

LOWER SAN DIEGO RIVER WATER QUALITY

WY17 Supplemental Water Quality Monitoring Report

Appendices D-I



Invasive Aquatic Plant Infestation Lower Mission Valley (Site 2 River Gardens/YMCA)

Supporting Water Quality Monitoring Data for the Lower San Diego River

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LOWER SAN DIEGO RIVER WATER QUALITY WY17 SUPPLEMENTAL REPORT

Appendices D-I

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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 D - LSDR Water Quality Monitoring Metrics 13-yr Summary

| Table D.1 WQM Metrics Summary (Annual & Seasonal Averages) | | | | | | | | | | | | | | |
|--|------|------|------|------|------|------|------|------|------|------|------|------|------|------------|
| | WY 5 | WY 6 | WY 7 | WY 8 | WY 9 | WY10 | WY11 | WY12 | WY13 | WY14 | WY15 | WY16 | WY17 | 13-yr Norm |
| Annual (October-September): | | | | | | | | | | | | | | |
| ADF, cfs | 56 | 12 | 8 | 16 | 18 | 30 | 23 | 12 | 8 | 4 | 9 | 13 | 41 | 19.2 |
| 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 | 18.6 | 18.0 |
| SpC, uS/cm | 2.06 | 2.14 | 2.34 | 2.22 | 2.39 | 2.29 | 2.16 | 2.34 | 2.44 | 2.51 | 2.19 | 2.27 | 2.14 | 2.27 |
| DO, mg/L | 6.62 | 6.00 | 5.95 | 6.26 | 6.25 | 5.22 | 5.53 | 5.16 | 5.30 | 3.87 | 4.53 | 4.69 | 5.08 | 5.42 |
| DO%Sat, | 62 | 59 | 60 | 65 | 65 | 55 | 58 | 54 | 54 | 40 | 48 | 49 | 54 | 55.7 |
| pH | 7.63 | 7.44 | 7.53 | 7.89 | 7.66 | 7.84 | 7.83 | 7.64 | 7.77 | 7.67 | 7.77 | 7.71 | 7.77 | 7.70 |
| WQI | 41 | 37 | 36 | 38 | 37 | 35 | 38 | 33 | 32 | 22 | 29 | 29 | 33 | 34 |
| Grade | C | D+ | D+ | C- | D+ | D | C- | D | D | E+ | D | D | D | D |
| Summer (June-September) Period: | | | | | | | | | | | | | | |
| ADF, cfs | 3.1 | 3.6 | 1.2 | 1.8 | 1.1 | 1.7 | 2.9 | 1.5 | 1.1 | 0.8 | 5.2 | 0.6 | 1.8 | 2.0 |
| 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 | 23.1 | 22.5 |
| SpC, uS/cm | 2.54 | 2.39 | 2.66 | 2.91 | 3.10 | 2.89 | 2.74 | 2.99 | 2.96 | 2.90 | 2.20 | 3.07 | 2.70 | 2.77 |
| DO, mg/L | 4.93 | 5.17 | 4.82 | 5.32 | 4.94 | 3.84 | 3.79 | 3.64 | 3.32 | 2.41 | 3.68 | 3.12 | 2.81 | 3.98 |
| DO%Sat, % | 49 | 59 | 52 | 61 | 56 | 44 | 44 | 43 | 38 | 38 | 43 | 36 | 32 | 45.8 |
| pH | 7.66 | 7.40 | 7.75 | 8.05 | 7.80 | 7.66 | 7.83 | 7.33 | 7.78 | 7.52 | 7.84 | 7.53 | 7.74 | 7.69 |
| WQIa | 25 | 26 | 22 | 25 | 22 | 22 | 22 | 19 | 16 | 11 | 21 | 13 | 18 | 20 |
| Grade | D- | D- | E | D- | E | E | E | E | E | F | E | E- | E | E |
| Winter (December-March) Period: | | | | | | | | | | | | | | |
| ADF, cfs | 142 | 18 | 17 | 43 | 49 | 76 | 48 | 19 | 18 | 10 | 17 | 32 | 113 | 46.4 |
| 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 | 14.4 | 13.5 |
| SpC, uS/cm | 1.41 | 1.95 | 2.00 | 1.54 | 1.52 | 1.39 | 1.38 | 1.68 | 2.01 | 2.19 | 1.91 | 1.73 | 1.29 | 1.69 |
| DO, mg/L | 9.34 | 6.84 | 7.08 | 7.20 | 7.57 | 6.10 | 7.33 | 6.67 | 7.63 | 5.13 | 5.28 | 6.17 | 7.54 | 6.91 |
| DO%Sat | 84 | 59 | 69 | 69 | 74 | 61 | 71 | 63 | 72 | 49 | 53 | 60 | 75 | 66.1 |
| pH | 7.56 | 7.52 | 7.48 | 7.94 | 7.49 | 7.83 | 7.89 | 7.93 | 7.70 | 7.95 | 7.81 | 7.79 | 7.75 | 7.74 |
| WQIa | 58 | 46 | 50 | 53 | 55 | 52 | 52 | 43 | 50 | 32 | 36 | 41 | 54 | 48 |
| Grade | B | C | B- | B- | B | B- | B- | C | B- | D | D+ | C | B | C |

(a) Values in red text are below 13-yr norms; values above norms are in blue text.

Table D.2 WQM Metrics Summary by Section and Reach (WY17/WY16 & 13-yr Norms)

| Section | Mission Valley | | Mission Gorge | Santee Basin | | Watershed |
|-----------------------------------|---------------------|---------------------|-----------------------------|---------------------|---------------------|---------------------|
| | Sites | 1-4 | | 5-7 | 8-10 | |
| Reach | LMV | UMV | MG | LSB | USB | LSDR ^(a) |
| Annual (Oct-Sept): | | | | | | |
| ADF, cfs | 66/20 (29) | 59/18 (27) | 37/14 (19) ^(b) | 30/12 (18) | 8/3 (4) | 40/13 (19) |
| Temp, °C | 20.0/20.0 (19.3) | 18.5/18.2 (17.9) | 17.5/17.4 (17.1) | 18.2/17.9 (17.5) | 18.5/17.6 (18.1) | 18.6/18.2 (18.0) |
| SpC, mS/cm | 2.467/2.486 (2.539) | 2.357/2.387 (2.522) | 2.083/2.213 (2.242) | 2.104/2.453 (2.252) | 1.697/1.807 (1.790) | 2.142/2.269 (2.269) |
| DO, mg/L | 4.74/4.82 (5.10) | 4.59/3.09 (4.49) | 7.13/7.18 (7.61) | 6.25/6.71 (6.71) | 2.71/1.62 (3.20) | 5.08/4.69 (5.42) |
| DO % of Sat, % | 51/52 (54) | 49/32 (46) | 73/74/79 | 66/71/67 | 17/29/32 | 54/49 (56) |
| WQIa | 33/35 (35) | 32/22 (31) | 41/40 (47) | 39/37 (38) | 18/9 (18) | 33/29 (34) |
| Grade | D/D (D+) | E/E (D) | C/C (C) | C/D+ (C-) | E/F (E) | D/D (D) |
| WY17 Rating | Marginal | Marginal | Fair | Fair | Poor | Marginal |
| WY16 Rating | Marginal | Poor | Fair | Marginal | Very Poor | Marginal |
| WY15 Rating | Poor | | Fair | | Very Poor | Marginal |
| WY14 Rating | Poor | | Marginal | | Very Poor | Poor |
| 13-yr Norm | Marginal | Marginal | Fair | | Poor | Marginal |
| Summer (June-Sept) Period: | | | | | | |
| ADF, cfs | 3.1/1.1 (3.3) | 2.8/1.0 (3.0) | 1.5/0.5(1.8) ^(c) | 1.1/0.5(1.8) | 0.3/0.1(0.3) | 1.8/0.6 (2.0) |
| Temp, °C | 24.9/24.5 (24.2) | 22.7/21.2 (21.8) | 22.7/21.3 (21.8) | 21.5/20.8 (21.6) | 23.8/21.7 (22.8) | 23.1/21.9 (22.5) |
| SpC, mS/cm | 3.234/3.620 (3.217) | 3.084/3.354 (3.168) | 2.586/2.978 (2.811) | 2.590/3.031 (2.628) | 2.006/2.358 (2.038) | 2.700/3.068 (2.772) |
| 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 | 20/17 (21) | 16/6 (15) | 18/18 (29) | 23/20 (26) | 12/5 (10) | 18/13 (20) |
| Grade | E/E (E) | E/F (E) | E/E (D) | E/E (D-) | F+/F (F) | E/E- (E) |
| WY17 Rating | Poor | Poor | Poor | | Very Poor | Poor |
| 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 | |

