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

LOWER SAN DIEGO RIVER
WATER QUALITY 2005 - 2019

Annual (WY19) Water Quality Monitoring Report

Kaiser Ponds (WQM Site 6) aquatic macrophytes viewing downstream from San Diego Mission Rd.

Water Quality Monitoring Results (October 2004 - October 2019)

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Lower San Diego River Water Quality 2005 - 2019

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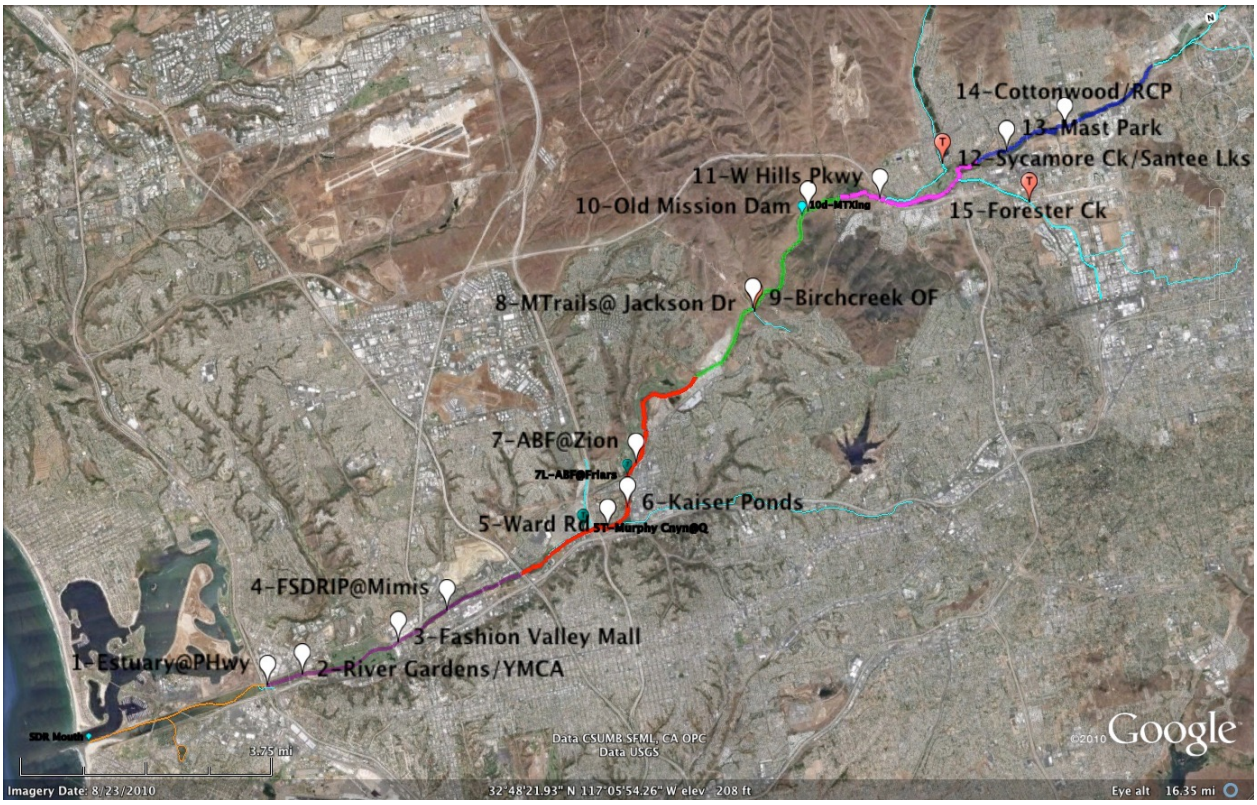
[a] *Appendices A-H are contained in a separate document.*

Questions regarding the San Diego RiverWatch WQM database or interpretation of results expressed in this and similar SDR WQ data monitoring reports can be directed to the attention of John C. Kennedy, through contacting SDRPF at info@SanDiegoRiver.org or the WQM Coordinator, Shannon-Quigley Raymond, at 619-297-7380.

Section 1 - Introduction

This report provides a summary of monthly values, seasonal patterns and annual trends in water quality monitoring data gathered and evaluated by SDRPF's RiverWatch citizen volunteers. WQM data collected monthly over the past 15 years at 15 sites within the Lower San Diego River (LSDR) watershed have been aggregated, in conjunction with hydrologic stream flow data to develop a numeric water quality index (WQI). Basic monthly data regarding individual water quality parameters and river hydrology for each of the sites monitored are maintained in an extensive Excel database file available at the SDRPF offices; this annual report examines Water Year 2019 (WY19) data in comparison to previous year results and 15-yr averages (norms). The LSDR watershed and water quality monitoring site locations are shown on **Figure 1-1**.

Figure 1-1 LSDR Watershed and Water Quality Monitoring Sites



Color Code for LSDR reaches on Figure 1-1 above: Estuary (orange), Lower Mission Valley (purple), Upper Mission Valley (red), Mission Gorge (green), Lower Santee Basin (pink), Upper Santee Basin (dark blue), Lakeside to El Capitan Reservoir (light green) and principal tributaries (light blue)

The water quality sites on Figure 1-1 and monthly RiverWatch water quality data can be viewed in detail on the SDRPF RiverWatch Info page website available at <www.sandiegoriver/river_watch.html>. Clicking on the right hand side of the page allows access to the data portal. In addition to water quality monitoring data, the portal also contains: San Diego StreamTeam Bio-assessment data, 401 Project information and USGS real-time streamflow data regarding daily peak discharge and gauge height for the two San Diego River gauging stations (Fashion Valley & Mast Rd Bridge near Santee).

The SDRPF water quality index (WQI) represents the RiverWatch team's response to the public's general

questions and concerns regarding overall health of the Lower San Diego River system. The index is a numeric (0-100) whereby increasing values signify improving water quality. The numerical index incorporates basic physical, chemical and bacteriological water quality data by integrating six parameters: water temperature (Temp), pH, specific conductivity (SpC), dissolved oxygen (DO and/or %DOSat), mean coliform count (MCC) and streamflow (Q); through determination of weighted factors for each parameter. The resulting values are aggregated to arrive at an overall score for each site, reach, section as well as the entire lower watershed (LSDR). The index values, grade, color codes and general conventions employed are presented in **Table 1.1.**

Table 1.1 LSDR Water Quality Index

SDR WQI (0-100)	Grade	Color Code	Percentile Range	Water Quality Threshold	General
75 or >	A - Very Good	Dark Blue	25%	Well above acceptable WQ criteria	Healthy (>50)
50 - 74	B - Good	Light Blue	25%	Exceeds acceptable WQ criteria	
38 - 49	C - Fair	Green	12.5%	Meets many but not all WQ criteria	Impaired/Ailing (25-49)
25 - 37	D - Marginal	Yellow	12.5%	Meets some acceptable WQ criteria	
13 - 24	E - Poor	Brown	12.5%	Meets few minimum WQ criteria	Unhealthy (< 25)
0 - 12	F - Very Poor	Pink/ Rose	12.5%	Well below minimum WQ criteria	

Note: The WQI was developed for fresh water quality metrics only and is not applicable for estuarine or ocean waters.

In general, sites with WQI values of 50 or above exceed expectations for acceptable water quality and are indicative of relatively 'healthy' conditions. Scores between 25 and 49 describe 'impaired or ailing' quality levels where evidence exists regarding failure to meet minimum water quality criteria. Waters' with scores of less than 25 do not meet minimum expectations and are considered 'unhealthy' and highly stressful to many aquatic life forms. For WQ parameters monitored by RiverWatch, the index expresses results relative to those levels necessary to sustain designated beneficial water uses for the LSDR (Hydrologic Area 907.1) based on State of California Water Quality Standards. Where criteria are non-specific, results are expressed relative to Southern California coastal area freshwater objectives. The index can not, without considerable loss of credability, be applied to estuaries and ocean waters.

Index values were computed using two formulas; one involving four key parameters (Temp, SpC and DO) monitored by RiverWatch combined with streamflow (Q), the second with two additional parameters (pH and MCC) combined with averaged streamflow. The equations used for both formulas (WQI_4 and WQI_6) are presented in Appendix B. Differences between the two determinations were found to be small. The initial determination (WQI_4) typically presents a broader range (from low to high value) than the second, as the 'normalizing' effects of pH and MCC values (both of which present less spatial and temporal variances for the LSDR) are excluded. The broader range WQI_4 values are expressed in this and previous annual reports.

The index, although specifically developed for the San Diego River, might also be applied to other Southern California coastal watercourses where comparable water quality metrics (i.e., DO, SpC, aater temperature and streamflow) are monitored on a regular and consistent basis. A special report comparing relative water qualities in three San Diego County watercourses; Los Penasquitos Creek below Poway, the Santa Margarita River below Temecula and near Fallbrook (SUMP), and the Lower San Diego River below Santee and in Mission Valley has been compiled through the SDRPF RiverWatch program.

Section 2 - Spatial Analysis of WY19 Water Quality Metrics and 15-yr Norms

Monthly water quality data collected and recorded at each site by RiverWatch WQM Team volunteers are used to determine annual averages, seasonal patterns and trends as presented in this report and appendices. Supplemental data collected by other monitoring organizations for streamflow (USGS) and coliform counts (SD CoastKeepers) are also included in the computations. The annual average water quality values for each of the 15 monitoring sites for WY19 as well as the 15-yr norms (average values calculated over past 15 years of monitoring) are presented in **Table 2.1**. WY19 values greater than the 15-yr norms are shown in blue, whereas values for this past water year below norms are expressed in red.

Table 2.1 Average Annual WQ Metrics for WY19 and 15-yr Norms by Site, Reach and Section

Site:	*LSDR Reach & Section*		Temp, oC	SpC, mS/cm	pH	DO, mg/L	DO %Sat	Flow, cfs	WQI[4] Values [a], (Difference) & Grade	
1	LMV	West	20.0/*19.6*	2.6/2.7	8.0/7.8	6.8/*6.1*	75/67	**36**/*28*	40/37 (3)	**C**/*D+*
2			19.0/*19.0*	2.5/2.6	7.8/7.7	4.4/*4.4*	47/46		30/*30* (0)	**D**/*D*
3			19.1/*19.2*	2.5/2.5	7.9/7.8	4.7/*4.6*	50/48		**32**/*31* (1)	**D**/*D*
4			19.3/*19.7*	2.2/2.5	7.9/7.8	6.5/*6.1*	69/66		**43**/*40* (3)	**C**/*C*
5	UMV		16.9/*17.2*	2.5/2.6	7.9/7.6	4.7/*4.8*	48/49	**34**/*26*	**31**/*32* (-1)	**D**/*D*
6			18.1/*18.3*	2.4/2.6	7.7/7.6	3.6/*3.6*	36/36		25/*25* (0)	**E**/*E*
7			18.0/*18.0*	2.3/2.5	7.5/7.6	5.1/*5.0*	53/52		**34**/*33* (1)	**D**/*D*
8	MG	Mid	17.3/*17.1*	2.2/2.3	7.8/7.7	6.8/*7.3*	70/74	**22**/*18*	45/*47* (-2)	**C**/*C*
9 [b]			14.9/*15.8*	4.0/4.9	8.3/7.8	9.7/*9.2*	96/93		**37**/*35* (2)	**D**/*D*
10			16.9/*17.7*	2.1/2.3	8.2/7.8	6.5/*7.1*	66/73	**19**/*16*	**40**/*44* (-4)	**C**/*C*
11	LSB	East	16.5/*16.7*	2.2/2.2	7.7/7.6	5.4/*6.1*	55/59		**35**/*37* (-2)	**D**/*D+*
12 [b]			17.5/*17.8*	1.2/1.6	8.4/7.9	7.7/*7.2*	80/72		**48**/*35* (13)	**C**/*D*
15 [b]			17.3/*18.1*	2.3/2.7	8.1/8.1	5.4/*7.4*	55/71	**15**/*10*	**32**/38 (-6)	**D**/*C*
13	USB		18.0/*18.4*	1.9/1.9	7.9/7.7	1.1/*2.9*	12/*30*	**9**/*5*	8/*17* (-9)	**F**/*E*
14			18.3/*17.5*	1.4/1.5	8.0/7.8	3.3/*3.3*	35/*32*		**27**/*19* (*8*)	**D**/*E*
(1-15)	**LSDR Avg.**		**17.8**/***18.0***	**2.2**/***2.3***	**8.0**/**7.7**	**4.9**/***5.3***	**51**/***54***	**27**/***23***	**31**/***33*** **(-2)**	**D**/*D*
c	**LSDR (Qwt)**		**17.9**/**18.0**	**2.2**/**2.3**	**8.0**/**7.7**	**4.6**/**4.9**	**47**/**50**	**24**/**20**	**29**/***31*** **(-2)**	**D**/D

a) Average annual water quality index values, change (+/-) and resultant WQ letter grade for WY19 (bold) and the 15-yr norms (italics); values below norms for each metric are in red; values above norms in blue.
b) Lower San Diego River water quality monitoring sites located on tributary (T) streams.
c) Average flow-weighted LSDR WQ Index values based on USGS streamflow data presented in Appendic H.

