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070102-00001

February 18, 2021

VIA ELECTRONIC MAIL (daniel.e.orodenker@hawaii.gov) and (riley.k.hakoda@hawaii.gov)

Daniel Orodenker, Executive Officer
Land Use Commission
State of Hawaii
State Office Tower
Leiopapa A Kamehameha Building
235 South Beretania Street, Suite 406
Honolulu, HI 96813

Re: Annual Report: Docket No. A97-721 (Makena Resort)

Dear Executive Officer Orodenker:

On behalf of the ATC Makena Entities (defined below), we hereby submit this Annual Report for Docket No. A97-721.

I. BACKGROUND

On February 19, 1998, the Land Use Commission of the State of Hawaii (the "**Commission**") filed its *Findings of Fact, Conclusions of Law, and Decision and Order* (the "**1998 D&O**"), which reclassified 145.943 acres of land in Makena, island of Maui, state of Hawaii from the State Land Use Agricultural District into the State Land Use Urban District (hereinafter, the "**LUC Reclassified Property**"). The LUC Reclassified Property consists of six non-contiguous areas of various sizes, adjacent to, and largely surrounded by, pre-existing Urban District land. At the time of the reclassification, the LUC Reclassified Property was owned by Makena Resort Corp., the original Petitioner in this Docket.

The ATC Entities, consisting of ATC Makena N Golf LLC, ATC Makena S Golf LLC, ATC Makena Land SF1 LLC, ATC Makena Land MF1 LLC, ATC Makena Land MF2 LLC, ATC Makena Land MF3 LLC, ATC Makena Land C1 LLC, ATC Makena Land U1 LLC, ATC Makena Land B1 LLC, ATC Makena Land MF4 LLC, ATC Makena Land SF2 LLC and ATC Makena Land AH1 LLC (collectively, the "**ATC Entities,**" together with ATC Makena Hotel LLC, the "**ATC Makena Entities**"), acquired portions of the LUC Reclassified Property, and other properties, by three Commissioner's Deeds dated August 27, 2010.

One deed was recorded in the Bureau of Conveyances of the State of Hawaii as Document No. 2010-125618 and applies to TMK No. (2) 2-1-005: 108. Another deed was recorded in the Bureau as Document No. 2010-125620 and applies to TMK No. (2) 2-1-008: 090. The third deed was recorded in the Bureau as Document No. 2010-125626 and applies to TMK Nos. (2) 2-1-005: 086 (a portion of which is within the LUC Reclassified Property), and 125 (which is not within the LUC Reclassified Property).

The remaining portion of the LUC Reclassified Property (approximately 27.83 acres) is owned by H2R, LLC. Our understanding, based on public records, is that an entity called Hawaii Development LLC conveyed that property to H2R, LLC by deed recorded October 1, 2018. H2R, LLC is not affiliated with the ATC Makena Entities. The ATC Makena Entities never held title to that portion of the LUC Reclassified Property that is currently owned by H2R, LLC.

This Annual Report covers only those portions of the LUC Reclassified Property that are owned by the ATC Makena Entities, identified by the following TMK Nos.: (2) 2-1-005: 108 (por.), 2-1-008: 090 (por.), and 2-1-005: 086 (por.) (formerly TMK 2-1-007:004), referred to in the responses herein as the "**Petition Area**." This Annual Report does not address any properties owned by others, such as the property owned by H2R, LLC.

On August 27, 2012, the Commission filed an Order Granting With Modification Movant's Motion for Sixth Amendment to the Findings of Fact, Conclusions of Law, and Decision and Order, Filed on February 19, 1998, and for Release of Certain Conditions (the "**2012 Amendment**"). Pursuant to the 2012 Amendment, the Commission released the ATC Makena Entities from Conditions 4, 15 and 21, and amended Conditions 12 and 22 (thereafter renumbered to 11 and 19). An Amended and Restated Declaration of Conditions was recorded on September 7, 2012, in the Bureau as Doc. No. A-46330782.

II. STATUS OF COMPLIANCE WITH LUC CONDITIONS

The following 19 conditions (in italics) are the conditions set forth in the 1998 D&O, as amended by the 2012 Amendment. ATC Makena Entities' description of efforts made and underway to comply with each stated condition follows as a response after each condition.

1. *Petitioner shall provide affordable housing opportunities for low, low-moderate, and gap group income residents of the State of Hawai'i in accordance with applicable laws, rules, and regulations of the County of Maui. The location and distribution of the affordable housing or other provisions for affordable housing shall be under such terms as may be mutually agreeable between Petitioner and the County of Maui.*

Response: The ATC Makena Entities acknowledge that the Petitioner is subject to the provisions of said condition and will comply.

2. *Petitioner shall coordinate with the County of Maui Board of Water Supply to incorporate the proposed project into the County Water Use and Development Plan for the area. Prior to the granting of the first discretionary permit for the single-family and multi-family residential development described in paragraph 20 of the Decision and Order or the hotel described in paragraph 21 of the Decision and Order and by or before one year from the issuance date of this Decision and Order, Petitioner shall furnish the Commission with a letter from the County of Maui Board of Water Supply confirming that (a) the potable water allocation that will be credited to Petitioner will be available to and sufficient for the proposed project as it is described in the Petition, (b) the availability of potable water will not be an obstacle or impediment to the development of the proposed project as described in the Petition and (c) the proposed project as it is described in the Petition has been incorporated into the County Water Use and Development Plan for the area and that this plan will prevent the continued overpumping of the sustainable yield of the Iao aquifer.*

Response: As provided in prior Annual Reports, this condition was complied with as set forth in a letter from David Craddick, Director of the Department of Water Supply, County of Maui, dated February 18, 1999.

Additional letters regarding compliance with this condition, dated October 1, 2003, from Petitioner to the Department of Water Supply, and the response from George Tengan, Director of Water Supply, dated October 7, 2003, were attached to a prior Annual Report submitted in this Docket.

The ATC Makena Entities understand that this condition has been satisfied.

3. *Petitioner shall participate in the funding and construction of adequate water source, storage, and transmission facilities and improvements to accommodate the proposed project in accordance with the applicable laws, rules and regulations of the County of Maui, and consistent with the County of Maui water use and development plan.*

Response: The ATC Makena Entities acknowledge this condition. Furthermore, the ATC Makena Entities understand that in 1976 the Petitioner participated in the Central Maui Source Development Joint Venture and also the Central Maui Transmission Joint Venture, which developed water sources in Waiehu, Maui and a transmission line from the newly developed water sources down to the Wailea and Makena regions. Further, in 1985, Makena Resort Corp. constructed a 1.5-million-gallon water storage tank at the Makena Resort.

4. *Petitioner shall contribute to the development, funding, and/or construction of school facilities, on a pro rata basis for the residential developments in the proposed project, as determined by and to the satisfaction of the State Department of Education ("DOE"). Terms of the contribution shall be agreed upon by Petitioner and DOE prior to Petitioner acquiring county rezoning or prior to Petitioner applying for building permits if county zoning is not required.*

Response: ATC Makena Entities understand that this condition has been satisfied. Pursuant to an Educational Contribution Agreement for Makena Resort between the original Petitioner and the Department of Education dated August 17, 2000, the parties have agreed upon a cash contribution by Petitioner which shall represent a fair share payment for the development, funding and/or construction of school facilities by Petitioner.

5. *Petitioner shall participate in the pro rata funding and construction of adequate civil defense measures as determined by the State of Hawai'i and County of Maui civil defense agencies.*

Response: This condition has been satisfied. Initially, at the request of the State Department of Defense ("**DOD**"), the ATC Makena Entities agreed to allow two (2) emergency siren sites to be developed on land owned by the ATC Makena Entities. One at the Makena Wastewater Treatment Plant, and one near Makena Big Beach (Oneloa) (sirens 157 and 158, respectively). As reported in the 15th Annual Report, the ATC Makena Entities executed Rights of Entry/License Agreements with the DOD in 2012. However, in December 2016, DOD informed the ATC Makena Entities that it had decided to forgo the location near Makena Big Beach (Oneloa), and instead would be installing the second siren at Makena State Park. However, DOD still intended to use the site near the Makena Wastewater Treatment Plant. In 2017, DOD completed installation of the siren at the Makena Wastewater Treatment Plant.

6. *Should any human burials or any historic sites such as artifacts, charcoal deposits, stone platforms, pavings, or walls be found, Petitioner shall stop work in the immediate vicinity and contact SHPD. The significance of these finds shall then be determined and approved by SHPD, and an acceptable mitigation plan shall be approved by SHPD. SHPD must verify that the fieldwork portion of the mitigation plan has been successfully executed prior to work proceeding in the immediate vicinity of the find. Burials must be treated under specific provisions of Chapter 6E, Hawai`i Revised Statutes.*

Response: The ATC Makena Entities acknowledge that the Petition Area is subject to the provisions of said condition and will comply.

7. *Petitioner shall follow the State DLNR recommendations for Petition Areas 1, 2 and 3, for archaeological data recovery and preservation. An archaeological data recovery plan (scope of work) must be approved by SHPD. That plan then must be successfully executed (to be verified in writing by the SHPD), prior to any grading, clearing, grubbing or other land alteration in these areas. In Petition Area 1, three significant historic sites (1969, 2563, 2569) are committed to preservation. A preservation plan must be approved by SHPD. This plan, or minimally its interim protection plan phase, must be successfully executed (to be verified in writing by the SHPD), prior to any grading, clearing, grubbing or other land alteration in these areas.*

Response: The ATC Makena Entities acknowledge that the Petition Area is subject to the provisions of said condition and will comply prior to any grading, clearing, grubbing or other land alteration in these areas.

8. *Petitioner shall implement efficient soil erosion and dust control measures during and after the development process to the satisfaction of the State Department of Health and County of Maui.*

Response: The ATC Makena Entities acknowledge that the Petition Area is subject to the provisions of said condition and will comply at the appropriate time prior to commencement of construction.

9. *Petitioner shall initiate and fund a nearshore water quality monitoring program. The monitoring program shall be approved by the State Department of Health in consultation with the U.S. Fish and Wildlife Service, the National Marine Fisheries Services, and the State Division of Aquatic Resources, DLNR. Petitioner shall coordinate this consultation process with the concurrence of the State Department of Health. Mitigation measures shall be implemented by Petitioner if the results of the monitoring program warrant them. Mitigation measures shall be approved by the State Department of Health in consultation with the above mentioned agencies.*

Response: The ATC Makena Entities continue to implement and fund a nearshore water quality monitoring program. This program initially collected base line water samples and analyzed the same to determine turbidity, chemical compound contents and biota sampling. This monitoring program continues with at least semi-annual sampling at four separate nearshore sites.

