LOWER SAN DIEGO RIVER WATER QUALITY

WY16 Supplemental Water Quality Monitoring Report

Appendices A-I

Lower Mission Valley (Morena Bridge) oil spill containment and cleanup

Supporting Water Quality Monitoring Data for the Lower San Diego River

John C. Kennedy, PE

November 2016

LOWER SAN DIEGO RIVER WATER QUALITY

WY16 SUPPLEMENTAL WQM REPORT

Appendices A-I

Table of Contents

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

Appendix A - Glossary

Abbreviations:

AADF - Average Annual Daily Flow
ACC - Average Coliform Count (arithmetic mean of fecal coliform, e-Coli & total coliform in MPN/100mL)
ADF – Average Daily (stream) Flow or discharge
AFY - acre-foot per year
Avg– Average
cfs - cubic feet per second (flow/discharge)
Ck – Creek
CY - Calendar Year (Jan 1 - Dec 31)
DO – Dissolved Oxygen
DOD- Dissolved Oxygen Deficit (level below minimum)
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 = 1000 *u*S/cm)
MG – Mission Gorge (mid-section of LSDR)
MV – Mission Valley (West section of LSDR)
MPN - Most Probable Number (of coliform organisms)
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)
SD – Standard Deviation (also San Diego)
SDRPF – San Diego River Park Foundation
TDS – Total Dissolved Solids
Temp. – Temperature
TN/TP – Total Nitrogen/ Total Phosphorus (nutrients)
USGS – U.S. Geological Survey
*u*S/cm –microSeimens per centimetre (1 *u*S/cm = 0.001 mS/cm)
u/s - upstream // {d/s - downstream}
W - West // {E - East}
WQI – Water Quality Index (WQI_a)
WQI(4) - WQI using 4 parameters
WQI(6) - WQI using 6 parameters
WY – Water Year (Oct 1 – Sept 31)
% - percent
%Sat - percent of DO saturation value
^oC – degrees Celsius
^oF – degrees Fahrenheit

Formulas:

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

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

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

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

DO - DO%Sat relationship is defined by the following polynomial equation:
$DO(mg/L)=DO\%Sat*[0.004*T^2-0.343*T+14.2]/100$;
$DO\%Sat = DO(mg/L)*100/[0.004* T^2-0.343T+14.2]$,
where T = temperature is in ^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 have also be applied to water quality and hydrologic data for other coastal area watercourses where comparable metrics are monitored and recorded.

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

Appendix B - References

1. *The Role of the San Diego River in Development of Mission Valley,* Nan Papageorge, The Journal of San Diego History (Vol. 17, No. 2), Spring 1971

2. *Evaluation of the Mission, Santee, and Tijuana Hydrologic Subareas for Reclaimed-Water Use, San Diego County, CA,* John Izbicki, USGS Water Resources Investigations Report 85-4032, 1985

3. *Water Quality Control Plan for the San Diego Basin,* San Diego RWQCB, 1994

4. *Waste Discharge and Water Recycling Requirements for the Production and Purveyance of Recycled Water,* Padre Dam Municipal Water District (PDMWD), San Diego County, San Diego RWQCB, 1997

5. *Groundwater Report,* San Diego County Water Authority (SDCWA), 1997

6. *Waste Discharge Requirements for PDMWD Padre Dam Water Recycling Facility, Discharge to Sycamore Creek and the San Diego River,* San Diego County, San Diego RWQCB Order No. 98-60 (NPDES No. CA010749), 1998

7. *Modification of Water Quality Order 99-08-DWQ State Water Resources Control Board (SWRCB) National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges Associated with Construction Activity, S*an Diego RWQCB Resolution No. 2001-046, 2001

8. *General Waste Discharge Requirements for Groundwater Extraction Waste Discharges from Construction, Remediation, and Permanent Groundwater Extraction Projects to Surface Water within the San Diego Region except for San Diego Bay.* San Diego RWQCB, Order No 2001-96 (NPDES No. CAG919002), 2001

9. .*Waste Discharge Requirements for Discharge of Urban Runoff from Municipal Separate Storm Sewer Systems (MS4) Draining the Watersheds of the County of San Diego, the Incorporated Cities of San Diego County, and the San Diego Unified Port District,* San Diego Regional Water Quality Control Board (RWQCB) Order No 2001-01 (NPDES No. CAS0108758), 2001

10. *San Diego River Watershed Urban Runoff Management Plan,* City of San Diego in conjunction with Cities of El Cajon, La Mesa, Santee, Poway and County of San Diego, 2001

note: all references are available on-line.

11. *General Waste Discharge Requirements for Discharges of Hydrostatic Test Water and Potable Water to Surface Waters and Storm Drains or Other Conveyance Systems,* San Diego Region, San Diego RWQCB, 2002

12. *San Diego River Watershed Urban Runoff Management Plan,* City of San Diego Lead Agency, City of Santee, City of Poway, County of San Diego, Jan 2003

13. *Watershed Sanitary Survey,* City of San Diego Water Department, Jan 2001, rev. May 2003

14 . *Clean Water Action Plan and Status Report,* County San Diego Project Clean Water, June 2003

15. *San Diego River Watershed Water Quality Report,* Anchor Environmental & others, Oct 2003

16. *San Diego River Watershed Management Plan Final WMPlan,* Anchor Environmental and others, SDR Watershed Work Group, March 2005

17. *2005 Watershed Sanitary Survey - Volume 2 San Diego River System,* City of San Diego Water Department, Water Quality Laboratory, Aug 2005

18. *San Diego River Baseline Sediment Investigation Final Report,* City of San Diego, Weston Solutions, Oct. 2005

19. *Monitoring Workplan for the Assessment of Trash in San Diego County Watersheds,* (Weston Solutions, Brown & Caldwell), County of San Diego, Aug 2007

20. *San Diego Integrated Regional Water Management Plan, S*an Diego County Water Authority, City of San Diego and County of San Diego, Oct 2007

21. *San Diego Regional Urban Runoff Management Plan Draft,* County of San Diego, Dec 2007

22. *Allopathic potential of two invasive alien Ludwig spp,* Dandelot et. al., Elsevier Aquatic Botany 88 (4):311-316, Dec 8, 2007

23. *Surface Water Ambient Monitoring Program (SWAMP) Report on the San Diego Hydrologic Unit,* Final Technical Report 2007, Southern California Coastal Water Research Project, San Diego RWQCB, Jan 2008

Appendix B - References (continued)

24. *San Diego River Watershed Urban Runoff Management Plan,* City of San Diego, Storm Water Pollution Prevention Division, TRC, March 2008

25. *There is No San Diego River*, Bill Manson, San Diego Weekly Reader, Oct 22, 2008

26. *The Ecological and Hydrological Significance of Ephemeral and Intermittent Streams in the Arid and Semi-arid American Southwest,* EPA/660/R-08/134, Nov. 2008

27. *Water, The Epic Struggle for Wealth, Power, and Civilization,* Steven Solomon, Harper, 2010

28. *San Diego River FY 2008-2009 WURMP Annual Report*, TRC, January 2010

29. *San Diego River Tributary Canyons Project* Final Feasibility Report, April 2010

30. *The invasive water primrose Ludwigia grandiflora in Germany: First record and ecological risk assessment,* Nehring & Kolthoff, Agency for Nature Conservation, Germany, Aquatic Invasions 2011 REABIC (Vol 6, i1: 83-89) Dec 16, 2010

31. *Guidelines for Citizen Monitors*, SWAMP Clean Water Team Citizen Monitoring Program Guidance Compendium, SWRCB website (10/5/11 update)

32. *2011 Long-Term Effectiveness Assessment, San Diego Stormwater Co-permittees Urban Runoff Management Programs,* Final Report, Walker Assoc. Weston Solutions, June 2011

33. *San Diego River Conservancy 2012 Work Plan*, Governing Board, March, 2012

34. *The Day the San Diego River Was Saved: The History of Floods and Floodplain Planning in Mission Valley,* Philip R. Pryde, Journal of San Diego History, (Vol. 57, No. 3) 2012

35. *San Diego River Watershed Bioassessment and Fish Tissue Analysis*, RWQCB, Feb. 2013

36. *San Diego River Park Master Plan*, City of San Diego, April 18, 2013

37. *Watershed Asset Management Plan, Final Report,* Storm Water Division, Transportation and Storm Water Department, City of San Diego, July 19, 2013

38. *San Diego River Watershed Comprehensive Load Reduction Plan - Phase II*, Tetra Tech Inc, Final July 24, 2013

39. *Aquatic Conservation: Marine and Freshwater Ecosystems, A success story: water primroses, aquatic pests,* Thouvenot, Haury & Thiebaut, (Vol 23, i5: 790-803) Oct. 2013

40. *San Diego River Restoration Involves Clearing Homeless, And Their Trash,* Susan Murphy, KPBS, Jan. 16, 2014

41. *San Diego River Watershed Monitoring and Assessment Program*, B. Bernstein (SWAMP-MR-RB9-2014-0001), RWQCB, Jan. 20, 2014

42. *Nonstructural Non-Modeled Activity Pollutant Load Reduction Research - Addendum Final,* HDR, City of San Diego, Nov. 5, 2014

43. *Lower San Diego River Monthly and Annual Water Quality Monitoring Reports*, SDRPF RiverWatch, 2005-2016

44. *San Diego River Watershed Management Area Water Quality Improvement Plan,* Walker Assoc. & AMEC, San Diego RWQCB, September 2015

45. *Lower San Diego River Dissolved Oxygen Levels,* John Kennedy, San Diego River Coalition presentation, June 19, 2015

46. *Lower San Diego River Streamflow and Water Quality Metrics Monitored by RiverWatch,* John Kennedy, SDR Coalition presentation, Aug. 21, 2015

47. *Analysis of Anionic Contribution to Total Dissolved Solids in the Lower San Diego River,* Janae Fried, SDSU Thesis (Geological Sciences), Fall 2015

48. *San Diego River Watershed Management Area Water Quality Improvement Plan,* L. Walker & Assoc., January 2016

49. *A Brief Walk Along the San Diego River - A Field Guide,* Marly Nicole Isler, Francis Parker School

50. *Ludwigia hexapetala (Uruguay water-primrose),* California Invasive Plant Council, <Cal-IPC/Invasive Plant/profiles/Ludwigia hexapetala>

note: all references are available on-line.

