	"	+	+	3/22/04	- 11/2/04
SM1	2005	+	+	3/29/05	- 11/1/05
SM2	"	+	+	3/29/05	- 11/1/05
SM3	"	+	SM1	4/5/05	- 11/1/05
SM4	"	+	+	3/29/05	- 11/2/05
SM5	"	+	+	4/20/05	- 11/1/05
SM6	"	+	SM7	3/24/05	- 11/2/05
SM7	"	+	+	3/29/05	- 11/2/05
SM8	"	+	+	3/24/05	- 11/2/05
SM1	2006	+	+	5/1/06	- 10/30/06
SM2	"	+	+	5/1/06	- 10/25/06
SM3	"	+	SM1	5/1/06	- 10/30/06

SM4	"	+	+	5/4/06 - 10/30/06
SM5	"	+	+	5/2/06 - 10/30/06
SM6	"	+	SM7	5/2/06 - 10/25/06
SM7	"	+	+	5/2/06 - 10/30/06
SM8	"	+	+	5/2/06 - 10/30/06

Note: For the two stations that lack a precipitation gage (SM3 and SM6), the "modified water year" precipitation for the indicated gage was assumed as noted in the table.

The hydrologist's "water year" runs from Oct 1 of the preceding year to Sep 30 of the water year. As documented in the following tables, the "modified water year" used in this study normally runs from Nov 1 to Oct 31, with the actual dates determined by the latest date of monitoring in the given year.

Year	Modified Water Year	
	Start Date	End Date
2003	11/4/02	- 11/3/03
2004	11/3/03	- 11/2/04
2005	11/3/04	- 11/2/05
2006	10/31/05	- 10/30/06

In order to work in a Modified Water Year, the rainfall and discharge data were adjusted as discussed in this Technical Memorandum.

First, the WCD-monitored rainfall was adjusted by the ratio of the total rainfall monitored by the National Weather Service (NWS) during the Modified Water Year start and end dates to the total rainfall monitored by the NWS during the WCD-monitoring period start and end dates, as shown in attached Table 1.

Using the drainage areas from the XP-SWMM model developed by SRF (see below), and calculating the volumetric discharges at each of the stream monitoring locations, a depth of runoff was determined for each monitored period (Attached Table 2).

Station	Drainage Area [acres]
SM1	5,814
SM2	2,510
SM3	899
SM4	8,982
SM5	843
SM6	9,460
SM7	14,051
SM8	24,938

The WCD-monitored volumetric discharge was adjusted with the same aforementioned ratios used to adjust the rainfall data. Apparent runoff coefficients were calculated in the attached Table 2.

**Table 1
Precipitation Data**

Station	Year	NWS* Precipitation Data							Station Precipitation**	
		Monitoring Period		Modified Water Year		Monitoring Period	Modified Water Year	Ratio of (Mod Wat Yr): (Mon Period)	Monitoring Period	Modified Water Year
		Start Date	End Date	Start Date	End Date	[inches]	[inches]		[inches]	[inches]
SM1	2003	5/27/03	10/30/03	11/4/02	11/3/03	16.27	30.11	1.8506	12.35	22.86
SM2	"	5/27/03	10/30/03	"	"	16.27	"	1.8506	12.73	23.56
SM6	"	5/29/03	10/28/03	"	"	15.92	"	1.8913	12.70	24.02
SM8	"	5/29/03	11/3/03	"	"	16.41	"	1.8349	13.09	24.02
SM1	2004	3/24/04	11/2/04	11/3/03	11/2/04	25.49	30.73	1.2056	18.03	21.74
SM4	"	5/4/04	11/2/04	"	"	22.79	"	1.3484	19.59	26.42
SM6	"	3/31/04	11/2/04	"	"	25.00	"	1.2292	20.97	25.78
SM7	"	4/5/04	11/2/04	"	"	25.00	"	1.2292	20.97	25.78
SM8	"	3/22/04	11/2/04	"	"	25.49	"	1.2056	21.68	26.14
SM1	2005	3/29/05	11/1/05	11/3/04	11/2/05	27.34	31.52	1.1529	18.27	21.06
SM2	"	3/29/05	11/1/05	"	"	27.34	"	1.1529	20.73	23.90
SM3	"	4/5/05	11/1/05	"	"	26.33	"	1.1971	17.60	21.06
SM4	"	3/29/05	11/2/05	"	"	27.34	"	1.1529	21.99	25.35
SM5	"	4/20/05	11/1/05	"	"	25.48	"	1.2370	19.63	24.28
SM6	"	3/24/05	11/2/05	"	"	27.34	"	1.1529	--	25.92
SM7	"	3/29/05	11/2/05	"	"	27.34	"	1.1529	22.48	25.92
SM8	"	3/24/05	11/2/05	"	"	27.34	"	1.1529	22.32	25.73
SM1	2006	5/1/06	10/30/06	10/31/05	10/30/06	21.99	31.75	1.4438	14.08	20.33
SM2	"	5/1/06	10/25/06	"	"	21.99	"	1.4438	15.67	22.62
SM3	"	5/1/06	10/30/06	"	"	21.99	"	1.4438	--	20.33
SM4	"	5/4/06	10/30/06	"	"	21.82	"	1.4551	16.89	24.58
SM5	"	5/2/06	10/30/06	"	"	21.83	"	1.4544	13.18	19.17
SM6	"	5/2/06	10/25/06	"	"	21.83	"	1.4544	--	26.53
SM7	"	5/2/06	10/30/06	"	"	21.83	"	1.4544	18.24	26.53
SM8	"	5/2/06	10/30/06	"	"	21.83	"	1.4544	18.32	26.64

