S A N D I E G O R I V E R P A R K
F O U N D A T I O N

LOWER SAN DIEGO RIVER
WATER QUALITY 2011

Water Quality Monitoring Report Appendices

Site 13 - USB (Mast Park, Santee)

Supporting Water Quality Monitoring Data for the Lower San Diego River

John C. Kennedy, PE

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PO Box 80126, San Diego, CA 92138 • telephone: 619 297 7380 • fax: 619 297 7385 • info@SanDiegoRiver.org

Lower San Diego River Water Quality - 2011

Table of Contents (WQM Report - separate document)

WY11 WQM Report Appendices Table of Contents

Appendix A - San Diego RiverWatch Monitoring Program

Appendix A provides an overview of SDRPF's RiverWatch water quality monitoring (WQM) program that, over the past 7 years, has been continuously engaged in collecting and evaluating data pertaining to the Lower San Diego River (LSDR) watershed on a monthly basis.

Monitoring Period & Coverage: Monthly monitoring over past 7 years (Oct. 2004 – Nov. 2011) covering the Lower San Diego River and its tributaries extending downstream from Lakeside (river mile 19.8 elev. 340 ft amsl) to the Estuary (river mile 2.96, elev. 4.8 ft amsl) at the I-5/Pacific Hwy. overpasses. The LSDR watershed and monitoring sites are shown on **Figure A.1.**

Monitoring Sites: 15 total - 12 on main course (Mission Valley Section - sites 1-7, Mission Gorge Section - sites 8-10, Santee Basin Section - sites 11-15) plus three tributary stream sites are listed in **Table A.1.** Site locations, river milage, bed elevations and coordinates are provided in **Table A.2.**

Table A.1 LSDR Sections, Reaches and Monitoring Sites

Section/Reach/Tributary	Site #	Comments
Estuary Entrance	1E/1W	Tidal Influence at transition from river to SDR Estuary
Lower Mission Valley (LMV)	2E/W, 3 & 4	4 miles of lower river extending to I-805
Upper Mission Valley (UMV)	5,6 & 7	4-mile stretch from I-805 to Princes View Dr
Mission Valley (West Sites)	1-7	8-mile western portion through Mission Valley
Mid-Section Mission Gorge (MG)	8,9 & 10	5-mile mid-section, Princess View Dr to Kumeyaay Lk
Lower Santee Basin (LSB)	11,12&15	2 mile stretch from Kumeyaay Lk to Carlton Hills Blvd
Upper Santee Basin (USB)	13 & 14	3 mile stretch from Carlton Hills Blvd to Riverford Rd
Santee Basin (SB)	11-15	5-mile eastern section from Kumeyaay Lk to Lakeside
Eastern Portions (East Sites)	8 -15	10-mile eastern/upper 3 reaches (2 sections)
Tributaries:		
Murphy Canyon/Qualcom [a)]	5a	Enters SDR southwest of Qualcom Stadium
Jackson Dr/Birchcreek Outfall [b)]	9	Enters SDR at Sycott Wash (d/s of Site 8)
Santee Lakes/E. Sycamore Cnyn Creek	12	Enters SDR d/s of Carlton Oaks GC (u/s of Site 11)
Forester Creek [c)]	15	Enters SDR at Carlton Oaks GC (u/s of Site 12)
Lower SDR Watershed (LSDR)	1-15	Weighted average of all 5 reaches or all 3 sections

(a) Monthly monitoring discontinued in WY07; nearby Ward Rd bridge site renumbered as 5.
(b) Monthly monitoring initiated in 2008; site also termed Jackson Outfall (OF).
(c) Monthly monitoring at various locations initiated in 2007.

WQ Parameters: Seven measured and recorded parameters (Temp, pH, SC, DO, DO%Sat, NO_3 & PO_4) plus subjective field observations re: environs and characteristics are listed in **Table A.3.** As nutrient testing for NO_3 and PO_4 is carried out at five selected sites; two in West (2 & 6) and three in East (11,14 & 15), respectively, results are not used in performing statistical analyses regarding reaches/sections of the river. Number of datum for each of the five physical-chemical parameters monitored monthly at each site over the 7-yr period (Oct. 04 - Oct. 11) are commonly in the range of 75 to 84. Two other water quality parameters monitored by others at several sites, stream flows from USGS (Poway Office) and coliform counts from SDCoastKeeper, are also recorded for purposes of determining the water quality index.

Table A.2 - LSDR WQM Site Information

Site #	Site Name	u/s mi.	Elev. ft	Location	GIS Coordinates Latitude	Longitude
LMV - Lower Reach W. Mission Valley: I-5 Bridge to I-805 Bridge (Sites 1-4)						
1	Estuary W/E	2.96	6	Between PC Hwy & I-5 on encased sewer main	32.76131	-117.2037
2	River Gardens E/W	3.50	11	W of YMCA, d/s of Trolly overpass at riffle	32.76230	-117.1944
3	Fashion Valley Mall W	5.08	22	below Town & Country Pedestrian Bridge	32.76517	-117.1687
4	FSDRIP	5.98	36	N. of Mimi's Cafe on Mission Center Rd Bridge	32.76986	-117.1548
UMV - Upper Reach E. Mission Valley: I-805 Bridge to North end of Admiral Baker Field (Sites 5-7)						
5	Ward Rd Bridge	8.89	50	S of Trolly overpass at Del Rio S intersection	32.78024	-117.1103
6	Kaiser Ponds	9.46	56	E of Mission SD de Acala at SD Mission Rd	32.78406	-117.1042
7	Admiral Baker Field	9.98	58	L - Lower (below Friars Rd bridge)	32.79038	-117.1031
	ABF - Zion	10.2	62	Z - Terminus of Zion Ave at Riverdale St	32.79304	-117.0998
West (MV) - Mission Valley Section: Estuary to Admiral Baker Field (Sites 1-7) [LMV+UMV]						
MG - Mission Gorge Reach: Quarry Area to Old Mission Dam (Sites 8-10)						
8	Mission Trails at Jackson Dr	13.8	159	at SDCWA below Scycott Crossing	32.82124	-117.0621
9	Jackson Dr/Birchcreek OF	13.9	198	San Marcos area tributary by Jackson Dr. Trail	32.82268	-117.0622
10	Old Mission Dam W/E	15.7	265	Downstream side of Old Mission Dam	32.83977	-117.0433
Mid-Section (MG) - Mission Gorge Section: Quarry Area to Old Mission Dam (Sites 8-10)						
LSB - Lower Reach Santee Basin: W. Hills Pkwy to Carlton Hills Blvd Bridge (Sites 11,12 &15)						
11	West Hills Pkwy	17	300	at/below West Hills Pkwy Bridge	32.83936	-117.0244
12	Carlton Oaks Dr/Santee	18.2	320	Sycamore Ck/Santee Lakes at Carlton Oaks Dr.	32.84431	-117.0064
15	Forester Creek	18.9	336	Forester Ck (tributary) at Prospect Ave.	32.83221	-116.9866
USB - Upper Reach Santee Basin: Carlton Hills Blvd Bridge to Riverford Rd (Sites 13-14)						
13	Mast Park	18.50	330	Pedestrian Bridge behind (N of) Walmart	32.84696	-116.9734
14	Cottonwood Ave/RCP	19.8	340	W of RCP plant at Chubb Ln/Cottonwood Ave	32.84434	-116.9895
East (SB) - Santee Basin Section: West Hills Parkway to Lakeside (Sites 11-15 above) [LSB+USB]						
LSDR - Lower San Diego River Watershed: Estuary to Lakeside (Sites 1-15 above) [MV2+MG+SB]						

Reaches (5) - averaged values for combination of adjacent sites excluding tributaries within identified portions of river (LMV, UMV, MG, LSB, USB) .
Sections (3) - averaged values for adjacent reaches (MV = LMV+UMV, MG=MG, SB = LSB+USB
Tributaries (3) – sites located on small creeks/drainages tributary to main watercourse.
LSDR – computed values for entire lower watershed (distance-weighted average of all 5 reaches or all 3 sections); average (LMV+UMV+MG+SB) or average (MV2+MG+SB).

Protocol: *East Side* – (Santee Basin & Mission Gorge Sections). The eight sites within upper three reaches (MG, LSB & USB) typically monitored 3rd Fri. or Sat. of month. *West Side* - (Mission Valley Section). Seven sites within lower two reaches (LMV & UMV) monitored monthly, typically 3rd Sun. morning of month.

Table A.3 - LSDR Water Quality Monitoring Parameters

WQ Parameter	unit	Comments
Measured monthly at all sites:		
1. Temperature (Temp)	oC	Basic characteristic and WQ driver (Table C.1)
2. pH	-	Degree of acidity (<7.0) or alkalinity (>7.0) (Table C.3)
3. Specific Conductivity (SC)	mS/cm	Measure of ionic content or dissolved solids (Table C.2)
4. Dissolved Oxygen (DO)	mg/L	Good indicator of relative water quality (Table C.4)
5. Percent of DO Saturation (DO%Sat)	%	Good indicator of general water quality (Table C.5)
Sampled/tested monthly at selected sites: (typically 5 - 3 East & 2 West)		
6. Nitrate (NO_3-N)	mg/L	Important nutrient for biological activity
7. Phosphate (PO_4-P)	mg/L	Key nutrient for biological activity
Discontinued on regular basis in 2006:		
8. Turbidity	NTU	Discontinued due to inaccurate/invalid readings
9. Barometric Pressure	mBars	Suspended readings as external data readily available
Environmental Observations recorded at all sites:		
Atypical or notable conditions (scum, discoloration, odors, etc.), trash/debris, homeless encampments, biological activity (aquatic, avian, terrestrial), expansion of invasive species, erosion, scouring, other noteworthy comments re: watercourse, shoreline and adjacent environs.		
General WQ Conditions observed at all sites: (numerical coding added in 2010)		
Weather Condition, Presence of Algae, Clarity, Color, Odor, Flow, Foam, Litter, Odor, Oil and Grease (O&G)		
Parameters measured by others at selected sites		
10. Coliform counts	MPN/ 100mL	SDCoastKeeper data taken at Fashion Valley Rd and Old Mission Dam monitoring sites (Table E.2)
11. Stream Flow	cfs	USGS gauging stations at Fashion Valley and Mast Rd near Santee (Table E.1)

Team Leaders and multiple citizen volunteers (typically 3-8 persons) meet at an appointed site, organize field equipment/transportation, drive to sites, measure physical-chemical water quality using Sonde instrument, note special conditions/observations, collect samples for subsequent testing, return to office, perform nutrient (NO_3 & PO_4) tests, store samples for subsequent laboratory (e.g., sediment toxicity) analyses and clean/check-in/store field equipment.

