LOWER SAN DIEGO RIVER WATER QUALITY

WY22 Water Quality Monitoring Report Appendices A-I

Algal/phytoplankton bloom occuring Aug, 2022 at Mast Park E ponds (WQM Site 13E)

Water Quality Monitoring Data and Supporting Information

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November 2022

LOWER SAN DIEGO RIVER
WY22 WATER QUALITY REPORT APPENDICES A-I

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Appendix A
San Diego RiverWatch Water Quality Monitoring Program

Appendix A provides an overview of SDRPF's RiverWatch water quality monitoring (WQM) program teams that have been engaged in collecting and assessing basic data pertaining to the Lower San Diego River (LSDR) watercourse on a continuous, monthly basis since late 2004.

Monitoring Period & Coverage: Monthly monitoring over past 17 years (Oct. 2004 – Sept. 2021) covering the main course of the San Diego River and tributary streams extending some 18 miles downstream from Lakeside (elev. 340 ft amsl) to the top of the Estuary (elev. 5 ft amsl) below the I-5/Pacific Hwy. overpasses nearly 3 miles inland from where the river enters the Pacific Ocean. The LSDR watershed and monitoring sites are shown on **Figure A.1.**

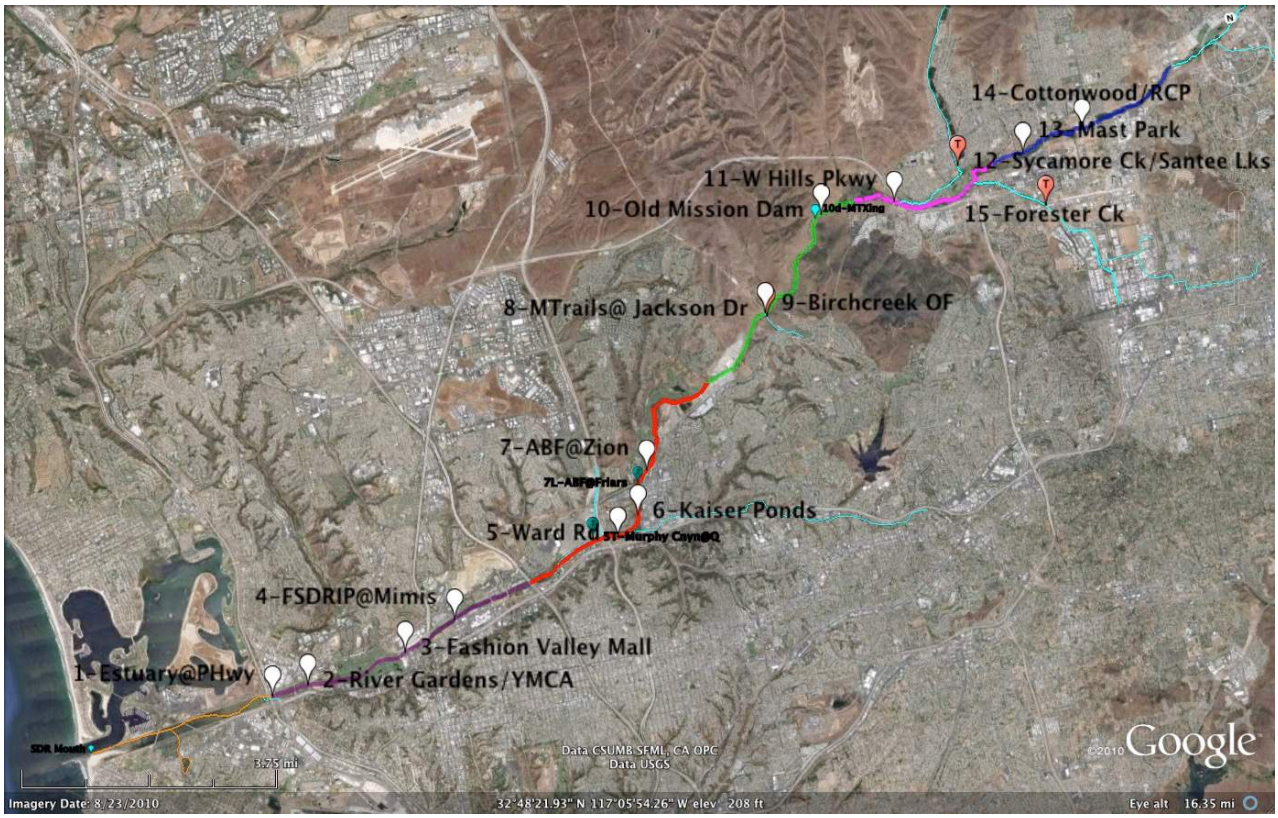

Figure A.1 - Lower San Diego River Catchment Area and WQM Sites

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), key tributaries (light blue). Figure details can be downloaded through Google Earth from SDRPF website/River Monitoring page: file <Fig1.1WQMR.kmz>

Mo**nitoring Sites**: 16 total - 13 on main course (Mission Valley Section - sites 1-7, Mission Gorge Section - sites 8-10, Santee Basin Section - sites 11-15) plus three key tributary stream sites are listed in **Table A.1.**

Table A.1 LSDR Sections, Reaches and WQ Monitoring Sites

Section/Reach/Tributary	Site #s	Comments
Estuary entrance	1e/1w	Tidal influence at transition from estuary to river
Lower Mission Valley (LMV)	2e/w, 3	3-mile reach of lower river from I-5 to SR163
Mid-Mission Valley (MMV)	4, 5	2-mile reach extending from SR163 to I805
Upper Mission Valley (UMV)	6, 7	3-mile stretch from I-805 to Princess View Dr
West Sites - Mission Valley Section	(1-7)	8-mile western portion through Mission Valley
Mission Gorge (MG) Mid-Section	(8,9T,10)	5-mile midsection, Princess View Dr to Hollis Lk
Lower Santee Basin (LSB)	11,12T,15T	2-mile reach from Hollis Lk to Carlton Hills Blvd
Upper Santee Basin (USB)	13E/W, 14	3-mile reach from Carlton Hills Blvd to SR67
Santee Basin (SB) Section	(11-15T)	5-mile eastern portion from Mission Trails Regional Park to Lakeside (SR67)
East Sites - MG and SB	(8 -15T)	10-mile upper portions incl. MG and Santee Basin
LSDR Tributaries:		
Murphy Canyon/Qualcom [a)]	*{5}* [a)]	Enters LSDR southwest of Aztec Stadium
Jackson Dr/Birchcreek Outfall [b)]	9T	Enters LSDR at SD River/Aqueduct trail crossing (Suycott Wash)
Santee Lakes/E. Sycamore Cnyn Ck	12T	Enters LSDR at Carlton Oaks CC golfcourse (u/s)
Forester Creek [c)]	15T	Enters LSDR at SR52 (u/s of Site 11)
Lower SDR Watershed (LSDR)	(1-15T)	Weighted average of all 5 reaches or all 3 sections

(a) Monthly monitoring discontinued in WY07; nearby Ward Rd bridge site (oriignally #6) renumbered as 5.
(b) Monthly monitoring initiated in 2008; site also termed Jackson Dr. Outfall (OF) is along the SDR Xing trail.
(c) Monthly monitoring initiated in 2007 with adjusted site locations in 2009 and 2015 during channel improvements, reverted back to near original location at Mission Gorge Rd. bridge in 2018.

WQ Parameters: Seven key parameters are measured and recorded: Temp, pH, SpC, DO, DO%Sat, two fundmental nutrients; nitrogen (NO_3) and phosphrous (PO_4), plus subjective field observations regarding general environs and water characteristics, as listed in **Table A.2.** Nutrient testing is carried out at six river sites; two in West (2, 6) and four in East (11, 13W, 14, 15T). Monitoring data are used in performing statistical analyses regarding each identified reach and section of the river. The number of datum for each physical-chemical parameter monitored at each site compiled over the past 17 years exceeds several hundred providing a sound statistical basis in performing analyses. Two additional parameters compiled at several sites by other entities include streamflow derived from USGS (Poway Office) gauging station data and coliform counts extracted from SDCoastKeeper files for the period 2010-2018. Both data sets are used for purposes of calculating the SDR water quality index.

Protocol: *Eastern Sites* – (Santee Basin & Mission Gorge sections). Nine sites located within the upper three reaches (MG, LSB, USB) are typically monitored the 3rd Fri. of every month by the RiverWatch East Team. *Western Sites* - (Mission Valley section). The seven sites within the three

lower reaches (LMV, MMV, UMV) are typically monitored by the RiverWatch West Team on the 3rd Sunday of the month.

Table A.2 - LSDR Water Quality Monitoring Parameters

WQ Parameter	unit	Comments
Measured monthly at all sites:		
1. Temperature (Water Temp)	°C	Basic characteristic and WQ driver (see Table C.1)
2. pH	-	Degree of acidity (<7.0) or alkalinity (>7.0) (see Table C.3)
3. Specific Conductivity (SpC)	mS/cm	Measure of ionic content or dissolved solids (see Table C.2)
4. Dissolved Oxygen (DO)	mg/L	Good indicator of relative water quality (see Table C.4)
5. Percent of DO Saturation (DO%Sat)	%	Good indicator of general water quality (see Table C.5)
Sampled/tested monthly at selected sites: (typically 3-5 East & 2 West)		
6. Nitrate (NO_3-N)	mg/L	Basic nutrient for biological activity (see Table C-6)
7. Phosphate (PO_4-P)	mg/L	Key nutrient for biological activity; in excess, can be limiting
8. Turbidity	NTU	General indicator of amount of suspended/settleble solids
9. Barometric Pressure	mBars	Atomosphiric (air) pressure that along with water temperature affects dissolved oxygen levels/other readings.
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. Special note as to invasive aquatic plant growth on water surface.		
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), e		
Parameters measured by others at selected sites		
10. Streamflow	cfs	USGS gauging stations at Fashion Valley and Mast Rd. near Santee (see Table B.1)
11. Coliform counts: (Escheria-coli, Enterococcus, Total Coliform bacteria)	MPN/100mL	SD CoastKeeper data taken at Fashion Valley Rd and Old Mission Historic Dam monitoring sites (see archives).

Team Leaders (1-2) and citizen volunteers (2-6) typically meet at an appointed location, organize field equipment, transportation, drive to sites, measure physical-chemical water quality parameters using a YSI Sonde device, note special conditions/observations, collect samples for subsequent nutrient testing, return to office or a designated field site, perform (NO_3 & PO_4) tests, store samples for subsequent analyses as needed, clean/check-in/store field equipment and discuss findings, observations/results.

Table A-3 - San Diego RiverWatch Water Quality Monitoring Site Locations

Site #	Site Name	u/s mi.	Elev. ft.	Location	GIS Coordinates Lat.	Long.
LMV - Lower Reach W Mission Valley: I-5 extending 2.5 miles upstream to SR163 (incl. sites 1-3)						
1	Estuary E/W	2.96	6	between PCHwy & I-5 on encased sewer main	32.76131	-117.20373
2	River Gardens E/W	3.50	11	W of YMCA, d/s of trolly at sewer/ped X-ing	32.7623	-117.1944
3	Fashion Valley Mall W	5.08	22	below T&C foot bridge by FV Transit Center	32.76517	-117.16869
MMV - Middle Reach Mission Valley: SR163 extending 3.1 miles upstream to I-15 (incl. sites 4,5)						
4	FSDRIP at Mimi's	5.98	36	d/s on Mission Center Rd. bridge W	32.76986	-117.15482
5	Ward Rd Bridge	8.89	50	below trolly overpass at Camino. del Rio N	32.78024	-117.11029
UMV - Upper Reach E Mission Valley: I-15 extending 2.5 miles upstream to N end of Admiral Baker Field (Sites 6,7)						
6	Kaiser Ponds	9.46	56	E. of Mission SD de Acala at SD Mission Rd.	32.78406	-117.10419
7	Admiral Baker Field	9.98	58	L - Lower (below Friars Rd bridge)	32.79038	-117.10314
	ABF - Zion/Riverdale	10.2	62	Z - Terminus of Zion Ave at Riverdale St.	32.79304	-117.09984
West (MV) - Mission Valley Section: I-5 to Admiral Baker Field E (incl. sites 1-7) [LMV,MMV,UMV]						
MG - Mission Gorge Reach: ABF-E extending 3.5 miles upstream to Old Mission Dam (incl. sites 8-10)						
8	Mission Trails @ Jackson D	13.82	159	SDCWA d/s of Suycott Crossing	32.82124	-117.06205
9T	Jackson/Birchcreek OF	13.86	198	San Marcos stormdrain by River Xing Trail	32.82268	-117.06224
10	Old Mission Dam W/E	15.65	265	Downstream side of Old Mission Dam	32.83977	-117.04332
Mid-Section (MG) -Mission Gorge Section: Quarry Area to Old Mission Dam (incl. sites 8-10)						
LSB - Lower Reach Santee Basin: W Hills Pkwy to Carlton Hills Bridge (incl sites 11,12T,15T)						
11	West Hills Pkwy	17.03	300	below West Hills Pkwy overpass at USGS sta.	32.83936	-117.02436
12T	Carlton Oaks Dr/Santee L	18.23	320	W Sycamore Ck/Santee Lakes @ Carlton Oaks	32.84431	-117.00635
15T	Forester Creek at Mission Gorge Rd (Rt 52/Prospect)	18.86	334	Primary tributary entering SDR just u/s of Site 11 past W.Hills Pkwy/Rt 52 at W end of CGC	32.83221	-116.98658
USB - Upper Reach Santee Basin: Carlton Hills Blvd extending 3 miles upstream to Riverford Rd (incl. sites 13W/E,14						
!3W	Mast Park West	18.35	328	below Carlton Hills Blvd. bridge	32.4691	-116.97333
13E	Mast Park East (foot bridge)	18.50	330	Pedestrian bridge behind (N of) Walmart and trail at end of River Rock Ct.	32.84696	-116.97335
14W	Cottonwood Ave/RCP	19.84	340	N. of Chubb Ln. d/s of old RCP plant culvert	32.84434	-116.98947
14E	Magnolia Ave. bridge	19.9	342	Under Magnolia Bridge/west end of culverts	32.84424	-116.98950
East (SB) - Santee Basin Section: West Hills Parkway to Lakeside (Sites 11-15 above) [LSB+USB]						
LSDR - Lower San Diego River Watershed: SD Estuary extending 18.5 miles to Lakeside @ SR67 (Sites 1-15T above) [LMV+MMV+UMV+MG+LSB+USB]						

Data Management: Water quality data recorded by team volunteers are regularly managed via 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 website w/date, site location, parameter value and additional observations of general interest.

