

**Marine surveys for the proposed repair and
maintenance of Hotel Wharf, Apra Harbor, Guam**

Submitted by
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Prepared for
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March 29, 2019

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1. INTRODUCTION

1.1. Project Background

The Port Authority of Guam (PAG) is proposing to carry out repair and maintenance activities at Hotel Wharf and approximately 1.6 km (1 mi) of adjacent access road within the Jose D. Leon Guerrero Commercial Port, Apra Harbor. The wharf repair will involve the removal and replacement of the existing cap, the installation of new tie rods and anchoring, the driving of new sheet pile outside of the existing structure, backfilling the new sheet pile, and capping. In order to adequately assess the potential impacts to corals and other reef benthos within the areas expected to be impacted by the repair and maintenance of Hotel Wharf, and to obtain information required to avoid and minimize these impacts, Duenas, Camacho & Associates, Inc. (DCA) contracted the author to conduct a survey of corals, benthic cover, macroinvertebrates, and Endangered Species Act (ESA)-listed or candidate species that occur within the project area. This report provides the results of the surveys and includes recommendations to assist with the permitting requirements for the proposed project. A more detailed description of the project is presented in a report submitted previously by AMEC Environmental & Infrastructure, Inc. (AMEC) (2014).

1.2. Scope of work

The relevant resource agencies are requiring marine surveys for the submerged south, west, and east sides of Hotel Wharf, as well as the seafloor occurring in the vicinity of the wharf. The area of seafloor targeted for surveys extends 30 m from the base and sides of the wharf; this area includes the area of seafloor where the new wharf face will occur, as well as the area of seafloor that would be contained within a silt curtain during construction. Additionally, discrete patch reefs that occur within the 30 m impact area, but which are not intersected by the transects, as well as those patch reefs and other natural hardbottom communities that occur within 50 m from the wharf will also be surveyed, as these communities may be indirectly impacted by degraded water quality during construction. The resource agencies are requiring the following information be obtained for the wharf sides and the seafloor in the vicinity of the wharf:

- Hard coral colony density and size class data
- Benthic cover estimates
- Large mobile macroinvertebrate density data
- Detailed location information for any listed and candidate threatened or endangered species occurring within the vicinity of the project

2. METHODS

2.1. Site description

Hotel Wharf is part of the Jose D. Leon Guerrero Commercial Port, which is located on the north side of Apra Harbor (Figure 1). The harbor hosts Guam's only deep (>40 m) lagoon environment, bounded to the south by Orote Peninsula and to the north by Cabras Island and the Glass Breakwater. Following World War II, the breakwater was built across the Luminao barrier reef and the Calalan Bank, a submerged bank that extends westward of the reef. The depth of the harbor and its relatively calm water conditions facilitate significant commercial, military, and recreational activities, but also support an environment unique among the islands of the Mariana Archipelago. This important marine environment is comprised of several biophysical zones, each supporting distinct marine communities, and hosts a large number of species not found anywhere else in Guam's waters (Paulay et al. 1997).

Hotel Wharf occurs within the Zone II designated by Paulay et al. (1997), which corresponds to the original backreef of Luminao Reef. The wharf interrupts a shallow (~1.5 m) reef flat that extends from the western side of Cabras Island in the east to the western edge of the Luminao barrier reef in the west. The area of reef flat immediately to the west of Hotel Wharf extends approximately 80 m from the shore, which is comprised a mix of riprap and naturally-accumulated sand, to the southern edge of the flat. The reef flat to the east of the wharf extends approximately 15 m from riprap to the southern edge of the flat. The reef flat adjacent to both sides of the wharf both abruptly drop 2–3 m to a sandy slope. The sandy slope extends southward, dropping more steeply from the edge of the reef flat to an area approximately in line with the southern wharf face, then sloping gradually across a distance of about 70 m before sloping more steeply to the lagoon bottom.

The southward-oriented wharf face is 153 m (~500 ft) across, and both the eastern and western sides extend approximately 22 m (~59 ft) from the adjacent riprap on shore, for a total wharf length of 192 m (~629 feet) below the mean high-water mark. The wharf face extends to a depth of approximately 9 m (~30 ft) at the mudline, while the eastern and western wharf sides extend southward, and perpendicular to, the riprapped shoreline, across the shallow (1.5 m) reef flat to a maximum depth of approximately 8–9 m. Based on figures provided by DCA, the surface area of the existing submerged vertical sheet pile is approximately 1395 m². This area estimate does not account for the ribbed topography of the sheet pile, but was considered suitable for calculating area coral colony count estimates, as coral colonies almost entirely absent from the shaded, recessed sides of the sheet pile.

The primary area of seafloor targeted for surveys extends 30 m from the base of the sheet pile wall on the west, south, and east sides of the wharf; this area includes the area of seafloor where the new wharf face will occur, as well as the area of seafloor that would be contained within a silt curtain during construction. The 30 m wide indirect impacts area was initially proposed by a previous contractor, AMEC, and approved by the relevant agencies. However, information provided to the author after the scope of the current study was approved and field work had begun indicated that the silt curtain could be placed as close as 12 m from the existing wharf face. Additionally, discrete patch reefs and other areas of hardbottom that occur within the 50 m impact area were also surveyed, as these communities may be indirectly impacted by degraded water quality or anchor damage during construction.

2.2. General survey approach

All surveys were carried out by a team of three biologists, including the author, a subcontracted coral biologist (Roxanna Miller), and a biologist (Devin Keogh) employed with DCA across five days between January 19 and February 2, 2019. The coral colony, benthic cover, and macroinvertebrate surveys occurred along transects placed on the three wharf sides, the seafloor at the base of the wharf, and the area of seafloor extending 30 m from the wharf sides. Additional transects were placed along a relatively large area of aggregate reef and mixed sand/hardbottom that runs roughly parallel to, and approximately 25 m from, the south wharf face. Transects were not used for the small (< 5 m in longest dimension) patch reefs occurring within the survey area; instead, all corals and large mobile macroinvertebrates were censused, and benthic cover was measured, for the whole patch reef.

A total of nine 50-meter-long transects were surveyed on the southern wharf face, including three sets of transects placed nearly end-to-end at depths of 1 m, 5 m, and 9 m (Figure 2). The transects placed along the 1 m depth contour targeted a concrete beam that extends 30 cm from the wharf just below the sea surface (Figure 23). Review of video footage taken in November 2013 by AMEC revealed the presence of hard corals along this beam, but fewer reef-building corals in the shaded underside of the beam. It should be noted, however, that numerous non-reef-building dendrophylliid corals (a.k.a. “tube corals” or “sun corals”) were known to occur on the underside of the beam. An additional set of two transects each were surveyed on the east and west sides at depths of 1 m and 5 m (Figure 2).

A set of three 50 m transects were placed nearly end-to-end along the base of the south wharf face, at a distance of approximately 1.5 m from the wharf, in order to assess the area of seafloor that will be directly impacted by the placement of the new wharf face and sides (Figure 4). Similar seafloor transects (22 m and

25 m long, respectively) were placed along the east and west wharf sides at the same offset distance from the base of the wharf.

A set of sixteen 30 meter-long transects were placed at regular intervals (every 15 m), and extending perpendicularly from, the bottom of the wharf sides in order to assess marine communities that may occur within the area encompassed by the silt curtain (Figure 5). Benthic photo transect surveys were carried out along two additional seafloor transects (transects A and B, Figure 5) on March 9 to increase the sample size for the reef flat areas adjacent to the wharf. Two 30 m transects were placed on the area of mixed sand and hardbottom occurring parallel to the wharf face, and one 50 m and one 35 m transect were placed on the area of aggregate reef also occurring parallel to the wharf face (Figure 5). Portions of these areas of hardbottom extended several meters beyond the 30 m distance from the wharf face, but all data collected on these areas were included in the analysis. All patch reefs occurring within an area extending 50 m from the wharf were mapped, their area estimated, and marine communities assessed (Figure 6). While many of the patch reefs occurred at a distance greater than 30 m from the wharf face, data collected at all surveyed patch reefs were included in the analysis. A Global Positioning System (GPS) receiver placed on a float was used in combination with a camera calibrated with the GPS to generate location information for the patch reefs, Endangered Species Act (ESA) listed or candidate species, and other notable features. The images were georeferenced using the RoboGEO software application and maps were generated using QGIS, an open-source Geographic Information System (GIS) application.

2.3. Coral colony survey

All coral colonies occurring within a one-meter-wide belt centered on the transect tape were identified and sized (longest dimension to nearest cm) along all wharf sides and all seafloor transects except the two additional transects later surveyed on the reef flat adjacent to the wharf. All coral colonies occurring on small (< 5 m in longest dimension) patch reefs located within 50 m of the wharf face were censused. Colony density estimates for the shallow (1 m) wharf face transects were calculated using area values that accounted for the additional survey area added to the width of the shallow transects on the wharf face and sides by the concrete beam that extended 30 cm from the wharf.

2.4. Benthic cover survey

Benthic photo transect surveys were carried out across the length of all sides of the wharf face as well as the seafloor transects. Images were obtained every meter along the left side of the transect using a compact point-and-shoot camera placed atop a PVC pipe monopod. A single planar-view image was obtained for

each patch reef. Images were imported from the Secure Digital (SD) card into Adobe Lightroom software and a batch white balance adjustment was applied to groups of images with similar white balance characteristics. Images were then exported and renamed.

Benthic cover estimates were generated through an analysis of the photo transect images using the Coral Point Count with Excel Extension (CPCe) application. A total of 16 points were overlaid on each image using a random-stratified approach, whereby a single point was randomly placed within each cell of a four by four grid placed over the image. The benthic feature falling under each point was identified. Hard corals were identified to species when possible, although some taxa, such as massive *Porites*, *Montipora*, and others, often could not be identified to species level using the photo transect images. Other biological cover types identified in the point count analysis include soft corals and sponges. All other points were classified as occurring on hardbottom, unconsolidated sediment, or debris. Due to the small size of the patch reefs and the limited number of visible coral colonies, it was determined that more accurate estimates of percent coral cover would be obtained by utilizing the area measurement function of CPCe to delineate the area of each patch reef and all visible coral colonies. The cover of sponges was not assessed for patch reefs; no soft corals were observed on the patch reefs.

2.5. Macroinvertebrate survey

All mobile macroinvertebrates were identified and counted within two-meter-wide belt transects centered on the transect tape for all transects. Patch reefs were also censused for mobile macroinvertebrates. As with the coral belt transect surveys, the macroinvertebrate belt transect area—and thus the macroinvertebrate density calculations—accounted for the additional area added to the width added to shallow wharf face transects by the concrete beam.

2.6. ESA-listed or candidate species survey

All listed or candidate ESA species observed on the wharf sides or within an area extending 50 m from the wharf were noted and their location recorded using geo-referenced images. Any listed or candidate ESA species incidentally observed beyond the 50 m area were also recorded. A comprehensive list of all listed or candidate ESA species known or expected to occur in the waters around Guam is provided in Appendix A.

3. RESULTS AND DISCUSSION

3.1. Overview

The results of the multiple surveys are presented separately for the areas expected to be directly (Direct Impacts Zone) and indirectly (Indirect Impacts Zone) impacted by activities associated with the proposed repair and maintenance of Hotel Wharf. In consideration of the possibility that the silt curtain may be placed closer to the wharf than the original 30 m estimate, the Indirect Impacts Zone is further divided into the 30 m Indirect Impacts Zone and the 20 m Indirect Impacts Zone. Areas expected to be directly impacted by the proposed project activities include the wharf sides and the area of seafloor extending 2.4 m, 1.9 m, and 3 m from the base of the west, south, and east wharf sides, respectively. It is anticipated that all of the corals and other benthic organisms occurring in the Direct Impacts Zone will experience total mortality. Areas expected to be indirectly impacted by the proposed project activities include the area of seafloor and water column located between the expected location of the newly constructed wharf face and the inner side of the silt curtain; the silt curtain is expected to be placed at either 30 m or 20 m from the planned location of the newly constructed wharf face.

3.2. Direct Impacts Zone

As described above, the Direct Impacts Zone includes the wharf face and the area of seafloor extending 2.4 m, 1.9 m, and 3 m from the base of the west, south, and east wharf sides, respectively. The construction of the new wharf face and sides will result in the mortality of all benthic organisms within the direct impact area, and potentially of small mobile, site-attached, organisms associated with benthos within the direct impact area.

3.2.1. Qualitative observations

All sides of the wharf face hosted similar benthic communities, although some differences in the abundance and diversity of macrophytes and turf algae—likely related to light exposure— were observed. Common conspicuous algae taxa on the wharf face included the erect macrophytes *Padina* sp., *Dichotomaria marginata*, *Tricleocarpa fragilis*, *Halimeda* spp., and *Dictyota* spp., as well as several unidentified adherent fleshy and crustose coralline species. Solitary and colonial ascidians and encrusting sponges were also common on the wharf face, and an unidentified oyster species was abundant in the area of the wharf face above a depth of about 1 m. The abundance, biomass, and diversity of benthic organisms generally decreased with depth along the wharf face, likely in response to the reduction in light and greater accumulation of sediment (Figures 24–25). The benthic community occurring on the shaded underside of

the concrete beam was distinct from other areas of the wharf face, being primarily comprised of encrusting sponges, crustose coralline algae, and *Halimeda* spp., with few other macrophytes. This area also hosted numerous dendrophylliid corals, also known as tube or sun corals (Figure 26), and at the southeast corner numerous colonies of an octocoral—possibly the non-native species, *Carijoa riisei* (snowflake coral)—were observed (Figure 27).

Benthic communities occurring on the seafloor at the base of the wharf face can be broadly divided into those occurring on the hardbottom of the reef flats to the east and west of wharf and those occurring on the sandy slope and flat at the base of the south wharf face and the deeper portions of the east and west sides. The benthic communities on the reef flat were dominated by fleshy erect macrophytes such as *Padina* sp., *Halimeda* spp., *Dichotomaria marginata*, and *Dictyota* spp. (Figure 28). The sandy slope and flat at the base of the south wharf face and the deeper portions of the eastern and western sides hosted a mix of uncolonized sand/silt and debris primarily colonized with sediment-laden turf algae, but also hosting the occasional sponge or hard coral colony (Figure 29).

3.2.2. Coral diversity, colony density and colony size

A total of 2739 coral colonies, at a mean density of 3.4 ± 2.6 col/m², were recorded along transects surveyed within the Direct Impacts Zone, with 2529 (92%) observed on the wharf sides at a mean density of 4.4 ± 2.5 colonies/m² and 210 (8%) observed on the transects surveyed at the seafloor along the base of the wharf at a mean density of 1.1 ± 0.3 colonies/m² (Table 1, Figure 7). Colony density values for all taxa are provided for all transects surveyed on the wharf sides in Appendix B, and for the transects surveyed at the base of the wharf in Appendix C.

Based on relative abundance values derived from the belt transect survey colony counts, the coral community across the wharf face and sides was comprised primarily of *Leptastrea purpurea* (39% of all colonies), dendrophylliid sp. (26%), *Pocillopora damicornis* (12%), and massive *Porites* spp. (6%). However, different assemblages were observed in association with distinct, depth-influenced habitat types that spanned the wharf sides. The coral community occurring on and immediately above the beam was comprised primarily by *Leptastrea purpurea* (53%), *Pocillopora damicornis* (18%), dendrophylliid sp. (16%), and unidentified *Leptastrea* species (7%), while the community observed at the mid-depth (5 m) and deep (9 m) transects on the wharf face and sides was comprised primarily of dendrophylliid sp. (43%), *Leptastrea purpurea* (16%), massive *Porites* spp. (14%), and *Stylocoeniella armata* (6%) colonies. The relatively low-density coral community occurring on the seafloor at the base of the wharf was also distinct,

primarily comprised of massive *Porites* spp., *Stylocoeniella armata*, *Pocillopora damicornis*, and *Lobophyllia hemprichii*.

A total of 43 coral taxa were observed within the Direct Impacts Zone, including 35 coral taxa observed on the wharf sides and 29 observed at the wharf base. Note that species counts are likely underestimates, as multiple species may be identified as the single taxon (e.g., “*Porites* sp. -massive”) because of the difficulty in identifying these species in the field.

Mean colony diameter for all colonies observed on transects surveyed within the Direct Impacts Zone was small, at 4.8 ± 6.2 cm (Table 1, Figure 9). Mean colony diameter of colonies observed on transects surveyed on the wharf sides was similarly small (4.3 ± 5.5 cm), influenced by the large number of small *Leptastrea purpurea* colonies, while mean colony diameter for the seafloor at the base of the wharf, which hosted fewer small *Leptastrea* colonies, was larger, at 10.8 ± 9.3 cm.

Based on the colony density values derived from the count values obtained for the belt transect surveys and the area of substrate, it is estimated that 6528 coral colonies occur within the Direct Impact Zone, including 6071 on the wharf face and 428 on the seafloor at the base of the wharf (Appendix I).

3.2.3. Benthic cover

Benthic cover estimates for areas within the Direct Impacts Zone were derived from a total of 703 benthic photo transect images, including 56 images obtained from the total of four transects placed along the east and west wharf sides, 450 images from nine transects placed along the south wharf side, and 197 images from the five transects placed along the base of the wharf. Mean percent cover of hard corals, soft corals, sponges, other hardbottom, unconsolidated sediment, and debris are presented for each survey area within the Direct Impacts Zone (Tables 2–3) and can be visualized in Figures 11–12. Percent cover values for each transect within the Direct Impacts Zone are provided in Appendix K (south wharf side), Appendix L (east and west wharf sides), and Appendix M (wharf base), and can be visualized in Figures 15–16.

Mean percent coral cover across all depths for the east, west, and south wharf sides was $0.5 \pm 0.7\%$, $2.3 \pm 1.0\%$, and $0.6 \pm 0.4\%$, respectively. Coral cover, averaged across all transects on the wharf was $0.9 \pm 0.8\%$. Mean coral cover on the seafloor at the base of the entirety of the wharf was $0.6 \pm 0.3\%$, and was 0.3% , 1% , and $0.5 \pm 0.2\%$ for the east, west, and south sides, respectively. A mixed algal assemblage comprised of erect and adherent macrophytes described in Section 3.2.1 was by far the most dominant cover type on

the wharf sides (“Other hardbottom”, ~97%). Soft coral and sponge percent cover were relatively low on the wharf sides ($0.1\% \pm 0.3\%$, and $2.1 \pm 2.3\%$, respectively), although the difficulty of discerning encrusting sponges from other benthic cover types may have resulted in an underestimation of total sponge cover. The seafloor at the base of the wharf, which included both reef flat hardbottom and sand/debris habitat, was covered by a mixed algal assemblage on hardbottom areas, sand, and debris, with each cover type comprising approximately a third of the total cover for the area. Sponge cover was very low (0.2 ± 0.3) and soft corals were not detected for the seafloor at the base of the wharf.

