LOWER SAN DIEGO RIVER WATER QUALITY

WY21 Water Quality Monitoring Report (Appendices A-I)

Summer 2021 algal/phytoplankton growth occuring below Magnolia Ave bridge (WQM Site 14).

Water Quality Monitoring Data and Supporting Information

John C. Kennedy, PE

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LOWER SAN DIEGO RIVER
WY21 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/foot 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 in from end of River Rock Ct.	32.84696	-116.97335
14W	Cottonwood Ave/RCP	19.84	340	N. of Chubb Ln. at old RCP plant culvert	32.84434	-116.98947
14E	Magnolia Ave. bridge	19.9	342	Under Magnolia Bridge/West end of culvert	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 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 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 recorded by other entities.

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 (SD)
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 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 flow, as its better aerated, whereas eutrophication most often occurs in reaches of very low velocity.

LSDR average daily flow (ADF) values as recorded at the two USGS gauging stations in the lower watershed are expressed for the 17-yr monitoring period (Oct 2004 - Sept 2021) and over the past 57 years (1965-2021) of record in **Tables B.1** and **B.2**, respectively**.** The current 17-yr norms are roughly 20% below the 57-yr long-term values in Mission Valley and 25% below in the Santee Basin. WY21 ADF is 39% below the 17-yr norm and 49% less than the historic averages recorded at the Fashion Valley site. Average LSDR streamflow for WY21 of 9.0 cfs is 60% below the current 17-year norm and 48% less than the 57-yr long-term average of 17.4 cfs.

Table B.1 - Lower SDR Average Daily Streamflow (WY21 and 17-yr Norms)

Location	West - Mission Valley		East - Santee Basin		LSDR [a]	
Season	WY21	*17-yr norm*	WY21	*17-yr norm*	WY21	*17-yr norm*
Fall (Oct-Nov) ADF, cfs	5.1	*15.3*	5.0	*9.7*	4.5	*12*
Winter (Dec-Mar) ADF, cfs	58.0	*70.7*	15.9	*37.5*	39.1	*51.4*
Spring (April-May) ADF, cfs	5.3	*21.6*	3.9	*12.4*	92.5	*16.2*
Summer (June-Sept) ADF, cfs	1.3	*2.6*	0.8	*1.5*	2.7	*2.0*
Annual ADF [b], cfs	11.8	*30.6*	7.0	*17.1*	9.0	*22.5*
Wet Season (Nov-April)	29.0	*70.7*	15.9	*37.6*	21.3	*51.4*
Dry Season (May-Oct)	1.3	*2.7*	0.8	*1.5*	1.0	*2.1*
River Discharge, AFY [c]	8,540 7.6 mgd	*22,155* *19.8 mgd*	5,070 4.5 mgd	*12,380* *11.0 mgd*	6,515 5.8 mgd	*16,290* *14.5 mgd*

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 (1914-2021) and Average Daily Streamflow (1954-2021)

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	580/22.8	68	113	92
Wet	10	9%		15-20	380-499	430/16.9	48	81	66
Above Norm [d]	19	18%		12-15	300-379	340/13.4	26	44	35
Normal	40	37%	37%	8-12	200-299	250/9.8	10	18	15
Dry	27	25%	33%	5-8	125-199	160/6.3	7	12	10
Very Dry	8	7%		<5	<125	100/3.9	5	9	7
Total/AAvg	107	100%		9.94		252/9.9	14.2	23.3	17.4

a) Total annual rainfall accumulated from 1 October through September 31 of following 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.

Total annual rainfall and ADF over the past 57 years of hydrologic record and during the 17-year period of RiverWatch monitoring for the two LSDR gauging stations are presented in **Tables B.2 and B.3**, respectively. In terms of total annual rainfall (TARF), WY05 has been the only "Very Wet" (TARF > 20") hydrologic year over the past 17 annual cycles. On the other hand, there have been four water year's (07, 13, 14 and 21) in the past 17 that were all "Very Dry" (TARF <5"). WY15 is the only water year since RiverWatch began where rainfall was somewhat above normal but recorded streamflow was below. WY21 total rainfall of 4.74 inches (120 mm) is 49% below the 17-yr norm and 52% below long-term average of 9.86 inches (250 mm). The 17-yr ADF's for the East and West sections of 18 and 31 cfs, respectively are roughly 25% below long-range values while average daily flows for this year (WY21) were 60% below the 17-yr norms and 68% less than the long-range (57-yr) values.

Monthly discharge data (min, max and average daily flow) for the two USGS gauging stations extending from Oct. 2004 through Oct. 2021 are plotted in **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 improvement in WY15, tempered by lows in WY18 and again this year (WY21), as expressed in thre charts.

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 last 17 years of record.

Table B.3 - Annual Rainfall and Average Daily Flow (WY05-WY21)

(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	-436%	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%**	**7.0 (5)**	**11.8 (9)**	**9 (6)**	**-60%**
17-yr Norm (05-21)	*238*	*9.38*	*0%*	*17.7 (6)*	*30.6 (20)*	*22.5(14)*	*0%*
57-yr AAD	*250*	*9.86*	*5%*	*21.8/(14)*	*36.7 (24)*	*28.4 (18)*	*26%*

a) Percent difference from 17-yr 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 17 yr Norm.

Average daily streamflow (as lines) and total annual rainfall (as bars) are also expressed in **Chart B.3** on a water years 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 (WYs 07,14,18 and 21) also experienced below normal streamflow. The six years of highest rainfall (WY's05,11,15,17,19 and 20) were all above normal in terms of streamflow. WY21 again experienced well below normal rainfall and significantly less streamflow than last year (WY20), the 17-year norms and long-term 57-yr averages. The variances and patterns in rainfall and streamflow remain consistant for summer and winter values, and for eastern and western sections of the river.

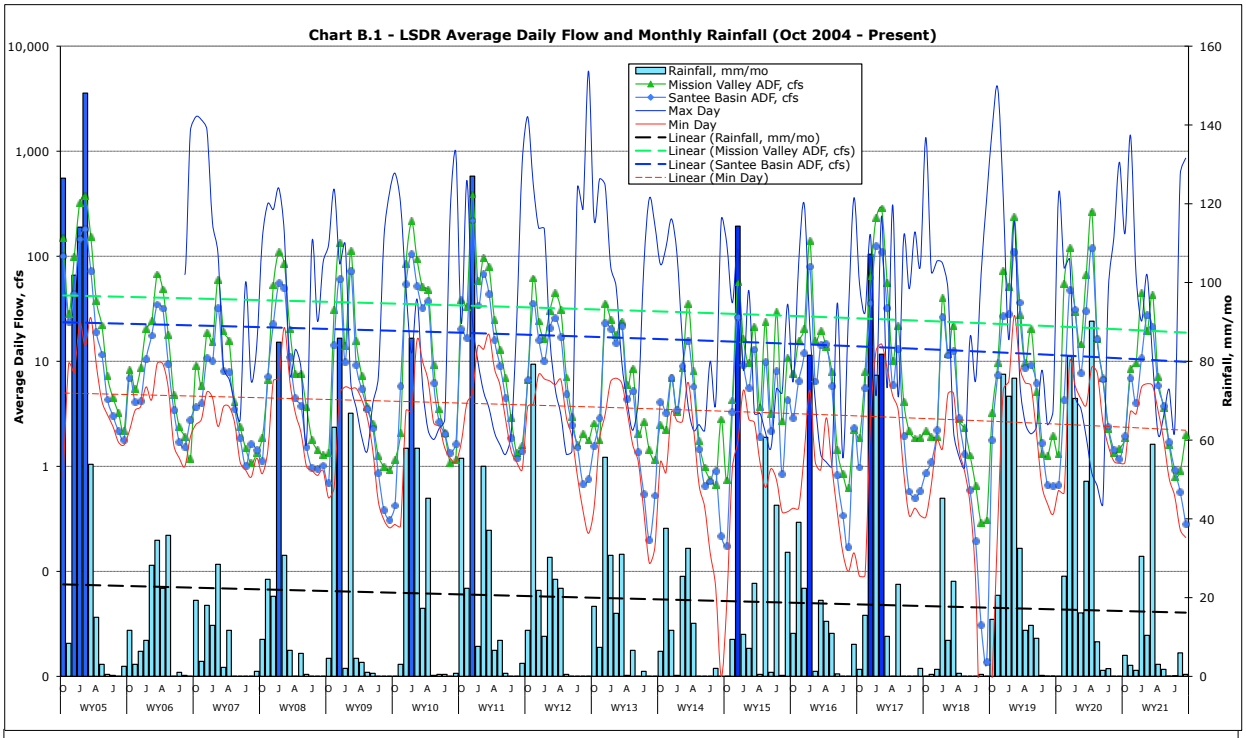
Chart B.1 - LSDR Average Daily Flow and Monthly Rainfall (Oct 2004 - Present)
Rainfall, mm/mo
Mission Valley ADF, cfs
Santee Basin ADF, cfs
Max Day
Min Day
Linear (Rainfall, mm/mo)
Linear (Mission Valley ADF, cfs)
Linear (Santee Basin ADF, cfs)
Linear (Min Day)
Average Daily Flow, cfs
Rainfall, mm/mo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