3. *Processed (formatted/aggregated) data* - with statistical computations associated with LSDR sites, reaches, sections and tributaries for each WQ parameter of interest. Monthly and annual summary results presented on SDRPF website/RiverWatch Online Info. Center webpage.

Statistical Computations: Basic statistical values calculated from the data include

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
Coefficient of Variance (CoV)– Variance divided by the Mean
Trendlines - Moving/running average values taken over 12-month period.

Riverwatch WQM Program Reporting: Monthly and annual reports regarding the quantifiable water quality data monitored and resultant metrics for the lower San Diego River watershed are prepared on a regular basis and posted to the SDRPF website (see **https://www.sandiegoriver.org** (click on <Our Work/Conserve/Healthy River, Healthy Communities/RiverWatch/Online Information Center>). Additionally the field data are compiled to a master database for both record keeping purposes and sharing with interested public agencies.

Appendix B
San Diego River Hydrology in Relation to Water Quality

Streamflow or river discharge, is the volume of water moving past a designated location over a fixed period of time. It constitutes one of the primary drivers of changes in water quality. Often expressed as cubic feet per second (cfs) or million gallons per day (mgd), flow is the amount of water moving off a watershed or catchment area into the watercourse, as affected by weather (e.g., increasing during after rainstorms and decreasing during dry spells) and continually changing throughout each season. River flow rapidly decreases during summer months when rainfall is minimal, evaporation rates high and riparian vegetation extracts water from adjacent lands. August and September, the last two months of summer (and the water year), are commonly, but not always, months of lowest flow. A function of both volume and velocity, streamflow has a major impact on living organisms, riparian habitat, benthic conditions and overall river water quality. Velocity of flow, typically increasing as volume increases, determines the kinds and types of organisms that live in an aquatic system and also affects the amount of silt and sediment transported. Fast moving water typically contains much higher DO concentration levels than sluggish flows, as its better aerated, whereas eutrophication most often occurs in reaches with very low velocity.

LSDR average daily flow (ADF) values as recorded at two USGS gauging stations in the lower watershed are expressed for the 18yr monitoring period (Oct 2004 - Sept 2022) and over the past 58 years (1965-2022) of record in **Tables B.1** through **B.3.** WY22 ADF values by season and associated 18yr norms are presented in **Table B.1**. Long term total annual rainfall and average annual streamflow are expressed in **Table B.2. Table B.3** provides annnual rainfall and streamflow for the past 18 years. Current 18yr streamflow norms are roughly 20% less than the long-term (58-yr) values in Mission Valley and 26% less for the Santee Basin. Average LSDR streamflow for WY22 is 47% below the current 18yr norm and 66% less than the long-term average.

Table B.1 - Lower SDR Average Daily Streamflow (WY22 and 18 Year Norms)

Location	West - Mission Valley		East - Santee Basin		LSDR [a]	
Season	WY22	*18yr norm*	WY22	*18yr norm*	WY22	*18yr norm*
Fall (Oct-Nov) ADF, cfs	6.1	*6.7*	3.1	*3.4*	4.0	*4.4*
Winter (Dec-Mar) ADF, cfs	33.3	*70.7*	17.0	*36.8*	21.5	*44.7*
Spring (April-May) ADF, cfs	5.3	*21.6*	3.9	*14.2*	9.3	*16.8*
Summer (June-Sept) ADF, cfs	1.3	*2.6*	0.8	*1.8*	1.1	*2.0*
Annual ADF [b], cfs	15.3	*27.8*	7.0	*16.1*	10	*19.1*
Wet Season (Nov-April)	26.9	*50.8*	12.5	*28.6*	17.2	*34.8*
Dry Season (May-Oct)	3.7	*7.2*	1.4	*4.1*	2.2	*4.9*
River Discharge, AFY [c]	10,855	*21,490*	5,050	*10,300*	7,035	*13,810*

a) Lower San Diego River average daily flow represents a mean hydrologic condition based on averaging the two USGS gauging station flow values.
(b) ADF values are expressed in cubic feet per second (cfs) and million gallons per day (mgd); 1 cfs = 0.646 mgd.
(c) Total annual discharge expressed in thousand acre-feet (1 AF = 325,900 gallons) and million gallons per day (mgd)

Table B.2 - Total Annual Rainfall (1914-2022) and Average Daily Streamflow (1954-2022)

Type	# of Years	Percent of Total Years		Total Annual Rainfall [a]			Average Daily Streamflow, cfs		
				inches	mm	Avg., mm	East [b]	West [c]	LSDR
Very Wet	3	3%	30%	>20"	>500	580/23"	68	113	92
Wet	10	9%		15-20	380-499	430/17"	48	81	66
Above Norm [d]	19	18%		12-15	300-379	340/13"	26	44	35
Normal	40	37%	37%	8-12	200-299	250/10"	10	18	15
Dry	28	25%	33%	5-8	125-199	160/6"	7	12	10
Very Dry	8	7%		<5"	<125	100/4"	5	9	7
Total/AAvg	108	100%		9.98"		254/10"	14	23	17

a) Total annual rainfall accumulated from 1 October through September 31 of a water year.
b) Santee Basin USGS Stream Gauge Station #11022480 below West Hills Pkwy bridge near Mast Blvd. in Santee.
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 in the 25-50 mgd range.

In terms of total annual rainfall (TARF), as shown in Table B.2, WY05 is the only "Very Wet" (TARF > 20") hydrologic year over the past 18 annual cycles. On the other hand, there have been four water year's (07,13,14, and 21) that were all "Very Dry" (TARF <5"). WY15 has been the only water year since RiverWatch started where rainfall was slighty above normal but recorded streamflows below. WY22 total rainfall of 6.75 inches (180 mm) is 49% below the 18yr norm and 52% below long-term average of 9.86 inches (250 mm). The 18yr ADF's for the East and West sections of the lower river are roughly 25% below long-range values while average daily flows for this year (WY22) were 60% below 18yr norms and 68% less than the long-range (58-yr) values.

Monthly discharge data (min, max and average daily flow) for the two USGS gauging stations extending from Oct. 2004 through Oct. 2022 have been plotted on **Chart B.1.** Average daily flow (ADF) for the Lower San Diego River varies from less than 0.2 cfs (0.1 mgd) during the summer (dry) months to nearly 220 cfs (142 mgd) during several winter (wet) periods in the East (Santee Basin) and up to 390 cfs (252 mgd) in the West (Mission Valley) section. Running average ADF values, trending downward in WY12-WY14 began a slight increase in WY15, tempered by slight declines in WY18 and again in WY21. WY22 streamfows are

Monthly and seasonal average daily flow (lines) and annual rainfall (bars/columns) over the monitoring period for both stations are shown in **Chart B.2.** As wet season flows are several hundred times greater than dry-season summer-time flows, the flow values are expressed on log scale, whereas the rainfall scales are linear. Seasonal flow patterns express range, variance and strong positive correlation between log ADF values and monthly rainfall over the past 18 years of record.

Table B.3 - Annual Rainfall and Average Daily Flow (WY05-WY22)

(Type of Year)	Annual Rainfall		Variance [a]	ADF, cfs (mgd)			Variance [d]
	mm	inches		East [b]	West [c]	LSDR	
WY05 (Very Wet)	574	22.60	141%	50.9 (33)	100 (65)	71.5 (46)	213%
WY06 (Dry)	152	6.00	-36%	10.7 (7)	17.5 (11)	13.6 (9)	-40%
WY07 (Very Dry)	98	3.85	-59%	7.2 (5)	12.8 (8)	9.5 (6)	-58%
WY08 (Dry)	183	7.20	-23%	13.3 (9)	25.0 (16)	18.2 (12)	-19%
WY09 (below normal)	232	9.15	-2%	15.0 (10)	27.2 (18)	20.1 (13)	-11%
WY10 (above normal)	282	11.10	18%	25.1 (16)	42.5 (27)	32.4 (21)	44%
WY11 (above normal)	323	12.70	35%	43.3 (28)	61.9 (40)	46.9 (30)	109%
WY12 (Dry)	201	7.91	-16%	11.9 (8)	19.1 (12)	14.9 (10)	-34%
WY13 (Very Dry)	165	6.48	-31%	8.1 (5)	10.6 (7)	9.1 (6)	-59%
WY14 (Very Dry)	129	5.06	-46%	4.3 (3)	6.1 (4)	5.1 (3)	-77%
WY15 (above normal)	302	11.91	27%	7.1 (5)	15.2 (10)	10.5 (7)	-54%
WY16 (Dry)	208	8.20	-13%	12.2 (8)	20.4 (16)	15.6 (10)	-31%
WY17 (above normal)	323	12.73	36%	27.7 (18)	57.3 (37)	40.0 (26)	78%
WY18 (Very Dry)	85	3.34	-64%	5.0 (4)	7.2 (5)	5.9 (4)	-74%
WY19 (above normal)	327	12.89	37%	20.0 (13)	36.9 (24)	27.0 (17)	20%
WY20 (above normal)	345	13.60	45%	22.5 (14)	48 (31)	33.1 (21)	47%
WY21 (Very Dry)	120	4.74	-49%	7.2 (5)	11.8 (9)	9.0 (6)	-59%
WY22 (Dry)	**171**	**6.75**	-27%	**7.0 (5)**	**15.0 (10)**	**10.3 (7)**	-53%
18yr Norm (05-22)	*235*	*9.24*	*0%*	*16.1 (6)*	*29.7 (20)*	*21.8(14)*	*0%*
58-yr AAD	*250*	*10.0*	*5%*	*21.8/(14)*	*36.7 (24)*	*28.4 (18)*	*26%*

a) Percent difference from 18yr average total annual rainfall (9.38 in/yr); black-above, red-below average.
b) Santee Basin USGS Stream Gauge Station 00067556 near Mast Rd., Santee (West Hills Pkwy.)
c) USGS Stream Gauge Station 00459999 at Fashion Valley Mall; incomplete data prior to 1965.
d) Percent difference from 18yr Norms.

Average daily streamflow (as lines) and total annual rainfall (as columns) are also expressed in **Chart B.3** on a water-year basis. Highest flows during the RiverWatch monitoring period at both gauging stations were recorded in WY05 (very wet year), while the lowest were in WY14 (very dry year) following three years of well below normal rainfall. (WY12-14). All four years of low rainfall (WY's 07,14,18 and 21) also experienced below normal streamflow. The six years of highest rainfall ('05,11,15,17,19 and 20) were all above normal in terms of streamflow. WY22 experienced below normal rainfall and comperable streamflow to last year (WY21). The variances and patterns in rainfall and streamflow remain consistant for both summer and winter values and for eastern and western sections of the river.

