**SUBJECT: Response to RWQCB FY2022 Carlsbad Watershed Management Area Water Quality Improvement Plan Annual Report Comment Letter (CW-794838)**

The Cities of Carlsbad, Encinitas, Escondido, Oceanside, San Marcos, Solana Beach, Vista, and the County of San Diego (Copermittees) are in receipt of the San Diego Regional Water Quality Control Board (RWQCB) "2021-2022 Water Quality Improvement Plan (WQIP) Annual Report Review: Carlsbad Watershed Management Area (WMA)" letter dated June 19, 2023 (FY2022 Letter).

Provided below are the City of Oceanside's responses to the requests for additional analysis made by the RWQCB in the Comment Letter regarding the Loma Alta Slough Alternative TMDL (Resolution R9-2014-0020). Beneath each comment provided by the RWQCB (**in bold** below) is either a reference to an attachment to this memo or the analysis requested by the RWQCB. Monitoring data and analyses provided in this memo utilized data collected from the 2016-2022 monitoring period established in the Resolution, the project's Final Monitoring Plan, and the Quality Assurance Project Plan (QAPP). As noted in the Carlsbad WMA's September 6, 2023 written response to the RWQCB Comment Letter, no new data from outside the monitoring period were used in the following responses.

***1. Tabulate all collected monitoring data (2016-2022) into a single Excel spreadsheet format.***

Loma Alta Slough monitoring data from 2016-2022 is provided in Attachment 1 (chemistry data) and Attachment 2 (field data).

***2. Submit supporting documentation that shows all data collected was uploaded into the California Environmental Data Exchange Network (CEDEN) website.***

CEDEN submittal receipts for monitoring data from 2016-2022 are provided in a zipped file as Attachment 3 to this memo. Submittal receipts are provided for field data for all seven years of monitoring (2016-2022). Submittal receipts for chemistry data are only provided for five years of monitoring (2018-2022). Receipts for the chemistry data for monitoring years 2016 and 2017 were misplaced; however, if a search of CEDEN is conducted, you will find that the data was submitted by the City of Oceanside to CEDEN.

***3. Present data trends from 2016-2022 for nitrogen, phosphorus, dissolved oxygen, macro algae biomass and cover.***

Data trends from 2016-2022 for the Long-Term Water Quality Monitoring in Loma Alta Slough are presented in Table 1. Trends for total and dissolved nitrogen and phosphorus, and dissolved oxygen are for data collected at stations in the Slough (Stations LA-SD and LA-SU), for samples collected at two receiving water stations upstream of the Slough (LA-Tributary, and LA-Creek), and composite samples collected upstream of the Slough (LA-COMP). Dissolved oxygen was continuously collected in the Slough each monitoring year over the two-month monitoring period at three water depths (surface, mid, and bottom). Trends for dissolved oxygen in the Slough were calculated based on the average concentration for the two-month period for each of the three water depths (bottom, mid-column and surface). Trends for macroalgal biomass and percent cover are for macroalgal surveys conducted within the Slough.

**Table 1. Data Trends from 2016-2022 in Loma Alta Slough and Upstream Watershed.**

| Station | Analyte | Sample Count | Statistical Test | Trend | p-value | Percent ND | Regression or Thiel-Sen Slope | R-Square |
|---|---|---|---|---|---|---|---|---|
| LA Slough | Average Biomass | 7 | Mann-Kendall | Decreasing | 0.001 | 0% | -0.0535 | NA |
| LA Slough | Average Percent Cover | 7 | Mann-Kendall | No Trend | 0.068 | 0% | NA | NA |
| LA-COMP | Dissolved Nitrogen | 42 | Lognormal Regression | Decreasing | 0.037 | 0% | -0.0001 | 0.11 |
| LA-Creek | Dissolved Nitrogen | 14 | Lognormal Regression | No Trend | 0.348 | 0% | NA | NA |
| LA-SD | Dissolved Nitrogen | 14 | Lognormal Regression | No Trend | 0.113 | 0% | NA | NA |
| LA-SU | Dissolved Nitrogen | 14 | Lognormal Regression | No Trend | 0.439 | 0% | NA | NA |
| LA-Tributary | Dissolved Nitrogen | 14 | Normal Regression | No Trend | 0.892 | 0% | NA | NA |
| LA-Creek | Dissolved Oxygen | 104 | Mann-Kendall | Increasing | <0.001 | 0% | 0.0017 | NA |
| LA-Tributary | Dissolved Oxygen | 104 | Lognormal Regression | Decreasing | 0.009 | 0% | -0.0001 | 0.07 |
| LA-SD | Dissolved Oxygen - Bottom | 7 | Mann-Kendall | No Trend | 0.281 | 0% | NA | NA |
| LA-SU | Dissolved Oxygen - Bottom | 7 | Mann-Kendall | No Trend | 0.500 | 0% | NA | NA |
| LA-SD | Dissolved Oxygen - Mid | 7 | Mann-Kendall | No Trend | 0.119 | 0% | NA | NA |
| LA-SU | Dissolved Oxygen - Mid | 7 | Mann-Kendall | No Trend | 0.386 | 0% | NA | NA |