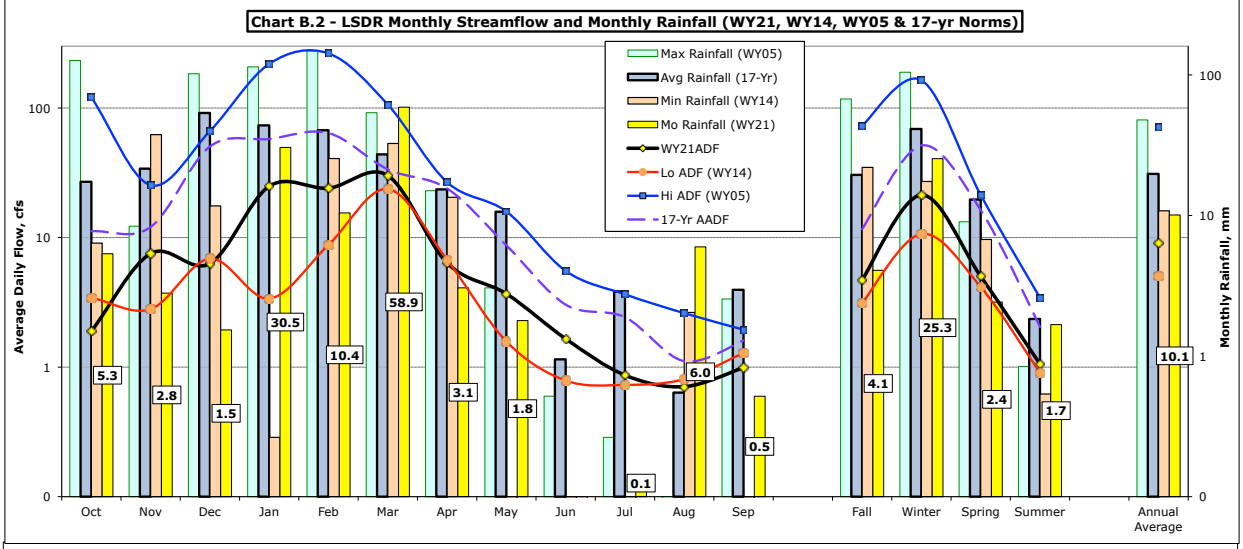
Chart B.2 - LSDR Monthly Streamflow and Monthly Rainfall (WY21, WY14, WY05 & 17-yr Norms)
Max Rainfall (WY05)
Avg Rainfall (17-Yr)
Min Rainfall (WY14)
Mo Rainfall (WY21)
WY21ADF
Lo ADF (WY14)
Hi ADF (WY05)
17-Yr AADF
Average Daily Flow, cfs
Monthly Rainfall, mm
5.3
2.8
1.5
30.5
10.4
58.9
3.1
1.8
0.1
6.0
0.5
4.1
25.3
2.4
1.7
10.1
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Fall
Winter
Spring
Summer
Annual Average

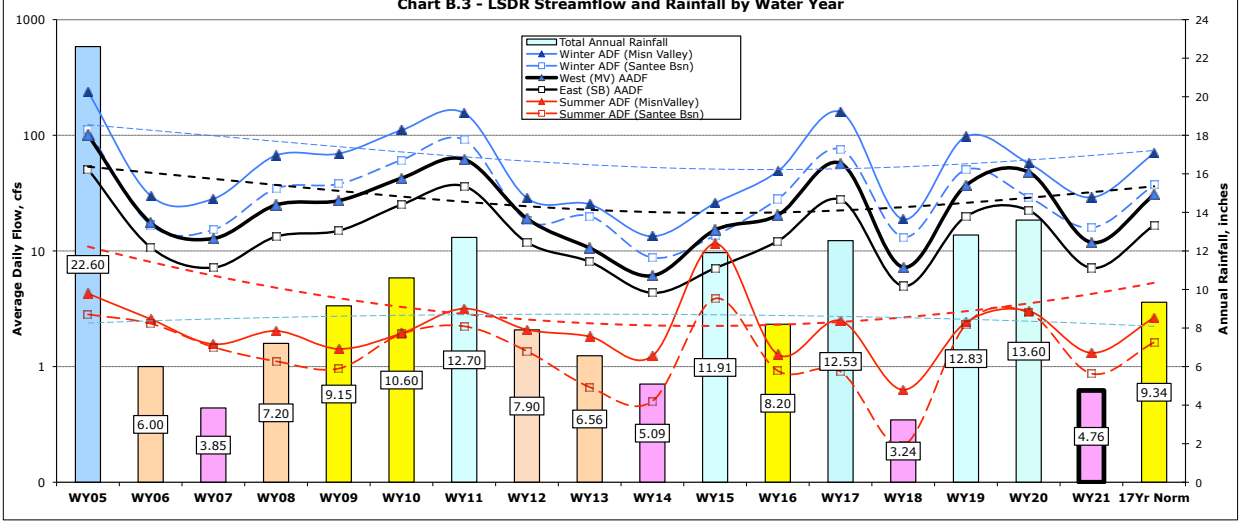
Chart B.3 - LSDR Streamflow and Rainfall by Water Year
Total Annual Rainfall
Winter ADF (Misn Valley)
Winter ADF (Santee Bsn)
West (MV) AADF
East (SB) AADF
Summer ADF (MisnValley)
Summer ADF (Santee Bsn)
Average Daily Flow, cfs
Annual Rainfall, inches
22.60
6.00
3.85
7.20
9.15
10.60
12.70
7.90
6.56
5.09
11.91
8.20
12.53
3.24
12.83
13.60
4.76
9.34
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
17Yr Norm

Appendix C
Monthly WQM Site Data for WY21/WY20

Appendix C consists of six tables listing this (WY21) and last (WY20) year's RiverWatch water quality monitoring data by month (down) and site (across). Tables C.1(W) and C.1(M-E) present water temperature recordings. Tables C.2- Specific Conductance, C.3 - pH, C.4 - Dissolved Oxygen Concentration , C.5- DO as Percent of Saturation, and C.6 Nutrients (NO3 & PO4) at selected sites.

Table C.1(W) West Section Water Temperature (WY21/WY20) Data

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	22.4/24.4	18.7/19.8	19.3/20.7	16.9/20.5	15.4/16.0	16.7/18.3	19.4/18.8
Nov	16.5/18.4	16.0/17.5	17.2/17.8	16.7/18.0	16.7/14.4	17.5/16.0	15.7/16.5
Dec	12.9/13.2	12.2/12.1	12.6/12.1	12.0/11.8	11.3/11.6	11.5/11.8	11.6/11.4
Jan	13.0/12.8	12.1/12.6	12.5/12.5	11.7/12.4	12.5/11.7	12.3/12.0	13.5/11.6
Feb	15.1/16.6	14.9/16.5	14.9/16.5	14.7/15.7	14.2/15.2	14.3/15.7	13.7/15.5
Mar	15.3/18.3	15.0/16.7	15.0/17.2	14.3/16.6	14.4/18.3	14.3/16.9	14.7/17.5
Apr	19.9/17.5	19.0/17.2	19.0/17.6	18.6/17.7	17.2/16.9	18.4/17.2	18.2/17.6
May	21.3/21.5	20.8/21.2	20.4/21.5	20.1/21.5	18.9/20.8	20.1/21.0	20.4/20.9
Jun	23.8/23.1	*23.4/23.0*	22.8/23.0	23.5/23.2	20.5/22.3	22.5/23.1	22.6/23.2
Jul	29.8/28.9	25.5/27.3	25.3/26.6	27.2/27.1	21.5/23.2	23.3/26.2	24.9/24.4
Aug	23.9/29.2	23.7/27.5	24.1/26.6	24.5/28.1	20.8/23.4	22.3/25.9	23.6/25.9
Sept	24.0/24.0	22.7/23.0	22.4/23.9	22.6/23.5	18.9/20.7	20.7/21.2	22.6/23.2
AA [bc]	**19.8/20.7**	**18.7/19.5**	**18.8/19.7**	**18.6/19.7**	**16.9/17.9**	**17.8/18.8**	**18.4/18.9**
Norn	*19.69*	*18.99*	*19.19*	*19.62*	*17.20*	*18.30*	*18.10*

a) All values expressed in °C; WY21 averages greater than WY20 results are shown in black; below in red.
b) Average annual water year results are based on unweighted averaging of monthly data (Oct-Sept); water temps >22oC are shown in tan cells; values < 15oC within blue.
c) WY21 annual average water temperatures at all west section monitoring sites are lower than last year's results. WY21 averages are below 17-yr norms at sites 2-6 and above at 1 and 7.