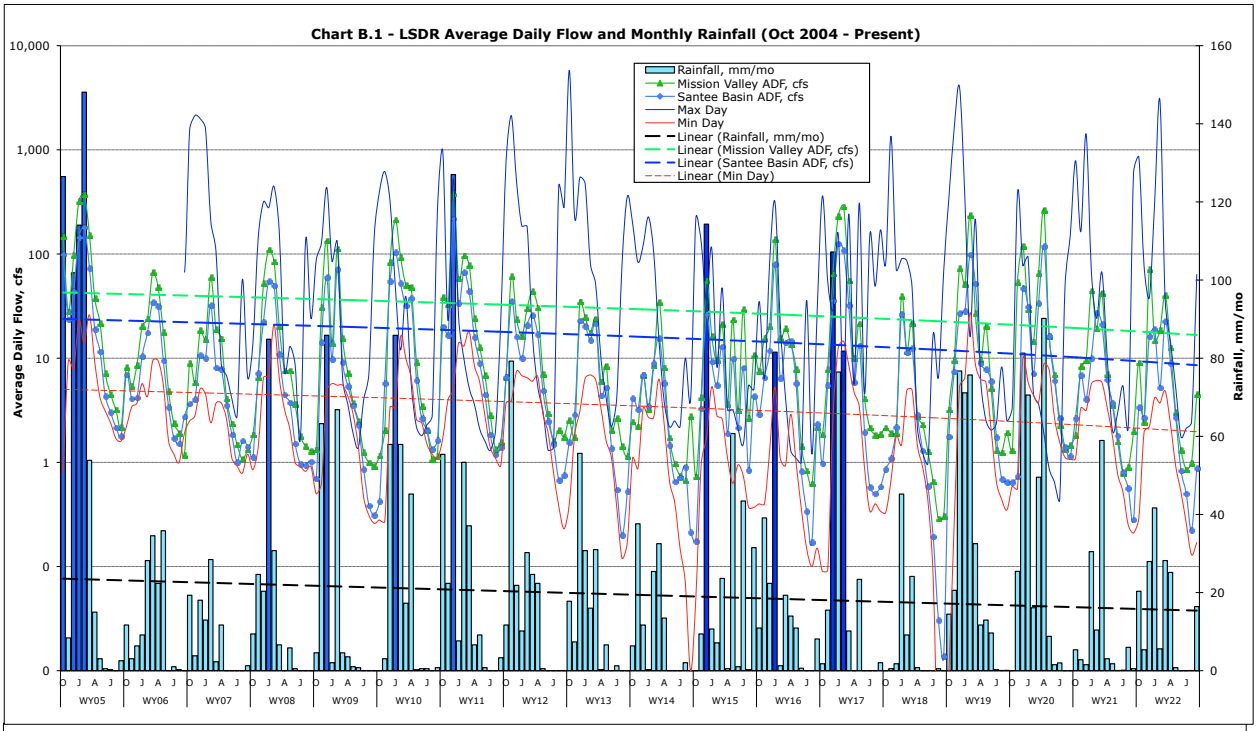
Chart B.1 - LSDR Average Daily Flow and Monthly Rainfall (Oct 2004 - Present)
Rainfall, mm/mo
Mission Valley ADF, cfs
Santee Basin ADF, cfs
Max Day
Min Day
Linear (Rainfall, mm/mo)
Linear (Mission Valley ADF, cfs)
Linear (Santee Basin ADF, cfs)
Linear (Min Day)
Average Daily Flow, cfs
Rainfall, mm/mo
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22

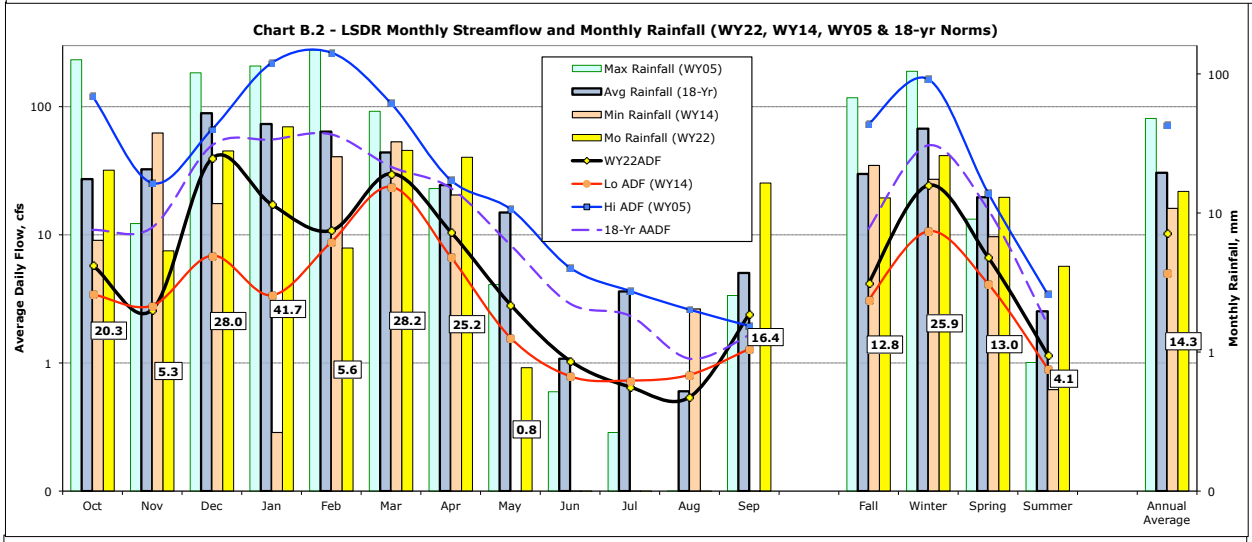
Chart B.2 - LSDR Monthly Streamflow and Monthly Rainfall (WY22, WY14, WY05 & 18-yr Norms)
Max Rainfall (WY05)
Avg Rainfall (18-Yr)
Min Rainfall (WY14)
Mo Rainfall (WY22)
WY22ADF
Lo ADF (WY14)
Hi ADF (WY05)
18-Yr AADF
Average Daily Flow, cfs
Monthly Rainfall, mm
20.3
5.3
28.0
41.7
5.6
28.2
25.2
0.8
16.4
12.8
25.9
13.0
4.1
14.3
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Fall
Winter
Spring
Summer
Annual Average

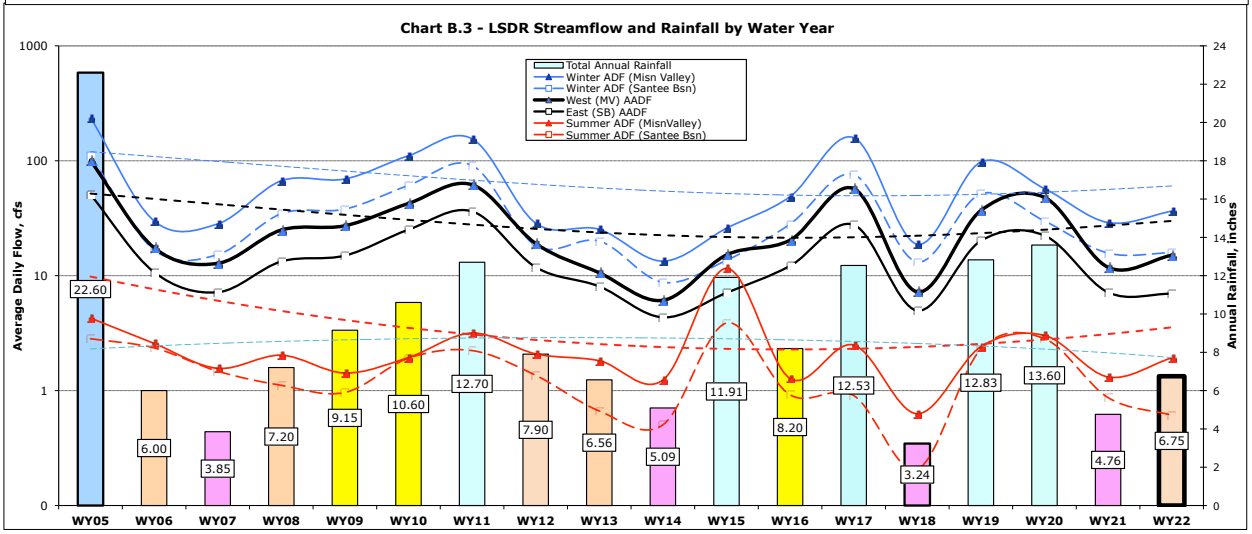
Chart B.3 - LSDR Streamflow and Rainfall by Water Year
Total Annual Rainfall
Winter ADF (Misn Valley)
Winter ADF (Santee Bsn)
West (MV) AADF
East (SB) AADF
Summer ADF (MisnValley)
Summer ADF (Santee Bsn)
Average Daily Flow, cfs
Annual Rainfall, inches
22.60
6.00
3.85
7.20
9.15
10.60
12.70
7.90
6.56
5.09
11.91
8.20
12.53
3.24
12.83
13.60
4.76
6.75
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22

Appendix C
Monthly WQM Site Data for WY21/WY22

Appendix C consists of 12 tables listing last (WY21) and this year's (WY22) RiverWatch water quality monitoring data by month (down) and site (across). Tables C.1(W&E) express water temperatures in degrees Celsius, Tables C.2 (W&E) - Specific Conductance in mS/cm, C.3(W&E) - pH, C.4(W&E) - Dissolved Oxygen concentrations in mg/L, C.5(W&E) - DO as Percent of Saturation and C.6-Nutrient (NO3 & PO4) concentrations at two west and four

Table C.1(W) West Section Water Temperatures (WY21/WY22) Data

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	22.4/**20.5**	18.7/**17.8**	19.3/**17.4**	16.9/**17.8**	15.4/**14.6**	16.7/**16.3**	19.4/**17.2**
Nov	16.5/**17.8**	16.0/**16.8**	17.2/**16.5**	16.7/**16.4**	16.7/**14.8**	17.5/**15.3**	15.7/**16.1**
Dec	12.9/**13.1**	12.2/**12.9**	12.6/**12.9**	12.0/**12.2**	11.3/**12.4**	11.5/**12.5**	11.6/**12.3**
Jan	13.0/**15.1**	12.1/**14.3**	12.5/**14.3**	11.7/**14.2**	12.5/**13.1**	12.3/**13.6**	13.5/**13.4**
Feb	15.1/**15.0**	14.9/**14.4**	14.9/**15.9**	14.7/**13.9**	14.2/**15.2**	14.3/**15.0**	13.7/**16.2**
Mar	15.3/**18.0**	15.0/**17.7**	15.0/**17.8**	14.3/**18.7**	14.4/**16.6**	14.3/**16.9**	14.7/**16.8**
Apr	19.9/**20.8**	19.0/**20.6**	19.0/**20.2**	18.6/**20.8**	17.2/**17.0**	18.4/**18.8**	18.2/**19.5**
May	21.3/**22.0**	20.8/**20.7**	20.4/**20.6**	20.1/**21.4**	18.9/**17.5**	20.1/**19.2**	20.4/**18.9**
Jun	23.8/**24.6**	23.4/**23.3**	22.8/**23.1**	23.5/**23.8**	20.5/**18.7**	22.5/**20.6**	22.6/**22.4**
Jul	29.8/**25.2**	25.5/**23.6**	25.3/**24.2**	27.2/**26.0**	21.5/**20.8**	23.3/**22.3**	24.9/**24.0**
Aug	23.9/**28.7**	23.7/**25.6**	24.1/**25.6**	24.5/**27.6**	20.8/**21.8**	22.3/**23.8**	23.6/**25.3**
Sept	24.0/**25.7**	22.7/**22.3**	22.4/**22.5**	22.6/**23.3**	18.9/**20.5**	20.7/**21.3**	22.6/**22.7**
AA [bc]	19.8/**20.5**	18.7/**19.2**	18.8/**19.2**	18.6/**19.7**	16.9/**16.9**	17.8/**18.0**	18.4/**18.7**
Norm	*19.73*	*19.00*	*19.19*	*19.62*	*17.19* [d]	*18.28*	*18.13*

a) All values expressed in °C; WY22 averages (bold type) greater than last year's (WY21) results are shown in black; below in red.

b) Average annual water year results are based on unweighted averaging of monthly data (Oct-Sept); WY22 water temps >21oC are shown in tan cells; WY22 values equal to 15oC or less shown in blue.

c) Annual average water temperatures at all west section monitoring sites in WY22 are greater than last year's results. WY22 averages are slightly above 18yr norms at sites 1,2,3,4&7 and below at sites 5&6.

d) Site 5 (Mast Rd) monthly water temperatures are typically several degrees less than other west section readings due to groundwater exfiltration (springs) in the immediate vicinity.

Table C.1(M-E) Middle and East Section Water Temperature (WY21/WY22) Data

Site	8	9T	10	11	12T	13E	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	15.3/**16.5**	10.7/**14.8**	14.3/**16.1**	14.7/**16.2**	18.1/**18.1**	15.9/**16.1**	19.7/**17.3**	13.9/**15.2**
Nov	13.3/**15.5**	10.5/**13.9**	13.0/**14.4**	14.2/**15.4**	15.9/**16.9**	13.6/**15.0**	16.0/**16.9**	13.7/**14.6**
Dec	9.0/**11.4**	6.3/**10.6**	8.8/**10.8**	10.2/**11.4**	11.5/**12.5**	9.6/**12.9**	11.6/**13.6**	9.5/**10.3**
Jan	9.4/**14.2**	8.0/**14.2**	9.3/**13.2**	10.7/**13.8**	12.3/**15.0**	10.2/**12.8**	11.5/**13.7**	9.6/**13.6**
Feb	11.6/**11.7**	7.1/**12.5**	11.9/**10.2**	12.2/**12.0**	15.0/**14.2**	12.8/**11.3**	13.3/**13.4**	11.9/**10.9**
Mar	12.3/**15.2**	9.2/**12.7**	12.9/**14.2**	13.2/**14.3**	14.3/**16.6**	13.8/**14.2**	14.9/**16.7**	13.7/**14.8**
Apr	16.7/**18.6**	13.1/**12.3**	17.0/**18.9**	16.2/**17.0**	dry/**18.2**	17.9/**16.9**	19.1/**20.1**	16.2/**18.8**
May	18.5/**19.7**	15.0/**16.8**	19.0/**19.8**	17.3/**18.4**	20.7/**20.8**	18.6/**19.0**	20.9/**22.0**	18.1/**18.6**
Jun	23.1/**21.0**	23.1/**19.4**	23.0/**23.9**	20.9/**19.9**	20.5/**dry**	22.1/**21.6**	25.1/**23.5**	21.5/**21.5**
Jul	24.3/**20.7**	20.4/**19.7**	23.0/**22.8**	21.2/**20.7**	dry/**dry**	24.5/**23.3**	26.8/**25.2**	22.5/**21.8**
Aug	22.2/**21.7**	21.2/**20.9**	24.1/**24.4**	21.5/**22.2**	dry/**dry**	23.1/**24.7**	26.7/**21.8**	22.3/**22.7**
Sep	18.3/**23.5**	15.3/**23.8**	20.4/**25.1**	19.5/**23.5**	dry/**dry**	20.7/**24.8**	21.1/**26.5**	18.7/**24.5**
AA[bd]	16.2/**17.5**	13.3/**16.4**	16.4/**17.8**	16.0/**17.1**	16.0/**16.5**	16.9/**17.7**	18.9/**19.2**	16.0/**17.3**
Norm	*17.12*	*15.67* [e]	*17.60*	*16.68*	*17.58*	*18.25*	*17.75*	*17.85*

a) All values expressed in oC; WY22 values (bold) greater than WY21 results are shown in black; below in red.
b) Annual average water year values and 18yr norms are based on unweighted averaging of monthly data (Oct-Sept); water temps >20oC are expressed in tan cells, <15oC in blue cells.
c) Forester Creek discharges within the Lower Santee Basin below Carlton Hills Golfcourse just upstream of SR52.
d) WY22 annual average water temperatures at all mid and east section monitoring sites are greater than last year's (WY21) results; WY22 averages are slightly above 18yr norms at sites 8-11 & 14, and below norms at sites 12T, 13 & 15T.
e) Site 9T (Birchcreek Outfall) monthly water tempertures are typically lower than at other sites as the source are nearby groundwater seeps draining the upstream catchment area.