Appendix C - SDRPF RiverWatch WQM Team

Supervision/Coordination: Rob Hutsel (2004 - 2005), Kym Hunter (2006 - 2007), Shannon Quigley-Raymond (2008 - 2016)

Volunteers: (3+ 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
Clint Williams
Conrad Brennen**
Craig McCartney
Dani Tran
David Lapota
Demitrio Duran
Donna Zoll
Doug Taylor
Ebony Quilteret
Edward Garritty
Erin Babich
Fred Ward
Gabriel Martinez Mercado
Gary Strawn**
George Liddle**
Gina Martin
Jack Greco
Jalil Ahmad
Janae Fried
Jason Andres
Jim Thornley
Joan Semler
John Kennedy**
Joyce Nower
Katharyn Morgan
Kathryn Stanaway
Katy Robinson
Kelly Brown
Kenneth Santos
Kevin Bernaldez
Krissy Lovering
Krystal Tronboll
Laqueta Strawn
Linda King
Linda Tarke
Lindsey Dornes
Lindsey Teunis
Lois Dorn
Lucas Salazar
Madison McLaughlin
Maesa Hanhan
Marcus King
Mark Carpenter
Mark Dreiling**
Mark Hammer
Marlene Baker
Martin Offenhauer**
Mary Hansen
Matt Olson
Melissa Garret
Melissa Maigler
Michael Mikulak
Michael Sowadski
Mike Hanna**
Mike Hunter
Mitchell Manners
Mitzi Quizon
Mojisola Ogunleye
Natelie Rodriguez
Nicole Beeler
Norrie Robbins
Paul Hormick**
Paul Nguyen
Raymond Ngo
Reggie Agarma
Russell Burnette
Sami Collins
Samuel Martin
Sandra Pentney
Shelia-Ann Jacques
Silvana Procopio
Tim Toole
Tina Davis
Tom Younghusband**
Toni Nguyen
Tony de Garate
Trish Narwold
Valerie Rawlings
Veronika Shevchenko
Vidhya Nagarajan
Wendy Kwong
Yang Jiao
Yvette Navarro

** Team Leaders, 3x+ WY16 volunteers are listed in blue

Appendix D -
LSDR Water Quality Monitoring Metrics 12-yr Summary

Table D.1 WQM Metrics Summary (Annual & Seasonal Averages)

	WY5	WY6	WY7	WY8	WY9	WY10	WY11	WY12	WY13	WY14	WY15	**WY16**	*12-yr Norm*
Annual (October-September):													
ADF, cfs	65	12	8	16	18	29	42	13	8	4	9	**15**	*20.0*
Temp, °C	17.7	18.3	17.7	17.7	17.7	18.1	17.8	18.0	17.3	17.9	18.7	**18.2**	*17.9*
SpC, uS/cm	2.13	2.19	2.42	2.32	2.49	2.36	2.21	2.39	2.50	2.58	2.19	**2.30**	*2.342*
DO, mg/L	6.96	5.96	5.94	6.24	6.15	5.43	5.80	5.47	5.58	3.92	4.53	**4.91**	*5.67*
DO%Sat,	68	59	60	64	64	57	60	57	57	40	48	**51**	*58*
pH	7.63	7.44	7.53	7.89	7.66	7.85	7.85	7.67	7.77	7.67	7.78	**7.49**	*7.68*
WQI	41	37	36	38	37	35	38	33	32	22	29	**29**	*34*
Grade	C	D+	D+	C-	D+	D	C-	D	D	E+	D	**D**	*D*
Summer (June-September) Period:													
ADF, cfs	2.9	2.0	1.2	1.3	1.0	1.6	2.2	1.4	1.0	0.8	6.1	**0.6**	*1.8*
Temp, °C	21.8	23.7	21.8	22.9	22.8	21.9	21.7	22.9	21.7	22.7	22.9	**21.9**	*22.4*
SpC, uS/cm	2.62	2.48	2.78	3.07	3.25	3.04	2.86	3.13	3.09	3.02	2.18	**3.16**	*2.86*
DO, mg/L	5.28	5.07	4.86	5.30	4.82	3.95	3.94	3.79	3.32	2.33	3.56	**3.19**	*4.12*
DO%Sat, %	55	57	52	61	55	46	45	45	38	39	42	**37**	*48*
pH	7.56	7.52	7.48	7.94	7.49	7.84	7.90	7.95	7.71	7.98	7.84	**7.14**	*7.70*
WQIa	25	26	22	25	22	22	22	19	16	11	21	**13**	*20*
Grade	D-	D-	E	D-	E	E	E	E	E	F	E	**E-**	*E*
Winter (December-March) Period:													
ADF, cfs	150	20	18	44	46	73	105	20	19	9	17	**33**	*46.2*
Temp, °C	13.5	12.8	13.8	12.4	13.3	14.2	13.7	12.4	12.4	13.4	15.3	**14.1**	*13.5*
SpC, uS/cm	1.45	1.99	2.04	1.57	1.55	1.38	1.33	1.69	2.02	2.24	1.89	**1.73**	*1.74*
DO, mg/L	9.61	6.85	7.01	7.18	7.49	6.37	7.74	7.16	8.09	5.27	5.44	**6.50**	*7.06*
DO%Sat	90	61	67	68	74	64	75	67	76	50	54	**63**	*67*
pH	7.66	7.40	7.75	8.05	7.80	7.65	7.84	7.35	7.77	7.52	7.84	**7.51**	*7.68*
WQIa	58	46	50	53	55	52	52	43	50	32	36	**41**	*47*
Grade	B	C	B-	B-	B	B-	B-	C	B-	D	D+	**C**	*C*

(a) Values in red are below 12-yr norms; values above norms are in blue.

Table D.2 WQM Metrics Summary by Section and Reach (WY16/WY15 & 12-yr Norms)

Section	Mission Valley		Mission Gorge	Santee Basin		**Watershed**
Sites	1-4	5-7	8-10	11,12T &15T	13&14	**all (1-15T)**
Reach	LMV	UMV	MG	LSB	USB	**LSDR** [a]
Annual (Oct-Sept):						
ADF, cfs	15/6 (31)	10/4 (28)	8/5 (20) [b]	7/4 (17)	4/2 (8)	**11/5 (24)**
Temp, °C	20.0/19.8 (19.3)	18.2/18.6 (17.8)	17.4/17.8 (17.1)	17.9/19.0 (17.4)	17.6/18.3 (18.0)	**18.2/17.7 (17.9)**
SpC, mS/cm	2.015/2.781 (2.550)	2.247/2.935 (2.549)	2.326/2.413 (2.259)	2.367/2.315 (2.245)	1.990/2.081 (1.795)	**2.192/2.582 (2.345)**
DO, mg/L	2.89/2.68 (5.07)	3.09/3.03 (4.60)	7.98/7.21 (7.82)	7.27/5.06 (6.75)	2.05/2.08 (3.38)	**4.70/4.09 (5.67)**
DO %of Sat, %	31/28 (54)	33/32 (47)	73/80	52/65	22/35	**50/42 (58)**
pH	7.56/7.70	7.53/7.55	7.65/7.69	7.73/7.76	7.77/7.70	**7.77/7.68**
WQIa	35/23 (36)	22/22 (30)	40/44 (48)	37/43 (38)	8/10 (18)	**29/29 (34)**
Grade	D/E (D+)	E/E (D)	C/C (C)	D+/C (C-)	F/F (E)	**D/D (D)**
WY16 Rating	**Marginal**	**Poor**	**Fair**	**Marginal**	**Very Poor**	**Marginal**
WY15 Rating	Poor		Fair		Very Poor	Marginal
WY14 Rating	Poor		Marginal		Very Poor	Poor
12-yr Norm	*Marginal*	*Marginal*	*Fair*		*Poor*	*Marginal*
Summer (June-Sept) Period:						
ADF, cfs	13.6/1.3 (3.3)	10/1 (2.5)	6.2/0.8(2.1) [c]	4.4/0.6(1.8)	2.0/0.2(0.8)	**7.6/0.8 (2.1)**
Temp, °C	24.5/24.0 (24.2)	21.2/23.1 (21.7)	21.3/22.2 (21.7)	20.8/22.9 (21.7)	21.7/22.3 (22.7)	**21.9/22.9 (22.4)**
SpC, mS/cm	1.743/3.150 (3.178)	2.260/3.445 (3.159)	2.318/3.080 (2.816)	2.614/2.539 (2.595)	1.972/2.300 (2.011)	**2.178/3.024 (2.864)**
DO, mg/L	1.82/1.11 (3.57)	1.79/2.17 (2.95)	7.13/4.51 (6.42)	6.98/3.35 (5.73)	1.94/2.03 (2.59)	**3.87/2.63 (4.30)**
DO % of Sat, %	22/13 (42)	21/25 (34)	81/51 (73)	38/59	22/24 (29)	**45/41 (49)**
WQI	17/15 (21)	6/11 (15)	18/31 (30)	20/37 (26)	5/9 (10)	**13/21 (20)**
Grade	E/E (E)	F/F (E)	E/D (D)	E/D+ (D-)	F/F (F)	**E-/E (E)**
WY16 Rating	**Poor**	**Very Poor**	**Poor**		**Very Poor**	**Poor**
WY15 Rating	Poor	Very Poor	Marginal		Very Poor	Poor
WY14 Rating	Very Poor			Poor	Very Poor	
12-yr Norm	*Poor*		*Marginal*		*Very Poor*	*Poor*

Table D.2 WQM Metrics by Section and Season (Continued)

Reach	LMV	UMV	MG	LSB	USB	**LSDR [a]**
Winter (Dec-March) Period:						
ADF, cfs	26/13 (72)	24/11 (70)	16/10 (46)	14/9 (39)	7/4 (20)	**17/9 (47)**
Temp, °C	15.3/16.4 (14.4)	14.7/15.5 (13.6)	12.8/14.2 (12.6)	14.8/15.7 (13.2)	13.0/14.8 (13.4)	**14.1/15.3 (13.5)**
SpC, mS/cm	1.941/2.528 (1.887)	1.608/2.608 (1.798)	2.048/1.963 (1.619)	2.069/2.006 (1.832)	1.861/1.923 (1.485)	**1.890/2.241 (1.741)**
DO, mg/L	4.02/3.71 (6.73)	3.69/4.23 (6.41)	8.97/8.89 (9.01)	8.20/6.47 (7.94)	1.77/2.56 (4.32)	**5.50/5.32 (7.09)**
DO % of Sat, %	41/36 (66)	37/40 (62)	87/83 (86)	84/62 (72)	18/25 (40)	**55/50 (68)**
WQI	44/33 (50)	38/28 (46)	58/58 (63)	52/52 (50)	14/11 (28)	**41/36 (47)**
Grade	C/D (B-)	C-/D (C)	B/B (B)	B/B (B-)	E/F (D)	**C/D+ (C)**
WY16 Rating	**Fair**		**Good**		**Poor**	**Fair**
WY15 Rating	Marginal		Good		Very Poor	Marginal
WY14 Rating	Marginal		Good	Fair	Poor	Marginal
12-yr Norm	*Good*	*Fair*	*Good*		*Marginal*	*Fair*