Table C.1(M-E) Middle and East Section Water Temperature (WY21/WY20) Data

Site	8	9T	10	11	12T	13E	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	15.3/16.3	10.7/15.3	14.3/17.6	14.7/17.5	18.1/21.4	15.9/18.6	19.7/20.5	13.9/17.7
Nov	13.3/16.6	10.5/13.8	13.0/14.5	14.2/16.0	15.9/18.6	13.6/14.3	16.0/17.3	13.7/15.1
Dec	9.0/9.2	6.3/8.2	8.8/8.8	10.2/9.9	11.5/12.8	9.6/10.9	11.6/12.3	9.5/9.6
Jan	9.4/11.3	8.0/13.7	9.3/11.1	10.7/12.0	12.3/12.4	10.2/11.1	11.5/12.0	9.6/11.6
Feb	11.6/13.9	7.1/12.7	11.9/13.7	12.2/13.3	15.0/16.8	12.8/12.8	13.3/15.1	11.9/15.2
Mar	12.3/16.9	9.2/16.4	12.9/16.6	13.2/16.4	14.3/17.0	13.8/16.3	14.9/16.6	13.7/14.2
Apr	16.7/19.2	13.1/19.1	17.0/16.0	16.2/16.3	-/18.7	17.9/17.3	19.1/16.8	16.2/16.7
May	18.5/19.5	15.0/17.5	19.0/18.0	17.3/17.3	20.7/19.9	18.6/18.9	20.9/20.2	18.1/18.7
Jun	23.1/21.1	23.1/17.4	23.0/21.2	20.9/20.0	20.5/21.6	22.1/21.1	25.1/23.1	21.5/21.5
Jul	24.3/23.3	20.4/18.9	23.0/24.3	21.2/21.4	-/-	24.5/23.5	26.8/26.6	22.5/23.1
Aug	22.2/23.4	21.2/21.4	24.1/25.1	21.5/22.7	-/-	23.1/25.1	26.7/28.7	22.3/24.1
Sep	18.3/23.3	15.3/19.8	20.4/21.8	19.5/20.3	-/-	20.7/21.3	21.1/23.9	18.7/20.5
AA[bd]	**16.2/17.8**	**13.3/16.2**	**16.4/17.4**	**16.0/16.9**	**16.0/17.7**	**16.9/17..6**	**18.9/19.4**	**16.0/17.3**
Norm	*17.10*	*15.63*	*17.59*	*16.66*	*17.64*	*18.28*	*17.66*	*17.89*

a) All values expressed in oC; WY21 values greater than WY20 results are shown in black; below in red.
b) Annual average water year values and 17-yr norms are based on unweighted averaging of monthly data (Oct-Sept); water temps >22oC are expressed in tan cells, <15oC in blue cells.
c) Forester Creek discharges within the Lower Santee Basin reach near Carlton Hills Golfcourse just upstream of SR52.
d) WY21 annual average water temperatures at all mid and east section monitoring sites are lower than last year's results; the WY21 averages are below 17-yr norms at all sites with exception of 14 (Magnolia Ave. bridge).

Table C.2(W) West Section Specific Conductance (WY21/WY20 Data)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	25.5/10.8	3.81/3.88	3.73/3.54	3.26/3.18	3.81/3.69	4.03/3.78	3.77/3.03
Nov [c]	9.8/22.8	2.32/4.00	2.43/3.75	3.13/3.26	3.32/3.93	3.12/4.03	2.28/2.99
Dec	19.3/22.6	3.47/1.96	3.42/1.86	3.23/1.91	3.12/1.91	2.86/1.71	2.56/1.92
Jan	34.2/2.12	2.23/2.02	2.11/2.01	2.01/2.04	2.04/1.88	1.84/1.86	1.97/1.96
Feb	2.41/2.74	1.97/2.47	2.01/2.36	1.97/2.19	1.94/1.96	1.89/2.15	1.97/2.05
Mar	1.19/3.97	1.08/1.12	0.98/1.05	1.04/1.03	1.17/1.16	1.16/1.16	1.37/1.24
Apr	5.49/1.23	2.81/0.93	2.45/0.92	2.47/0.93	2.23/0.86	2.26/0.87	2.25/0.92
May	5.83/2.71	3.17/2.42	3.00/2.32	2.94/2.32	3.05/2.25	2.85/2.10	2.76/2.12
Jun	11.9/4.68	3.50/2.88	3.42/2.80	3.21/2.70	3.49/2.83	3.11/2.52	3.11/2.46
Jul	23.5/6.45	3.71/3.23	3.61/3.14	3.28/3.15	3.62/3.28	3.54/2.92	3.18/2.90
Aug	20.5/26.6	4.87/3.64	3.58/3.48	3.15/3.32	3.76/3.47	3.48/3.40	3.18/3.44
Sep	37.4/44.4	3.83/4.16	3.48/3.37	3.17/2.95	3.97/3.37	4.32/3.40	3.17/3.05
Avg [d]	**16.4/12.6**	**3.06/2.73**	**2.85/2.55**	**2.74/2.42**	**2.96/2.55**	**2.87/2.49**	**2.63/2.34**
Norm	*9.137*	*2.668*	*2.564*	*2.469*	*2.612*	*2.602*	*2.471*

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) WY21 values greater than last year's (WY20) results are displayed in black; values below last year in red.
c) November 2020 was the only month that SpC values at all west section sites (1-7) were less than last year's results.
d) WY21 SpC values were above those from last year and the 17-yr norms at all west section sites (1-7).

Table C.2(M-E) Middle and East Section Specific Conductance (WY21/WY20 Data)

Site	8	9T	10	11	12T	13E	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct [d]	2.57/3.13	5.00/5.37	2.45/3.00	2.26/2.91	1.80/2.06	2.31/2.50	1.70/1.81	2.42/2.76
Nov	2.28/2.05	4.67/4.63	2.31/2.08	2.34/2.10	1.84/1.89	2.05/1.38	2.05/1.12	2.47/2.88
Dec	2.37/1.82	4.75/3.32	2.33/1.85	2.26/1.84	1.82/0.92	2.00/1.40	1.78/0.86	2.54/2.31
Jan	1.97/1.97	4.17/4.29	2.00/2.00	1.98/2.12	1.54/0.97	1.75/1.55	1.66/1.16	2.45/2.66
Feb	1.56/1.11	3.22/3.02	1.60/1.19	1.65/1.26	1.34/0.69	1.53/1.07	1.37/0.88	2.05/0.99
Mar	1.33/0.89	2.89/2.21	1.35/1.01	1.50/1.08	1.29/0.50	1.34/0.63	1.29/0.62	1.90/2.63
Apr	1.97/1.24	3.99/2.93	2.02/1.28	2.10/1.39	dry/0.57	1.63/1.11	1.38/1.01	2.87/2.55
May	2.27/1.87	4.55/4.16	2.25/1.88	2.29/2.00	1.52/0.71	1.97/1.67	1.66/1.44	2.86/2.63
Jun	2.44/2.38	4.84/4.85	2.50/2.44	2.65/2.59	1.76/dry	2.08/1.91	1.75/1.59	2.83/2.89
Jul	2.71/2.66	5.09/4.88	2.73/2.65	2.69/2.72	dry/dry	2.18/2.09	1.76/1.66	3.08/2.84
Aug	2.99/2.66	5.35/4.62	2.81/2.58	2.53/2.54	dry/dry	2.32/1.99	1.82/1.55	3.07/2.68
Sep	3.45/3.13	5.29/5.37	2.85/3.00	2.80/2.91	dry/2.06	2.40/2.50	1.89/1.81	2.77/2.76
AA [be]	**2.33/2.11**	**4.48/4.13**	**2.27/2.08**	**2.25/2.11**	**1.61/1.13**	**1.96/1.64**	**1.68/1.29**	**2.61/2.54**
Norm	*2.316*	*4.742*	*2.250*	*2.235*	*1.612*	*1.907*	*1.517*	*2.682*

a) All values expressed in milli-Siemens/cm; WY21 values greater than WY20 results are in black, below in red. Cells in blue <2.0: cells in tan >4.0 mS/cm

b) WY21 annual averages and 17-yr 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.

d) Oct. 2020 was the only month this year's (WY21) SpC values were less than last year's results at all mid (9-10) and east section (10-15) sites.

e) WY21 SpC values were above (greater than) those from both last year and the 17-yr norms at all 8 mid and east section sites (7-15).

Table C.3(W) West Section pH (WY21/WY20) Data

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	8.02/7.82	7.75/7.65	7.90/7.84	7.87/7.79	7.98/7.48	6.98/7.47	7.95/7.30
Nov	7.95/7.50	8.01/7.50	7.57/7.50	7.94/7.50	7.88/7.50	7.80/7.50	8.82/7.50
Dec	8.03/7.70	8.09/7.75	8.06/7.94	8.04/7.78	8.02/7.71	8.03/7.73	8.29/7.67
Jan	7.65/7.89	7.82/7.75	7.81/7.83	8.11/7.77	7.71/7.73	7.71/7.63	7.86/7.60
Feb	7.94/7.80	7.74/7.78	7.80/-	7.81/-	7.82/7.77	7.80/7.64	7.91/-
Mar	7.19/7.75	7.80/7.70	7.59/7.79	7.71/7.85	7.71/7.84	7.66/7.92	7.85/7.60
Apr	7.79/7.75	7.75/7.77	7.71/7.73	7.71/7.74	7.63/7.74	7.60/7.58	7.70/7.69
May	8.04/8.03	7.74/7.83	7.77/8.03	7.71/7.95	7.74/7.84	7.83/7.28	7.78/7.81
Jun	7.87/7.58	7.64/7.81	7.86/7.87	7.87/7.86	7.31/7.71	7.61/7.64	7.69/7.68
Jul	7.94/7.98	7.66/8.01	7.87/7.99	8.11/8.02	7.52/7.71	7.35/7.80	7.07/7.85
Aug	7.67/7.99	7.68/7.93	7.90/7.92	7.91/8.15	7.89/7.36	7.72/7.58	7.74/7.81
Sep	7.70/8.14	7.54/8.10	7.63/8.14	7.61/8.25	7.69/7.94	7.57/7.89	7.56/8.05
AA [b]	**7.82/7.83**	**7.77/7.80**	**7.79/7.87**	**7.87/7.87**	**7.74/7.69**	**7.64/7.64**	**7.84/7.69**
Norm	*7.76*	*7.69*	*7.77*	*7.79*	*7.63*	*7.62*	*7.58*

a) All pH values are unit-less; monthly values of 8.0 or greater are in tan cells; and at 7.5 or below in pink.
b) WY20 annual average and 16-yr norms are based on averaging of monthly data (Oct-Sept); averages > 16-yr norms are shown in blue; belwo norms in 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.