Nine monitoring sites present WY19 average annual WQI values greater than 15-yr norms, while six are below. The greatest increase (13 points) is associated with Site #12T, Carlton Oaks, whereas the greatest decline (-9 points) is Site #13 at Mast Park. Average annual water temperatures in WY19 were less than the 15-yr norms at 10 out of 15 sites while down 0.2 degree overall from the LSDR 15-yr annual average of 18.0 C. Specific Conductivity values in WY19 were slightly below 15-yr norms at nearly all sites within the lower watershed. Overall SpC (average all sites) is 4% less the 15-yr average annual norm of 2.3 mS/cm. DO values are lower than 15-yr norms at six sites, the same at two and above at another six. Overall this year's DO values are roughly 6% below the 15-yr LSDR average annual norm of 4.9 mg/L. DO values for WY19 are also slightly down from last year by approximately 0.3 mg/L (3% Sat). although well above the poorest year (WY14) by nearly 0.5 mg/L. The highest average annual DO levels on the river were monitored in WY05 at 6.72 mg/L (65% Sat.).

Average annual, seasonal and monthly min.-max. range water quality metrics for WY19 and the 15-yr norms are also presented by river reach and section in **Table 2.2.** Three reaches of the river (USB, LSB & MG) present slightly lower index values for the past year than their associated 15-yr norms. Average annual water temperatures, dissolved oxygen and specific conductivies for all reaches and sections of the river were near 15-yr norms. Streamflows exceeded 15-yr norms in all reaches and sections throughout WY19. The most significant declines in water quality metrics monitored within the lower river watershed occurred during the dry-weather months.

Table 2.2 Water Quality Metrics for WY19 and 15-yr Norms by Season, Reach and Section

Parameter, units		Temp, oC	SpC, mS/cm	pH	DO, mg/L	DO %Sat	Flow, cfs	WQI Value, [a](Diff) & Grade	
Max. Month		23.2/*25.4*	3.1/*4.0*	8.6/*8.7*	8.6/*10.2*	85/*102*	139/*230*	**68**/*78* (-10)	B/*A-*
Winter (D,J,F,M)		14.3/*13.6*	1.3/*1.7*	7.7/*7.7*	7.1/*6.5*	70/*62*	63/48	**38**/*47* (-9)	C-/*C*
Avg. Annual		17.8/*18.0*	2.2/2.3	7.7/*7.7*	4.9/*5.3*	51/*54*	27/*23*	**31**/*33* (-2)	**D**/*D*
Avg. (Flow Wtd)		**17.9**/18.0	**2.2**/2.3	**7.7**/7.7	**4.6**/4.9	**47**/50	**24**/20	**29**/*31* **(-2)**	**D/D**
Summer (J,J,A,S)		22.1/*22.5*	2.7/2.8	7.7/*7.7*	2.6/*3.3*	30/*38*	2.4/*2.1*	**10**/*19* (-9)	**F**/E
Min. Month		13.5/*9.3*	0.6/*0.6*	7.5/*7.1*	1.9/*1.8*	20/*20*	0.8/*0.1*	**11**/7 (4)	**F**/F
LSDR Reach & Section Averages:									
USB	East	18.2/*18.1*	2.0/*1.8*	7.7/7.7	2.0/*3.0*	21/*31*	9/*5*	14/*17* (-3)	**E-**/*E*
LSB		17.1/*17.4*	2.6/2.3	7.6/7.8	5.7/*6.5*	58/64	19/*16*	35/*36* (-1)	**D**/*D+*
MG	Mid	16.7/*17.1*	3.0/2.3	7.9/7.8	7.3/*7.5*	74/*77*	22/*18*	42/*46* (-4)	**C**/*C*
UMV	West	17.7/*17.8*	3.1/*2.6*	7.7/7.6	4.5/*4.4*	46/*46*	34/*26*	30/*30* (0)	**D**/*D*
LMV		19.4/*19.4*	3.2/*2.6*	7.9/7.7	5.2/*5.0*	55/*53*	36/*28*	36/*35* (1)	**D+**/*D*

a) Average annual water quality index value, difference (+/-) from 15-year norms and resultant WQI letter grade. Values/grades below 15-year norms (in italics) are expressed in red; values above in blue.

Spatial water quality values expressed in Tables 2.1 and 2.2 for the fifteen Lower San Diego River system monitoring sites are presented in **Chart 2.1** (Water Quality Data Profile) and **Chart 2.2** (Water Quality Index and LSDR Streamflow) on the following page. The overall water quality index for WY19 of 29 (D Marginal) is two points below the 15-yr average annual norm of 31 (D Marginal). This year's average annual index value is nine points above the lowest annual WQI of 20 (E Poor) experienced in WY14. The river's highest overall average annual index of 40 (Fair) occurred in WY05. Only two water year's (WY14 and WY18) have shown overall average index values in the Poor E (WQI 13-24) range.

Average annual water quality values for water temperature, pH, dissolved oxygen and specific conductivity at each monitoring site, river reach and section in order of their location upstream for WY19 (Oct.'18-Sept.'19) and the 15-yr norms are shown in **Chart 2.1**. This year's average annual results are shown as heavy solid lines in black with values presented; blue lines are last year's (WY18) results and the red lines are 15-yr annual averages or norms for each site. Average annual water temperatures for WY19 remain slighly below 15-yr norms in the upper secions (SB) and slightly below in the lower (MV) sections; also slightly lower than last year's averages. Average downstream water temperatures are typically higher than monitored at upstream sites. There is little variance in average pH values from site-to-site or from one year to the next. DO levels for WY19 are generally above those from last year (WY18) and near the 15-yr norms. Average annual DO values at two sites (6,13) were below threshold levels of 4 mg/L; whereas last year five sites had averages below 4 mg/L. Monitored DO values represent the greatest variation between sites. Lowest values are typically recorded in the Upper Santee Basin (sites 13&14) and Upper Mission Valley below Kaiser Ponds (site 6) whereas the highest values are observed in the Mission Gorge section (middle reach sites 8-10). Excluding tributary sites, average annual conductivity (SpC) values generally increase along the mainstem from upstream to downstream. SpC averages for WY19 are near 15-yr norms and significantly below last year's values at all sites.

The WQI, an aggregate or composite index of water quality monitoring metrics for WY19, the 15-yr norms, the overall best (WY05) and worst (WY14) year results are presented in **Chart 2.2**. As shown by the solid black line (this year's results) in comparison to the colored bars (15-yr norms), the two sites furthest upstream, Mast Park (13) and Magnolia Ave (14), continue to experience Poor (E) to Very Poor (F) water quality as does the Kaiser Ponds site (6). On an average annual basis, highest WQI values continue to be associated with the three Mission Gorge sites (8-10). The overall WQI profile for WY19 (black line) is in general quite near the 15-yr norms (colored bars) and well above last year's (WY18) results (dashed black line). Greatest departures (variance) from the 15-yr WQI norms for WY19 are found in the Mission Gorge and Santee Basin portions of the lower watershed. Water quality conditions throughout Mission Valley (both Upper and Lower reaches) in WY19 are noticably improved from last year's (WY18) values. As evidenced in the past, above normal flows tend to flush the lower river system resulting in improved overall water quality. WY19 experienced above normal stream flow. WY18 was well below normal.

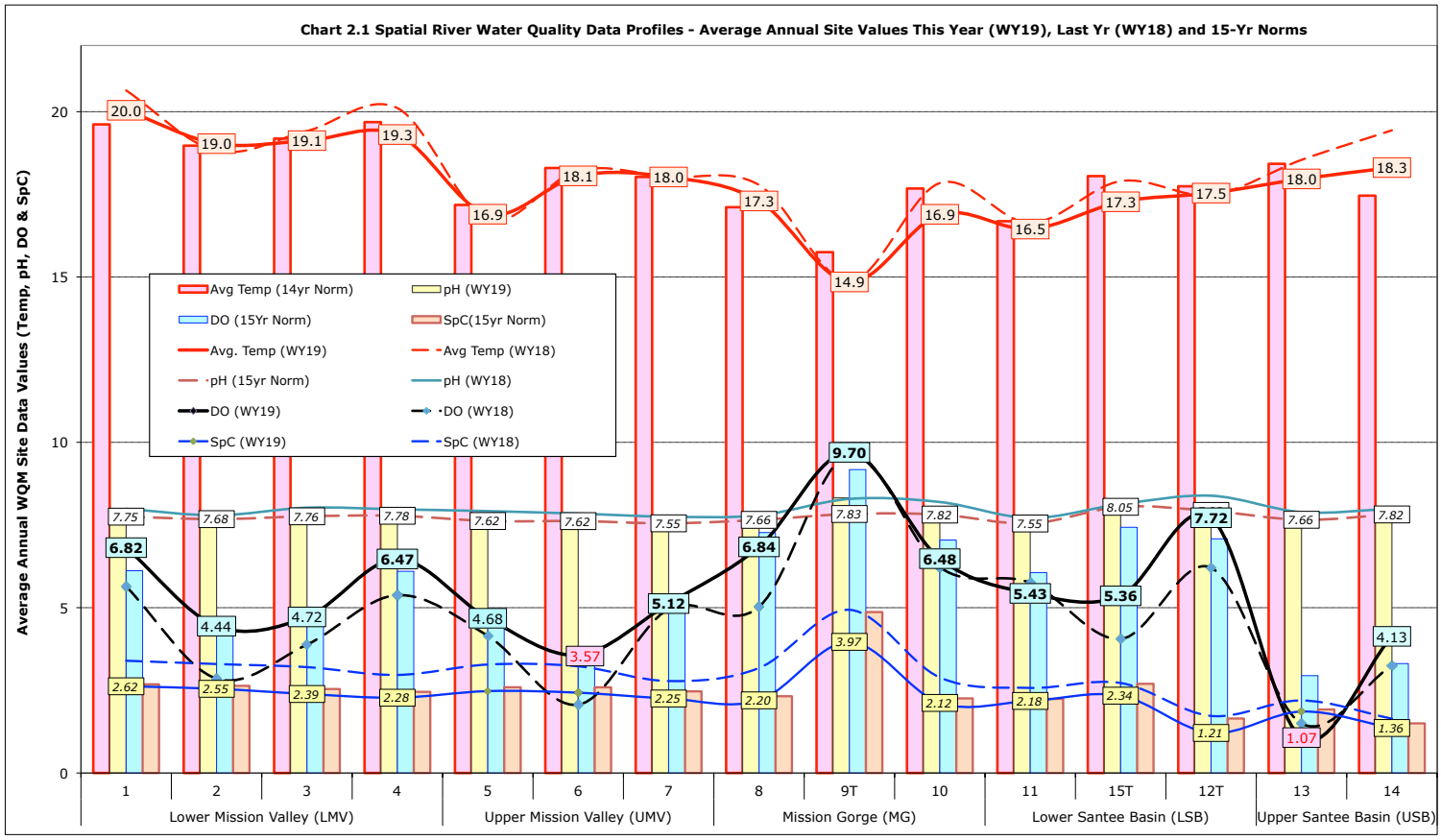


Chart 2.1 Spatial River Water Quality Data Profiles - Average Annual Site Values This Year (WY19), Last Yr (WY18) and 15-Yr Norms
Average Annual WQM Site Data Values (Temp, pH, DO & SpC)
Avg Temp (14yr Norm)
pH (WY19)
DO (15Yr Norm)
SpC(15yr Norm)
Avg. Temp (WY19)
Avg Temp (WY18)
pH (15yr Norm)
pH (WY18)
DO (WY19)
DO (WY18)
SpC (WY19)
SpC (WY18)
Lower Mission Valley (LMV)
Upper Mission Valley (UMV)
Mission Gorge (MG)
Lower Santee Basin (LSB)
Upper Santee Basin (USB)