Enclosed herein are Quarterly Water Quality Sampling Reports dated June 2020 and July 2020, which were transmitted to the Department of Health by letter dated October 21, 2020.

The ATC Makena Entities acknowledge that the Petition Area is subject to the provisions of said condition and will comply.

10. *Petitioner shall submit a Traffic Impact Analysis Report (TIAR) for review and approval by the State Department of Transportation and the County of Maui.*

Response: As described in prior Annual Reports, a TIAR was prepared and submitted for review by the State Department of Transportation (DOT) and the County of Maui as part of the change in zoning application. Following certain comments by DOT, revisions were made to the TIAR which DOT agreed with as set forth in a letter from Kazu Hayashida, Director of Transportation, dated May 2, 2000, a copy of which was provided to the Commission with a prior Annual Report in this Docket.

In addition, as set forth in prior Annual Reports, the Petitioner prepared and submitted a Makena Resort Master Traffic Study, dated June 6, 2003 (Revised September 14, 2003), which was submitted to the SDOT and County of Maui, and approved by the County on September 26, 2003.

ATC Makena Entities understand that this condition has been satisfied.

11. *Petitioner shall participate in the pro rata funding and construction of local and regional transportation improvements and programs including dedication of rights-of-way as determined by the State Department of Transportation ("DOT") and the County of Maui. Agreement between Petitioner and DOT as to the level of funding and participation shall be obtained within fourteen (14) years from June 1, 2000.*

Response: The ATC Makena Entities acknowledge that they are subject to provisions of said condition and will comply.

This condition has been partially satisfied, as detailed below. Moreover, the ATC Makena Entities continue to engage with the DOT on an agreement to address the pro rata share of funding and participation toward transportation improvements related to the Petition Area.

The ATC Makena Entities submitted a draft memorandum of agreement to DOT in 2019, have continued correspondence with DOT and met with DOT representatives in 2020 to review the draft memorandum of agreement at which

time DOT expressed a desire to delay entering into a formal agreement with the ATC Makena Entities regarding the obligations related to the Petition Area until the ATC Makena Entities had completed a traffic study that covers more than just the approximately 120-acre Petition Area (most of which was and continues to be in golf course use). The traffic study will cover some 1,000 acres in the Makena area. The ATC Makena Entities is preparing a draft of this traffic study in conjunction with its upcoming environmental review process for some of its Makena area properties, anticipated to commence in 2021. The ATC Makena Entities are working with DOT to establish and confirm the appropriate parameters of this traffic study and are scheduling to meet with their traffic engineer and DOT in March 2021.

The current approach to satisfy this condition is different from the plan that was in effect for several years. Under the prior plan, which was coordinated with DOT, the condition was going to be satisfied through a joint effort between the ATC Makena Entities, Honua'ula Partners, LLC, A&B Wailea LLC, and Keaka LLC. Therefore, these parties jointly prepared a Final Environmental Assessment to assess the impacts of a widening of Piilani Highway. DOT accepted the FEA and issued a FONSI (OEQC in May 2012). These same parties intended to enter into an "Inter-Developer Agreement" to address the actual construction of improvements. However, after all of that effort it became apparent that the multi-party approach would not be feasible because the landowners were all at different stages of development and subject to different conditions of approval. The ATC Makena Entities understand that certain of the landowners have pursued individual agreements with DOT; ATC Makena Entities are likewise pursuing such an agreement with DOT.

Partial satisfaction of this condition was achieved through the "Agreement for Planning and Design of Piilani Highway Expansion" between Makena Resort Corp. (the original Petitioner), and DOT in 2001. Under this Agreement, Petitioner agreed to fund the planning and design of the restriping and other improvements to Piilani Highway from Mokulele Highway to Kilohana Drive, to increase it from two lanes to four lanes. This work has been completed.

12. *Petitioner shall fund the design and construction of drainage improvements required as a result of the development of the Property to the satisfaction of the appropriate State of Hawai`i and County of Maui agencies.*

Response: ATC Makena Entities acknowledge that they are subject to the provisions of said condition and will comply.

As reported in prior Annual Reports, Petitioner prepared a Drainage Master Plan, which was submitted to the County Department of Public Works and

Environmental Management and Planning Department on July 1, 2003, and approved by the County on August 20, 2003.

13. *The Petition Areas will be developed in accordance with the Kihei-Makena Community Plan.*

Response: The ATC Makena Entities acknowledge that development of the Petition Area is to be in accordance with the Kihei-Makena Community Plan.

14. *Petitioner shall fund, design and construct all necessary traffic improvements necessitated by development of the Petition Areas as required by the State Department of Transportation and the County of Maui Department of Public Works and Waste Management.*

Response: The ATC Makena Entities acknowledge that they are subject to the provisions of said condition and will comply. Traffic improvements required by DOT will be addressed pursuant to Condition 11.

15. *Petitioner shall develop the Property in substantial compliance with the representations made to the Commission. Failure to so develop the Property may result in a reversion of the Property to its former classification, a change to a more appropriate classification, or other reasonable remedy as determined by the Commission.*

Response: The ATC Makena Entities acknowledge that they are subject to the provisions of said condition and will comply.

16. *Petitioner shall give notice to the Commission of any intent to sell, lease, assign, place in trust, or otherwise voluntarily alter the ownership interests in the Property, prior to development of the Property.*

Response: The ATC Makena Entities acknowledge that they are subject to the provisions of said condition and will comply.

17. *Petitioner shall timely provide without any prior notice, annual reports to the Commission, the Office of Planning, and the County of Maui Planning Department in connection with the status of the subject project and Petitioner's progress in complying with the conditions imposed herein. The annual report shall be submitted in a form prescribed by the Executive Officer of the Commission.*

Response: The ATC Makena Entities acknowledge that they are subject to the provisions of said condition and will comply. The submittal of this Annual Report by the ATC Makena Entities is in compliance with this condition.

18. *The commission may fully or partially release or amend the conditions provided herein as to all or any portion of the petition area upon timely motion and upon the provision of adequate assurance of satisfaction of these conditions by Petitioner.*

Response: The ATC Makena Entities acknowledge that they are subject to the provisions of said condition.

19. *Petitioner shall record the conditions imposed herein by the Commission and every amendment thereto with the Bureau of Conveyances pursuant to Section 15-15-92, Hawai'i Administrative Rules.*

Response: This condition has been satisfied and the ATC Makena Entities acknowledge that they are subject to the provisions of said condition in the event of any amendments. The ATC Makena Entities recorded an Amended and Restated Declaration of Conditions Applicable To An Amendment to District Boundary From Agricultural to Urban, in the Bureau on September 7, 2012 as Document Number A-46330782, a copy of which was provided to the Commission as part of a prior Annual Report transmittal.

If you have any questions or require any further information, please contact me or Mr. Ka'imi Judd at 808-640-6023.

Sincerely,

Jennifer A. Lim

cc: State of Hawaii, Office of Planning, via US Mail
County of Maui, Department of Planning, via US Mail

Encls. Transmittal to Myron Honda, State of Hawaii, Department of Health Clean Water Branch, October 21, 2020.
Mākena Golf & Beach Club quarterly water quality sampling June 2020, AECOS, Inc.
Mākena Golf & Beach Club quarterly water quality sampling July 2020, AECOS, Inc.

ATC Makena Hotel, LLC
c/o Makena Golf & Beach Club

October 21, 2020

Mr. Myron Honda
State of Hawaii, Department of Health
Clean Water Branch
2827 Waimano Home Road #225
Pearl City, HI 96782

RE: State Land Use District Boundary Amendment Docket A9-721 Condition No. 9, County of Maui Zoning Ordinance No. 3613 Condition No. 19, Marine Water Quality Monitoring.

Dear Mr. Honda,

ATC Makena Holdings, LLC, in compliance with the above referenced conditions, respectfully submits the enclosed Marine Water Quality Quarterly Monitoring Reports prepared by AECOS Inc. dated October 6, 2020 for the quarterly tests performed in June of 2020 and dated October 15, 2020 for quarterly tests performed in July of 2020.

Should you have any questions, require a hardcopy, or require additional information, please do not hesitate to contact me at (808) 640-6023, or by email at kjudd@makenagbc.com.

Sincerely,

Makena Golf & Beach Club,
For ATC Makena Hotel, LLC

DocuSigned by:
Kaimi Judd
2C2B511CEAD548D...
Kaimi Judd
Vice President of Development

Enclosures (2):
a. PDF Copy of the June 2020 Quarterly Water Quality Sampling Report
b. PDF Copy of the July 2020 Quarterly Water Quality Sampling Report

Cc:
Mark Roy, Munekiyo Hiraga
Joshua Woodburn, Makena Golf & Beach Club

a.

June 2020 Quarterly Water Quality Monitoring Report

Mākena Golf & Beach Club
quarterly water quality sampling event

June 2020

September 16, 2020
October 6, 2020, revised

Final Report

AECOS No. 1535I

Allen Cattell, Ph.D.
AECOS, Inc.
45-939 Kamehameha Highway, Suite 104
Kāne'ohe, Hawai'i 96744
Phone: (808) 234-7770 Email: Cattell@aecos.com

Introduction

The State Land Use Commission requires that Mākena Golf and Beach Club (MG&BC) submit water quality monitoring reports to the Hawai'i Department of Health (HDOH) to ensure compliance with Condition No. 10, in the "Declaration of Conditions", a document that pertains to the Amendment of the MG&BC District Boundary, dated April 17, 1998. The monitoring report must also ensure compliance with Condition 19 of the County of Maui, Zoning Ordinance 3613. The goals of the monitoring program established to comply with requirements of Condition No. 10 and Ordinance 3613 are: (1) assess degree to which fertilizers, as well as other nutrient sources, used on land to enhance golf course turf growth and resort landscaping leach to groundwater and subsequently reach nearshore waters and (2) establish evidence of delivery of these nutrients into the nearshore environment (see *AECOS* 2019a,b).