Table C.2(W) West Section Specific Conductance (WY21/WY22) Data

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	25.5/**18.7**	3.81/**2.11**	3.73/**1.85**	3.26/**1.95**	3.81/**3.82**	4.03/**3.84**	3.77/**3.02**
Nov [c]	9.8/**19.5**	2.32/**2.96**	2.43/**2.65**	3.13/**2.77**	3.32/**3.54**	3.12/**4.02**	2.28/**2.94**
Dec	19.3/**1.60**	3.47/**1.57**	3.42/**1.41**	3.23/**1.27**	3.12/**1.04**	2.86/**0.94**	2.56/**1.01**
Jan	34.2/**24.3**	2.23/**2.22**	2.11/**2.21**	2.01/**2.08**	2.04/**2.14**	1.84/**2.11**	1.97/**2.24**
Feb	2.41/**3.17**	1.97/**2.44**	2.01/**2.58**	1.97/**2.28**	1.94/**2.51**	1.89/**2.54**	1.97/**2.47**
Mar	1.19/**2.16**	1.08/**1.57**	0.98/**1.50**	1.04/**1.53**	1.17/**1.60**	1.16/**1.44**	1.37/**1.68**
Apr	5.49/**5.18**	2.81/**2.16**	2.45/**1.93**	2.47/**1.99**	2.23/**0.91**	2.26/**1.67**	2.25/**1.88**
May	5.83/**11.8**	3.17/**2.84**	3.00/**2.40**	2.94/**2.69**	3.05/**3.43**	2.85/**2.61**	2.76/**2.17**
Jun	11.9/**21.2**	3.50/**3.77**	3.42/**3.14**	3.21/**2.96**	3.49/**3.12**	3.11/**2.88**	3.11/**2.64**
Jul	23.5/**21.3**	3.71/**3.81**	3.61/**3.50**	3.28/**3.16**	3.62/**3.59**	3.54/**3.36**	3.18/**2.70**
Aug	20.5/**29.7**	4.87/**4.66**	3.58/**3.56**	3.15/**3.12**	3.76/**3.74**	3.48/**3.81**	3.18/**2.76**
Sep	37.4/**29.5**	3.83/**3.15**	3.48/**2.56**	3.17/**2.28**	3.97/**3.63**	4.32/**3.86**	3.17/**2.74**
AAvg [d]	16.4/**15.7**	3.06/**2.77**	2.85/**2.44**	2.74/**2.34**	2.96/**2.76**	2.87/**2.76**	2.63/**2.35**
Norm	*9.500*	*2.674*	*2.557*	*2.462*	*2.620*	*2.611*	*2.464*

a) All values expressed in milli-Siemens/cm; SpC values >4.0 are shown in tan cells, values < 2.0 mS/cm are in blue cells.
b) WY22 values greater than last year's (WY21) results are displayed in bold black; values below last year in bold red.
c) November 2021 was the only month that SpC values at all west section sites (1-7) were less than last year's readings.
d) Average WY22 SpC values (bold print) are less than last year's readings at all west section sites (1-7).

Table C.2(M-E) Middle and East Section Specific Conductance (WY21/WY22 Data)

Site	8	9T	10	11	12T	13E	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	2.57/**1.97**	5.00/**4.53**	2.45/**1.89**	2.26/**2.47**	1.80/**1.99**	2.31/**2.37**	1.70/**1.85**	2.42/**2.87**
Nov	2.28/**2.49**	4.67/**4.65**	2.31/**2.49**	2.34/**2.43**	1.84/**1.97**	2.05/**2.20**	2.05/**1.92**	2.47/**2.78**
Dec	2.37/**1.25**	4.75/**3.15**	2.33/**1.23**	2.26/**1.54**	1.82/**1.84**	2.00/**1.11**	1.78/**1.76**	2.54/**2.21**
Jan	1.97/**2.17**	4.17/**3.45**	2.00/**2.10**	1.98/**1.97**	1.54/**1.62**	1.75/**1.82**	1.66/**1.53**	2.45/**2.62**
Feb	1.56/**1.40**	3.22/**2.59**	1.60/**1.24**	1.65/**1.81**	1.34/**1.53**	1.53/**1.92**	1.37/**1.61**	2.05/**0.87**
Mar	1.33/**1.91**	2.89/**4.05**	1.35/**1.95**	1.50/**2.03**	1.29/**1.46**	1.34/**1.65**	1.29/**1.50**	1.90/**2.77**
Apr	1.97/**2.09**	3.99/**4.13**	2.02/**2.16**	2.10/**2.32**	dry/**1.37**	1.63/**1.49**	1.38/**1.30**	2.87/**2.90**
May	2.27/**2.32**	4.55/**4.46**	2.25/**1.94**	2.29/**2.13**	1.52/**1.38**	1.97/**1.65**	1.66/**1.38**	2.86/**2.64**
Jun	2.44/**2.41**	4.84/**3.81**	2.50/**2.47**	2.65/**2.50**	1.76/**dry**	2.08/**2.05**	1.75/**1.65**	2.83/**2.93**
Jul	2.71/**2.65**	5.09/**4.15**	2.73/**2.70**	2.69/**2.62**	dry/**dry**	2.18/**1.20**	1.76/**1.70**	3.08/**2.76**
Aug	2.99/**3.27**	5.35/**5.00**	2.81/**2.86**	2.53/**2.63**	dry/**dry**	2.32/**2.33**	1.82/**1.69**	3.07/**2.92**
Sep	3.45/**3.37**	5.29/**5.28**	2.85/**3.18**	2.80/**2.71**	dry/**dry**	2.40/**2.43**	1.89/**1.83**	2.77/**2.91**
AA [bd]	2.33/**2.28**	4.48/**4.10**	2.27/**2.18**	2.25/**2.26**	1.61/**1.65**	1.96/**1.94**	1.68/**1.64**	2.61/**2.43**
Norm	*2.313*	*4.742*	*2.246*	*2.236*	*1.613*	*1.909*	*1.524*	*2.668*

a) All values expressed in milli-Siemens/cm; WY22 values greater than WY21 results are in bold black, below in bold red. Cells in blue <2.0mS/cm: cells in tan >4.0 mS/cm.

b) WY22 annual averages and 18yr norms (in italics) are based on averaging of monthly data (Oct-Sept).

c) Forester Creek discharges within the Lower Santee Basin enter SDR below Carlton Hills Golf Course at SR52

d) Average WY22 SpC values are less than last year's (WY21) values at six sites (8-10&13E-15T) and greater at two sites (11&12T); WY22 annual average values are less than 18yr norms at four sites (8-10 & 15T) and greater at (11-13E &15T).

Table C.3(W) West Section pH (WY21/WY22) Data

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	8.02/7.75	7.75/**7.84**	7.90/**8.10**	7.87/**8.04**	7.98/7.97	6.98/**7.69**	7.95/7.75
Nov	7.95/7.80	8.01/7.53	7.57/7.45	7.94/7.50	7.88/7.74	7.80/7.67	8.82/7.88
Dec	8.03/7.21	8.09/7.23	8.06/7.41	8.04/7.33	8.02/7.34	8.03/7.20	8.29/7.27
Jan	7.65/**7.75**	7.82/7.60	7.81/7.60	8.11/7.60	7.71/7.70	7.71/7.60	7.86/**7.90**
Feb	7.94/7.60	7.74/7.60	7.80/7.65	7.81/7.50	7.82/7.60	7.80/7.60	7.91/7.70
Mar	7.19/**7.50**	7.80/7.40	7.59/7.50	7.71/7.60	7.71/7.50	7.66/7.40	7.85/7.60
Apr	7.79/7.64	7.75/7.53	7.71/7.55	7.71/7.55	7.63/7.40	7.60/7.24	7.70/7.43
May	8.04/7.68	7.74/7.46	7.77/7.51	7.71/7.54	7.74/7.43	7.83/7.31	7.78/7.37
Jun	7.87/7.81	7.64/7.63	7.86/7.71	7.87/**8.00**	7.31/**7.58**	7.61/7.46	7.69/7.40
Jul	7.94/**8.04**	7.66/7.60	7.87/7.62	8.11/**8.17**	7.52/**7.55**	7.35/**7.60**	7.07/**7.38**
Aug	7.67/**7.76**	7.68/7.45	7.90/7.29	7.91/**8.04**	7.89/7.42	7.72/7.53	7.74/7.35
Sep	7.70/7.51	7.54/7.27	7.63/7.23	7.61/7.25	7.69/7.48	7.57/7.36	7.56/7.39
AA [bd]	7.82/7.67	7.77/7.51	7.79/7.55	7.87/7.68	7.74/7.56	7.64/7.47	7.84/7.53
Norm	*7.76*	*7.68*	*7.76*	*7.78*	*7.63*	*7.61*	*7.57*

a) All pH values are unit-less; WY22 monthly values of 8.0 or greater are in tan cells and 7.5 or below in pink.
b) WY22 annual average and 18yr norms are based on averaging of monthly data (Oct-Sept); values greater than last year's results are in bold black; below in bold red.
c) Forester Creek discharges within the Lower Santee Basin section of the river downstream of Carlton Oaks Golf course just upstream of Site 11 and West Hills Pkwy.
d) WY22 average annual pH results are lower than last year's (WY21) values at all seven West section sites.

Table C.3(M-E) Middle and East Section pH (WY21/WY22) Data

Site	8	9T	10	11	12T	13E	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	8.19/**7.82**	8.39/**7.44**	8.10/**8.04**	7.97/**7.91**	8.20/**8.24**	7.66/**7.82**	8.09/**8.24**	8.27/**7.99**
Nov	8.24/**8.06**	8.36/**7.97**	8.26/**7.92**	8.03/**7.81**	8.24/**8.00**	7.89/**7.81**	8.13/**7.92**	8.27/**7.80**
Dec	8.12/**7.62**	8.34/**8.10**	8.44/**7.47**	8.21/**7.25**	8.57/**7.54**	8.05/**7.37**	8.37/**7.69**	8.30/**7.60**
Jan	7.57/**8.20**	7.01/**8.40**	8.01/**8.40**	7.96/**7.60**	8.48/**7.60**	7.72/**7.40**	7.81/**8.20**	7.87/**7.80**
Feb	8.16/**7.90**	8.07/**8.40**	8.02/**7.60**	7.94/**7.50**	8.70/**7.70**	7.92/**7.50**	7.97/**7.90**	7.92/**7.60**
Mar	7.96/**8.10**	8.10/**8.30**	7.95/**7.60**	7.72/**7.70**	8.10/**7.50**	7.66/**7.50**	7.98/**8.10**	7.92/**7.80**
Apr	7.80/**8.02**	7.92/**8.17**	8.11/**7.81**	7.87/**7.62**	dry/**8.40**	7.86/**7.35**	8.01/**7.82**	8.02/**7.74**
May	7.61/**7.06**	7.77/**8.07**	7.97/**7.80**	7.77/**7.63**	8.03/**7.30**	7.67/**7.49**	8.12/**7.81**	7.85/**7.65**
Jun	7.69/**7.31**	7.99/**8.24**	7.60/**7.98**	7.67/**7.65**	7.58/**dry**	7.65/**7.50**	8.07/**7.78**	7.61/**7.75**
Jul	8.00/**7.11**	7.93/**8.23**	7.89/**7.49**	8.08/**7.75**	dry/**dry**	7.74/**7.59**	7.96/**7.89**	7.78/**7.79**
Aug	7.62/**7.21**	8.06/**8.05**	7.93/**7.71**	7.76/**7.62**	dry/**dry**	7.92/**7.57**	8.18/**7.39**	8.22/**7.63**
Sep	7.63/**7.50**	7.97/**8.04**	8.43/**8.38**	8.07/**7.58**	dry/**dry**	8.00/**7.53**	7.79/**7.78**	8.36/**7.67**
WY22 [b]	7.88/**7.66**	7.99/**8.12**	8.06/**7.85**	7.92/**7.63**	8.25/**7.79**	7.81/**7.54**	8.04/**7.88**	8.03/**7.73**
Norm	*7.68*	*7.89*	*7.83*	*7.58*	*7.93*	*7.66*	*7.84*	*8.03*

a) All values are unit-less; monthly values of 8.0 or above are in tan cells, while those at 7.5 or below are in pink.
b) WY22 and 18yr annual norms are based on averaging monthly results (Oct-Sept); annual averages greater than last year's (WY21) values are shown in bold black; below are in bold red.
c) Averaage annual pH readings in WY22 are below last year' results at all mid and east section sites with exception of 9T (Birchcreek Outfall).