3.2.4. Macroinvertebrate diversity and density

A total of 130 mobile macroinvertebrates representing 14 species were observed in belt transects surveys within the Direct Impact Zone, for a total density of 0.09 ± 0.1 ind/m², including 97 individuals (0.07 ± 0.09 ind/m²) representing 12 species on the wharf sides and 33 individuals (0.12 ± 0.13 ind/m²) representing 7 species along the base of the wharf (Table 6, Figure 21). The most commonly observed macroinvertebrate taxa in the Direct Impacts Zone were *Diadema* sp., *Actinopyga echinites*, *Echinometra mathaei*, and *Culcita novaeguineae*, with *Diadema* sp., *A. echinites* and *C. novaeguineae* dominant on the wharf sides and *E. mathaei*, *A. echinites*, and *C. novaeguineae* dominant on the seafloor at the base of the wharf. The most abundant taxa in the Direct Impacts zone, the long-spined sea urchin (*Diadema* sp.), was almost exclusively observed in recesses in the underside of the shallow beam across the wharf sides. Density values for all macroinvertebrate taxa observed within each of the belt transects placed on the wharf are provided in Appendix Q, while values for transects placed along the base of the wharf are provided in Appendix R.

3.2.5. ESA-listed or candidate species

No ESA-listed or candidate species were observed in the vicinity of the project site.

3.3. Indirect Impacts Zone

As described above, the Indirect Impacts Zone includes the area of seafloor located between the wharf face and the inner side of the silt curtain; the silt curtain was originally expected to be placed approximately 30 m from the wharf face, but more recent information indicates that it may be placed closer and that the area of indirect impacts may extend 20 m from the wharf face. In consideration of this new information, data are presented for both the 30 m and 20 m Indirect Impacts Zones when appropriate. The difference between the impacts associated with a 30 m or 20 m indirect impacts buffer distance is significant, and is not proportional to the difference in the area of these two buffer zones, as an area of aggregate reef and mixed sand and hardbottom with much higher coral cover than the surrounding sandy areas occurring parallel to

the wharf face would partially fall within the 30 m buffer. If the silt curtain is placed 20 m from the wharf the aggregate reef and mixed sand/hardbottom areas would fall outside of the silt curtain and there would be a 3 m or more separation from the silt curtain anchors. Unless highly turbid water escapes the silt curtain or anchors are improperly placed, impacts to the benthic communities associated with these areas are likely to be minimal or avoided entirely if the 20 m Indirect Impacts Zone is implemented.

3.3.1. Qualitative observations

The seafloor within the Indirect Impacts Zone includes distinct bottom types, each supporting different benthic assemblages. The benthic communities on the shallow reef flat areas occurring adjacent to the eastern and western wharf sides were similar, being dominated by the erect macrophytes *Padina* sp., *Halimeda* spp., and *Galaxaura rugosa*, and supporting some coral taxa, such as *Pavona decussata* and *Porites cylindrica*, that were not observed elsewhere in the project site (Figure 28). The slope and flat occurring at the base of the southern wharf face and the deeper portion of the wharf sides is primarily covered by uncolonized sand, but debris and hardbottom, including the surveyed patch reefs and smaller patches of hardbottom colonized by turf algae and *Halimeda* spp. are scattered across the area (Figures 30 and 33). The area of hardbottom occurring at the seaward edge of the 30 m Indirect Impacts Zone, and extending up to 40 m from the wharf face, can be broadly divided into an area of mixed sand and hardbottom (Figure 31) and an aggregate reef area that is primarily hardbottom and hosts more coral growth (Figure 33). The hardbottom within the mixed sand/hardbottom and aggregate reef areas hosts a benthic community similar to that of other hardbottom occurring elsewhere in the Indirect Impacts Zone, primarily dominated by turf algae and *Halimeda* spp., with *Porites rus* and, to a lesser degree, other coral taxa, also comprising a notable proportion of the benthic community in the aggregate reef area.

3.3.2. Coral diversity, colony density and colony size

A total of 1283 coral colonies, at a mean density of 2.1 ± 1.6 col/m², were recorded along transects surveyed within the Indirect Impacts Zone, with 531 observed on the seafloor transects perpendicular to the wharf face at a mean density of 1.1 ± 0.8 col/m², 510 on the transects surveyed on the area of hardbottom occurring parallel to the south wharf face at a mean density of 3.5 ± 2.2 col/m², and 242 on the 26 surveyed patch reefs at a mean density of 2.5 ± 1.6 col/m² (Table 1, Figure 8). Colony density values for all taxa are provided for all of the seafloor transects placed perpendicular to the wharf face in Appendix D, for the transects in the mixed sand/hardbottom and aggregate reef areas in Appendix E, and for individual patch reefs in Appendix F (patch reefs 1–13) and Appendix G (patch reefs 14–26).

Based on relative abundance values for colonies observed across the entirety of the Indirect Impacts Zone, the coral community across this area was comprised primarily of *Porites rus* (31% of all colonies), massive *Porites* spp. (18%), unidentified *Astreopora* spp. (9%), and *Astreopora gracilis* (8%). However, as with the Direct Impacts Zone, different coral assemblages were observed in association with distinct habitat types within the Indirect Impact Zone. The coral community occurring on the reef flat transects placed perpendicular to the wharf face and sides was comprised primarily of massive *Porites* spp. (39%), *Pocillopora damicornis* (27%), *Pavona decussata* (10%), and *Porites rus* (10%), while the community observed on the transects placed across the sand flat was comprised primarily of *Porites rus* (23%), *Astreopora gracilis* (16%), massive *Porites* spp. (15%), a massive *Porites* species tentatively identified as *P. stephensoni* (12%), and unidentified *Astreopora* spp. (10%). The area of mixed sand/hardbottom hosted a coral community comprised primarily of *Porites rus* (34%), unidentified *Astreopora* spp. (29%), and massive *Porites* spp. (12%), while the adjacent aggregate reef area with a greater proportion of hardbottom and higher coral cover hosted a coral community dominated by *Porites rus* (68%), with some massive *Porites* spp. (9%) and *P. horizontalata* (7%). When considered in aggregate, the coral community of the surveyed patch reefs was primarily comprised of massive *Porites* spp. (20%), *Astreopora gracilis* (17%), and *A myriophthalma*.

A total of 39 coral taxa were observed across the entirety of the Indirect Impact Zone, with 13 observed on the reef flat transects, 20 on the sand flat transects, 19 on the hardbottom transects, and 23 across all surveyed patch reefs.

Mean colony diameter across the Indirect Impacts Zone (17 ± 21 cm) was significantly larger than that observed in the Direct Impacts Zone, likely a result of the relatively few *Leptastrea* colonies, the absence of dendrophylliid sp. colonies, and the relatively large *Porites rus* colonies in the Indirect Impacts Zone (Table 1, Figure 10). Mean colony diameter within the Indirect Impacts Zone was largest (19 ± 25 cm) in the aggregate reef hardbottom area occurring at the seaward extend of the zone, and smallest (13 ± 15 cm) on the reef flat adjacent to the east and west wharf sides.

Based on the colony density values derived from the count values obtained for the belt transect surveys and the area of suitable substrate, it is estimated that 7794 coral colonies occur within the 30 m Indirect Impacts Zone, including 2241 on the reef flat and 5055 on the sand flat. It is estimated that 4639 coral colonies occur within the 20 m Indirect Impacts Zone, including 1417 on the reef flat and 2978 on the sand flat. The colony count estimate for the Indirect Impacts Zone was determined using only the data from the transects

placed perpendicular to the wharf face, as these transects were placed in a systematic, unbiased manner within the zone, and the ends of some of which traversed portions of the mixed sand/hardbottom and aggregate reef areas. It is important to note that the colony estimates for the 20 m Indirect Impacts Zone are likely an overestimate, as the colony density values used to arrive at these estimates were from 30 m-long belt transects that extended into the aggregate reef and mixed sand/hardbottom areas that fall outside the 20 m buffer area but within the 30 m buffer area. The coral belt transects survey data could not be extracted for a 20 m length post-hoc, as it was not known at the time of the surveys that a 20 m buffer area is likely to be implemented.

3.3.3. *Benthic cover*

Benthic cover estimates for areas within the 30 m Indirect Impacts Zone were derived from a total of 685 benthic photo transect images, including 540 images obtained from the total of 18 transects (16 original + 2 additional) placed on the seafloor perpendicular to the wharf and 145 images from four transects placed along the area of mixed sand/hardbottom and aggregate reef oriented parallel to the south wharf face. Mean percent cover of hard corals, soft corals, sponges, other hardbottom, unconsolidated sediment, and debris are presented for each area within the 30 m Indirect Impacts Zone in Table 4 and Figures 13, and for the 20 m Indirect Impacts Zone in Table 5 and Figure 14. Percent cover values for each transect within the 30 m Indirect Impacts Zone are provided in Appendix N (perpendicular seafloor transects) and Appendix O (seafloor hardbottom areas), and can be visualized in Figures 17–18. Percent cover values for the seafloor transects within the 20 m Indirect Impacts Zone are provided in Appendix P and Figure 18, while percent cover values for the surveyed patch reefs are provided in Figures 19–20.

Mean percent coral cover for the reef flat transects and sand flat transects in the 30 m Indirect Impacts Zone was $2.8 \pm 2.6\%$ and $1.2 \pm 1.8\%$, respectively, while it was $3.4 \pm 4.2\%$ and 0% for the 20 m Indirect Impacts Zone. Coral cover was $2.6 \pm 1.3\%$ and $14.8 \pm 2.5\%$ for the mixed sand/hardbottom and aggregate reef areas, respectively. A mixed algal assemblage comprised of erect and adherent macrophytes described in Section 3.3.1 was the most dominant cover type on the reef flat (“Other hardbottom”, 85% in 30 m zone and 91% in 20 m zone), while uncolonized sand was the dominant cover type on the sand flat transects (71% in 30 m zone and 73% in 20 m zone). The cover of debris, which was colonized primarily by sediment-laden turf algae and encrusting sponges, was a notable 13% on the sand flat transects within the 30 m Indirect Impacts Zone and X% within the 20 m Indirect Impacts Zone. Soft coral cover on the reef flat and sand flat transects in both the 30 m and 20 m zones was below the level of detection, and sponge cover was very low ($<0.3\%$) on the sand flat transects and absent on the reef flat transects. A mixed algal assemblage comprised

primarily of *Halimeda* spp. and turf algae (“Other hardbottom,” 45%) contributed the greatest percentage of cover for the aggregate reef area, followed by uncolonized sand (39%) and hard coral (15%), while uncolonized sand (62%) was the dominant cover type for the mixed sand/hardbottom area, followed by a mixed algal assemblage of *Halimeda* spp. and turf algae (“Other hardbottom,” 32%). Sponge cover was low (<1%) for both the aggregate reef and mixed sand/hardbottom areas; soft coral cover was below the level of detection for both areas.

3.3.4. Macroinvertebrate diversity and density

A total of 55 mobile macroinvertebrates representing 10 species were observed in belt transects surveys within the 30 m Indirect Impact Zone, for a total density of 0.02 ± 0.07 ind/m², including 50 individuals (0.05 ± 0.11 ind/m²) representing nine species on the seafloor transects perpendicular to the wharf face, four individuals (0.02 ± 0.01 ind/m²) representing two species along the transects on the mixed sand/hardbottom and aggregate reef areas, and one *Parasalenia gratiosa* (0.01 ± 0.03) on the surveyed patch reefs (Table 6, Figure 21). The most commonly observed macroinvertebrate taxa in the 30 m Indirect Impacts Zone were *Actinopyga echinites*, *Echinometra mathaei*, and *Culcita novaeguineae*. *Actinopyga echinites*, *E. mathaei*, and *Bohadschia argus* were the most common macroinvertebrate taxa on the perpendicular seafloor transects, while three *C. novaeguineae* and one *Thelenota anax* were the only macroinvertebrates observed on the transects placed on the mixed sand/hardbottom and aggregate reef areas. The macroinvertebrate counts for the 20 m Indirect Impacts Zone could not be extracted post-hoc, but the density calculations should be relatively similar for both the 30 m and 20 m zones. Density values for all macroinvertebrate taxa observed within each of the belt transects surveyed on the reef flat and sand flat within the 30 m Indirect Impacts Zone are provided in Appendix S, while values for transects placed along the hardbottom areas within the Indirect Impacts Zone are provided in Appendix T.

3.3.5. ESA-listed or candidate species

No ESA-listed or candidate species were observed in the vicinity of the project site.

4. CONCLUSIONS AND RECOMMENDATIONS

This marine assessment aimed to document the corals and other benthic organisms, mobile macroinvertebrates, and ESA-listed or candidate species within the vicinity of the proposed Hotel Wharf repair and maintenance project site. The project site was divided into a Direct Impacts Zone, which includes the submerged portions of the wharf face as well as the seafloor at the base of the wharf face, and two Indirect Impacts Zones, which includes the area of reef flat, sand slope, and sand flat extending 20 m and 30 m from the wharf face. Patch reefs extending up to 50 m from the wharf face were also surveyed. The 30 m Indirect Impacts Zone included an area of mixed sand and hardbottom as well as an area of aggregate reef that occur parallel to the southern wharf face and which straddle the seaward boundary of the zone. These hardbottom areas occur entirely outside the 20 m Indirect Impacts Area. It is expected that all benthic organisms and site-attached mobile species occurring within the Direct Impacts Zone will be destroyed during construction of the new wharf face and face and sides, while a portion of those present within the Indirect Impacts Zones may experience partial or full mortality as a result of impaired water quality or from physical damage associated with improper anchor placement, debris removal, or other activities.

It is estimated that a total of 6528 coral colonies occur within the Direct Impacts Zone, while 7794 colonies and 4639 colonies are estimated to occur in the 30 m and 20 m Indirect Impacts Zones, respectively. As mentioned above, it is important to note that the colony count estimates for the 20 m Indirect Impacts Zone are likely overestimates, as the colony density values used to arrive at these estimates were from 30 m-long belt transects that extended into the aggregate reef and mixed sand/hardbottom areas that fall outside the 20 m buffer area. In addition to providing estimates of the number of colonies that would be impacted by the construction of the new wharf face, the colony count estimates for individual taxa can also be used to estimate the number of colonies that could be removed from the project site and transplanted to suitable habitat. The number of colonies that are candidates for transplants is likely much lower than the total number colonies estimated to occur in the project area, as the abundant taxa, *Leptastrea* spp. and dendrophylliid sp., which in combination represent 4374 of the 6528 colonies estimated to occur within the Direct Impacts Zone, are not likely to be transplanted from the site. The colony size data collected during this survey effort could also be used to further refine the estimates of the number of colonies that are suitable for transplantation.

While impaired water quality and physical damage is likely to affect corals and other benthic organisms occurring within the silt curtain, the lack of dredging activity associated with this project will likely mean

that impacts to water quality will be relatively limited, and excessive physical damage can be minimized by placing anchors or other objects on sandy areas and avoiding contact with hardbottom by the anchor, chain, or line. It is strongly recommended that no anchors or other objects be placed near the aggregate reef area, as this area has relatively high coral cover and hosts large *Porites rus* (a.k.a. “plate-and-pillar corals”) colonies that are easily damaged by physical contact. It is also recommended that individuals traversing the shallow reef flat adjacent to the wharf take care to avoid contact with corals occurring on the reef flat, which include fragile species such as *Pavona decussata* and *Pocillopora damicornis*.

REFERENCES

- AMEC Environmental & Infrastructure, Inc. 2014. Marine survey and Essential Fish Habitat Assessment report, Hotel Wharf and Access Road Maintenance and Repair Project, Cabras Island, Guam.
- Paulay, G., L. Kirkendale, G. Lambert, and J. Starmer. 1997. The marine invertebrate biodiversity of Apra Harbor: significant areas and introduced species, with focus on sponges, echinoderms, and ascidians. Report prepared for Naval Activities Guam.

TABLES

Table 1. Number of surveyed transects, total survey area (m²), total number of colonies, mean colony density (col/m² ± SD), and mean colony diameter (cm ± SD) for survey areas within the Direct and 30 m Indirect Impacts Zones of the Hotel Wharf repair and maintenance project site.

	No. of trans.	Total survey area	Total no. of colonies	Mean colony density	Mean colony diameter
<u>Direct Impact Zone</u>	18	762	2739	3.4 ± 2.6	4.8 ± 6.2
Wharf sides	13	561	2529	4.4 ± 2.5	4.3 ± 5.5
East side	2	30	195	5.8 ± 1.7	4.2 ± 4.8
South side	9	495	2125	4.1 ± 2.5	4.3 ± 5.6
West side	2	36	209	4.0 ± 4.4	4.7 ± 5.2
Wharf base	5	201	210	1.1 ± 0.3	10.8 ± 9.3
East side	1	25	28	1.1 ± -	11.1 ± 6.7
South side	3	150	152	1.0 ± 0.5	10.0 ± 9.7
West side	1	26	30	1.2 ± -	14.6 ± 8.6
<u>30 m Indirect Impact Zone</u>	20	725	1283	2.1 ± 1.6	17.1 ± 20.7
Seafloor transects	16	480	531	1.1 ± 0.8	14.4 ± 16.8
Reef flat	3	120	224	2.3 ± 0.8	12.5 ± 14.8
Sand	13	360	307	0.8 ± 0.5	15.7 ± 18.0
Seafloor hardbottom	4	145	510	3.5 ± 2.2	19.4 ± 25.2
Aggregate reef	2	85	372	4.7 ± 2.8	21.3 ± 27.9
Mixed sand/HB	2	60	138	2.3 ± 1.1	14.2 ± 14.9
Patch reefs (n = 26)	-	100	242	2.5 ± 1.6	18.0 ± 16.6

Table 2. Percent cover (\pm SD) of major benthic classes for the wharf sides (Direct Impacts Zone).