Table C.3(M-E) Middle and East Section pH (WY21/WY20) Data

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	8.19/7.57	8.39/8.24	8.10/7.45	7.97/7.28	8.27/7.60	7.66/7.42	8.09/7.86	8.27/7.85
Nov	8.24/7.53	8.36/8.13	8.26/7.63	8.03/7.27	8.24/7.89	7.89/7.18	8.13/7.63	8.27/7.82
Dec	8.12/8.11	8.34/8.38	8.44/7.57	8.21/7.36	8.57/7.94	8.05/7.46	8.37/7.77	8.30/8.34
Jan	7.57/8.14	7.01/8.31	8.01/7.70	7.96/7.51	8.48/7.90	7.72/7.50	7.81/8.02	7.87/8.11
Feb	8.16/8.13	8.07/8.42	8.02/7.70	7.94/7.29	8.70/8.07	7.92/7.35	7.97/8.08	7.92/8.17
Mar	7.96/8.14	8.10/8.49	7.95/8.05	7.72/7.85	8.10/8.06	7.66/7.55	7.98/7.96	7.92/8.05
Apr	7.80/8.20	7.92/8.50	8.11/7.95	7.87/8.02	dry/7.90	7.86/7.64	8.01/7.88	8.02/8.29
May	7.61/8.13	7.77/8.44	7.97/7.78	7.77/7.85	8.03/7.97	7.67/7.81	8.12/8.02	7.85/8.19
Jun	7.69/8.07	7.99/8.29	7.60/7.79	7.67/7.71	7.58/7.92	7.65/7.48	8.07/8.04	7.61/8.05
Jul	8.00/8.08	7.93/8.27	7.89/7.97	8.08/8.02	dry'dry	7.74/7.80	7.96/8.26	7.78/8.18
Aug	7.62/7.60	8.06/8.29	7.93/7.92	7.76/7.67	dry/dry	7.92/7.65	8.18/8.23	8.22/8.05
Sep	7.63/8.13	7.97/8.44	8.43/8.13	8.07/8.06	dry/dry	8.00/8.14	7.79/8.23	8.36/8.24
WY20 [b]	**7.88/7.99**	**7.99/8.35**	**8.06/7.80**	**7.92/7.66**	**8.25/7.92**	**7.81/7.58**	**8.04/8.00**	**8.03/8.11**
Norm	*7.69*	*7.87*	*7.83*	*7.58*	*7.94*	*7.66*	*7.84*	*8.05*

a) All values are unit-less; monthly values at 8.0 or above are shown in tan cells, while those at 7.5 or below are in pink.
b) WY20 and 16-yr annual average values based on averaging monthly results (Oct-Sept); annual averages >16-yr norms are shown in blue; below norms in red.

Table C.4(W) West Section Dissolved Oxygen Concentration (WY21/WY20) Data

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	8.37/5.38	3.64/2.60	2.67/3.09	8.10/4.92	7,46/2.32	**5.10/0.07**	4.58/4.15
Nov	7.25/4.63	6.73/3.60	5.55/3.42	7.77/6.03	7.20/3.24	**5.73/0.80**	7.30/4.27
Dec	6.66/8.12	7.58/9.03	6.37/10.80	7.05/10.55	6.78/8.02	4.65/8.45	6.47/9.66
Jan	6.31/10.23	7.49/8.10	8.27/9.01	7.37/7.93	7.40/8.55	7.17/8.42	7.43/9.94
Feb	8.07/5.53	7.76/6.15	7.68/6.72	5.92/5.20	6.42/6.17	4.38/5.00	7.40/7.75
Mar	6.15/6.22	6.77/5.54	6.20/6.04	6.01/5.99	8.60/7.55	5.78/6.04	8.68/8.52
Apr	4.35/6.59	3.84/5.82	3.80/6.39	3.18/5.82	3.73/6.41	2.80/6.44	5.33/7.57
May	6.46/6.49	3.92/4.74	3.54/3.36	2.72/7.04	4.64/3.90	2.46/2.53	3.50/5.29
Jun	4.01/4.72	2.49/4.14	1,67/2.90	3.16/4.18	2.78/3.18	0.51/1.78	3.81/4.18
Jul	6.81/5.27	2.73/3.49	3.05/3.30	7.19/3.50	2.61/2.48	0.33/1.67	3.84/3.50
Aug	3.16/8.33	1.89/3.35	1.87/5.32	2.45/7.79	2.86/2.90	**0.66/0.43**	2.32/5.06
Sep	3.73/6.32	2.39/3.71	2.18/3.38	1.36/5.88	4.23/3.10	0.51/1.20	3.35/5.11
WY21/20	**5.94/6.49**	**4.77/5.02**	**4.40/5.31**	**5.19/6.24**	**5.39/4.82**	**3.34/3.57**	**5.34/6.25**
Norm	*6.14*	*4.44*	*4.63*	*6.05*	*4.81*	*3.55*	*5.09*

a) All values expressed in milligrams/liter and (Percent of Saturation); WY21 and 16-yr averages less than 5 mg/L (DO depletion threshold) shown in red, less than 2.5 mg/L (hypoxic level) cells highlighted in light yellow and <1.0 mg/L (exaerobic zone) in dark yellow. 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/WY20) Data

Site	8	9T	10	11	12T	13E	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	7.37/2.94	11.17/8.4	7.57/4.81	6.43/4.22	7.25/5.47	1.69/2.67	1.53/2.03	9.51/4.8
Nov	8.98/6.86	10.31/7.3	9.33/6.79	8.24/4.95	7.58/5.66	4.07/0.09	5.69/2.55	9.23/6.17
Dec	9.67/12.12	11.17/12.47	10.79/9.34	8.52/9.21	8.92/7.27	1.78/1.79	7.55/2.89	9.55/9.55
Jan	10.1/11.53	11.35/10.52	10.22/9.33	8.32/7.92	8.33/8.18	1.81/0.45	2.73/5.93	8.12/9.51
Feb	8.99/10.2	10.52/11.3	7.97/8.71	8.43/7.85	9.96/8.78	1.38/0.11	6.29/7.66	6.36/8.51
Mar	9.28/8.6	10.68/10.3	8.29/6.01	8.09/7.27	8.60/7.31	2.54/0.92	9.17/9.94	7.92/8.18
Apr	8.09/8.57	9.95/9.49	8.27/5.77	9.47/6.9	-/8.41	6.44/2.00	4.88/4.07	8.51/9.8
May	4.68/7.65	6.63/9.65	4.22/3.75	4.85/5.71	4.20/7.78	1.39/1.55	4.32/4.1	4.23/6.8
Jun	3.72/6.73	8.41/9.04	4.27/2.27	4.95/4.76	1.51/6.32	3.57/1.42	4.81/2.99	3.29/4.3
Jul	1.44/4.44	9.25/8.18	4.86/5.8	4.57/4.82	-/-	1.98/1.24	2.98/3.64	4.66/6.05
Aug	1.21/3.51	6.54/10.26	2.11/5.76	3.75/5.32	-/-	1.73/0.89	3.37/5.16	2.09/4.76
Sep	1.38/7.0	6.51/9.7	4.08/5.58	4.02/4.66	-/-	0.59/1.57	2.32/3.51	3.10/5.86
AA [b]	**6.24/7.51**	**9.37/9.72**	**6.83/6.16**	**6.64/6.13**	**7.06/7.24**	**2.42/1.23**	**4.64/4.54**	**6.38/7.03**
Norm	*7.22*	*9.22*	*6.98*	*6.10*	*7.09*	*2.81*	*3.46*	*7.35*

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

b) WY21 & WY20 average annual values and 17-yr normss 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/WY20) Data

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	96/65	39/29	30/35	87/55	75/24	**54/1**	50/45
Nov	75/49	68/38	57/37	81/64	74/32	**60/8**	74/44
Dec	63/77	72/80	61/101	66/99	63/74	44/78	61/89
Jan	59/97	70/77	78/85	68/75	70/79	68/78	72/92
Feb	81/58	78/65	77/69	63/54	63/62	43/50	72/79
Mar	62/67	68/57	65/64	59/62	87/80	57/63	82/84
Apr	49/70	42/61	41/67	34/62	38/67	30/67	62/80
May	75/74	44/55	39/39	30/83	50/45	28/29	39/61
Jun	48/56	30/50	20/35	37/50	31/37	6/21	45/50
Jul	86/68	34/45	38/42	85/44	29/27	4/20	46/42
Aug	37/107	23/43	22/66	30/100	32/35	8/5	28/63
Sept	46/70	28/44	25/41	16/70	46/34	6/14	40/59
WY21/20	**65/72**	**50/54**	**46/57**	**56/68**	**55/50**	**34/36**	**56/66**
Norm	*67.2%*	*46.5%*	*48.7%*	*65.1%*	*49.2%*	*36.3%*	*52.6%*

a) All values expressed as percent of saturation; WY21 values less than WY20 results are listed in red.
b) WY 21 values < 55% (DO depletion threshold) are expressed in red ,< 25% (hypoxic level) cells highlighted in light yellow and <10% (exaerobic zone) dark yellow.. DO% Sat values of 50% or greater are shown in blue cells.
c) WY21/20 annual average and 17-yr norms are based on averaging of monthly data (Oct-Sept).