Table C.4(W) West Section Dissolved Oxygen Concentration (WY21/WY22) Data

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	8.37/3.95	3.64/3.01	2.67/2.04	8.10/2.56	7.46/3.50	5.10/0.60	4.58/**5.57**
Nov	7.25/5.43	6.73/4.05	5.55/0.48	7.77/0.55	7.20/4.73	5.73/0.64	7.30/3.24
Dec	6.66/6.16	7.58/5.43	6.37/4.76	7.05/6.21	6.78/6.24	4.65/4.59	6.47/**7.22**
Jan	6.31/**7.36**	7.49/6.80	8.27/4.98	7.37/6.50	7.40/6.20	7.17/4.57	7.43/**7.61**
Feb	8.07/**7.56**	7.76/6.59	7.68/6.59	5.92/**7.37**	6.42/**7.20**	4.38/**7.92**	7.40/**9.18**
Mar	6.15/**6.63**	6.77/**6.90**	6.20/**6.75**	6.01/**9.38**	8.60/5.88	5.78/5.40	8.68/6.56
Apr	4.35/**5.86**	3.84/**3.97**	3.80/**3.90**	3.18/**4.85**	3.73/**4.81**	2.80/0.23	5.33/4.55
May	6.46/3.13	3.92/2.74	3.54/2.43	2.72/**3.81**	4.64/3.70	2.46/0.40	3.50/3.15
Jun	4.01/**6.05**	2.49/**2.98**	1.67/**2.03**	3.16/**6.43**	2.78/**2.90**	0.51/0.23	3.81/**4.62**
Jul	6.81/**6.89**	2.73/2.62	3.05/1.78	7.19/7.02	2.61/2.27	0.33/**0.98**	3.84/3.24
Aug	3.16/**6.24**	1.89/1.77	1.87/1.50	2.45/**7.75**	2.86/1.95	0.66/0.22	2.32/**4.81**
Sep	3.73/3.11	2.39/0.96	2.18/0.63	1.36/0.27	4.23/2.32	0.51/0.47	3.35/**3.84**
WY21/**22**	5.94/5.70	4.77/3.98	4.40/3.16	5.19/**5.23**	5.39/4.31	3.34/2.19	5.34/5.30
Norm	*6.12*	*4.41*	*4.55*	*6.01*	*4.78*	*3.48*	*5.11*

a) All values expressed in milligrams/liter and (Percent of Saturation); WY22 and 18yr averages less than 5 mg/L (DO depletion threshold) shown in light yellow, less than 2.5 mg/L (hypoxic level) cells highlighted in bright yellow and <1.0 mg/L (exaerobic zone) in pink. DO levels of 7.0 mg/L or greater are shown in blue cells.

Table C.4(ME) Mid and East Section Dissolved Oxygen Concentration (WY21/WY22) Data

Site	8	9T	10	11	12T	13E	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	7.37/**7.46**	11.2/10.8	7.57/6.95	6.43/5.77	7.25/5.25	1.69/0.8	1.53/**1.59**	9.51/5.79
Nov	8.98/7.67	10.3/7.27	9.33/7.72	8.24/6.91	7.58/4.24	4.07/0.91	5.69/2.00	9.23/8.01
Dec	9.67/**11.4**	11.2/**12.0**	10.8/5.52	8.52/7.72	8.92/8.15	1.78/**2.12**	7.55/5.73	9.55/7.24
Jan	10.1/**11.9**	11.4/**11.7**	10.2/7.87	8.32/8.02	8.33/**2.71**	1.81/**2.21**	2.73/**13.2**	8.12/5.45
Feb	8.99/**11.4**	10.5/**12.2**	7.97/8.02	8.43/7.58	9.96/6.46	1.38/**2.56**	6.29/**8.15**	6.36/**6.63**
Mar	9.28/**11.5**	10.7/**12.7**	8.29/6.65	8.09/7.86	8.60/4.19	2.54/**5.50**	9.17/8.40	7.92/6.63
Apr	8.09/**9.01**	9.95/**10.5**	8.27/**9.85**	9.47/6.02	dry/**4.07**	6.44/0.80	4.88/**4.97**	8.51/6.73
May	4.68/**5.99**	6.63/**9.32**	4.22/**4.97**	4.85/4.79	4.20/1.74	1.39/**1.44**	4.32/3.08	4.23/4.05
Jun	3.72/1.78	8.41/**8.77**	4.27/**5.12**	4.95/4.64	1.51/**dry**	3.57/0.98	4.81/1.94	3.29/**6.07**
Jul	1.44/0.88	9.25/6.78	4.86/0.44	4.57/4.13	dry/**dry**	1.98/1.62	2.98/1.50	4.66/3.75
Aug	1.21/0.26	6.54/**6.95**	2.11/1.15	3.75/**3.93**	dry/**dry**	1.73/1.67	3.37/1.59	2.09/**3.65**
Sep	1.38/**1.95**	6.51/5.59	4.08/2.36	4.02/3.49	dry/**dry**	0.59/**4.56**	2.32/1.58	3.10/**3.52**
AA [b]	6.24/**6.68**	9.37/**9.54**	6.83/5.55	6.64/5.90	7.06/4.60	2.42/2.07	4.64/4.48	6.38/5.63
Norm	*7.19*	*9.24*	*6.90*	*6.09*	*6.93*	*2.77*	*3.52*	*7.25*

a) All values expressed in milligrams/liter; values less than 5 mg/L (DO depletion threshold) are expressed in light yellow ,< 2.5 mg/L (hypoxic level) cells highlighted in dark yellow and <1 mg/L (exaerobic zone) in pink. DO levels of 7.0 mg/L or greater are shown in blue cells,

b) WY21 & WY22 average annual values and 18yr norms are based on monthly data (Oct-Sept).

c) Tributary discharges within the Lower Santee Basin reach enter the main stream below the west end of Carlton Oaks Golf Course just upstream of SR 67.

Table C.5(W) West Section DO Percent of Saturation (WY21/WY22) Data

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	96/**45**	39/**32**	30/**22**	87/**28**	75/**36**	54/**06**	50/**59**
Nov	75/**57**	68/**42**	57/**04**	81/**06**	74/**47**	60/**06**	74/**33**
Dec	63/**59**	72/**52**	61/**45**	66/**58**	63/**59**	44/**43**	61/**68**
Jan	59/**73**	70/**67**	78/**49**	68/**64**	70/**59**	68/**45**	72/**74**
Feb	81/**76**	78/**65**	77/**67**	63/**72**	63/**72**	43/**79**	72/**94**
Mar	62/**71**	68/**73**	65/**72**	59/**101**	87/**61**	57/**56**	82/**68**
Apr	49/**66**	42/45	41/**43**	34/**54**	38/**50**	30/**03**	62/**50**
May	75/**36**	44/**31**	39/**28**	30/**43**	50/**39**	28/**04**	39/**35**
Jun	48/**73**	30/**35**	20/**24**	37/**72**	31/**32**	06/**03**	45/**54**
Jul	86/**83**	34/**32**	38/**21**	85/**93**	29/**26**	04/**11**	46/**39**
Aug	37/**78**	23/**22**	22/**20**	30/**99**	32/**22**	08/**03**	28/**60**
Sept	46/**38**	28/**13**	25/**07**	16/**03**	46/**26**	06/**06**	40/**44**
WY21/**22**	65/**63**	50/**42**	46/**34**	55/**58**	55/**44**	34/**22**	56/**56**
Norm	67.2%	46.3%	47.9%	64.7%	48.9%	35.6%	52.8%

a) All values expressed as percent of saturation; WY22 values less than WY21 results are listed in bold red; otherwise in bold black.

b) WY 22 values < 55% (DO depletion threshold) are expressed in light yellow ,< 25% (hypoxic level) cells highlighted in dark yellow and <10% (exaerobic zone) pink. DO% Sat values of 70% or greater are shown in blue cells.

Table C.5(M-E) Mid and East Section DO Percent of Saturation (WY21/WY22) Data

Site	8	9T	10	11	12T	13W	13E	14	15T
Reach	Mission Gorge			Lower Santee Basin			Upper Santee Basin		LSB [c]
Oct	75/**77**	103/**107**	74/70	64/59	75/56	58/28	17/05	17/16	93/58
Nov	82/78	94/74	89/76	81/70	76/45	50/42	36/09	53/21	85/81
Dec	84/**105**	92/**109**	93/50	77/71	82/77	35/**44**	16/**20**	70/56	84/65
Jan	90/**117**	97/**115**	95/**76**	75/**78**	78/27	51/42	16/**21**	26/**128**	71/53
Feb	83/**106**	88/**115**	74/72	80/71	99/63	42/**54**	13/**24**	55/**79**	54/**60**
Mar	86/**105**	95/**121**	79/65	78/77	86/44	48/47	23/**54**	91/87	77/66
Apr	84/**97**	97/**110**	87/**108**	98/63	dry/**44**	78/24	69/08	53/**55**	88/73
May	50/**66**	67/**97**	47/**56**	51/**52**	48/20	43/27	15/**17**	50/35	45/44
Jun	44/20	92/**96**	34/**58**	56/52	17/**dry**	38/23	41/12	57/23	38/**70**
Jul	17/10	103/76	59/05	52/47	-/**dry**	41/40	27/19	37/18	54/43
Aug	14/03	75/**80**	26/14	43/**46**	-/**dry**	54/46	26/21	42/19	24/**43**
Sep	16/**25**	69/60	46/29	44/43	-/**dry**	47/**60**	10/**55**	26/20	34/**43**
'21/**22**	60/**67**	89/**97**	69/57	67/61	70/47	49/40	26/22	48/46	62/58
Norm	*73.2%*	*93.5%*	*71.6%*	*59.9%*	*70.4%*	*45.5%*	*28.7%*	*35.5%*	*69.8%*

a) All values expressed as percent of saturation; WY22 values < 55% (DO depletion threshold) are expressed in light yellow ,< 25% (hypoxic level) cells highlighted in dark yellow and <10% (exaerobic zone) pink.. DO% Sat values of 70% or greater are shown in blue cells.

b) WY21/22 annual average and 18yr norms are based on averaging of monthly data (Oct-Sept).

c) ForesterCk discharges within the Lower Santee Basin reach below Carlton Oaks Golf Course just u/s of SR52.

Table C.6 WY21/22 Nutrients (NO_3 and PO_4) Data at Selected WQM Sites

Site# Name	2 YMCA	7 ABF	15T Drain (El Cajon)	11 WHP	13W-MPW	14 MAG	15T FSTR CK
Section	Mission Valley Sites		Santee Basin (Eastern Sites)				
WY	21/22	21/22	21/22	21/22	21/22	21/22	21/22
Nitrogen, N as NO3 in black on top line and Phosphorus, P as PO4 in red below, expressed in mg/L							
Oct	0.1/0.0 0.3/0.4	0.1/0.0 0.3/0.1	—/— —/—	0.1/0.2 0.5/0.6	0.2/— 0.4/—	0.1/0.1 0.6/0.2	2.0/1.0 0.0/0.3
Nov	—/— —/—	—/— —/—	—/— —/—	—/0.3 —/0.4	—/— —/—	—/0.0 —/0.4	—/1.3 —/0.1
Dec	0.1/0.0 0/3/0.3	0.1/0.0 0.3/0.1	—/— —/—	0.2/0.6 0.4/0.2	0.2/— 0.4/—	0.1/— 0.5/—	3.0/— 0.2/—
Jan	—/— —/—	—/— —/—	—/— —/—	0.1/0.3 0.3/0.2	0.3/— 0.3/—	0.3/— 0.3/—	0.2/— 0.4/—
Feb	—/— —/—	—/— —/—	0.1/— 0.1/—	0.2/0.2 0.4/0.1	0.1/— 0.1/—	0.1/— 0.1/—	1.0/— 0.1/—
Mar	—/— —/—	—/— —/—	0.0/— 0.3/—	0.1/0.3 0.4/0.3	—/— 0.2/—	0.1/— 0.6/—	1.6/— 0.1/—
Apr	—/— —/—	—/— —/—	0.7/— 0.2/—	0.1/— 0.2/—	0.1/— 0.3/—	0.1/— 0.2/—	0.8/— 0.2/—
May	—/0.1 —/0.4	—/0.1 —/0.25	—/— —/—	—/— —/—	—/— —/—	—/— —/—	—/— —/—
Jun	0.1/0.0 0.4/0.5	0.1/0.0 0.1/0.15	2.2/0.0 0.1/0.2	0.2/0.0 0.4/0.5	0.1/0.0 0.3/0.6	0.1/0.1 0.1/0.3	0.4/0.9 0.3/0.3
Jul	0.1/— 0.1/—	0.1/0.0 0.4/0.0	—/0.1 —/0.2	0.1/0.0 0.1/0.5	—/0.0 0.7/0.4	0.1/0.2 0.7/0.1	—/1.1 0.2/0.3
Aug	—/— —/—	—/0.0 —/0.0	—/0.0 —/0.3	0.1/0.0 0.7/0.6	—/0.0 0.4/0.3	0.1/— 0.4/—	—/— 0.2/—
Sept	—/0.1 —/0.7	—/0.1 —/0.1	—/0.1 —/0.5	—/0.1 0.5/0.7	—/0.1 0.6/1.0	—/0.1 0.6/0.1	—/1.1 —/0.1
Max.	0.1/0.1 0.4/0.7	0.1/0.1 0.4/0.3	2.2/0.1 0.3/0.5	0.2/0.6 0.7/0.7	0.3/0.1 0.7/1.0	0.3/0.2 0.7/0.4	2.0/1.3 0.4/0.3

a) Nutrient values for nitrate (NO_3) as nitrogen in black, and phosphate (PO_4) as phosphrous in red, expressed in mg/L. Values > 0.5, indicating reasonable cause for upstream nutrient source assesment, are in yellow cells.