**Table 1. Data Trends from 2016-2022 in Loma Alta Slough and Upstream Watershed.**

| Station | Analyte | Sample Count | Statistical Test | Trend | p-value | Percent ND | Regression or Thiel-Sen Slope | R-Square |
|---|---|---|---|---|---|---|---|---|
| LA-SD | Dissolved Oxygen - Surface | 7 | Mann-Kendall | No Trend | 0.119 | 0% | NA | NA |
| LA-SU | Dissolved Oxygen - Surface | 7 | Mann-Kendall | No Trend | 0.386 | 0% | NA | NA |
| LA-COMP | Dissolved Phosphorus | 42 | Lognormal Regression | No Trend | 0.958 | 21% | NA | NA |
| LA-Creek | Dissolved Phosphorus | 14 | Lognormal Regression | No Trend | 0.842 | 14% | NA | NA |
| LA-SD | Dissolved Phosphorus | 14 | Lognormal Regression | No Trend | 0.081 | 14% | NA | NA |
| LA-SU | Dissolved Phosphorus | 14 | Normal Regression | No Trend | 0.306 | 7% | NA | NA |
| LA-Tributary | Dissolved Phosphorus | 14 | Mann-Kendall | No Trend | 0.225 | 50% | NA | NA |
| LA-COMP | Total Nitrogen | 42 | Lognormal Regression | Decreasing | 0.005 | 0% | -0.0001 | 0.18 |
| LA-Creek | Total Nitrogen | 14 | Lognormal Regression | No Trend | 0.197 | 0% | NA | NA |
| LA-SD | Total Nitrogen | 14 | Lognormal Regression | No Trend | 0.182 | 0% | NA | NA |
| LA-SU | Total Nitrogen | 14 | Lognormal Regression | No Trend | 0.606 | 0% | NA | NA |
| LA-Tributary | Total Nitrogen | 14 | Normal Regression | No Trend | 0.300 | 0% | NA | NA |
| LA-COMP | Total Phosphorus | 42 | Lognormal Regression | No Trend | 0.175 | 2% | NA | NA |

**Table 1. Data Trends from 2016-2022 in Loma Alta Slough and Upstream Watershed.**

| Station | Analyte | Sample Count | Statistical Test | Trend | p-value | Percent ND | Regression or Thiel-Sen Slope | R-Square |
|---|---|---|---|---|---|---|---|---|
| LA-Creek | Total Phosphorus | 14 | Mann-Kendall | No Trend | 0.415 | 14% | NA | NA |
| LA-SD | Total Phosphorus | 14 | Mann-Kendall | No Trend | 0.117 | 0% | NA | NA |
| LA-SU | Total Phosphorus | 14 | Normal Regression | No Trend | 0.328 | 0% | NA | NA |
| LA-Tributary | Total Phosphorus | 14 | Lognormal Regression | No Trend | 0.481 | 7% | NA | NA |

NA - Not applicable for analytes that have no trend.

ND - Non-detect

***4. Show nitrogen and phosphorus ratios for each month where data was collected between 2016-2022.***

Total and dissolved nitrogen and phosphorus ratios are provided in Attachment 4 for all samples collected from 2016-2022 in the upstream watershed (LA-COMP, LA-Tributary, and LA-Creek) and in the Slough (LA-SD and LA-SU).

***5. Analyze/discuss relationships with phosphorus and algae, and nitrogen and algae.***

To evaluate the relationship between observed algal growth with nutrient concentrations, a correlation analysis was performed using data collected in Loma Alta Slough from 2016 through 2022. Data used for the analysis included nitrogen and phosphorus concentrations from samples collected at two locations in the Slough (Stations LA-SD and LA-SU), and average algal biomass and percent algal cover data from macroalgae surveys conducted in the Slough. The data for the analysis were collected twice a monitoring year (once in July and once in August) during the summer dry-season per the requirements of the Resolution (R9-2014-0020).