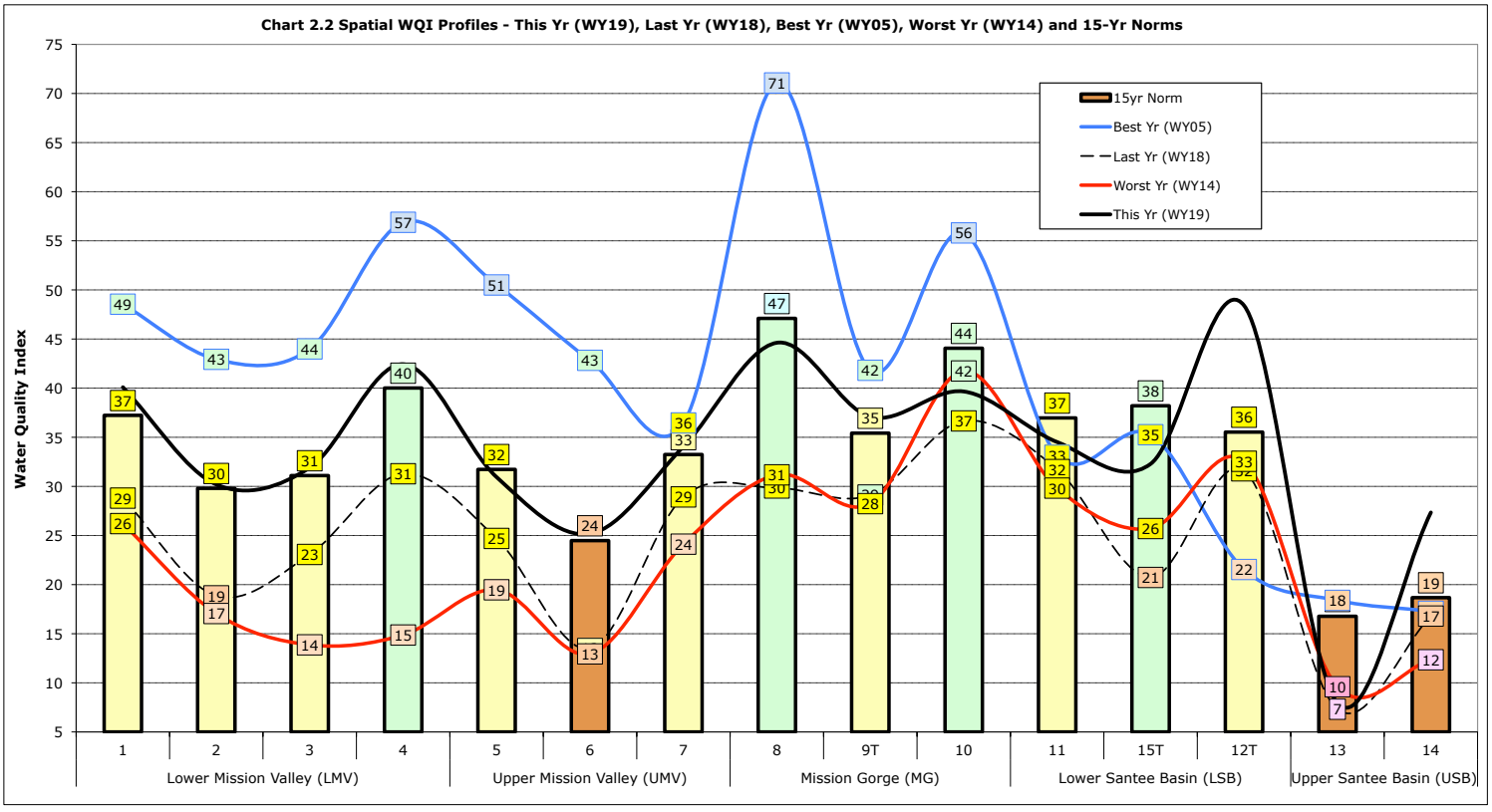


Chart 2.2 Spatial WQI Profiles - This Yr (WY19), Last Yr (WY18), Best Yr (WY05), Worst Yr (WY14) and 15-Yr Norms
Water Quality Index
15yr Norm
Best Yr (WY05)
Last Yr (WY18)
Worst Yr (WY14)
This Yr (WY19)
Lower Mission Valley (LMV)
Upper Mission Valley (UMV)
Mission Gorge (MG)
Lower Santee Basin (LSB)
Upper Santee Basin (USB)

Section 3 - Temporal Analysis of WY19 Data and 15-yr Norms

Monthly, seasonal and annual water quality monitoring metrics data and WQI results for the Lower San Diego River are presented in **Table 3.1** for this year (WY19) in comparison to 15-yr norms shown italicized. WY19 values above the 15-yr norms are in blue; values below in red. With few exceptions temporal water quality WY19 values exceeded last year's (WY18) results for water temperatures, Specific Conductivity and pH, while DO, flow and WQI values were without exception lower this year than last. Overall water quality in the lower river watershed improved an entire grade level (11 points) throughout the year, irrespective of the specific season.

Table 3.1 LSDR WQM Metrics for WY19 and 15-yr Norms by Month and Season

		Temp	SpC	pH	DO	DO%	Flow	WQI [a]	
Month	*Season:*	*oC*	*mS/cm*		*mg/L*	*% Sat*	*cfs*	*Value & Grade*	
Oct	Fall	16.7/*18.7*	2.88/*2.83*	7.7/*7.7*	**2.94**/*3.67*	**30**/*39*	**2.1**/*2.1*	**17**/*20*	**E**/*E*
Nov		13.5/*14.8*	3.13/*2.69*	7.7/*7.7*	**4.64**/*4.92*	**45**/48	**0.5**/*8.0*	**18**/*28*	**E**/*D*
Dec	Winter	13.5/*12.0*	1.90/*1.80*	7.6/7.7	**6.04**/*6.20*	**59**/57	**46**/*26*	**42**/*40*	**C**/C
Jan		14.9/*11.9*	1.30/*1.70*	7.7/7.7	**5.93**/*7.50*	**59**/69	**28**/*54*	**47**/*48*	**C**/C+
Feb		13.9/*14.0*	0.56/*1.62*	7.6/7.8	**8.01**/*6.84*	**79**/66	**139**/*60*	**51**/*45*	**B-**/C
Mar		14.6/*16.7*	1.36/*1.60*	7.7/7.7	**8.57**/*6.50*	**85**/66	**39**/***50***	**66**/*48*	**B**/C+
Apr	Spring	19.5/*18.2*	1.90/*1.94*	7.5/7.7	**4.51**/*5.40*	**49**/57	**9.8**/*16*	**30**/*39*	**D**/C
May		19.6/*20.2*	1.96/*2.21*	**7.5**/7.7	**3.50**/*4.69*	**39**/52	**9.8**/*10*	**27**/*32*	**D**/*D*
June	Summer	21.6/*22.2*	2.22/*2.55*	8.1/*7.8*	**3.34**/*3.96*	**38**/*45*	**6.4**/*3.8*	**21**/*23*	**E**/*E*
July		23.2/*23.2*	2.67/*2.73*	7.7/*7.6*	**2.95**/*3.16*	**35**/*37*	**1.5**/*2.0*	**15**/*16*	**E**/*E*
Aug		22.6/*23.3*	2.98/*2.94*	7.5/7.7	**2.30**/*3.08*	**27**/*36*	**0.8**/*1.2*	**11**/*14*	**F**/*E-*
Sept		21.1/*21.4*	3.07/*2.97*	7.6/7.7	**1.90**/*3.08*	**20**/*35*	**0.9**/*1.3*	**10**/*16*	**F**/*E*
Fall (O&N)		18.3/*16.8*	2.76/*2.71*	7.7/7.7	**3.39**/*4.30*	**36**/*43*	**1.3**/*5.1*	**18**/*24*	**E**/*E+*
Winter (D,J,F,M)		14.7/*13.6*	1.68/*1.73*	7.7/7.7	**7.14**/*6.50*	**70**/62	**63**/*48*	**52**/*45*	**B-**/*C*
Spring (A&M)		18.5/*19.2*	2.07/*2.11*	7.7/7.7	**4.32**/*5.04*	**46**/*54*	**2.0**/*13*	**29**/*35*	D/*D+*
Summer (J,J,A,S)		22.9/*22.5*	2.80/*2.81*	7.7/7.7	**2.62**/*3.32*	**30**/38	**2.4**/*2.1*	**14**/*17*	**E-**/*E*
Annual (O-S)		**17.9**/*18.0*	**2.16**/*2.29*	**7.7**/*7.7*	**4.55**/*4.92*	**47**/*50*	**23.7**/*20*	**29**/*31*	**D**/*D*

a) Values based on RiverWatch physical-chemical metrics (WQI_4) combined with USGS stream flow for eastern (West Hills Pkwy) and western sections (Fashion Valley). WY19 values/grades below the 15-yr norms (in italics) are shown in red; those equal to or above in blue.

Monthly and seasonal variances in water quality monitoring metrics for the past two water years and the 15-yr norms are expressed in **Chart 3.1.** (WQM Data) on the next page. Dissolved oxygen values are highest during the winter/spring months (Dec-May) whereas specific conductivity and water temperatures are greatest during the dry summer months (June-Sept) and into early Fall (Oct). Coliform counts and pH values show far less seasonal fluctuation, although lesser variances from norms in monthly values are evident. The broad range in DO, SpC and temperature values monitored at all sites throughout the year provide the best indications of temporal variance in water quality. Seasonal variances between this year's data (WY19), shown as solid lines, last year's results (dashed lines) and the 15-yr norms (bars) are comparable. In general, temporal variance in WY19 water quality data closely match patterns in 15-yr norms, slightly more so than last year's values. This year's temporal water quality metrics are considered indicative of both normalized monthly occurrences as well as those monitored during the previous year (WY18). The greatest distinction between last year's metrics and this year's occur during the wet-weather (winter) season. Streamflows, as shown on the next chart, have a large impact on variance in other temporal WQ metrics.

Chart 3.2 provides an overall graphic showing temporal variance in WQI values and streamflow throughout WY19 compared to monthly averages over the previous water year (WY18) as well as the 15-year norms. As shown in **Chart 3.2**, the WQI values for WY19 (heavy red line) that are also listed in Table 3.1 (far left coulumn) are relatively close to the 15-yr norms (colored bars) for most months of the year. The strong relationship between flow (both wet weather and dry) and water quality continues to effect results. Depletion in DO levels combined with well-below normal dry-weather flows constitute the primary drivers in low index values during both Fall (O,N) and Summer (J,J,A,S) months. The normal and somewhat above wet weather flows from Dec. through May resulted in improvements over WY18 results. In general, water quality for the Lower San Diego River watershed is highest (B-C Good to Fair) when flows are greatest during the Winter months (Dec-March) and poorest (E-F Poor to Very Poor) in Summer (June-Sept) when streamflow is lowest and water temperatures highest. The overall annual average WQI for the LSDR in WY19 of 29 (D Marginal) is only two points (-6%) below the 15-yr average index value of 31. Last year's well below average results (-29%) occured during a well below averge rainfall and streamflow year. Although DO depletions were not as great this year as last they have persisted at multiple sites throughout the dry-weather period, particularly in the upper Santee Basin.