Appendix D

Water Quality Index Values

The Lower San Diego River (LSDR) Water Quality Index (WQI) 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 and others. The index is intended to aid in assessment of the LSDR watershed, primarily for non-body contact recreational uses and environmental enhancement. As designed, the metric constitutes a means to compare averages, variances and trends in normalized values over time (temporally) and by relative location (spatially) within the watershed. The index allows one to interpret large amounts of aggregated data and relate overall water quality variations to changes, be they from natural causes or anthropogenic impairments. The WQI has been used to identify general water quality trends over the past 18 years of monitoring and single out potential problem areas within the lower watershed. Such patterns and specific locations are then screened and evaluated in greater detail through direct observation of pertinent site-specific data by various public agencies and organizations entrusted with protection and enhancement of river water quality. Used in this manner, the index provides a further metric for evaluating effectiveness of many of the San Diego River improvement programs and may also be of support to agencies and organizations responsible in reformulating priorities or updating specific policies.

Running average WQI values from WY05 through WY22 are expressed by river section and reach on **Charts D.1 and D.2**, respectively. The overall temporal varience in WQI values and streamflow are expressed on **Chart D.3**. The spacial variances in index values for all the lower river monitoring sites are presented on **Chart D.4**.

Chart D.1 provides the range (max.-green, min.-red) in monthly values, the running averages by river section as well as monthly streamflow (blue bars) over the 18yr period (WY05-WY22) of water quality monitoring. The positive correlation in seasonal fluctuation between streamflow and water quality values is clear. Poorer water quality at all sections during years of below average stream discharge are shown. The overall (heavy black line) general decline in the index over 16 years is shown as a dashed line. Although the average annual rate of decline in the index is on the order of one percent; WYs 19 & 20 witnessed a measurable recovery from WY18 near-minimum values. The current running average index of 29 is 13% below the 18yr norm of 33. The highest index of 41 in WY05 was 25% above norm. The lowest running average index value (of 21 in Nov. '04) was 36% below the current norm.

Chart D.2 presents overall (LSDR) monthly running avearge WQI values (heavy black lines) over the past 18 years. Seasonal patterns expressed in monthly results and trends described by running averages in values are apparent for each reach of the river. The water quality fluctuations over time in individual reaches, sections and the overall LSDR flow-weaighted values expressed on both a running average and seasonal cycle basis can be observed. The Upper Santee Basin (USB) reach (red line, sites 13&14) have presented the lowest index values since March of 2010, whereas Mission Gorge (blue line, mid-section of the lower river watershed) consistently presents the highest values. It can also be noted (in both charts) that the greatest rate of decline in lower river water quality occured over a three year period (WY12 through early WY15) during an extended period of well-below normal streamflow.

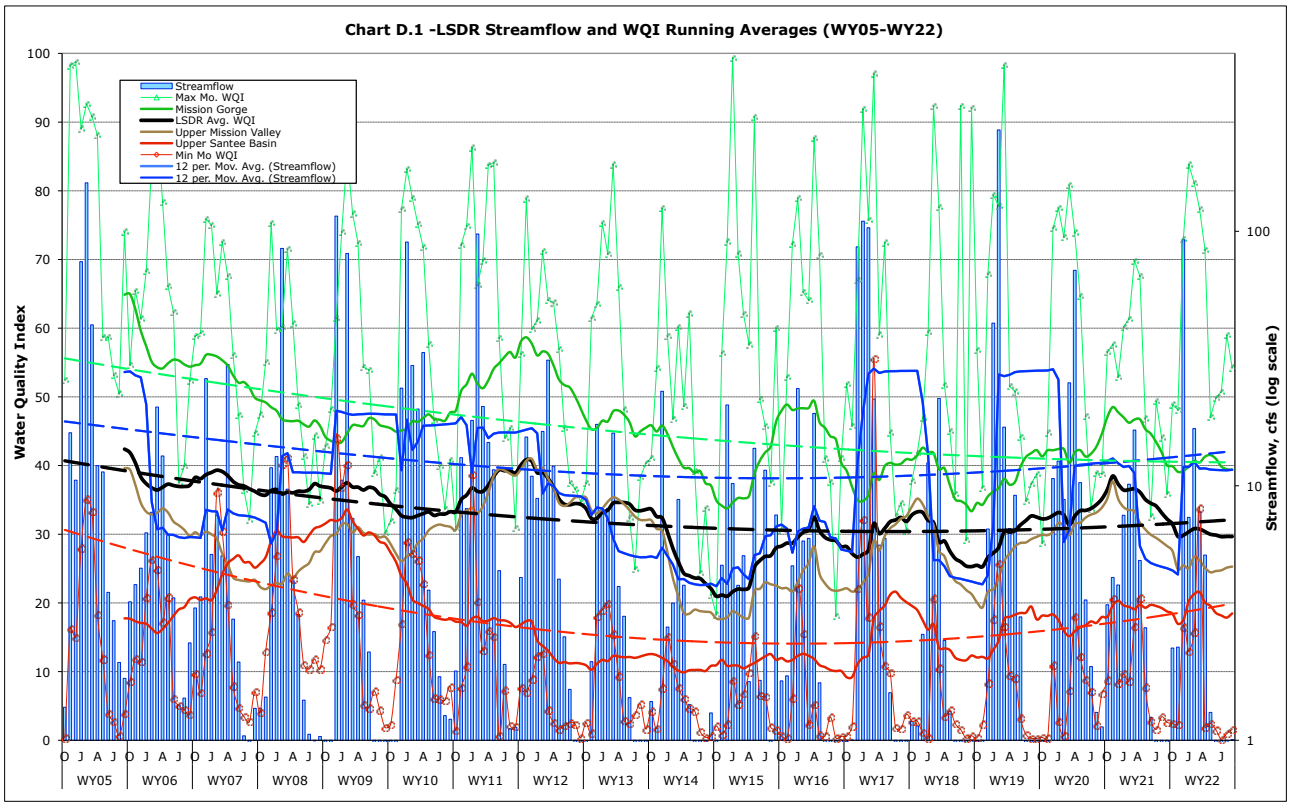
Chart D.1 -LSDR Streamflow and WQI Running Averages (WY05-WY22)
Water Quality Index
Streamflow, cfs (log scale)
Streamflow
Max Mo. WQI
Mission Gorge
LSDR Avg. WQI
Upper Mission Valley
Upper Santee Basin
Min Mo WQI
12 per. Mov. Avg. (Streamflow)
12 per. Mov. Avg. (Streamflow)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
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WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22

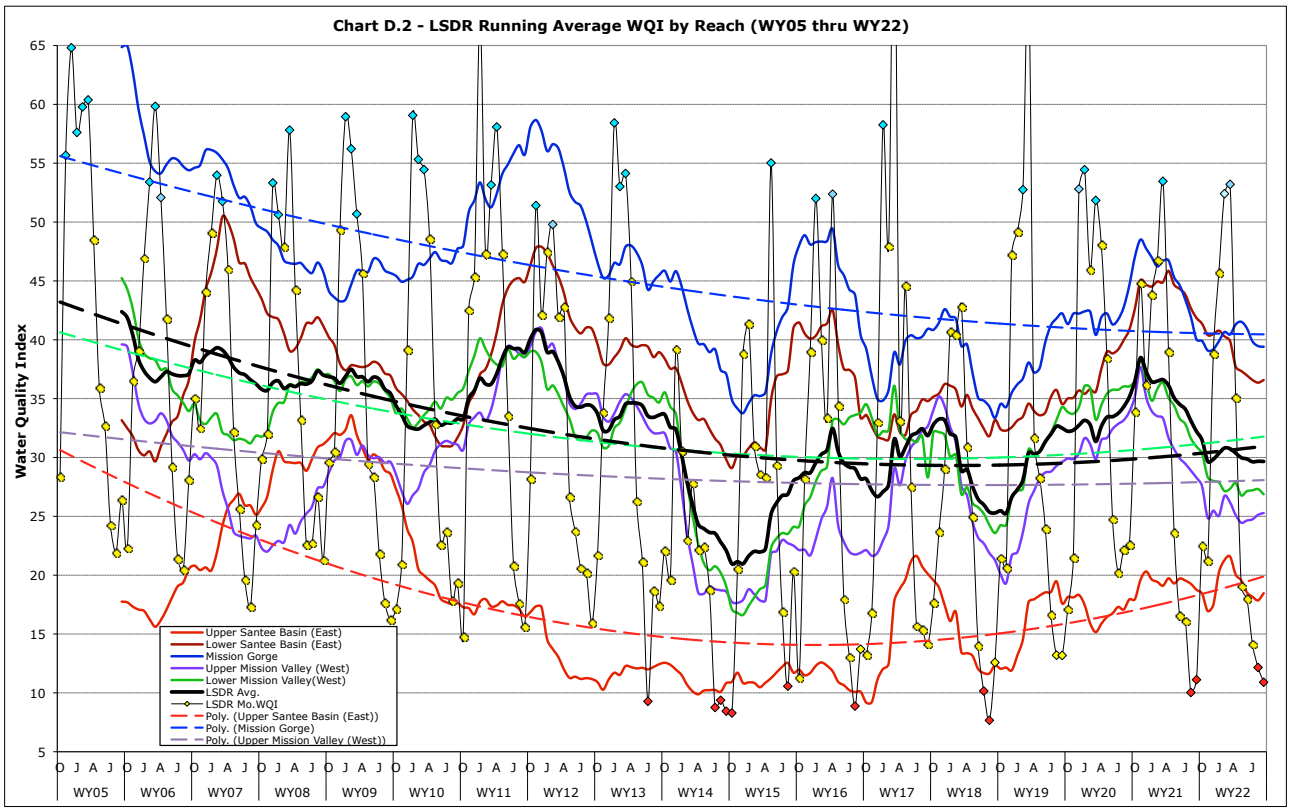
Chart D.2 - LSDR Running Average WQI by Reach (WY05 thru WY22)
Water Quality Index
Upper Santee Basin (East)
Lower Santee Basin (East)
Mission Gorge
Upper Mission Valley (West)
Lower Mission Valley(West)
LSDR Avg.
LSDR Mo.WQI
Poly. (Upper Santee Basin (East))
Poly. (Mission Gorge)
Poly. (Upper Mission Valley (West))
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22

Chart D.3 presents a temporal summary of variances in the water quality index values profiled on a monthly, seasonal and average annual water year basis for the five reaches of the river and overall. The variances in WQI can be visually compared to changes in 3-day streamflow (blue bars) expressed on the same temporal basies. Positive correlations are evident, i.e., increased average daily flow and higher water quality values. Low-flows extending throughout the summer and early fall months result in significantly poorer water quality. In year's of above average dry-weather (base) flows (WY14 & WY18), improvements in index values for each of the five reaches and overall (heavy black line) of the lower river system results. Irrespective of the water year the Mission Gorge reach (blue curve) has presented the highest WQI values while the Upper Santee Basin reach (red curve) has (with exception of WY07 & WY08) shown lowest values. The second poorest water quality reach is the Upper Mission Valley reach (green curve). The second best reach is the Lower Santee Basin (brown curve). On a seasonal basis Autumn and Summer values are consistantly lower than Winter (highest) and Spring (second highest) values for all reaches and overall. August is typically the month of lowest water quality and lowest streamflow. January and March are commonly the months of best water quality for all reaches. Larger flood flows often occuring in February typically depress WQI values by several points comparred to the other months of winter.

Chart D.4 provides a spatial profile of average annual WQI by river monitoring site, reach and section for this year (WY22), compared to last year (WY21), the best (WY05), the worst (WY14) and the 18yr winter (Dec-Jan), summer (Jun-Sept) and annual (Oct-Sept) norms. The sites are shown from left to right in the order they occur ascending upstream. The current (WY22) average annual WQI values for each site, shown as both a heavy black line and as colored bars, are slightly below norms (also dashed color bars) at all but one site (#9T-Birchcreek Outfall). Sites with lowest water quality in WY22, as well as over the past decade, are #13E-Mast Park East in Upper Santee Basin and #7-Kaiser Pond outfall in Upper Mission Valley. The Mission Gorge portion (sites 8-10) of the watershed continues to demonstrate best overall water quality. The 18 yr winter (dashed blue) and summer (dashed red) WQI norms are also shown in profile to provide basic appreciation of the range in index values occuring throughout the lower river system extending some 23 miles from Lakeside to the estuary in lower Mission Valley between I-5 and Pacific Highway.

Monthly and running average WQI values for each reach of the lower river and overall are presented in Section 5 of the WY22 Annual WQM Report (see Charts 5.1-5.6) together with discussion of the individual trends associated with each. It is apparent that some reaches of the river experience water quality changes far more rapidly than others and that several sites represent "hotspots" of continued poorer quality waters that are less suseptable to changes in ambient conditions.