Table C.5(M-E) Mid and East Section DO Percent of Saturation (WY21/WY20) Data

Site	8	9T	10	11	12T	13W	13E	14	15T
Reach	Mission Gorge			Lower Santee Basin			Upper Santee Basin		LSB [c]
Oct	75/31	103/85	74/49	64/45	75/62	58/-	17/29	17/23	93/51
Nov	82/87	94/56	89/68	81/51	76/61	50/-	36/1	53/27	85/61
Dec	84/106	92/107	93/81	77/78	82/69	35/-	16/17	70/27	84/85
Jan	90/107	97/103	95/86	75/74	78/78	51/-	16/4	26/55	71/88
Feb	83/100	88/108	74/85	80/76	99/90	42/-	13/1	55/77	54/86
Mar	86/84	95/106	79/61	78/75	86/76	48/-	23/9	91/103	77/81
Apr	84/95	97/103	87/58	98/71	-/92	78/-	69/21	53/42	88/102
May	50/85	67/102	47/39	51/60	48/86	43/-	15/18	50/46	45/73
Jun	44/75	92/91	34/26	56/52	17/71	38/-	41/17	57/35	38/48
Jul	17/53	103/89	59/70	52/55	-/-	41/-	27/17	37/46	54/71
Aug	14/40	75/117	26/69	43/62	-/-	54/19	26/11	42/67	24/58
Sep	16/83	69/108	46/64	44/52	-/-	47/21	10/17	26/42	34/66
WY21/20 [b]	**61/79**	**89/98**	**69/63**	**67/63**	**70/80**	**49/-**	**25/14**	**48/49**	**62/73**
Norm	*73.5%*	*93.3%*	*72.5%*	*59.7%*	*71.8%*	*na*	*29.1%*	*34.9%*	*70.4%*

a) All values expressed as percent of saturation; WY21 values < 55% (DO depletion threshold) are expressed in red ,< 25% (hypoxic level) cells highlighted in light yellow and <10% (exaerobic zone) dark yellow.. DO% Sat values of &) or greater are shown in blue cells.

b) WY21/20 annual average and 17-yr 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 WY21/20 Nutrient (NO_3 and PO_4) Data at Selected WQM Sites

Site# Name	2 YMCA	7 ABF	El Cajon/ 12T	11 WHP	13W- MPW	14 MAG	15T FSTR CK
Section	Mission Valley Sites		Santee Basin (Eastern Sites)				
WY	21/20	21/20	21/—	21/20	21/20	21/20	21/20
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	—/— —/—	—/— —/—	—/— —/—	—/— —/—	—/— —/—	—/— —/—	—/— —/—
Jun	0.1/— 0.4/—	0.1/— 0.1/—	2.2/— 0.1/—	0.2/0.2 0.4/0.4	0.1/— 0.3/—	0.1/0.1 0.1/0.3	0.4/0.9 0.3/0.3
Jul	0.1/— 0.1/—	0.1/— 0.4/—	—/— —/—	0.1/0.3 0.1/0.4	—/— 0.7/—	0.1/0.2 0.7/0.1	—/1.1 0.2/0.3
Aug	—/— —/—	—/— —/—	—/— —/—	0.1/0.2 0.7/0.8	—/— 0.4/—	0.1/— 0.4/—	—/— 0.2/—
Sept	—/0.1 —/0.4	—/0.1 —/0.3	—/— —/—	—/0.1 0.5/0.4	—/0.1 0.6/0.6	—/0.1 0.6/0.1	—/0.9 —/0.1
Max.	0.1/0.1 0.4/0.4	0.1/0.0 0.4/0.3	2.2/— 0.3/—	0.2/0.6 0.7/0.6	0.3/0.1 0.7/0.6	0.3/0.2 0.7/0.4	2.0/1.3 0.4/0.3

a) Nutrient values for nitrogen, as nitrate (NO_3), in black and phosphrous. as phosphate (PO_4), in red, expressed in mg/L. Values > 0.5, indicating potential cause for further assesment of upstream sources, 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 17 years of monitoring and potential problem areas within the LSDR watershed. Such patterns and locations are then 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 of the environment. Used in this manner, the index provides an additional metric for evaluating effectiveness of some of the San Diego River water quality 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 WY21 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 17-yr period (WY05-WY21) of water quality monitoring. The positive correlations in seasonal fluctuation between streamflow and water quality values are shown. General trends of lower water quality at all sites in years of below average stream discharge are evident. 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 31 is five percent below the 17-year norm of 32. The WY18 index of 22.4 was 28% below the 17-yr norm. The lowest running average index value of 19 was reached in October of 2014; 39 percent below the 17-yr norm

Chart D.2 presents overall (LSDR) monthly running avearge WQI values (heavy black lines) over the 16-year period. 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 highest values. It can also be noted (in both charts H1 & H2) that the greatest rate of decline in lower river water quality occured over a three year period (WY12 through WY 14) during a period of well-below normal streamflow.

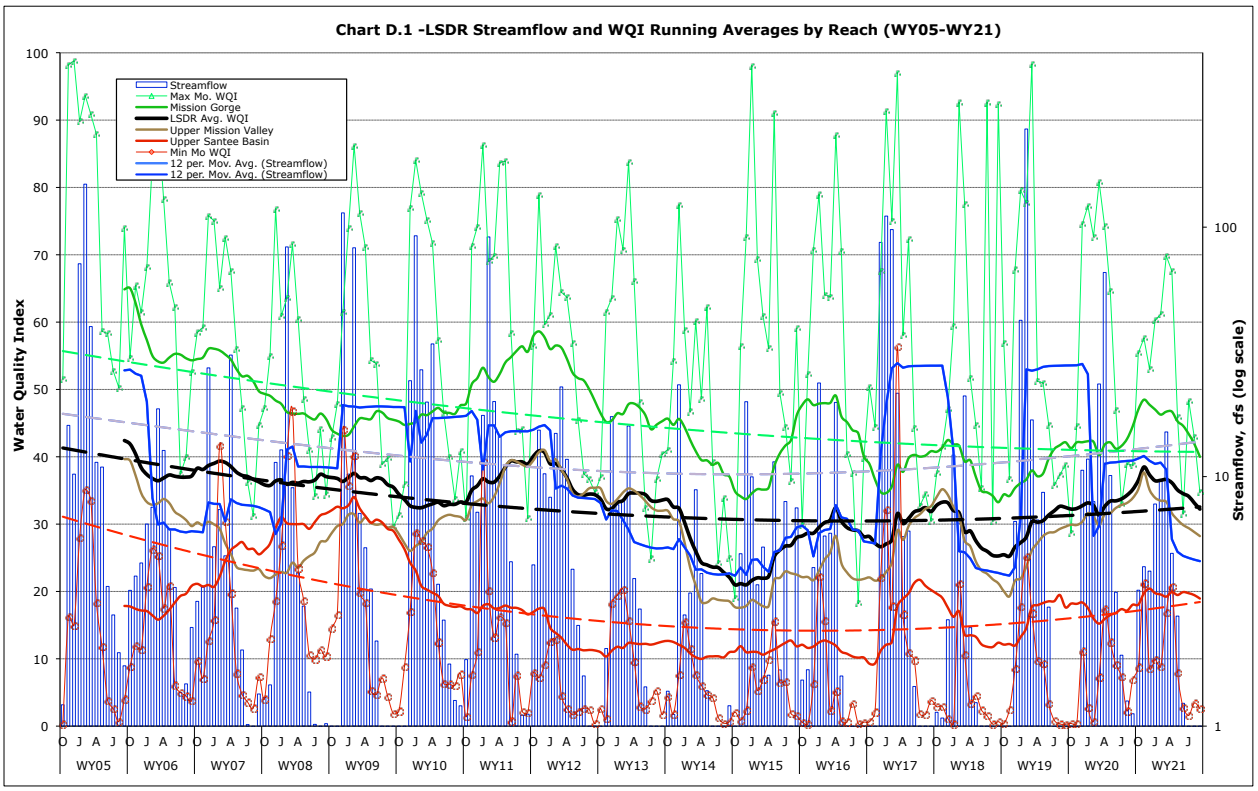
Chart D.1 -LSDR Streamflow and WQI Running Averages by Reach (WY05-WY21)
Water Quality Index
Streamflow, cfs (log scale)
Streamflow
Max Mo. WQI
Mission Gorge
LSDR Avg. WQI
Upper Mission Valley
Upper Santee Basin
Min Mo WQI
12 per. Mov. Avg. (Streamflow)
12 per. Mov. Avg. (Streamflow)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
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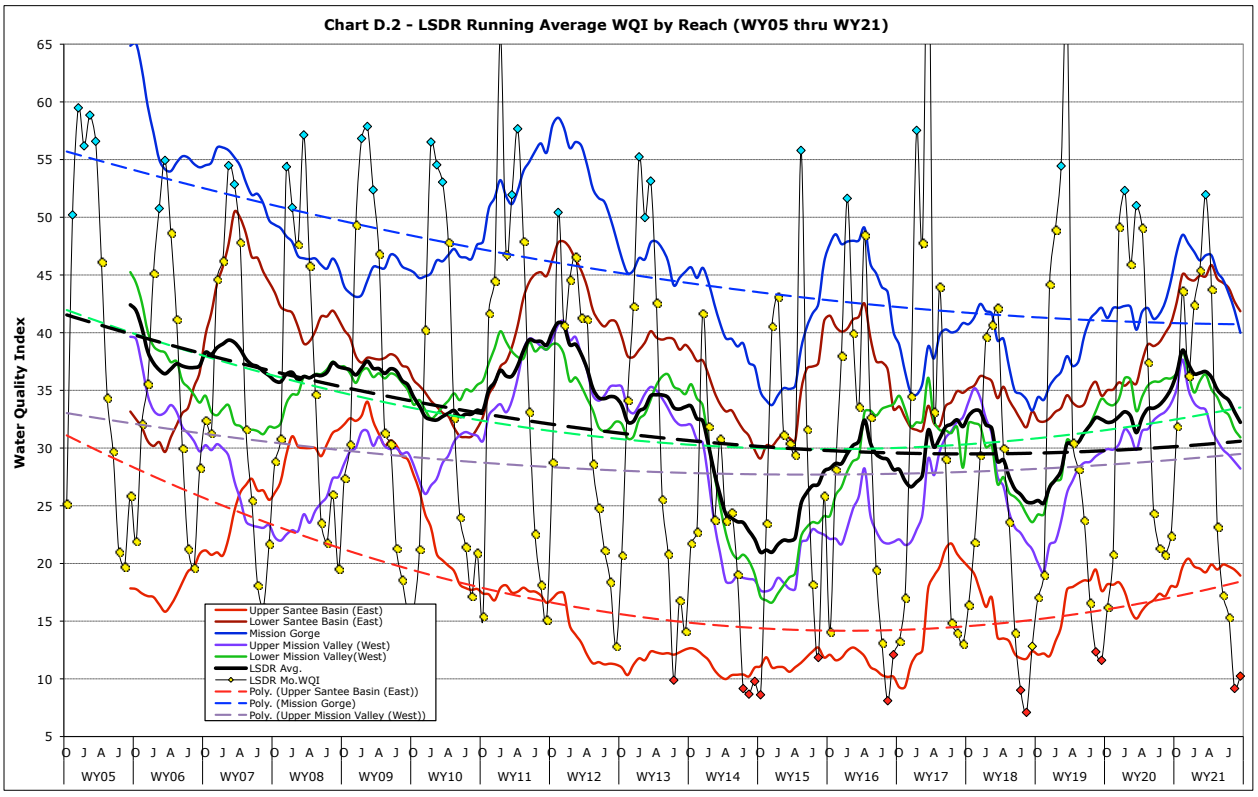
Chart D.2 - LSDR Running Average WQI by Reach (WY05 thru WY21)
Water Quality Index
Upper Santee Basin (East)
Lower Santee Basin (East)
Mission Gorge
Upper Mission Valley (West)
Lower Mission Valley(West)
LSDR Avg.
LSDR Mo.WQI
Poly. (Upper Santee Basin (East))
Poly. (Mission Gorge)
Poly. (Upper Mission Valley (West))
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21