Data Management: Water quality data are typically managed in a three-step process.
1. *Raw* (source) data - each site, several of which have two monitoring locations (e.g. upstream/ downstream of dam, riffle or crossing), date/time, measured WQ parameters, and non-quantifiable supporting observations and comments.
2. *Compiled* (vetted/proofed) data - provided on Ecolayers w/date, site location, parameter value and additional observations of interest.
3. *Processed* (formatted/aggregated) data - with statistical computations associated with LSDR sites, reaches, sections and tributaries for each WQ parameter of interest including those monitored by others.

Statistical Computations: Various basic statistical values have been calculated from the data.

Mean – average of a series (sum of values divided by number of values)
Median – middle value of an ordered series (50% larger - 50% smaller)
Minimum – lowest or smallest value measured
Maximum – highest or greatest value measured
Range – Difference between maximum and minimum values
1st Quartile (Q1) – 25% of values smaller - 75% larger
2nd Quartile (Q2) – 50% of values larger - 50% smaller (same as median value)
3rd Quartile (Q3) – 75% of values smaller - 25% larger
Variance – sum of the squares of deviation from the mean or average value
Standard Deviation (SD) – square root of the variance
Skew – third moment about the mean divided by the standard deviation (SD)
Coefficient of Variance (CoV)– Variance divided by the mean
Trend line - Moving average value taken over 12 month period (for LSDR)

Figure A.1 - Lower San Diego River Catchment and WQM Sites

Color Code for LSDR reaches on figure above: Estuary (orange), LMV (purple), UMV (red), MG (dark green), LSB (violet), USB (dark blue), Lakeside (light green), tributaries (light blue). Figure details can be downloaded through Google Earth from SDRPF website/River Monitoring page: file <Fig1.1WQMR.kmz>

Questions regarding the San Diego River WQM database or interpretation of results expressed in these appendices can be directed to the attention of the report's author, John C. Kennedy, through contacting SDRPF at info@SanDiegoRiver.org, or the RiverWatch Coordinator at 619-297-7380.

Appendix B - LSDR Hydrology and Water Quality

Stream flow or discharge, the volume of water moving past a designated location over a fixed period of time, is a primary driver of changes in water quality. Flow, often expressed as cubic feet per second (cfs) or million gallons per day (mgd), constitutes the amount of water moving off a watershed into a watercourse, as affected by weather (increasing during rainstorms and decreasing during dry spells) and changing during different seasons. Flow decreases during summer months when rainfall is minimal, evaporation rates high and actively growing riparian vegetation extracts water from the ground. August and September are typically months of lowest flow. A function of both volume and velocity, stream flow has a major impact on living organisms, watercourse habitats and on overall water quality. Velocity of flow, typically increasing as volume increases, determines the kinds of organisms that live in the system and also affects the amount of silt and sediment thats transported. Fast moving watercourses usually contain higher levels of DO than slow streams, as they are better aerated.

LSDR average daily flow (ADF) values as recorded at the two USGS gauging stations in the lower watershed are expressed in **Table B.1** for both the monitoring period (Oct 2004 - Oct 2011) and the past 46 years (1965-2011) of official records**.** The two averages are in close accord for both stations.

Table B.1 - Lower SDR Average Daily Flows (WY05-WY11)

Season	West - Mission Valley		East - Santee Basin		LSDR [a]	
Units [b]	cfs	mgd	cfs	mgd	cfs	mgd
Fall (Oct/Nov)	21	13.5	14	9.1	18	11.3
Winter (Dec-Mar)	83	53.4	41	26.8	62	40.1
Spring (April/May)	17	11.1	10	6.5	14	8.8
Summer (June-Sept)	2.4	1.5	1.7	1.1	2.1	1.3
7-Yr Annual Avg. (Oct-Sept)	37.1	24.0	21.0	13.6	29	18.8
Recent 47-Yr Avg. (1965-2011)	36.3	23.5	21.7	14.0	29	18.7
Total Annual Discharge, AFY [c]	26,320		15,680		20,940	

(a) Lower San Diego River average daily flow represents a mean hydrologic condition based on averaging the two USGS stream gauging station values.
(b) ADF values are expressed in both cubic feet per second (cfs) and million gallons per day (mgd); 1 mgd = 1.7 cfs.
(c) Average annual discharge volume expressed in acre-feet (1 AF = 325,900 gallons) between 1965 and 2011.

Correlations between total annual rainfall and ADF considered over the past 98 years of hydrologic record and during the period of SDRPF RiverWatch monitoring for the two lower SDR gauging stations are presented in **Tables B.2 and B.3**, respectively. WY05 was a "Very Wet" hydrologic year, whereas WY07 was "Very Dry". WY06 & 08 were "Dry" years while the past two years (WY09 & 10) were considered "Normal" in terms of both total annual rainfall and average daily flow. The 7-yr ADF in the East and West is 21 and 37 cfs, respectively; both values are approximately the same as the past 45- as well as 98-yr SDR average daily discharges.

Monthly discharge data (min, max and average daily flow) at the two gauging stations extending from Oct 2004 through Oct 2011 are presented in **Chart B.1.** Average daily flow (ADF) for the lower San Diego River varies from less than 1 cfs during the summer (dry) months to nearly 200 cfs during some winter (wet) seasons in the East (Santee Basin) and up to 380 cfs in the West (Mission Valley) section. ADF values have been trending upward since WY07 as shown by the 12-month moving average.

Table B.2 - Rainfall and Long-Term Average Daily Flow (1914-2011)

Type	# of Years	Percent of Total Years		Total Annual Rainfall [a]			Average Daily Flow, cfs		
				inches	mm	Avg., mm	East (b)	West (c)	LSDR
Very Wet	3	3%	30%	>20	>500	580	105	175	142
Wet	10	10%		15-20	380-499	430	75	125	102
Above Norm [d]	17	17%		12-15	300-379	340	40	68	54
Normal	38	39%	39%	8-12	200-299	245	14	24	18
Dry	25	26%	31%	5-8	125-199	160	7	11	9
Very Dry	5	5%		<5	<125	100	5	8	6.5
Annual Avg.	98	100%		10.2		260	26	43	35

a) Total annual rainfall from 1 October through September 31.
b) Santee Basin USGS Stream Gauge Station # 11022480 at Mast Rd.
c) Mission Valley USGS Stream Gauge Station # 11023000 at Fashion Valley Mall; incomplete data prior to 1968.
d) Above normal annual rainfall (12-15 in/yr) resulting in LSDR average daily flows between 25 and 75 cfs.

Table B.3 - Annual Rainfall and Average Daily Flow (WY05-WY11)

(Type of Year)	Annual Rainfall		Variance [a]	ADF, cfs			Variance [d]
	mm	inches		East [b]	West [c]	LSDR	
WY05 (Very Wet)	576	22.7	122%	51	100	76	117%
WY06 (Dry)	153	6.0	-41%	11	18	14	-60%
WY07 (Very Dry)	98	3.9	-62%	7	13	10	-70%
WY08 (Dry)	185	7.3	-29%	13	25	19	-45%
WY09 (Normal)	232	9.1	-11%	15	27	21	-40%
WY10 (Normal)	269	10.6	4%	31	42	36	3%
WY11 (Above Normal)	264	12.7	23%	33	54	43	23%
7-Yr Average (05-11)	254	10.0	-2%	23	40	31	-11%
29-Yr Avg. ('83-11)	261	10.3	1%	25	39	32	-9%
98-Yr Long-Term Avg.	260	10.2	0%	26	43	35	0%

(a) Percent difference from long term average annual rainfall (260 mm/yr or 10.2 in/yr); black-above, red-below.
(b) Santee Basin USGS Stream Gauge Station at Mast Rd.
(c) Mission Valley USGS Stream Gauge Station at Fashion Valley Mall; incomplete data prior to 1965.
(d) Percent difference from long-term average annual daily flow (i.e., 26 cfs at Santee and 43 cfs in Mission Valley).

Monthly and seasonal average annual flows and rainfall over the 7-yr monitoring period for both stations are shown in **Chart B.2.** The seasonal flow patterns describe the range, variance and correlation in monthly ADF and rainfall over the past 7 years of RiverWatch monitoring. Winter wet season stream flows within the lower watershed are 100-to-250 times greater than summer, dry season flows. Average annual, winter and summer flows and rainfall for each of the last 7 water years are presented in **Chart B. 3.** Highest flows during the monitoring period at both gauging stations were recorded in WY05 (very wet year); the lowest in WY07 (very dry year). Water years (WY06-09) each witnessed below normal rainfall and runoff/flow. WY10 witnessed near normal rainfall and average river discharge. WY11 was an above normal year in terms of both rainfall and average annual stream flow exceeding long term (98-Yr) values by 23 percent.

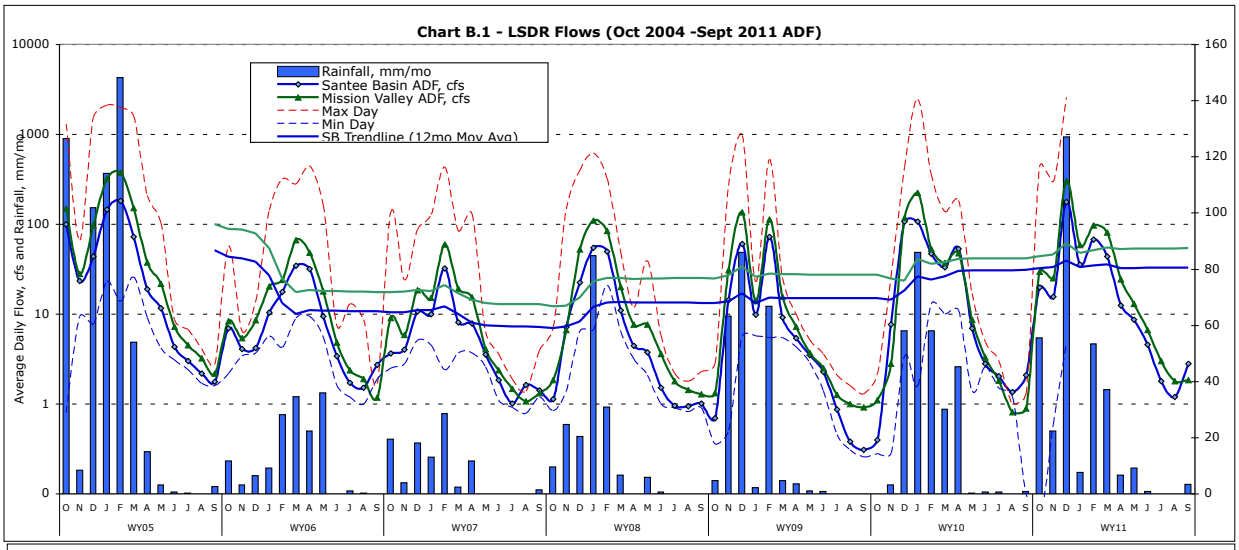


Chart B.1 - LSDR Flows (Oct 2004 -Sept 2011 ADF)
Rainfall, mm/mo
Santee Basin ADF, cfs
Mission Valley ADF, cfs
Max Day
Min Day
SB Trendline (12mo Mov Avg)
Average Daily Flow, cfs and Rainfall, mm/mo
WY05
WY06
WY07
WY08
WY09
WY10
WY11