Because not all parameters exhibited normal distribution based on the Shapiro Wilk normality test, the correlation analysis was performed using the Spearman rank order correlation. Nitrogen and phosphorous concentrations were available as dissolved and as total fractions for both LA-SD and LA-SU stations. Correlations were performed using nutrient concentrations from each site and the average of the values from both sites, as well as the sum of nitrogen and phosphorous concentrations for each combination. Results of the correlation analysis are provided in Table 2. Neither the average biomass nor the average algal cover showed significant correlations with any of the tested combinations. The strongest correlation observed is a negative correlation between the mean total nitrogen and both the algal biomass and the algal cover.

This initially counter-intuitive result is not entirely surprising considering several factors. Due to the small overall data set (only 14 datapoints per parameter), observing a non-random correlation with high confidence is relatively unlikely, supported by the fact that none of the correlations were significant. Another confounding factor is the non-linear relationship between algal biomass and algal cover, which indicates differences in growth patterns between the years. Several other factors besides nutrient loading influence algal growth (Evans-White et al., 2013; Fan et al., 1993; Fiedler et al., 2015; Stevenson et al., 2006) such as:

- Nutrient speciation
- Temperature
- Flow velocity
- Flow patterns
- Salinity
- Algal species
- Predation
- Competition between algal species
- UV intensity and duration

In summary, based on the available data and considering the complex processes influencing algal growth a direct relationship between nutrient concentrations and algal growth in Loma Alta Slough was not observed.

**Table 2. Spearman Correlation Coefficients for Macroalgae vs Nutrient Values**

| Sites | Parameter | Average Biomass | Average Percent Algal Cover |
|---|---|---|---|
| LA-Slough | Average Biomass | 1.00 | 0.49 |
| | Average Percent Algal Cover | 0.49 | 1.00 |
| LA-SD | Total Dissolved Nitrogen | -0.48 | -0.37 |
| | Total Nitrogen | -0.44 | -0.57 |
| | Total Dissolved Phosphorous | -0.14 | -0.41 |
| | Total Phosphorus | -0.06 | -0.39 |
| LA-SU | Total Dissolved Nitrogen | -0.23 | 0.10 |
| | Total Nitrogen | -0.23 | -0.22 |
| | Total Dissolved Phosphorous | 0.35 | 0.51 |
| | Total Phosphorus | 0.31 | 0.19 |
| LA-SD | Sum of Total Dissolved Nitrogen and Phosphorous | -0.41 | -0.10 |
| | Sum of Total Nitrogen and Phosphorous | -0.44 | -0.39 |
| LA-SU | Sum of Total Dissolved Nitrogen and Phosphorous | -0.18 | 0.14 |
| | Sum of Total Nitrogen and Phosphorous | -0.25 | -0.24 |
| LA-SD & LA-SU combined | Mean Total Dissolved Nitrogen | -0.44 | -0.35 |
| | Mean Total Nitrogen | -0.57 | -0.60 |
| | Mean Total Dissolved Phosphorous | 0.12 | -0.16 |
| | Mean Total Phosphorus | -0.02 | -0.17 |
| | Mean Sum of Total Dissolved Nitrogen and Phosphorous | -0.38 | -0.05 |
| | Mean Sum of Total Nitrogen and Phosphorous | -0.42 | -0.37 |

**References:**


Evans-White, M.A., Haggard, B.E. and Scott, J.T., 2013. A review of stream nutrient criteria development in the United States. *Journal of environmental quality*, *42*(4), pp.1002-1014.

Fang, P., Zedler, J.B. and Donohoe, R.M., 1993. Nitrogen vs. phosphorus limitation of algal biomass in shallow coastal lagoons. *Limnology and Oceanography*, *38*(5), pp.906-923.

Fiedler, D., Graeber, D., Badrian, M. and Köhler, J., 2015. Growth response of four freshwater algal species to dissolved organic nitrogen of different concentration and complexity. *Freshwater Biology*, *60*(8), pp.1613-1621.

Stevenson, R.J., Rier, S.T., Riseng, C.M., Schultz, R.E. and Wiley, M.J., 2006. Comparing effects of nutrients on algal biomass in streams in two regions with different disturbance regimes and with applications for developing nutrient criteria. *Advances in algal biology: A commemoration of the work of Rex Lowe*, pp.149-165.

# ATTACHMENTS

**Attachment 1: LAS_ 2016-2022_Chem.xlsx**

**Attachment 2: LAS_2016-2022_Field.xlsx**

**Attachment 3: LAS_CEDEN_Receipts.zip**

**Attachment 4: LAS_2016-2022-TN_TP_Ratio.xlsx**