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 river reaches and the overall weighted LSDR averages. The variances in WQI can be visually compared to changes in 3-day streamflow (blue bars) on the same basis. Positive correlations are evident, i.e., increased average daily flow results in improved water quality metrics. Low flow throughout the summer months results in considerably poorer water quality. The past two year's of above average dry-weather (base) flows, extending from early April through the end of September, resulted in significant improvements in index values for each of the five reaches and overall (heavy black line) of the lower river system from WY18 and WY14 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 WY's 07 & 08) has shown the lowest values. The next to poorest quality reach is the Upper Mission Valley reach (green curve). The next to best water quality reach is the Lower Santee Basin reach (brown curve). On a seasonal basis Autumn and Summer results are consistantly lower than Winter (hihest) and Spring (next highest) values in all reaches and overall. August is the month of lowest water quality and lowest flow. January and March are commonly the moths of best water quality in all reaches as greater flood flows commonly occuring in February often lower WQI values by several points.

Chart D.4 provides a spatial profile of average annual WQI by river monitoring site, reach and section for this year (WY20), compared to last year (WY19), the best (WY05), the worst (WY14) and 16-yr winter (Dec-Jan), summer (Jun-Sept) and annual (Oct-Sept) norms. The sites are in the order they occur ascending upstream. The current (WY20) average annual WQI values for each site, shown as both a heavy black line and as colored bars, are above annual norms (also dashed color bars) at all but two sites (#10-OMD and #13-Mast Pk E). Sites with lowest water quality in WY20, as well as over the past decade, are #13-Mast Pk E, #14-Magnolia Ave. within the Upper Santee Basin (red curve) and #6-Kaiser Pnds in Upper Mission Valley (green curve). The Mission Gorge portion (blue curve) of the watershed (site#'s 8-10) continues to demonstrate best overall water quality. The 16-yr winter and summer WQI norms (dashed blue and red curves, respectively) are also shown in profile to provide a 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 WY21 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 continual poorer water quality much less suseptable to changes in ambient conditions.

(JCK 11/2/2021)

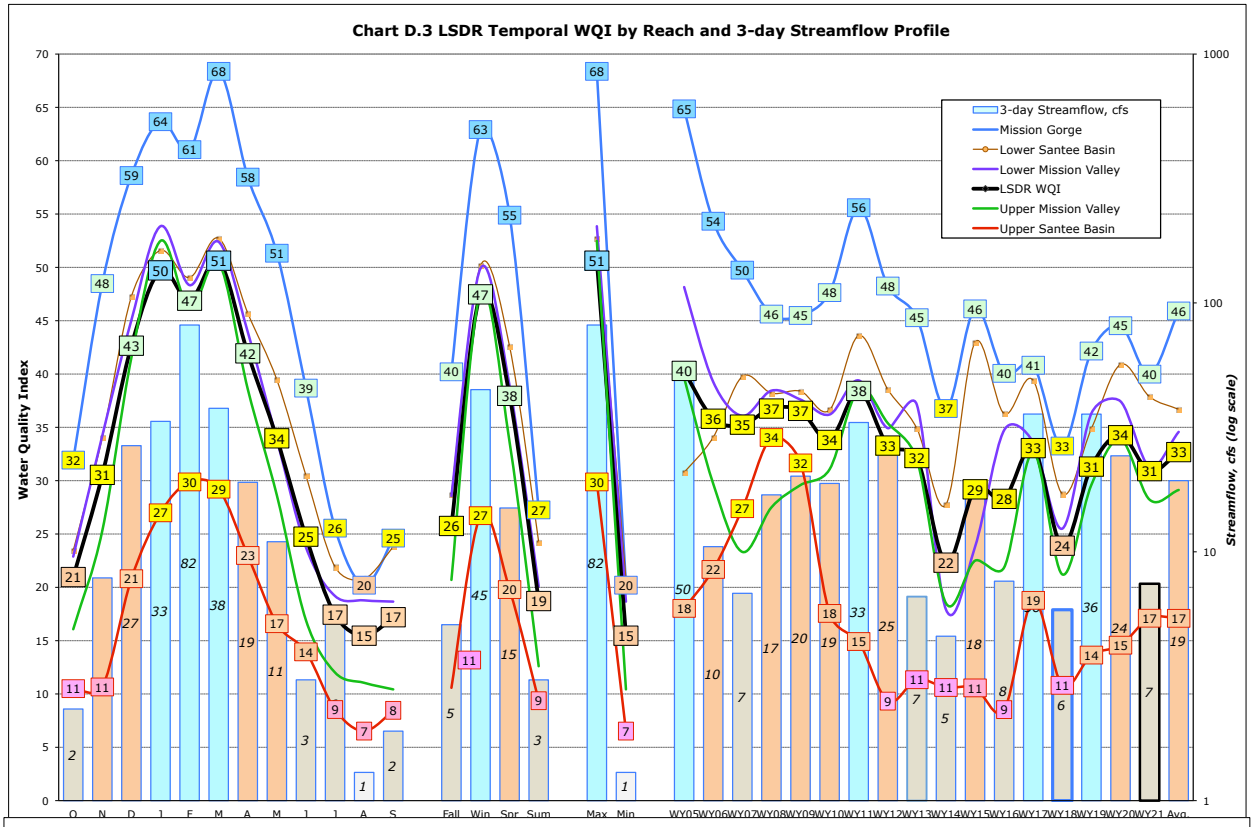
Chart D.3 LSDR Temporal WQI by Reach and 3-day Streamflow Profile
Water Quality Index
Streamflow, cfs (log scale)
3-day Streamflow, cfs
Mission Gorge
Lower Santee Basin
Lower Mission Valley
LSDR WQI
Upper Mission Valley
Upper Santee Basin
O N D J F M A M J J A S
Fall Win Spr Sum
Max Min
WY05 WY06 WY07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