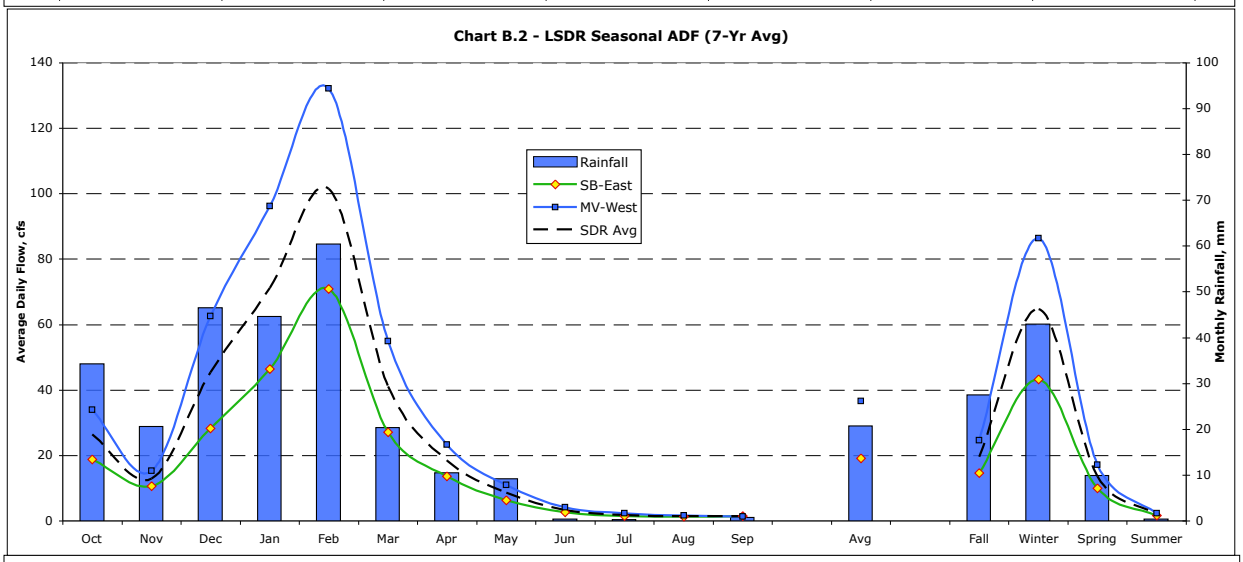


Chart B.2 - LSDR Seasonal ADF (7-Yr Avg)
Rainfall
SB-East
MV-West
SDR Avg
Average Daily Flow, cfs
Monthly Rainfall, mm
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Avg
Fall
Winter
Spring
Summer

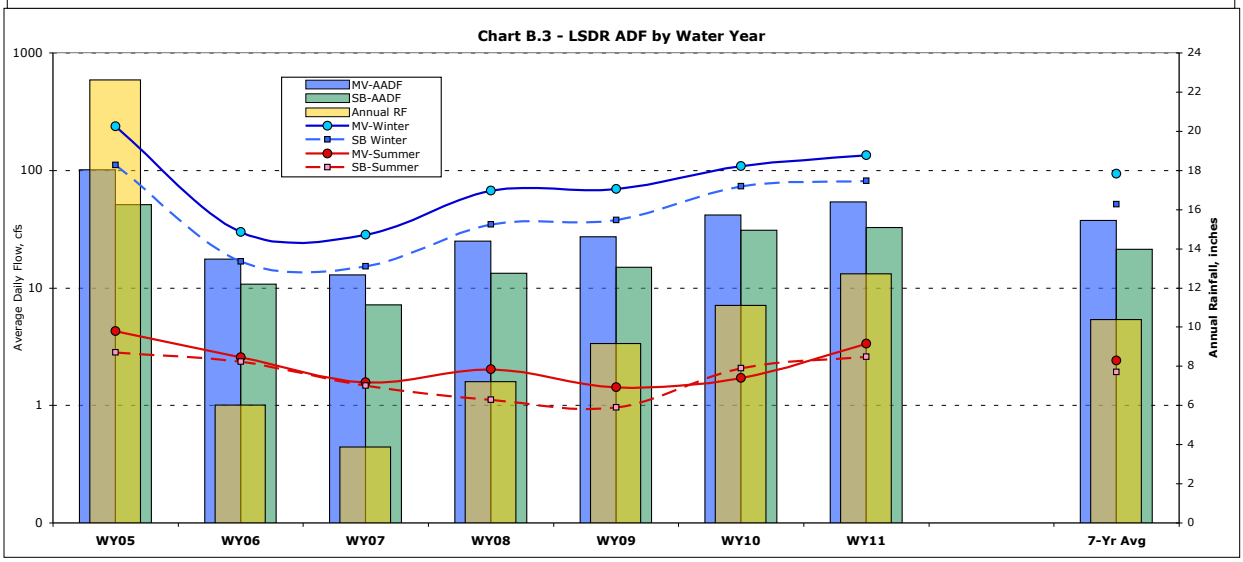


Chart B.3 - LSDR ADF by Water Year
MV-AADF
SB-AADF
Annual RF
MV-Winter
SB Winter
MV-Summer
SB-Summer
Average Daily Flow, cfs
Annual Rainfall, inches
WY05
WY06
WY07
WY08
WY09
WY10
WY11
7-Yr Avg

Appendix C - WY11 LSDR Monthly WQM Site Data

Table C.1(W) WY11 West Section Water Temperature

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	20.1	20	20.1	20.4	18.4	19.3	19.6
Nov	15.7	15.7	15.9	15.6	15.5	15.5	15.5
Dec	14.6	14.5	14.7	14.8	14.1	13.9	14.1
Jan	13.7	13.3	13.4	13.3	12.3	12.9	12.8
Feb	13.5	13.5	15.2	12.6	13.1	13.2	12.9
Mar	17.1	17.3	17.3	17.2	15.9	16.7	16.5
Apr	19.7	19.7	19.6	19.5	18.8	19.3	19
May	19.9	20.2	20	20.2	19.8	20.4	19.9
Jun	21.9	22.2	22.7	22.9	21.5	22.6	22.5
Jul	23.1	23.5	23.8	24.5	21.1	23.1	21.8
Aug	23.2	22.8	23	24.4	20.2	22.1	22.7
Sep	21.3	21.3	21.5	22.5	19	20.6	21.7
WY11 Avg [b]	**18.65**	**18.67**	**18.93**	**18.99**	**17.48**	**18.3**	**18.25**

a) All values expressed in oC.
b) Water Year 2011 values are based on averaging of monthly values (Oct- Sept).

Table C.1(E) WY11 Mid and East Section Water Temperature

Site	8	9	10	11	12	13	14	15
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	19.30	19.75	20.20	19.50	19.70	19.90	20.50	20.90
Nov	14.90	13.30	15.50	15.30	16.30	15.20	15.50	15.70
Dec	12.30	10.40	12.50	12.30	13.70	13.10	12.90	12.60
Jan	11.80	8.90	12.10	11.80	13.00	13.60	12.30	9.90
Feb	13.20	10.90	13.40	12.80	14.30	13.50	13.40	12.10
Mar	15.30	10.80	15.80	14.70	17.20	16.50	15.70	13.00
Apr	16.30	13.30	17.00	15.60	18.30	17.40	17.40	15.00
May	17.30	15.30	18.20	17.00	19.30	18.80	18.60	17.80

Site	8	9	10	11	12	13	14	15
Jun	21.10	17.30	22.60	19.50	21.00	22.20	21.80	20.60
Jul	21.80	18.70	23.50	20.20	21.00	22.70	22.80	22.30
Aug	21.70	18.90	23.30	20.70	21.50	21.70	22.70	23.10
Sep	20.90	18.40	21.60	20.00	22.40	20.90	21.70	21.80
WY11 Avg [b]	**17.16**	**14.66**	**17.98**	**16.62**	**18.14**	**17.96**	**17.94**	**17.07**

a) All values expressed in oC.
b) Water Year 2011 values are based on averaging of monthly values (Oct- Sept).
c) Tributary discharges within the Lower Santee Basin reach just upstream of Carlton Hills Golf course.

Table C.2(W) WY11 West Section Specific Conductivity

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	5.230	3.140	2.560	3.670	3.670	3.820	3.280
Nov	1.620	1.640	1.500	0.780	2.160	2.300	2.320
Dec	2.340	2.280	2.160	1.770	2.200	2.260	2.410
Jan	2.060	2.060	2.060	2.030	1.960	1.860	1.880
Feb	0.640	0.625	0.579	0.522	0.489	0.485	0.646
Mar	1.860	1.880	1.870	1.860	1.820	1.700	1.740
Apr	1.920	1.900	1.780	1.690	1.670	1.520	1.670
May	1.940	1.870	1.760	2.000	2.370	2.270	2.080
Jun	3.640	2.740	2.690	2.610	2.610	2.480	2.480
Jul	8.910	3.210	3.180	3.100	3.230	2.940	3.060
Aug	8.990	3.590	3.690	3.260	3.540	3.540	3.690
Sep	7.180	3.750	3.660	3.270	3.650	3.780	3.410
WY11 Avg [b]	**3.861**	**2.390**	**2.291**	**2.214**	**2.447**	**2.413**	**2.389**

a) All values expressed in milli-Siemen/cm.
b) Water Year 2011 values are based on averaging of monthly values (Oct- Sept).

Table C.2(E) WY11 Mid and East Section Specific Conductivity

Site	8	9	10	11	12	13	14	15
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	2.610	5.590	2.640	2.710	2.440	2.170	1.790	2.690
Nov	2.420	5.320	2.410	2.440	2.120	1.860	1.480	2.760

Site	8	9	10	11	12	13	14	15
Dec	2.250	5.000	2.260	2.280	1.950	1.750	1.410	2.500
Jan	1.630	4.760	1.650	1.720	1.000	1.330	1.250	2.940
Feb	1.100	3.610	1.230	1.690	1.180	1.440	1.520	2.570
Mar	1.560	4.610	1.530	1.630	0.980	1.300	1.220	2.820
Apr	1.670	4.680	1.670	1.770	0.880	1.780	1.380	2.820
May	1.450	4.110	1.490	1.810	1.030	1.620	1.530	2.570
Jun	2.210	5.000	2.250	2.310	1.280	1.880	1.670	2.880
Jul	3.590	5.290	2.650	2.580	1.825	2.070	1.760	2.900
Aug	2.900	5.580	2.930	2.900	1.940	2.180	1.900	2.960
Sep	2.740	5.390	2.650	2.870	1.860	2.170	1.910	2.830
WY11 Avg [b]	**2.178**	**4.912**	**2.113**	**2.226**	**1.540**	**1.796**	**1.568**	**2.770**

a) All values expressed in milli-Siemens/cm.
b) Water Year 2011 values are based on averaging of monthly values (Oct- Sept).
c) Tributary discharges within the Lower Santee Basin reach just upstream of Carlton Hills Golf course.