Water quality parameters of particular interest for the purposes of our monitoring program are termed nutrients[1]. Nutrient enrichment can enhance nuisance algae production in aquatic environments (HDLNR, 2016). Nutrient enrichment can also negatively impact corals and other biological components in Hawai'i coastal waters (Laws et al., 2004; MRC, 2011; *AECOS*, 2016). A

[1] "Nutrients" are nitrogen and phosphorus chemical compounds that promote plant growth, including algal growth in the marine environment.

separate program is monitoring nearshore biological assemblages off the MG&BC resort to determine if marine water quality is impacting the biota extant there (see *AECOS*, 2020).

Tables and figures throughout this report compare this second quarter, 2020 water quality monitoring with means calculated from eight previous monitoring efforts undertaken quarterly between June 2018 and February 2020.

Background

Waters south from Nahuna Point, including Mākena Bay and Maluaka Bay (Figure 1) to Pu'u Ola'i are designated as "Class A, open coastal waters" in State of Hawai'i, water quality standards (HDOH, 2014) and included on the HDOH 2018 list of impaired waters in Hawai'i prepared under Clean Water Act §303(d) for nitrate+nitrite, ammonium, total nitrogen, and turbidity (HDOH, 2018). These waters are listed as a "Category 2" water body—meaning that some uses are attained; a "Category 3" water body—meaning that insufficient data and/or information exist to make use-support determinations—and as a "Category 5" water body—meaning that available data and/or information indicate that at least one designated use is not supported or is threatened, and a Total Maximum Daily Load (TMDL)[2] study is needed.

Marine waters from Pu'u Ola'i south are designated as Class AA "open coastal waters" in State of Hawai'i, water quality standards (HDOH, 2014) and included on the HDOH 2018 list of impaired waters in Hawai'i for nitrate+nitrite, ammonium, turbidity, and chlorophyll α (HDOH, 2018). These waters are also listed under Categories 2, 3. and 5. A TMDL study is needed.

Methods

The June 9, 2020 quarterly monitoring event was conducted along three monitoring transects in nearshore waters adjacent to MG&BC (Transects M-1, M-2, and M-3) and at a control site located well south of Pu'u Ola'i (Transect M-4; see Fig. 1). Stations were sampled in the surface waters at 2-m, 10-m, 50-m, and 100-m distances from shore along each transect between 1000 and 1400 hours. Water quality samples were also collected at three irrigation source water wells: Seibu Well 1, Seibu Well 6, and Seibu Well 4 (Fig. 1).

[2] TMDL studies are conducted to establish limits on discharges of substances causing impairments to water quality of aquatic environments.

Figure 1. Location of water quality monitoring transects (M-1 through M-4) and irrigation supply wells at MG&BC.

Temperature, salinity, pH, and dissolved oxygen (DO) were measured *in situ*. Water samples were collected, chilled, and returned to the *AECOS* laboratory for additional analyses (*AECOS* Log No. 40131). The following parameters were measured from these samples: salinity, turbidity, ammonium, nitrate+nitrite, total nitrogen (total N or TN), ortho-phosphate, total phosphorus (total P or TP), and chlorophyll a. Table 1 lists the instruments and analytical methods used for these field measurements and laboratory analyses.

On the June 9 event, cloud cover increased from about 5 percent in the morning to about 30 percent by afternoon. The tide was low at 0934 hours (+0.34 ft),

rising to a high of +0.78 ft at 1402 hours (Station161525, Mākena; NOAA, 2020). Winds were light (< 5 mph) from the southwest to north and nearshore surf was mostly calm (smooth to < 1 ft). Samples were collected between 1000 and 1400 hours.

Table 1. Analytical methods and instruments used for water quality analyses.

Analysis	Method	Reference	Instrument
Temperature	SM 2550B	SM (2017)	YSI Model 550 DO meter thermistor
Salinity	SM 120.1	SM (2017)	Accument AB200
pH	SM 4500H+	SM (2017)	pH pHep HANNA meter
Dissolved Oxygen	SM 4500-O G	SM (2017)	YSI Model 550 DO meter
Turbidity	EPA 180.1	USEPA (1993b)	Hach 2100Q Turbidimeter
Ammonium	EPA 349	USEPA (1997a)	Lachat Quickchem 8500
Nitrate + Nitrite	EPA 353.2	USEPA (1993a)	Lachat Quickchem 8500
Total Nitrogen	EPA 353.4	USEPA (1993a)	Shimadzu TNM-1
Ortho-Phosphate	EPA 365.5	USEPA (1997b)	Lachat Quickchem 8500
Total Phosphorus	EPA 365.5	USEPA (1997b)	Lachat Quickchem 8500
Chlorophyll α	SM10200H(M)	SM (1998)	Turner Fluorometer

Results

Water quality results are shown in Tables 2 and 3, compared with the long-term means (our quarterly monitoring results sampled between June 2018 and February 2020). In June 2020, temperatures were very close to long-term averages, lowest along Transect M-4. Salinities were also close to long-term averages at all stations, and showed a small increase southward from Transect M-1 to Transect M-4. pH values were slightly lower than the long-term means and demonstrated no particular horizontal trends. The lowest pH values occurred along Transect M-4. DO saturation in June 2020 were elevated compared with historic means along all four transects. The distribution of turbidity was variable between transects and under long-term means at all transects except M-1. Chlorophyll α concentrations were also variable in June 2020 and not close to long-term means.

Table 2. Physical water quality and chlorophyll α means from June 2018 through February 2020 (n = 8), compared to June 9, 2020 results.

Transect	DFS† (m)	Salinity (ppt)		Temperature (° C)		pH		DO (% Sat.)		Turbidity (NTU)		Chl. α (µg/L)	
		Means	June 2020	Means	June 2020	Means	June 2020	Means	June 2020	Means	June 2020	Means	June 2020
M-1	2	33.79	33.40	27.1	27.5	8.12	8.02	103	103	1.35	2.46	0.69	1.69
	10	34.08	33.81	26.9	26.7	8.19	8.20	109	115	0.79	0.59	0.46	0.41
	50	34.30	33.93	26.9	26.7	8.19	8.20	105	113	0.72	0.49	0.39	0.27
	100	34.49	34.23	26.9	26.5	8.17	8.13	101	104	0.49	0.54	0.31	0.21
	Means	**34.17**	**33.84**	**27.0**	**26.9**	**8.17**	**8.14**	**104**	**109**	**0.84**	**1.02**	**0.46**	**0.65**
M-2	2	33.92	34.16	26.8	27.4	8.13	8.11	97	119	2.78	1.14	0.69	0.37
	10	33.97	33.94	26.8	26.8	8.17	8.11	96	96	1.89	0.89	0.53	0.24
	50	34.06	34.11	26.7	26.9	8.17	8.13	97	108	1.21	0.32	0.36	0.27
	100	34.38	34.55	26.6	26.7	8.16	8.10	97	97	0.68	0.42	0.21	0.29
	Means	**34.08**	**34.19**	**26.7**	**27.0**	**8.16**	**8.11**	**97**	**105**	**1.64**	**0.69**	**0.45**	**0.29**
M-3	2	33.60	33.71	26.7	27.0	8.15	8.14	110	118	0.81	0.52	0.66	1.99
	10	34.10	34.01	26.6	26.8	8.17	8.14	108	115	0.71	0.32	0.48	0.40
	50	34.35	34.53	26.7	26.6	8.16	8.13	103	107	0.52	0.32	0.28	0.43
	100	34.42	34.62	26.7	26.7	8.16	8.12	99	104	0.43	0.31	0.21	0.22
	Means	**34.12**	**34.22**	**26.7**	**26.8**	**8.16**	**8.13**	**105**	**111**	**0.62**	**0.37**	**0.41**	**0.76**
M-4	2	34.00	34.54	26.4	26.4	8.11	8.05	100	115	1.48	1.31	0.76	0.54
	10	34.10	34.02	26.3	25.9	8.14	8.09	102	106	1.21	0.73	0.58	0.38
	50	34.41	34.46	26.4	25.9	8.15	8.05	103	100	0.86	0.46	0.32	0.24
	100	34.44	34.51	26.3	26.0	8.15	8.05	100	97	0.50	0.52	0.21	0.23
	Means	**34.24**	**34.38**	**26.3**	**26.1**	**8.14**	**8.06**	**101**	**105**	**1.01**	**0.76**	**0.47**	**0.35**
Dry Criteria		**+/- 10%**		**+/- 1C°**		**7.6–8.6**		**≥75%**		**≤0.20 NTU**		**≤0.15 µg/L**	

† distance from shore ‡ geometric mean Red exceeds standard

Nitrate+nitrite and ammonium concentrations from the June sampling event were elevated along Transect M-1 compared with historic means. Nitrate+nitrite concentrations tended to decrease with distance from shore on all transects and were notably under the long-term means on Transect M-2.

Ammonium concentrations, on the other hand, demonstrated little change with distance from shore. Total nitrogen concentrations were elevated along all transects in June. Ortho-phosphate concentrations were low and similar to historic means on all four transects. Total phosphorus concentrations were generally close to long-term values, slightly above on Transect M-1.

Table 3. Water quality nutrient concentration geometric means (n = 8) from June 2018 through February 2020, compared to June 9, 2020 results.