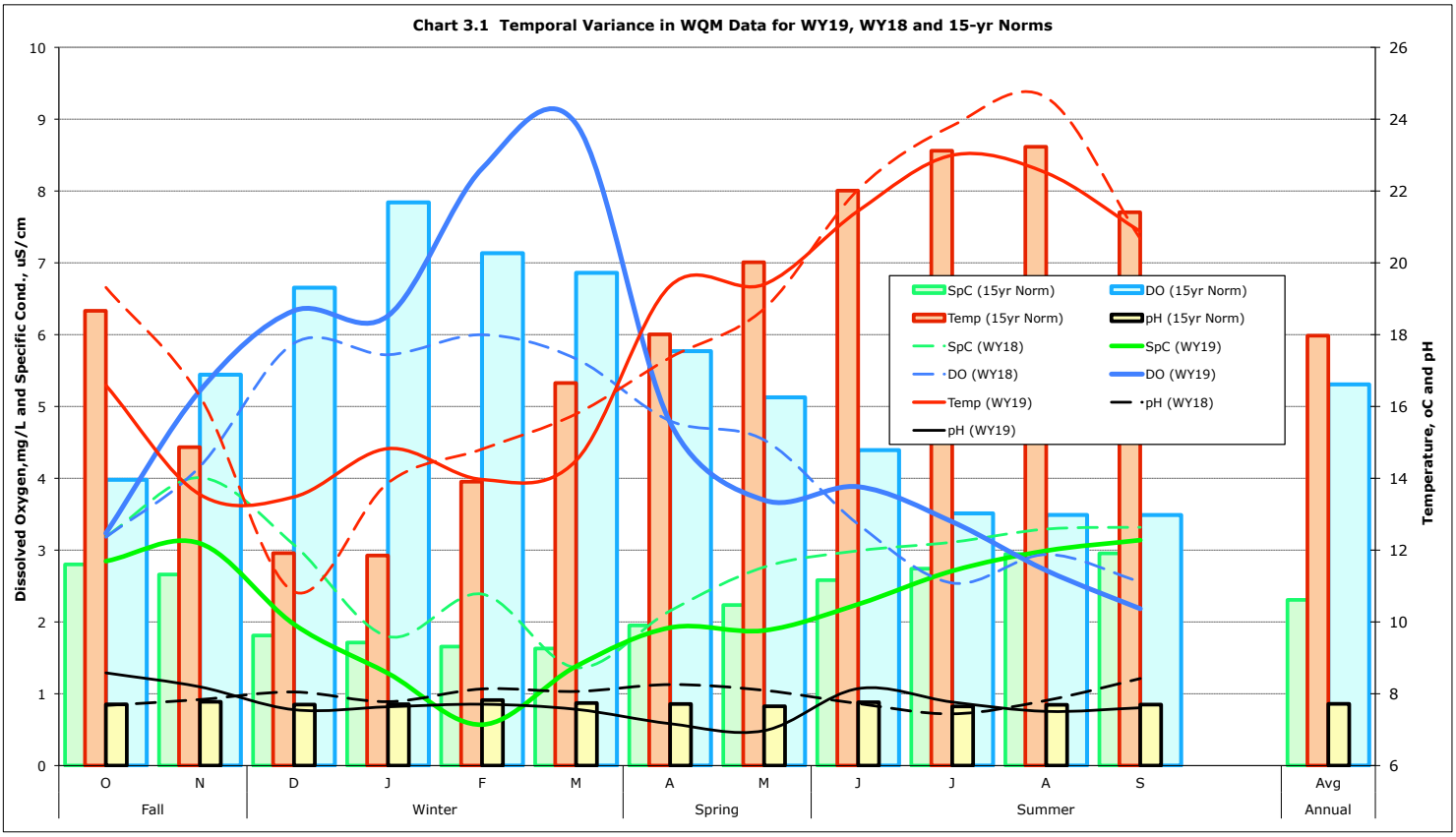


Chart 3.1 Temporal Variance in WQM Data for WY19, WY18 and 15-yr Norms
Dissolved Oxygen,mg/L and Specific Cond., uS/cm
Temperature, oC and pH
SpC (15yr Norm)
DO (15yr Norm)
Temp (15yr Norm)
pH (15yr Norm)
SpC (WY18)
SpC (WY19)
DO (WY18)
DO (WY19)
Temp (WY19)
pH (WY18)
pH (WY19)
O N D J F M A M J J A S Avg
Fall
Winter
Spring
Summer
Annual

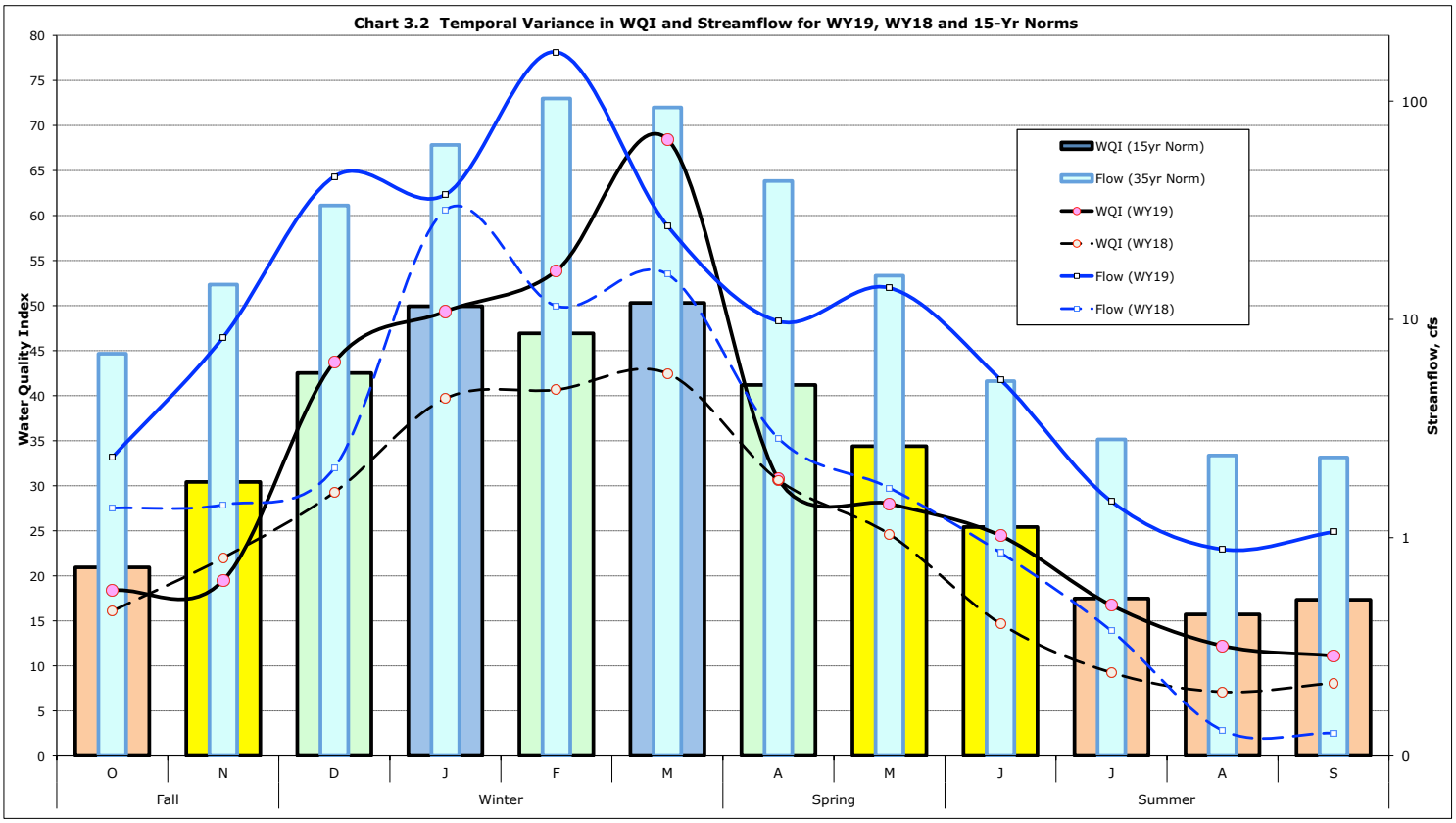


Chart 3.2 Temporal Variance in WQI and Streamflow for WY19, WY18 and 15-Yr Norms
Water Quality Index
Streamflow, cfs
WQI (15yr Norm)
Flow (35yr Norm)
WQI (WY19)
WQI (WY18)
Flow (WY19)
Flow (WY18)
O N D J F M A M J J A S
Fall
Winter
Spring
Summer

Section 4 - Trends in Water Quality Metrics (WY05 through WY19)

Trends in SDRPF monitored water quality metrics, based on data collected by RiverWatch from September 2005 through September 2019, are presented in this chapter. The metrics include water temperature, specific conductivity, pH, dissolved oxygen, streamflow and the water quality index. Twelve month running average values considered with overall straight-line averages represent a reasonable indication of relative change over the past 15 years of monitoring for each metric.

Table 4.1 presents 12-month running average values for each of the key water quality metrics monitored over the past 15 years. Running averages above 15-yr norms are listed in blue; values below norms are in red. The 15-yr norms (12-mo running averages) are expressed in italics in the bottom row.

Table 4.1 - 12-mo Running Average WQM Metrics (WY05-WY19)

	Temp	SpC	pH	DO	DO%	Flow	WQI [a]	
	oC	*mS/cm*		*mg/L*	*% Sat*	*cfs*	*Values & Grade*	
WY05	17.68	2.064	7.66	6.63	62	71.5	41/40	C Fair
WY06	18.32	2.141	7.40	6.00	59	13.6	36/35	D+ Marginal
WY07	17.70	2.342	7.75	5.95	60	9.5	36/34	D+ Marginal
WY08	17.67	2.223	8.05	6.26	63	18.2	37/36	C- Fair
WY09	17.73	2.393	7.80	6.25	64	20.1	36/35	D+ Marginal
WY10	18.08	2.287	7.66	5.21	54	32.4	34/32	D Marginal
WY11	17.77	2.160	7.83	5.53	57	46.9	38/36	C- Fair
WY12	18.03	2.339	7.33	5.16	53	14.9	33/31	D Marginal
WY13	17.32	2.441	7.78	5.30	54	9.1	32/30	D Marginal
WY14	17.86	2.505	7.52	3.87	40	5.1	22/20	E Poor
WY15	18.69	2.189	7.84	4.53	48	10.t	29/25	D Marginal
WY16	18.19	2.269	7.53	4.69	49	15.6	28/25	D Marginal
WY17	18.55	2.154	7.74	5.05	53	40.0	33/31	D Marginal
WY18	18.18	2.788	7.91	4.28	44	5.9	24/22	E Poor
WY19	**17.79**	**2.170**	**7.76**	**4.91**	**51**	**27.3**	**31/29**	**D Marginal**
15yr Avg	*17.97*	*2.298*	*7.71*	*5.33*	*54*	*22.7*	*33/31*	*(D Marginal)*

Values based on SD RiverWatch physical-chemical metrics (WQI_4) combined with USGS stream flow for eastern (West Hills Pkwy) and western (Fashion Valley) gauging stations. Values/grades below 15-yr norms shown in red; above in blue.

Running average, maximum and minimum monthly monitoring site **water temperature** results for the LSDR watershed are presented on **Chart 4.1**. Running average water temperatures held fairly steady between WY05 and mid-WY11, declined by approximately one-half a degree celsius by WY14, then increased by approximately a degree over the next year (by late WY15) and have remained reasonably constant during the last four years. Typical variance in running average water temperature over the past decade is in the range of 3% above to 3% below norms, however, from Oct. 2013 to Oct. 2015 (24 months) variance in water temperature rose from 4.6% below to 5.2% above the 15-yr norm of 18°C. Maximum monthly water temperatures have trended higher than monthly minimums over the past decade. Higher running average water temperatures observed over the past few years are a result of higher 24-hr average, daytime and nighttime lows in both air and ground temperatures experienced in San Diego as well as throughout much of Southern California. There were only two months in WY17 and WY18 (Dec. & Jan.) when water temperatures fell below 13°C while this year (WY19) there were none. Elevated water temperatures typically result in greater rates of decomposition and lowered saturation levels of dissolved oxygen. As can be seen in both running average colored lines for max (red) and average (black) and associated dashed (straight) lines that trends in water temperature over the past 15 years are upward. The average annual increase is on the order of 0.4 percent; an overall rise in average annual river temperature of approximately 0.5°C. Average water temperature for the LSDR in WY19 was 17.9°C, down 2% from last year's value. The coolest water temperature year since monitoring began was WY13 when the average annual water temperature was 17.3°C. WY15 was the warmest water temperature year at 18.7°C.

Trends in monthly monitored **Specific Conductivity** (SpC) values for the LSDR are presented in **Chart 4.2**. Minimum and maximum running averages for all sites monitored have varied little over the 15-yr period, however, the overall LSDR running average rose from a low 2.06 mS/cm range (*10% below average*) during the first few years of monitoring to 2.78 mS/cm (21% *above average)* last year (WY18). Considerably greater rainfall during WY19 and resultant near-normal dry-weather stream flow have caused SpC values to fall below the 15-yr norm of 2.29 mS/cm. The current LSDR running average SpC of 2.184 mS/cm is 5.4% below the 15-yr norm. The slight rising overall trend in SpC for all sections of the lower river is, however, expected to continue. The current overall average annual rise in conductivity is 2.5% or 0.05 mS/cm per annum. The variance in maxima at all sites has remained fairly steady of the past 15 years of monitoring, however, site minimun values have increased due to lower average daily flow and rising average daily temperatures resulting in somewhat higher evaporation rates.

Trends in monthly **pH** values are presented in **Chart 4.3**. The overall or general trend in values monitored for the LSDR has been relatively consistant over the 15 years (WY05-WY19). The initial five years of below average pH may have been due, at least in part, to faulty equipment as monthly minima and maxima values since WY10 have consistently read higher. Excluding the initial year's, there has been but a small variance (<3%) in the overall running average pH from the 15-yr norm of 7.71. The overall trend in pH for the lower river is, however, slightly positive; similar to temperature and conductivity. Values have increased by an average of 0.3% per annum since RiverWatch monitoring was started, primarily as site minima values have risen. It is concluded that the lower river may be becoming slightly more alkiline (basic) as average flows have declined and water temperatures have increased. The most common cause of higher pH water is less available carbon dioxide caused by elevated rates of aerobic resperation that accompany warmer waters. Tracking the trend in pH is important as a general indicator of the natural process of eutrophication in the lower sections of the river.