Table C.3(W) WY11 West Section pH

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	7.64	7.47	7.48	7.46	7.47	7.55	7.21
Nov	7.68	7.63	7.60	7.73	7.55	7.51	7.78
Dec	7.84	7.71	7.71	7.75	7.77	7.52	7.82
Jan	7.96	7.86	7.89	7.88	7.88	7.80	7.70
Feb	7.75	7.72	7.73	7.70	7.72	7.80	7.98
Mar	7.93	7.85	7.84	8.04	8.03	8.13	8.11
Apr	8.03	7.81	7.89	7.88	7.87	7.89	7.82
May	7.76	7.62	7.77	7.74	7.77	7.80	7.79
Jun	7.50	8.08	7.94	7.95	8.07	7.88	7.70
Jul	7.90	7.80	7.80	7.90	7.70	7.90	7.80
Aug	7.78	7.75	7.71	7.76	7.75	7.76	7.67
Sep	7.77	7.55	7.55	7.62	7.51	7.52	7.33
WY11 Avg [b]	**7.80**	**7.74**	**7.74**	**7.78**	**7.76**	**7.76**	**7.73**

a) All values are unit-less.

Table C.3(E) WY11 Mid and East Section pH

Site	8	9	10	11	12	13	14	15
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	7.71	8.10	7.85	7.46	7.64	7.30	7.63	7.63
Nov	7.88	8.01	7.92	7.41	7.90	7.25	7.46	7.94
Dec	8.00	8.10	7.98	7.78	8.11	7.57	7.86	8.06
Jan	8.17	8.17	7.98	7.55	8.29	7.80	7.82	8.23
Feb	8.00	8.41	8.33	7.37	8.10	7.94	8.06	8.30
Mar	8.23	8.23	8.24	7.90	8.32	7.93	8.17	8.28
Apr	8.34	8.39	8.58	7.55	8.85	8.73	8.96	8.66
May	7.80	8.14	8.42	7.43	8.29	7.76	8.01	8.21
Jun	8.18	8.28	8.25	7.70	8.98	8.46	8.60	8.37
Jul	7.50	8.00	8.00	7.59	7.70	7.80	7.90	8.10
Aug	7.75	7.80	8.00	7.55	7.62	7.68	8.09	8.15
Sep	7.67	8.00	7.94	7.22	7.82	7.53	7.85	7.76
WY11 Avg [b]	**7.94**	**8.14**	**8.12**	**7.54**	**8.13**	**7.81**	**8.03**	**8.14**

a) All values are unit-less.
b) Water Year 2011 values are based on averaging of monthly values (Oct- Sept).
c) Tributary discharges within the Lower Santee Basin reach just upstream of Carlton Oaks Golf course.

Table C.4(W) WY11 West Section Dissolved Oxygen

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	5.17	1.97	1.09	1.90	2.28	0.22	2.65
Nov	6.64	6.62	6.06	6.76	4.50	2.70	7.90
Dec	8.11	6.67	6.65	6.79	5.50	3.69	7.94
Jan	11.86	10.13	10.48	9.96	9.70	10.11	10.78
Feb	7.30	7.21	7.43	7.85	7.88	5.79	8.76
Mar	6.66	5.98	5.98	7.19	7.04	8.38	8.35
Apr	6.30	5.44	5.81	8.31	6.51	8.11	8.37
May	4.66	4.20	3.36	6.18	5.88	6.70	7.09
Jun	6.30	5.40	3.92	5.51	4.12	4.31	4.23

Site #	1	2	3	4	5	6	7
Jul	5.74	2.35	2.66	1.69	2.97	2.50	2.25
Aug	5.80	2.32	2.64	3.61	2.73	0.99	2.34
Sep	5.08	2.00	1.77	4.04	2.74	0.78	2.60
WY11 Avg [b]	**6.64**	**5.02**	**4.82**	**5.82**	**5.15**	**4.52**	**6.11**

a) All values expressed in milligrams/liter.

Table C.4(E) WY11 Mid and East Section Dissolved Oxygen

Site	8	9	10	11	12	13	14	15
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	4.08	8.01	3.83	4.08	5.49	0.29	2.24	3.04
Nov	9.86	11.11	9.04	6.60	6.50	1.52	1.28	7.95
Dec	11.29	12.57	9.09	7.37	9.37	1.82	3.16	8.40
Jan	11.95	12.89	9.83	8.36	8.65	5.44	8.26	9.80
Feb	9.35	11.41	7.07	7.96	7.20	2.62	6.23	7.41
Mar	8.89	11.20	7.80	7.63	8.42	1.71	3.80	8.10
Apr	10.74	13.23	9.41	8.61	9.25	2.14	4.86	9.45
May	10.36	11.83	7.47	7.58	9.67	2.09	2.98	6.72
Jun	8.02	10.09	6.53	5.78	7.97	0.11	1.95	6.27
Jul	7.27	9.31	6.08	5.16	6.16	1.44	1.83	7.22
Aug	6.2	7.17	5.40	4.45	5.45	0.44	1.20	9.36
Sep	5.42	7.27	3.90	4.26	5.34	0.43	1.50	2.35
WY11 Avg [b]	**8.62**	**10.51**	**7.12**	**6.49**	**7.46**	**1.67**	**3.27**	**7.17**

a) All values expressed in milligrams/liter.
b) WY11 Avg. values are based on averaging of monthly values (Oct- Sept).
c) Tributary discharges within the Lower Santee Basin reach just upstream of Carlton Oaks Golf course.

Table C.5(W) WY11 West Section Dissolved Oxygen Percent Saturation

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	58	22	12	22	24	2	29
Nov	67	67	62	68	45	28	80
Dec	80	67	66	67	54	36	78

Site #	1	2	3	4	5	6	7
Jan	114	97	100	95	91	95	102
Feb	70	69	70	74	75	55	83
Mar	69	63	63	75	72	87	86
Apr	69	60	64	91	71	88	91
May	51	46	37	69	65	75	79
Jun	71	63	46	65	47	50	50
Jul	67	28	32	20	34	29	26
Aug	69	27	31	43	30	11	27
Sep	58	23	20	47	30	8	29
WY11 Avg [b]	**70**	**53**	**50**	**61**	**53**	**47**	**63**

a) All values expressed in percent.
b) Water Year 2011 values are based on averaging of monthly values (Oct- Sept).

Table C.5(E) WY11 Mid and East Section Dissolved Oxygen Percent Saturation

Site	8	9	10	11	12	13	14	15
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	45	89	44	45	61	3	25	41
Nov	98	108	91	67	67	15	13	81
Dec	106	114	86	70	91	18	30	84
Jan	111	113	94	78	83	53	79	87
Feb	89	105	69	76	71	26	61	69
Mar	89	102	79	76	88	17	38	79
Apr	109	128	98	87	100	23	51	96
May	109	120	84	79	106	23	32	69
Jun	92	108	77	64	91	1	23	71
Jul	84	94	72	58	68	17	22	81
Aug	71	80	66	51	61	5	14	111
Sep	62	80	45	48	63	5	17	27
WY11 Avg [b]	**89**	**103**	**75**	**67**	**79**	**17**	**34**	**75**

a) All values expressed in percent.
b) Water Year 2011 values are based on averaging of monthly values (Oct- Sept).
c) Tributary discharges within the Lower Santee Basin reach just upstream of Carlton Oaks Golf course.

Appendix D
WY11 LSDR WQM Data by Others

U.S. Geological Survey (USGS) stream flow values (mean daily discharge in cubic feet per second) presented in **Table D.1** for the Lower San Diego River gauging stations are provisional data subject to revision. Processing and review of the 2011 data is typically completed in December with subsequent approval for publication. The two stations are managed by the Poway South Field Office. Data for the San Diego River gauging stations as well as other streams and rivers throughout California are available via URL at http://waterdata.usgs.gov/nwis/dv?.

Table D.1 USGS Stream Flow Data

	Fashion Valley (Sta. 11023000)				Santee Basin (Sta. 11022480)			
Month	Min.	Max.	ADF [a]	ADFm [b]	Min.	Max.	ADF [a]	ADFm [b]
Oct	1.8	450	2.3	42	1.7	249	1.8	20
Nov	6.7	281	61	33	4.0	193	4.4	17
Dec	11	5800	24	387	5.0	2770	5.3	214
Jan	24	227	26	59	14	146	17.0	36
Feb	17	544	203	97	13	438	79.0	68
Mar	27	474	29	81	19	323	20.7	44
Apr	10	81	19	24	8.3	25	13.0	13
May	7.2	51	21	13	5.9	28	9.6	8.7
Jun	4.2	10	6.0	6.7	2.7	6.5	4.4	4.6
Jul	2.2	4.1	2.9	3.0	1.4	2.6	1.9	1.8
Aug	1.5	2.5	1.6	1.8	1.1	1.3	1.1	1.2
Sep	1.2	5.1	1.3	1.8	1.1	4.4	2.2	2.8
WY11 Avg.			**33.1**	**62.4**			**13.8**	**35.8**

a) Average daily flow at time (during period) of water quality monitoring.
b) Average daily flow for the month.

San Diego CoastKeeper (SDCK) coliform count values (in MPN/100 mL) from the organization's two San Diego River monitoring stations for 2011 are presented in **Table D.2**. Monitoring results for 2009 through 2011 for selected San Diego area watersheds, including the lower San Diego River (HSU 907.1), can be accessed via the organization's URL website at: http//www.sdwatersheds.org/wiki/Main-Page.

Table D.2 San Diego CoastKeeper Coliform Count Data

	Fashion Valley Road (SDG-010)			Old Mission Historical Dam (SDG-020)		
Month	EC [a]	Ent. [b]	TCB [c]	EC [a]	Ent. [b]	TCB [c]
Oct	350	320	17,330	150	100	3,280
Nov	30	20	1,150	990	1,050	5,480
Dec	200	190	2,880	310	730	24,190
Jan	30	50	5,170	150	130	5,480
Feb	10	-	1,010	90	210	1,500
Mar	40	60	820	50	290	1,870
Apr	930	30	30	2,250	50	70
May	50	60	840	120	50	2,420
June	20	30	1,110	480	320	2,910
July [d]	*40*	*50*	*560*	*20*	*20*	*650*
Aug	200	40	650	20	10	14,140
Sept	-	10	3,870	50	10	3,450
WY11 Avg. [e]	**150**	**90**	**3,630**	**390**	**250**	**5,100**
Oct	110	90	2,490	160	10	6,870
Nov	150	-	2,600	360	-	4,610
Dec	30	90	1,840	170	280	2,620

a) Escherichia-coli (E.coli) bacteria expressed in MPN/100mL
b) Enterococcus (faecalis) bacteria expressed in MPN/100mL
c) Total Coliform bacteria (common) expressed in MPN/100mL.
d) WQ monitoring was not performed during July 2011; values in italics are July 2010 monitoring results.
e) Average coliform counts for WY11 have been calculated by RiverWatch for comparative purposes only; values are neither endorsed nor validated by San Diego CoastKeeper.