Transect	DFS† (m)	NO_3+NO_2 (µgN/L)		NH_4 (µgN/L)		TN (µgN/L)		PO_4 (µgP/L)		TP (µgP/L)	
		Means	June 2020	Means	June 2020	Means	June 2020	Means	June 2020	Means	June 2020
M-1	2	71	127	15	27	208	256	2.2	5.0	8	16
	10	54	71	15	20	168	186	2.0	2.0	6	6
	50	48	63	15	15	166	192	2.0	2.0	7	12
	100	32	62	19	22	140	203	1.2	2.0	6	5
	Means	**51**	**81**	**16**	**21**	**171**	**209**	**2**	**3**	**6**	**10**
M-2	2	41	26	11	3	134	124	4.0	3.0	43	41
	10	39	42	13	8	141	125	3.3	4.0	9	7
	50	36	24	11	3	124	177	3.3	2.0	7	7
	100	32	4	12	7	118	106	2.3	2.0	7	8
	Means	**37**	**24**	**12**	**5**	**129**	**133**	**3**	**3**	**16**	**16**
M-3	2	71	102	16	5	219	218	4.3	4.0	7	9
	10	49	48	12	3	159	146	4.1	2.0	6	5
	50	36	8	16	18	126	177	2.0	1.0	7	7
	100	20	19	14	5	121	123	2.0	2.0	6	13
	Means	**44**	**44**	**15**	**8**	**157**	**166**	**3**	**2**	**7**	**9**
M-4	2	20	28	14	10	103	123	2.3	4.0	8	6
	10	17	17	16	9	99	124	3.0	3.0	6	5
	50	13	5	15	45	98	132	1.6	2.0	8	3
	100	13	6	15	15	85	108	1.6	2.0	4	2
	Means	**16**	**14**	**15**	**20**	**96**	**122**	**2**	**3**	**7**	**4**
Dry Criteria		**≥3.5 µgN/L**		**≥2µgN/L**		**≥110 µgN/L**		**ns**		**≥16µgP/L**	

† distance from shore Red exceeds standard ns - no standard

Generally, groundwater seepage into nearshore coastal waters will produce a reduction in salinity and an increase in nitrate+nitrite. Conditions further offshore, however, are more likely to reflect water moving into the MG&BC vicinity from points farther away and not influenced by groundwater influx along the Mākena shore. Using the PacIOOS Regional Ocean Modeling System (ROMS), we can display water current movements off the southwestern coast of East Maui that occurred prior to our sampling efforts.

The direction and position of a current marker on June 9, 2020 are shown in Figure 2 starting at 0200 hours and ending at 1100 hours. Water movement off the coast at this time was in a southerly direction and during the sampling event had flowed from off Wailea, about 1.3 nautical miles north of the MG&BC (PacIOOS, 2020).

Figure 2. Predicted current flows off southwest Maui during morning hours of June 9, 2020 (PacIOOS, 2020).

Discussion

The slightly reduced salinities recorded on the June 9 at 2-m stations on transects M-1 and M-3 likely reflect nearshore groundwater seepage measured

during a low tide coupled with relatively calm wind conditions (breezier winds would enhance mixing of surface water down into the water column). Nitrate+nitrite concentrations were elevated along both transects at 2-m and then tended to decrease with distance from shore. Ammonium concentrations were somewhat elevated along transects M-1 and M-4, but low along both transects M-2 and M-3. Ammonium is not typically related to salinity, being generated within the nearshore waters from natural biological activities. Ortho-phosphate concentrations were typically present in low concentrations in the project area and demonstrate no correlation with salinity. Total nitrogen and total phosphorus concentrations were elevated at the 2-m stations for both transect M-1 and M-3.

Nutrient Subsidies

Table 4 provides an overview of potential groundwater nutrient subsidies in nearshore marine waters on June 9, 2020. Using the 2-m stations—the most likely to reveal groundwater inputs—the nitrate+nitrite concentrations were elevated (measured concentration exceeded estimated concentration based on salinity) at transects M-1 and M-3. Nitrate+nitrite elevations were directly related to low salinities during this sampling event.

Table 4. Estimated nitrate+nitrite subsidy at nearshore stations (2-m), June 9, 2020.

Well	Measured		Estimated	Subsidy
Transect	NO_3+NO_2	Salinity	NO_3+NO_2	NO_3+NO_2
	(µgN/L)	(PSU)	(µgN/L)	(µgN/L)
Seibu Wells	1967	1.32	---	---
M-1	127	33.40	55	72
M-2	26	34.16	54	0
M-3	102	33.71	55	47
M-4	28	34.54	53	0

Table 5 shows there were no ortho-phosphate subsidies at any transect on June 9, 2020. The lack of subsidy at the 2-m station of Transect 1 occurs because the ortho-phosphate background concentration measured at 100-m station on Transect 4 (2 µgP/L) is subtracted from subsidy calculation. Ortho-phosphate is used only infrequently in fertilizing grounds at MG&BC

Table 5. Estimated ortho-phosphate subsidy at nearshore stations (2-m), June 9, 2020.

Well Transect	Measured PO_4 (µgP/L)	Salinity (PSU)	Estimated PO_4 (µgP/L)	Subsidy PO_4 (µgP/L)
Seibu Wells	68	1.32	---	---
M-1	5	33.40	3	0
M-2	3	34.16	3	0
M-3	4	33.71	3	0
M-4	4	34.54	3	0

Irrigation and Fertilizer Tracking

We track monthly turf and landscaping fertilization/irrigation rates, using monthly data provided by Jonathan Galicinao at MG&BC. Irrigation water nutrient concentrations are measured in several irrigation supply wells on each sampling event. Figures 5, 6, and 7 present a comparison of unused monthly nitrate+nitrite fertilizer with nitrate-nitrite subsidies calculated for 2-m stations at transects M-1, M-2, and M-3 on each sampling event since March 2018.

Potential fertilizer nitrate+nitrite residuals (blue bars) are estimates using 20% of application values (Johnson et al., 2018). Nitrate+nitrite excess or subsidy concentrations, calculated for the 2-m stations, are plotted as red dots. Note that the greatest applications of nitrate+nitrite fertilizer were in February and June 2019 and January 2020. Nearshore excess nitrate+nitrite concentrations were highest in March and August 2019 and February 2020 at Transect M-1—within one to two months after elevated fertilization. However, similar 'peaks' in excess nitrate-nitrite appeared only in March 2019 and February 2020 at Transects M-2 and a single peak at Transect M-3 in February 2020. A further complication is the fact that the December 2018 subsidy at M-1 is nearly as high as the peak in August 2019, but unrelated to any preceding high in application rate. Clearly, additional measurements over a longer period will be required to establish if any valid relationship exists between application of fertilizer at MG&BC and our salinity-based method[3] of estimating excess nitrate-nitrite off the Mākena shore. If needed and as these data accumulate, we should be able to recommend changes to fertilizer application methods that will meet Mākena

[3] Explained in detail in *AECOS*, 2018, p. 10-11.

golf course and landscaping requirements and minimize measureable effects on nearshore waters.

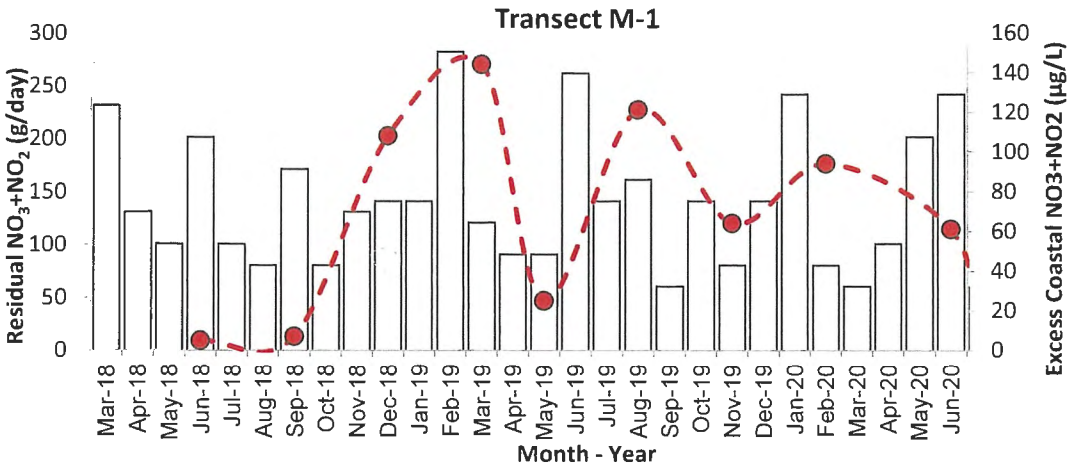

Figure 5. Mean daily application of nitrate+nitrite to golf course turf and landscaping (blue bars; g/day) and excess calibrated nitrate+nitrite (red circles µg/L) at 2-m station on Transect M-1.

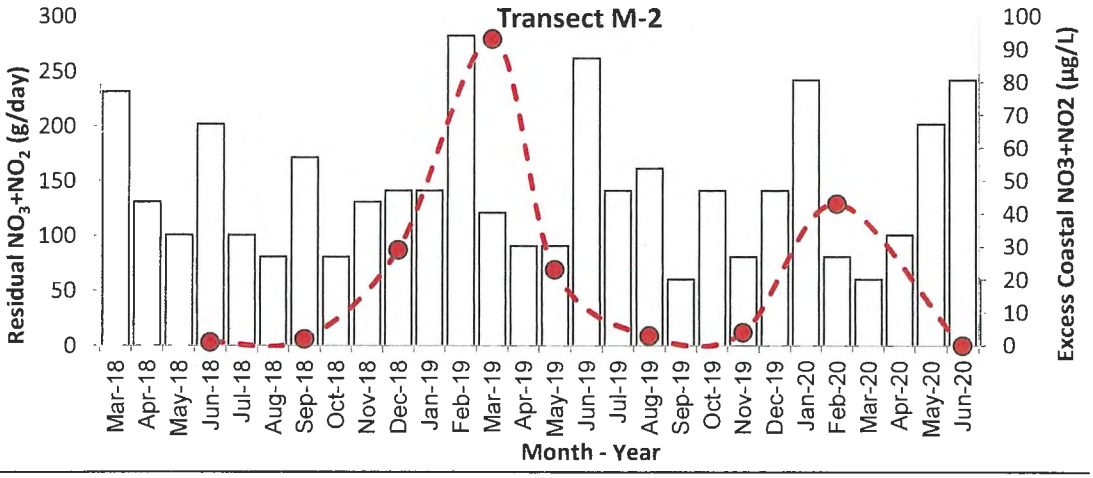

Figure 6. Mean daily application of nitrate+nitrite to golf course turf and landscaping (blue bars; g/day) and excess calibrated nitrate+nitrite (red circles µg/L) at 2-m station on Transect M-2.