| 13-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 | 183/49 (73) | 165/44 (57) | 103/32 (46) | 82/28 (39) | 21/47 (9) | 113/32 (46) |
| Temp, °C | 15.0/15.3 (14.4) | 14.4/14.7 (13.7) | 13.2/12.8 (12.7) | 14.8/14.8 (13.2) | 14.4/13.0 (13.5) | 14.4/14.1 (13.5) |
| SpC, mS/cm | 1.377/1.765 (1.838) | 1.074/1.781 (1.741) | 1.374/1.698 (1.606) | 1.554/1.990 (1.823) | 1.049/1.397 (1.444) | 1.286/1.726 (1.691) |
| 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 | 52/44 (50) | 57/38 (47) | 67/58 (63) | 60/52 (51) | 32/14 (28) | 54/41 (48) |
| Grade | B/C (B-) | B/C- (C) | B/B (B) | B/B- (B-) | D/F (D) | B/C (C+) |
| WY17 Rating | Good | | Good | | Fair | Good |
| WY16 Rating | Fair | | Good | | Poor | Fair |
| WY15 Rating | Marginal | | Good | | Very Poor | Marginal |
| WY14 Rating | Marginal | | Good | Fair | Poor | Marginal |
| 13-yr Norm | Good | Fair | Good | | Marginal | Fair |

WY17/16 WQ metrics below (less than) 13-yr norms shown in red text; values above norms are shown in blue text.

(a) Weighted average of all reaches within the Lower SDR watershed.

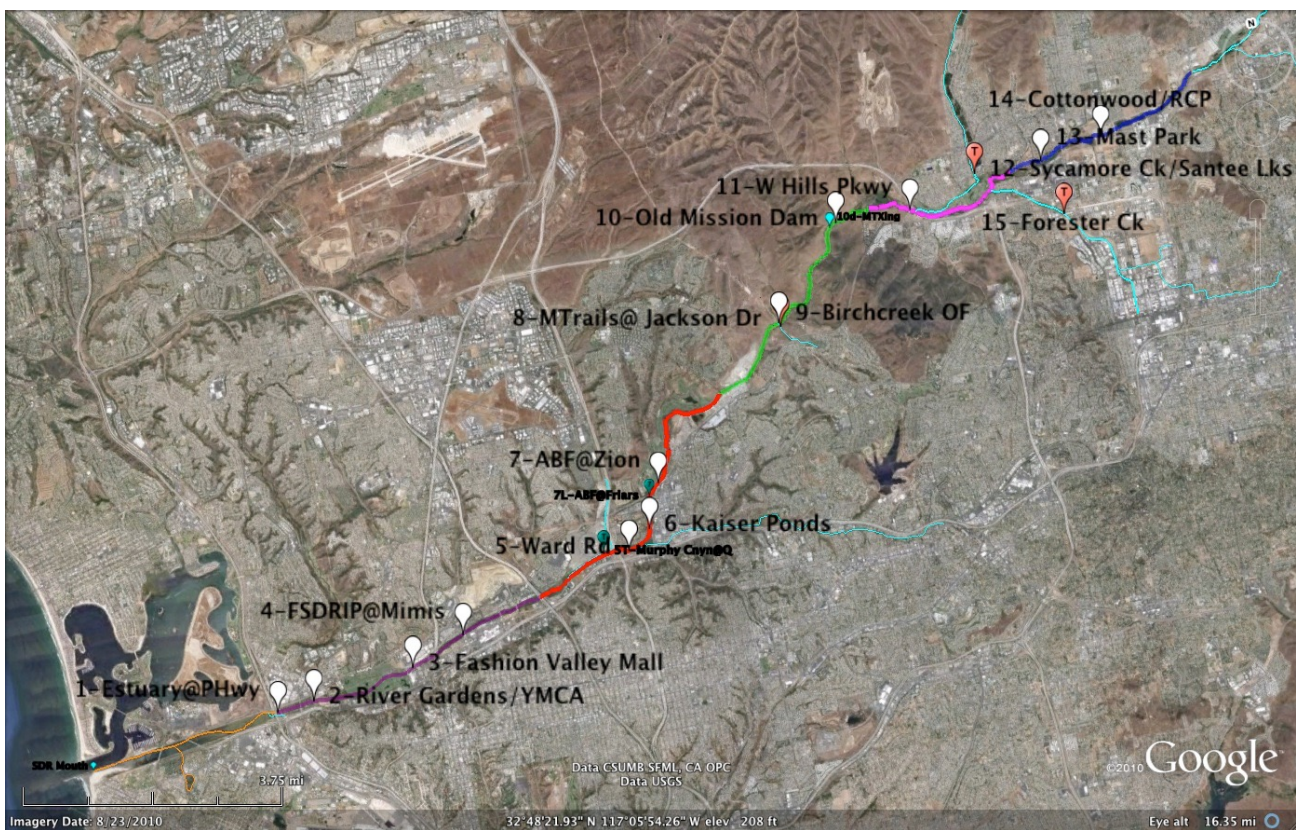
(b) Stream flow based on river channel gains and losses averaged between Santee Basin and Mission Valley.

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 last 13 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 13 years (Oct. 2004 – Sept. 2017) 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**.

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 and again in 2017 back to original location.