Appendix E
Water Quality Indexing

Decision-makers, non-technical water managers, many vested watershed stakeholders as well as the general public usually have neither time nor training to study and understand detailed technical assessments of water quality data. Over the past several decades numerous indexes have been developed to summarize water quality data in an easily expressed and readily understood format. Water quality professionals are frequently resistant to an automated, uncritical summarization represented by such indexes and there are sound reasons to use results with caution. Often scientists and water resource professionals prefer to give no answer rather than an imperfect answer that can lead to misunderstanding. Layman and many decision makers, however, would prefer an imperfect answer to no answer at all. The use of an index may not be an optimal way to understand large-scale water quality issues, but for many it provides a reasonable mechanism. Professionals can appreciate the need for imperfect answers and conversely others need to recognize and accept an answer's limitations.

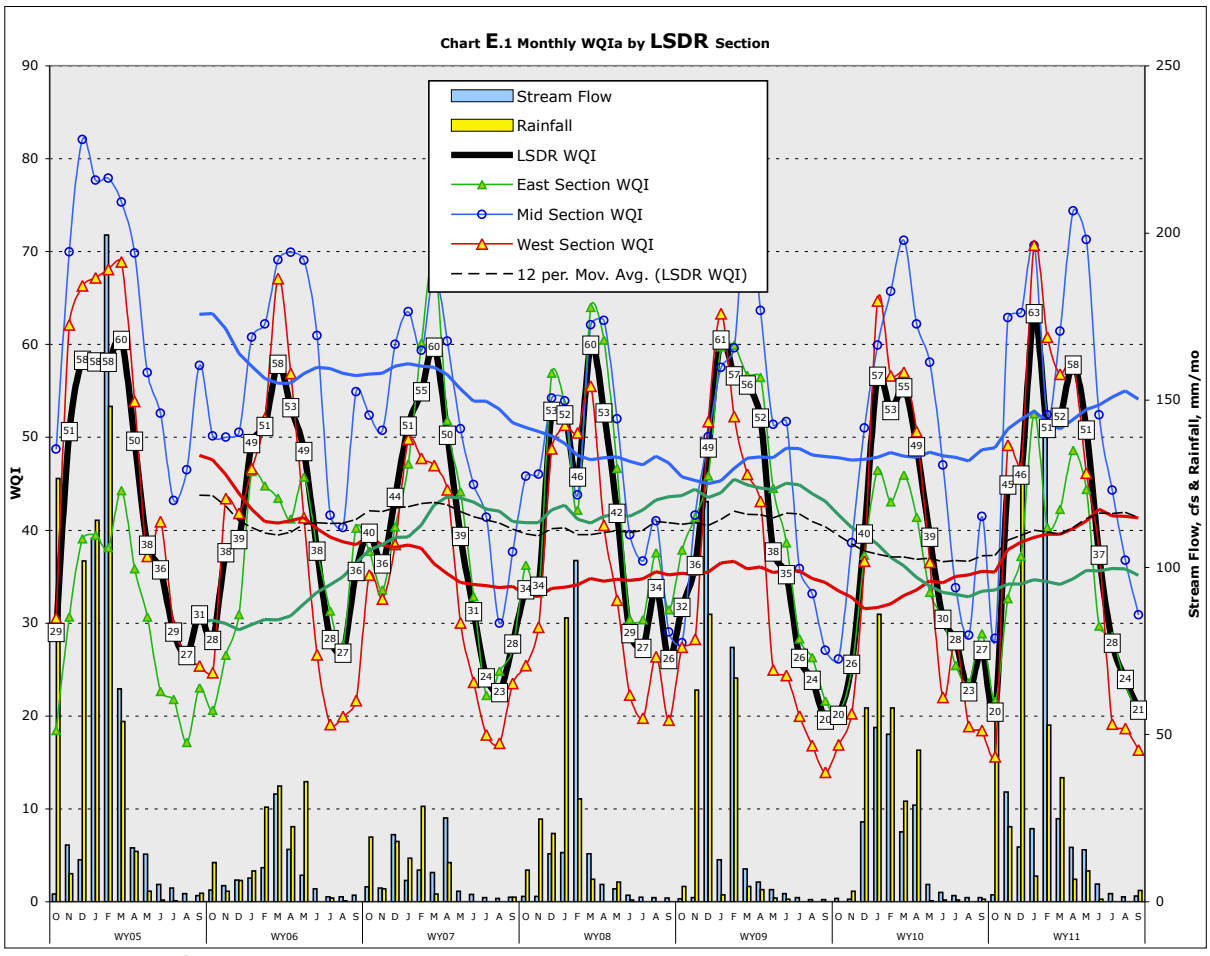
Water quality indexing was first proposed and demonstrated in the 1970s, however, prior to the personal computer, calculations were fairly labor-intensive so the technique was not widely used or accepted by many monitoring agencies. As use and limitations were commonly misunderstood, the potential of using an index for communicating water quality status and trends was often overlooked. Evaluation of water quality in terms of raw data can be very misleading and confusing not only for the layman but also to stakeholders with diverse and sometimes conflicting perspectives. It is typically difficult for individuals interested in water quality to interpret reams of raw data in order to gain an understanding of water quality conditions. This quest often results in faulty conclusions regarding water quality status and watershed management practices. An index is simply an attempt to integrate complex analytical data and generate a single number expressing the relative degree of impairment of a water body at a given point in time or given locale. The underlying objective of the exercise is to enhance communications with the general public, interested stakeholders, public agencies and increase citizen awareness of water quality conditions.

By design indexes contain less information than the raw data they summarize; many uses of water quality data cannot be met with an index. An index is generally most useful for comparative purposes (e.g., what river sites or reaches have particularly poor water quality?) and for temporal questions (e.g., how is the water quality at present relative to what is has been in the past?). Indexes are less suited to specific questions. Site-specific decisions need to be based on analysis of original water quality data. Basically, an index can be a useful tool for "communicating water quality information to the lay public and to legislative decision makers," it is not, however "a complex predictive model for technical and scientific application". This index was developed as a mechanism to summarize and report routine monitoring data to interested parties. SDRPF's RiverWatch team does not monitor biological constituents or toxic substances, thus issues related to public health, body contact recreation and aquatic life are not effectively addressed by the index.

Besides being general in nature (i.e., imprecise), there are several reasons that an index may fail to accurately communicate water quality information. First, most indexes are based on pre-identified sets of water quality constituents. For example, a specific site may show a good WQI score, and yet have water quality impaired by other constituents not included in the index. Another reason, data aggregation can mask, normalize or over-emphasize short-term water quality issues. A satisfactory WQI at a particular site or reach does not necessarily mean that water quality is or always was satisfactory. A good score, however, does at least indicate that inferior water quality for those constituents evaluated is not chronic during the period included for the index.

The index has been developed for the purpose of providing a simple and concise expression of regularly monitored physical-chemical and bacteriological water quality data compiled by the SDRPF RiverWatch Team as well as several other monitoring groups; it is intended to aid in assessment of the Lower San Diego River watershed primarily for non-body contact recreational uses and environmental enhancement. It constitutes a mechanism to compare averages, variances and trends in normalized values over time (temporally) and by relative location (spatially) within the watershed. The index allows anyone to easily interpret large amounts of aggregated data and relate overall water quality variation to changes, be they from natural causes or man-made impairments. The WQI is used to identify general water quality trends over the past 7 years of monitoring and potential problem areas within the SDR watershed. Such patterns and locations can then be screened and evaluated in greater detail through direct observation of pertinent site-specific data by public agencies and water quality professionals entrusted with protection and enhancement. Used in this manner, the index provides a supplemental metric for evaluating effectiveness of San Diego River water quality improvement programs and also assist responsible agencies and organizations in establishing priorities for watershed management purposes.

Annual, monthly and seasonally averaged SDR WQI values are presented on subsequent pages in **Table E.1** by river section, overall average and in **Table E.2** for each water year over the past 7 years (WY05-WY11) of monitoring. The tabulated results are presented temporally in **Charts E.1** (monthly values over past 7 years for each reach plus trend lines - 12-mo moving average) and **E.2** (7-yr averaged monthly, seasonal and annual values) and spatially in **Chart E.3** by site number in chronological order ascending upstream. The average river distance between individual sites is approximately 1 mile although there is a considerable range (from <0.1 to >1.8 miles) from one locale to another.