Cover type	South			East			West			Entire wharf		
	Mean	SD	SE	Mean	SD	SE	Mean	SD	SE	Mean	SD	SE
Hard coral	0.6	0.4	0.2	0.5	0.7	0.3	2.3	1.0	0.3	0.9	0.8	0.3
Soft coral	0.1	0.1	0.05	0.4	0.6	0.2	0.0	0.0	0.0	0.1	0.3	0.1
Sponge	2.6	2.3	0.9	2.2	3.2	1.3	0.0	0.0	0.0	2.1	2.3	0.9
Dead coral	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other hardbottom	96.5	2.1	0.8	96.8	3.1	1.2	97.7	1.0	0.4	96.7	2.0	0.8
Sand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Debris	0.2	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.2

Table 3. Percent cover (\pm SD) of major benthic classes for the area of seafloor at the base of the wharf (Direct Impacts Zone).

	South		East		West		Entire base	
Cover type								
Hard coral	0.5	\pm 0.2	0.3	\pm -	1.0	\pm -	0.6	\pm 0.3
Soft coral	0.0	\pm 0.0	0.0	\pm -	0.0	\pm -	0.0	\pm 0.0
Sponge	0.3	\pm 0.3	0.0	\pm -	0.0	\pm -	0.2	\pm 0.3
Dead coral	0.0	\pm 0.0	0.0	\pm -	0.0	\pm -	0.0	\pm 0.0
Other hardbottom	1.7	\pm 1.6	72.4	\pm -	65.5	\pm -	28.6	\pm 37.0
Sand	39.4	\pm 27.2	25.6	\pm -	30.5	\pm -	34.8	\pm 20.3
Debris	58.2	\pm 28.8	1.7	\pm -	3.0	\pm -	35.8	\pm 36.7

Table 4. Percent cover (\pm SD) of major benthic classes for seafloor transects surveyed within the 30 m Indirect Impacts Zone.

Cover type	Seafloor transects				Hardbottom area			
	Reef flat		Sand flat		Agg. reef		Mixed sand/HB	
Hard coral	2.8	\pm 2.6	1.2	\pm 1.8	14.8	\pm 2.5	2.6	\pm 1.3
Sponge	0.1	\pm 0.1	0.3	\pm 0.3	0.8	\pm 0.8	0.9	\pm 0.7
Other hardbottom	85.4	\pm 12.2	15.4	\pm 13.2	44.8	\pm 11.8	31.5	\pm 5.6
Sand	11.3	\pm 13.6	70.6	\pm 13.9	38.8	\pm 9.5	62.0	\pm 3.7
Debris	0.4	\pm 0.6	12.5	\pm 10.4	0.9	\pm 0.7	3.0	\pm 4.0

Table 5. Percent cover (\pm SD) of major benthic classes for seafloor transects surveyed within the 20 m Indirect Impacts Zone.

Cover type	Seafloor transects			
	Reef flat		Sand flat	
Hard coral	3.4	\pm 4.2	0.0	\pm 0.0
Soft coral	0.0	\pm 0.0	0.0	\pm 0.0
Sponge	0.1	\pm 0.2	0.2	\pm 0.3
Other hardbottom	90.5	\pm 6.0	9.1	\pm 9.7
Sand	5.3	\pm 6.9	72.7	\pm 12.3
Debris	0.6	\pm 0.9	18.1	\pm 12.3

Table 6. Mean density (ind/m² ± SD) of major macroinvertebrate groups observed during surveys of the Direct Impacts Zone and 30 m Indirect Impacts Zone.

	<u>Seastars</u>	<u>Urchins</u>	<u>Sea cucumbers</u>	<u>Edible mollusks</u>	<u>All macroinverts</u>
<u>Direct impacts zone</u>	0.01 ± 0.01	0.04 ± 0.07	0.04 ± 0.08	0.00 ± 0.01	0.09 ± 0.1
Wharf sides	0.01 ± 0.01	0.03 ± 0.06	0.03 ± 0.06	0.00 ± 0.01	0.07 ± 0.09
East side	0.00 ± 0.00	0.00 ± 0.00	0.11 ± 0.16	0.01 ± 0.02	0.13 ± 0.18
South side	0.01 ± 0.01	0.04 ± 0.07	0.02 ± 0.03	0.00 ± 0.00	0.07 ± 0.08
West side	0.03 ± 0.04	0.01 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.04 ± 0.05
Wharf base	0.01 ± 0.02	0.05 ± 0.09	0.06 ± 0.12	0.00 ± 0.00	0.12 ± 0.13
East side	0.00 ± 0.00	0.02 ± 0.00	0.28 ± 0.00	0.00 ± 0.00	0.3 ± -
South side	0.02 ± 0.02	0.00 ± 0.00	0.00 ± 0.01	0.00 ± 0.00	0.03 ± 0.02
West side	0.00 ± 0.00	0.22 ± 0.00	0.02 ± 0.00	0.00 ± 0.00	0.24 ± -
<u>30 m Indirect impacts zone</u>	0.00 ± 0.01	0.01 ± 0.03	0.01 ± 0.06	0.00 ± 0.00	0.02 ± 0.07
Seafloor hardbottom	0.01 ± 0.01	0.00 ± 0.00	0.00 ± 0.01	0.00 ± 0.00	0.02 ± 0.01
Aggregate reef	0.01 ± 0.01	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00	0.01 ± 0.02
Mixed sand/HB	0.02 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.02 ± 0.00
Seafloor perp trans	0.00 ± 0.01	0.01 ± 0.03	0.04 ± 0.09	0.00 ± 0.00	0.05 ± 0.11
Reef flat	0.01 ± 0.02	0.06 ± 0.05	0.14 ± 0.20	0.00 ± 0.00	0.21 ± 0.18
Sand flat	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.04	0.00 ± 0.00	0.02 ± 0.04
Patch reef (n=26)	0.00 ± 0.00	0.01 ± 0.03	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.03

FIGURES I.
Maps and Graphs



Figure 1. Map of Guam depicting the location of the Jose D. Leon Guerrero Commercial Port and Hotel Wharf, Apra Harbor.

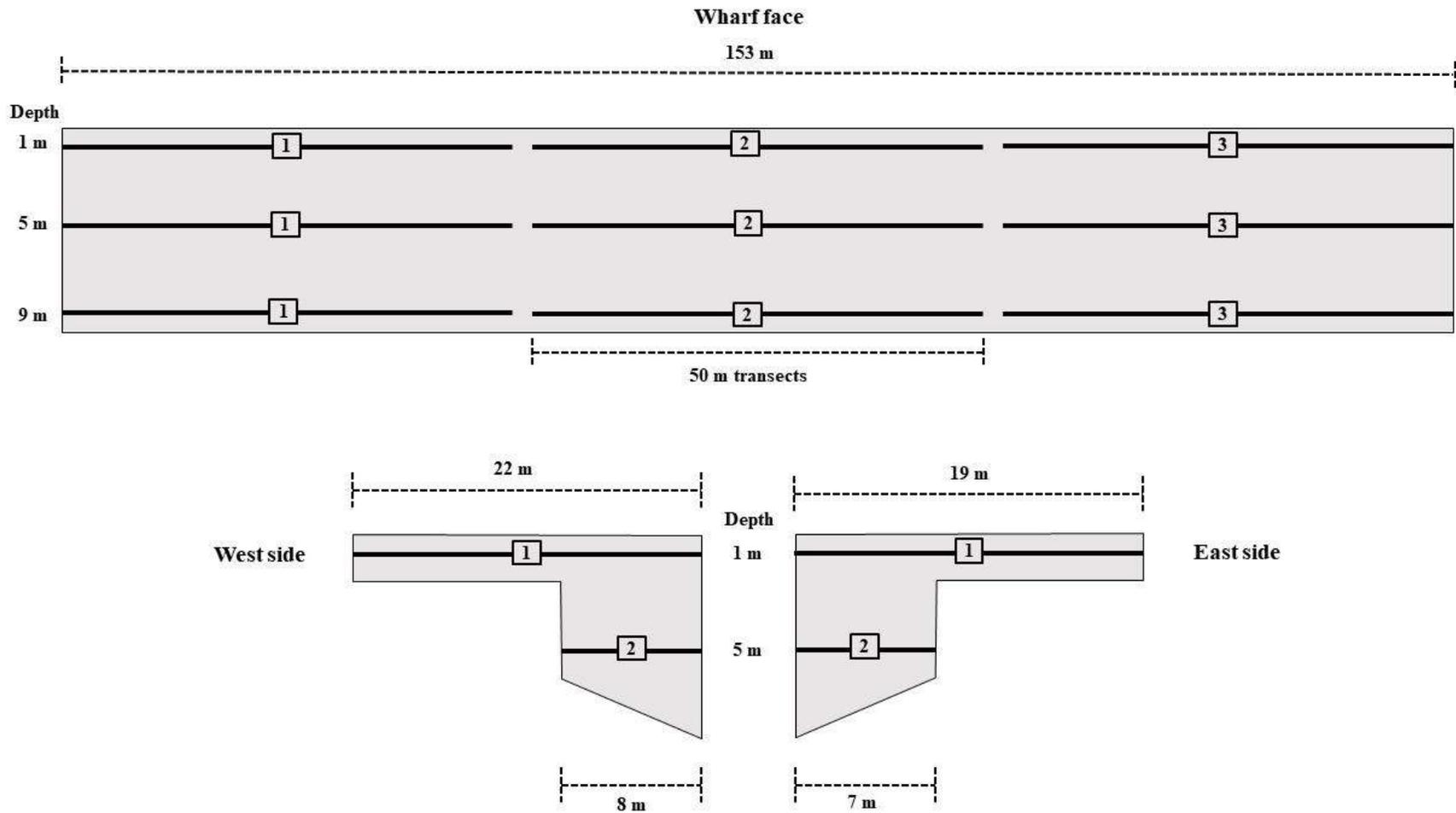


Figure 2. Diagram depicting the locations of survey transects on the wharf sides. Not to scale.

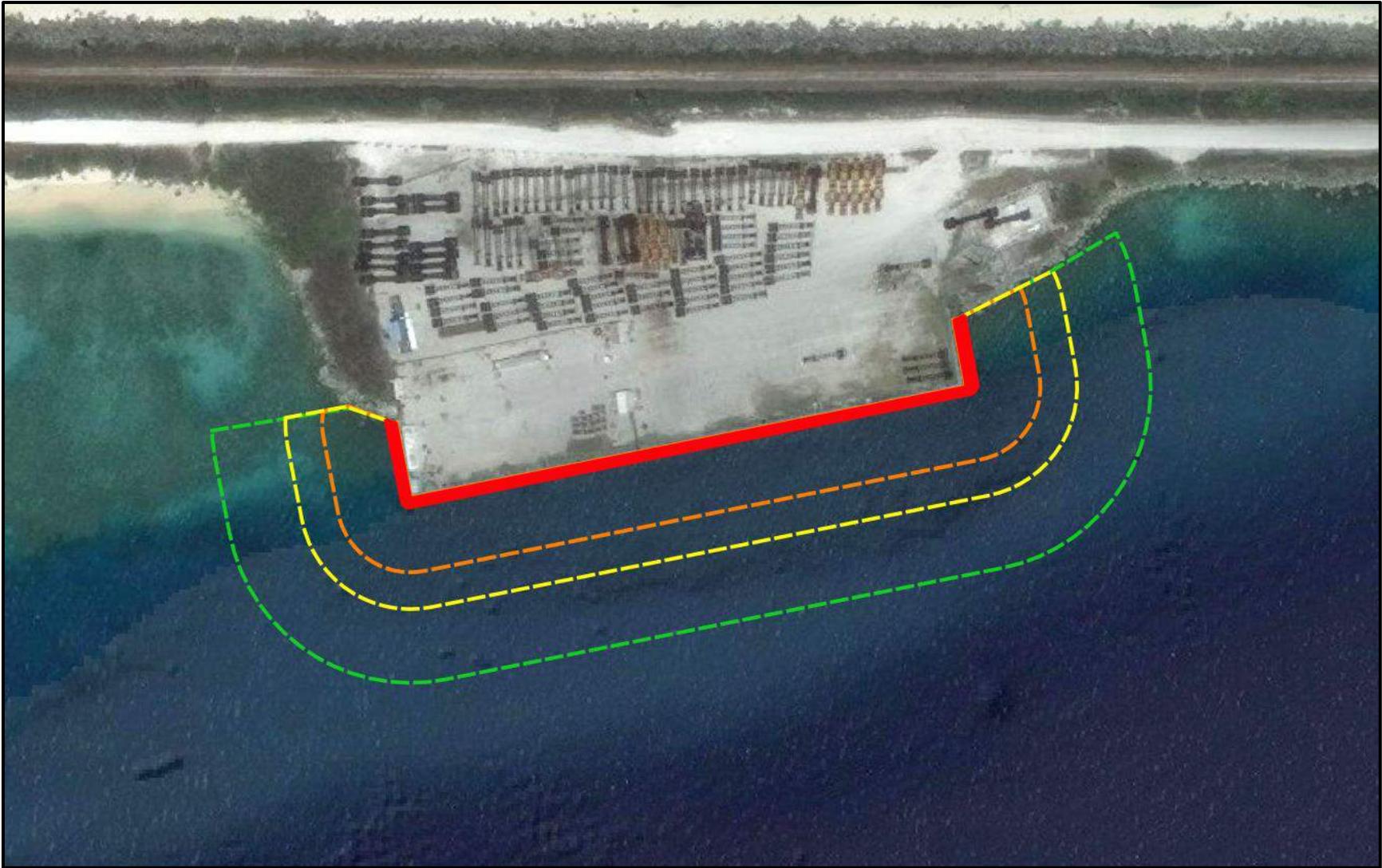


Figure 3. Map depicting the Direct Impacts Zone (red) and the 20 m (orange), 30 m (yellow), and 50 m (green) Indirect Impacts Zones. Note that this map depicts only the general location of the Direct Impacts Zone and not the exact placement of the new wharf face.

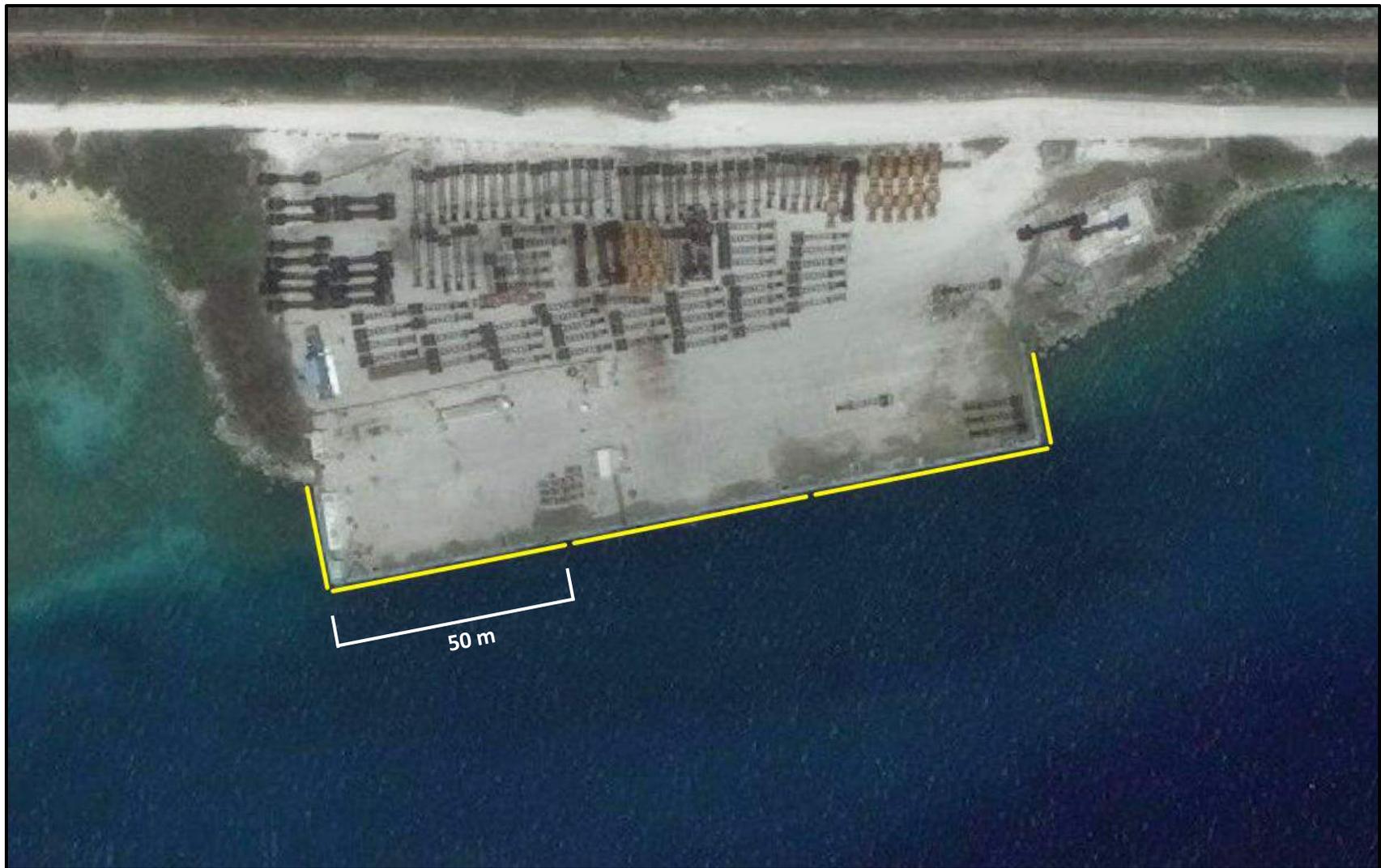


Figure 4. Map depicting the location of the transects placed at the base of the wharf (Direct Impacts Zone).