WQ Parameters: Seven measured and recorded parameters (Temp, pH, SpC, DO, DO%Sat, NO₃ & PO₄) plus subjective field observations re: environs and characteristics are listed in **Table E.2**. As nutrient testing for NO₃ and PO₄ 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 13-yr period (Oct. 04 - Sept. 17) 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 computing 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 Water Quality Monitoring Parameters

| WQ Parameter | unit | Comments |
|--|---------------|--|
| <i>Measured monthly at all sites:</i> | | |
| 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) |
| <i>Sampled/tested monthly at selected sites: (typically 5 - 3 East & 2 West)</i> | | |
| 6. Nitrate (NO ₃ -N) | mg/L | Important nutrient for biological activity |
| 7. Phosphate (PO ₄ -P) | mg/L | Key nutrient for biological activity |
| <i>Discontinued on regular basis in 2006:</i> | | |
| 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. | | |
| <i>General WQ Conditions observed at all sites: (numerical coding added in 2010)</i> | | |
| Weather Condition, Presence of Algae, Clarity, Color, Odor, Flow, Foam, Litter, Odor, Oil and Grease (O&G), e | | |
| <i>Parameters measured by others at selected sites</i> | | |
| 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 (3-8) meet at an appointed location, organize field equipment/transportation, drive to sites, measure physical-chemical water quality using the YSI Sonde meter, note special conditions/observations, collect samples for subsequent testing, return to office, perform nutrient (NO₃ & PO₄) 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/running 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. River flow rapidly decreases during summer months when rainfall is minimal, evaporation rates high and riparian vegetation extracts water from the ground. August and September, the last two months of summer and the water year, 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 much 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 13-yr monitoring period (Oct 2004 - Sept 2017) and over the past 53 years (1965-2017) of official record. The average daily flow values are in close accord for both stations; river discharge over the past 13 years is about 11 percent below the 53-year norm in Mission Valley and 18% below the Santee norm. WY17 discharge is 60% greater than the 53-yr norm at the Fashion Valley Site and 26% above the norm at Santee. River discharge on average for WY17 is 48 percent greater than the long-range norm and 64 percent in excess of the 13 year norm.

Correlations between total annual rainfall and ADF 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”). WY17, WY15 and WY11 were each “Above Normal” rainfall years (12-15”) while WY09 and WY10 (8-12”) were considered “Normal” in terms of total annual rainfall. The 13-yr ADF in the East and West sections are 18 and 32 cfs, respectively; the values are 15-20 percent below long-range LSDR average daily discharges. WY17 total rainfall (12.72 inches) was 28% above the long-range average while average daily flow for the year was 41% above the long-range norm (53-yr average) of 28 cfs.

Monthly discharge data (min, max and average daily flow) for the two USGS gauging stations extending from Oct. 2004 through Sept. 2017 are plotted 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 several winter (wet) periods in the East (Santee Basin) and up to 390 cfs (252 mgd) in the West (Mission Valley) section. Running average ADF values, trending downward in WY12-WY14 increased in WY15, fell in WY16 then increased again in WY17 as expressed on **Charts F.1 and F.3**. The seasonal flux is shown on **Chart F.2**.

Table F.1 - Lower SDR Average Daily Flows (WY05-WY17)

(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); WY17 and 53-Yr averages.

Table F.2 - Rainfall and Long-Term Average Daily Flow (1914-2017)

| 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% | >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% | 8-12 | 200-299 | 250 | 10 | 18 | 15 |
| Dry | 26 | 26% | 5-8 | 125-199 | 160 | 7 | 12 | 10 |
| Very Dry | 6 | 6% | <5 | <125 | 100 | 5 | 9 | 7 |
| Total/ An. Avg | 103 | 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-WY17)

| (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 | 127% | 50.9 (33) | 100 (65) | 71.5 (46) | 152% |
| WY06 (Dry) | 152 | 6.00 | -40% | 10.7 (7) | 17.5 (11) | 13.6 (9) | -52% |
| WY07 (Very Dry) | 98 | 3.85 | -61% | 7.2 (5) | 12.8 (8) | 9.5 (6) | -67% |
| WY08 (Dry) | 183 | 7.20 | -28% | 13.3 (9) | 25.0 (16) | 18.2 (12) | -36% |
| WY09 (Below Normal) | 232 | 9.15 | -8% | 15.0 (10) | 27.2 (18) | 20.1 (13) | -29% |
| WY10 (Normal) | 282 | 11.10 | 12% | 25.1 (16) | 42.5 (27) | 32.4 (21) | 14% |
| WY11 (Above normal) | 323 | 12.70 | 28% | 43.3 (28) | 61.9 (40) | 46.9 (30) | 65% |
| WY12 (Dry) | 201 | 7.91 | -20% | 10.1 (8) | 19.0 (12) | 14.9 (10) | -48% |
| WY13 (Very Dry) | 166 | 6.55 | -34% | 8.2 (5) | 10.9 (7) | 9.1 (6) | -68% |

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| Site # | Site Name | u/s Elev | | Location | GIS Coordinates | |
|--|-----------------------------|----------|-------|--|-----------------|------------|
| | | mi. | . ft. | | 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 Trolley 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 Trolley 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 | 334 | Forester Ck (tributary) at Rapture Ln. | 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 | E of RCP plant at Chubb Ln./Magnolia | 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] | | | | | | |

| | | | | | | | |
|-----------------|-----|------|------|---------|---------|---------|------|
| WY14 (Very Dry) | 129 | 5.06 | -49% | 4.3 (3) | 6.1 (4) | 5.1 (3) | -82% |
|-----------------|-----|------|------|---------|---------|---------|------|

| | | | | | | | |
|-----------------------|-----|-------|------|-----------|-----------|-----------|------|
| WY15 (Above normal) | 302 | 11.91 | 20% | 7.1 (5) | 15.2 (10) | 10.5 (7) | -63% |
| WY16 (Dry) | 208 | 8.20 | -18% | 12.2 (8) | 24.4 (16) | 15.6 (10) | -45% |
| WY17 (above normal) | 323 | 12.72 | 28% | 27.7 (18) | 57.3 (37) | 40.0 (26) | 41% |
| 13-yr Average (05-17) | 244 | 9.61 | -3% | 18.1 (12) | 30.0 (19) | 23.6 (15) | -23% |
| 100-yr Average | 252 | 9.92 | 0% | 21.8/(14) | 36.7 (24) | 28.4/(18) | 0% |