Running average **dissolved oxygen (DO)** values and monthly minima-maxima are presented in **Chart 4.4** (pg14). A general but somewhat irregular decline in average and min./max. values from Oct. 2004 through Oct. 2019 can be observed. LSDR maximum monthly values between early 2015 and late last year (Dec. 2017) slowly increased although remaining below 15-yr norms. The current running average DO value of 4.91 mg/L (Sept 2019) is approximately 7% below the 15-yr norm of 5.27 mg/L. Depleted

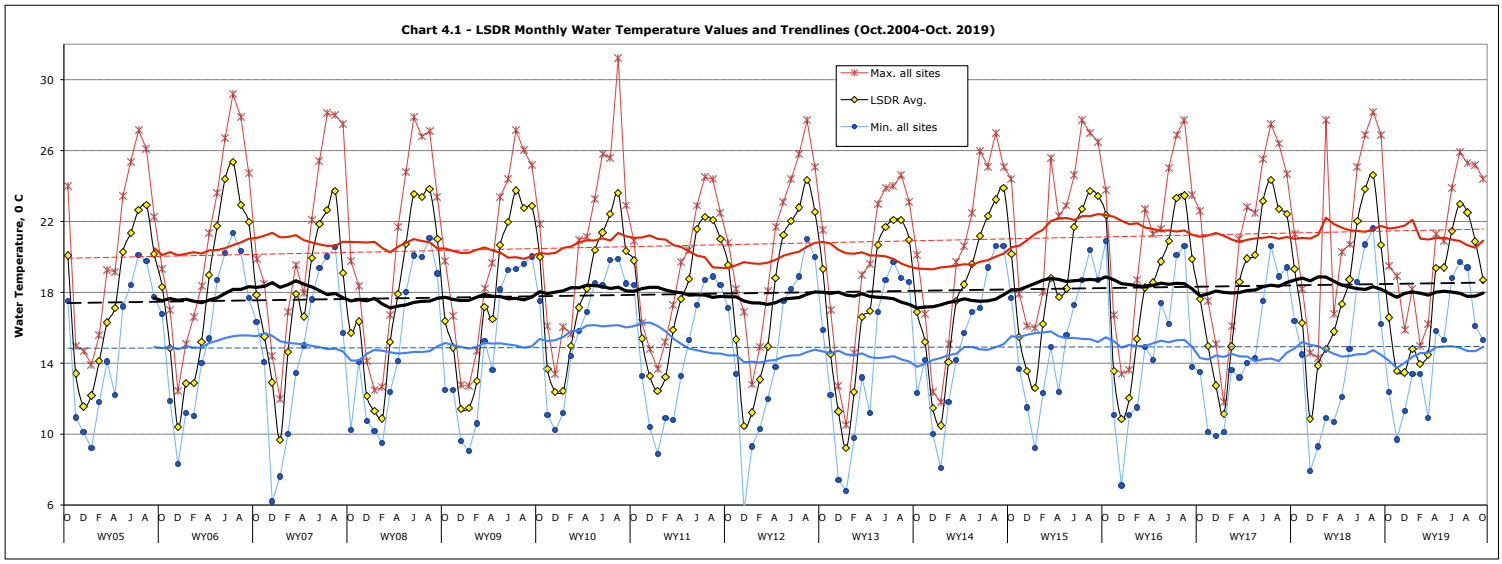


Chart 4.1 - LSDR Monthly Water Temperature Values and Trendlines (Oct.2004-Oct. 2019)
Water Temperature, 0 C
Max. all sites
LSDR Avg.
Min. all sites
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19

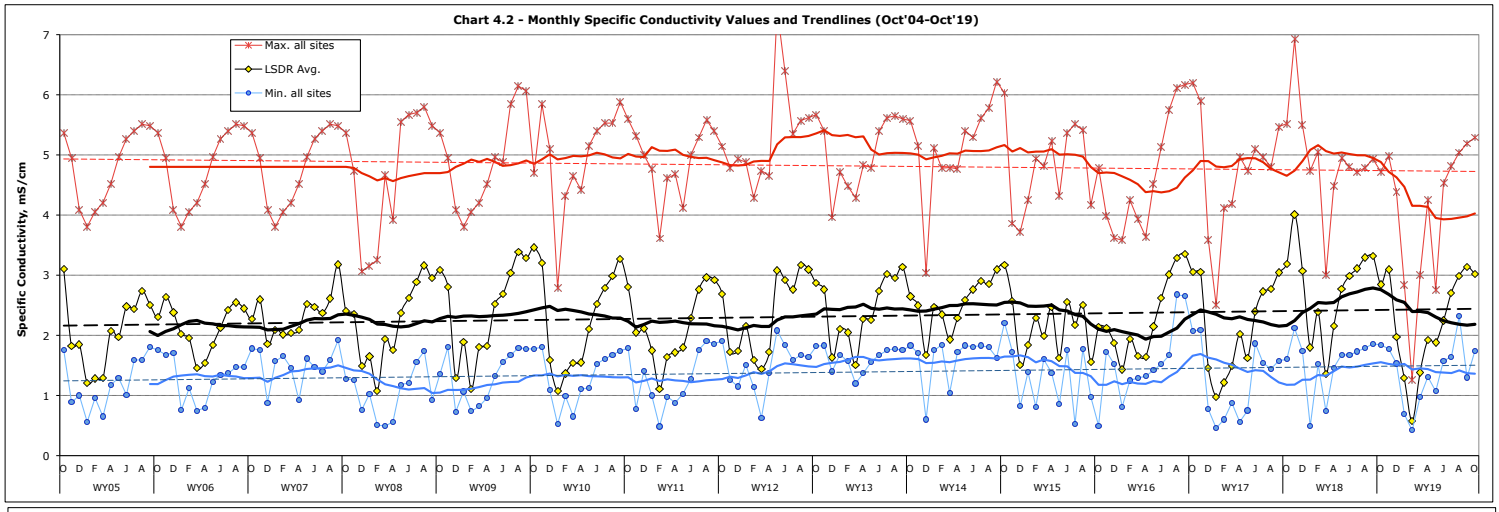


Chart 4.2 - Monthly Specific Conductivity Values and Trendlines (Oct'04-Oct'19)
Specific Conductivity, mS/cm
Max. all sites
LSDR Avg.
Min. all sites
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19

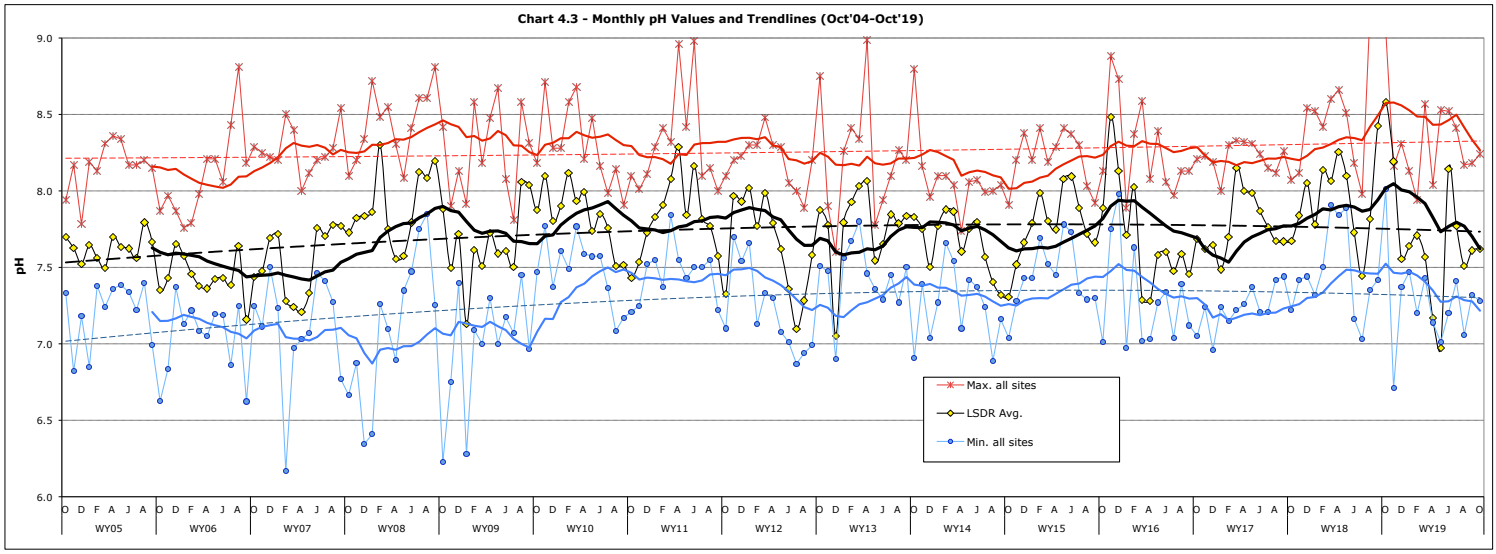


Chart 4.3 - Monthly pH Values and Trendlines (Oct'04-Oct'19)
pH
Max. all sites
LSDR Avg.
Min. all sites
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19

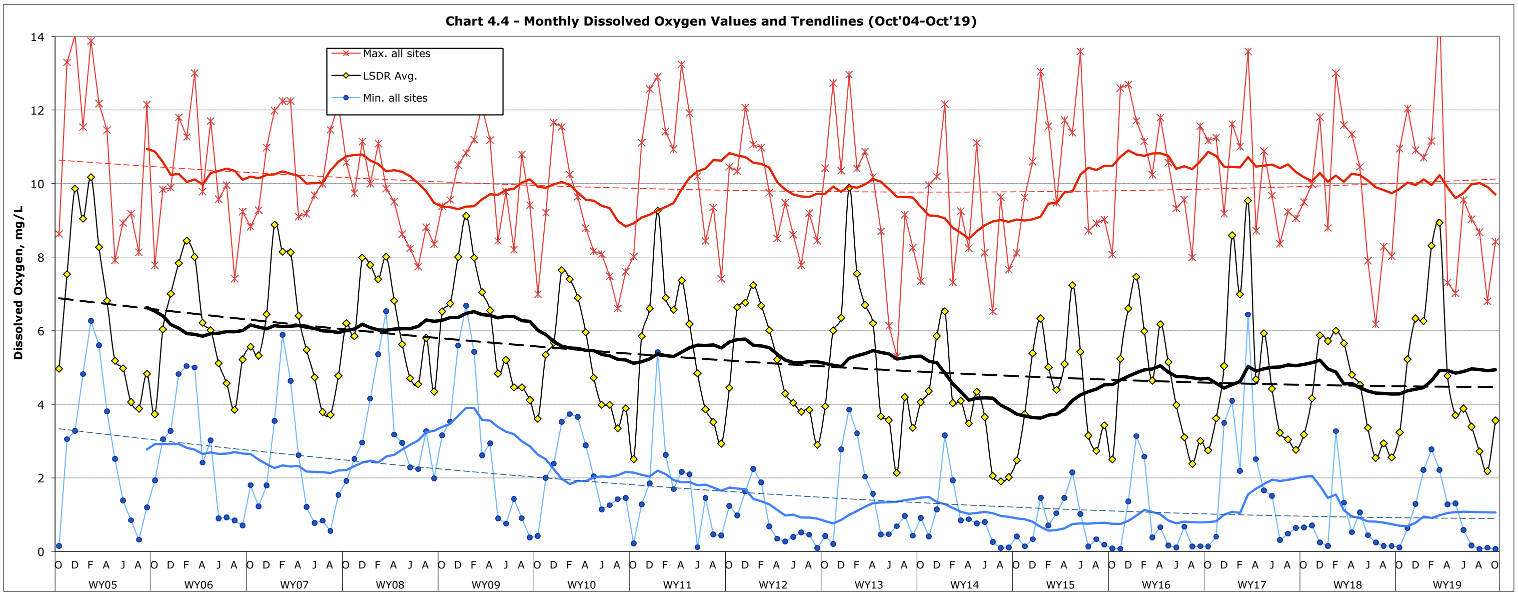


Chart 4.4 - Monthly Dissolved Oxygen Values and Trendlines (Oct'04-Oct'19)
Max. all sites
LSDR Avg.
Min. all sites
Dissolved Oxygen, mg/L
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19