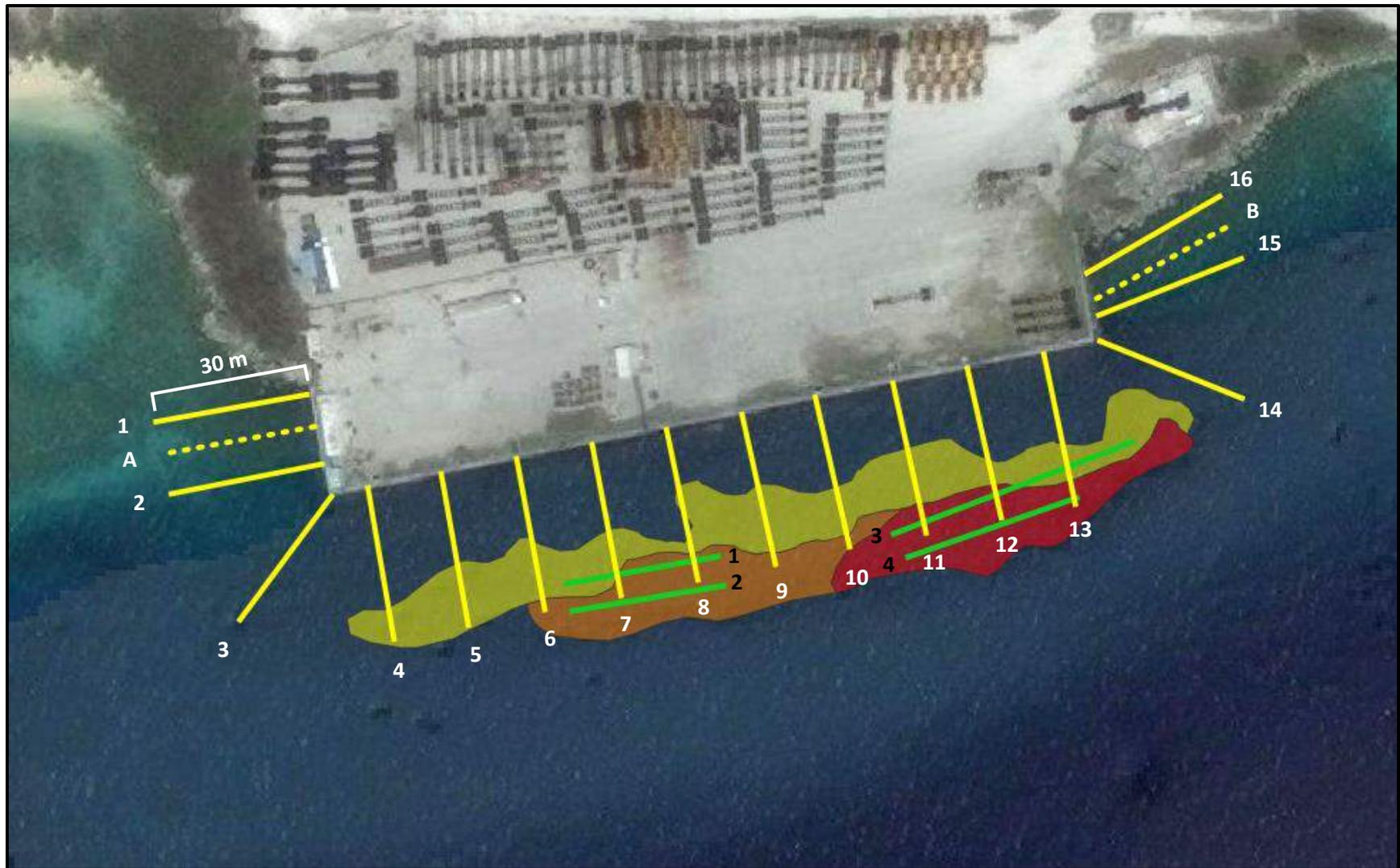


Figure 5. Map depicting the location of the seafloor transects Indirect Impacts Zone, including the 30-meter-long transects placed perpendicular to the wharf (yellow) and transects (mixed lengths) placed across an area of hardbottom oriented parallel to the south wharf face (green). The red, orange, and yellow polygons represent areas with aggregate reef and high coral cover (red), mixed sand and hardbottom with low coral cover (orange), and sand with widely scattered hardbottom and few coral colonies (yellow).

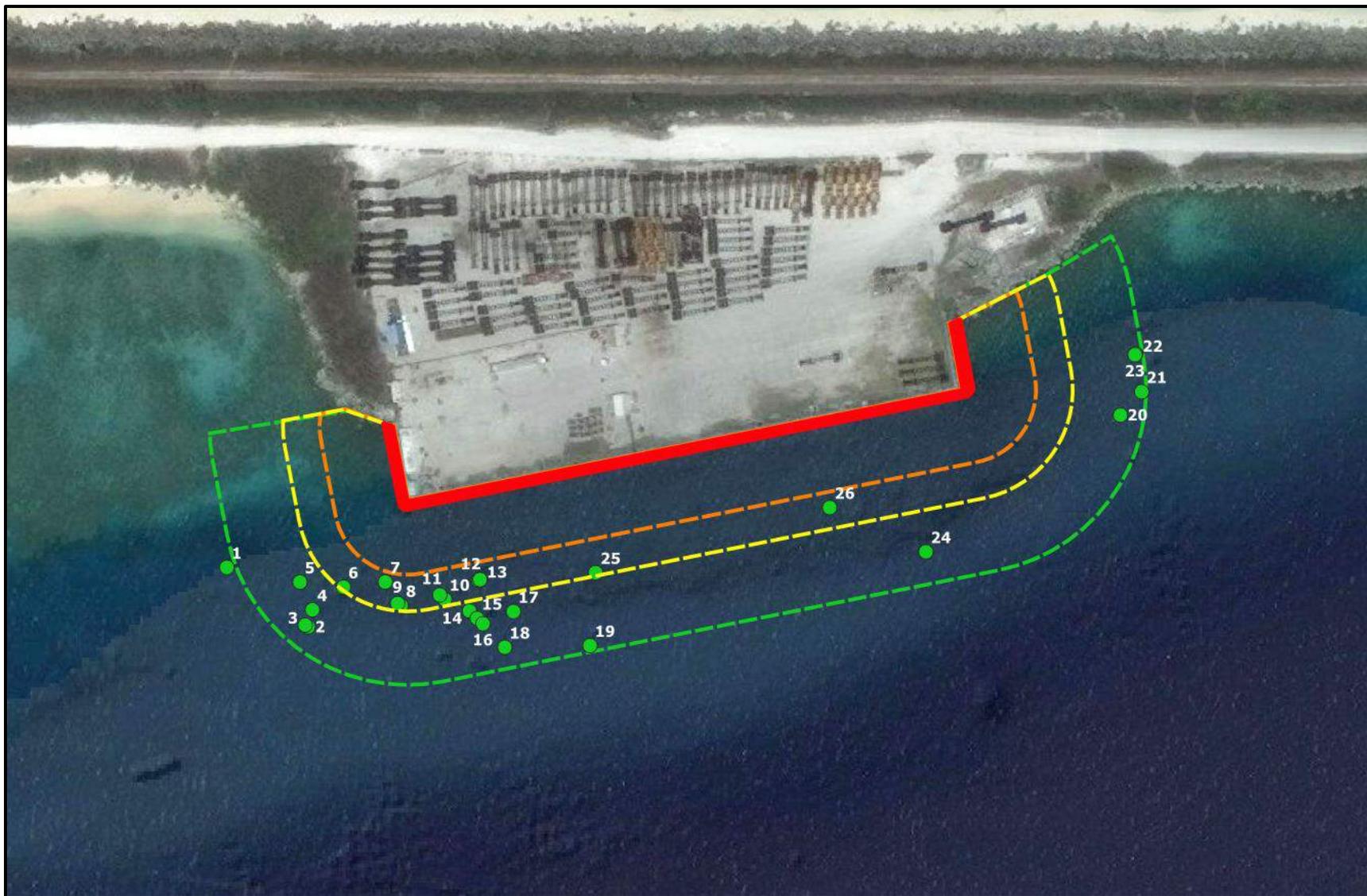


Figure 6. Map depicting the location of the surveyed patch reefs in relation to the Direct Impacts Zone (red) and the 20 m (orange), 30 m (yellow), and 50 m (green) Indirect Impacts Zones. Note that this map depicts only the general location of the Direct Impacts Zone and not the exact placement of the new wharf face.

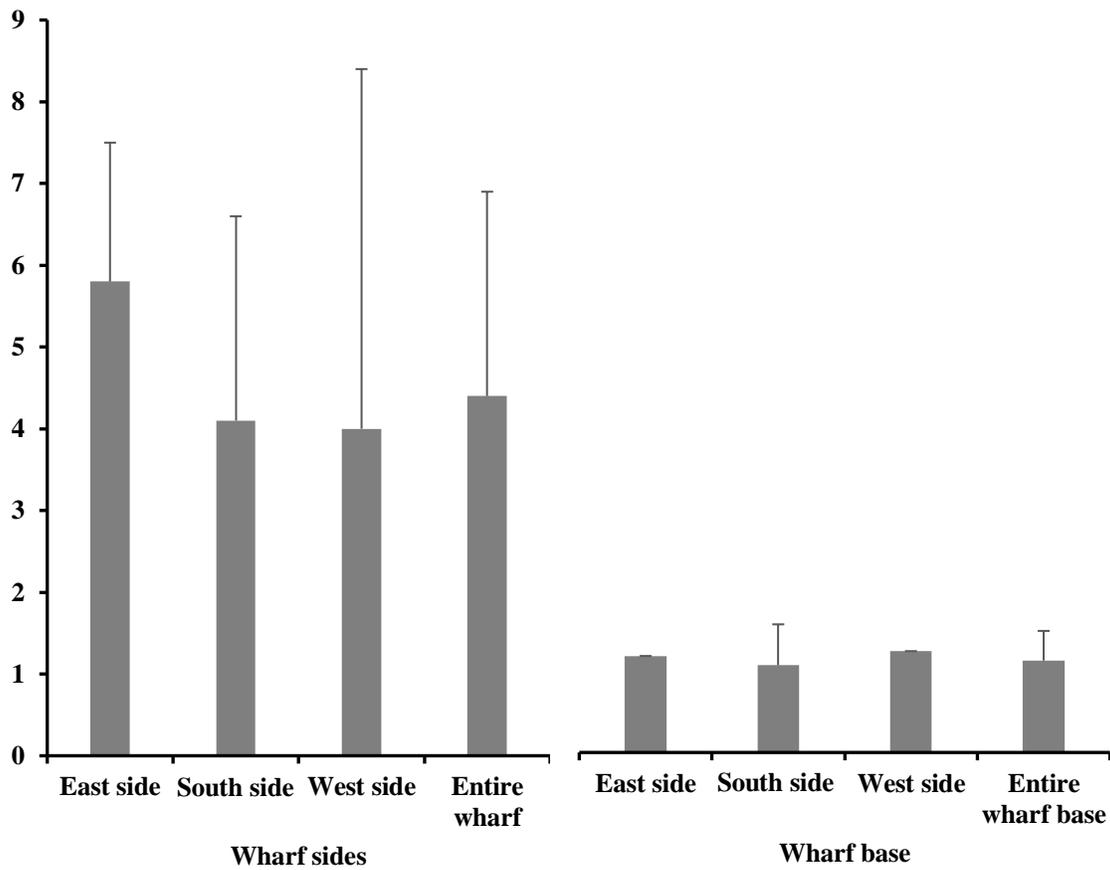


Figure 7. Mean coral colony density (col/m² ± SD) for transects surveyed on the wharf and the seafloor at the base of the wharf (Direct Impacts Zone).

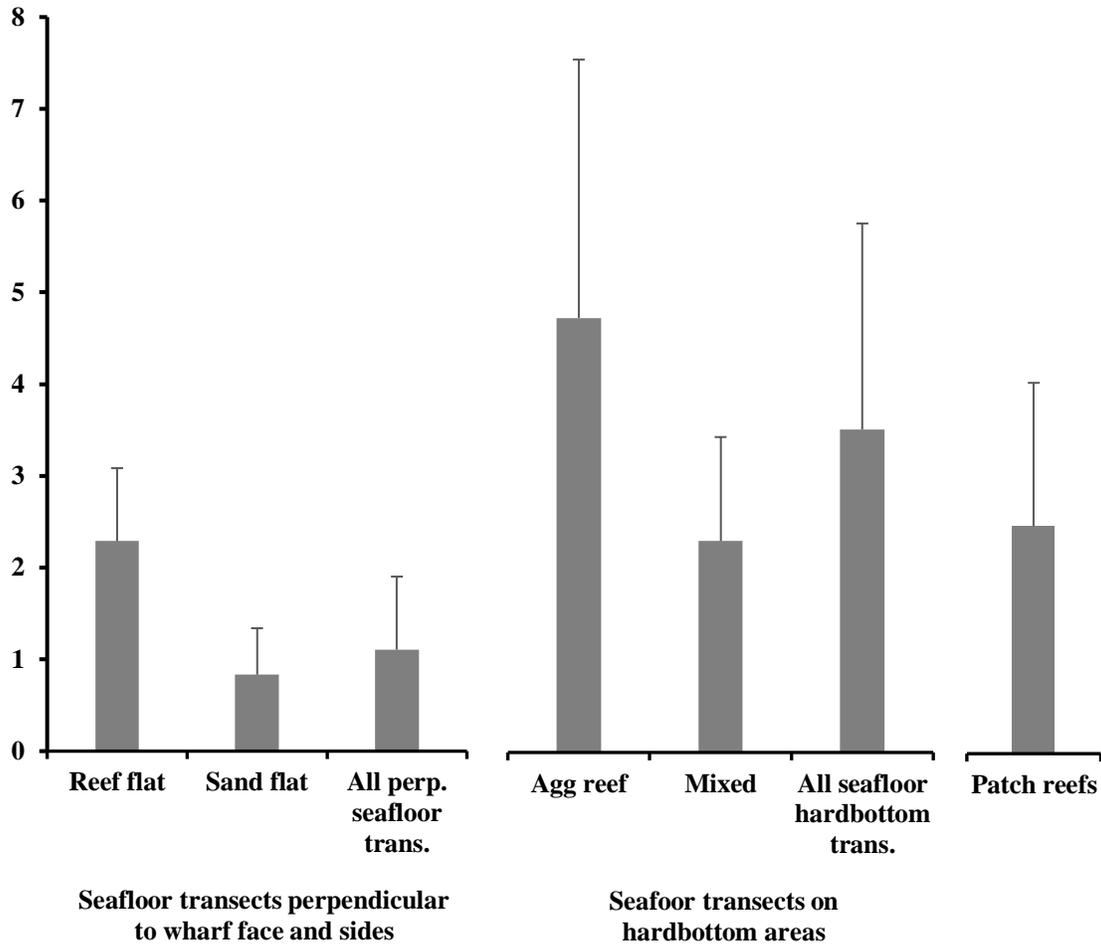


Figure 8. Mean coral colony density (col/m² ± SD) on seafloor transects and patch reefs surveyed within the 30 m Indirect Impacts Zone.

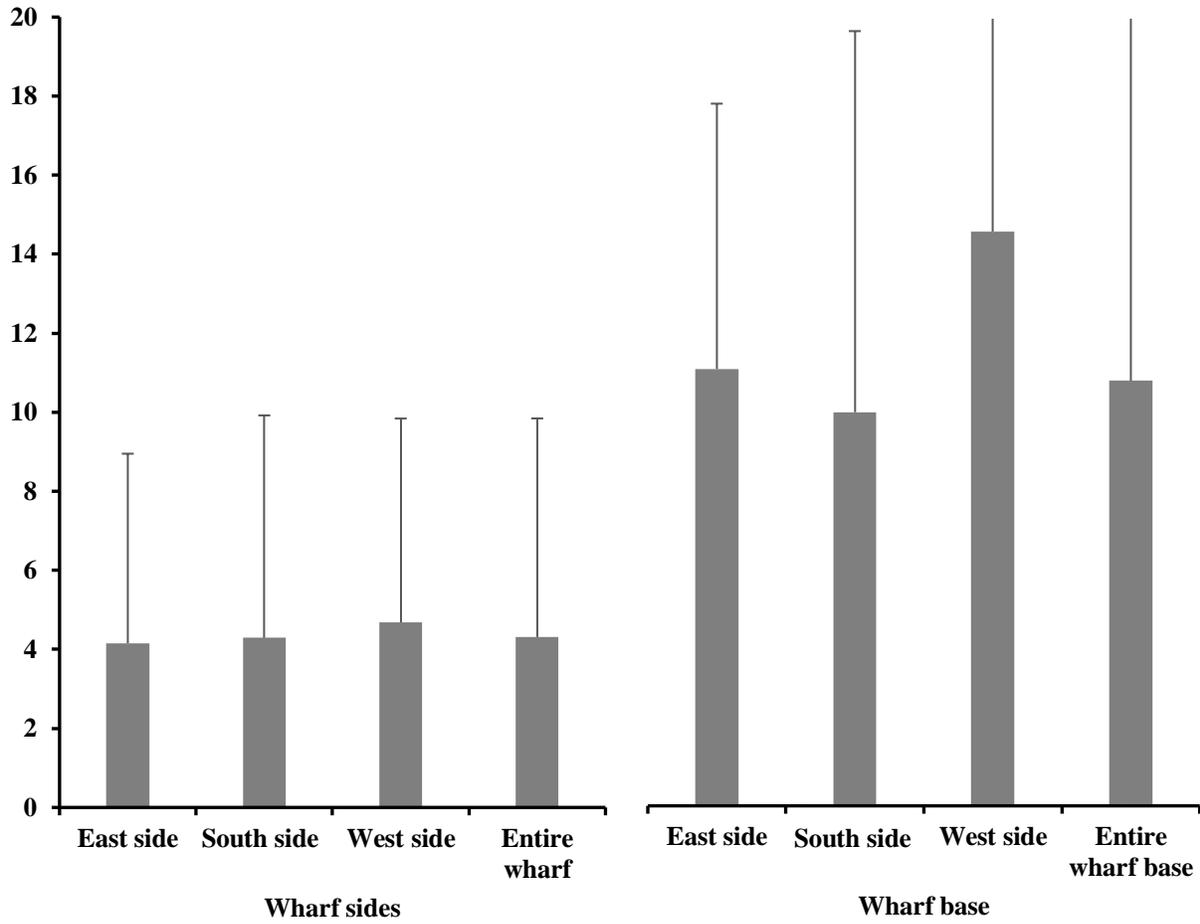


Figure 9. Mean coral colony diameter (cm \pm SD) for transects surveyed on the wharf and the seafloor at the base of the wharf (Direct Impacts Zone).