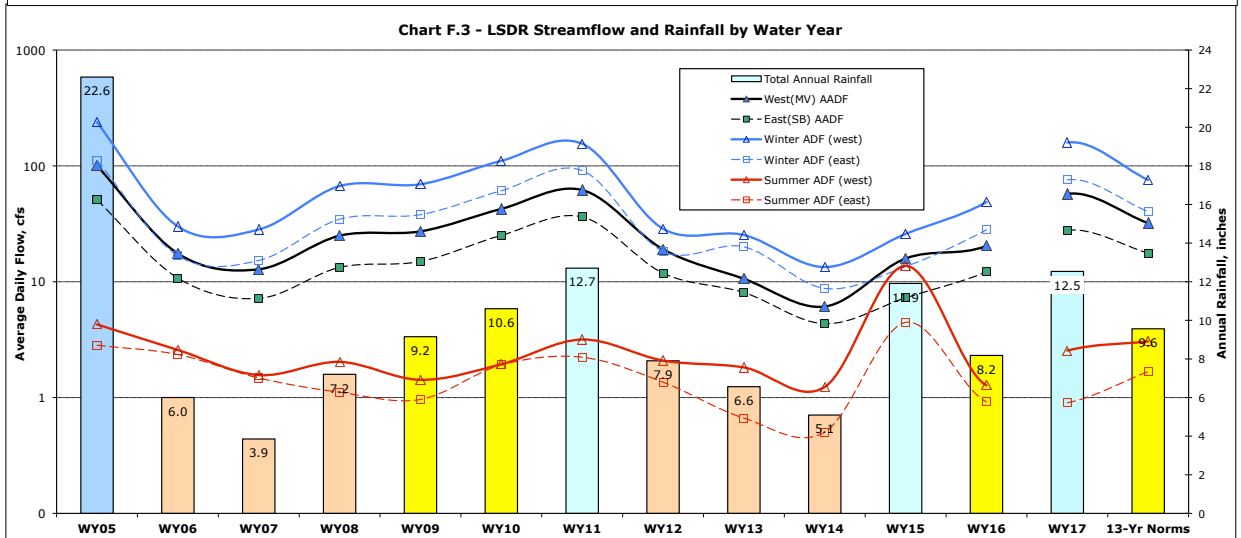
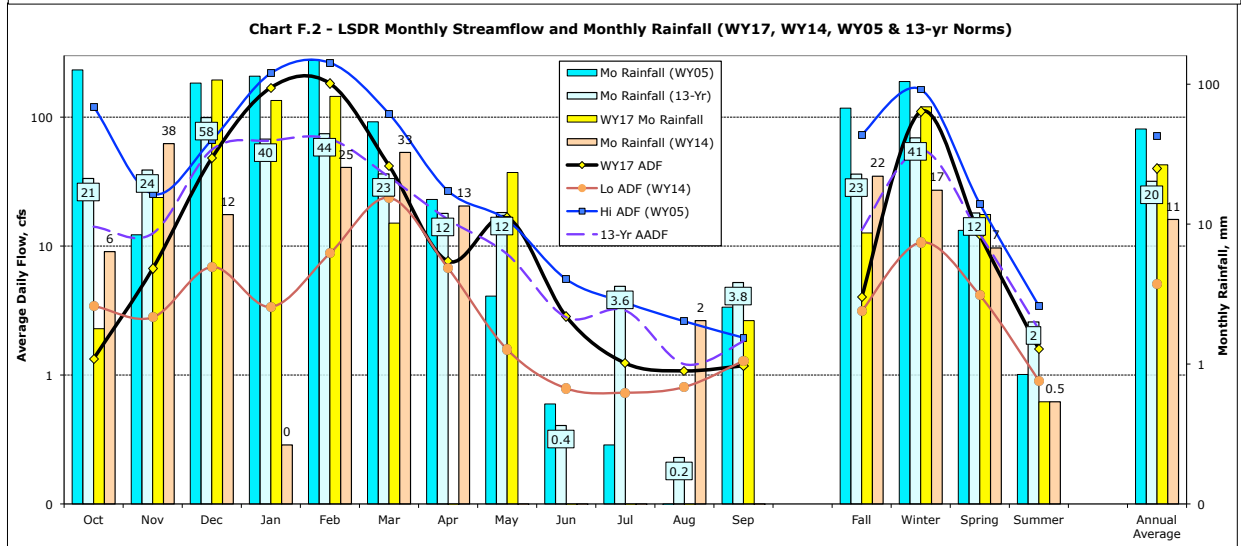
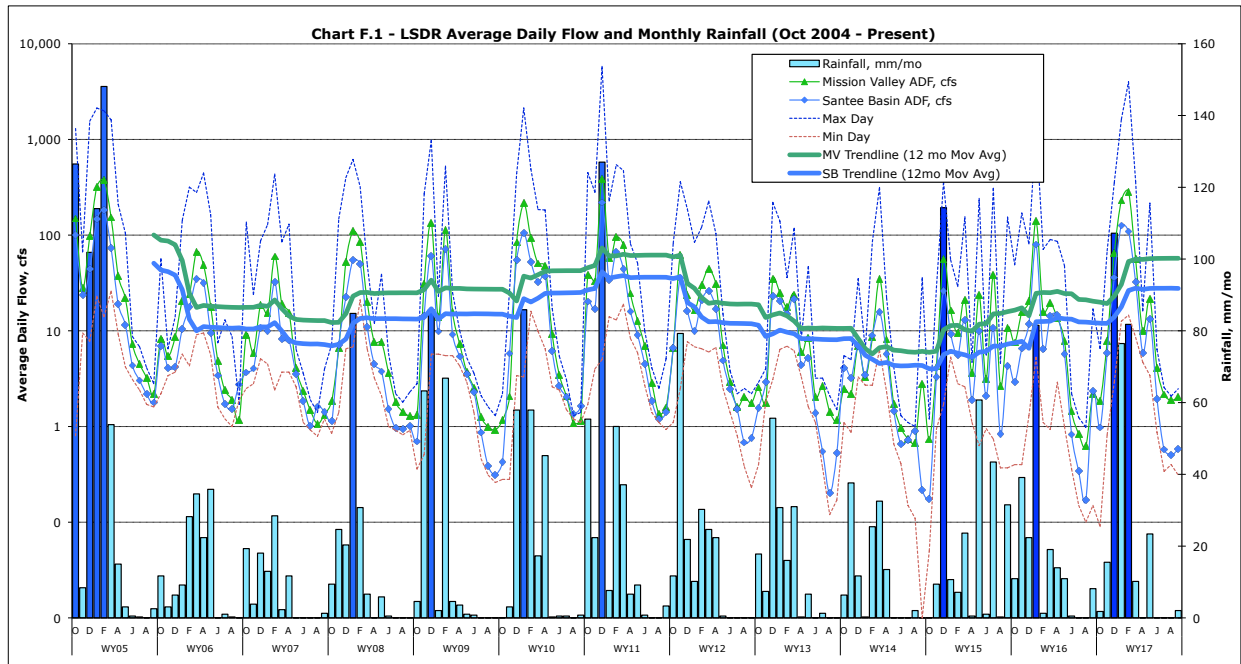
- a) Percent difference from 100-yr average annual rainfall (253 mm/yr or 9.95 in/yr); black-above, red-below average.
- b) Santee Basin USGS Stream Gauge Station 00067556 at Mast Rd., Santee.
- c) USGS Stream Gauge Station 00459999 at Fashion Valley Mall; incomplete data prior to 1965.
- d) Percent difference from average annual daily flow (i.e., 32 cfs / 21 mgd).

Monthly and seasonal average annual flows (lines) and rainfall (bars/columns) over the monitoring period for both stations are shown in **Chart F.2**. The seasonal flow patterns express range, variance and positive correlation in monthly ADF and rainfall over the past 13 years. Winter season streamflow within the lower watershed is several hundred times greater than summer, dry-season flow.

Average annual, winter and summer flows and rainfall for each of the last 13 water years are expressed graphically 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, and '14 were all below normal, witnessing both below average rainfall and runoff/streamflow. WY09 witnessed near normal rainfall and river discharge. Water years '11, '15 and '17 were slightly above normal years in terms of total annual rainfall (verticle bars) and average daily streamflow (lines). Lowest total annual rainfall occurred in WY07, whereas lowest average annual streamflow, both upstream at Santee and downstream in Mission Valley occurred in WY14 following three years of well below normal rainfall. In WY17, total annual rainfall amounting to 12.72 inches was 21% above the 13-yr norm (9.3 inches) while average annual streamflow was 69% above the 13-yr norm and 41% above the 53-year average.

| Season Units ^(b) | West - Mission Valley | | East - Santee Basin | | LSDR ^(a) | |
|--------------------------------------|-----------------------|-------|---------------------|------|---------------------|------|
| | cfs | mgd | cfs | mgd | cfs | mgd |
| Fall (Oct-Nov) | 4.85 | 3.1 | 3.45 | 2.2 | 4.0 | 2.6 |
| Winter (Dec-Mar) | 159. | 102.7 | 75.8 | 49.0 | 110.5 | 20.3 |
| Spring (April-May) | 17.8 | 11.5 | 9.6 | 6.2 | 12.2 | 7.8 |
| Summer (June-Sept) | 2.55 | 1.6 | 0.93 | 0.6 | 1.6 | 1.0 |
| Annual Avg. (WY17) | 57.3 | 37.0 | 27.7 | 17.9 | 40.0 | 25.8 |
| 13-yr Annual Avg. (2005-2017) | 32.0 | 20.7 | 18.1 | 11.7 | 23.6 | 15.2 |
| 53-yr Annual Avg. (1965-2017) | 36.0 | 23.3 | 22.0 | 14.2 | 27.0 | 17.4 |
| Annual Discharge, AFY ^(c) | 41,440/26,095 | | 20,050/15,920 | | 32,255/19,490 | |