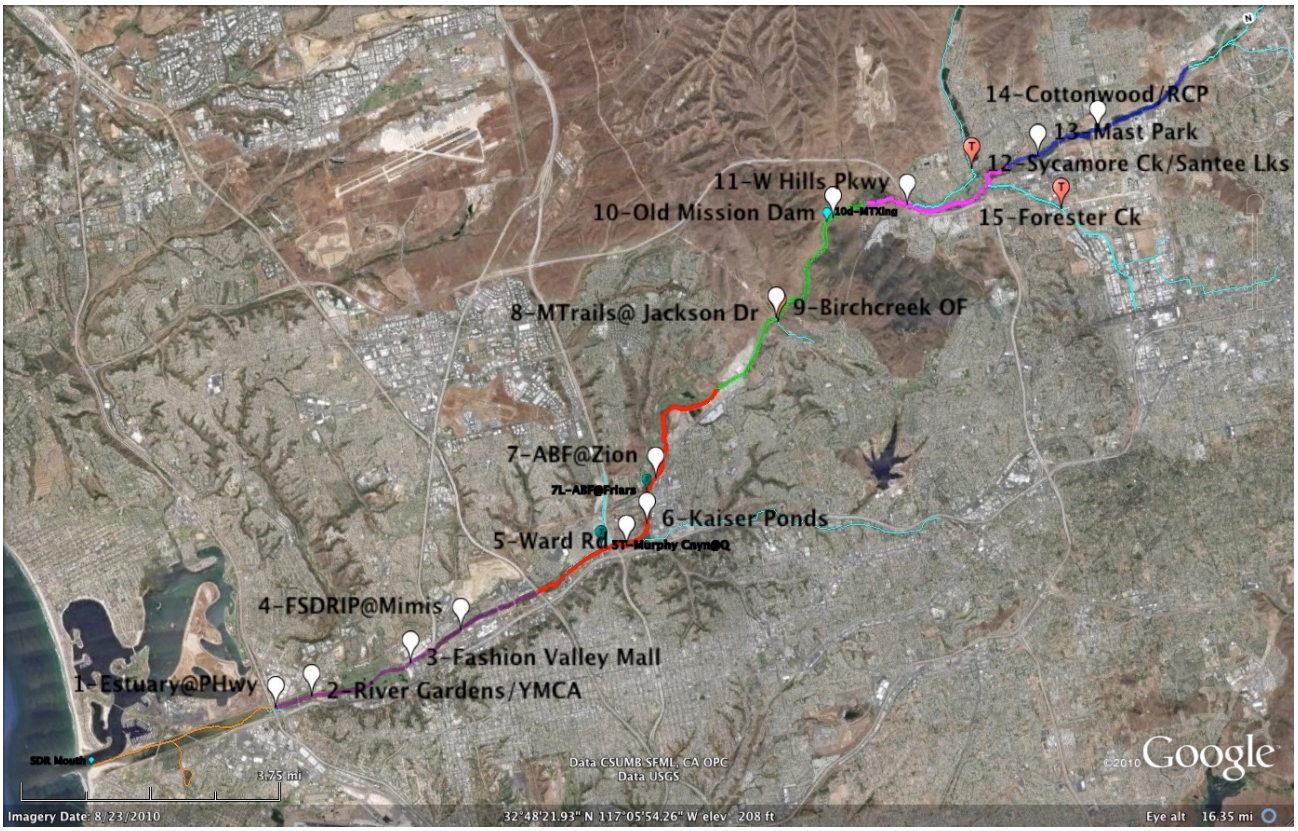
WY16/15 WQ metrics below (less than) 12-yr Norms shown in red; values above norms are shown in blue.
(a) Weighted average of all reaches within the Lower SDR watershed.
(b) Stream flow based on river channel gains and losses averaged between Santee Basin and Mission Valley.

Appendix E - San Diego RiverWatch WQ Monitoring Program

Appendix E provides an overview of SDRPF's RiverWatch water quality monitoring (WQM) program that, over the past 10 years, has been engaged in collecting and assessing data pertaining to the Lower San Diego River (LSDR) watershed on a continuous monthly basis.

Monitoring Period & Coverage: Monthly monitoring over past 10 years (Oct. 2004 – Sept. 2014) covering the Lower San Diego River and its tributaries extending downstream from Lakeside (river mile 19.8 elev. 340 ft amsl) to the Estuary (river mile 2.96, elev. 5.8 ft amsl) under the I-5/ Pacific Hwy. overpasses. The LSDR watershed and monitoring sites are shown on **Figure E.1.**

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



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

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

Table E.1 LSDR Sections, Reaches and Monitoring Sites

Section/Reach/Tributary	Site #s	Comments
Estuary Entrance	1E/1W	Tidal influence at transition from river to estuary
Lower Mission Valley (LMV)	2E/W, 3 & 4	4 miles of lower river extending to I-805
Upper Mission Valley (UMV)	5,6 & 7	4-mile stretch from I-805 to Princes View Dr
Mission Valley (West Sites)	1-7	8-mile western portion through Mission Valley
Mid-Section : Mission Gorge (MG)	8,9T & 10	5-mile mid-section, Princess View Dr to Kumeyaay Lk
Lower Santee Basin (LSB)	11,12T&15T	2-mile stretch from Kumeyaay Lk to Carlton Hills Blvd
Upper Santee Basin (USB)	13 & 14	3-mile stretch from Carlton Hills Blvd to Riverford Rd
Santee Basin (SB)	11-15T	5-mile eastern section from Kumeyaay Lk to Lakeside
Eastern Sections (East Sites)	8 -15T	10-mile eastern/upper 3 reaches (2 sections)
Tributaries:		
Murphy Canyon/Qualcom [a)]	5a	Enters LSDR southwest of Qualcom Stadium
Jackson Dr/Birchcreek Drain [b)]	9T	Enters LSDR at Sycott Wash (d/s of Site 8)
Santee Lakes/E. Sycamore Cnyn Ck	12T	Enters LSDR at Carlton Oaks GC (u/s of 15T)
Forester Creek [c)]	15T	Enters LSDR at Carlton Oaks GC (d/s of 12T)
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 renumbered as 5.
(b) Monthly monitoring initiated in 2008; site also termed Jackson Dr. Outfall (OF).
(c) Monthly monitoring initiated in 2007 with adjusted site location in 2009.

WQ Parameters: Seven measured and recorded parameters (Temp, pH, SpC, DO, DO%Sat, NO_3 & PO_4) plus subjective field observations re: environs and characteristics are listed in **Table E.3.** As nutrient testing for NO_3 and PO_4 is carried out at five selected sites; two in West (2 & 6) and three in East (11,14 & 15T), respectively, results are not used in performing statistical analyses regarding reaches/sections of the river. Number of datum for each of the five physical-chemical parameters monitored monthly at each site over the 11-yr period (Oct. 04 - Sept. 15) are in the range of 100 to 120. Two other water quality parameters monitored by others at several sites, streamflow from USGS (Poway Office) and coliform counts from SDCoastKeeper, are also recorded for purposes of determining the water quality index.

Protocol: *East Side* – (Santee Basin & Mission Gorge Sections). The 8 sites within upper three reaches (MG, LSB & USB) typically monitored 3rd Fri. or Sat. of month. *West Side* - (Mission Valley Section). Seven sites within the lower two reaches (LMV & UMV) monitored monthly, typically 3rd Sun. of month.

Table E.2 - LSDR WQM Site Information

Site #	Site Name	u/s mi.	Elev. ft.	Location	GIS Coordinates Lat.	Long.
LMV - Lower Reach W Mission Valley: I-5 Bridge to I-805 Bridge (Sites 1-4)						
1	Estuary W/E	2.96	6	between PCH & I-5 on encased sewer main	32.76131	-117.20373
2	River Gardens E/W	3.5	11	W of YMCA, d/s of Trolly at riffle	32.7623	-117.1944
3	Fashion Valley Mall W	5.08	22	below Town & Country Pedestrian Bridge	32.76517	-117.16869
4	FSDRIP	5.98	36	N of Mimi's on Mission Center Rd Bridge	32.76986	-117.15482
UMV - Upper Reach E Mission Valley: I-805 Bridge to N end of Admiral Baker Field (Sites 5-7)						
5	Ward Rd Bridge	8.89	50	S. of Trolly overpass at Del Rio S intersection	32.78024	-117.11029
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 Rd	10.2	62	Z - Terminus of Zion Ave at Riverdale St	32.79304	-117.09984
West (MV) - Mission Valley Section: Estuary to Admiral Baker Field (Sites 1-7) [LMV+UMV]						
MG - Mission Gorge Reach: Quarry Area to Old Mission Dam (Sites 8-10)						
8	Mission Trails @ Jackson Dr	13.82	159	SDCWA downstream of Scycott Crossing	32.82124	-117.06205
9T	Jackson Dr/Birchcreek OF	13.86	198	San Marcos area tributary by Jackson Dr. 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 (Sites 8-10)						
LSB - Lower Reach Santee Basin: W Hills Pkwy to Carlton Hills Bridge (Sites 11,12 &15)						
11	West Hills Pkwy	17.03	300	at/below West Hills Pkwy Bridge	32.83936	-117.02436
12T	Carlton Oaks Dr/Santee	18.23	320	W Sycamore Ck/Santee Lakes @ Carlton Oaks Dr.	32.84431	-117.00635
15T	Forester Creek	18.86	336	Forester Ck (tributary) at Prospect Ave.	32.83221	-116.98658
USB - Upper Reach Santee Basin: Carlton Hills Bridge to Riverford Rd (Sites 13-14)						
13	Mast Park	18.50	330	Pedestrian Bridge behind (N of) Walmart	32.84696	-116.97335
14	Cottonwood Ave/RCP	19.84	340	W of RCP plant at Chubb Ln/Cottonwood	32.84434	-116.98947
East (SB) - Santee Basin Section: West Hills Parkway to Lakeside (Sites 11-15 above) [LSB+USB]						
LSDR - Lower San Diego River Watershed: SD Estuary to Lakeside (Sites 1-15 above) [MV2+MG+SB]						

(Table E.2 footnotes located top of next page)

(Table E.2 footnotes:)
Reaches (5) - averaged values for combination of adjacent sites excluding tributaries within identified portions of river (LMV, UMV, MG, LSB, USB) .
Sections (3) - averaged values for adjacent reaches (MV = LMV+UMV, MG = MG, SB = LSB+USB)
Tributaries (3) – sites located on small creeks/drainages tributary to main stream watercourse.
LSDR – computed values for entire lower watershed (distance-weighted average of all 5 reaches or all 3 sections); average (LMV+UMV+MG+LSB+USB) or average (MV+MG+SB).

Table E.3 - LSDR Water Quality Monitoring Parameters

WQ Parameter	unit	Comments
Measured monthly at all sites:		
1. Temperature (Temp)	°C	Basic characteristic and WQ driver (see Table G.1)
2. pH	-	Degree of acidity (<7.0) or alkalinity (>7.0) (see Table G.3)
3. Specific Conductivity (SpC)	mS/cm	Measure of ionic content or dissolved solids (see Table G.2)
4. Dissolved Oxygen (DO)	mg/L	Good indicator of relative water quality (see Table G.4)
5. Percent of DO Saturation (DO%Sat)	%	Good indicator of general water quality (see Table G.5)
Sampled/tested monthly at selected sites: (typically 5 - 3 East & 2 West)		
6. Nitrate (NO_3-N)	mg/L	Important nutrient for biological activity
7. Phosphate (PO_4-P)	mg/L	Key nutrient for biological activity
Discontinued on regular basis in 2006:		
8. Turbidity	NTU	Discontinued due to probe replacement
9. Barometric Pressure	mBars	Suspended readings as external data readily available
Environmental Observations recorded at all sites:		
Atypical or notable conditions (scum, discoloration, odors, etc.), trash/debris, homeless encampments, biological activity (aquatic, avian, terrestrial), expansion of invasive species, erosion, scouring, other noteworthy comments re: watercourse, shoreline and adjacent environs. 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. Stream Flows	cfs	USGS gauging stations at Fashion Valley and Mast Rd near Santee (see Table H.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 Table H.2)

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

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

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

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

Appendix F - LSDR Hydrology and Water Quality

Stream flow or discharge, is the volume of water moving past a designated location over a fixed period of time. It constitutes a primary driver 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 into a watercourse, as affected by weather (increasing during rainstorms and decreasing during dry spells) and changing during each season. Flow rapidly decreases during summer months when rainfall is minimal, evaporation rates high and actively growing riparian vegetation extracts water from the ground. August and September are typically months of lowest flow. A function of both volume and velocity, stream flow has a major impact on living organisms, riparian habitat, benthic conditions and overall water quality. Velocity of flow, typically increasing as volume increases, determines the kinds of organisms that live in the system and also affects the amount of silt and sediment transported. Fast moving waters usually contain higher levels of DO than sluggish flows, as they are better aerated.