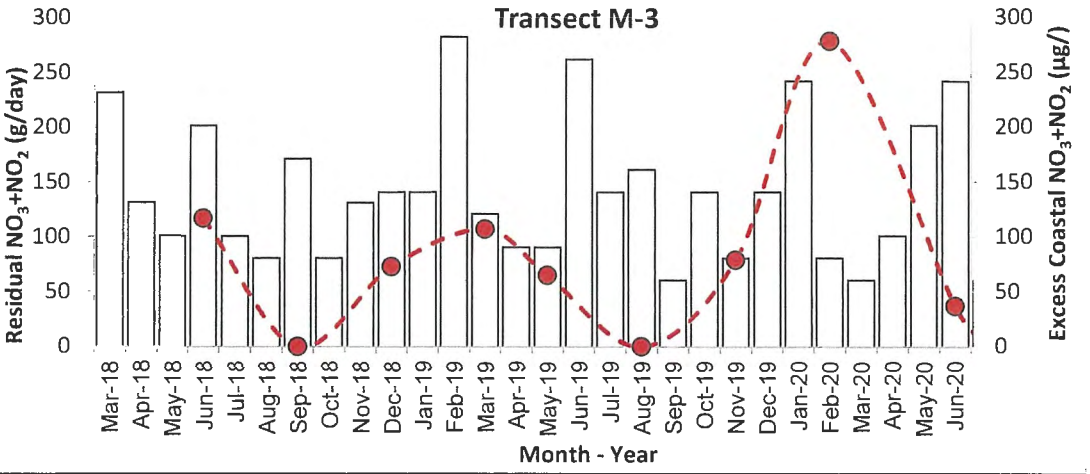

Figure 7. Mean daily application of nitrate+nitrite to golf course turf and landscaping (blue columns; g/day) and excess calibrated nitrate+nitrite (red circles µg/L) at 2-m station on Transect M-3.

Chlorophyll α and Nutrient Limitation

Inorganic nitrogen and phosphorus compounds are typically identified as potentially "limiting" nutrients in Hawaiian marine waters—phytoplankton and macroalgae require these nutrients for growth and photosynthesis. Increases in a limiting nutrient concentration can result in enhanced growth of phytoplankton and macroalgae. Excessive algal growth has happened in the coastal waters off Kīhei due to increased discharge of both nitrogen and phosphorus compounds from the Kīhei Wastewater Treatment Plant (Laws et al., 2004; Dailer et al., 2010). Thus, maintaining low limiting nutrient **co**ncentration is essential to maintaining a pristine biological community off Mākena.

We can estimate the limiting nutrient (nitrogen or phosphorus) by comparing molar ratios (N:P ratios) of dissolved inorganic nitrogen (DIN: nitrate, nitrite, and ammonium) to dissolved inorganic phosphate (DIP: ortho-phosphate). N:P ratios for 20 Hawaiian algal species range from 15:1 to 44.1 with an average of about 29:1 (Atkinson and Smith, 1983). High N:P ratios (>29.1) are related to DIP limitation and low N:P ratios (<29.1) are related to DIN limitation.

Sufficient nutrient and chlorophyll α data are not presently available to make statistical inferences regarding actual limiting nutrient determinations in

Mākena waters. However, analyses using averages of accumulating data can be useful to decipher trends. Data presented herein are based on the previous nine sample sets and will likely change as additional monitoring adds to the data set.

N:P ratios can vary as shown in Table 6 from place to place along the coast. For example, during the present sampling event, N:P values for monitoring stations along M-1 and M-3 transects were mostly DIP limited, due to the fact that DIN values were high along these transects. N/P limitation can also vary between stations along individual transects, as shown in Transect M-4.

Table 6. A summary of average DIN and DIP values for eight monitoring events (June, 2018 – February, 2020) and June 2020.

Transect	**DFS†** (m)	**DIP** (µM/L)		**DIN** (µM/L)		**DIN:DIP** ratio		**N/P Limited** potential	
		Means	June 2020	Means	June 2020	Means	June 2020	Means	June 2020
M-1	2	0.07	0.16	6	11	85	68	P	P
	10	0.06	0.06	5	7	79	101	P	P
	50	0.07	0.06	5	6	69	86	P	P
	100	0.04	0.06	4	6	95	93	P	P
M-2	2	0.13	0.10	4	2	29	21	?	N
	10	0.11	0.13	4	4	35	28	P	N
	50	0.11	0.06	3	2	32	29	P	?
	100	0.07	0.06	3	1	42	12	P	N
M-3	2	0.14	0.13	6	8	45	59	P	P
	10	0.13	0.06	4	4	33	56	P	P
	50	0.06	0.03	4	2	57	58	P	P
	100	0.06	0.06	2	2	38	27	P	N
M-4	2	0.07	0.13	2	3	32	21	N	N
	10	0.10	0.10	2	2	24	19	N	N
	50	0.05	0.06	2	4	37	55	P	P
	100	0.05	0.06	2	2	40	23	P	P

Since different algal species represent a wide range of N:P requirements (Atkinson & Smith, 1983), constantly changing nutrients tend to prevent excessive algal growth, preventing extensive growth of just one or a few species.

Summary

June 2020 monitoring results included water temperatures close to long-term means. Salinity was low at Transect M-1 compared with historic means and increased progressively to Transect M-4. DO saturations were slightly elevated. Nitrate+nitrite and ammonium concentrations were elevated in comparison with historic means at Transect M-1 and for ammonium at Transect M-4. Ortho-phosphate concentrations were low and comparable with historic means.

Current tracking with the PacIOOS modeling indicates currents were moving in a southerly direction prior to and during the June 9, 2020 sampling event. Ocean water had travelled about 1.4 nautical miles from Wailea to Mākena project area by 1100 hours.

Subsidies for nitrate+nitrite concentrations occurred at the 2-m stations on two transects (M-1 and M-3) in the MG&BC area. There were no subsidies for ortho-phosphate at any transect. No nutrient subsidies were noted at Transect M-4.

An analysis of DIN to DIP ratios for this sampling event suggests that DIP was the presumptive limiting nutrient for algal growth along transects M-1 and M-3; DIN along Transect M-2; and both DIN and DIP along Transect M-4.

References

AECOS, Inc. (*AECOS*). 2016. Marine biological surveys for the proposed Mākena Resort M-5/M-6/S-7/B-2 project, Mākena, Maui. ATC Mākena Holdings, LLC. *AECOS* No. 1470A: 56 pp.

_____. 2018. Makena Golf & Beach Club quarterly water quality sampling event. July 2018. Prep. for Makena Golf & Beach Club. *AECOS* No. 1535A: 15 pp.

_____. 2019a. Mākena Golf & Beach Club, 2018 annual water quality monitoring report. Prep. for Mākena Golf & Beach Club. *AECOS* No. 1535C: 30 pp.

_____. 2019b. Mākena Golf & Beach Club, 2019 annual water quality monitoring report. Prep. for Mākena Golf & Beach Club. *AECOS* No. 1535G: 21 pp.

AECOS, Inc. (*AECOS*). 2020. Marine biological surveys for the proposed Mākena Future Lands Project, Mākena, Maui. Pep, for AREG AC Mākena Propco LLC. *AECOS* No. 1602: 64 pp.

Atkinson, M. J. and S. V. Smith. 1983. C:N:P ratios of benthic marine plants. *Limnol. & Oceangr.*, 28(3): 568-574.

Dailer, M. L., R. S. Knox, J. E . Smith, M. Napier, and C. M. Smith. 2010. Using $\delta^{15}N$ values in algal tissue to map locations and potential sources of anthropogenic nutrient inputs on the island of Maui, Hawai'i, USA. *Mar. Poll. Bull.* 60(5): 655-671.

Hawaii Department of Health (HDOH). 2014. Hawai'i Administrative Rules, Title 11, Department of Health, Chapter 54, Water Quality Standards. November 15, 2014. 110 pp.

_____. 2018. 2018. State of Hawai'i water quality monitoring and assessment report: integrated report to the U.S. Environmental Protection Agency and the U.S. Congress pursuant to §303(3) and §305(b), Clean Water Act (P.L. 97-117). 127 pp.

Hawai'i Department of Land and Natural Resources (HDLNR). Status of Maui's Coral Reefs. URL: http://dlnr.hawaii.gov/dar/files/2014/04/-MauiReef Declines.pdf.

Johnson, A. G., J. A. Engott, M. Bassiouni, and K. Rotzoll. 2018. Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai'i, 1978-2007. Scientific Investigations Report 2014-5168. Version 2.0, February 2018. U.S. Department of the Interior & U.S. Geological Survey. 64 pp.

Laws, A. E., D. Brown, and C. Peace. 2004. Coastal water quality in the Kihei and Lahaina districts of the Island of Maui, Hawaiian Islands: impacts from physical habitat and groundwater seepage: implications for water quality standards. *Inter. J. Environ. Poll.*, 22(5): 531-546.

Marine Research Consultants, Inc. (MRC). 2011. An evaluation of causal factors affecting coral reef community structure in Ma'alaea Bay, Maui, Hawaii. Job No. WW09-22. Prep. for County of Maui. 84 pp.

National Oceanic and Atmospheric Administration (NOAA). 20209. Tide Predictions for gauge 1615202, Makena, HI. Available at URL: https://tidesandcurrents.noaa.com. Last observed on February 19, 2020.

Pacific Islands Ocean Observing System (PacIOOS). 2020. Available on at URL: https://www.pacioos.hawaii.edu/currents-category/model/; last accessed on June 26, 2020.

Standard Methods (SM). 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition. American Public Health Association, American Water Works Association, Water Environment Federation.

_____. 2017. Standard Methods for the Examination of Water and Wastewater, 23rd Edition. American Public Health Association, American Water Works Association, Water Environment Federation.

U.S. Environmental Protection Agency (USEPA). 1993a. Method 353.2 Revision 2.0: Determination of Nitrate-Nitrite Nitrogen by Automated Colorimetry. National Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268. 15 pp.

_____. 1993b. Method 180.1: Determination of Turbidity by Nephelometry. Version 2. Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268. 11 pp.

_____. 1997a. Method 349.0: Determination of Ammonia in Estuarine and Coastal Waters by Gas Segmented Continuous Flow Colorimetric Analysis. National Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268. 16 pp.

_____. 1997b. Method 365.5: Determination of Ortho-Phosphate in Estuarine and Coastal Waters by Automated Colorimetry Analysis. National Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268. 9 pp.

U.S. Geological Society. (USGS). 2018. Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai'i, 1978-2007. Scientific Investigations Report 2014-5168. U.S. Department of the Interior. U.S. Geological Survey. 64 pp.

b.