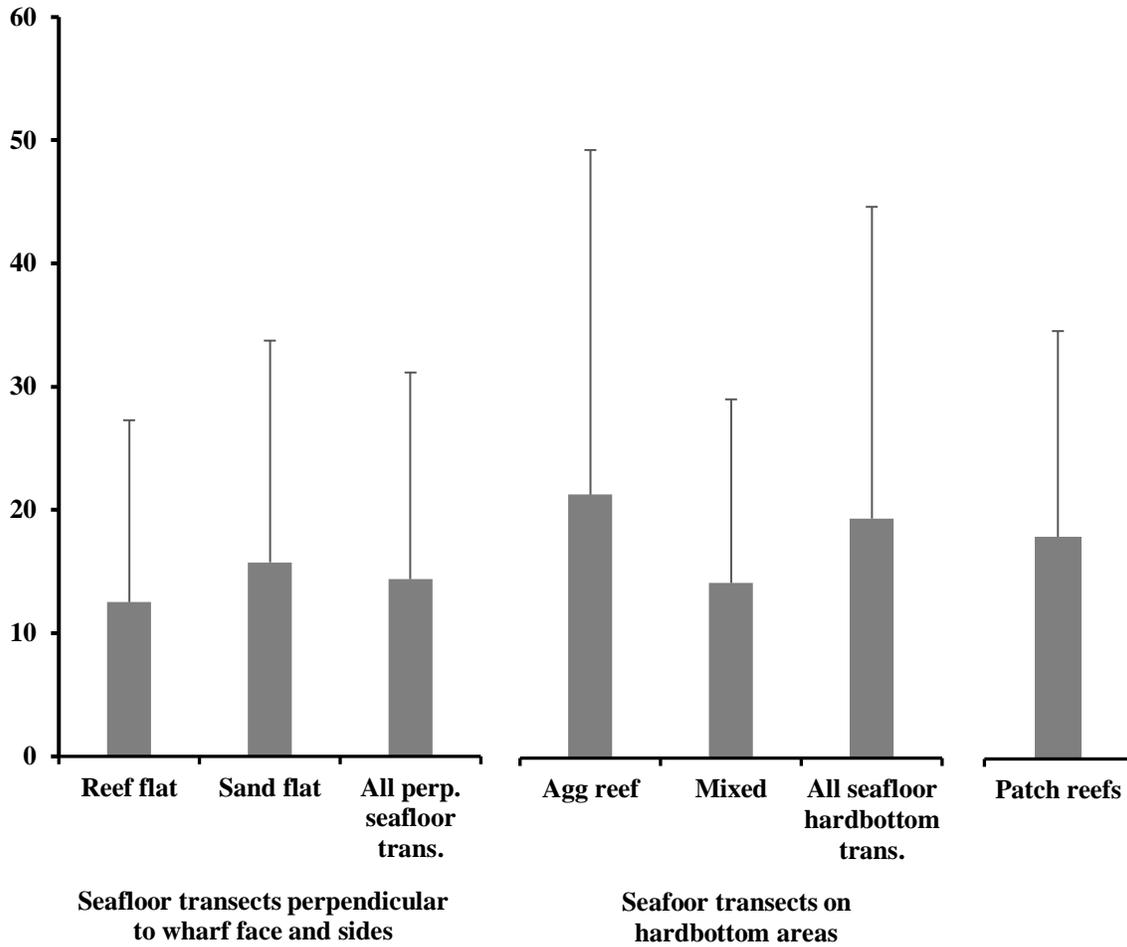


Figure 10. Mean coral colony diameter (cm \pm SD) for seafloor transects and patch reefs surveyed within the 30 m Indirect Impacts Zone.

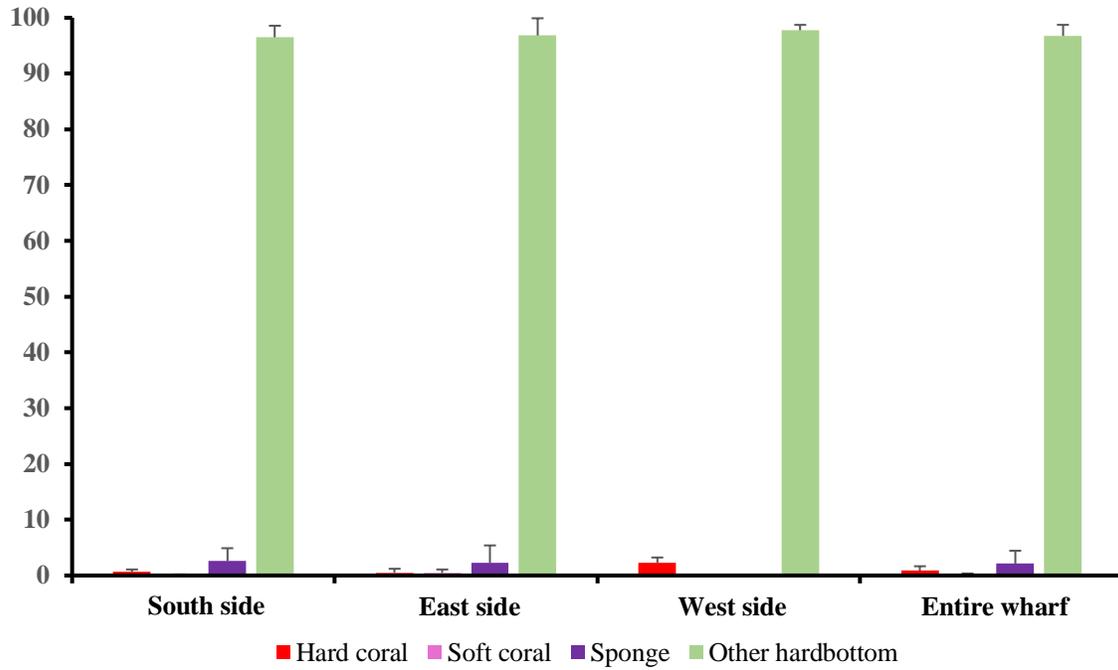


Figure 11. Percent cover (\pm SD) of major benthic classes for the wharf sides and the entire wharf within the Direct Impacts Zone.

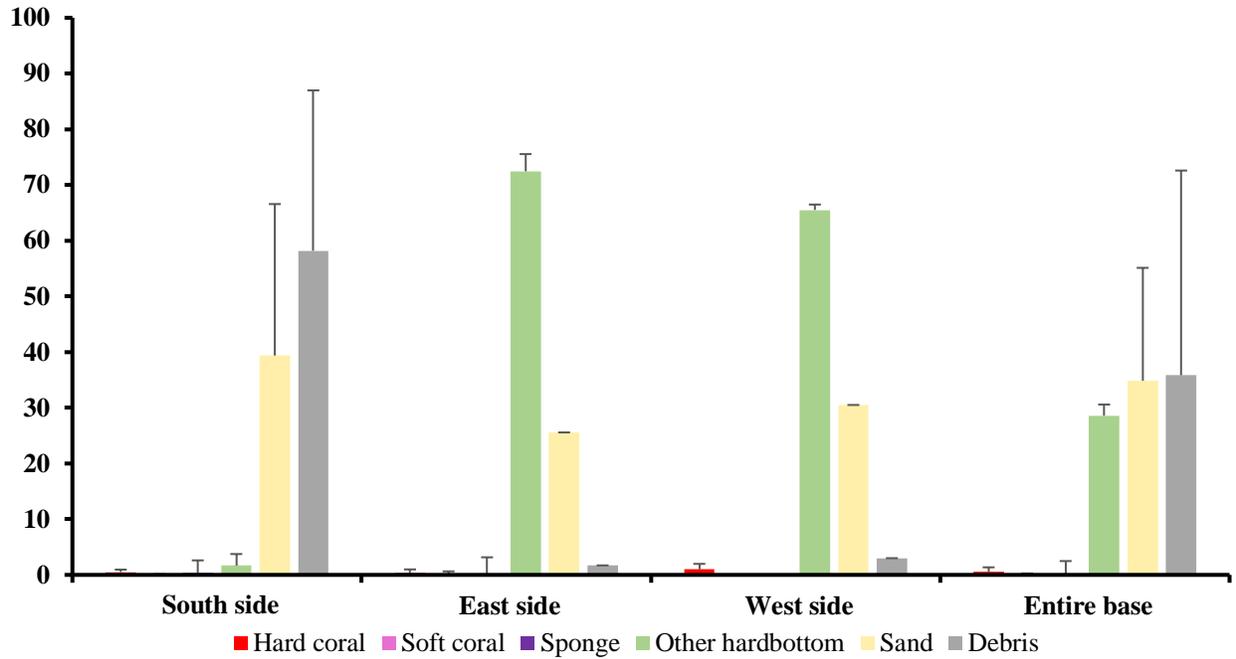


Figure 12. Percent cover (\pm SD) of major benthic classes for the area of seafloor at the base of the wharf within the Direct Impacts Zone.

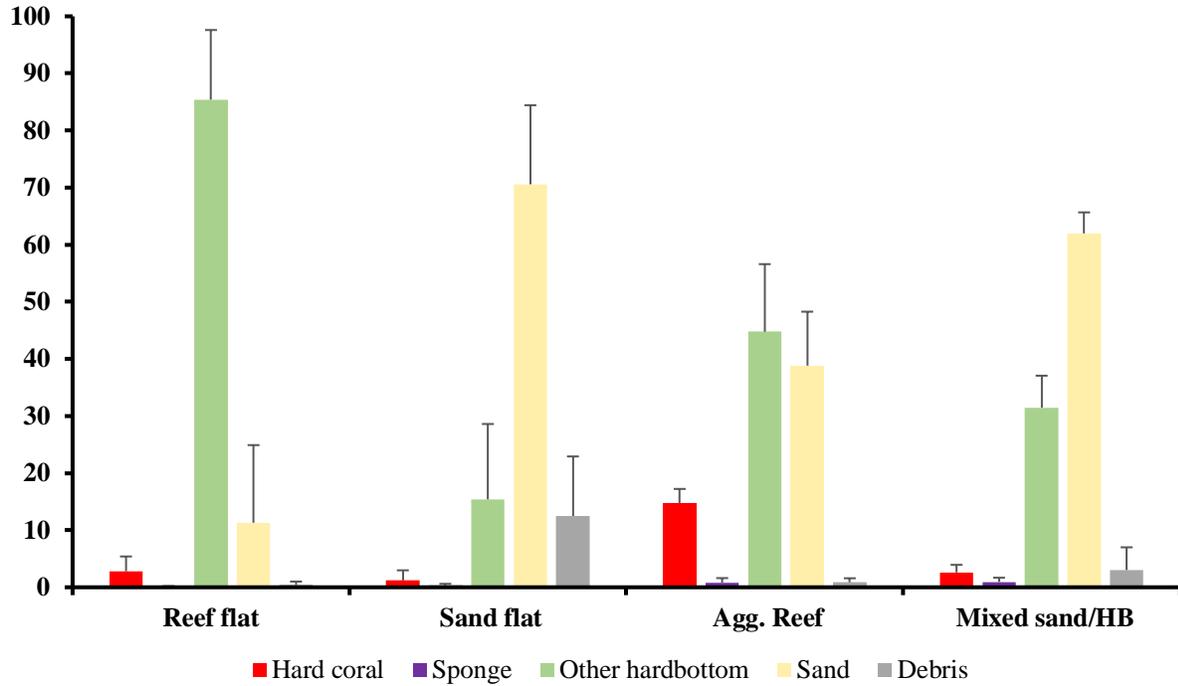


Figure 13. Percent cover (\pm SD) of major benthic classes for seafloor transects surveyed within the 30 m Indirect Impacts Zone.

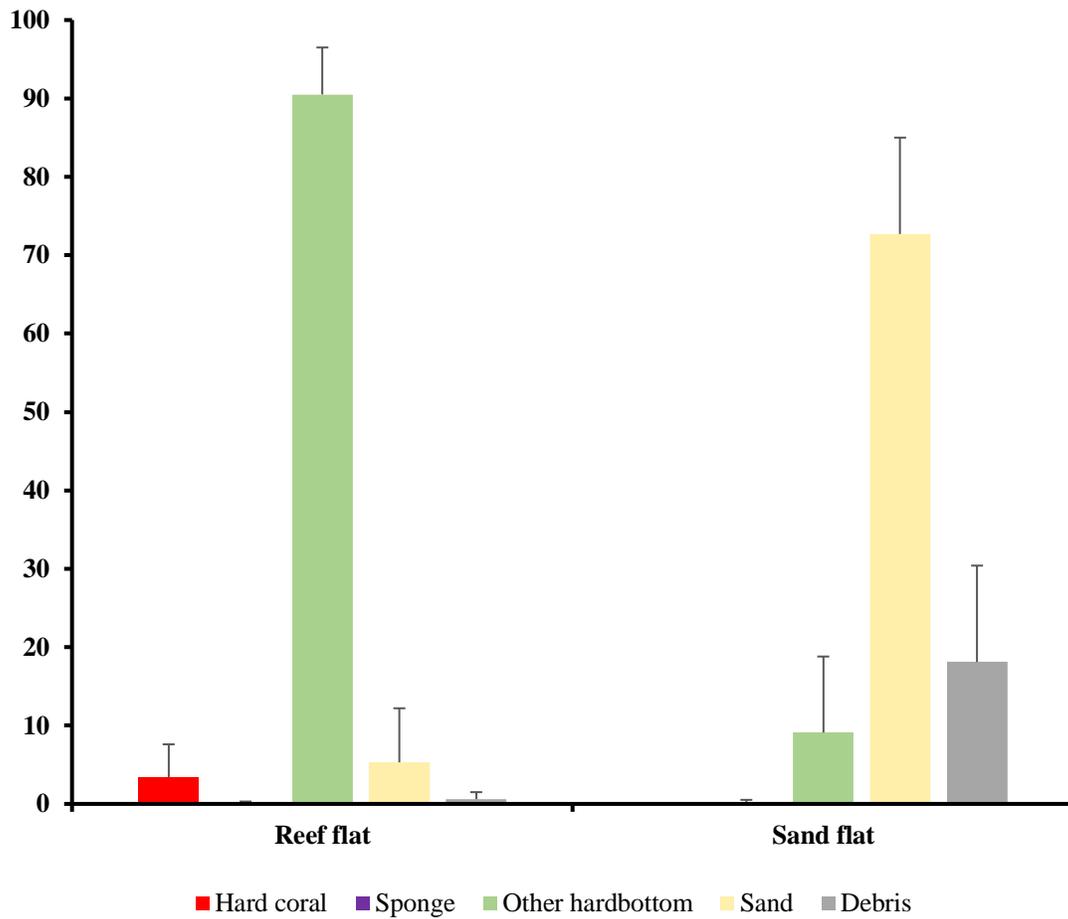


Figure 14. Percent cover (\pm SD) of major benthic classes for seafloor transects surveyed within the 20 m Indirect Impacts Zone.

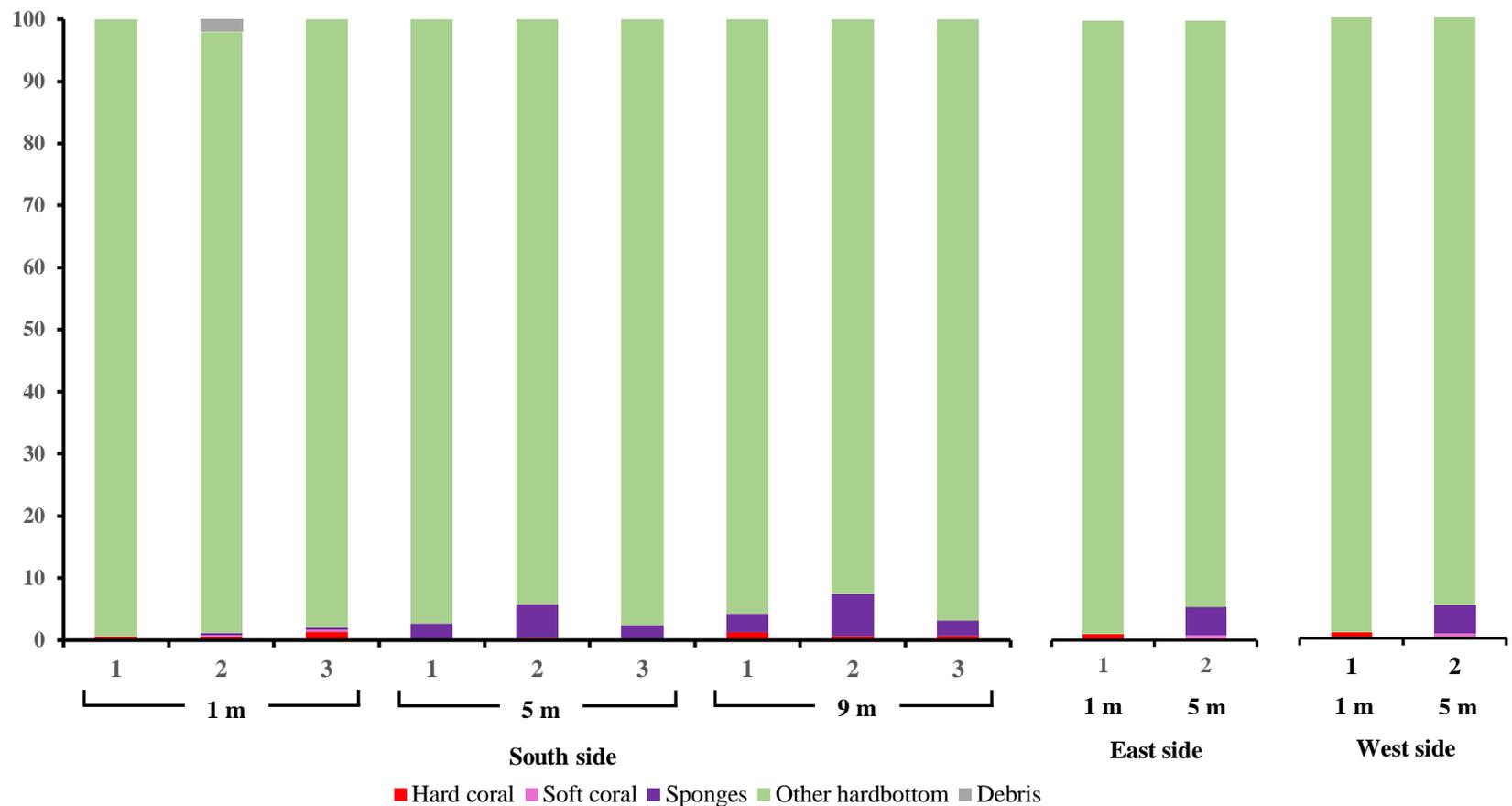


Figure 15. Percent cover of major benthic classes for the wharf transects surveyed within the Direct Impact Zone.