LSDR average daily flow (ADF) values as recorded at the two USGS gauging stations in the lower watershed are expressed in **Table F.1** for both the 12-yr monitoring period (Oct 2004 - Sept 2016) and over the past 52 years (1965-2016) of official record**.** The average daily flow values are in close accord for both stations; river discharge over the past 12 years has run about 16 percent below the 52-year norm in Mission Valley and 20% below the Santee norm. WY16 discharge is 33% below the 52-yr norm at the Fashion Valley Site and 35% below the norm at Santee. On average river discharge for WY16 is 40 percent below the long-range (50+ year) norm and 19 percent below the past 12 year norm.

Correlations between total annual rainfall and ADF considered over the past 53 years of hydrologic record and during the period of SDRPF RiverWatch monitoring for the two lower SDR gauging stations are presented in **Tables F.2 and F.3**, respectively. WY05 was a "Very Wet" (>20") hydrologic year, whereas WY07 was "Very Dry"(<5"). WY11 and WY15 were both "Above Normal" rainfall years (12-15") while WY09 and WY10 (8-12") were considered "Normal" in terms of total annual rainfall. The 12-yr ADF in the East and West are 18 and 30 cfs, respectively; the values are 15 to 20 percent below the long-range LSDR average daily discharges.

Monthly discharge data (min, max and average daily flow) at the two gauging stations extending from Oct 2004 through Oct 2016 are presented in **Chart F.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 some 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 increased in WY15 and fell in WY16 as shown in **Charts F.1** and **F.3**.

Table F.1 - Lower SDR Average Daily Flows (WY05-WY16)

Season	West - Mission Valley		East - Santee Basin		LSDR [a]	
Units [b]	cfs	mgd	cfs	mgd	cfs	mgd
Fall (Oct-Nov)	12.2	7.9	4.7	3.0	6.6	4.3
Winter (Dec-Mar)	28.1	18.2	47.5	30.7	31.5	20.3
Spring (April-May)	10.8	7.0	10.3	6.7	8.75	5.7
Summer (June-Sept)	0.8	(0.5)	0.9	0.6	1.9	1.2
Annual Avg. (WY16)	19.9	12.9	12.2	7.9	13.3	8.6
12-Yr Annual Avg. (2005-2016)	29.9	19.3	17.4	11.2	19.8	12.8
52-Yr Annual Avg. (1965-2016)	36.0	23.3	22.0	14.2	27.0	17.4
Annual Discharge, AFY [c]	14,490/26,095		8,850/15,920		9,630/19,530	

(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 both cubic feet per second (cfs) and million gallons per day (mgd); 1 cfs = 0.646 mgd.
(c) Annual discharge volume expressed in acre-feet (1 AF = 325,900 gallons); WY16 and 53-Yr averages.

Table F.2 - Rainfall and Long-Term Average Daily Flow (1914-2016)

Type	# of Years	Percent of Total Years		Total Annual Rainfall [a]			Average Daily Stream Flow, mgd		
				inches	mm	Avg., mm	East [b]	West [c]	LSDR
Very Wet	3	3%	31%	>20	>500	580	68	113	92
Wet	10	10%		15-20	380-499	430	48	81	66
Above Norm [d]	18	18%		12-15	300-379	340	26	44	35
Normal	40	38%	38%	8-12	200-299	250	10	18	15
Dry	26	26%	31%	5-8	125-199	160	7	12	10
Very Dry	6	6%		<5	<125	100	5	9	7
Total/An. Avg	102	100%		9.85		250	16	25	21

a) Total annual rainfall from 1 October through September 31.
b) Santee Basin USGS Stream Gauge Station #11022480 at Mast Road 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.

Table F.3 - Annual Rainfall and Average Daily Flow (WY05-WY16)

(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	129%	50.9 (33)	100 (65)	71.5 (46)	119%
WY06 (Dry)	152	6.00	-39%	10.7 (7)	17.5 (11)	13.6 (9)	-57%
WY07 (Very Dry)	98	3.85	-61%	7.2 (5)	12.8 (8)	9.5 (6)	-71%
WY08 (Dry)	183	7.20	-27%	13.3 (9)	25.0 (16)	18.2 (12)	-43%
WY09 (Below Normal)	232	9.15	-7%	15.0 (10)	27.2 (18)	20.1 (13)	-38%
WY10 (Normal)	282	11.1	13%	25.1 (16)	42.5 (27)	32.4 (21)	0%
WY11 (Above Normal)	323	12.7	29%	43.3 (28)	61.9 (40)	46.9 (30)	52%
WY12 (Dry)	201	7.91	-20%	11.9 (8)	18.9 (12)	14.9 (10)	-52%
WY13 (Very Dry)	166	6.55	-33%	8.1 (5)	10.7 (7)	9.1 (6)	-71%
WY14 (Very Dry)	129	5.06	-49%	4.3 (3)	6.1 (4)	5.1 (3)	-84%
WY15 (Above Normal)	302	11.91	21%	7.1 (5)	15.2 (10)	10.5 (7)	-67%
WY16 (Dry)	200	7.88	-20%	14.3 ( )	24.2 ( )	18.5 ( )	-%
12-yr Average (05-16)	237	9.33	-2%	18.0 (12)	30.2 (20)	22.5 (15)	-23%
103-yr Average	252	9.92	0%	25/(16)	39/(25)	32/(21)	0%

a) Percent difference from 103-Yr average annual rainfall (252 mm/yr or 9.92in/yr); black-above, red-below average.
b) Santee Basin USGS Stream Gauge Station at Mast Rd., Santee
c) USGS Stream Gauge Station at Fashion Valley Mall; incomplete data prior to 1965.
d) Percent difference from average annual daily flow (i.e., 32 cfs (21 mgd)).

Monthly and seasonal average annual flows and rainfall over the monitoring period for both stations are shown in **Chart F.2.** The seasonal flow patterns express range, variance and correlation in monthly ADF and rainfall over the last 12 years. Winter season streamflow within the lower watershed is several hundred times greater than summer, dry-season flow. Average annual, winter and summer stream flow and rainfall for each of the past 12 water years are presented in **Chart F.3.** Highest flows during the monitoring period at both gauging stations were recorded in WY05 (very wet year); the lowest in WY14 (very dry year). Water years '06, '07, '08, '12, '13, '14 and '16 were all below normal, witnessing both below average rainfall and runoff/streamflow. WY09 witnessed near normal rainfall and river discharge. Water years 2010 and 2011 were slightly above normal years in terms of total annual rainfall and average daily streamflow. Lowest total annual rainfall occurred in WY05, whereas lowest average annual streamflow, both upstream at Santee and downstream in Mission Valley occurred in WY14. In WY15, total annual rainfall amounting to 10.4 inches was 11% above the norm (9.3 inches) while average annual streamflow remained 52% below the 12-yr norm and 74% below the 52-year average.

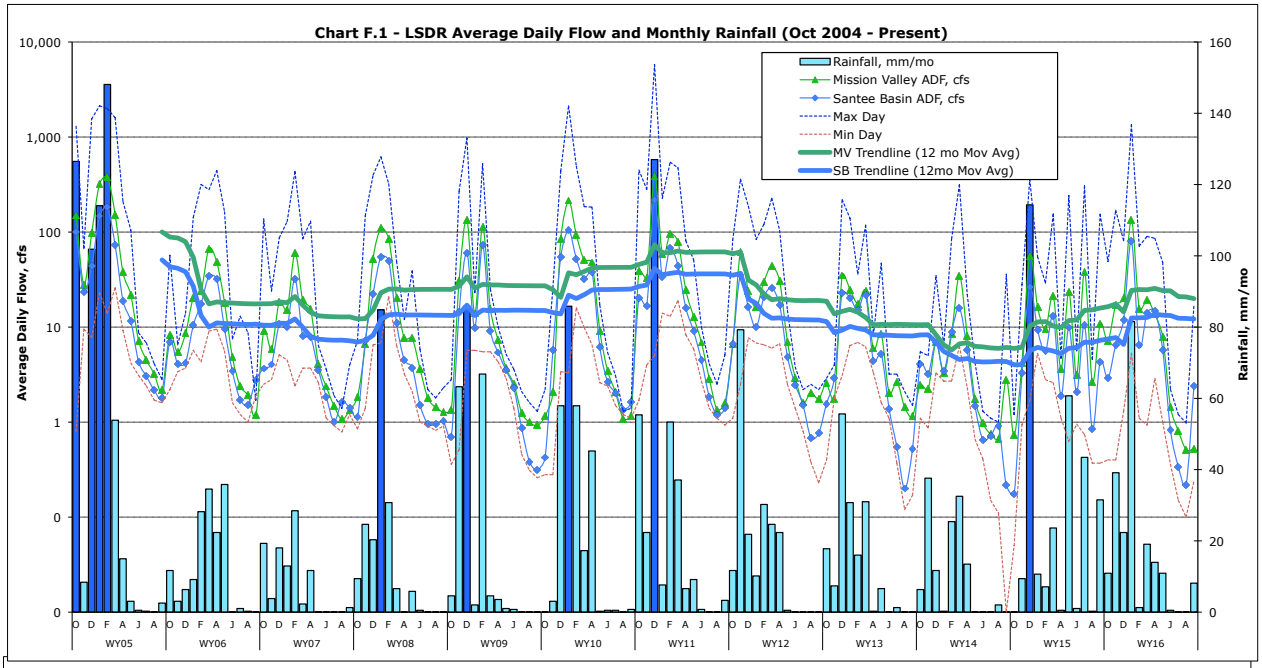


Chart F.1 - LSDR Average Daily Flow and Monthly Rainfall (Oct 2004 - Present)
Average Daily Flow, cfs
Rainfall, mm/mo
Rainfall, mm/mo
Mission Valley ADF, cfs
Santee Basin ADF, cfs
Max Day
Min Day
MV Trendline (12 mo Mov Avg)
SB Trendline (12mo Mov Avg)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16