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Appendix G - LSDR Monthly WQM Site Data

Table G.1(W) West Section Water Temperature (WY17 Data)

| Site # | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-------------|----------------------|-------------------|-------------------|-------------------|----------------------|-------------------|-------------------|
| Reach | Lower Mission Valley | | | | Upper Mission Valley | | |
| Oct | 17.1 | 19.1 | 19.7 | 20.0 | 15.3 | 17.2 | 17.3 |
| Nov | 16.1 | 16.2 | 16.9 | 17.5 | 14.0 | 14.5 | 14.3 |
| Dec | 13.8 | 13.7 | 13.6 | 13.4 | 13.0 | 13.5 | 13.3 |
| Jan | 11.5 | 11.3 | 11.1 | 11.3 | 10.9 | 11.1 | 10.8 |
| Feb | 15.6 | 15.0 | 14.8 | 14.6 | 14.4 | 14.3 | 14.4 |
| Mar | 20.1 | 19.9 | 19.9 | 19.9 | 18.9 | 19.5 | 19.2 |
| Apr | 22.5 | 22.2 | 22.7 | 22.8 | 19.9 | 21.7 | 21.3 |
| May | 22.4 | 22.2 | 22.5 | 22.5 | 21.0 | 21.6 | 21.8 |
| Jun | 24.4 | 23.8 | 24.4 | 25.5 | 21.9 | 24.0 | 22.7 |
| Jul | 27.4 | 25.6 | 26.0 | 27.5 | 22.5 | 24.4 | 25.1 |
| Aug | 26.4 | 24.0 | 24.3 | 25.2 | 20.8 | 22.9 | 23.3 |
| Sept | 23.7 | 23.1 | 23.4 | 24.2 | 20.3 | 22.4 | 22.4 |
| Avg. | 20.1 (19.5) | 19.7(19.0) | 19.9(19.2) | 20.4(19.7) | 17.8(17.2) | 18.9(18.3) | 18.8(18.0) |

a) All values expressed in °C; WY17 values greater than 13-yr norms (in parentheses) are shown in red; below in blue.

b) Water Year results are based on straight (unweighted) averaging of monthly data (Oct- Sept); temps > 24C in yellow cells.

Table G.1(E) Middle and East Section Water Temperature (WY17 Data)

| Site | 8 | 9T | 10 | 11 | 12T | 13 | 14 | 15T |
|-------|---------------|------|------|--------------------|------|--------------------|------|------------------|
| Reach | Mission Gorge | | | Lower Santee Basin | | Upper Santee Basin | | LSB ^c |
| Oct | 18.5 | 13.5 | 17.4 | 16.1 | 22.6 | 17.7 | - | 16.2 |
| Nov | 16.1 | 10.1 | 13.3 | 14.5 | 17.3 | 14.6 | - | 16.0 |
| Dec | 11.2 | 9.9 | 10.7 | 11.8 | 13.9 | 11.9 | 15.0 | 15.1 |
| Jan | 10.6 | 10.1 | 11.0 | 11.0 | 11.8 | 11.4 | 11.3 | 11.8 |
| Feb | 14.8 | 13.6 | 15.1 | 15.1 | 16.1 | 15.1 | 15.1 | 16.0 |
| Mar | 17.4 | 13.2 | 17.8 | 17.0 | 20.8 | 18.5 | 17.3 | 21.0 |

| Site | 8 | 9T | 10 | 11 | 12T | 13 | 14 | 15T |
|------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Apr | 18.7 | 14.0 | 19.3 | 17.2 | 21.8 | 18.8 | 16.9 | 22.0 |
| May | 18.8 | 14.3 | 19.2 | 17.4 | 22.2 | 18.8 | 18.8 | 22.0 |
| Jun | 22.8 | 17.5 | 23.6 | 22.6 | - | 23.5 | - | 23.5 |
| Jul | 23.9 | 20.6 | 25.8 | 21.2 | - | 24.5 | 26.3 | 23.8 |
| Aug | - | 18.9 | - | 20.0 | - | 22.9 | 25.1 | 21.5 |
| Sep | 21.9 | 19.4 | 23.3 | 20.2 | - | 22.3 | 24.7 | 21.5 |
| Avg^b | 17.7(17.1) | 14.6(15.9) | 17.9(17.2) | 17.0(16.7) | 19.0(17.8) | 18.3(18.5) | 18.9(17.2) | 19.2(18.1) |

a) All values expressed in oC; WY17 values greater than 13-yr norms are shown in red; below in blue.

b) Water year WY17 and 13-yr 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 (WY17 Data)

| Site # | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------------------------|----------------------|------------------|------------------|------------------|----------------------|------------------|------------------|
| Reach | Lower Mission Valley | | | | Upper Mission Valley | | |
| Oct | 10.640 | 3.710 | 3.420 | 2.960 | 4.060 | 4.180 | 3.160 |
| Nov | 12.670 | 3.560 | 3.230 | 3.410 | 4.040 | 4.180 | 3.080 |
| Dec | 16.500 | 1.610 | 1.660 | 1.440 | 1.040 | 0.910 | 0.770 |
| Jan | 1.130 | 1.040 | 1.030 | 1.060 | 1.110 | 1.000 | 1.060 |
| Feb | 2.150 | 1.090 | 0.970 | 0.850 | 0.650 | 0.670 | 0.600 |
| Mar | 1.900 | 1.880 | 1.830 | 1.810 | 1.790 | 1.640 | 1.650 |
| Apr | 2.670 | 2.630 | 2.580 | 2.530 | 2.550 | 2.340 | 2.320 |
| May | 1.690 | 1.630 | 1.590 | 1.660 | 1.750 | 1.480 | 1.810 |
| Jun | 13.910 | 2.614 | 2.604 | 2.210 | 2.828 | 2.349 | 2.661 |
| Jul | 14.831 | 3.326 | 3.244 | 3.261 | 2.915 | 2.965 | 3.273 |
| Aug | 15.400 | 3.538 | 3.485 | 3.336 | 3.255 | 3.363 | 3.148 |
| Sep | 8.960 | 3.640 | 3.550 | 3.030 | 3.410 | 3.710 | 3.130 |
| Avg^b | 8.54/7.86 | 2.52/2.59 | 2.43/2.50 | 2.33/2.49 | 2.45/2.54 | 2.40/2.56 | 2.22/2.46 |

a) All values expressed in milli-Siemens/cm; values >4.0 are in yellow cells, values < 2.0 uS/cm are in blue cells.

b) Water Year 2017 values greater than 13 yr norms are in red; blue values below.