Notes:

*NWS (National Weather Service) data are for station 212881 "Forest Lake 4SE" (i.e., station located 4 miles SE of the City of Forest Lake). The ratio of (modified water year precipitation):(monitoring period precipitation) is specific to each station. For example, the NWS precipitation for station SM6's monitoring period in 2003 (i.e., streamflow monitoring period; SM6 did not have a precipitation gage) was 15.92 inches, whereas the NWS precipitation for modified water year 2003 was 30.11 inches; thus, the ratio for SM6 in 2003 was (30.11 inches)/(15.92 inches) = 1.8913 (i.e., 1.8913:1), as shown in the table. Note that the NWS precipitation for *modified water year 2002* (Nov 1, 2001 - Oct 31, 2002) was 46.70 inches.

**For each station with a precipitation gage, the modified water year precipitation was estimated by multiplying the station's monitoring period precipitation by the ratio based on NWS data that is noted above. For the two stations that lack a precipitation gage (SM3 and SM6), the modified water year precipitation for a nearby gage was assumed (see Table jbe-2). The monitoring period precipitation for these two stations was then estimated by dividing the modified water year precipitation by the NWS-based ratio calculated for the station for its streamflow monitoring period.

**Table 2
Streamflow/Runoff Data**

Station	Year	Monitoring Period Dates		Monitoring Period Runoff		Modified Water Year Runoff		Station Precip. for Modified Water Year [inches]	Apparent Runoff Coefficient [--]
		Start Date	End Date	Volume [ac-ft]	Depth [inches]	Volume [ac-ft]	Depth [inches]		
SM1	2003	5/27/03	10/30/03	1,155	2.38	2,137	4.41	22.86	0.193
SM2	"	5/27/03	10/30/03	732	3.50	1,355	6.48	23.56	0.275
SM6	"	5/29/03	10/28/03	3,336	4.23	6,309	8.00	24.02	0.333
SM8	"	5/29/03	11/3/03	9,234	4.44	16,943	8.15	24.02	0.339
SM1	2004	3/24/04	11/2/04	1,320	2.72	1,591	3.28	21.74	0.151
SM4	"	5/4/04	11/2/04	2,419	3.23	3,262	4.36	26.42	0.165
SM6	"	3/31/04	11/2/04	4,033	5.12	4,957	6.29	25.78	0.244
SM7	"	4/5/04	11/2/04	6,512	5.56	8,005	6.84	25.78	0.265
SM8	"	3/22/04	11/2/04	10,099	4.86	12,175	5.86	26.14	0.224
SM1	2005	3/29/05	11/1/05	403	0.83	465	0.96	21.06	0.046
SM2	"	3/29/05	11/1/05	207	0.99	239	1.14	23.90	0.048
SM3	"	4/5/05	11/1/05	344	4.59	412	5.50	21.06	0.261
SM4	"	3/29/05	11/2/05	2,601	3.47	2,999	4.01	25.35	0.158
SM5	"	4/20/05	11/1/05	366	5.21	453	6.45	24.28	0.266
SM6	"	3/24/05	11/2/05	3,214	4.08	3,705	4.70	25.92	0.181
SM7	"	3/29/05	11/2/05	4,595	3.92	5,298	4.52	25.92	0.175
SM8	"	3/24/05	11/2/05	3,909	1.88	4,507	2.17	25.73	0.084
SM1	2006	5/1/06	10/30/06	273	0.56	394	0.81	20.33	0.040
SM2	"	5/1/06	10/25/06	57	0.27	82	0.39	22.62	0.017
SM3	"	5/1/06	10/30/06	154	2.06	222	2.97	20.33	0.146
SM4	"	5/4/06	10/30/06	1,567	2.09	2,280	3.05	24.58	0.124
SM5	"	5/2/06	10/30/06	223	3.18	324	4.62	19.17	0.241
SM6	"	5/2/06	10/25/06	1,063	1.35	1,546	1.96	26.53	0.074
SM7	"	5/2/06	10/30/06	1,731	1.48	2,518	2.15	26.53	0.081
SM8	"	5/2/06	10/30/06	3,896	1.87	5,666	2.73	26.64	0.102