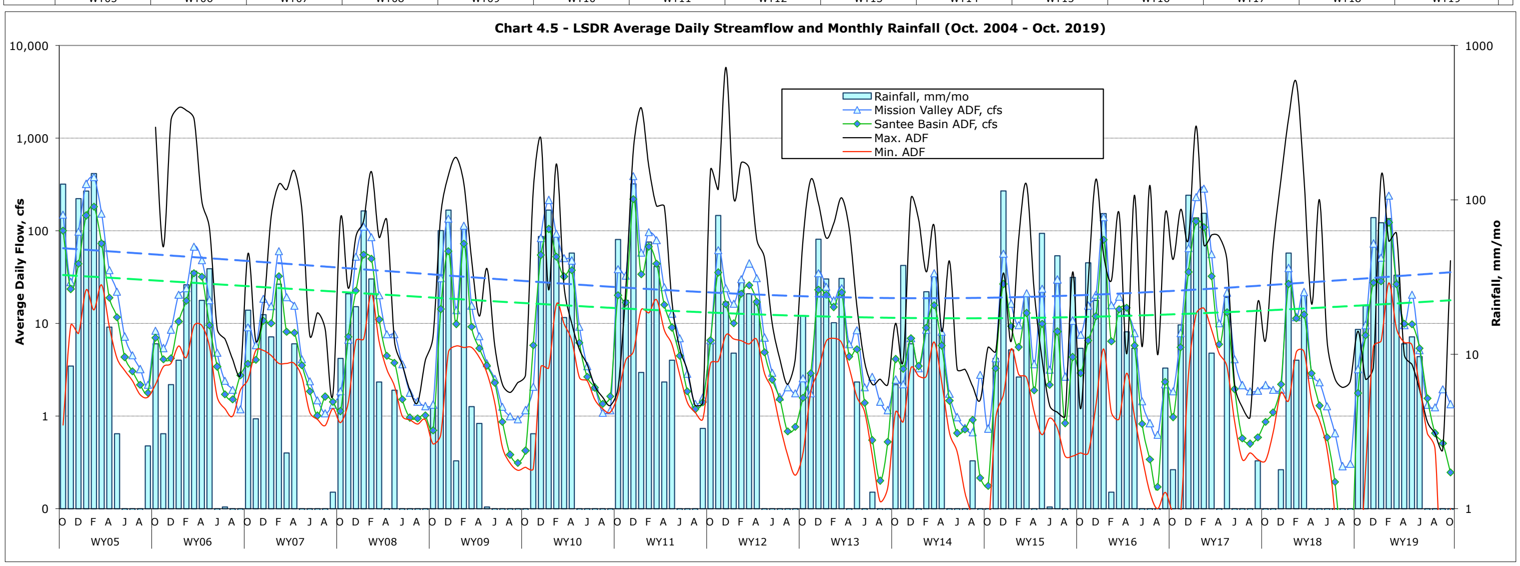


Chart 4.5 - LSDR Average Daily Streamflow and Monthly Rainfall (Oct. 2004 - Oct. 2019)
Rainfall, mm/mo
Mission Valley ADF, cfs
Santee Basin ADF, cfs
Max. ADF
Min. ADF
Average Daily Flow, cfs
Rainfall, mm/mo
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19

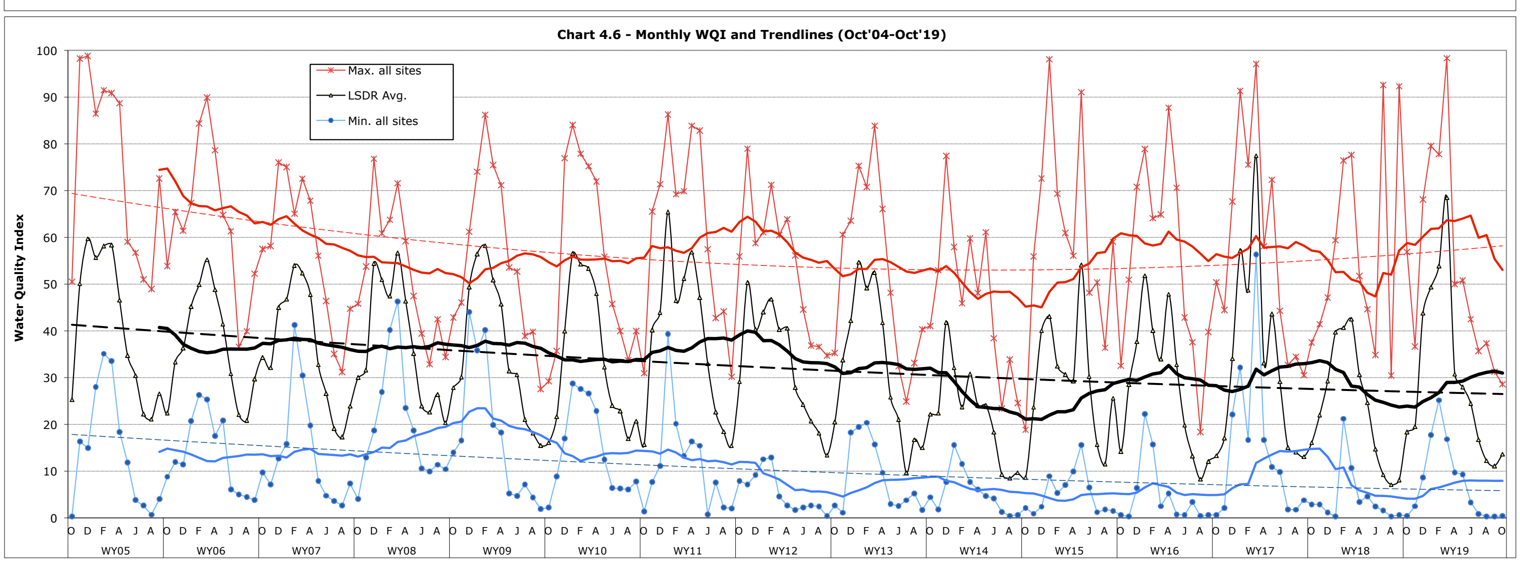


Chart 4.6 - Monthly WQI and Trendlines (Oct'04-Oct'19)
Max. all sites
LSDR Avg.
Min. all sites
Water Quality Index
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19

dissolved oxygen levels that have been monitored throughout various reaches and segments of the lower river result from low streamflow, especially during the driest-weather months, combined with above average water temperatures and rapid decomposition of oxygen demanding organic materials (biomass). With the lack of significant flushing action during relatively mild storm flow events over the past decade, a large amount of decomposing biomass* has accrued within slower moving portions of the river channel. Overall running average DO values are expected to improve subsequent to one or more major storm flow events resulting in significant channel flushing, displacement of organic-rich sediments and significant reduction of poorly-rooted and free-floating invasive aquatic plants. The trend in overall LSDR DO values has, over the past 15 years, declined in excess of 2 mg/L from roughly 6.5 mg/L to 4.5 mg/L. This represents an average annual drop in DO of approximately 2.4% (0.13 mg/L) since RiverWatch monitoring was inniated. As can be seen on Chart 4.4, the rate of decline in minimum values (-3 % per annum) is noticably greater than the rate of decline in maxima (-0.5%/yr). Extended periods of very low flow have resulted in lower overall DO levels.

Trends for total monthly rainfall and running average streamflows in the Santee Basin (SB) and Mission Valley (MV) sections are expressed in **Chart 4.5.** The trend in average daily streamflow throughout the LSDR watershed fell by an order of magnitude (from 100 cfs to 10 cfs) between WY05 to WY06, then slowly rose to 80 cfs in WY11. Lowest running average streamflows of 7-8 cfs for Mission Valley and 3 cfs for the Santee Basin, occured in WY14. Due to the distribution and magnitude of rainfall in both WY15 and WY16, running average streamflows rose back to 15-20 cfs (Mission Valley) and 8-12 cfs (Santee Basin), but still below 15-yr norms. WY18 streamflows fell sharply as the watershed recieved near record low rainfall. Dry weather flows in June through September of last year were some of the lowest recorded in the past 4-5 decades. With above normal rainfall in WY19, stream flows have climbed back to slightly above long-term norms.

The overall **water quality index** (WQI) for LSDR as well as minimum and maximum running average values for monitoring sites within the watershed are presented in **Chart 4.6.** The WQI provides a general indication of the relative condition of the river based on individual water quality parameters monitored by RiverWatch and streamflow (river discharge) as measured by the USGS at two gauging stations. Similar to trends in DO (Chart 4.4), running average WQI values that were in general decline from late WY09 to early WY15 slowly increased through 2017. LSDR running averages reached their lowest value of 20 (E Poor) in 2014, at 35% below the 15-yr norm of 31 (D Marginal). This year's running average WQI of 29 (D Marginal) is only 4% below the 15-yr norm. WY18 presented the second lowest index at 22. The above normal rainfall and when it occured in WY19 resulted in higher running average index values similar to those experienced in WY09 and WY11. A below average rainfall year next year could result in a further decline in the index. Much depends on hydrodynamics of the river both during wet and dry-weather periods. A major flushing flow at some point in time could have a significant impact on the index trend. Over the past 15 years the index has fallen roughly ten points or an average of 0.67 points per annum. Both minima and maxima index values have fallen at comperable rates.

The trends and relative variances in water quality metrics shown in **Charts 4.1-4.6** are interrelated. Declining rainfall results in less streamflow which results in declining dissolved oxygen levels and increased specific conductivities. As all of the parameters are incorporated in computation of the water quality index, trends over the past 15 years are similar. The lower river system experienced its best water quality during the wettest year (WY05) followed by a general decline during the well-below average rainfall and river discharge period from WY10 through WY13. The river experienced its poorest water quality during the driest, lowest average annual streamflow year (WY14) monitored over the past 15 years. An uptrend toward normalized values was evident over the past several years (WY15-WY17), but again declined in WY18. WY19 has seen some recovery. WQI trendlines by individual river reach and specific segment as well as for the overall system are presented in Section 5.

Section 5 - Trends in LSDR Water Quality Index (WY05 through WY19)

Annual and seasonal LSDR WQI values are presented in **Table 5.1** by river reach, section, and overall (LSDR) average for each water year (WY05-WY19) of monitoring. Values and grades above 15-yr norms are listed in black; values below the 15-yr norms (expressed in italics) are shown in red. The WY19 values, expressed in bold font, are improved over last year's results for all reaches and sections of the lower river. Overall the LSDR average annual WQI rose seven points from last year's value increasing from the E+ Poor water quality range to D Marginal, two points below the 15-year norm.

Table 5.1 - Average Annual and Seasonal WQI by Reach and Section (WY05-WY19)

Annual Avg.	LMV Reach	UMV Reach	MV Section	MG Section	LSB Reach	USB Reach	SB Section	LSDR Overall Avg.	
WY05	48	42	46	63	31	18	24	41/40	C (highest)
WY06	39	33	37	54	34	22	28	36/35	D+
WY07	36	28	33	49	40	27	34	36/34	D+
WY08	38	30	35	45	38	34	36	37/36	C-
WY09	38	29	34	45	38	32	35	36/35	D+
WY10	36	32	34	47	37	18	27	34/32	D
WY11	39	38	39	54	44	15	29	38/36	C-
WY12	35	35	35	47	39	9	24	33/31	D
WY13	37	32	35	44	35	11	23	32/30	D
WY14	18	19	18	36	28	11	19	22/20	E (lowest)
WY15	24	22	23	44	43	11	27	29/25	D
WY16	35	22	29	40	37	9	23	28/25	D
WY17	34	32	33	41	39	19	29	33/31	D
WY18	26	22	24	33	27	10	19	24/22	E+
WY19	**36**	**30**	**34**	**42**	**35**	**14**	**24**	**31/29**	**D**
15-yr Norm	*35*	*30*	*33*	*46*	*36*	*17*	*27*	*33/31*	*D Marginal*
Winter	LMV	UMV	MV	MG	LSB	USB	SB	LSDR Overall	
WY05	63	65	64	84	44	33	39	58/58	B (highest)
WY06	54	50	52	60	40	29	35	47/46	C
WY07	49	42	46	61	55	40	48	50/47	B-/C+
WY08	56	47	52	54	52	52	52	52/52	B
WY09	57	48	53	61	54	49	52	54/53	B
WY10	54	53	54	66	54	28	41	51/49	B-/C+
WY11	57	56	56	66	54	27	40	52/50	B-
WY12	48	49	49	58	44	14	29	43/41	C
WY13	58	53	56	67	49	21	35	50/48	B-/C+

WY14	26	26	26	55	39	15	27	32/29	D (lowest)
WY15	33	29	31	58	53	11	32	37/32	D+/D
WY16	44	38	41	57	52	14	33	41/37	C/D+
WY17	53	58	55	66	60	35	48	54/53	B
WY18	38	37	38	58	41	16	29	38/36	C/D+
WY19	**58**	**56**	**57**	**69**	**58**	**29**	**43**	**54/52**	**B**
15-yr Norm	*50*	*47*	*49*	*63*	*50*	*28*	*39*	*47/45*	*C+ Fair*
Summer	LMV	UMV	MV	MG	LSB	USB	SB	LSDR Overall	
WY05	31	24	28	45	20	5	13	25/24	D-/E+
WY06	23	14	19	44	30	18	24	26/23	D-/E+
WY07	23	14	19	34	24	14	19	22/20	E
WY08	23	20	22	31	25	18	21	23/22	E
WY09	21	14	18	31	25	16	20	21/20	E
WY10	21	17	20	33	26	9	17	21/19	E
WY11	23	17	20	37	30	5	17	22/20	E
WY12	22	18	20	25	27	4	15	19/17	E
WY13	18	14	16	18	23	5	14	16/14	E
WY14	10	11	10	12	16	9	12	11/11	F+
WY15	15	11	13	32	37	9	23	21/17	E
WY16	18	7	13	18	19	5	12	13/11	E-/F+
WY17	20	16	18	20	22	11	17	18/17	E
WY18	12	8	10	9	15	6	10	10/9	F (lowest)
WY19	**22**	**11**	**17**	**23**	**22**	**3**	**13**	**16/14**	**E**
15-yr Norm	*20*	*14*	*18*	*27*	*24*	*9*	*17*	*19/17*	*E Poor*

Table 5.1 WQI Letter/Color Code: A (>75) Very Good (dark blue), B (50-74) Good (light blue), C (38-49) Fair (green), D (25-37) Marginal (yellow), E (13-24) Poor (brown), and F (0-12) Very Poor (red). WQI values in red are below 15-yr norms (expressed in black italics) for the same reach or section of the river; values at 15-yr norms are in blue, values above in black. Overall LSDR WQI values are site averaged (each site considered equal weight) and flow-weighted averages.