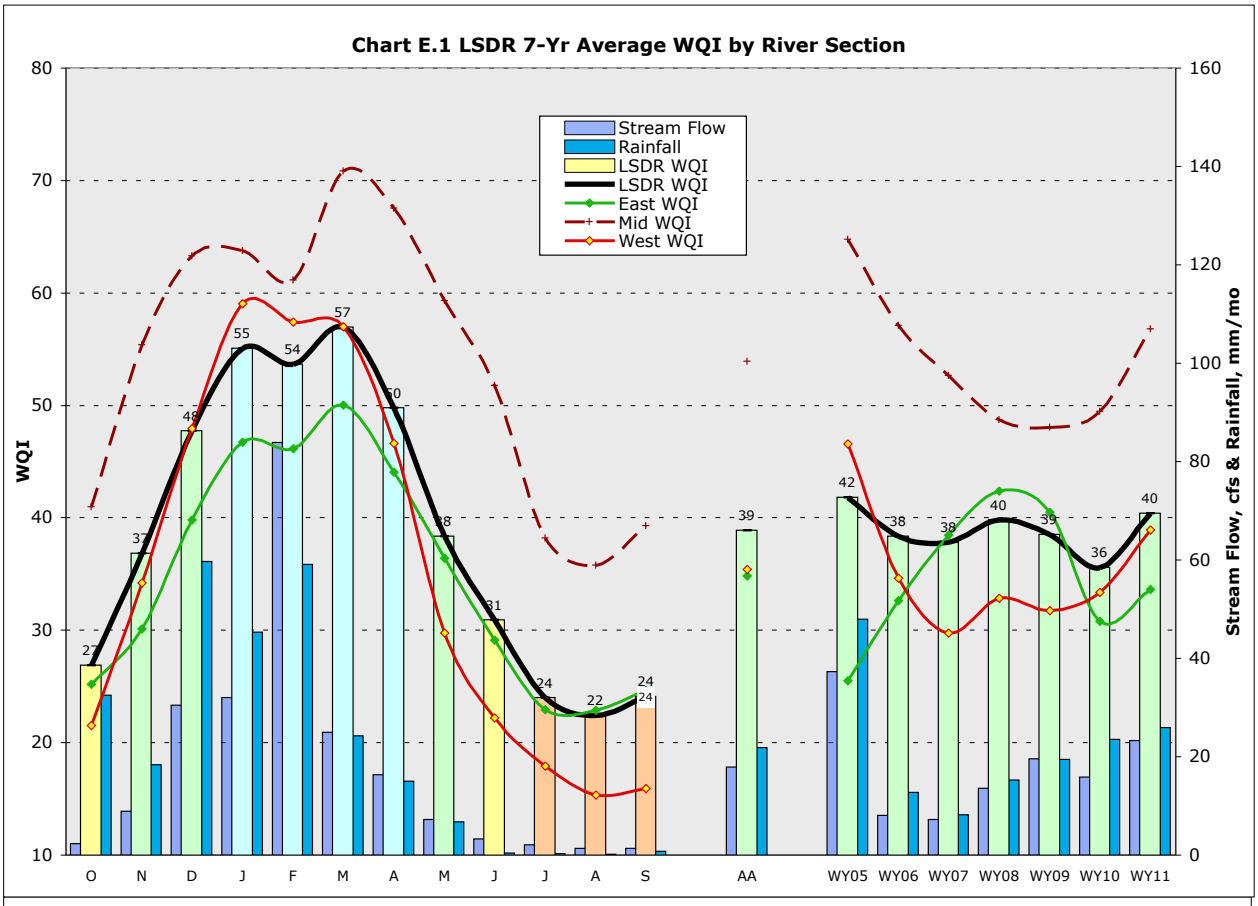


Chart E.1 LSDR 7-Yr Average WQI by River Section
Stream Flow
Rainfall
LSDR WQI
LSDR WQI
East WQI
Mid WQI
West WQI
WQI
Stream Flow, cfs & Rainfall, mm/mo
O N D J F M A M J J A S AA WY05 WY06 WY07 WY08 WY09 WY10 WY11

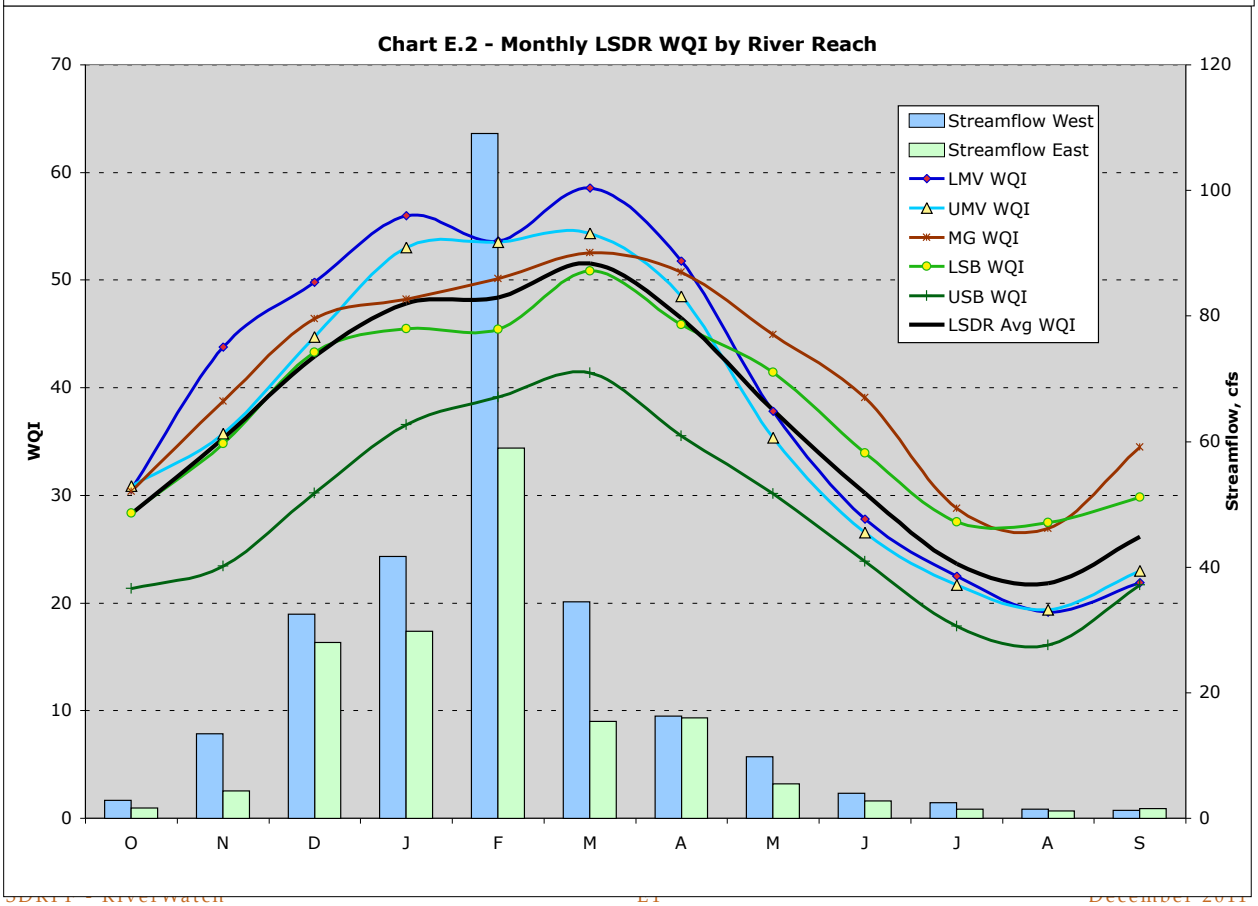


Chart E.2 - Monthly LSDR WQI by River Reach
Streamflow West
Streamflow East
LMV WQI
UMV WQI
MG WQI
LSB WQI
USB WQI
LSDR Avg WQI
WQI
Streamflow, cfs
O N D J F M A M J J A S

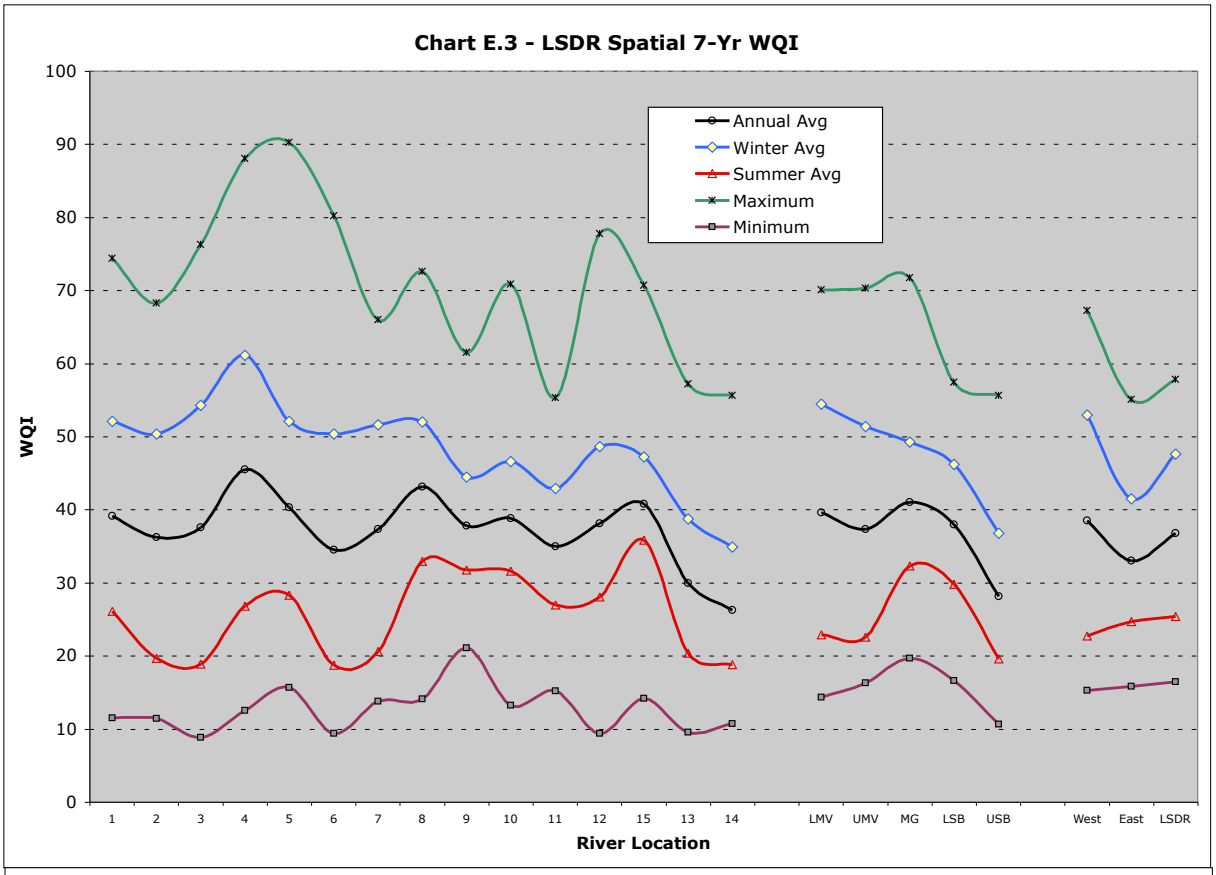


Chart E.3 - LSDR Spatial 7-Yr WQI
WQI
River Location
Annual Avg
Winter Avg
Summer Avg
Maximum
Minimum
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
6
7
8
9
10
11
12
15
13
14
LMV
UMV
MG
LSB
USB
West
East
LSDR