July 2020 Quarterly Water Quality Monitoring Report

Mākena Golf & Beach Club
quarterly water quality sampling event

July 2020

September 11, 2020 | ***Final Report*** | *AECOS* No. 1535J
October 6, 2020, revised
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Introduction

The State Land Use Commission requires that Mākena Golf and Beach Club (MG&BC) submit **water quality monitoring reports to the Hawai'i Department of** Health (HDOH) to ensure compliance with Condition No. 10, **in the** "Declaration of Conditions", a document that pertains to the Amendment of the MG&BC District Boundary, dated April 17, 1998. The monitoring report must also ensure compliance to Condition 19 of the County of Maui, Zoning Ordinance 3613. The goals of the monitoring program established to comply with requirements of Condition No. 10 and Ordinance 3613 are: (1) assess degree to which fertilizers, as well as other nutrient sources used on land to enhance golf course turf growth and resort landscaping leach to groundwater and subsequently reach nearshore waters and (2) establish evidence of delivery of these nutrients into the nearshore environment (see *AECOS* 2019a,b).

Water quality parameters of particular interest for the purposes of our monitoring program are termed nutrients[1]. Nutrient enrichment can enhance nuisance algae production in aquatic environments (HDLNR, 2016). Nutrient enrichment can also negatively impact corals and other biological components **in Hawai'i coastal waters (Laws et al., 2004; MRC, 2011;** *AECOS*, 2016). A

[1] **"Nutrients" are nitrogen and phosphorus chemical compounds that promote plant growth,** including algal growth in the marine environment.

separate program is monitoring nearshore biological assemblages off the MG&BC resort to determine if marine water quality is impacting the biota extant there (see *AECOS*, 2020).

Tables and figures throughout this report compare the most recent (July 17, 2020) water quality monitoring results with means calculated from ten previous monitoring efforts undertaken quarterly between June 2018 and June 2020.

Background

Waters south from Nahuna Point, including Mākena Bay and Maluaka Bay (Figure 1) to Pu'u Ola'i are designated as "Class A, open coastal waters" in State of Hawai'i, water quality standards (HDOH, 2014) and included on the HDOH 2018 list of impaired waters in Hawai'i prepared under Clean Water Act §303(d) for nitrate+nitrite, ammonium, total nitrogen, and turbidity (HDOH, 2018). These waters are listed as a "Category 2" water body—meaning that some uses are attained; a "Category 3" water body—meaning that insufficient data and/or information exist to make use-support determinations; and as a "Category 5" water body—meaning that available data and/or information indicate that at least one designated use is not supported or is threatened, and a Total Maximum Daily Load (TMDL)[2] study is needed.

Marine waters from Pu'u Ola'i south are designated as Class AA "open coastal waters" in State of Hawai'i, water quality standards (HDOH, 2014) and included on the HDOH 2018 list of impaired waters in Hawai'i for nitrate+nitrite, ammonium, turbidity, and chlorophyll α (HDOH, 2018). These waters are also listed under Categories 2, 3. and 5. A TMDL study is needed.

Methods

The July 17, 2020 quarterly monitoring event was conducted along three monitoring transects in nearshore waters adjacent to MG&BC (Transects M-1, M-2, and M-3), and at a control site located well south of Pu'u Ola'i (Transect M-4). Stations were sampled in the surface waters at a 2-m, 10-m, 50-m, 100-m distance from shore along each transect. Water quality samples were also collected at three irrigation source water wells: Seibu Well 1, Seibu Well 6, and Seibu Well 4 (see Fig. 1).

[2] TMDL studies are conducted to establish limits on discharges of substances causing impairments to water quality of aquatic environments.

Figure 1. Location of water quality monitoring transects (M-1 through M-4) and irrigation supply wells at MG&BC.

Temperature, salinity, pH, and dissolved oxygen (DO) were measured *in situ*. Water samples were collected, chilled, and returned to the *AECOS* laboratory for additional analyses (*AECOS* Log No. 40370). The following parameters were measured from these samples: salinity, turbidity, ammonium, nitrate+nitrite, total nitrogen (total N or TN), ortho-phosphate, total phosphorus (total P or TP), and chlorophyll **a**. Table 1 lists the instruments and analytical methods used for these field measurements and laboratory analyses.

On the July 17 event, the tide was low at 0701 hours (-0.06 ft), rising to a high of +1.79 ft at 1459 hours (Station161525, **Mākena; NOAA, 2020**). Winds were

light (< 3 mph) from the north to northwest and nearshore surf was mostly calm (smooth to < 1 ft). Samples were collected between 0810 and 1145 hours.

Table 1. Analytical methods and instruments used for water quality analyses.

Analysis	Method	Reference	Instrument
Temperature	SM 2550B	SM (2017)	YSI Model 550 DO meter thermistor
Salinity	SM 120.1	SM (2017)	Accument AB200
pH	SM 4500H+	SM (2017)	pH pHep HANNA meter
Dissolved Oxygen	SM 4500-O G	SM (2017)	YSI Model 550 DO meter
Turbidity	EPA 180.1	USEPA (1993b)	Hach 2100Q Turbidimeter
Ammonium	EPA 349	USEPA (1997a)	Lachat Quickchem 8500
Nitrate + Nitrite	EPA 353.2	USEPA (1993a)	Lachat Quickchem 8500
Total Nitrogen	EPA 353.4	USEPA (1993a)	Shimadzu TNM-1
Ortho-Phosphate	EPA 365.5	USEPA (1997b)	Lachat Quickchem 8500
Total Phosphorus	EPA 365.5	USEPA (1997b)	Lachat Quickchem 8500
Chlorophyll α	SM10200H(M)	SM (1998)	Turner Fluorometer

Results

Water quality results, displayed in Tables 2 and 3, are compared with long-term means. On July 17, 2020, salinities were low at all stations along all transects but Transect M-4, where salinities were close to the long-term means. Temperatures along all four transects were higher, whereas pH values were lower. DO saturation along all four transects, were similar with historic means, although generally quite variable. The distribution of turbidity values varied between stations. The highest mean turbidity was noted at Transect M-1, the lowest at Transect M-3. **Chlorophyll α** concentrations were similar to long-term means except on Transect M-4, where chl. **α** was notably high during the July 17 event.

Nitrate+nitrite concentrations (Table 3) showed decreasing values in the waters southward from Transect M-1 to Transect M-4. Nitrate+nitrite concentrations along Transect M-1 were similar to long-term means, but concentrations along the other three transects were low compared with historic means, while ammonium concentrations on Transect M-1 and Transect M-3 were elevated

compared to long-term means. Total nitrogen was low compared to historic means. Along all four transects, ortho-phosphate concentrations were similar to historic means, whereas total phosphorus concentrations were elevated along all transects except M-2; the highest mean TP occurred at Transect M-2.

Table 2. Physical water quality and chlorophyll α means from June 2018 through June 2020 (n = 10), compared to July 17, 2020 results.

Transect	DFS† (m)	Salinity (ppt)		Temperature (° C)		pH		DO (% Sat.)		Turbidity (NTU)		Chl. α (µg/L)	
		Means	July 2020	Means	July 2020	Means	July 2020	Means	July 2020	Means‡	July 2020	Means‡	July 2020
M-1	2	33.55	32.74	27.1	29.6	8.11	8.09	103	110	1.47	2.90	0.78	0.91
	10	33.66	32.10	26.6	27.1	8.18	8.14	108	106	0.74	0.85	0.47	0.57
	50	33.89	32.23	26.6	27.1	8.18	8.12	104	104	0.68	0.74	0.39	0.53
	100	34.15	32.48	26.6	27.1	8.16	8.10	100	95	0.49	0.43	0.27	0.27
	Means	**33.81**	**32.39**	**26.8**	**27.7**	**8.16**	**8.11**	**104**	**104**	**0.85**	**1.23**	**0.48**	**0.57**
M-2	2	33.79	32.40	26.9	27.6	8.12	8.07	99	101	2.14	2.45	0.39	0.05
	10	33.80	32.38	26.8	27.0	8.16	8.09	96	92	1.49	1.35	0.35	0.27
	50	33.89	32.32	26.7	27.0	8.16	8.09	98	96	0.83	0.46	0.27	0.30
	100	34.15	31.89	26.7	27.0	8.14	8.03	97	93	0.62	0.45	0.23	0.29
	Means	**33.91**	**32.25**	**26.8**	**27.2**	**8.14**	**8.07**	**97**	**96**	**1.27**	**1.18**	**0.31**	**0.23**
M-3	2	33.47	32.15	26.9	28.1	8.15	8.19	111	119	0.72	0.54	0.63	0.52
	10	33.92	32.40	26.7	27.1	8.16	8.08	108	97	0.57	0.54	0.45	0.41
	50	34.22	32.85	26.7	27.0	8.15	8.1	102	94	0.43	0.40	0.27	0.27
	100	34.29	32.81	26.7	26.9	8.15	8.11	101	108	0.41	0.36	0.22	0.31
	Means	**33.97**	**32.55**	**26.7**	**27.3**	**8.15**	**8.12**	**105**	**105**	**0.53**	**0.46**	**0.39**	**0.38**
M-4	2	34.05	33.97	26.4	26.9	8.10	8.11	102	108	1.36	1.87	0.64	1.87
	10	34.02	33.41	26.3	26.5	8.12	8.04	102	102	1.04	1.64	0.47	1.64
	50	34.41	34.36	26.4	26.8	8.13	8.05	102	95	0.65	0.69	0.30	0.69
	100	34.46	34.58	26.4	26.8	8.12	7.96	99	89	0.48	0.34	0.21	0.34
	Means	**34.24**	**34.08**	**26.4**	**26.8**	**8.12**	**8.04**	**101**	**99**	**0.88**	**1.14**	**0.41**	**1.14**
Hawai'i Dry Criteria		**+/- 10%**		**+/- 1C°**		**7.6–8.6**		**≥75%**		**≤0.20 NTU**		**≤0.15 µg/L**	

† distance from shore ‡ geometric mean Red exceeds standard

Generally, groundwater seepage into the nearshore will produce a reduction in salinity and an increase in nitrate+nitrite. Conditions further offshore likely reflect water moving into the survey area from points north or south along the coast. That is, water quality is not much influenced by groundwater influx at

Table 3. Nutrient concentration geometric means from June 2018 through June 2020 (n = 10), compared to July 17, 2020 results.