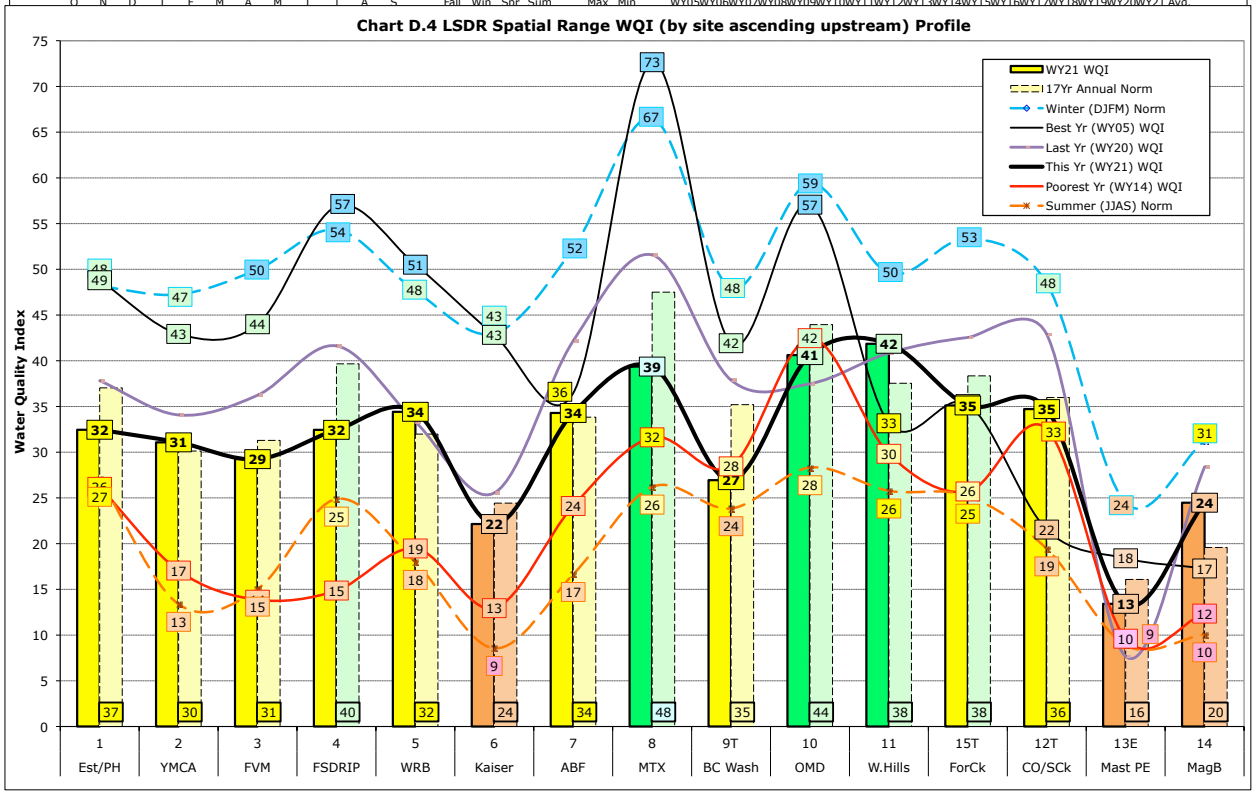
Chart D.4 LSDR Spatial Range WQI (by site ascending upstream) Profile
Water Quality Index
WY21 WQI
17Yr Annual Norm
Winter (DJFM) Norm
Best Yr (WY05) WQI
Last Yr (WY20) WQI
This Yr (WY21) WQI
Poorest Yr (WY14) WQI
Summer (JJAS) Norm
1 Est/PH
2 YMCA
3 FVM
4 FSDRIP
5 WRB
6 Kaiser
7 ABF
8 MTX
9T BC Wash
10 OMD
11 W.Hills
15T ForCk
12T CO/SCk
13E Mast PE
14 MagB

Appendix E - 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:** (monitoring/sampling/testing multiple times)

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

*** Team Leaders

Appendix F - 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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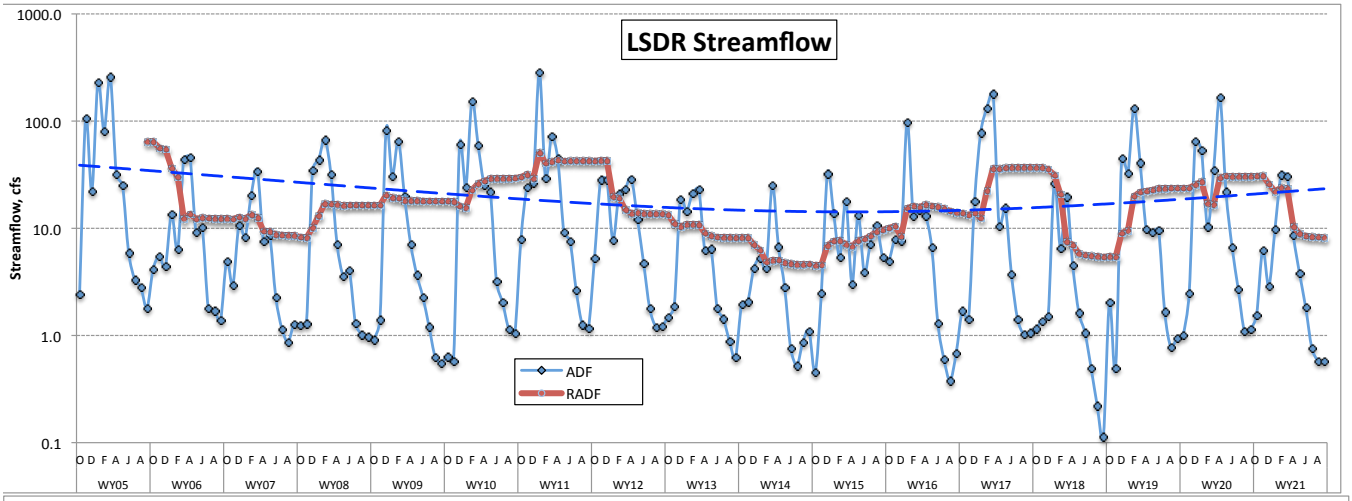
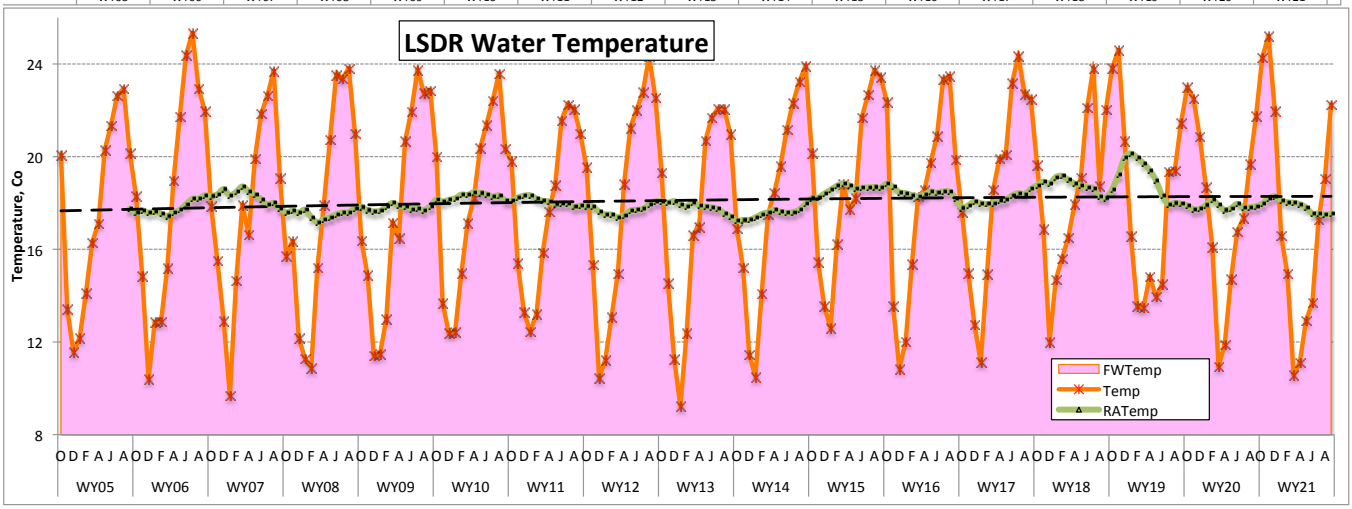
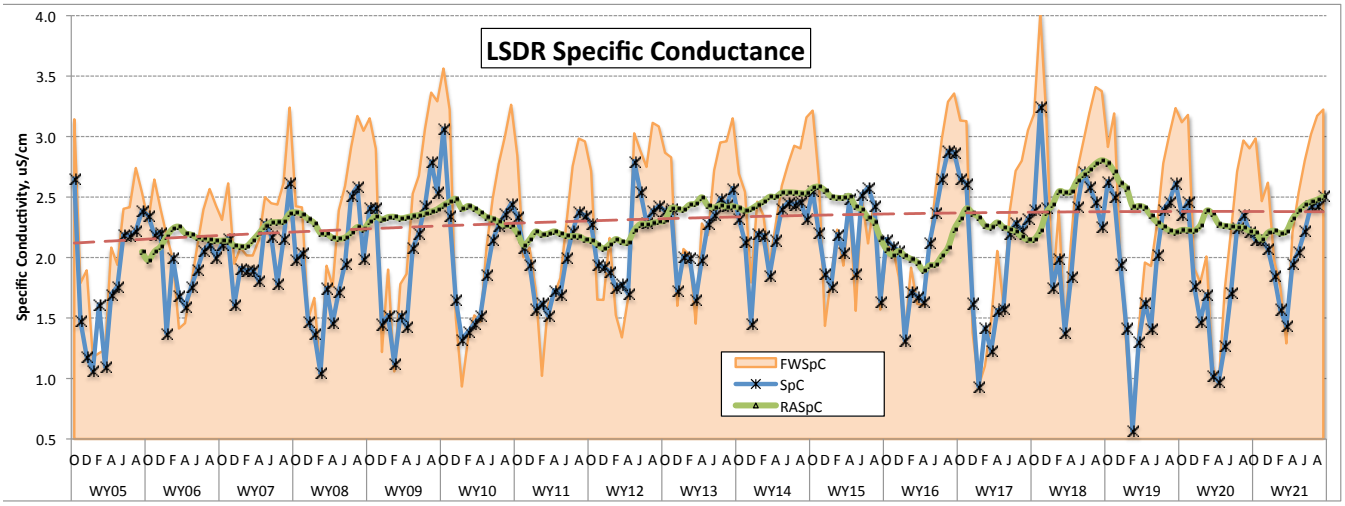
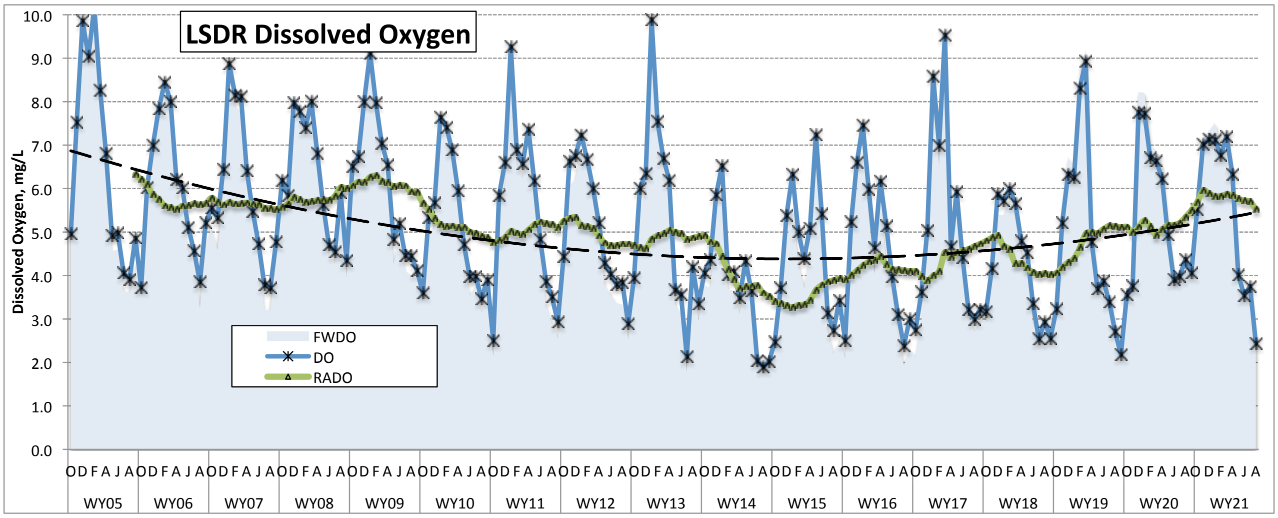
Table H.1 - RiverWatch WQM Data Summary WY20						
Section	Mission Valley		Mission Gorge	Santee Basin		Watershed
Sites	1-4	5-7	8-10	11,15T,12T	13W,13E,14	**all (1-15)**
Reach	LMV	UMV	MG	LSB	USB	LSDR [a]
Annual (October 2019 - September 2020):						
ADF, cfs	49 *(30)*	46 (28)	26 (19) [b]	21 *(16)*	9.3 *(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)*