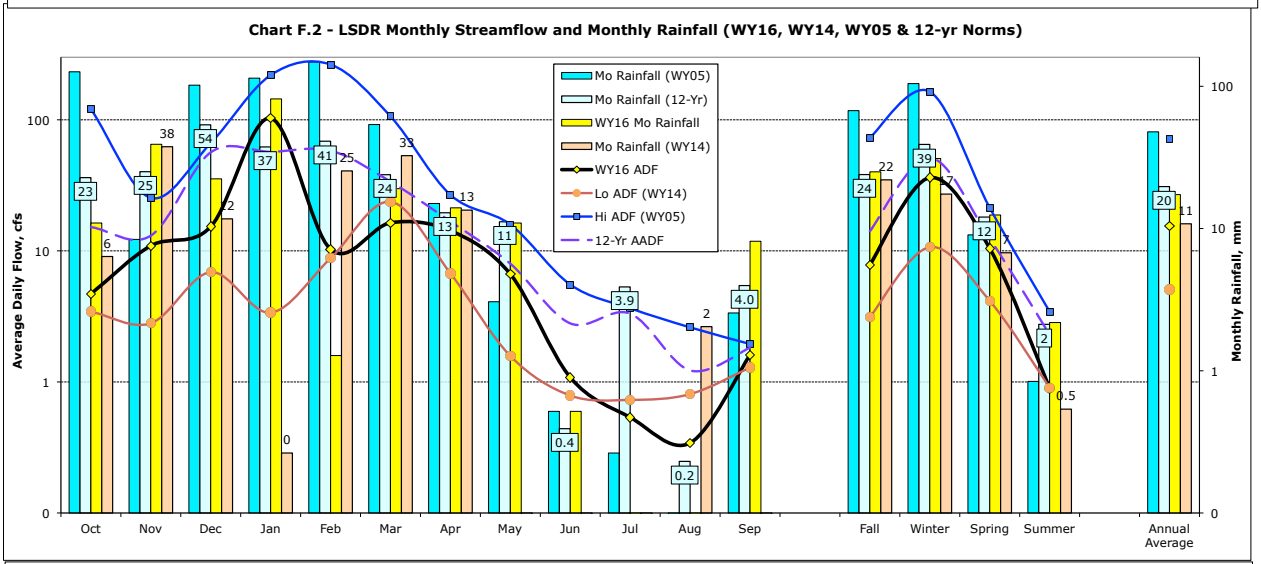


Chart F.2 - LSDR Monthly Streamflow and Monthly Rainfall (WY16, WY14, WY05 & 12-yr Norms)
Average Daily Flow, cfs
Monthly Rainfall, mm
Mo Rainfall (WY05)
Mo Rainfall (12-Yr)
WY16 Mo Rainfall
Mo Rainfall (WY14)
WY16 ADF
Lo ADF (WY14)
Hi ADF (WY05)
12-Yr AADF
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Fall
Winter
Spring
Summer
Annual Average

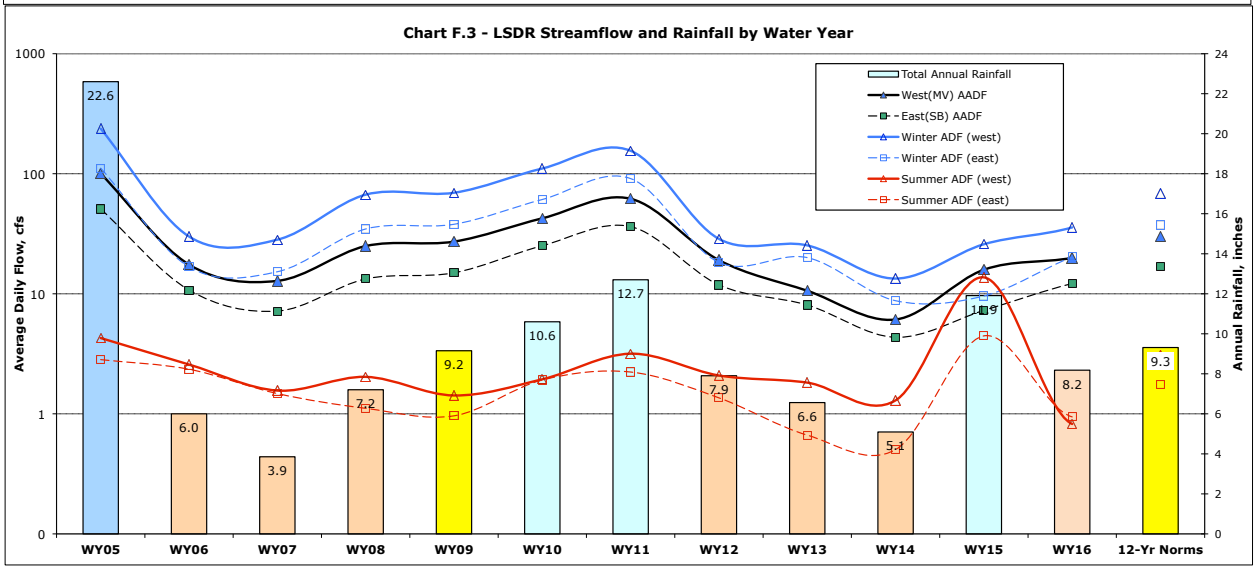


Chart F.3 - LSDR Streamflow and Rainfall by Water Year
Average Daily Flow, cfs
Annual Rainfall, inches
Total Annual Rainfall
West(MV) AADF
East(SB) AADF
Winter ADF (west)
Winter ADF (east)
Summer ADF (west)
Summer ADF (east)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
12-Yr Norms

Appendix G - LSDR Monthly WQM Site Data

Table G.1(W) West Section Water Temperature (WY15/WY16 Data)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	22.7/22.7	20.6/23.6	20.0/23.5	20.3/23.8	17.7/22.4	19.0/23.3	20.2/22.7
Nov	16.7/16.7	16.0/14.7	15.8/15.2	15.9/15.3	14.1/13.0	14.7/13.8	14.1/13.7
Dec	14.3/12.4	14.3/12.1	14.1/12.4	13.9/11.8	13.4/11.8	13.6/11.7	13.7/12.1
Jan	13.6/13.6	13.5/12.9	13.4/12.6	13.4/12.8	12.4/12.1	12.9/12.3	12.9/12.3
Feb	18.0/17.0	17.6/16.5	17.9/16.6	17.6/16.6	15.1/15.4	16.4/15.8	17.2/15.6
Mar	20.2/19.3	20.0/19.5	20.2/19.6	20.7/19.5	18.7/18.6	20.0/19.2	19.6/19.2
Apr	21.2/21.3	20.2/19.7	20.9/20.0	22.3/20.9	16.4/18.4	18.8/19.1	18.2/19.1
May	17.8/21.4	17.5/20.5	18.2/20.5	18.8/21.6	17.8/18.6	18.2/20.2	17.3/19.7
Jun	23.7/24.5	23.5/22.9	23.6/23.6	24.6/25.0	19.8/19.3	22.0/21.9	23.0/21.2
Jul	22.5/26.5	22.1/24.8	21.9/24.7	21.6/26.9	22.2/20.9	23.8/22.8	24.5/23.8
Aug	25.6/27.7	24.6/24.6	24.5/24.7	25.3/26.5	21.6/20.7	22.9/22.6	24.2/23.8
Sept	25.0/23.1	24.8/21.3	24.9/21.9	26.0/23.5	23.8/17.7	24.6/19.2	24.5/19.9
Avg [b]	**20.1/20.5**	**19.6/19.4**	**19.6/19.6**	**20.0/20.4**	**17.8/17.4**	**18.9/18.5**	**19.1/18.6**

a) All values expressed in °C; WY16 values greater (higher temp) than WY15 data are shown in red; below in blue.
b) Water Year results are based on straight (unweighted) averaging of monthly data (Oct- Sept).

Table G.1(E) Middle and East Section Water Temperature (WY16/WY15 Data)

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	22.5/20.0	21.3/18.4	22.8/19.1	21.7/19.4	-/24.4	20.9/20.8	21.7/—	22.7/20.0
Nov	12.5/15.8	11.1/15.5	11.8/13.7	13.4/15.9	16.6/17.9	12.9/16.1	12.9/14.1	12.5/16.6
Dec	9.1/12.9	7.1/11.5	8.7/12.8	10.5/13.2	12.6/16.1	10.0/13.8	10.0/13.9	13.4/11.9
Jan	11.4/11.5	11.5/9.2	11.5/11.6	12.0/12.0	12.5/16.0	11.2/11.9	11.2/11.6	12.4/15.6
Feb	14.7/16.0	11.5/14.3	15.0/16.2	14.3/16.2	18.3/12.3	13.8/15.7	14.4/15.7	18.7/18.0
Mar	17.5/17.5	14.9/14.9	17.8/18.0	17.1/16.8	22.7/25.6	16.6/17.7	17.5/17.6	18.7/18.8

Site	8	9T	10	11	12T	13	14	15T
Apr	18.0/16.6	14.2/12.4	18.7/17.6	16.6/15.6	-/-	18.7/17.7	18.0/14.6	19.1/19.5
May	19.6/18.0	17.4/15.6	20.8/18.3	18.5/17.5	-/22.9	19.7/18.6	19.2/18.9	20.2/17.7
Jun	20.0/21.0	16.2/17.3	21.6/22.8	18.3/19.6	-/-	21.4/22.4	18.9/19.0	21.0/23.1
Jul	22.4/22.5	20.9/19.9	24.9/23.8	20.7/20.3	-/27.7	24.2/23.3	20.1/18.7	26.3/26.3
Aug	23.5/23.6	20.6/21.1	25.5/24.4	20.9/21.4	-/27.0	23.3/24.6	-/20.4	24.5/26.7
Sep	20.0/22.6	13.8/18.7	19.7/22.6	19.2/21.3	-/-	19.9/22.7	-/23.3	20.1/26.5
Avg [b]	**17.6/18.2**	**15.0/15.7**	**18.2/18.4**	**16.9/17.4**	**16.5/21.1**	**17.7/18.8**	**16.3/17.1**	**19.1/20.1**

a) All values expressed in oC; WY16 values greater (higher) than WY15 data are shown in red; below in blue.
b) Water year (WY16/WY15) average values are based on straight (unweighted) averaging monthly data (Oct-Sept).
c) Forester Creek discharges within the Lower Santee Basin reach downstream of Carlton Hills Golf course.