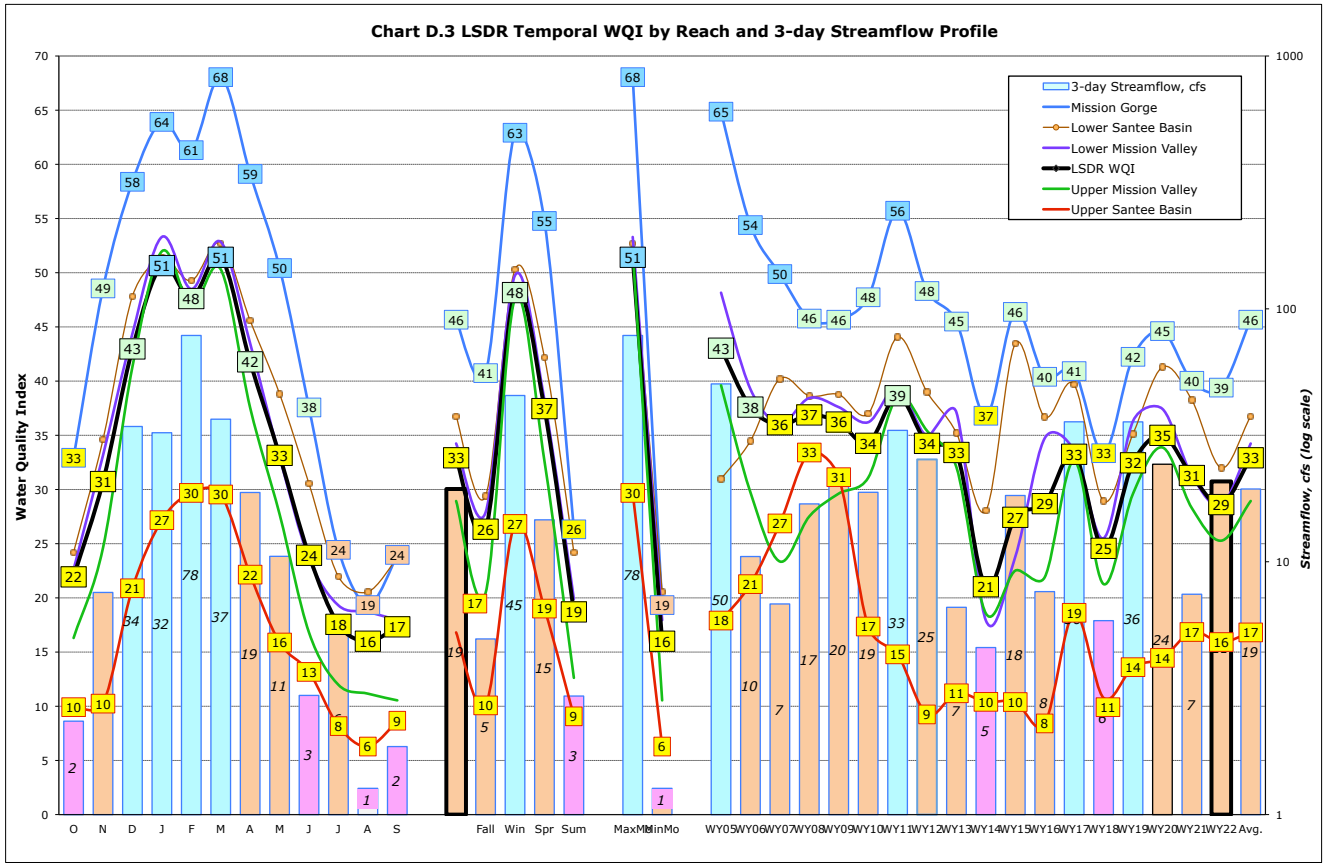
Chart D.3 LSDR Temporal WQI by Reach and 3-day Streamflow Profile
Water Quality Index
Streamflow, cfs (log scale)
3-day Streamflow, cfs
Mission Gorge
Lower Santee Basin
Lower Mission Valley
LSDR WQI
Upper Mission Valley
Upper Santee Basin
O N D J F M A M J J A S
Fall Win Spr Sum
MaxMo MinMo
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15 WY16 WY17 WY18 WY19 WY20 WY21 WY22 Avg.

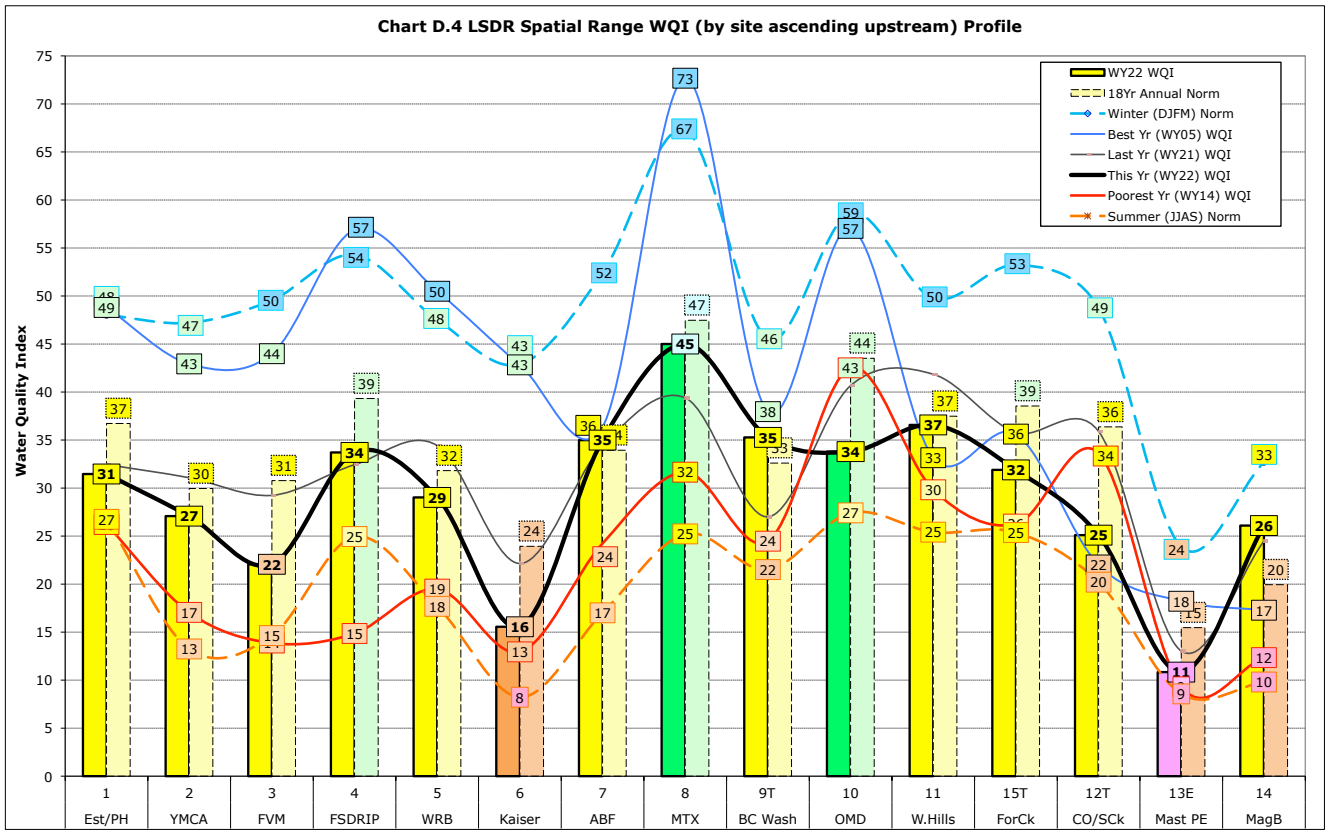
Chart D.4 LSDR Spatial Range WQI (by site ascending upstream) Profile
Water Quality Index
WY22 WQI
18Yr Annual Norm
Winter (DJFM) Norm
Best Yr (WY05) WQI
Last Yr (WY21) WQI
This Yr (WY22) WQI
Poorest Yr (WY14) WQI
Summer (JJAS) Norm
1 Est/PH
2 YMCA
3 FVM
4 FSDRIP
5 WRB
6 Kaiser
7 ABF
8 MTX
9T BC Wash
10 OMD
11 W.Hills
15T ForCk
12T CO/SCk
13E Mast PE
14 MagB

Appendix G - San Diego RiverWatch WQM Team Members

Supervision/Coordination: Rob Hutsel (2004-05), Kym Hunter (2006-07), Shannon Quigley-Raymond (2008-19), Lisa Schiavinato, Natasha Rodriguez, Aixa Willoughby (2020-21), Sarah Hutchmacher (2021-22). Current list of RiverWatch **Volunteers:** (site monitoring/sampling/testing at multiple events)

Aidan Kennedy
Alan Ramirez
Alexandra Shalosky
Amethyst Cruspero
Amy Cook
Ang Nguyen
Barbara Owen
Bill Martin
Birgit Knorr
Bob Stafford **
Brent Redd
Calvin Vine **
Cameron Bradley
Carl Abulencia
Celena Cui
Chandler Hood
Chris Peter
Chris (Soltan)
Christine Lavoine
Clint Williams
Cody Gallagher
Conrad Brennen **
Craig McCartney
Dani Tran
Danielle Marshall
David Lapota
Demitrio Duran
Donna Zoll
Doug Taylor
Duncan Miller
Ebony Quilteret
Edward Garritty
Ehk'lu (Soltan)
Emily Erlewine
Erin Babich
Fred Ward
Gabriel M. Mercado
Gary Strawn ***
George Liddle ***
Gina Martin
Heidi Rodarmer
Jack Greco
Jalil Ahmad
Janae Fried
Jasmin Augstin
Jason Andres
Jim Thornley
Joan Semler
John Kennedy ***
Joyce Nower
Karrengton Fountain
Katharyn Morgan
Katherine Crosby
Kathryn Stanaway
Katy Robinson
Kelly Brown
Kenneth Santos
Kevin Bernaldez
Krissy Lovering
Krystal Tronbol
Laqueta Strawn
Linda King
Linda Tarke
Lindsey Dornes
Lindsey Teunis
Lindy Harshberger
Lois Dorn
Lucas Salazar
MadisonMcLaughlin
Maesa Hanhan
Marcus King
Mark Carpenter
Mark Drieling **
Mark Hammer
Marlene Baker
Martin Offenhauer **
Mary Hansen
Matt Olson
Melany Vina
Melissa Garret
Melissa Maigler
Michael Mikulak
Michael Sowadski
Mike Hanna **
Mike Hunter
Mitchell Manners
Mitzi Quizon
Mojisola Ogunleye
Natelie Rodriguez
Nicole Beeler
Noah Potts
Norrie Robbins
Paul Hormick **
Paul Nguyen
Rachel Morales
Randy Mitchell
Raymond Ngo
Reggie Agarma
Russell Burnette
Sami Collins
Samuel Martin
Sandra Pentney
Sara Winter
Shelia-Ann Jacques
Silvana Procopio
Star Soltan
Tim Toole
Tina Davis
TomYounghusband **
Toni Nguyen
Tony de Garate
Trish Narwold
Valerie Rawlings
Veronika Shevchenko
Vidhya Nagarajan
Vince Caldwell ***
Wendy Kwong
Yang Jiao
Yvette Navarro
Bethany Caeter
Monica Torres

*** Team Leaders

Appendix H - Glossary

Abreviations:

AADF - Average Annual Daily Flow
ACC - Average Coliform Count (arithmetic mean of fecal coliform, e-Coli & total coliform in MPN/100mL)
ADWF – Average Daily (stream) Dry-Weather Flow
AFY - acre-feet per year
Avg– Average
cfs - cubic feet per second (flow/discharge)
Ck – Creek
CY - Calendar Year (Jan 1 - Dec 31)
DO – Dissolved Oxygen
DOD- Dissolved Oxygen Depletion (level below minimum required
DO%Sat – Dissolved Oxygen 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 = 1,000 uS/cm)
MG – Mission Gorge (mid-section of LSDR)
MV – Mission Valley (West section of LSDR)
MPN - Most Probable Number (of coliform organisms)
SB – Santee Basin (East section of LSDR)
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
SpC – Specific Conductivity (also Conductivity or Conductance; sometimes abbreviated SC)
SDRPF – San Diego River Park Foundation
TDS – Total Dissolved Solids
Temp. – Temperature
TN/TP – Total Nitrogen/ Total Phosphorus (nutrients)
USGS – U.S. Geological Survey
uS/cm –microSeimens per centimetre
(1 uS/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 parameters
WQI(6) - WQI using 6 parameters
WY – Water Year (Oct 1 – Sept 31)
% - percent
%Sat - percent of DO saturation value
C – degrees Celsius $^oC = (^oF-32)*5/9$
^oF – degrees Fahrenheit $^oF = (^oC*9/5) + 32$

Formulas:

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 streamflow/river discharge.

Total Dissolved Solids (TDS in mg/L) = 670*Specific Conductivity, (where SpC is in mS/cm). An approximate relationship for LSDR 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 ^oC.
Other variables, incl. barometric pressure, elevation and conductivity (SpC), have negligible impact on the DO-DO%Sat relationship within the LSDR watershed.

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

WQI_4 = DO%Sat*2.5*T factor*Q factor/log(SpC);
where SpC 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)

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

The SDR WQI is developed specifically for the SDRPF RiverWatch Monitoring Program, however, the equations may also be applied to water quality and hydrologic data for other coastal watercourses where comparable metrics are available.