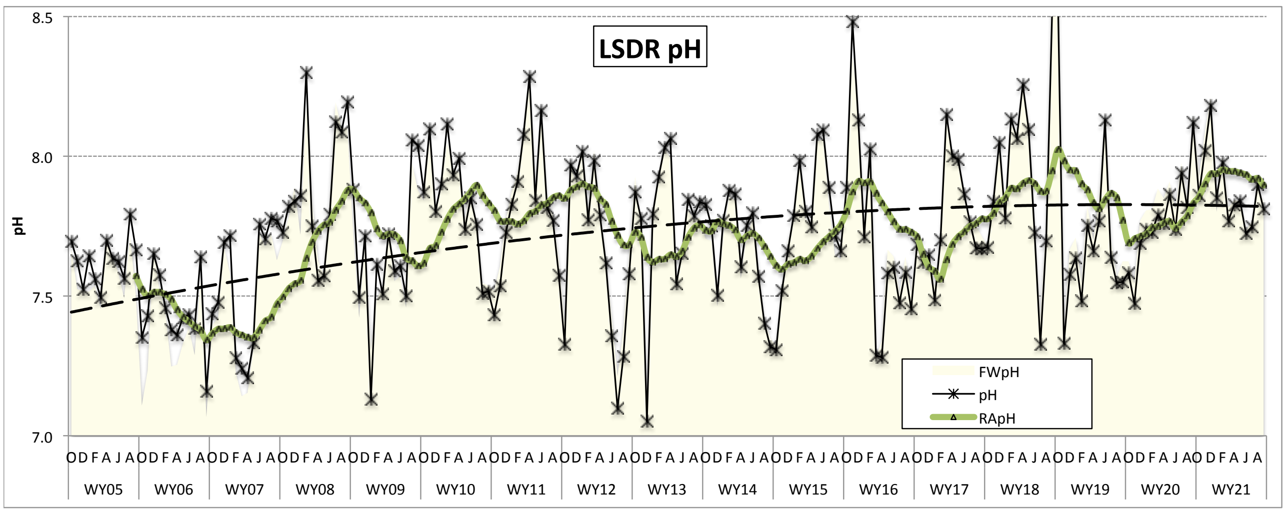
Table H.2 - RiverWatch WQM Data Summary WY21							
Section	Mission Valley			Mission Gorge	Santee Basin		**All**
Sites	1-3	4, 5	6-7	8-10	11,15T,12T	13W,13E,14	**(1-15)**
Reach	LMV	MMV	UMV	MG	LSB	USB	**LSDR** [a]
Annual (October 2020 - September 2021):							
ADF, cfs	12 *(30)*	12 *(30)*	11 *(29)*	8 *(19)* [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+

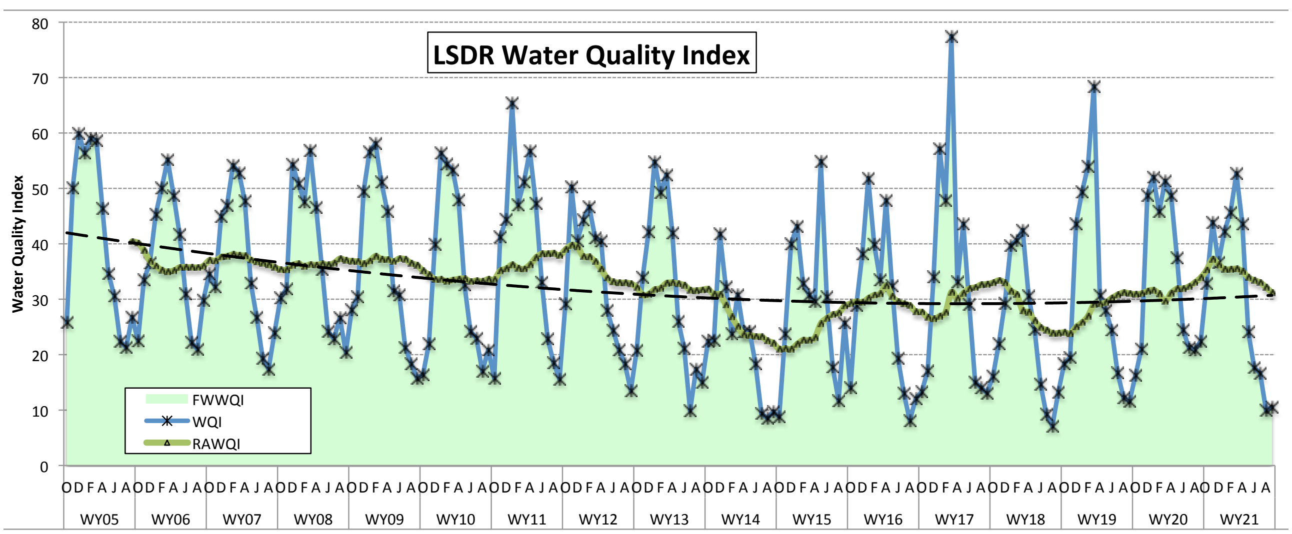

LSDR Streamflow
Streamflow, cfs
1000.0
100.0
10.0
1.0
0.1
ADF
RADF
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21


LSDR Water Temperature
Temperature, Co
24
20
16
12
8
FWTemp
Temp
RATemp
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21


LSDR Specific Conductance
Specific Conductivity, uS/cm
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
FWSpC
SpC
RASpC
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21


LSDR Dissolved Oxygen
Dissolved Oxygen, mg/L
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
FWDO
DO
RADO
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15 WY16 WY17 WY18 WY19 WY20 WY21


LSDR pH
pH
8.5
8.0
7.5
7.0
FWpH
pH
RApH
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15 WY16 WY17 WY18 WY19 WY20 WY21


LSDR Water Quality Index
Water Quality Index
80
70
60
50
40
30
20
10
0
FWWQI
WQI
RAWQI
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15 WY16 WY17 WY18 WY19 WY20 WY21