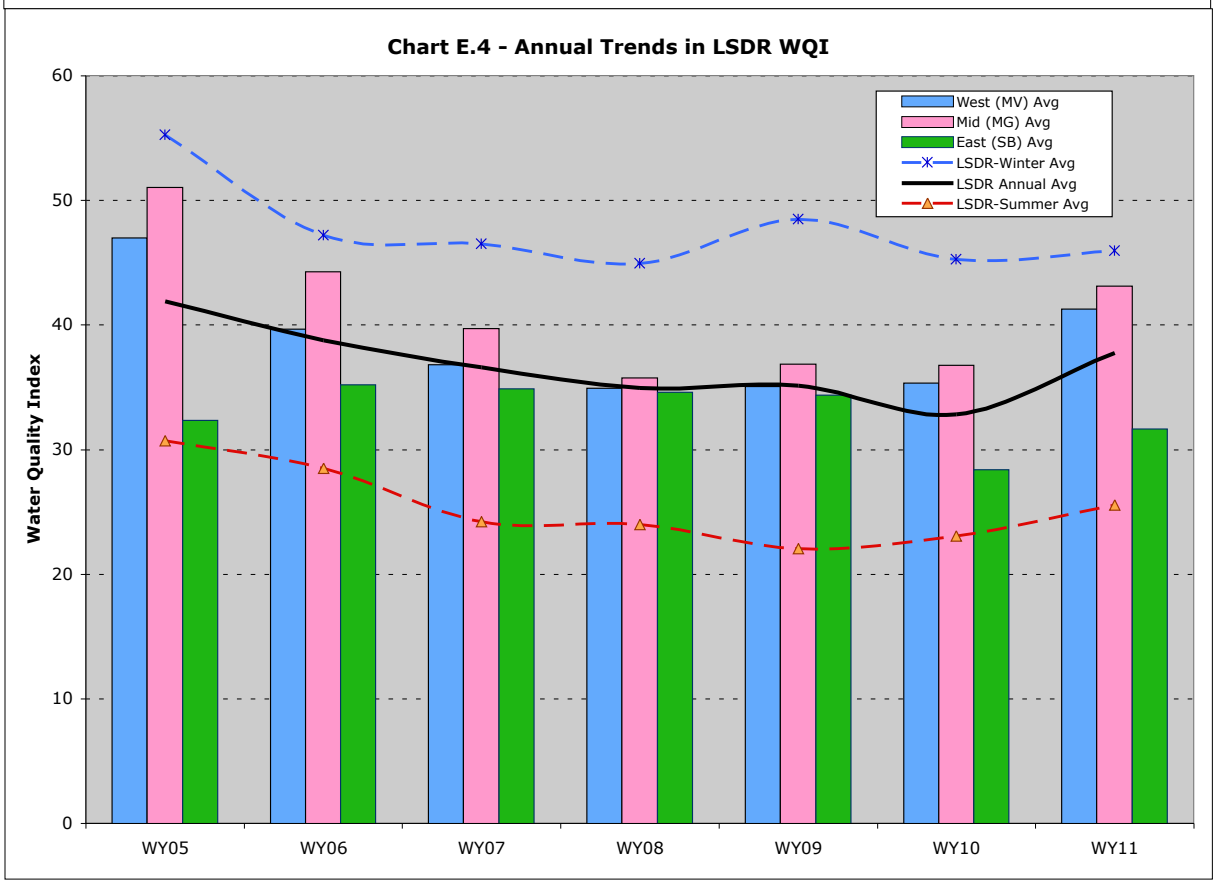


Chart E.4 - Annual Trends in LSDR WQI
Water Quality Index
West (MV) Avg
Mid (MG) Avg
East (SB) Avg
LSDR-Winter Avg
LSDR Annual Avg
LSDR-Summer Avg
0
10
20
30
40
50
60
WY05
WY06
WY07
WY08
WY09
WY10
WY11

Table E.1 WY11 Monthly WQI4 &WQI6 Values by WQM Site - West Section

Site Number	1	2	3	4	5	6	7	(1-7)
Name	Estuary	R.Gdns	F.Vly	FSDRIP	Ward Rd	K-Ponds	ABF	West
Reach	Lower Mission Valley				Upper Mission Valley			MV
Oct	26-29	11-20	6-18	10-19	11-20	1-13	17-23	12-20
Nov	53-56	53-56	49-54	60-60	35-44	21-37	60-60	47-51
Dec	59-53	50-47	49-47	52-49	40-41	27-35	58-52	48-46
Jan	86-74	72-65	75-67	71-64	67-62	73-65	78-69	74-67
Feb	58-58	57-58	60-60	62-61	66-86	42-75	60-65	58-64
March	53-55	48-52	48-52	57-57	55-55	68-63	67-63	57-57
April	49-54	43-51	46-53	66-67	52-58	68-67	69-68	56-60
May	37-45	33-44	27-40	49-53	45-51	53-55	58-58	43-49
June	39-52	35-47	25-40	35-48	26-41	31-43	31-43	32-44
July	28-31	13-22	14-23	9-19	16-24	16-21	14-21	16-23
Aug	25-33	11-23	12-24	16-28	13-25	5-17	13-22	14-24
Sept	21-27	9-19	8-18	18-27	12-22	4-15	14-21	12-20
Annual Avg	**44-47**	**36-42**	**35-41**	**42-46**	**36-44**	**34-42**	**45-47**	**39-44**

Table E.2 Annual Average WQI4 & WQI6 Values by WQM Site -West Section

	1	2	3	4	5	6	7	(1-7)
Annual Avg.	Estuary	R.Gdns	F.Vly	FSDRIP	Ward Rd	K-Ponds	ABF	West
WY05	49-50	45-47	45-48	59-57	49-52	44-48	38-43	47-49
WY06	34-42	29-38	32-39	52-57	36-44	33-39	28-36	35-42
WY07	29-36	25-35	33-40	44-50	32-42	22-31	26-34	30-38
WY08	36-39	32-36	35-38	41-44	33-39	26-32	30-34	33-37
WY09	37-40	29-35	32-37	42-45	26-34	24-30	35-38	32-36
WY10	35-38	34-38	34-38	37-41	32-38	27-33	37-40	34-38
WY11	**44-47**	**36-42**	**35-41**	**42-46**	**36-44**	**34-42**	**45-47**	**39-44**
7-Yr Avg	38-42	33-39	35-40	45-49	35-42	30-37	34-39	36-40

WQI Color Code:

Dk Blue (A) Very Good, Lt Blue (B) Good, Green (C) Fair, Yellow (D) Marginal, Brown (E) Poor, Red (F) Very Poor

Table E.3 WY11 Monthly WQI4 &WQI6 Values by WQM Site - East Section

Site #	8	9t	10	11	12t	13	14	15t	(11-15)
Name	MT@J	JDOF	OMD	WHB	COR	Mast Pk	Cw/RCP	Forster Ck	Santee Basin
Reach	Mission Gorge			Lower Santee Bsn		Upper Santee Bsn		LSB	East
Oct	26-31	53-34	28-28	30-30	34-36	2-10	15-24	24-27	18-25
Nov	73-58	68-57	67-53	49-44	45-43	11-26	10-25	56-48	30-35
Dec	79-61	73-53	62-52	51-45	63-55	13-27	22-31	58-50	36-38
Jan	85-68	68-58	69-61	57-54	67-57	42-44	62-56	58-51	54-51
Feb	60-60	47-59	42-49	44-55	55-52	18-32	44-45	43-45	37-44
March	71-60	65-57	59-55	56-55	73-63	14-31	31-39	56-50	40-45
April	86-72	88-68	75-65	66-64	81-69	18-30	40-42	70-60	48-49
May	86-75	85-65	65-59	60-60	81-73	17-34	24-37	50-49	41-48
June	60-55	73-45	50-44	45-43	60-52	1-17	15-24	46-41	27-32
July	46-49	58-41	42-40	38-38	38-44	10-22	12-24	46-44	25-32
Aug	36-39	45-34	38-34	31-32	31-37	3-16	7-18	51-47	20-27
Sept	32-37	44-34	27-29	29-33	31-37	3-18	9-21	14-22	16-25
WY11 Avg	**62-55**	**64-50**	**52-47**	**46-46**	**55-52**	**13-26**	**24-32**	**48-45**	**33-38**

Table E.4 Annual Average WQI4 & WQI6 Values by WQM Site -East Section

Site#	8	9t	10	11	12t	13	14	15t	(11-15)
Name	MT@J	JDOF	OMD	WHB	COR	Mast Pk	Cw/RCP	Forster Ck	East
WY05	74-68	49-45	56-56	33-38	25-35	19-32	19-32	37-39	26-35
WY06	61-60	46-37	53-53	40-42	43-49	28-37	22-34	37-39	33-40
WY07	55-53	49-38	50-48	48-47	47-49	37-41	24-34	43-41	39-42
WY08	49-48	52-39	49-44	46-43	41-44	48-46	30-35	49-45	44-43
WY09	50-50	51-43	46-46	42-43	46-47	46-47	24-33	54-51	42-44
WY10	52-50	50-41	47-45	33-38	48-48	19-29	21-31	50-47	31-36
WY11	**62-55**	**64-50**	**52-47**	**46-46**	**55-52**	**13-26**	**24-32**	**48-45**	**33-38**
7-Yr Avg	57-55	52-42	50-48	41-42	44-46	30-37	24-33	46-44	35-40

WQI Color Code:

Dk Blue (A) Very Good, Lt Blue (B) Good, Green (C) Fair, Yellow (D) Marginal, Brown (E) Poor, Red (F) Very Poo

Appendix F - LSDR Water Quality Monitoring Data Summary

Table F.1 WQM Data Summary (Annual & Seasonal Averages)

	WY05	WY06	WY07	WY08	WY09	WY10	**WY11**	7-Yr Avg.	Percent Change over 1 Yr [a]	Percent Change over 7 Yr [b]	Percent Change over Avg. [c]
Annual (Oct-Sept):											
ADF, cfs	76	14	10	19	21	36	**43**	31	19%	-43%	39%
Temp, °C	17.7	18.3	17.7	17.7	17.6	18.1	**17.7**	17.8	-2%	0%	-1%
SpC, uS/cm	2.125	2.175	2.409	2.313	2.486	2.357	**2.204**	2.295	-6%	4%	-4%
DO, mg/L	6.92	5.92	5.93	6.30	6.13	5.43	**5.74**	6.05	6%	-17%	-5%
DO%Sat, %	68	59	59	64	63	57	**60**	61	5%	-12%	-2%
pH	7.58	7.33	7.49	7.89	7.61	7.85	**7.88**	7.66	0%	4%	3%
MCC, #/100mL	-	-	-	-	440	600	**420**	480	-30%		-13%
WQIa	44	41	41	41	40	38	**42**	41	11%	-5%	2%
Grade	C+	C	C	C	C	C-	**C**	C	up	down	up
Summer (June-Sept) Period:											
ADF, cfs	3.6	2.5	1.5	1.6	1.2	1.7	**3.0**	2.2	76%	-17%	36%
Temp, °C	21.8	23.7	21.8	22.9	22.8	21.9	**21.6**	22.4	-1%	-1%	-4%
SpC, uS/cm	2.442	2.210	2.627	2.764	2.916	2.636	**2.852**	2.635	8%	17%	0%
DO, mg/L	5.23	5.04	4.87	5.41	4.70	3.83	**3.86**	4.71	1%	-26%	-18%
DO%Sat, %	54	56	52	60	54	44	**44**	52	0%	-19%	0%
pH	7.58	7.33	7.70	8.08	7.72	7.72	**7.84**	7.71	2%	3%	0%
MCC, #/100mL	-	-	-	-	350	90	260	230	189%		13%
WQIa	31	32	26	29	26	27	**27**	28	0%	-13%	-4%
Grade	D+	D	D-	D	D-	D-	**D-**	D		down	down
Winter (Dec-March) Period:											
ADF, cfs	175	23	22	51	54	91	**108**	72	19%	-38%	50%
Temp, °C	13.5	12.8	13.8	12.4	13.3	15.7	**13.6**	13.6	-13%	1%	0%
SpC, uS/cm	1.807	2.140	2.190	1.863	2.056	2.077	**1.645**	1.968	-21%	-9%	-16%
DO, mg/L	8.60	6.80	7.00	6.20	7.55	6.37	**7.74**	7.32	22%	-10%	6%
DO%Sat	81	62	67	68	73	63	**75**	70	19%	-7%	7%
pH	7.51	7.46	7.42	7.89	7.52	7.84	**7.95**	7.66	1%	6%	4%
MCC, #/100mL	-	-	-	-	560	1480	**470**	840	-68%		-44%
WQIa	59	49	52	53	55	51	**53**	53	4%	-10%	0%
Grade	B	C+	B-	B-	B	B-	B-	B-	up	down	

(a) Percent change in this year's value (WY11) from last year (WY10).
(b) Percent change in this year's value (WY11) from first year (WY05).
(c) Percent change in this year's value (WY11) above (+) or below (-) 7-yr Average.
d) Values in red represent years of below average water quality.