The running averages, as well as variances in monthly index values, for each reach of the lower river system are presented in the series of charts (5.1 through 5.6) on pages 19 and 20.

Over the past decade, as shown on **Chart 5.1**, average monthly WQI values associated with the **Lower Mission Valley Reach** (Sites 1-4) of the river have varied from a high of 81 (A Very Good) in March of this year to a low of 4 (F Very Poor) in September 2014. The general trend in running average WQI for the reach, as well as for four individual monitoring sites, declined from the low 40's (C Fair) during WY's '05 and '06 to the mid-teens (E Poor) by early WY15. The running average WQI (*black line*) improved to the mid-30's during the second half (April-Sept) of WY16 and much of last year. Site 3 (Fashion Valley Mall, *blue line*) has consistently exhibited the lowest running average WQI, while Site 4 (FSDRIP at Mission Valley Rd., *red line*) has consistently witnessed the highest values for the reach. The most significant

decline in the WQI for the reach over the 15-year monitoring period occurred in WY14. There was a steady, general improvement from WY14 lows during the second half of WY15 and throughout WY16 into WY17. A general decline occurred throughout WY18, followed by recovery to WY17 values in WY19. The running average index for this reach has dropped by ten percent (from 45 to 40) over the past 15 years.

As shown in **Chart 5.2** , the range in monthly WQI values for the **Upper Mission Valley Reach** (Sites 5-7) of the river are similar to those in Lower Mission Valley, although somewhat less variable. Site 6 (Kaiser Ponds at Mission Valley Rd, *green line*) has continuously presented lowest running average WQI values since early 2017, while Site 7 (Admiral Baker Field at Zion, *blue line*), situated just upstream of the ponds, has presented the highest values on an extended basis since mid-2008. The highest monthly WQI reading of 84 (A Very Good) for the Upper Mission Valley reach was monitored in March of last year, whereas the lowest reading of 3 (F Very Poor) was recorded in October 2016. The overall trend in running average WQI values (*black line*) from mid 2014 through 2017 was generally positive. Index values for each site and for the entire reach that trended downward in WY18 have recovered to prior year levels in WY19. The overall trend since WY06 has been negative (in decline) as growth of invasive aquatic plants and increase in biomass has proliferated throughout much of this reach during extended periods of minimal flow. The rate of decline in running average index in this reach over 15 years is twenty percent, decreasing from 40 in WY06 to the present value of 32. Significant recovery in this reach is problemmatic without improved channel maintence due to extensive accrual of biomass and insufficient flushing.

Running average WQI for the **Mission Gorge Reach** (Sites 8-10) of the river, as shown in **Chart 5.3**, has also declined, especially during WY's 12-14. Highest monthly WQI values of 89 (A Very Good) were computed in Nov. 2004 and Feb. 2005, contrasted with a low of 4 (F Very Poor) in Aug. 2014 and again in August of last year. In general running average WQI for this reach is the highest of the five reaches with average an WQI of 47 (C+ Fair). The trend in Mission Gorge WQI values (*black line*) are, however, comparable to those in the Mission Valley reaches. General decline in index values from WY06 through WY09, followed by a slight upturn in WY10 and WY11, and a more significant decline in subsequent water years to a low of 33 (D Marginal) in early WY15. WY17 witnessed an overall nine-point recovery in the running average WQI by September. The index for this reach fell during the second half of WY18 to a record low of 32. WY19 saw recovery to a high of 40. The overal index has fallen ten points (25%) over 15 years in this section of the river.

The **Lower Santee Basin Reach** (Sites 11,15 & 12) monthly WQI values and running averages are shown in **Chart 5.4**. The range from winter month highs in the 50-70 range (B Good) to summer lows in the 10-15 range (E Poor) are common. Water quality improved in this reach from WY06 through WY11, then declined in subsequent water years, reaching a running average low of 27 (D- Marginal) in Oct. 2015, before recovering to the mid-40s (C Fair) throughout WY16 and low 40's in WY17. The previous low was surpassed by one point in both August and September of last year. WY19 witnessed partial recovery to an index of 34. Completion of the Forester Creek enhancement project (indicated by the *blue line*) extending from Prospect Ave. to the Mission Gorge Rd. has had a significant effect on overall river quality (*black line*) in the Lower Santee Basin portion of the river system. With above normal rainfall experienced in WY19, the Lower Santee Basin running average index improved significantly. The overall rate of decline in the index from 38 to 34 from WY05 through WY19 is less than ten percent. This reach of the river has shown the least change in water quality metrics over the 15 years of monitoring, due in large part to Forester Creek improvements.

Chart 5.5 presents monthly and running average WQI values for the **Upper Santee Basin Reach** (Sites 13 & 14) of the river system. This reach presents the poorest water quality values of all sections of the lower river. Monthly values have seldom exceeded 20 (E Poor) since the summer of 2011 and are typically less than 12 (F+ Very Poor) throughout all but the wet-weather months. The running average WQI for this

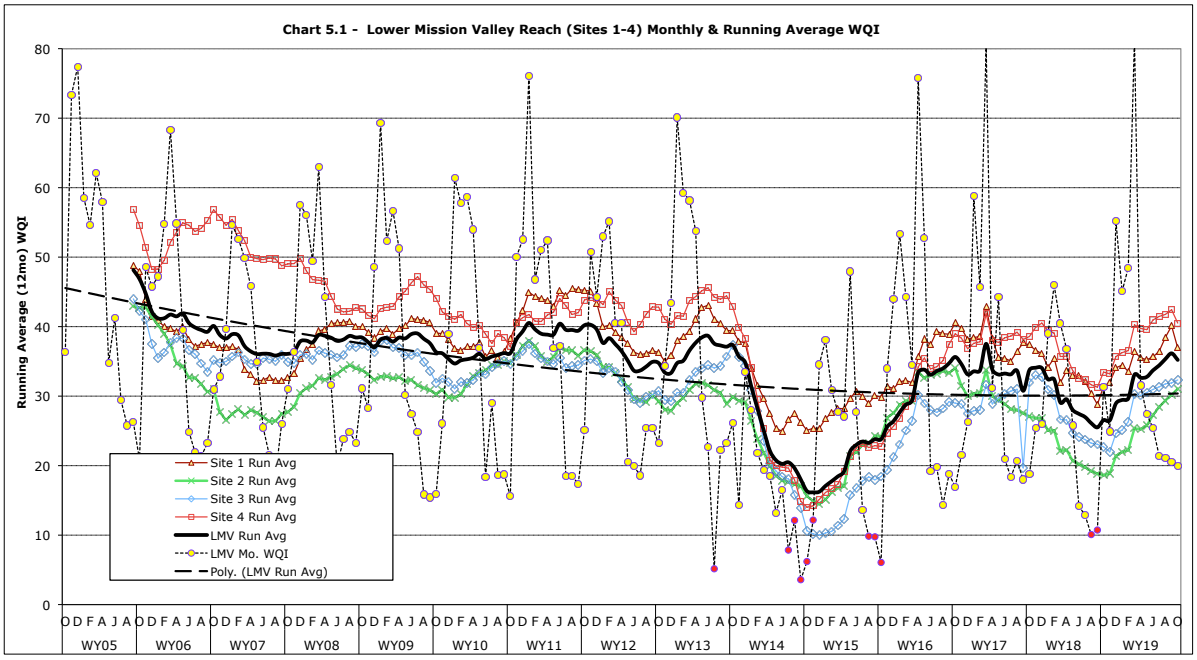


Chart 5.1 - Lower Mission Valley Reach (Sites 1-4) Monthly & Running Average WQI
Running Average (12mo) WQI
Site 1 Run Avg
Site 2 Run Avg
Site 3 Run Avg
Site 4 Run Avg
LMV Run Avg
LMV Mo. WQI
Poly. (LMV Run Avg)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19

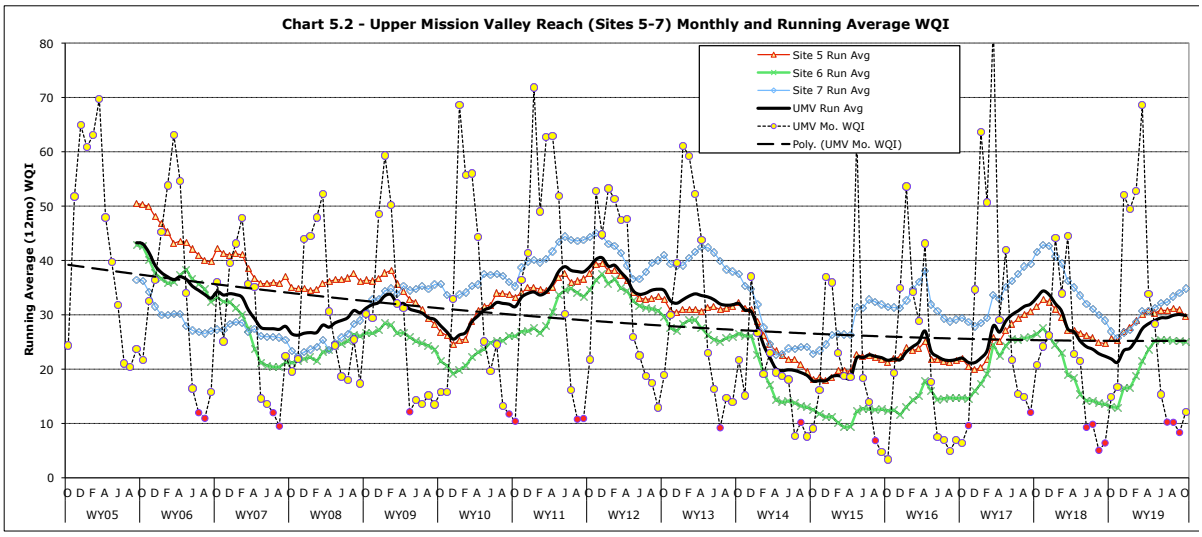


Chart 5.2 - Upper Mission Valley Reach (Sites 5-7) Monthly and Running Average WQI
Running Average (12mo) WQI
Site 5 Run Avg
Site 6 Run Avg
Site 7 Run Avg
UMV Run Avg
UMV Mo. WQI
Poly. (UMV Mo. WQI)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19

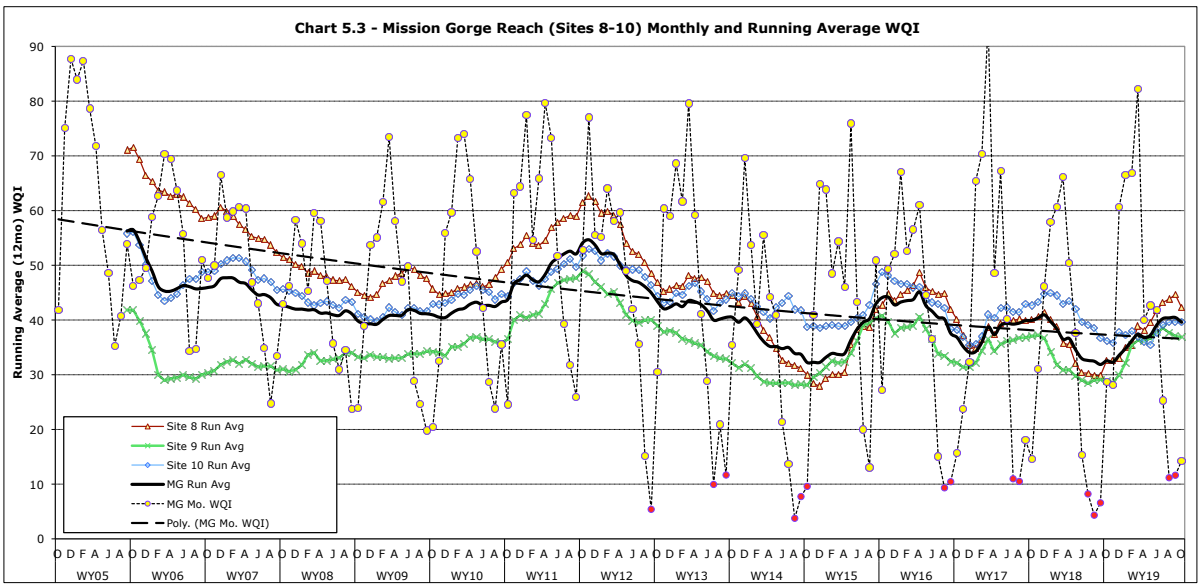


Chart 5.3 - Mission Gorge Reach (Sites 8-10) Monthly and Running Average WQI
Running Average (12mo) WQI
Site 8 Run Avg
Site 9 Run Avg
Site 10 Run Avg
MG Run Avg
MG Mo. WQI
Poly. (MG Mo. WQI)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19