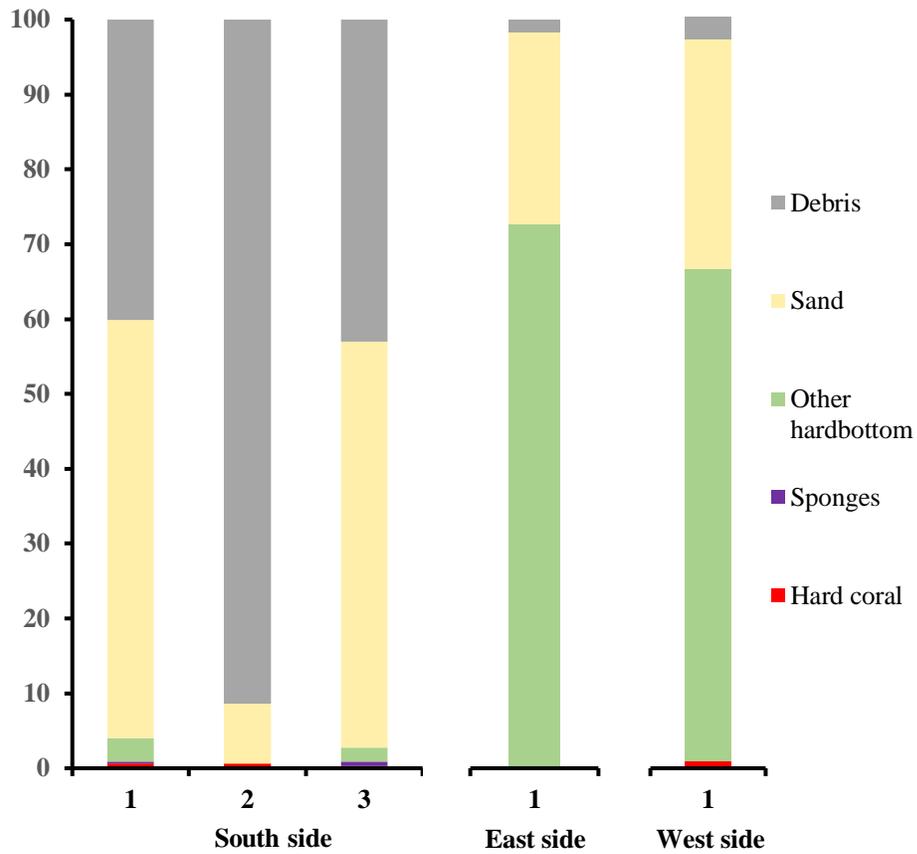


Figure 16. Percent cover of major benthic classes for seafloor transects at the base of the wharf (Direct Impacts Zone).

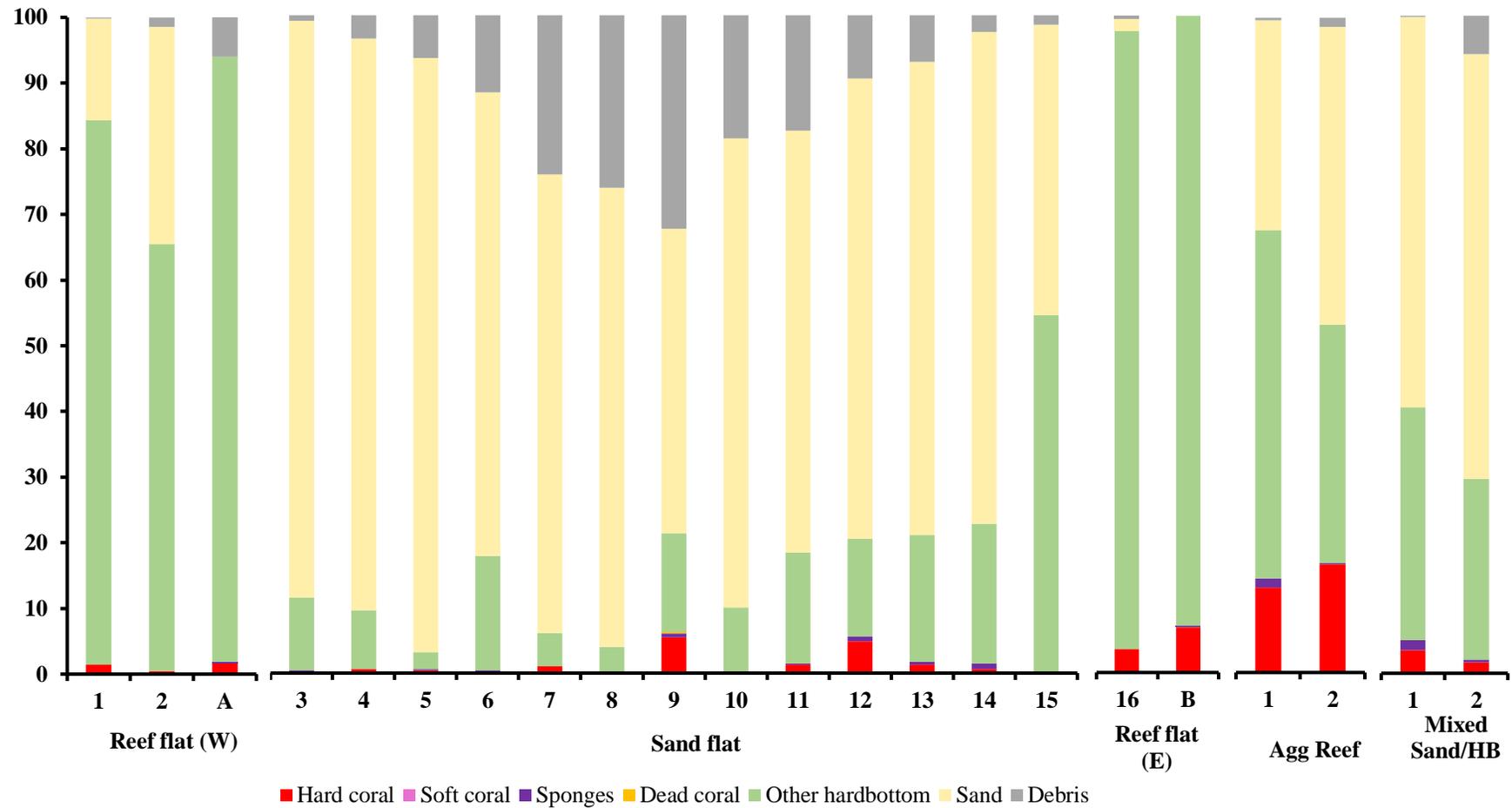


Figure 17. Percent cover of major benthic classes for seafloor transects within the 30 m Indirect Impacts Zone.

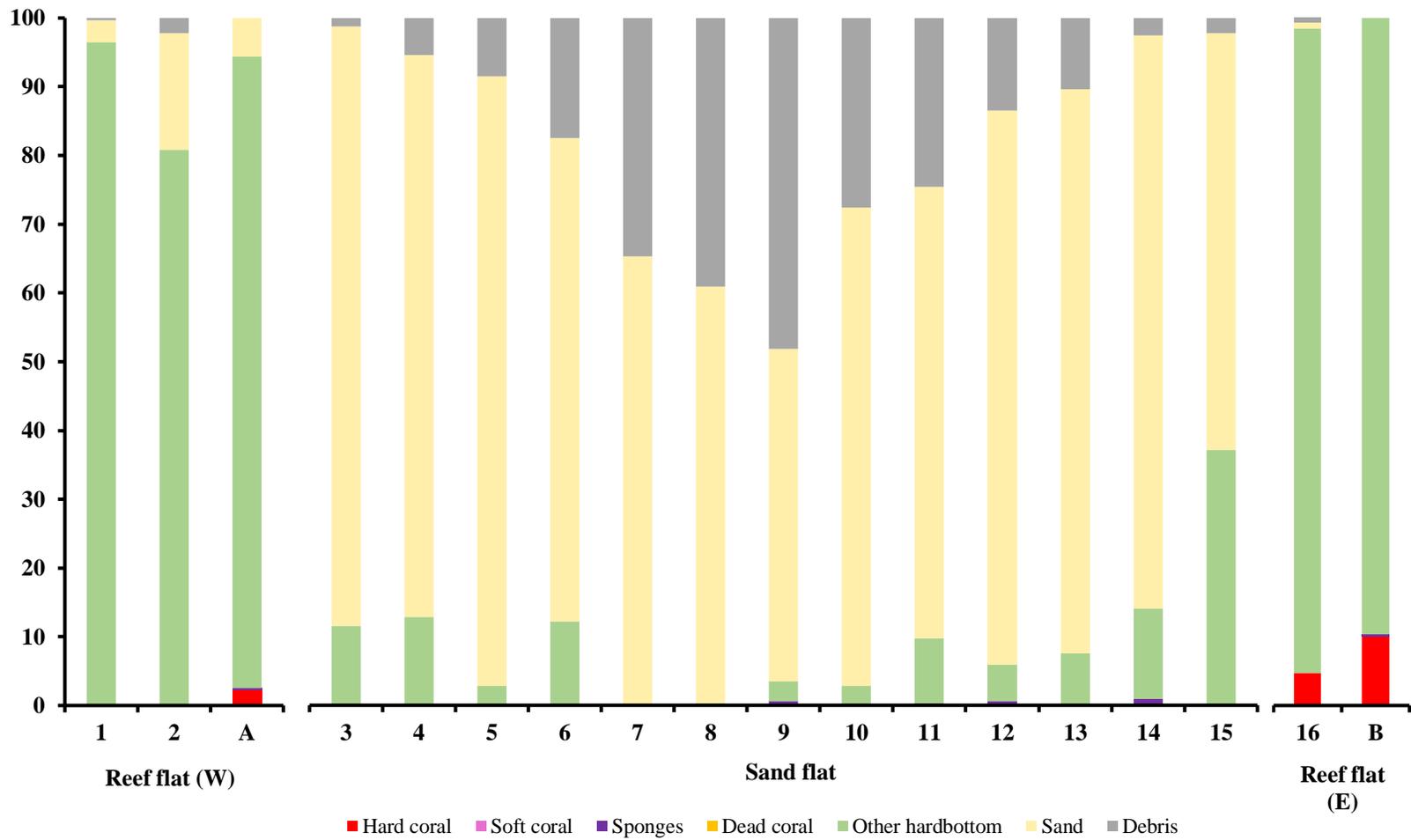


Figure 18. Percent cover of major benthic classes for seafloor transects within the 30 m Indirect Impacts Zone.

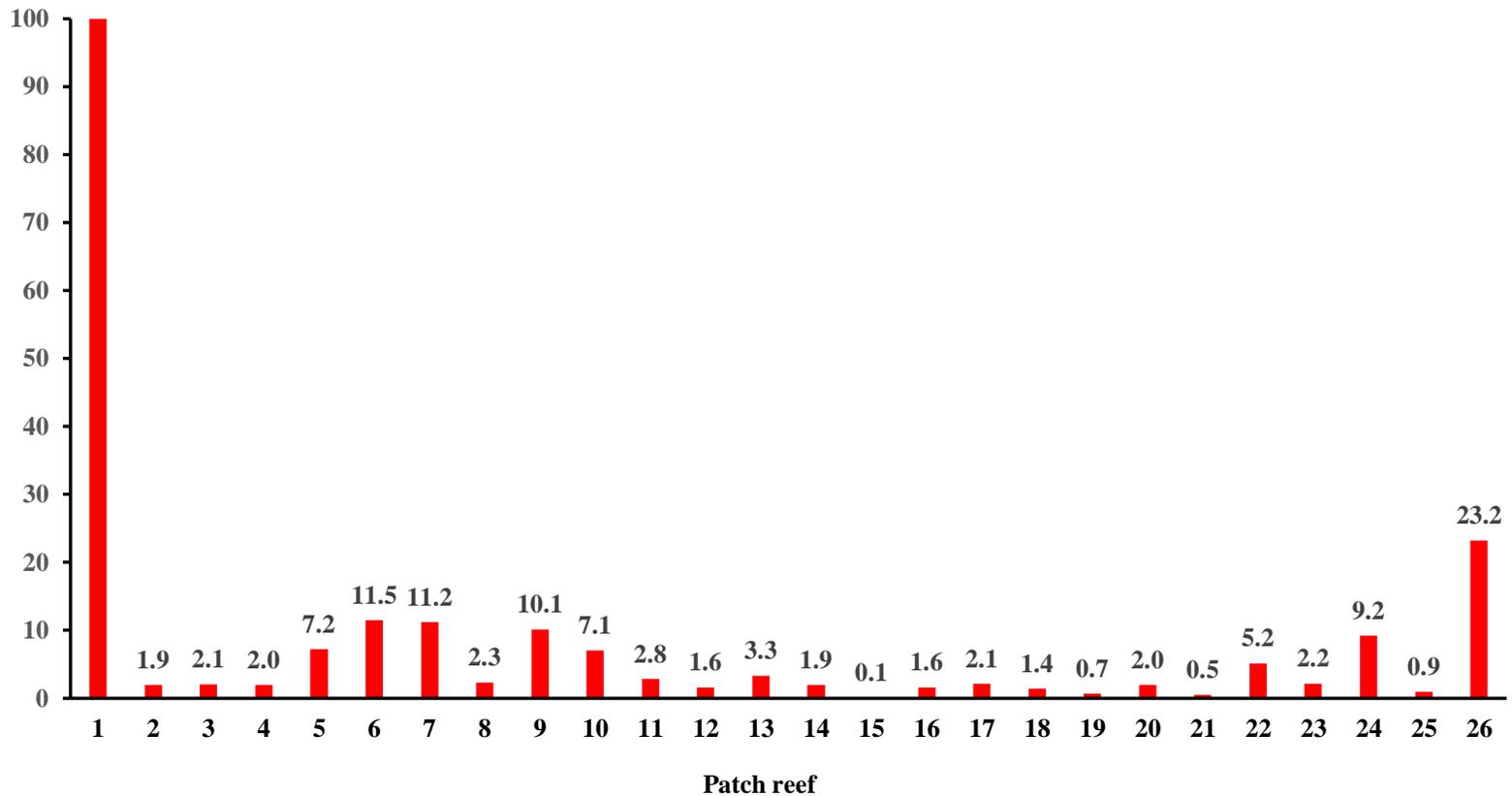


Figure 19. Percent coral cover for patch reefs surveyed within the Indirect Impacts Zone. While some patch reefs (including Patch reef 1, which was a single, large *Porites rus* colony) occurred beyond the 30 m zone (but within 50 m of the wharf), data for all patch reefs were included in the analysis for the Indirect Impacts Zone.

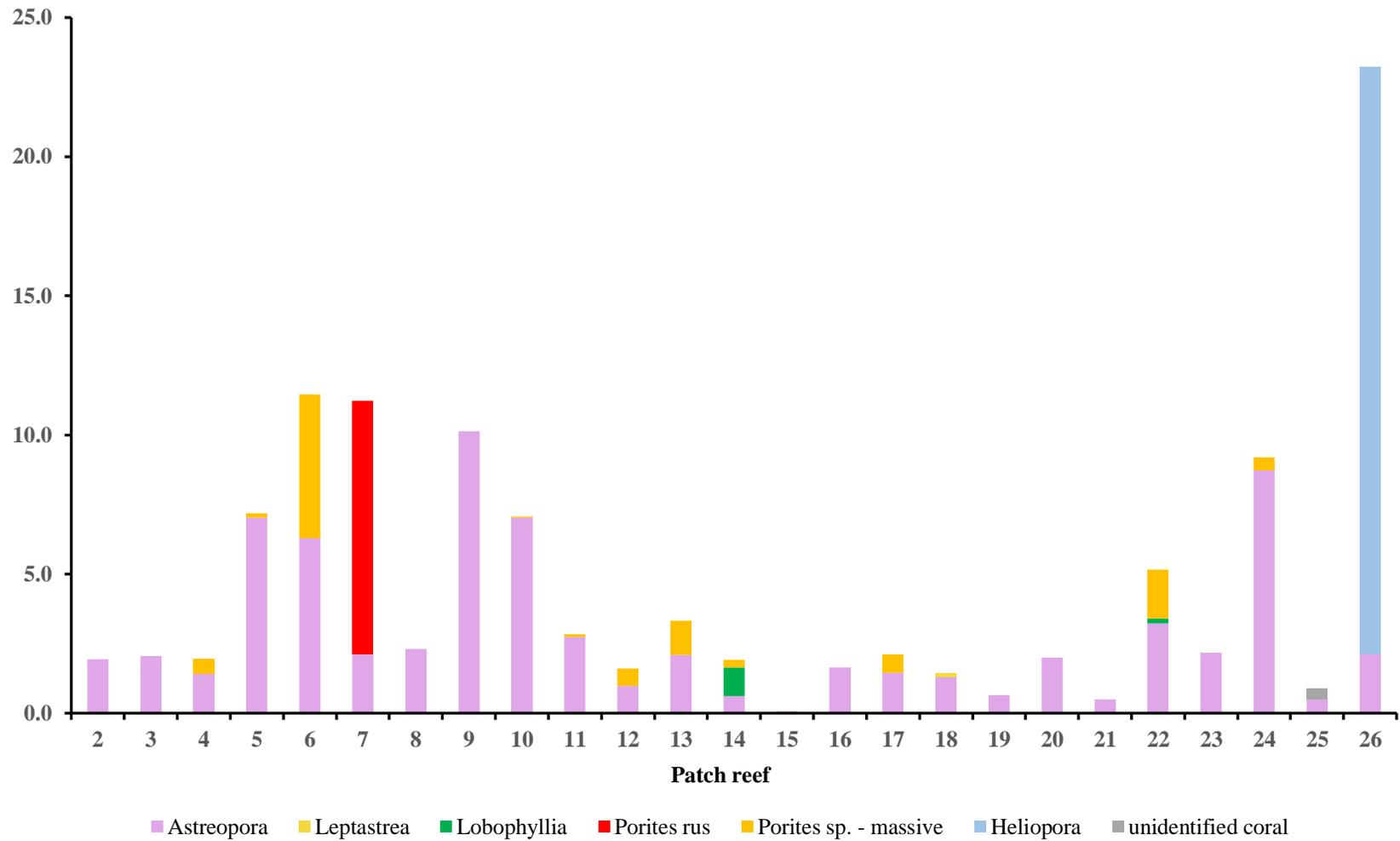


Figure 20. Percent cover of coral taxa for patch reefs surveyed within the Indirect Impacts Zone. Patch reef 1, which was comprised of a single, large *Porites rus* colony (100% coral cover), was excluded from this figure.