Table G.2(E) Middle and East Section Specific Conductivity (WY17 Data)

| Site | 8 | 9T | 10 | 11 | 12T | 13 | 14 | 15T |
|-------------------------|------------------|------------------|------------------|--------------------|------------------|--------------------|------------------|------------------|
| Reach | Mission Gorge | | | Lower Santee Basin | | Upper Santee Basin | | LSB ^c |
| Oct | 3.160 | 6.200 | 2.270 | 3.030 | 2.070 | 2.620 | — | 2.600 |
| Nov | 2.790 | 5.890 | 2.820 | 2.890 | 2.090 | 2.610 | — | 2.600 |
| Dec | 1.560 | 3.590 | 1580 | 1.730 | 1.910 | 1.550 | 1.270 | 1.800 |
| Jan | 0.870 | 2.130 | 0.910 | 0.950 | 0.458 | 0.680 | 0.610 | 2.500 |
| Feb | 1.580 | 4.110 | 1.610 | 1.690 | 1.020 | 1.170 | 1.000 | 2.500 |
| Mar | 1.440 | 4.190 | 1.440 | 1.530 | 0.880 | 0.960 | 0.990 | 2.000 |
| Apr | 1.960 | 4.970 | 2.000 | 2.060 | 0.560 | 1.560 | 1.320 | 1.900 |
| May | 1.400 | 4.740 | 1.910 | 1.980 | 0.750 | 1.510 | 1.280 | 2.200 |
| Jun | 2.330 | 5.100 | 2.358 | 2.352 | — | 1.866 | — | 2.914 |
| Jul | 2.775 | 4.958 | 2.623 | 2.401 | — | 2.195 | 1.537 | 3.003 |
| Aug | — | 4.800 | — | 2.106 | — | 2.349 | 1.444 | 3.000 |
| Sep | 4.530 | 5.470 | 2.830 | 2.730 | 1.580 | 2.410 | 1.580 | 2.900 |
| Avg ^b | 2.22/2.26 | 4.68/4.95 | 2.03/2.22 | 2.12/2.22 | 1.26/1.68 | 1.79/1.91 | 1.23/1.50 | 2.50/2.72 |

a) All values expressed in milli-Siemens/cm; WY17 values greater than 13-yr norms are in red, below in blue.

b) Water Year 2017 and 13-yr values based on averaging of monthly data (Oct-Sept); cells in blue <2.0, cells in yellow >4 uS/cm

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 (WY17 Data)

| Site # | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|--------|----------------------|------|------|------|----------------------|------|------|
| Reach | Lower Mission Valley | | | | Upper Mission Valley | | |
| Oct | 7.90 | 7.69 | 7.80 | 7.76 | 7.72 | 7.61 | 7.35 |
| Nov | 7.83 | 7.70 | 7.77 | 7.76 | 7.53 | 7.54 | 7.24 |
| Dec | 7.61 | 7.51 | 7.51 | 7.36 | 7.30 | 7.17 | 6.96 |
| Jan | 7.71 | 7.58 | 7.71 | 7.65 | 7.55 | 7.52 | 7.29 |
| Feb | 7.64 | 7.61 | 7.55 | 7.50 | 7.47 | 7.44 | 7.42 |
| Mar | 8.19 | 7.97 | 8.21 | 8.08 | 8.07 | 8.12 | 8.11 |

| Site # | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Apr | 8.02 | 7.97 | 7.98 | 8.04 | 7.90 | 7.76 | 7.85 |
| May | 8.02 | 7.85 | 7.98 | 7.84 | 7.79 | 7.98 | 8.18 |
| Jun | 7.65 | 8.10 | 7.97 | 7.91 | 7.89 | 7.83 | 7.77 |
| Jul | 7.93 | 7.60 | 8.24 | 7.92 | 7.68 | 7.63 | 7.45 |
| Aug | 7.86 | 7.54 | 7.85 | 7.84 | 7.56 | 7.68 | 7.42 |
| Sep | 7.80 | 7.50 | 7.83 | 7.84 | 7.55 | 7.68 | 7.53 |
| Avg^b | 7.85/7.72 | 7.72/7.66 | 7.86/7.73 | 7.79/7.76 | 7.66/7.60 | 7.66/7.60 | 7.55/7.54 |

a) All values are unit-less.

b) WY17 and 13-yr values based on averaging monthly results (Oct-Sept); annual averages less than 13-yr norms listed in red.

Table G.3(E) Middle and East Section pH (WY17 Data)

| Site | 8 | 9T | 10 | 11 | 12T | 13 | 14 | 15T |
|------------------------|------------------|------------------|------------------|--------------------|------------------|--------------------|------------------|------------------|
| Reach | Mission Gorge | | | Lower Santee Basin | | Upper Santee Basin | | LSB ^c |
| Oct | 7.05 | 8.00 | 8.13 | 7.29 | 8.23 | 7.74 | — | 8.21 |
| Nov | 7.45 | 8.00 | 7.90 | 7.29 | 8.14 | 7.51 | — | 7.97 |
| Dec | 7.85 | 8.19 | 7.93 | 7.53 | 7.63 | 7.82 | — | — |
| Jan | 7.65 | 7.91 | 7.74 | 7.24 | 7.89 | 7.38 | 7.38 | 8.00 |
| Feb | 7.88 | 8.07 | 7.92 | 7.15 | 8.26 | 7.80 | 7.90 | 8.30 |
| Mar | 7.82 | 7.96 | 8.09 | 7.22 | 8.08 | 8.16 | 8.33 | 8.30 |
| Apr | 7.95 | 8.02 | 8.32 | 7.26 | 7.88 | 8.02 | 8.17 | 8.20 |
| May | 7.74 | 8.01 | 8.19 | 7.37 | 7.98 | 7.93 | 8.31 | 8.30 |
| Jun | 7.21 | 8.15 | 7.93 | 7.64 | — | 7.81 | 7.90 | 7.41 |
| Jul | 7.21 | 8.15 | 7.93 | 7.64 | — | 7.81 | 7.90 | 7.41 |
| Aug | — | 8.11 | — | 7.59 | — | 7.44 | 8.12 | 7.70 |
| Sep | 7.44 | 8.09 | 8.26 | 7.52 | 7.97 | 7.49 | 7.97 | 7.75 |
| Avg^b | 7.57/7.64 | 8.06/7.76 | 8.03/7.79 | 7.40/7.54 | 8.01/7.89 | 7.74/7.65 | 8.00/7.80 | 7.96/8.05 |

a) All values are unit-less.

b) WY17 and 13-yr values are based on averaging of monthly data (Oct-Sept); averages less than 13yr norms shown in red.

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 (WY17 Data)

| Site # | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------------------------|----------------------|------------------|------------------|------------------|----------------------|------------------|------------------|
| Reach | Lower Mission Valley | | | | Upper Mission Valley | | |
| Oct | 5.89 | 2.31 | 0.91 | 3.56 | 1.25 | 0.28 | 2.04 |
| Nov | 5.76 | 3.59 | 2.90 | 3.68 | 1.86 | 0.40 | 3.27 |
| Dec | 4.25 | 3.49 | 4.61 | 3.99 | 4.23 | 4.27 | 5.69 |
| Jan | 9.13 | 8.96 | 8.98 | 8.89 | 9.38 | 9.18 | 10.75 |
| Feb | 7.16 | 7.24 | 7.96 | 7.52 | 7.70 | 6.29 | 8.50 |
| Mar | 10.24 | 9.21 | 9.70 | 10.61 | 9.37 | 10.06 | 11.19 |
| Apr | 3.80 | 3.85 | 3.89 | 5.81 | 3.84 | 2.51 | 5.38 |
| May | 4.78 | 4.99 | 5.22 | 6.92 | 4.85 | 5.53 | 5.56 |
| Jun | 5.42 | 1.51 | 2.94 | 4.77 | 3.32 | 2.45 | 4.23 |
| Jul | 7.35 | 1.25 | 2.63 | 3.57 | 2.81 | 0.31 | 4.90 |
| Aug | 7.62 | 1.29 | 3.14 | 4.07 | 2.52 | 1.14 | 4.03 |
| Sep | 5.84 | 0.80 | 2.38 | 3.67 | 2.11 | 0.64 | 3.27 |
| Avg^b | 6.44/6.10 | 4.04/4.49 | 4.60/4.64 | 5.59/6.16 | 4.44/4.80 | 3.59/3.68 | 5.73/4.99 |

a) All values expressed in milligrams/liter; WY17 and 13-yr averages less than 4 mg/L shown in red and cells highlighted in yellow.