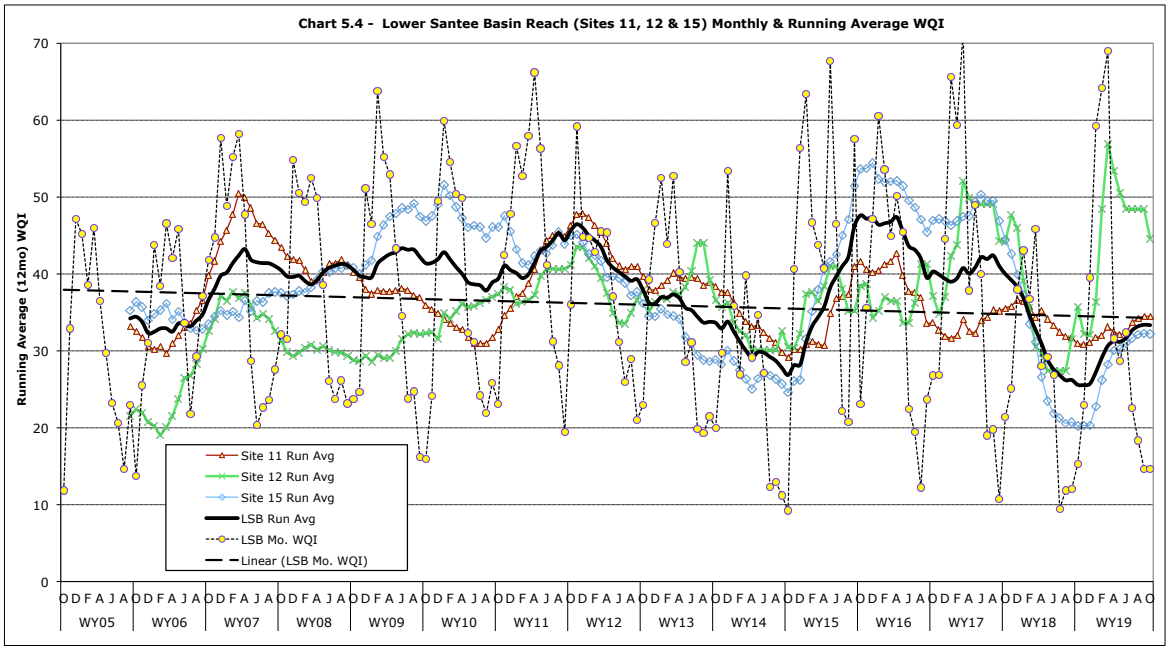


Chart 5.4 - Lower Santee Basin Reach (Sites 11, 12 & 15) Monthly & Running Average WQI
Running Average (12mo) WQI
Site 11 Run Avg
Site 12 Run Avg
Site 15 Run Avg
LSB Run Avg
LSB Mo. WQI
Linear (LSB Mo. WQI)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19

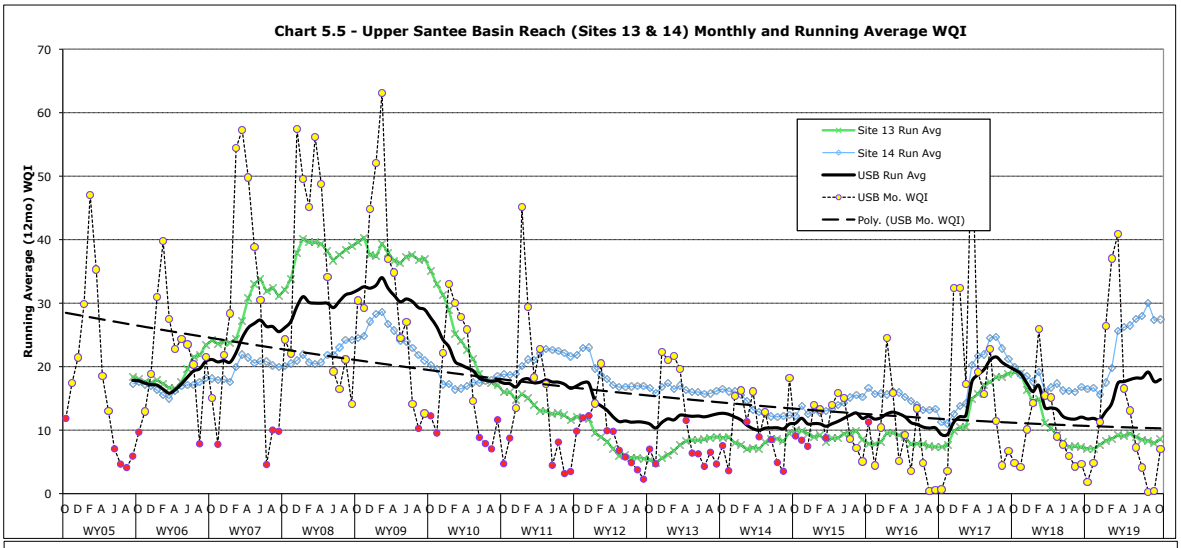


Chart 5.5 - Upper Santee Basin Reach (Sites 13 & 14) Monthly and Running Average WQI
Running Average (12mo) WQI
Site 13 Run Avg
Site 14 Run Avg
USB Run Avg
USB Mo. WQI
Poly. (USB Mo. WQI)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19

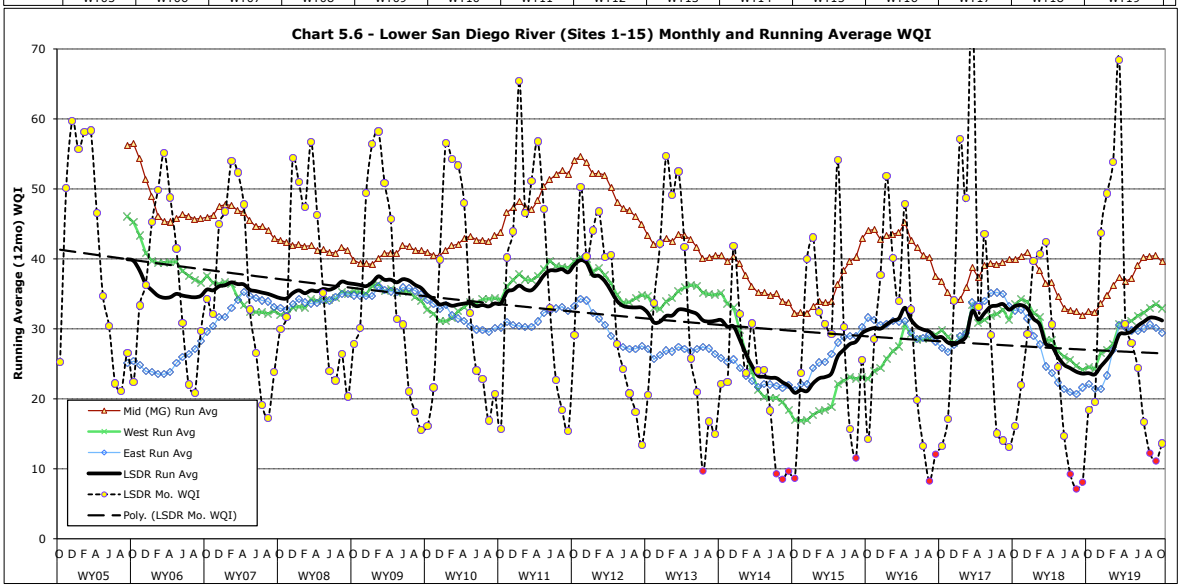


Chart 5.6 - Lower San Diego River (Sites 1-15) Monthly and Running Average WQI
Running Average (12mo) WQI
Mid (MG) Run Avg
West Run Avg
East Run Avg
LSDR Run Avg
LSDR Mo. WQI
Poly. (LSDR Mo. WQI)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19

reach has declined from highs above 30 (D Marginal) in WY09 to continuously between 10 and 12 (F Very Poor) during the five year period (WY12-WY16). WY17 saw a noticeable increase (ten points) in the running average index from early in the year reaching 18 (E- Poor) in September, however WY18 witnessed the opposite with a steady decline toward previous lows. WY19 witnessed partial recovery to previous highs, especially at site 14. The greatest variability has been associated with site 13, Mast Park (*green line).* The reach index has fallen 44% (from 32 to 18) over the past decade presenting the greatest decline in running average WQI of all reaches. Advanced eutrophication of multiple ponds situated within the Mast Park portion of the upper segment has lead to high levels of oxygen depletion throughout the year.

The monthly and running average variation in WQI values for the three main sections of the lower river (i.e., Santee Basin, Mission Gorge and Mission Valley) and the overall **Lower San Diego River** system (flow-weighted average of all 15 monitoring sites) are presented in **Chart 5.6.** WQI running average values recovered from WY14 lows for all three sections of the river during WY15 through WY17. They noticably declined in WY18 then rebounded (to WY13 & 16 levels) in WY19 throughout all three sections of the lower river. The Mission Gorge section (Chart 5.3) changed the least, while the upstream section (Santee Basin) declined the most. There were noticable increases in index values in all three sections of the river and thus overall in WY19. The current LSDR running average WQI of 29 (D Marginal) is only five percent below the 15-yr average. The overall trend in running average WQI for the LSDR that remained relatively steady in the range of 35 to 40 between WY06 and WY12, then declined to the low 20's in WY14 and early WY15, returning to the low 30's in WY16 and WY17. The LSDR flow weighted running average index rose seven points from 22 to 29 over the past year. The overall rate of change has fallen 15 points (from 40 to 25) over 15 years; presenting a 37.5% overall decline (one point change per annum).

The overall decline in running averages is a function of lowered oxygen levels in combination with elevated water temperatures and higher specific conductivities monitored at nearly all sites. These values are impacted by low streamflows especially during extended months without rainfall. WQI values can be expected to measurably increase when streamflows rise to normal or above and effective aquatic growth abatement measures are implemented or occur through natural flushing for specific reaches of the river. Higher minimum index values during the summer months result in positive gradients for 12-mo. running averages within a single water year, especially the case in the Mission Gorge section. Without interventions, overall negative trends in WQI values arenexpected to persist for many if not all portions of the lower river in the near future due to the natural processes of eutrofication that occur.

Depressed dissolved oxygen levels (often less than 3 mg/L) in conjunction with minimal dry-weather flow resulting in warmer, higher-conductance (more dissolved solids) waters are the primary causes of the low water quality index values. The low DO concentrations are believed to be the result of extensive and persistent eutrophication from bio-mass buildup of organic-rich detritus combined with restricted water movement. Until the spread of creeping water primrose (L*udwigia grandiflora)** and other invasive aquatics can be effectively managed and the resultant effects of eutrophication better managed, water quality in multiple reaches of the lower river system is expected to remain below that found in reaches of the river where improved circulation, mixing and natural re-oxygenation occurs.

** Ludwigia peploides, L. grandiflora, L. hexapetala* are members of a highly productive emergent aquatic perennial native to South and Central America, parts of the USA and likely Australia (USDA-ARS, 1997). It was introduced in France in 1830 and has become one of the most damaging invasive plants in that country. It has been more recently introduced to areas beyond its native range in the Unites States where it is often considered a noxious weed (INVADERS, 2009; Peconic Estuary Program, 2009). *L. grandiflora, et. al.* are adaptable and tolerate a wide variety of habitats where they can transform ecosystems both physically and chemically. It sometimes grows in nearly impenetrable mats; can displace native flora and interfere with flood control and drainage systems, clog waterways and impacts navigation and recreation. The plant also has allelopathic properties that can lead to dissolved oxygen crashes, the accumulation of sulphide and phosphate, 'dystrophic crises' and intoxicated ecosystems (Dandelot et al., 2005). Its common name is "floating water primrose", it produces a distintive small yellow flower during its bloom cycle (May-Nov.). It is a perenial herb (a dicot) called marsh purslane; a member of family ORAGRACEAE.