Transect	**DFS†** (m)	**NO_3+NO_2** (µgN/L)		**NH_4** (µgN/L)		**TN** (µgN/L)		**PO_4** (µgP/L)		**TP** (µgP/L)	
		Means	July 2020	Means	July 2020	Means	July 2020	Means	July 2020	Means	July 2020
M-1	2	71	42	16	26	211	196	2.5	3	8	5
	10	57	61	18	78	170	168	2.1	4	5	4
	50	51	67	14	12	168	158	2.0	2	7	6
	100	35	43	19	17	145	140	1.2	1	6	23
	Means	**54**	**53**	**17**	**33**	**173**	**166**	**2**	**3**	**7**	**11**
M-2	2	37	22	11	7	131	115	3.8	4	41	30
	10	37	23	12	14	135	107	3.3	3	9	9
	50	35	49	11	18	131	147	3.0	2	7	12
	100	25	22	12	19	116	113	2.3	2	9	18
	Means	**34**	**29**	**11**	**15**	**128**	**121**	**3**	**3**	**17**	**17**
M-3	2	66	22	13	7	204	106	3.7	1	6	2
	10	49	50	10	11	156	138	3.5	2	6	17
	50	29	22	20	110	127	142	2.1	6	8	16
	100	20	17	13	17	119	99	2.0	2	8	18
	Means	**41**	**28**	**14**	**36**	**151**	**121**	**3**	**3**	**7**	**13**
M-4	2	18	4	11	3	103	85	2.3	1	8	13
	10	18	22	15	13	102	110	3.0	3	7	29
	50	10	3	17	25	98	73	1.6	1	6	2
	100	10	3	14	8	87	86	1.6	2	3	2
	Means	**14**	**8**	**14**	**12**	**97**	**89**	**2**	**2**	**6**	**11**
Dry Criteria		**≥3.5 µgN/L**		**≥2µgN/L**		**≥110 µgN/L**		**ns**		**≥16µgP/L**	

† distance from shore Red exceeds standard ns - no standard

the shore. Using the PacIOOS Regional Ocean Modeling System (ROMS), we can display water current movements off the southwestern coast of East Maui that occurred prior to our sampling event (see Figure 2).

The direction and timing of current flow are shown in Fig. 2 starting at 0200 hours and ending at 1100 hours on July 17, 2020. In this time period, water currents off the coast were moving in a southeasterly to southerly direction. Current velocity estimates indicate that during the monitoring event, water had flowed from an area off Wailea, about 1.3 nautical miles north of the MG&BC (PacIOOS, 2020).

Figure 2. Predicted water movement during morning hours (0200 to 1100 hours) off East Maui on July 17, 2020 (PacIOOS, 2020).

Discussion

Low salinity values, recorded during the July 17, 2020 sampling event (at all stations on Transect M-1 through Transect M-3) indicate that groundwater influx distant from the Mākena area and from the Mākena Resort vicinity influenced salinity values. Low nitrate+nitrite concentrations along Transect M-2 and Transect M-3, coupled with low salinity water, is not a usual occurrence, but could reflect a residence time of soluble nitrates in the water sufficient for phytoplankton uptake. Ammonium concentrations, generated from natural biological activities in the ocean, were somewhat elevated along Transects M-1 through M-3. Ammonium concentrations, however, are not typically related to salinity. Ortho-phosphate was present in low concentrations and had no correlation with salinity.

Nutrient Subsidies

Table 4 illustrates no groundwater nitrate+nitrite subsidies in nearshore marine waters on July 17. Nitrate+nitrite concentrations (based on salinity calculations) were not elevated at the 2 m stations along any transects.

Table 4. Estimated nitrate+nitrite subsidies at nearshore stations (2-m), July, 2020.

Well	Measured		Estimated	Subsidy
Transect	NO_3+NO_2	Salinity	NO_3+NO_2	NO_3+NO_2
	(µgN/L)	(PSU)	(µgN/L)	(µgN/L)
Seibu Wells	1933	1.33	---	---
M-1	42	32.74	76	0
M-2	22	32.40	76	0
M-3	22	32.15	77	0
M-4	4	33.97	73	0

Table 5 illustrates no groundwater ortho-phosphate subsidies in nearshore marine waters on July 17. Ortho-phosphate concentrations (based on salinity calculations) were not elevated at the 2 m stations along any transects. There was no subsidy at Sta. 2 m on Transect M-2 as background ortho-phosphate concentration (2 µg/L at Sta. 100 m on Transect 4) was subtracted for subsidy estimate.

Irrigation and Fertilizer Tracking

We track turf and landscape fertilization/irrigation data on a monthly basis (data provided by Jonathan Galicinao at MG&BC). Nutrient concentrations are measured in several irrigation supply wells on each sampling event. Figures 3, 4, and 5 present our comparison of unused fertilizer residual (blue bars) with

Table 5. Estimated ortho-phosphate subsidies at nearshore stations (2-m), July, 2020.

Well	Measured		Estimated	Subsidy
Transect	NO_3+NO_2	Salinity	PO_4	PO_4
	(µgN/L)	(PSU)	(µgN/L)	(µgN/L)
Seibu Wells	1933	1.33	---	---
M-1	3.0	32.74	3.0	0
M-2	4.0	32.40	3.0	0
M-3	1.0	32.15	3.0	0
M-4	1.0	33.97	3.0	0

actual sampling event nitrate+nitrite concentrations (red circles) at 2 m stations. For these plots, we assume that 80 percent of applied nitrate+nitrite fertilizer concentrations are absorbed by plant material or otherwise lost and do not reach the groundwater (Johnson et al., 2018).

In the figures that follow, our calculated nitrate+nitrite subsidies calculated for 2-m stations are plotted as red dots. Note that the greatest applications of nitrate+nitrite fertilizer occurred in February and June 2019, and January and June 2020. At Transect M-1, excess nitrate+nitrite concentrations were highest in March and August 2019, and February 2020, about one to two months after elevated fertilization application. However, in December 2018, Transect M-1 peaked as high as the August 2019 value, but without a preceding elevated fertilization. The apparent lack of response in July 2020 to the application spike preceding may be due to the short period of time between application and the monitoring event.

At Transect M-2 (Fig. 4), similar nitrate-nitrite peaks were recorded following February 2019 and January 2020 application peaks. but not following the June 2019 peak, perhaps because of the longer delay until the monitoring event. The situation at M-3 is identical to that demonstrated at M-2.

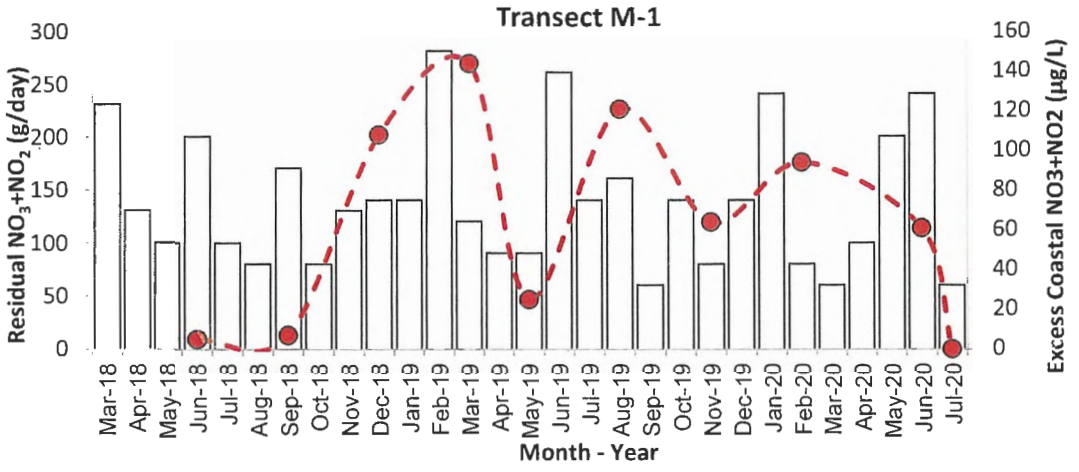

Figure 3. Mean daily application of nitrate+nitrite to golf course turf and landscaping (blue bars; g/day) and excess calibrated nitrate+nitrite (red circles µg/L) at 2-m station on Transect M-1.

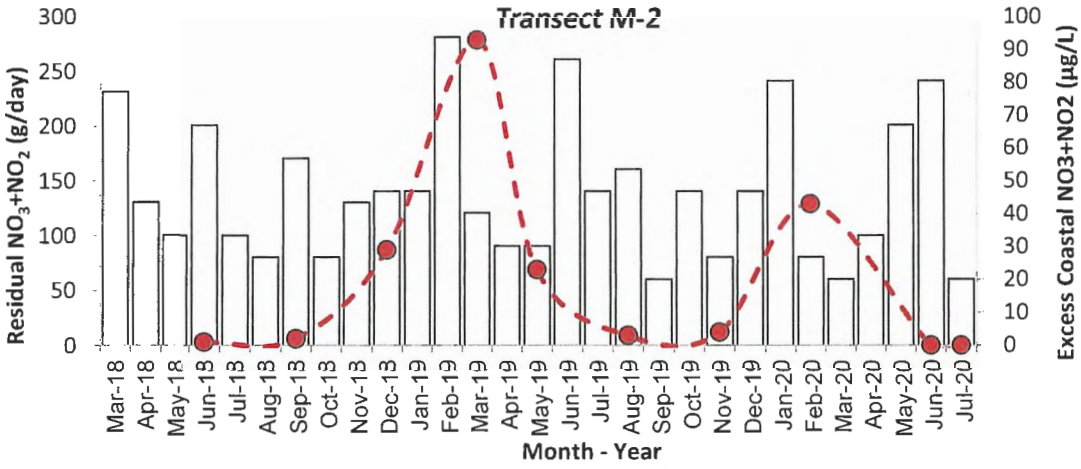

Figure 4. Mean daily application of nitrate+nitrite to golf course turf and landscaping (blue bars; g/day) and excess calibrated nitrate+nitrite (red circles µg/L) at 2-m station on Transect M-2.