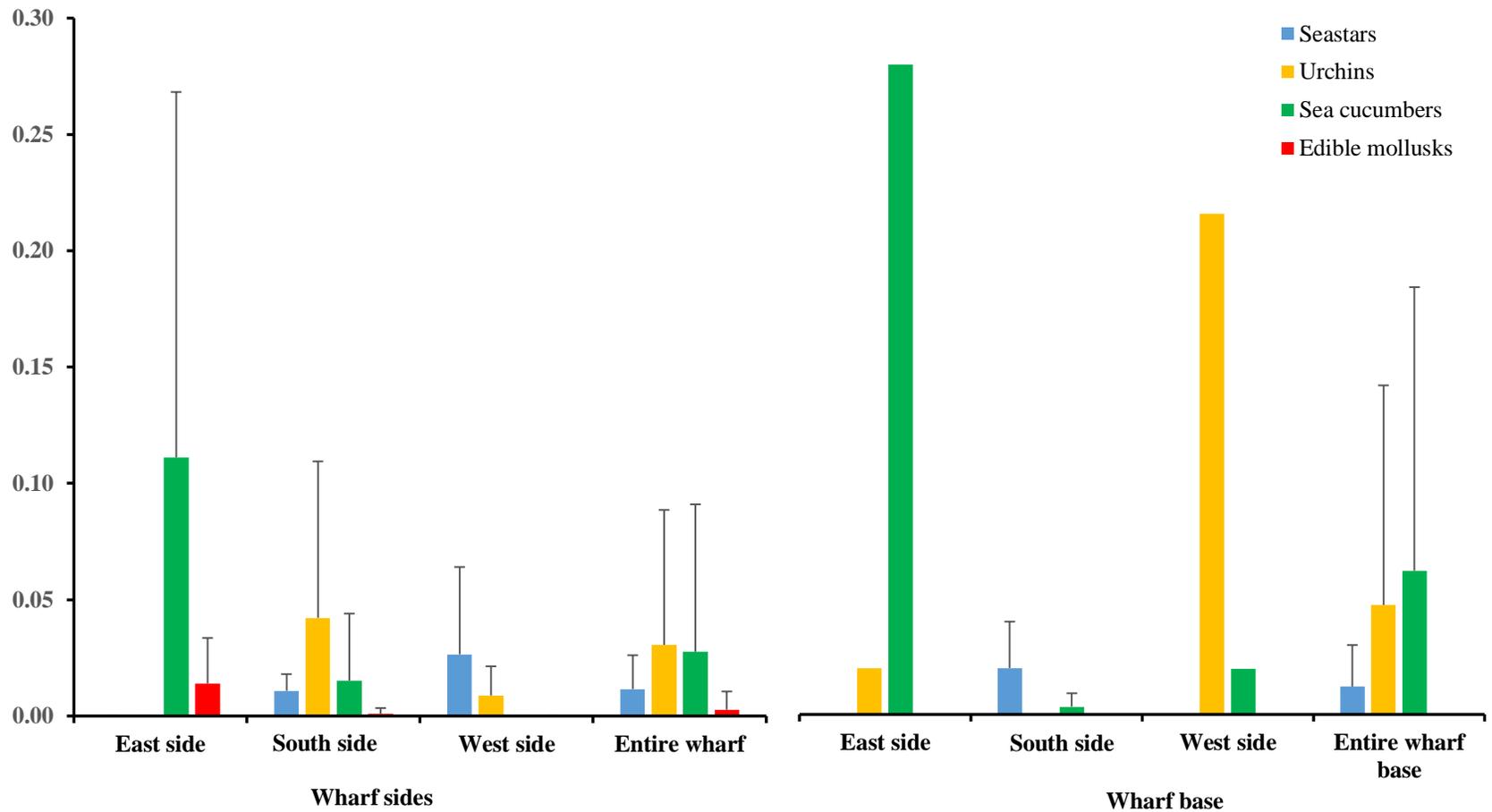


Figure 21. Density (ind/m²) of macroinvertebrate taxa observed within belt transects placed on the wharf sides and at the base of the wharf (Direct Impacts Zone).

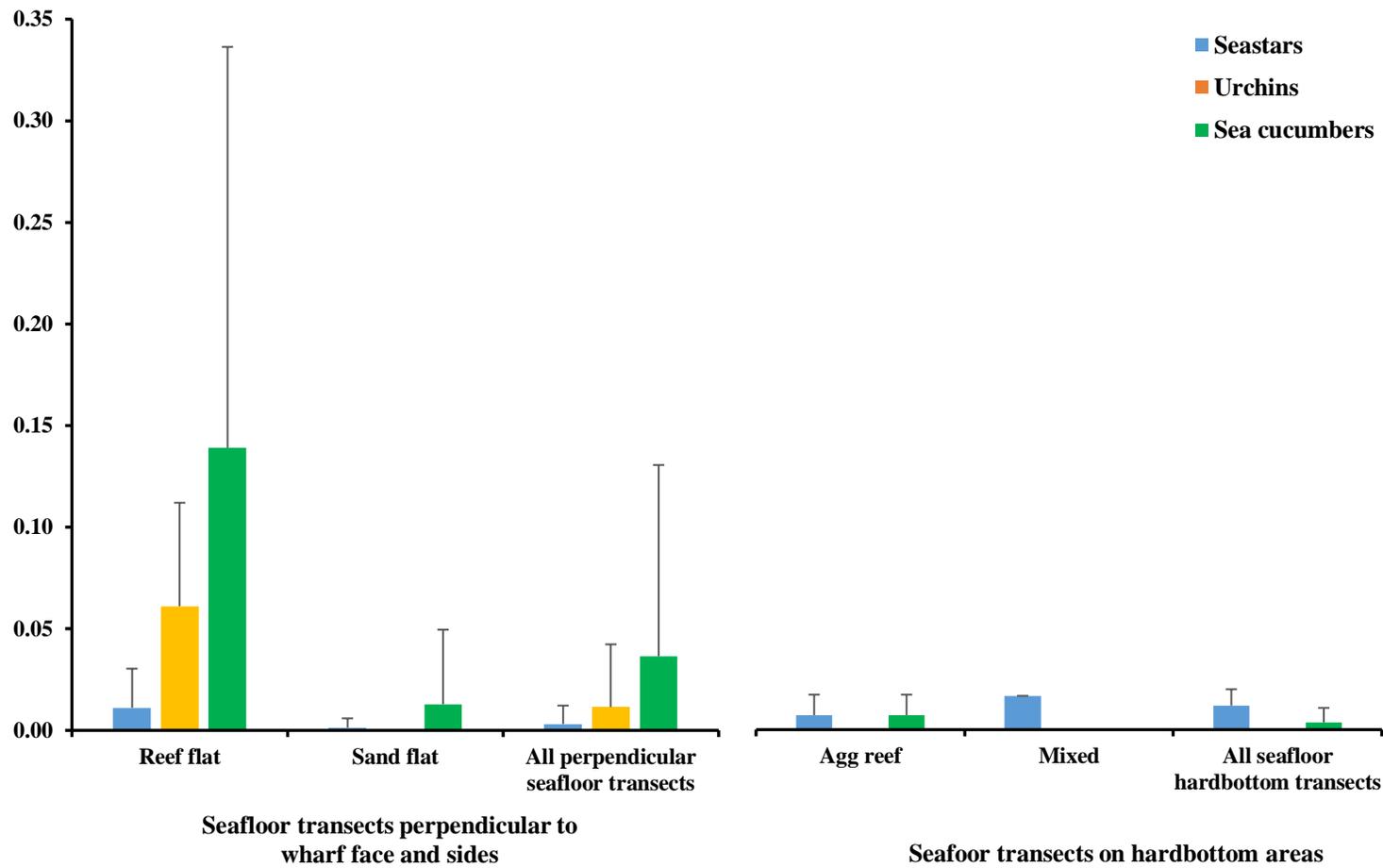


Figure 22. Density (ind/m²) of macroinvertebrate taxa observed in belt transects placed on the seafloor perpendicular to the wharf, and transects placed on an area of hardbottom that occurs parallel to the wharf face (30 m Indirect Impacts Zone).

FIGURES II.

Site photos



Figure 23. One of the shallow (~1.5 m) transects placed on a concrete beam that runs the length of the wharf sides.



Figure 24. A shallow (~1.5 m) benthic community on the west side of the wharf dominated by erect macrophytic algae.



Figure 25. A benthic community at a depth of about 9 m dominated by encrusting sponges and turf algae, typical of the extent of the wharf sides occurring below the shallow beam.



Figure 26. A benthic community dominated by encrusting sponges and turf algae, and numerous dendrophylliid corals, typical of the underside of the concrete beam that extends across the length of the wharf sides at a depth of approximately 1.5 m.

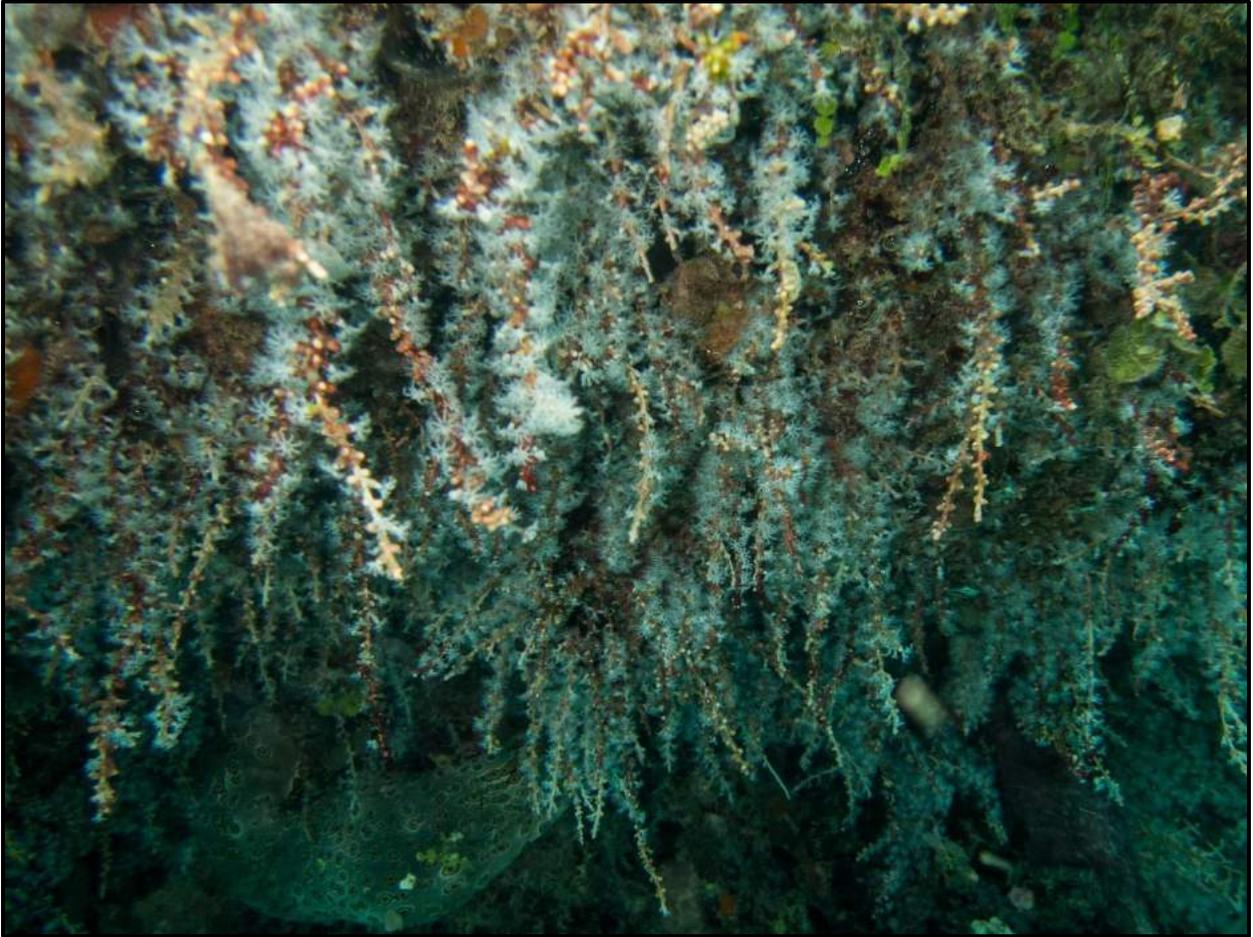


Figure 27. Dense octocoral growth below the concrete beam near the southeast corner of the wharf. While a specimen must be collected to confirm the identification, this species appears similar to the non-native octocoral, *Carijoa riisei*.



Figure 28. A benthic community on the reef flat adjacent to the west side of the wharf dominated by erect macrophytes, primarily *Padina* sp. and *Halimeda* spp. Coral cover is generally low across the reef flat, but notable colonies, such as the *Pavona decussata*, massive *Porites* spp., and *Porites cylindrica* colonies visible in this image, were observed in close proximity to the wharf.



Figure 29. A portion of the debris field occurring at the base of the south wharf face at a depth of approximately 9 m. The debris are strewn across a seafloor dominated by uncolonized, unconsolidated sediment, but some coral colonies were observed growing on the debris.



Figure 30. A view of the sand flat in the Indirect Impacts Zone, which is predominantly covered by uncolonized sand, with small patches of hardbottom.



Figure 31. A view of the area of mixed sand/hardbottom that runs parallel to, and approximately 20–35 m from, the south wharf face. This area straddles the 30 m Indirect Impacts Zone but occurs beyond the 20 m Indirect Impacts Zone.



Figure 32. Dense growth of the plate-and-pillar coral, *Porites rus*, and associated reef fishes, in the area of aggregate reef running parallel to, and approximately 25–40 m from, the south wharf face. This area partially occurs within the 30 m Indirect Impacts Zone, but falls outside the 20 m Indirect Impacts Zone.



Figure 33. A typical patch reef on the sand flat within the Indirect Impacts Zone.

APPENDIX A

Marine species reported from the waters of the Mariana Islands that are currently protected, or under consideration for protection, under the U. S. Endangered Species Act. Source: NOAA Fisheries.

Appendix A.

	Common Name	Scientific Name	ESA Listing
Marine mammals	Blue Whale	<i>Balaenoptera musculus</i>	Endangered
	Fin Whale	<i>Balaenoptera physalus</i>	Endangered
	Humpback Whale	<i>Megaptera novaeangliae</i>	Endangered
	Sei Whale	<i>Balaenoptera borealis</i>	Endangered
	Sperm Whale	<i>Physeter macrocephalus</i>	Endangered
	Dugong	<i>Dugong dugon</i>	Endangered
Sea turtle	Green Turtle, Central West	<i>Chelonia mydas</i>	Endangered
	Hawksbill Turtle	<i>Eretmochelys imbricata</i>	Endangered
	Leatherback Turtle	<i>Dermochelys coriacea</i>	Endangered
	Loggerhead Turtle, North	<i>Caretta caretta</i>	Endangered
	Olive Ridley Turtle	<i>Lepidochelys olivacea</i>	Threatened
Fishes	Scalloped Hammerhead Shark,	<i>Sphyrna lewini</i>	Threatened
	Giant Manta Ray	<i>Manta birostris</i>	Threatened
	Oceanic Whitetip Shark	<i>Carcharhinus</i>	Threatened
Corals	Needle coral	<i>Seriatopora aculeata</i>	Threatened
		<i>Acropora globiceps</i>	Threatened
		<i>Acropora retusa</i>	Threatened
	Cauliflower coral	<i>Pocillopora meandrina</i>	Candidate
Non-coral invertebrates	Giant clam	<i>Hippopus hippopus</i>	Candidate
	Giant clam	<i>Tridacna derasa</i>	Candidate
	Giant clam	<i>Tridacna gigas</i>	Candidate
	Giant clam	<i>Tridacna squamosa</i>	Candidate

APPENDIX B

Density (col/m²) of coral colonies for transects surveyed on the wharf (Direct Impacts Zone).

Appendix B.