Table F.2 WQM Data Summary (7-Yr Spatial Averages)

Section	Mission Valley		Mission Gorge	Santee Basin		**Watershed**
Sites	1-4	5-7	8-10	11,12 &15	13&14	**all (1-15)**
Reach	LMV	UMV	MG	LSB	USB	**LSDR [a]**
Annual (Oct-Sept):						
ADF, cfs	37	32	23 [b]	21	15	**31**
Temp, °C	19.23	17.68	17.01	17.19	18.07	**17.84**
SC, mS/cm	2.541	2.545	2.164	2.168	1.697	**2.295**
DO, mg/L	5.67	4.93	7.80	6.49	5.82	**6.05**
DOSat, %	60	51	81	67	62	**61**
pH	7.70	7.55	7.66	7.81	7.67	**7.66**
MCC, #/100mL	430	-	540	-	-	**480**
WQIa	38	33	54	43	28	**41**
Grade	C	D+	B-	C+	D	**C**
Rating	Fair	Marginal	Good	Fair	Marginal	**Fair**
Summer (June-Sept) Period:						
ADF, cfs	2.4	2.0	1.3 [c]	1.6	1.2	**2.2**
Temp, °C	24.25	21.54	21.67	21.97	22.74	**22.37**
SC, mS/cm	2.986	2.902	2.547	2.370	1.841	**2.635**
DO, mg/L	4.13	3.20	6.66	5.46	4.86	**4.71**
DOSat, %	48	36	75	60	57	**52**
MCC, #/100mL	240	-	220	-	-	**230**
WQIa	20	16	41	34	17	**28**
Grade	E	E	C	C-	E	**D**
Rating	Poor		Fair		Poor	**Marginal**
Winter (Dec-March) Period:						
ADF, cfs	93	75	55	50	25	**75**
Temp, °C	14.57	13.85	12.88	13.01	13.64	**13.59**
SC, mS/cm	2.135	2.185	1.795	1.968	1.547	**1.968**
DO, mg/L	7.16	6.58	8.81	7.53	6.78	**7.32**
DOSat, %	72	64	85	73	66	**70**
MCC, #/100mL	740	-	940	-	-	**840**
WQIa	58	53	65	53	40	**56**
Grade	B	B-	B	B-	C	**B**
Rating	Good				Fair	**Good**

(a) Weighted average of all reaches within the Lower SDR watershed.
(b) Stream flow based on averaged river gains and losses between Santee Basin and Mission Valley.
(c) During periods when surface water is evident; intermittent dry-weather conditions.

Appendix G - Glossary

Abbreviations:

AADF - Average Annual Daily Flow
ACC - Average Coliform Count (arithmetic mean of fecal coliform, e-Coli & total coliform in MPN/100mL)
ADF – Average Daily (stream) Flow or discharge
AFY - acre-foot per year
Avg.– Average
cfs - cubic feet per second (flow/discharge)
Ck – Creek
CY - Calendar Year (Jan 1 - Dec 31)
DO – Dissolved Oxygen
DO%Sat – DO expressed as percentage of DO level at saturation point
d/s – downstream // {u/s – upstream}
E – East // {W –West}
FSDRIP – First San Diego River Improvement Project
ft. – feet // {mi. - mile}
gal – gallon
Ln(x) - natural logarithm of (x) to base-e (2.718)
log(x) - common logarithm of (x) to base-10
L//U – lower//upper (as in river reaches)
LSDR – Lower San Diego River
max//min – maximum//minimum
MCC - Mean Coliform Count (geometric mean of fecal coliform, e-Coli & total coliform in MPN/100mL)
mg/L – milligrams per litre
mi. - mile
mS/cm – milliSeimens per centimetre (1 mS/cm = 1000 *u*S/cm)
MG – Mission Gorge (Mid-section of LSDR)
MV – Mission Valley (west section of LSDR)
MPN - Most Probable Number (of coliform organisms)
PDMWD – Padre Dam Municipal Water District
pH – measure of acidity or basicity (decimal logarithm of hydrogen ion activity)
ppm – parts per million
Q - stream flow or discharge
SB – Santee Basin (east section of LSDR)
SC – Specific Conductivity (also Conductivity or Conductance); also commonly abbreviated as SpC
SD – Standard Deviation (also San Diego)
SDRPF – San Diego River Park Foundation
SpC - Specific Conductivity; also abbreviated as SC
TDS – Total Dissolved Solids
T – Temperature (also abbreviated as Temp.)
TN/TP – Total Nitrogen/ Total Phosphorus (nutrients)
USGS – U.S. Geological Survey
*u*S/cm –microSeimens per centimetre (1 *u*S/cm = 0.001 mS/cm)
u/s - upstream // {d/s - downstream}
W - West // {E - East}
WQI – Water Quality Index (WQI_a)
WQI(4) - WQI using 4 WQ parameters/analytes
WQI(6) - WQI using 6 WQ parameters/analytes
WY – Water Year (Oct 1 – Sept 31)
% - percent
°C – degrees Celsius
°F – degrees Fahrenheit

Formulas:

$^oC = (^oF-32) \times 5/9$
$^oF = (^oC*9/5) + 32$

Flow (cfs) = Velocity (ft/sec)*Cross-sectional area (sq ft)

Constituent Load (lbs/day) = Q (mgd)*Concentration (ppm)*8.34; or = Q (cfs)*Concentration (mg/L)*5.39 where Q is stream flow/discharge.

Total Dissolved Solids (TDS in mg/L) = 670*Specific Conductivity, (where SC is in mS/cm).
An approximate relationship for Lower SDR watershed; other variables (e.g., temperature, pressure, specific ions) are considered negligible.

DO - DO%Sat relationship is defined by the following polynomial equation:
$DO(mg/L)=DO\%Sat*[0.004*T^2-0.343*T+14.2]/100$;
$DO\%Sat = DO(mg/L)*100/[0.004* T^2-0.343T+14.2]$,
where T = temperature is in °C.
Other variables, incl. barometric pressure, elevation and conductivity (SC), have negligible impact on the DO-DO%Sat relationship within the LSDR watershed.

SDR Water Quality Index (WQI) is calculated using the following series of equations:

WQI_4 = DO%Sat*2.5*T factor*Q factor/log(SC); where SC is expressed in *u*S/cm; the T factor = $0.0055T^3-0.163T^2+1.37T-2.5$, and the Q factor =
$0.56+0.173LnQ-0.002LnQ^2-0.0033LnQ^3$ (M Valley);
$0.72+0.15LnQ-0.0051LnQ^2-0.004LnQ^3$ (M Gorge);
$0.87+0.107LnQ-0.018LnQ^2-0.003LnQ^3$ (Santee);
$0.1+0.05LnQ-0.042LnQ^2-0.0011LnQ^3$ (Tributaries)

WQI_6 = Avg.[$DO\%f*wt_{(DO)}$, $SCf*wt_{(SC)}$, $pHf*wt_{(pH)}$, $MCCf*wt_{(MCC)}$, $Qf*wt_{(Q)}$, $Tempf*wt_{(T)}$]^1.75
where $wt_{(DO)} = 3$, $wt_{(SC)} = 2$, $wt_{(pH)} = 1$, $wt_{(MCC)} = 1$, $wt_{(Q)} = 2$ and $wt_{(T)} = 1$

WQIa = Avg. [WQI_4 and WQI_6]

The SDR WQI has been developed specifically for the SDRPF RiverWatch Monitoring Program, however, the equations can also be applied to water quality and hydrologic data pertaining to other coastal area watercourses.

Water Equivalents:

1 cf = 7.48 gal = 62.4 lbs of water
1 AF = 43,560 cf = 325,900 gal
1 psi = 2.31 ft of water
1 mg/L = 1 ppm (in water)
1 cfs = 450 gpm = 0.646 mgd =1.98 AF/day = 724 AFY
1 mgd = 694 gpm =1.547 cfs = 3.06 AF/day = 1,120 AFY
1000 gpm=1.436 mgd=2.23 cfs=4.42 AF/day=1,614 AFY
1 inch (rainfall) = 25.4 mm

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Appendix I - SDRPF's RiverWatch Team

Supervision/Coordination:

Shannon Quigley-Raymond ('08-11)
Kym Hunter ('06-07)
Rob Hutsel ('04-05)

Volunteers (5+ times):

Aidan Kennedy
Alan Ramirez
Amethyst Cruspero
Amy Cook
Ang Nguyen
Bill Martin
Birgit Knorr
Bob Stafford*
Brent Redd
Calvin Vine*
Cameron Bradley
Carl Abulencia
Celena Cui
Clint Williams
Conrad Brennen
Craig McCartney
Dani Tran
David Lapota
Demitrio Duran
Doug Taylor
Ebony Quilteret
Edward Garritty
Erin Babich
Fred Ward
Gabriel Martinez Mercado
Gary Strawn*
George Liddle
Gina Martin
Jack Greco
Jalil Ahmad
Jim Thornley
Joan Semler
John Kennedy*
Joyce Nower
Katharyn Morgan
Kathryn Stanaway
Kelly Brown
Kevin Bernaldez
Krissy Lovering
Krystal Tronboll
Laqueta Strawn
Linda King
Lois Dorn
Linda Tarke
Lindsey Teunis
Lucas Salazar
Maesa Hanhan
Mark Carpenter
Mark Hammer
Martin Offenhauer*
Mary Hansen
Melissa Garret
Melissa Maigler
Michael Mikulak
Mike Hanna*
Mike Hunter
Mitchell Manners
Mitzi Quizon
Natelie Rodriguez
Paul Hormick*
Raymond Ngo
Reggie Agarma
Russell Burnette
Sandra Pentney
Shelia-Ann Jacques
Tim Toole
Tina Davis
Silvana Procopio
Toni Nguyen
Tony de Garate
Trish Narwold
Veronika Shevchenko
Vidhya Nagarajan
Wendy Kwong
Yang Jiao
Yvette Navarro

* Team Leaders