Table G.2(W) West Section Specific Conductivity (WY16/WY15 Data)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	15.4/24.0	2.06/3.27	1.85/2.63	1.78/2.30	2.81/3.83	2.10/4.47	2.39/3.17
Nov	10.3/21.4	2.24/2.76	2.13/2.33	2.26/2.43	2.24/2.73	1.80/3.86	1.73/3.13
Dec	2.26/2.57	1.63/1.26	1.68/1.23	1.82/1.23	1.61/1.18	2.19/0.82	1.91/0.86
Jan	1.57/2.22	1.51/1.93	1.48/1.97	1.54/2.02	1.48/1.89	1.47/1.70	1.59/1.60
Feb	7.70/5.97	2.21/2.79	2.15/2.73	2.12/2.66	2.10/0.81	2.12/2.22	2.15/2.64
Mar	1.80/6.25	1.67/1.84	1.65/1.75	1.69/1.75	1.67/1.95	1.52/1.67	1.56/1.95
Apr	1.88/22.8	1.80/2.74	1.83/2.65	1.89/2.66	1.77/2.97	1.57/2.45	1.48/2.65
May	3.22/0.86	2.31/0.94	2.24/1.41	2.29/1.84	2.36/1.54	2.04/1.45	2.01/1.02
Jun	10.2/5.43	3.04/2.63	2.94/2.53	2.99/2.44	3.07/3.13	2.41/2.02	3.13/2.69
Jul	12.3/1.18	3.58/1.09	3.54/0.78	3.67/0.53	3.75/2.00	2.89/2.23	3.35/2.47
Aug	32.0/8.01	3.84/2.63	3.77/2.44	3.85/2.30	4.07/3.05	3.42/1.78	3.09/2.98
Sep	44.3/1.22	4.07/0.98	4.16/1.04	3.80/1.09	4.17/2.29	3.81/2.10	3.09/1.58
Avg [b]	**11.9/8.50**	**2.50/2.07**	**2.45/1.96**	**2.48/1.94**	**2.59/2.28**	**2.28/2.23**	**2.29/2.23**

a) All values expressed in milli-Siemens/cm; WY16 values greater than WY15 results are in red.
b) Water Year 2016/2015 values are based on averaging monthly data (Oct-Sept).

Table G.2(E) Middle and East Section Specific Conductivity (WY16/WY15 Data)

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	1.88/4.60	4.79/6.03	2.13/3.45	2.69/2.72	-/2.21	2.27/2.52	1.83/—	2.71/2.70
Nov	2.27/2.49	3.99/1.77	2.30/2.79	2.37/1.73	1.91/1.86	2.13/2.42	1.70/2.07	2.03/3.10
Dec	1.52/1.54	3.62/3.72	1.72/1.59	2.25/1.70	1.81/1.90	1.91/1.80	1.38/1.83	2.73/2.43
Jan	1.49/1.97	3.58/4.25	1.51/2.00	1.57/1.92	1.33/1.69	2.17/1.82	1.75/1.72	2.68/1.39
Feb	1.94/2.43	4.25/4.94	2.01/2.48	2.01/2.54	1.30/1.63	2.15/2.14	1.84/1.80	2.71/2.70
Mar	1.66/2.17	3.93/4.81	1.73/2.20	1.83/2.28	1.31/1.60	1.90/1.89	1.66/1.68	2.65/2.89
Apr	1.42/1.38	3.64/5.23	1.58/2.65	1.94/2.71	1.23/—	2.03/2.23	1.72/1.76	2.44/3.27
May	2.01/1.73	4.51/4.32	2.12/1.82	2.40/1.99	—/1.71	2.24/1.72	1.83/1.52	3.00/2.66
Jun	2.42/2.50	5.13/5.37	2.51/2.64	2.73/2.84	—/—	2.38/2.18	1.81/1.76	3.10/3.33
Jul	2.82/2.68	5.75/5.51	2.83/2.58	2.94/2.94	—/1.82	2.46/2.47	1.83/1.84	3.42/3.88
Aug	3.78/2.47	6.12/5.41	2.89/2.62	2.77/2.88	— /1.92	2.45/2.31	1.85/1.81	3.70/3.21
Sep	3.50/1.43	6.17/4.16	3.07/1.62	2.91/1.50	2.07/—	2.51/1.33	—/1.67	3.45/2.50
Avg [b]	**2.58/2.28**	**4.62/4.63**	**2.20/2.37**	**2.37/2.31**	**1.48/1.82**	**1.94/2.07**	**1.32/1.77**	**2.89/2.84**

a) All values expressed in milli-Siemens/cm; WY16 values greater than WY15 results are in red.
b) Water Year 2016/2015 values are based on averaging of monthly data (Oct-Sept).
c) Forester Creek discharges within the Lower Santee Basin enter SDR at west end of Carlton Hills Golf Course.

Table G.3(W) West Section pH (WY16/WY15 Data)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	7.68/7.40	7.80/7.21	7.82/7.11	7.90/7.14	7.82/7.42	7.89/7.34	8.00/7.23
Nov	8.42/7.89	8.54/7.40	8.17/7.28	8.19/7.28	8.18/7.49	8.02/7.44	8.23/7.37
Dec	7.98/7.63	8.06/7.51	8.13/7.45	8.06/7.43	8.17/7.45	8.12/7.54	8.43/8.11
Jan	7.74/7.51	7.53/7.47	7.68/7.50	7.68/7.49	7.60/7.91	7.62/7.54	7.80/7.47
Feb	8.15/7.76	8.00/7.84	8.01/7.70	7.97/7.69	7.96/8.09	8.01/8.22	8.06/8.40
Mar	7.11/7.58	7.12/7.53	7.12/7.59	7.12/7.58	7.10/7.54	7.02/7.58	7.22/7.65

Site #	1	2	3	4	5	6	7
Apr	7.40/7.62	7.42/7.89	7.57/7.92	7.78/7.82	7.19/7.73	7.21/7.79	7.23/7.45
May	8.39/8.03	7.76/7.92	7.97/8.08	8.23/7.78	7.48/7.79	7.56/7.84	7.44/8.02
Jun	7.91/7.94	7.63/8.02	7.77/8.03	7.82/7.92	7.47/7.73	7.49/7.86	7.34/8.23
Jul	7.97/7.87	7.61/7.56	7.71/7.86	7.78/8.21	7.36/7.75	7.40/7.59	7.27/7.64
Aug	7.97/7.55	7.94/7.64	7.75/7.70	7.94/7.63	7.97/7.52	7.51/7.67	7.63/7.41
Sep	7.64/7.54	7.51/7.58	7.78/7.51	7.93/7.59	7.36/7.52	7.43/7.30	7.12/7.37
Avg [b]	**7.86/7.69**	**7.74/7.63**	**7.79/7.64**	**7.87/7.63**	**7.64/7.66**	**7.61/7.64**	**7.65/7.70**

a) All values are unit-less.
b) Water Year 2016/2015 based on averaging monthly results (Oct-Sept).

Table G.3(E) Middle and East Section pH (WY16/WY15 Data)

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	7.84/7.20	7.77/7.91	7.85/7.04	7.01/7.20	-/7.34	7.89/7.36	8.13/—	8.02/7.47
Nov	7.90/7.44	8.03/8.14	8.56/7.52	7.75/7.44	8.16/7.76	8.87/7.54	8.36/—	8.65/8.20
Dec	8.22/7.98	8.04/8.24	8.33/7.88	8.73/7.63	-/8.38	7.99/7.52	8.20/—	8.10/8.03
Jan	7.56/7.90	7.81/8.02	7.69/8.09	6.97/7.43	7.83/8.18	7.79/7.77	7.82/8.10	7.89/8.20
Feb	8.01/7.98	8.20/8.06	8.02/7.98	7.63/7.81	8.59/8.41	7.92/7.88	8.37/7.91	8.00/8.28
Mar	7.75/7.88	8.09/8.02	7.38/7.98	7.33/7.52	7.60/8.19	7.11/7.85	7.14/8.03	7.62/7.99
Apr	7.71/7.65	8.08/7.78	7.33/7.96	7.70/7.93	7.42/—	7.03/7.65	7.16/7.91	7.52/8.29
May	7.92/8.31	8.12/8.07	7.80/8.26	7.58/8.33	—/8.41	7.27/8.06	7.62/8.21	7.70/8.08
Jun	7.70/8.04	8.06/8.01	7.96/8.13	7.55/8.37	—/—	7.49/8.10	7.73/8.34	7.60/8.19
Jul	7.04/7.66	7.90/7.55	7.89/8.02	7.46/7.33	—/8.30	7.31/7.84	7.61/8.09	7.59/8.01
Aug	7.46/7.31	7.57/7.38	8.13/7.76	7.39/7.29	—/8.03	7.39/7.71	-/7.96	7.50/7.77
Sep	7.50/7.77	7.95/7.64	8.13/7.92	7.12/7.77	—/—	7.38/7.76	--/7.82	8.02/7.90
Avg [b]	**7.72/7.76**	**7.97/7.90**	**7.92/7.88**	**7.52/7.67**	**8.00/8.11**	**7.62/7.75**	**7.81/8.04**	**7.85/8.03**

a) All values are unit-less.
b) Water Year 2016/2015 values are based on averaging of monthly data (Oct-Sept).
c) Forester Creek discharges within the Lower Santee Basin reach just upstream of Carlton Oaks Golf course.

Table G.4(W) West Section Dissolved Oxygen (WY16/WY15 Data)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	1.93/3.23	0.62/1.29	0.78/0.41	0.57/0.09	0.38/2.29	0.08/0.81	0.99/2.79
Nov	6.70/3.55	6.87/2.57	2.74/0.10	4.31/0.08	4.35/2.88	0.56/0.33	4.14/4.45
Dec	5.94/6.23	5.88/4.30	6.19/3.32	6.75/4.35	5.34/4.06	2.37/3.19	7.62/5.98
Jan	7.53/6.28	7.42/5.51	7.34/4.36	6.69/4.99	7.75/5.20	6.02/3.61	8.68/6.31
Feb	5.95/5.44	5.87/5.00	6.34/3.29	5.96/3.29	4.51/4.80	2.68/0.71	6.59/3.13
Mar	3.86/5.26	4.19/4.33	4.30/2.32	4.76/3.14	3.47/2.99	2.30/1.19	4.98/3.17
Apr	10.10/6.62	9.28/3.36	7.93/2.46	11.51/4.97	4.63/3.19	5.44/1.45	6.19/3.72
May	10.57/4.73	6.75/6.87	4.49/5.78	9.25/6.11	2.20/6.84	3.15/5.41	2.35/11.14
Jun	6.26/6.82	2.84/1.70	1.70/3.27	3.91/6.51	1.15/1.02	0.11/3.71	2.69/6.05
Jul	9.56/1.85	3.34/1.74	1.99/1.64	3.51/1.37	1.14/1.60	0.67/0.13	2.00/4.12
Aug	5.49/4.25	1.88/0.64	3.26/1.23	3.88/1.01	1.06/0.47	0.74/0.33	1.41/2.19
Sep	3.90/2.13	1.77/1.70	2.35/0.18	6.36/0.91	1.18/0.44	0.14/0.25	2.32/1.22
Avg [b]	**6.48/4.70**	**4.73/3.25**	**4.12/2.36**	**5.62/3.07**	**3.10/2.98**	**2.02/1.76**	**4.16/4.52**

a) All values expressed in milligrams/liter; WY16 /WY15 values less than 4 mg/L shown in red.