Table G.4(E) Middle and East Section Dissolved Oxygen (WY17 Data)

| Site | 8 | 9T | 10 | 11 | 12T | 13 | 14 | 15T |
|-------|---------------|-------|-------|--------------------|-------|--------------------|------|------------------|
| Reach | Mission Gorge | | | Lower Santee Basin | | Upper Santee Basin | | LSB ^c |
| Oct | 0.92 | 9.69 | 4.68 | 3.81 | 5.17 | 0.14 | — | 11.17 |
| Nov | 2.55 | 11.16 | 6.76 | 4.57 | 5.16 | 0.75 | — | 10.36 |
| Dec | 6.96 | 7.05 | 4.44 | 5.09 | 6.32 | 4.07 | 4.02 | 9.18 |
| Jan | 11.62 | 11.41 | 9.16 | 8.31 | 11.00 | 4.24 | 4.09 | 10.24 |
| Feb | 9.76 | 10.96 | 8.35 | 6.82 | 9.02 | 2.19 | 2.44 | 10.11 |
| Mar | 11.01 | 13.66 | 11.90 | 8.27 | 11.10 | 6.44 | 6.46 | 9.51 |

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| Site | 8 | 9T | 10 | 11 | 12T | 13 | 14 | 15T |
|------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Apr | 6.71 | 8.09 | 5.60 | 3.87 | 5.99 | 2.92 | 2.56 | 8.71 |
| May | 9.14 | 10.70 | 8.14 | 6.30 | 7.38 | 2.65 | 1.65 | 9.05 |
| Jun | 6.02 | 9.74 | 7.57 | 5.47 | — | 2.98 | — | 5.01 |
| Jul | 1.31 | 8.46 | 3.14 | 4.34 | — | 4.14 | 1.49 | 3.98 |
| Aug | — | 9.30 | — | 4.31 | — | 0.48 | 2.90 | 4.33 |
| Sep | 1.58 | 9.07 | 6.17 | 3.07 | 2.49 | 1.73 | 2.49 | 2.17 |
| Avg^b | 6.14/7.51 | 9.94/9.09 | 6.90/7.17 | 5.35/6.13 | 7.07/7.10 | 2.73/3.20 | 3.12/3.25 | 7.63/7.30 |

a) All values expressed in milligrams/liter; WY17 values less than 4 mg/L are expressed in red and cells highlighted in yellow.

b) WY17 and 13-yr 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 (WY17 Data)

| Site # | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------------|----------------------|----------------|----------------|----------------|----------------------|----------------|----------------|
| Reach | Lower Mission Valley | | | | Upper Mission Valley | | |
| Oct | 62 | 25 | 10 | 40 | 13 | 3 | 21 |
| Nov | 59 | 37 | 30 | 39 | 18 | 4 | 32 |
| Dec | 42 | 34 | 45 | 39 | 41 | 41 | 55 |
| Jan | 85 | 83 | 83 | 82 | 86 | 84 | 98 |
| Feb | 73 | 73 | 80 | 75 | 76 | 62 | 84 |
| Mar | 115 | 103 | 108 | 118 | 102 | 111 | 123 |
| Apr | 45 | 45 | 46 | 68 | 44 | 29 | 62 |
| May | 56 | 58 | 61 | 81 | 55 | 64 | 64 |
| Jun | 66 | 18 | 36 | 59 | 38 | 29 | 50 |
| Jul | 93 | 15 | 33 | 45 | 33 | 4 | 60 |
| Aug | 95 | 15 | 38 | 50 | 29 | 13 | 48 |
| Sep | 70 | 9 | 28 | 44 | 24 | 7 | 38 |
| Avg | 72 (67) | 43 (47) | 50 (49) | 62 (67) | 47 (49) | 38 (38) | 61 (52) |

a) All values expressed in percent; WY17 and 13-yr values (in parentheses) less than 45% are expressed in red highlighted in yellow

Table G.5(E) Middle and East Section DO Percent Saturation (WY17 Data)

| Site | 8 | 9T | 10 | 11 | 12T | 13 | 14 | 15T |
|-------------------------|----------------|----------------|----------------|--------------------|----------------|--------------------|----------------|------------------|
| Reach | Mission Gorge | | | Lower Santee Basin | | Upper Santee Basin | | LSB ^c |
| Oct | 10 | 94 | 49 | 39 | 61 | 1 | — | 115 |
| Nov | 26 | 100 | 65 | 45 | 54 | 7 | — | 106 |
| Dec | 64 | 63 | 40 | 48 | 62 | 38 | 38 | 88 |
| Jan | 106 | 102 | 84 | 76 | 103 | 39 | 38 | 96 |
| Feb | 98 | 107 | 84 | 69 | 93 | 22 | 25 | 104 |
| Mar | 116 | 132 | 127 | 87 | 126 | 70 | 68 | 108 |
| Apr | 73 | 79 | 62 | 41 | 69 | 32 | 27 | 101 |
| May | 100 | 106 | 89 | 67 | 86 | 29 | 18 | 105 |
| Jun | 71 | 103 | 90 | 64 | — | 36 | — | 60 |
| Jul | 16 | 96 | 39 | 50 | — | 50 | 19 | 48 |
| Aug | — | 101 | — | 48 | — | 6 | 36 | 50 |
| Sep | 18 | 100 | 73 | 34 | 30 | 20 | 30 | 25 |
| Avg ^b | 63 (77) | 99 (93) | 73 (75) | 56 (61) | 76 (73) | 29 (33) | 33 (33) | 84 (75) |

a) All values expressed as percent; WY17 and 13-yr values (in parentheses) less than 45% Sat are shown in red and cells highlighted in yellow.

b) Water Year 2017 and 13-yr 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 - WY17 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 future revision. Processing and review of 2017 data is typically completed by January of the next year 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 (WY17/WY16 Values)