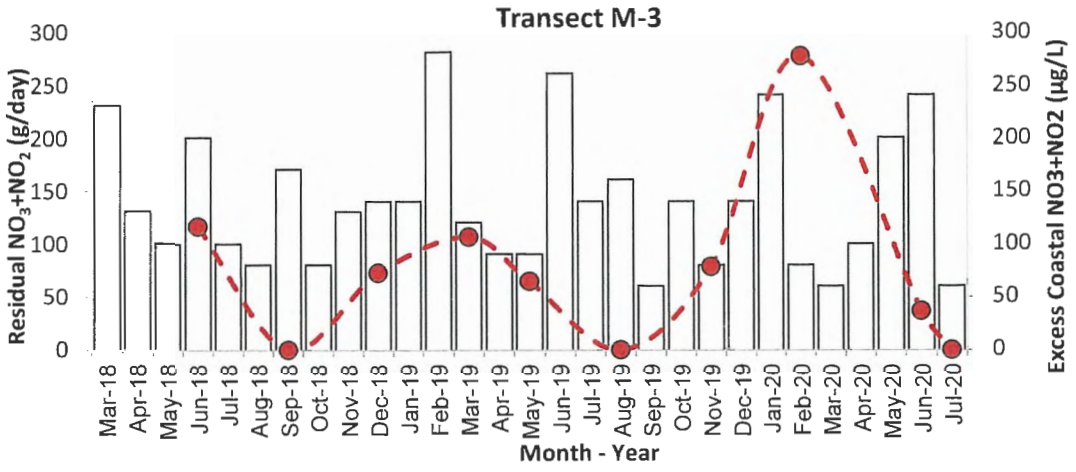

Figure 5. Mean daily application of nitrate+nitrite to golf course turf and landscaping (blue columns; g/day) and excess calibrated nitrate+nitrite (red circles µg/L) at 2-m station on Transect M-3.

Our sampling protocol and the turf managers' fertilizer application schedule are not connected in any way. Therefore, additional water quality measurements over a long period will be required to establish if any valid relationship exists between fertilizer application amounts and our salinity-based method[3] of **detecting "excess" nitrate+nitrite in the waters directly offshore** If needed and as additional data accumulates, we should be able to recommend changes to fertilizer application methods that will meet golf course and landscape requirements, while also minimizing measureable effects on nearshore water quality.

Nutrient Limitation

Inorganic nitrogen and phosphorus compounds are typically identified as **potentially "limiting" nutrients in** Hawaiian marine waters. Increases in a limiting nutrient concentration can result in enhanced growth of phytoplankton and macroalgae. Excessive algal growth has happened in the coastal waters off Kīhei due to increased discharge of both nitrogen and phosphorus compounds from the Kīhei Wastewater Treatment Plant (Laws et al., 2004; Dailer et al., 2010). Maintaining low limiting nutrient concentrations is essential to maintaining a pristine and diverse marine biological community.

[3] Explained in detail in *AECOS*, 2018, p. 10-11.

We can estimate the limiting nutrient (nitrogen or phosphorus) by comparing molar ratios (N:P ratios) of dissolved inorganic nitrogen (DIN: nitrate, nitrite, and ammonium) to dissolved inorganic phosphate (DIP: ortho-phosphate). N:P ratios for 20 Hawaiian algal species range from 15:1 to 44.1 with an average of about 29:1 (Atkinson and Smith, 1983). High N:P ratios (>29.1) are related to DIP limitation, whereas low N:P ratios (<29.1) are related to DIN limitation. Analyses using accumulating data averages can be useful to decipher trends and **sufficient nutrient and chlorophyll α data are not presently available to make** statistical inferences regarding actual limiting nutrient determinations in **Mākena waters.**

Table 6. A summary of average DIN and DIP values for ten monitoring events (June, 2018 – June, 2020) and July 2020.

Transect	**DFS†** (m)	**DIP** (µM/L)		**DIN** (µM/L)		**DIN:DIP** ratio		**N/P Limited** potential	
		Means	July 2020	Means	July 2020	July 2020	July 2020	July 2020	July 2020
M-1	2	0.08	0.10	6	5	78	50	P	P
	10	0.07	0.13	5	10	79	77	P	P
	50	0.07	0.06	5	6	72	87	P	P
	100	0.04	0.03	4	4	98	133	P	P
M-2	2	0.12	0.13	3	2	27	16	N	N
	10	0.11	0.10	4	3	33	27	P	N
	50	0.10	0.06	3	5	35	74	P	P
	100	0.07	0.06	3	3	37	45	P	P
M-3	2	0.12	0.03	6	2	47	64	P	P
	10	0.11	0.06	4	4	37	68	P	P
	50	0.07	0.19	4	9	52	49	P	P
	100	0.06	0.06	2	2	36	38	P	P
M-4	2	0.07	0.03	2	0	28	14	N	N
	10	0.10	0.10	2	3	24	26	N	N
	50	0.05	0.03	2	2	38	62	P	P
	100	0.05	0.06	2	1	33	12	P	N

N:P ratios can vary, as shown in Table 6, from place to place along the coast. For example, during the present sampling event, N:P values for monitoring stations along M-1 and M-3 transects were DIP limited, due to the fact that DIN values were high along these transects. N/P limitation can also vary between stations along individual transects, as shown in Transects M-2 and M-4. different algal species represent a wide range of N:P requirements (Atkinson & Smith, 1983), Constantly changing ratios prevent extensive growth of just one or a few species, maintaining diversity (of algae and the food chain).

Summary

The July 17, 2020 monitoring event revealed the somewhat unusual circumstance of low salinities and low nitrate+nitrite concentrations in these waters compared with historic means. Ortho-phosphate values were low but comparable to historic means.

Current tracking with the PacIOOS modeling system indicates currents were moving in a southeasterly to southerly direction prior to and during the July 17, 2020 sampling event. Ocean water had traveled about 1.3 nautical miles from Wailea area to **Mākena** by 1100 hours.

Subsidies for nitrate+nitrite concentrations were not present at any of the 2-m stations in the survey area. There were also no subsidies for ortho-phosphate at any transect.

DIN to DIP ratios indicate that DIP was the presumptive limiting nutrient for algal growth along transects M-1 and M-3. DIN was the limiting nutrient along transects M-2 and M-4 at the2 m and 10 m stations.

References

AECOS, Inc. (*AECOS*). 2016. Marine biological surveys for the proposed **Mākena** Resort M-5/M-6/S-7/B-**2 project, Mākena, Maui. ATC Mākena Holdings,** LLC. *AECOS* No. 1470A: 56 pp.

_____. 2018. Makena Golf & Beach Club quarterly water quality sampling event. July 2018. Prep. for Makena Golf & Beach Club. *AECOS* No. 1535A: 15 pp.

_____. 2019a. Mākena Golf & Beach Club, 2018 annual water quality monitoring report. Prep. for Mākena Golf & Beach Club. *AECOS* No. 1535C: 30 pp.

_____. 2019b. Mākena Golf & Beach Club, 2019 annual water quality monitoring report. Prep. for Mākena Golf & Beach Club. *AECOS* No. 1535G: 21 pp.

_____. 2020. Marine biological surveys for the proposed Mākena Future Lands Project, Mākena, Maui. Pep, for AREG AC Mākena Propco LLC. *AECOS* No. 1602: 64 pp.

Atkinson, M. J. and S. V. Smith. 1983. C:N:P ratios of benthic marine plants. *Limnol. & Oceangr.*, 28(3): 568-574.

Dailer, M. L., R. S. Knox, J. E . Smith, M. Napier, and C. M. Smith. 2010. Using $\delta^{15}N$ values in algal tissue to map locations and potential sources of anthropogenic nutrient inputs on the island of Maui, Hawai'i, USA. *Mar. Poll. Bull.* 60(5): 655-671.

Hawaii Department of Health (HDOH). 2014. Hawai'i Administrative Rules, Title 11, Department of Health, Chapter 54, Water Quality Standards. November 15, 2014. 110 pp.

_____. 2018. 2018. State of Hawai'i water quality monitoring and assessment report: integrated report to the U.S. Environmental Protection Agency and the U.S. Congress pursuant to §303(3) and §305(b), Clean Water Act (P.L. 97-117). 127 pp.

Hawai'i Department of Land and Natural Resources (HDLNR). Status of Maui's Coral Reefs. URL: http://dlnr.hawaii.gov/dar/files/2014/04/-MauiReef Declines.pdf.

Johnson, A. G., J. A. Engott, M. Bassiouni, and K. Rotzoll. 2018. Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai'i, 1978-2007. Scientific Investigations Report 2014-5168. Version 2.0, February 2018. U.S. Department of the Interior & U.S. Geological Survey. 64 pp.

Laws, A. E., D. Brown, and C. Peace. 2004. Coastal water quality in the Kihei and Lahaina districts of the Island of Maui, Hawaiian Islands: impacts from physical habitat and groundwater seepage: implications for water quality standards. *Inter. J. Environ. Poll.*, 22(5): 531-546.

Marine Research Consultants, Inc. (MRC). 2011. An evaluation of causal factors affecting coral reef community structure in Ma'alaea Bay, Maui, Hawaii. Job No. WW09-22. Prep. for County of Maui. 84 pp.

National Oceanic and Atmospheric Administration (NOAA). 20209. Tide Predictions for gauge 1615202, Makena, HI. Available at URL: https://tidesandcurrents.noaa.com. Last observed on February 19, 2020.

Pacific Islands Ocean Observing System (PacIOOS). 2020. Available online at URL: https://www.pacioos.hawaii.edu/currents-category/model/; last accessed on July 30, 2020.

Standard Methods (SM). 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition. American Public Health Association, American Water Works Association, Water Environment Federation.

_____. 2017. Standard Methods for the Examination of Water and Wastewater, 23rd Edition. American Public Health Association, American Water Works Association, Water Environment Federation.

U.S. Environmental Protection Agency (USEPA). 1993a. Method 353.2 Revision 2.0: Determination of Nitrate-Nitrite Nitrogen by Automated Colorimetry. National Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268. 15 pp.

_____. 1993b. Method 180.1: Determination of Turbidity by Nephelometry. Version 2. Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268. 11 pp.

_____. 1997a. Method 349.0: Determination of Ammonia in Estuarine and Coastal Waters by Gas Segmented Continuous Flow Colorimetric Analysis. National Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268. 16 pp.

_____. 1997b. Method 365.5: Determination of Ortho-Phosphate in Estuarine and Coastal Waters by Automated Colorimetry Analysis. National Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268. 9 pp.

U.S. Geological Society. (USGS). 2018. Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, **Hawai'i, 1978**-2007. Scientific Investigations Report 2014-5168. U.S. Department of the Interior. U.S. Geological Survey. 64 pp.