Table G.4(E) Middle and East Section Dissolved Oxygen (WY16/WY15 Data)

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	4.75/4.72	7.19/8.05	4.89/0.07	3.00/2.89	-/3.37	0.14/3.06	5.88/—	4.31/1.86
Nov	9.29/3.87	12.5/9.77	9.43/8.68	6.34/6.36	8.42/5.81	0.07/0.14	2.98/4.23	6.77/6.00
Dec	11.0/9.83	11.6/10.58	8.94/7.73	7.65/6.50	8.05/10.58	1.36/0.33	4.27/2.58	7.47/9.59
Jan	11.3/10.17	11.7/11.03	8.63/9.30	7.71/7.67	9.52/9,08	3.54/1.45	3.13/4.04	7.66/13.04
Feb	7.69/7.32	11.3/9.20	6.85/7.66	7.00/5.97	9.89/9.12	2.58/2.52	2.58/1.87	6.35/11.56
Mar	8.29/7.32	10.13/9.04	6.22/7.83	5.63/5.46	5.79/7.62	0.36/1.04	1.55/2.03	5.37/9.48
Apr	8.75/6.98	11.6/11.72	6.06/8.43	5.92/5.75	6.21/—	1.39/2.80	0.66/3.20	5.73/11.40
May	7.38/11.24	8.42/8.96	6.25/9.21	8.92/11.39	—/10.93	0.15/2.15	1.92/2.44	5.51/6.01

Site	8	9T	10	11	12T	13	14	15T
Jun	5.57/6.41	9.28/13.55	7.95/8.19	4.37/7.54	—/—	4.73/3.24	0.97/2.50	5.48/9.44
Jul	1.17/2.13	8.18/8.15	5.69/5.33	3.96/3.31	—/6.56	1.79/1.60	1.09/3.15	3.64/8.72
Aug	0.80/0.36	7.92/8.46	4.25/5.08	2.88/3.43	—/8.20	0.14/1.16	-/3.24	3.20/9.42
Sep	2.12/5.68	10.18/8.15	2.29/7.14	3.76/7.49	—/—	0.18/0.33	—/1.77	3.70/9.52
Avg [b]	**6.51/6.34**	**10.0/9.72**	**6.45/7.06**	**5.59/6.15**	**7.98/7.92**	**1.37/1.65**	**2.50/2.82**	**5.43/5.64**

a) All values expressed in milligrams/liter; WY14/WY15 values less than 4 mg/L are expressed in red.
b) WY16/15 values are based on averaging of monthly data (Oct-Sept).
c) Tributary discharges within the Lower Santee Basin reach enter at west end of Carlton Oaks Golf Course.

Table G.5(W) West Section DO Percent Saturation (WY15/WY16 Data)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	38/23	15/7	5/9	1/7	24/4	9/1	31/12
Nov	37/70	26/69	1/28	1/44	28/42	3/5	44/40
Dec	62/56	43/55	33/59	43/63	39/50	31/22	58/72
Jan	61/73	54/71	42/70	48/64	49/73	35/57	60/82
Feb	58/62	53/61	35/66	35/62	48/46	7/27	33/67
Mar	59/42	48/46	26/48	35/53	32/38	13/25	35/55
Apr	76/116	38/103	28/89	58/131	33/50	16/60	40/68
May	50/121	73/76	62/51	67/106	73/24	58/35	118/26
Jun	82/76	20/33	39/20	79/48	11/13	43/1	71/31
Jul	22/120	20/41	19/24	16/44	19/13	2/8	50/24
Aug	52/70	8/23	15/40	12/49	5/12	4/9	26/17
Sep	26/46	21/20	2/27	11/76	5/13	3/2	15/26
Avg [b]	**52/73 (66)**	**35/50 (48)**	**26/44 (49)**	**34/62 (67)**	**31/33 (49)**	**19/21 (38)**	**49/43 (51)**

a) All values expressed in percent; WY16/15 values less than 12-yr monthly norms (in parentheses) are expressed in red.
b) Water Year values are based on averaging of monthly data (Oct- Sept).

Table G.5(E) Middle and East Section DO Percent Saturation (WY16/WY15)

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	56/53	82/87	58/1	35/32	-/41	2/35	68/-	72/21
Nov	88/40	115/99	88/85	61/65	88/62	1/1	28/42	84/62
Dec	97/94	97/98	78/74	69/63	77/109	12/3	38/25	123/90
Jan	105/94	108/97	80/86	72/72	90/93	33/14	29/38	104/133
Feb	77/75	105/91	69/79	69/62	107/86	26/26	26/19	114/124
Mar	88/78	102/91	66/84	59/57	68/94	4/11	16/22	103/103
Apr	94/73	115/111	66/90	62/58	69/-	15/30	7/32	87/126
May	82/120	89/91	71/99	96/121	-/129	2/23	21/27	85/64
Jun	62/73	96/143	92/96	47/83	-/-	54/38	11/27	72/112
Jul	14/25	93/91	70/64	45/37	-/84	21/19	12/34	103/109
Aug	10/4	89/96	52/62	33/39	-/104	2/14	-/36	79/119
Sep	24/67	100/89	25/84	41/86	-/-	2/4	-/21	129/119
Avg [b]	**66/66(78)**	**99/99(92)**	**68/75(75)**	**58/65(61)**	**83/89(72)**	**14/18(33)**	**26/29(33)**	**96/97(75)**

a) All values expressed as percent; WY15/WY16 values less than 12-yr norms are shown in red.
b) Water Year 2016/2015 values are based on averaging of monthly (Oct-Sept) data.
c) Tributary discharges within the Lower Santee Basin enter SDR at west end of Carlton Oaks golf course.

Appendix H - WY16 LSDR WQM Data by Others

U.S. Geological Survey (USGS) stream flow values (mean daily discharge in cubic feet per second) presented in **Table H.1** for the two Lower San Diego River gauging stations are provisional data subject to revision. Processing and review of the 2016 data is typically completed in December with subsequent approval for publication. The two stations are managed by the Poway South Field Office. Data for the San Diego River gauging stations as well as other streams and rivers throughout California are available via URL at http://waterdata.usgs.gov/nwis/dv?.

Table H.1 USGS Stream Flow Data (WY16/WY15 Values)

	Fashion Valley (Sta. 11023000)				Santee Basin (Sta. 11022480)			
Month	Min.	Max.	ADF_3 [a]	ADFm [b]	Min.	Max.	ADF_3 [a]	ADFm [b]
Oct	2.4/0.6	49/1.2	4.7/0.6	7.2/0.7	0.4/0.1	36/0.6	1.7/0.2	2.9/0.2
Nov	2.4/1.5	170/28	5.6/4.3	17.1/4.2	0.4/0.9	77/34	1.5/5.0	6.5/3.3
Dec	5.0/1.6	81/360	13.1/34.7	20.1/56	1.3/1.7	64/126	3.3/18.3	11.9/26.6
Jan	10.0/8.4	1350/55	29.3/14.0	135/16	5.3/5.3	780/53	23.0/9.5	79.9/9.3
Feb	7.0/5.9	71/29	11.7/10.5	15.7/9.6	1.1/2.8	36/44	5.2/2.9	6.4/5.6
Mar	5.1/4.9	90/156	11.7/6.9	19.4/21.2	0.9/2.6	94/138	6.7/5.0	14.2/13.0
Apr	3.0/3.1	86/4.7	9.4/3.4	13.6/3.6	2.9/1.1	91/5.1	21.0/1.4	14.7/1.9
May	2.0/3.3	48/242	3.3/57.7	7.9/23.6	1.0/0.6	77/105	1.4/6.3	5.8/9.9
Jun	1.0/2.1	2.2/5.6	1.4/2.4	1.4/3.1	0.4/1.0	1.5/7.8	0.5/1.6	0.8/2.1
Jul	0.6/1.7	1.2/309	0.8/175	0.8/38.2	0.2/0.7	0.7/95	0.3/0.8	0.3/8.2
Aug	0.4/1.8	1.0/4.6	0.5/2.1	0.5/2.7	0.1/0.4	0.5/1.6	0.1/0.7	0.2/0.8
Sep	0.4/1.0	17/154	0.8/10.8	0.5/10.8	0.2/0.4	33/70	0.3/7.1	2.4/4.3
WY Avg.			**7.7/26.8**	**19.9/15.9**			**5.4/4.9**	**12.2/7.3**

a) Average daily flow over the antecedent 3-day period of water quality monitoring.
b) Average daily flow for entire month (30 days).
c) WY16 streamflow values lower (less) than WY15 results are shown in red; above (greater than) in blue.

Average daily flows in WY16 were up 70% (5 cfs) in the eastern portion of the lower river and 25% (4 cfs) in the western portion from last year's (WY15) values. LSDR discharge in WY16 amounted to 14,400 AF compared to 4,400 AF in WY14 and 11,500 AFY last year. The annual average discharge over the past 12 years of record is 21,600 AF. Average annual streamflow for

WY16 amounted to 42% of the 52-year mean flow for LSDR. The summer season (June-Sept) of this year represented one of the lowest periods of continuous dry weather flow recorded at Fashion Valley in the past several decades.

San Diego CoastKeeper (SDCK) coliform count values (in MPN/100 mL) from the organization's two San Diego River monitoring stations for WY16 and WY15 are presented in **Table H.2**. Sampling results from 2009 through April 2016 for seven San Diego area watersheds, including the lower San Diego River (HSU 907.1), can be accessed via the organization's URL website at http://www.sdcoastkeeper.org/learn/swimmable/san-diego-water-quality.html.

Table H.2 San Diego CoastKeeper Coliform Count Data (WY16/WY15 Values)

	Fashion Valley Road (SDG-010)			Old Mission Historical Dam (SDG-020)		
Month	EColi [a]	Enterocc [b]	TCB [c]	EColi [a]	Enterocc [b]	TCB [c]
Oct	109/213	95/108	1565/1423	30/10	305/132	708/301
Nov	41/1236	146/345	496/19863	31/98	31/52	288/3076
Dec	1017/4352	3555/6488	24192/24192	12033/4352	14136/6488	24192/24192
Jan	134/4350	52/2750	1850/120331	86/10	109/52	2035/2310
Feb	20/20	20/63	2489/3130	20/31	30/63	3255/836
Mar	10/41	10/41	1137/867	31/41	20/63	504/980
Apr	85/253	386/52	7215/1515	41/52	20/30	2310/784
May	-/1850	-/2909	-/3448	-/20	-/74	-/657
June	-/134	-/160	-/3654	-/1130	-/3076	-/24192
July	-/-	-/-	-/-	-/20	-/31	-/2142
Aug	-/63	-/20	-/2014	-/20	-/10	-/1067
Sept	-/318	-/805	-/9804	-/134	-/51	-/2310
WY Avg.	**-/1361**	**-/1496**	**-/7295**	**-/537**	**-/915**	**-/5503**
Summer	-/172	-/328	-/5157	-/326	-/792	-/7428
Winter	295/2191	909/2336	7417/37130	3574/1109	3574/1667	7497/7080

a) Escherichia-coli (E.coli) bacteria expressed in MPN/100mL
b) Enterococcus (faecalis) bacteria expressed in MPN/100mL
c) Total Coliform bacteria (common) expressed in MPN/100mL.
d) WY16 values greater than WY15 counts are shown in red; less in blue.
e) May through September 2016 coliform count data for SDR sites unavailable.