| Month | Fashion Valley (Sta. 11023000) | | | | Santee Basin (Sta. 11022480) | | | |
|---------------|--------------------------------|---------------|-------------------------------|-------------------------------|------------------------------|-------------|-------------------------------|-------------------------------|
| | Min. | Max. | ADF ₃ ^a | ADF _m ^b | Min. | Max. | ADF ₃ ^a | ADF _m ^b |
| Oct | 1.0/2.4 | 6.5/49 | 1.3/4.7 | 1.8/7.5 | 0.1/0.4 | 9.1/36 | 0.9/1.2 | 1.0/2.9 |
| Nov | 1.3/2.4 | 69/170 | 1.5/3.6 | 7.9/16 | 0.8/0.4 | 51/77 | 0.9/1.5 | 5.9/6.5 |
| Dec | 2.4/5.0 | 353/81 | 87/13.8 | 65/20 | 2.9/1.3 | 228/64 | 87/3.3 | 36/11.9 |
| Jan | 27/10.0 | 1630/ 1350 | 90/30.3 | 230/140 | 12.6/ 5.3 | 848/ 780 | 113/23.0 | 126/80 |
| Feb | 21/7.0 | 4000/ 71 | 197/11.0 | 284/16 | 14.6/ 1.1 | 1210/ 36 | 15/5.2 | 109/6.4 |
| Mar | 16.8/5.1 | 363/90 | 27.4/11.0 | 56/19 | 8.5/0.9 | 178/94 | 21/5.4 | 32/14.2 |
| Apr | 5.8/3.0 | 16/86 | 7.5/9.4 | 10/14 | 4.7/2.9 | 8/91 | 5.6/21.0 | 5.9/14.7 |
| May | 5.1/2.0 | 216/48 | 8.9/3.3 | 22/7.9 | 3.4/1.0 | 184/77 | 5.7/1.4 | 13.2/5.8 |
| Jun | 2.5/1.0 | 6.4/2.2 | 3.2/1.4 | 4.1/1.4 | 0.9/ 0.4 | 3.4/1.5 | 1.3/0.5 | 2.0/0.8 |
| Jul | 1.8/0.6 | 2.6/1.2 | 2.0/0.8 | 2.2/0.8 | 0.3/ 0.2 | 0.8/0.7 | 0.5/0.3 | 0.6/0.3 |
| Aug | 1.7/0.4 | 2.1/1.0 | 1.8/0.6 | 1.9/0.6 | 0.4/0.1 | 0.7/0.4 | 0.5/0.1 | 0.5/0.2 |
| Sept | 1.8/0.4 | 2.5/17 | 2.0/1.5 | 2.0/2.2 | 0.3/0.2 | 2.3/33 | 0.4/0.3 | 0.6/2.3 |
| WY Avg | | | 35.8/7.6 | 57.3/20.4 | | | 21.0/5.3 | 27.7/12.2 |

a) Average daily flow over the antecedent 3-day period of water quality monitoring.

b) Average daily flow for entire month (30 days).

c) WY17 streamflow values lower (less) than WY16 results are shown in red.

Average daily flows in WY17 were up 53% (9.6 cfs) in the eastern portion of the lower watershed and 80% (25 cfs) in the western portion from 13-yr norms. LSDR discharge in WY17 amounted to 41,420 AF compared to 4,415 AF in WY14 (recent year of lowest flow) and 14,750 AFY last year. Annual average discharge over the past 13 years of record is 23,150 AF. Average annual streamflow for WY17 amounted to 142% of the 53-year norm for LSDR. The summer season (June-Sept) of last year (WY16) presented one of the lowest periods of continuous dry weather flow recorded at Fashion Valley in the past several decades. This year (WY17) summer flows were considerably above seasonal norms due to late rain fall (May) and replenishment of local area shallow aquifers.

San Diego CoastKeeper (SDCK) coliform count values (in MPN/100mL) from the organization’s San Diego River monitoring stations for WY17, WY16 and WY15 are presented in **Table H.2**. Sampling results from 2009 through Sept 2017 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 (WY17/16/15 Values)

| Month | Fashion Valley Road (SDG-010) | | | Old Mission Historical Dam (SDG-020) | | |
|-------|-------------------------------|-------------------|------------------------|--------------------------------------|-------------------|---------------------|
| | EColi (a) | Enterocci(b) | TCB (c) | EColi (a) | Enterococ (b) | TCB (c) |
| Oct | 74/109/ 213 | 63/95/108 | 1198/1565/ 1423 | -/30/10 | -/305/132 | -/708/301 |
| Nov | 528/41/ 1236 | 10/146/ 345 | 2723/496/ 19,863 | -/31/98 | -/31/52 | -/288/ 3076 |
| Dec | 185/1017/ 4352 | 158/3555/ 6488 | 2809/24,192 /24,192 | -/12,033/ 4352 | -/14,136/ 6488 | -/24,192/ 24,192 |
| Jan | 1119/134/ 4350 | 1726/52/ 2750 | 24,192/1850 /12,033 | -/86/10 | -/109/52 | -/2035/2310 |
| Feb | 171/20/20 | 52/20/63 | 2987/2489/ 3130 | -/20/31 | -/30/63 | -/3255/836 |
| Mar | 369/10/41 | 218/10/41 | 12,033/1137 /867 | -/31/41 | /20/63 | -/504/980 |
| Apr | 20/85/253 | 51/386/52 | 512/7215/ 1515 | -/41/52 | -/20/30 | -/2310/784 |

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| | Fashion Valley Road (SDG-010) | | | Old Mission Historical Dam (SDG-020) | | |
|-------------------------------|-------------------------------|------------------|----------------------|--------------------------------------|-------------|-------------------|
| May | 75/84/ 1850 | 109/588/ 2909 | 425/5475/ 3448 | -/20/20 | -/52/74 | -/1145/657 |
| June | -/109/134 | -/63/160 | -/ 2613/3654 | -/86/1130 | -/10/3076 | -/529/24192 |
| July | 295/31/- | 134/31/- | 5794/3076/ - | -/10/20 | -/52/31 | -/1296/2142 |
| Aug | 185/20/63 | 52/10/20 | 1467/3968/ 2014 | -/20/20 | -/269/10 | -/960/1067 |
| Sept | 181/6028/ 318 | 31/436/ 805 | 1198/24,192 /9804 | -/496/134 | -/97/51 | -/ 24,192/2310 |
| WY Avg. | 291/640/ 1361 | 237/449/ 1496 | 5031/6522/ 7295 | -/ 10,075/537 | -/1261/915 | -/5118/5503 |
| Summer | 78/3094/ 172 | 162/135/ 328 | 2016/8462/ 5157 | -/153/326 | -/107/792 | -/6744/7428 |
| Winter | 369/295/ 2191 | 399/409/ 2336 | 7543/7417/ 37,130 | -/ 3574/1109 | -/3574/1667 | -/7497/7080 |
| Values Exceeding Threshold, % | 18/18/27 | 36/45/64 | 18/27/18 | -/18/18 | -/27/27 | -/9/18 |

- a) *Escherichia-coli* (*E.coli*) bacteria expressed in MPN/100m; counts exceeding 406 MPN/100ml threshold shown in red text.
 b) *Enterococcus (faecalis)* bacteria expressed in MPN/100mL; counts exceeding 100 MPN/100ml threshold shown in red text.
 c) Total Coliform bacteria (common) expressed in MPN/100mL; counts above 10,000 MPN/100ml level are shown in red text.
 d) Percent of total annual samples with values above threshold limits.

Appendix I - Water Quality Indexing

The LSDR WQM 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 others listed in Appendix H. The index is intended to aid in assessment of the Lower San Diego River watershed primarily for non-body contact recreational uses and environmental enhancement. As designed, the parameter 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 one to interpret large amounts of aggregated data and relate overall water quality variations to changes, be they from natural causes or man-made impairments. The WQI has been used to identify general water quality trends over the past 13 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 many San Diego River water quality improvement programs and also assist responsible agencies and organizations in establishing priorities and updating policies for watershed management.

Running average LSDR WQI values from WY05 through WY17 are expressed by river reach and river section on **Charts I.1 and I.2**, respectively. **Chart I.1** presents overall LSDR monthly WQI values over the 13-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 13 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, 2017) running average WQI of 31, up two points from the end of the last water year, is 5% below the 13-yr norm of 33 and trending upward.

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 small improvement in overall water quality from WY16.

Chart I.4 provides a spatial profile of average annual WQI by river monitoring site, reach and section for this year (WY17), compared to the best year (WY05), the worst (WY14) and the 13-yr

winter, summer and annual norms. The sites are in chronological order ascending upstream. The current (WY17) 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 WY17 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.