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 (head)
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
1,000 gpm = 1.436 mgd = 2.23 cfs = 4.42 AF/day = 1,614 AFY
1 inch (rainfall) = 25.4 mm

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Table E.1 - RiverWatch WQM Data Summary - WY20						
Section	Mission Valley		Mission Gorge	Santee Basin		Watershed
Sites	1-4	5-7	8-10	11,15T,12T	13W,13E,14	**all (1-15)**
Reach	LMV	UMV	MG	LSB	USB	LSDR [a]
Annual (October 2019 - September 2020):						
ADF, cfs	49 *(30)*	46 (28)	26 (19) [b]	21 *(16)*	9.3 *(5.0)*	**30** *(20)*
Temp, °C	19.9 *(19.4)*	18.5 *(17.9)*	17.3 *(17.1)*	17.5 (17.4)	18.2 *(18.1)*	**18.4** *(18.0)*
SpC, mS/cm	2.63 *(2.58)*	2.46 *(2.55)*	2.09 *(2.28)*	2.07 (2.25)	1.52 *(1.78)*	**2.15** *(2.28)*
DO, mg/L	5.52 *(5.06)*	3.73 *(4.44)*	7.50 *(7.49)*	6.50 *(6.54)*	2.33 *(2.99)*	**5.01** *(4.98)*
DO %of Sat.	60 *(54)*	38 *(46)*	77 *(77)*	67 *(64)*	25 *(31)*	**53** *(51)*
WQIa	37 *(35)*	34 *(30)*	45 *(46)*	41 *(37)*	15 *(17)*	**32** *(31)*
WY20 Grade	**D+ Marginal**	**D Marginal**	**C Fair**	**C Fair**	**E Poor**	**D Marginal**
16-yr Norm	*(D Marginal)*	*(DMarginal)*	*(C Fair)*	*D+ Marginal)*	*(E Poor)*	*(D Marginal)*
Summer Period (June 2020 - September 2020):						
ADF, cfs	3.4 *(3.2)*	3.2 (2.9)	2.9 (1.9) [c]	2.8 (1.8)	1.1 (0.4)	**2.7** *(2.1)*
Temp, °C	25.5 (24.3)	23.6 (21.9)	22.2 (21.8)	21.6 (21.5)	23.7 (22.9)	**23.5** *(22.6)*
SpC, mS/cm	3.32 (3.25)	3.09 (3.17)	2.39 (2.86)	2.07 (2.25)	1.52 (1.78)	**2.61** *(2.78)*
DO, mg/L	4.24 (3.22)	2.88 (2.51)	3.90 (5.58)	6.66 (5.62)	2.13 (2.13)	**3.95** *(3.42)*
DO % of Sat.	52 (39)	34 (29)	42 (61)	76/(64)	26 (25)	**47** *(39)*
WQI	25 (20.5)	17 (14.5)	30 (27.5)	29 (24.4)	10 (9.2)	**21** *(18.0)*
WY20 Grade	**D- Marginal**	**E Poor**	**D Marginal**	**D Marginal**	**F Very Poor**	**E Poor**
16-yr Norm	*(E Poor)*	*(E Poor)*	*(D Marginal)*	*(E+ Poor)*	*(F VeryPoor)*	*(E Poor)*
Winter Period (December 2019- March 2020):						
ADF, cfs	27 *(68)*	25 (62)	16 (43)	14 (36)	5.8 (11)	**17** *(45)*
Temp, °C	14.6 (14.5)	14.1 (13.7)	12.7 (12.7)	13.3 (13.4)	13.2 (13.6)	**13.8** *(13.6)*
SpC, mS/cm	1.86 (1.84)	1.75 (1.76)	1.76 (1.63)	1.75 (1.81)	1.24 (1.44)	**1.64** *(1.67)*
DO, mg/L	7.59 (6.91)	7.84 (6.57)	9.64 (9.16)	8.24 (7.92)	2.75 (3.94)	**5.46** *(6.46)*
DO % of Sat.	74 (68)	76 (64)	92 (87)	79 (73)	27 (37)	**53** *(62)*
WQI	54 (50)	57 (48)	63 (63)	54 (50)	19 (27)	**47** *(46)*
WY20 Grade	**B Good**	**B Good**	**B Good**	**B Good**	**E Poor**	**C Fair**
16-yr Norm	*(B- Good)*	*(C+ Fair)*	*(B Good)*	*(B- Good)*	*(DMarginal)*	*(C Fair)*

Table E.2 - RiverWatch WQM Data Summary - WY21							
Section	Mission Valley			Mission Gorge	Santee Basin		**All**
Sites	1-3	4, 5	6-7	8-10	11,15T,12T	13W,13E,14	**(1-15)**
Reach	LMV	MMV	UMV	MG	LSB	USB	**LSDR** [a]
Annual (October 2020 - September 2021):							
ADF, cfs	12 *(30)*	12 *(30)*	11 *(29)*	8 *(19)* [b]	7 *(17)*	3.1 *(7)*	8 *(21)*
Temp, °C	19.0 *(19.4)*	18.5 (18.6)	17.7 *(17.9)*	15.7 *(17.0)*	16.3 *(17.4)*	17.6 *(18.1)*	17.2 *(17.9)*
SpC, mS/cm	**2.95** *(2.61)*	**2.90** *(2.58)*	**2.82** *(2.56)*	**2.30** *(2.28)*	**2.27** (2.25)	**1.87** *(1.78)*	**2.51** *(2.35)*
DO, mg/L	4.79 *(5.04)*	4.74 (4.76)	4.69 *(4.49)*	7.29 *(7.47)*	6.52 *(6.54)*	**3.16** *(3.00)*	5.41 *(5.43)*
DO %of Sat.	50 *(53)*	49 *(50)*	**48** *(46)*	72 *(76)*	**65** *(65)*	**33** *(31)*	**51** *(51)*
WQIa	31 *(35)*	33 *(36)*	28 (29)	40 *(46)*	**38** *(37)*	**17** *(17)*	31 *(32)*
WY21 Grade	**31 D**	**33 D**	**28 D**	**40 C**	**38 C**	**17 E**	**31 D**
WY20 Grade	37 D+	37 D+	34 D	45 C	41 C	15 E	34 D
Summer Period (June 2021 - September 2021):							
ADF, cfs	1.3 *(3.4)*	1.3 *(3.3)*	1.2 *(3.2)*	0.9 *(2.0)* [c]	0.9 *(1.9)*	0.3 *(0.7)*	1.0 *(2.2)*
Temp, °C	**24.3** *(24.3)*	**23.1** *(23.0)*	**22.0** *(22.0)*	**21.8** *(21.8)*	20.9 *(21.5)*	**23.4** (22.9)	**22.4** *(22.4)*
SpC, mS/cm	**3.70** *(3.28)*	**3.60** *(3.22)*	**3.49** *(3.19)*	**2.81** *(2.85)*	**2.70** *(2.64)*	**2.10** *(2.01)*	**3.05** *(2.87)*
DO, mg/L	2.70 *(3.19)*	2.51 *(2.85)*	2.32 *(2.51)*	4.17 *(5.50)*	3.79 *(5.18)*	2.44 *(2.15)*	3.09 *(3.75)*
DO % of Sat.	32 *(38)*	29 *(33)*	27 *(29)*	48 *(63)*	43 *(56)*	**31** *(25)*	35 *(39)*
WQI	14 *(20)*	16 *(21)*	10 *(13)*	14 *(27)*	18 *(24)*	**10** *(9)*	13 *(18)*
WY21 Grade	**14 E-**	**16 E**	**10 F**	**14 E-**	**18 E**	**10 F**	**13 E-**
WY20 Grade	25 D-	24 E+	17 E	30 D	29 D	10 F	22 E
Winter Period (December 2020 - March 2021):							
ADF, cfs	28 *(70)*	27 *(68)*	26 *(66)*	18 *(44)*	16 *(38)*	7 *(17)*	19 *(47)*
Temp, °C	13.6 *(14.4)*	13.5 *(14.1)*	13.2 *(13.7)*	10.1 *(12.5)*	11.9 *(13.3)*	12.0 *(13.5)*	12.2 *(13.5)*
SpC, mS/cm	**2.16** *(1.86)*	**2.10** *(1.82)*	**1.99** *(1.77)*	**1.81** *(1.64)*	**1.86** *(1.81)*	**1.61** *(1.45)*	**1.91** *(1.73)*
DO, mg/L	**7.04** (6.91)	**6.90** *(6.75)*	**6.76** *(6.58)*	**9.69** *(9.19)*	**8.40** *(7.95)*	3.40 *(3.90)*	**7.31** *(7.11)*
DO % of Sat.	**69** (68)	**67** *(66)*	**65** *(64)*	**87** *(87)*	**78** (73)	32 *(37)*	62 *(63)*
WQI	47 *(50)*	48 *(51)*	44 *(48)*	58 *(63)*	**50** *(50)*	20 *(27)*	44 *(47)*
WY21 Grade	**47 C**	**48 C**	**44 C**	**58 B**	**50 B-**	**20 E**	**44 C**
WY20 Grade	54 B-	55 B	57 B	63 B	54 B-	19 E	49 C+

Table E.3 - RiverWatch WQM Data Summary - WY22							
Section	Mission Valley			Mission Gorge	Santee Basin		**All**
Sites	1-3	4, 5	6-7	8-10	11,15T,12T	13W,13E,14	**(1-15)**
Reach	LMV	MMV	UMV	MG	LSB	USB	**LSDR** [a]
Annual (October 2021 - September 2022):							
ADF, cfs	15 *(27)*	15 *(26)*	14 *(25)*	8.6 *(18)* [b]	7.0 *(16)*	3.1 *(7)*	9.7 *(19)*
Temp, °C	**19.2** *(19.1)*	18.3 (18.4)	**18.4** *(18.2)*	**16.9** *(16.4)*	**17.1** *(16.7)*	**18.5** *(18.0)*	**17.9** *(17.7)*
SpC, mS/cm	2.61 *(2.62)*	**2.80** *(2.56)*	**2.71** *(2.55)*	**2.41** *(2.25)*	**2.27** (2.24)	**1.83** *(1.72)*	**2.41** *(2.27)*
DO, mg/L	3.57 (4.48)	4.77 (5.40)	3.74 *(4.29)*	6.12 *(7.05)*	5.90 *(6.09)*	**3.27** *(3.11)*	4.65 *(5.10)*
DO %of Sat.	38 *(47)*	51 *(57)*	39 *(44)*	62 *(72)*	**61** *(60)*	**34** *(32)*	48 *(52)*
WQI[a] (norm)	29 *(34)*	31 *(36)*	25 (29)	39 *(46)*	32 *(37)*	16 *(17)*	29 *(33)*
WY21 Grade	31 D	33 D	28 D	40 C	38 C	17 E	31 D
WY22 Grade	29 D+	31 D+	25 D	39 C	32 C	16 E	29 D
Summer Period (June 2022 - September 2022):							
ADF, cfs	1.9 *(3.0)*	1.9 *(3.0)*	1.8 *(2.9)*	0.9 *(2.0)* [c]	0.6 *(1.8)*	0.2 *(0.7)*	1.1 *(2.0)*
Temp, °C	**23.8** *(23.7)*	**22.8** *(22.8)*	**22.8** *(22.6)*	**21.3** *(20.8)*	**21.6** *(20.6)*	**23.9** (22.8)	**22.6** *(22.1)*
SpC, mS/cm	**3.52** *(3.33)*	**3.20** *(3.17)*	3.09 *(3.15)*	**2.47** *(2.43)*	2.61 *(2.64)*	**1.99** *(1.93)*	**2.71** *(2.68)*
DO, mg/L	1.78 *(2.45)*	3.87 *(3.83)*	2.30 *(2.23)*	1.74 *(4.68)*	3.79 *(5.18)*	2.44 *(2.15)*	2.64 *(3.45)*
DO % of Sat.	22 *(29)*	47 *(45)*	28 *(26)*	21 *(54)*	43 *(56)*	**31** *(25)*	31 *(39)*
WQI (norm)	17 *(20)*	20 *(21)*	12 *(13)*	8 *(26)*	19 *(24)*	7 *(9)*	13 *(19)*
WY21 Grade	14 E-	16 E	10 F	14 E-	18 E	10 F	14 E-
WY22 Grade	**17 E**	**20 E**	**12 F+**	8 D	**19 E**	7 F	13 E-
Winter Period (December 2021 - March 2022):							
ADF, cfs	36 *(69)*	34 *(65)*	32 *(62)*	19 *(43)*	16 *(37)*	7.1 *(17)*	22 *(45)*
Temp, °C	**15.0** *(14.4)*	**14.5** *(14.0)*	**14.6** *(13.8)*	**12.8** *(12.1)*	**12.9** *(12.9)*	**13.6** *(13.5)*	**13.7** *(13.3)*
SpC, mS/cm	**1.94** *(1.85)*	**1.81** *(1.80)*	**1.80** *(1.76)*	**2.32** (2.02)	**1.84** *(1.74)*	**1.61** *(1.42)*	**1.88** *(1.75)*
DO, mg/L	6.10 (6.62)	6.87 *(7.09)*	**6.76** *(6.58)*	**9.16** *(9.11)*	**8.40** *(7.95)*	3.40 *(3.90)*	**7.18** *(6.79)*
DO % of Sat.	61 (66)	68 *(69)*	**66** *(65)*	**87** *(87)*	**78** (73)	32 *(37)*	**70** *(65)*
WQI (norm)	41 *(49)*	50 *(51)*	37 *(42)*	58 *(60)*	40 *(47)*	**25** *(23)*	41 *(44)*
WY21 Grade	47 C	48 C	38 C-	53 B	49 C+	22 E	40 C
WY22 Grade	**47 C**	**50 C**	37 D+	**58 B**	40 C	**25 D-**	**41 C**

Appendix F - Variances & Trends in LSDR WQM Metrics (WY05-WY22)

The variences 12-mo running average values for selected sections of the lower river and overall, extending from Sept. 2004 through Sept. 2022, for each of the primary WQM metrics are presented in **Charts F.1-F.5** along with associated 18-yr trend lines (dashed) for each portion of the river. **Chart F.6** compares the overall (LSDR) variances and trends for five of the key water quality metrics. Extended periods (cycles) of below average rainfall (red line) and streamflow (blue) result in below average DO (green), above average SpC (yellow) and below average WQI values (black line). These relationships are discussed in Section 5 of the Annual Report.