Appendix I - Water Quality Indexing

Decision-makers, many water managers, vested watershed stakeholders as well as the general public often have neither the time nor training to thoroughly study and fully understand detailed technical assessments of water quality data. Over the decades numerous indexes have been developed to summarize water quality data in an easily expressed and readily understood format. Although water quality professionals are often resistant to automated, uncritical summaries represented by such indexes; there are good reasons to use such results with caution. Scientists and water resource professionals sometimes prefer to provide no answer rather than an imperfect response that can lead to misunderstanding. Layman and many decision makers, however, would prefer an imperfect answer to no answer at all. Using an index may not be the optimal way to fully understand large-scale water quality issues, but it does provide a reasonable tool for gaining insight. Many experts appreciate the need for imperfect answers and conversely others recognize and accept an answer's limitations.

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

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

Besides being general in nature (i.e., imprecise), there are several reasons that an index may fail to accurately communicate water quality information. First, most indexes are based on pre-identified sets of water quality constituents. For example, a specific site may show a good. WQI score, and yet have water quality impaired by other constituents not included in the

indexAnother reason, data aggregation can mask, normalize or over-emphasize short-term water quality issues. A satisfactory WQI at a particular site or reach does not necessarily mean that water quality is or always was satisfactory. A good score, however, does at least indicate that inferior water quality for those constituents evaluated is not chronic during the period included for the index.

The index has been developed for the purpose of providing a simple and concise expression of regularly monitored physical-chemical and bacteriological water quality data compiled by the SDRPF RiverWatch Team as well as several other monitoring groups; it is intended to aid in assessment of the Lower San Diego River watershed primarily for non-body contact recreational uses and environmental enhancement. It constitutes a mechanism to compare averages, variances and trends in normalized values over time (temporally) and by relative location (spatially) within the watershed. The index allows anyone to easily interpret large amounts of aggregated data and relate overall water quality variation to changes, be they from natural causes or man-made impairments. The WQI is used to identify general water quality trends over the past 8 years of monitoring and potential problem areas within the SDR watershed. Such patterns and locations can then be screened and evaluated in greater detail through direct observation of pertinent site-specific data by public agencies and water quality professionals entrusted with protection and enhancement. Used in this manner, the index provides a supplemental metric for evaluating effectiveness of the many San Diego River water quality improvement programs and also assist responsible agencies and organizations in establishing priorities for watershed management.

Running average LSDR WQI values from WY05 through WY16 are expressed by river reach and river section on **Charts I.1 and I.2**, respectively. **Chart I.1** specifically presents overall LSDR monthly WQI values over the 12-year period. Cyclic seasonal patterns expressed in monthly results and trends described by running averages in WQI values are apparent for each reach of the river. **Chart I.2** provides the range (max-min) in monthly WQI values, the running averages by river section as well as monthly streamflows over the 12 year monitoring period. The water quality fluctuations over time in individual reaches, sections and the overall (average) Lower San Diego River expressed on both running average and seasonal cycle bases can be observed. The Upper Santee Basin reach (Sites 13&14) demonstrates the lowest index values since March of 2010, whereas the Mission Gorge (middle section) reach consistently shows the highest index values. It can also be noted (in both charts) that there has been an overall decline in water quality of the river, as evidenced by the WQI values, beginning in 2012. The overall LSDR running (12-mo) average index value fell 19 points from a high of 40 (20% above the 12-yr norm) to 21 over a 24-month period. The current (Sept 31, 2016) running average WQI of 29, down one point from the start of the water year, is 13% below the 12-yr norm of 33 and trending downward.

Chart I.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 LSDR average. These variances can be visually compared to changes in streamflow on the same basis. The positive correlations are evident, i.e., increased average daily flow results in improved water quality. Low flow throughout the summer period results in poorest water quality. This year's below average dry-weather flows extending from mid-May through mid-November resulted in a slight decline in overall water quality from WY15.

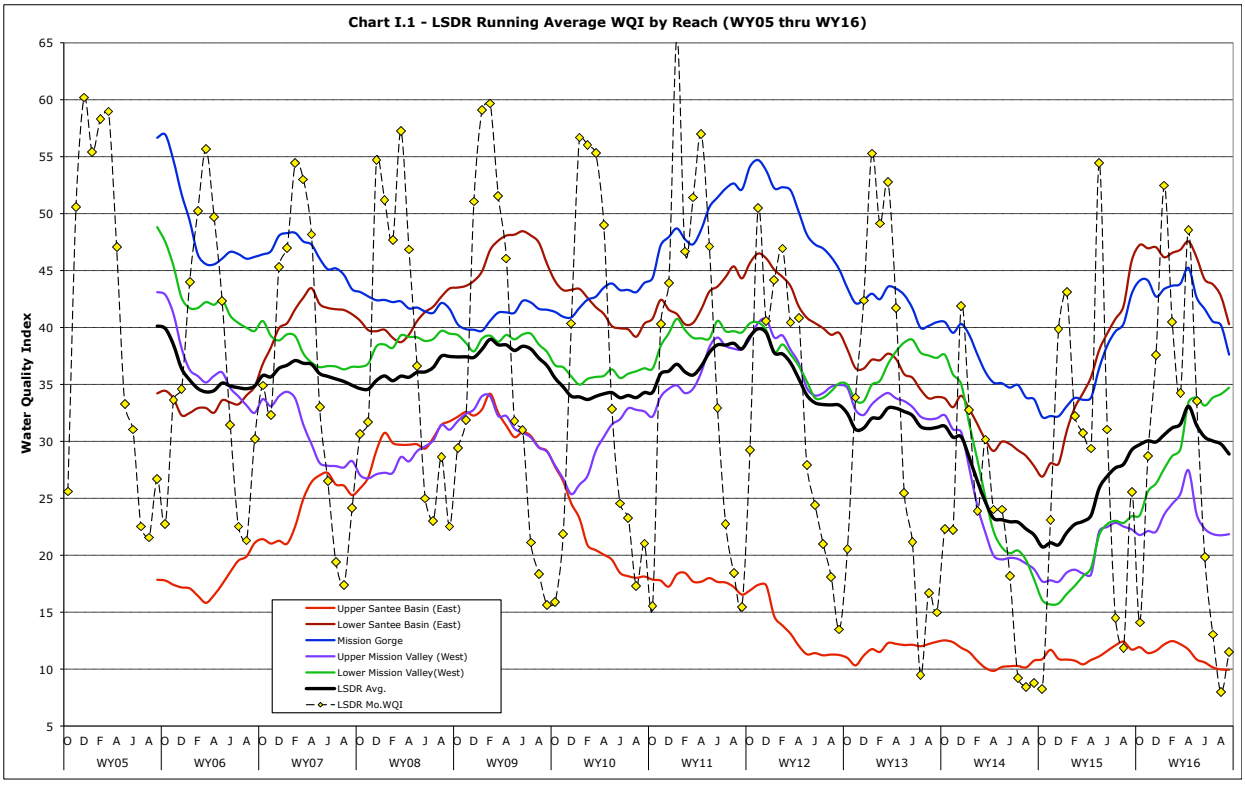


Chart I.1 - LSDR Running Average WQI by Reach (WY05 thru WY16)
Water Quality Index
Upper Santee Basin (East)
Lower Santee Basin (East)
Mission Gorge
Upper Mission Valley (West)
Lower Mission Valley(West)
LSDR Avg.
LSDR Mo.WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16

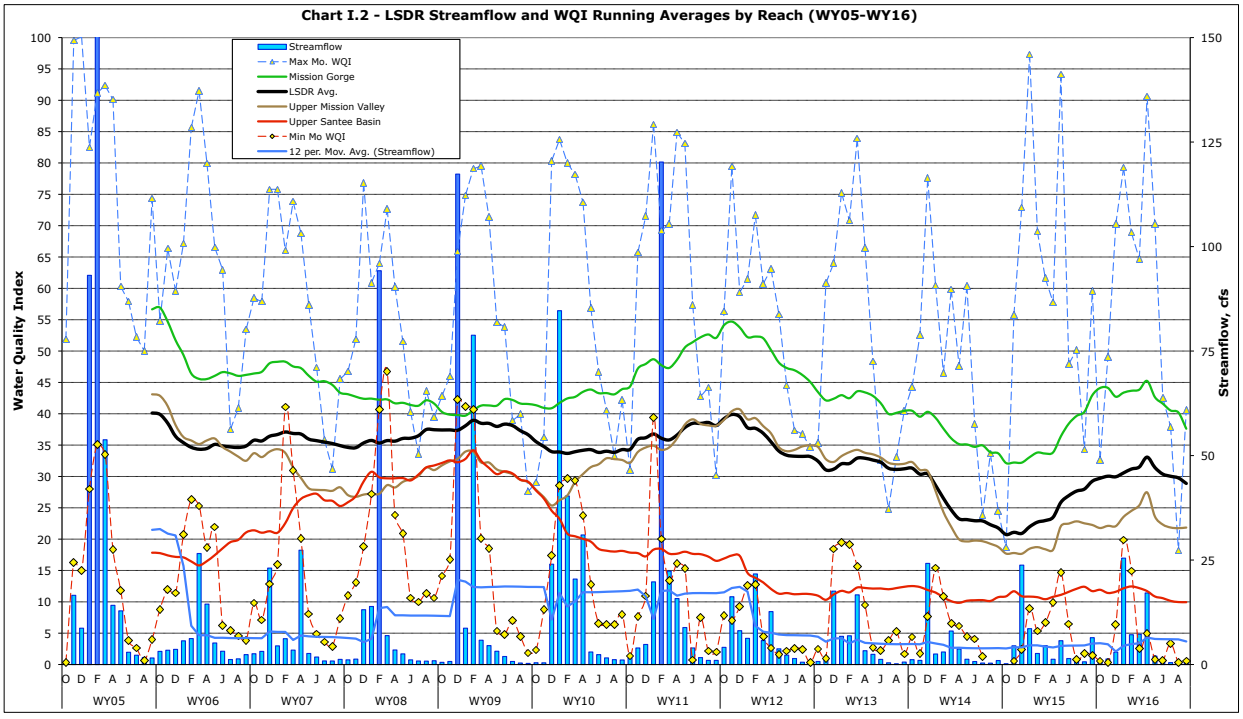


Chart I.2 - LSDR Streamflow and WQI Running Averages by Reach (WY05-WY16)
Water Quality Index
Streamflow, cfs
Streamflow
Max Mo. WQI
Mission Gorge
LSDR Avg.
Upper Mission Valley
Upper Santee Basin
Min Mo WQI
12 per. Mov. Avg. (Streamflow)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16

Chart I.4 provides a spatial profile of average annual WQI by river monitoring site, reach and section for this year (WY16), compared to the best year (WY05), the worst (WY14) and the 12-yr winter, summer and annual norms. The sites are in chronological order ascending upstream. The current (WY16) average annual WQI values for each site shown in black are above annual norms at two sites (15T and 12T) and considerably below the norms at ten other sites. The sites with poorest water quality for WY16 include Kaiser Ponds (6), Mast Park (13) and Cottonwood/ RCP (14). For the fifth consecutive year, the Upper Santee Basin reach (Sites 13 & 14) has experienced the poorest water quality in the Lower SDR watershed. The Mission Gorge reach (sites 8, 9T and 10) continues to demonstrate best overall water quality.