	East side		South side									West side	
	1 m	5 m	1 m			5 m			9 m			1 m	5 m
	1	2	1	2	3	1	2	3	1	2	3	1	2
<i>Astreopora</i>	0.00	0.00	0.00	0.00	0.00	0.10	0.14	0.02	0.08	0.04	0.18	0.00	0.08
<i>Astreopora gracilis</i>	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.02	0.00	0.02	0.04	0.00	0.00
<i>Astreopora randalli</i>	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.08
<i>Astreopora</i> sp.	0.00	0.00	0.00	0.00	0.00	0.02	0.14	0.00	0.08	0.02	0.14	0.00	0.00
<i>Cyphastrea</i> sp.	0.00	0.02	0.00	0.00									
dendrophylliid sp.	0.26	2.24	0.62	2.65	0.51	1.28	3.62	2.42	0.14	0.02	0.00	0.21	0.00
<i>Favia</i>	0.00	0.19	0.02	0.00	0.00	0.00	0.04	0.02	0.02	0.00	0.02	0.00	0.00
<i>Favia fавus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
<i>Favia</i> sp.	0.00	0.19	0.02	0.00	0.00	0.00	0.04	0.00	0.02	0.00	0.02	0.00	0.00
<i>Fungia</i> sp.	0.00	0.00	0.00	0.00	0.00	0.02	0.00						
<i>Homophyllia</i> sp.	0.00	0.02	0.00	0.00	0.00	0.00	0.00						
<i>Leptastrea</i>	5.00	0.28	2.55	1.37	6.72	1.26	0.24	1.12	0.12	0.18	0.16	5.55	0.24
<i>Leptastrea purpurea</i>	0.00	0.00	2.55	1.37	6.72	1.26	0.10	1.12	0.12	0.18	0.10	5.55	0.24
<i>Leptastrea</i> sp.	5.00	0.28	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.06	0.00	0.00
<i>Leptoseris</i>	0.00	0.00	0.00	0.00	0.02	0.06	0.02	0.06	0.12	0.00	0.00	0.00	0.00
<i>Leptoseris incrustans</i>	0.00	0.00	0.00	0.00	0.02	0.06	0.00	0.06	0.00	0.00	0.00	0.00	0.00
<i>Leptoseris mycetoseroides</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
<i>Leptoseris</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.00	0.00	0.00	0.00
<i>Lobophyllia</i>	0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.04	0.14	0.16	0.26	0.00	0.00
<i>Lobophyllia corymbosa</i>	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.00	0.02	0.04	0.00	0.00
<i>Lobophyllia hemprichii</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00
<i>Lobophyllia</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.14	0.00	0.22	0.00	0.00

Appendix B. Continued.

	East side		South side									West side	
	1 m	5 m	1 m			5 m			9 m			1 m	5 m
	1	2	1	2	3	1	2	3	1	2	3	1	2
<i>Montastraea magnistellata</i>	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Pavona</i>	0.00	0.00	0.03	0.00	0.03	0.00							
<i>Pavona danai</i>	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Pavona minuta</i>	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Pavona varians</i>	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Pocillopora</i>	1.71	0.00	1.94	0.25	1.89	0.14	0.04	0.16	0.08	0.02	0.00	1.31	0.08
<i>Pocillopora acuta</i>	0.00	0.00	0.09	0.00	0.11	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.08
<i>Pocillopora damicornis</i>	0.00	0.00	1.85	0.25	1.78	0.10	0.04	0.16	0.08	0.02	0.00	1.31	0.00
<i>Pocillopora</i> sp.	1.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Porites</i>	0.09	0.09	0.05	0.00	0.25	0.68	0.52	0.32	1.06	0.26	0.90	0.07	0.16
<i>Porites cylindrica</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
<i>Porites horizontalata</i>	0.00	0.00	0.00	0.00	0.00	0.02	0.12	0.00	0.00	0.06	0.24	0.00	0.00
<i>Porites rus</i>	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.50	0.00	0.10	0.00	0.08
<i>Porites</i> sp. -massive	0.09	0.09	0.05	0.00	0.23	0.64	0.38	0.32	0.50	0.20	0.50	0.07	0.08
<i>Porites</i> sp. - other	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.06	0.00	0.00
<i>Porites</i> sp. - submassive	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00
<i>Psammocora</i>	0.00	0.00	0.00	0.00	0.00	0.12	0.12	0.02	0.02	0.00	0.14	0.00	0.00
<i>Psammocora haimeana</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
<i>Psammocora profundacella</i>	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00
<i>Psammocora superficialis</i>	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Psammocora</i> sp.	0.00	0.00	0.00	0.00	0.00	0.04	0.10	0.00	0.02	0.00	0.14	0.00	0.00
<i>Stylocoeniella armata</i>	0.00	0.06	0.44	0.18	0.38	0.00	0.00						
All coral colonies	7.05	2.80	5.20	4.26	9.43	3.68	4.84	4.26	2.24	0.86	2.06	7.14	0.57

APPENDIX C

Density (col/m²) of coral colonies observed along transects placed on the seafloor at the base of the wharf
(Direct Impacts Zone).

Appendix C.

	East	South			West
	1	1	2	3	1
<i>Astreopora</i>	0.00	0.16	0.10	0.08	0.00
<i>Astreopora gracilis</i>	0.00	0.02	0.00	0.00	0.00
<i>Astreopora listeri</i>	0.00	0.00	0.00	0.00	0.00
<i>Astreopora myriophthalma</i>	0.00	0.00	0.02	0.00	0.00
<i>Astreopora ocellata</i>	0.00	0.00	0.00	0.00	0.00
<i>Astreopora randalli</i>	0.00	0.08	0.00	0.00	0.00
<i>Astreopora scabra</i>	0.00	0.02	0.00	0.00	0.00
<i>Astreopora</i> sp.	0.00	0.04	0.08	0.08	0.00
<i>Cycloseris</i> sp.	0.00	0.00	0.00	0.02	0.00
<i>Cyphastrea</i>	0.00	0.00	0.00	0.00	0.00
<i>Cyphastrea serailia</i>	0.00	0.00	0.00	0.00	0.00
<i>Cyphastrea</i> sp.	0.00	0.00	0.00	0.00	0.00
dendrophylliid sp.	0.00	0.04	0.00	0.00	0.00
<i>Favia</i>	0.00	0.00	0.00	0.02	0.00
<i>Favia fавus</i>	0.00	0.00	0.00	0.00	0.00
<i>Favia</i> sp.	0.00	0.00	0.00	0.02	0.00
<i>Fungia</i>	0.00	0.00	0.02	0.00	0.00
<i>Fungia concinna</i>	0.00	0.00	0.02	0.00	0.00
<i>Fungia</i> sp.	0.00	0.00	0.00	0.00	0.00
<i>Goniastrea retiformis</i>	0.00	0.00	0.00	0.00	0.00
<i>Heliopora coerulea</i>	0.00	0.00	0.00	0.00	0.00
<i>Homophyllia</i> sp.	0.00	0.00	0.00	0.00	0.00
<i>Leptastrea</i>	0.12	0.06	0.00	0.00	0.04
<i>Leptastrea purpurea</i>	0.12	0.06	0.00	0.00	0.04
<i>Leptastrea transversa</i>	0.00	0.00	0.00	0.00	0.00
<i>Leptastrea</i> sp.	0.00	0.00	0.00	0.00	0.00
<i>Leptoseris</i>	0.00	0.02	0.00	0.00	0.00
<i>Leptoseris incrustans</i>	0.00	0.02	0.00	0.00	0.00
<i>Leptoseris mycetoseroides</i>	0.00	0.00	0.00	0.00	0.00
<i>Leptoseris</i> sp.	0.00	0.00	0.00	0.00	0.00

Appendix C. Continued.

	East	South			West
	1	1	2	3	1
<i>Lobophyllia</i>	0.00	0.26	0.12	0.02	0.00
<i>Lobophyllia corymbosa</i>	0.00	0.06	0.00	0.00	0.00
<i>Lobophyllia hataii</i>	0.00	0.02	0.00	0.00	0.00
<i>Lobophyllia hemprichii</i>	0.00	0.18	0.12	0.00	0.00
<i>Lobophyllia robusta</i>	0.00	0.00	0.00	0.00	0.00
<i>Lobophyllia</i> sp.	0.00	0.00	0.00	0.02	0.00
<i>Montastrea magnistellata</i>	0.00	0.00	0.00	0.00	0.00
<i>Montipora</i>	0.00	0.00	0.00	0.00	0.00
<i>Montipora informis</i>	0.00	0.00	0.00	0.00	0.00
<i>Montipora</i> sp.	0.00	0.00	0.00	0.00	0.00
<i>Pavona</i>	0.04	0.00	0.00	0.00	0.39
<i>Pavona danai</i>	0.00	0.00	0.00	0.00	0.00
<i>Pavona decussata</i>	0.00	0.00	0.00	0.00	0.39
<i>Pavona minuta</i>	0.00	0.00	0.00	0.00	0.00
<i>Pavona varians</i>	0.04	0.00	0.00	0.00	0.00
<i>Pocillopora</i>	0.52	0.06	0.00	0.02	0.31
<i>Pocillopora acuta</i>	0.00	0.06	0.00	0.00	0.08
<i>Pocillopora damicornis</i>	0.52	0.00	0.00	0.00	0.24
<i>Pocillopora</i> sp.	0.00	0.00	0.00	0.02	0.00
<i>Porites</i>	0.44	0.52	0.16	0.42	0.43
<i>Porites cylindrica</i>	0.00	0.00	0.00	0.00	0.00
<i>Porites deformis</i>	0.00	0.00	0.00	0.00	0.00
<i>Porites horizontalata</i>	0.00	0.02	0.00	0.00	0.00
<i>Porites murrayensis</i>	0.00	0.00	0.00	0.00	0.00
<i>Porites rus</i>	0.00	0.00	0.00	0.16	0.00
<i>Porites stephensoni</i>	0.00	0.00	0.08	0.00	0.00
<i>Porites vaughani</i>	0.00	0.04	0.00	0.00	0.00
<i>Porites</i> sp. -massive	0.44	0.46	0.08	0.24	0.43
<i>Porites</i> sp. - other	0.00	0.00	0.00	0.02	0.00
<i>Porites</i> sp. - submassive	0.00	0.00	0.00	0.00	0.00
<i>Psammocora</i>	0.00	0.10	0.00	0.06	0.00
<i>Psammocora contigua</i>	0.00	0.00	0.00	0.00	0.00
<i>Psammocora haimeana</i>	0.00	0.00	0.00	0.06	0.00
<i>Psammocora profundacella</i>	0.00	0.00	0.00	0.00	0.00
<i>Psammocora superficialis</i>	0.00	0.00	0.00	0.00	0.00
<i>Psammocora</i> sp.	0.00	0.10	0.00	0.00	0.00
<i>Stylocoeniella armata</i>	0.00	0.32	0.22	0.24	0.00
All coral colonies	1.12	1.54	0.62	0.88	1.18

APPENDIX D

Density (col/m²) of coral colonies on seafloor transects placed perpendicular to the wharf (30 m Indirect Impacts Zone).

Appendix D.

	Reef flat (W)		Sand flat												Reef flat (E)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<i>Astreopora</i>	0.00	0.00	0.33	0.03	0.10	0.13	0.23	0.03	0.37	0.23	0.80	0.37	0.20	0.37	0.03	0.00
<i>Astreopora gracilis</i>	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.20	0.60	0.27	0.13	0.27	0.03	0.00
<i>Astreopora listeri</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.00	0.00
<i>Astreopora myriophthalma</i>	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.07	0.00	0.10	0.00	0.00
<i>Astreopora ocellata</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Astreopora randalli</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.00
<i>Astreopora scabra</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
<i>Astreopora</i> sp.	0.00	0.00	0.33	0.00	0.10	0.00	0.23	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Cycloseris</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Cyphastrea</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Cyphastrea serailia</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Cyphastrea</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
dendrophylliid sp.	0.00	0.03	0.00	0.00												
<i>Favia</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Favia favaus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Favia</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Fungia</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Fungia concinna</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Fungia</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Goniastrea retiformis</i>	0.03	0.00	0.00													
<i>Heliopora coerulea</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Homophyllia</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Leptastrea</i>	0.27	0.20	0.03	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.10	0.07	0.03
<i>Leptastrea purpurea</i>	0.27	0.20	0.03	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.10	0.07	0.03
<i>Leptastrea transversa</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Leptastrea</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix D. Continued.

	Reef flat (W)		Sand flat											Reef flat (E)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<i>Leptoseris</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Leptoseris incrustans</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Leptoseris mycetoseroides</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Leptoseris</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Lobophyllia</i>	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.00
<i>Lobophyllia corymbosa</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Lobophyllia hatai</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Lobophyllia hemprichii</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.00
<i>Lobophyllia robusta</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Lobophyllia</i> sp.	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Montastraea magnistellata</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Montipora</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
<i>Montipora informis</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Montipora</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
<i>Pavona</i>	0.77	0.00	0.00	0.07												
<i>Pavona danai</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
<i>Pavona decussata</i>	0.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Pavona minuta</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Pavona varians</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Pocillopora</i>	0.73	0.53	0.07	0.00	0.03	0.00	0.03	0.00	0.83							
<i>Pocillopora acuta</i>	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
<i>Pocillopora damicornis</i>	0.73	0.50	0.07	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.77
<i>Pocillopora</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix D. Continued .

	Reef flat (W)		Sand flat													Reef flat (E)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Porites	1.33	0.93	0.13	0.07	0.03	0.67	0.23	0.60	0.90	0.03	0.57	0.90	1.13	0.47	0.50	0.93
<i>Porites cylindrica</i>	0.07	0.03	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00
<i>Porites deformis</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Porites horizontalata</i>	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00
<i>Porites murrayensis</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.03	0.00	0.00
<i>Porites rus</i>	0.27	0.17	0.00	0.00	0.00	0.00	0.00	0.37	0.20	0.00	0.07	0.73	1.03	0.00	0.30	0.00
<i>Porites stephensoni</i>	0.00	0.03	0.00	0.03	0.00	0.53	0.00	0.07	0.00	0.03	0.10	0.10	0.10	0.27	0.00	0.00
<i>Porites vaughani</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Porites</i> sp. -massive	1.07	0.73	0.00	0.03	0.03	0.03	0.23	0.17	0.57	0.00	0.30	0.03	0.00	0.17	0.20	0.93
<i>Porites</i> sp. - other	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Porites</i> sp. - submassive	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Psammocora	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
<i>Psammocora contigua</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
<i>Psammocora haimeana</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Psammocora profundacella</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Psammocora superficialis</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Psammocora</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stylocoeniella armata	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.00	0.07	0.10	0.23	0.17	0.00	0.03	0.00	0.00
All coral colonies	3.20	1.73	0.57	0.10	0.23	0.90	0.50	0.67	1.33	0.37	1.63	1.47	1.43	1.03	0.60	1.93

APPENDIX E

Density (col/m²) of coral colonies observed on transects placed on hardbottom habitat occurring parallel to the south wharf face (Indirect Impacts Zone).

Appendix E.

	Mixed sand/HB		Aggregate reef	
	1	2	3	4
<i>Astreopora</i>	0.57	1.20	0.34	0.44
<i>Astreopora gracilis</i>	0.27	0.00	0.00	0.14
<i>Astreopora listeri</i>	0.00	0.00	0.00	0.02
<i>Astreopora myriophthalma</i>	0.10	0.00	0.00	0.08
<i>Astreopora ocellata</i>	0.00	0.00	0.00	0.00
<i>Astreopora randalli</i>	0.00	0.00	0.00	0.04
<i>Astreopora scabra</i>	0.07	0.00	0.00	0.08
<i>Astreopora</i> sp.	0.13	1.20	0.34	0.08
<i>Cycloseris</i> sp.	0.00	0.00	0.00	0.00
<i>Cyphastrea</i>	0.03	0.00	0.03	0.00
<i>Cyphastrea serallia</i>	0.03	0.00	0.00	0.00
<i>Cyphastrea</i> sp.	0.00	0.00	0.03	0.00
dendrophylliid sp.	0.00	0.00	0.00	0.00
<i>Favia</i>	0.00	0.00	0.00	0.00
<i>Favia fava</i>	0.00	0.00	0.00	0.00
<i>Favia</i> sp.	0.00	0.00	0.00	0.00
<i>Fungia</i>	0.00	0.00	0.00	0.00
<i>Fungia concinna</i>	0.00	0.00	0.00	0.00
<i>Fungia</i> sp.	0.00	0.00	0.00	0.00
<i>Goniastrea retiformis</i>	0.00	0.00	0.00	0.00
<i>Heliopora coerulea</i>	0.00	0.00	0.00	0.00
<i>Homophyllia</i> sp.	0.00	0.00	0.00	0.00
<i>Leptastrea</i>	0.07	0.03	0.06	0.00
<i>Leptastrea purpurea</i>	0.07	0.00	0.00	0.00
<i>Leptastrea transversa</i>	0.00	0.00	0.00	0.00
<i>Leptastrea</i> sp.	0.00	0.03	0.06	0.00
<i>Leptoseris</i>	0.00	0.00	0.00	0.00
<i>Leptoseris incrustans</i>	0.00	0.00	0.00	0.00
<i>Leptoseris mycetoseroides</i>	0.00	0.00	0.00	0.00
<i>Leptoseris</i> sp.	0.00	0.00	0.00	0.00
<i>Lobophyllia</i>	0.07	0.00	0.03	0.02
<i>Lobophyllia corymbosa</i>	0.00	0.00	0.03	0.00
<i>Lobophyllia hataii</i>	0.00	0.00	0.00	0.00
<i>Lobophyllia hemprichii</i>	0.07	0.00	0.00	0.02
<i>Lobophyllia robusta</i>	0.00	0.00	0.00	0.00
<i>Lobophyllia</i> sp.	0.00	0.00	0.00	0.00
<i>Montastraea magnistellata</i>	0.00	0.00	0.00	0.00

Appendix E. Continued

	Mixed sand/HB		Aggregate reef	
	1	2	3	4
Montipora	0.07	0.00	0.00	0.00
<i>Montipora informis</i>	0.07	0.00	0.00	0.00
<i>Montipora</i> sp.	0.00	0.00	0.00	0.00
Pavona	0.00	0.00	0.00	0.00
<i>Pavona danai</i>	0.00	0.00	0.00	0.00
<i>Pavona decussata</i>	0.00	0.00	0.00	0.00
<i>Pavona minuta</i>	0.00	0.00	0.00	0.00
<i>Pavona varians</i>	0.00	0.00	0.00	0.00
Pocillopora	0.00	0.00	0.00	0.00
<i>Pocillopora acuta</i>	0.00	0.00	0.00	0.00
<i>Pocillopora damicornis</i>	0.00	0.00	0.00	0.00
<i>Pocillopora</i> sp.	0.00	0.00	0.00	0.00
Porites	0.60	1.57	5.94	2.28
<i>Porites cylindrica</i>	0.00	0.00	0.00	0.00
<i>Porites deformis</i>	0.00	0.00	0.00	0.00
<i>Porites horizontalata</i>	0.00	0.00	0.46	0.18
<i>Porites murrayensis</i>	0.00	0.00	0.00	0.00
<i>Porites rus</i>	0.53	1.03	4.74	1.76
<i>Porites stephensoni</i>	0.07	0.00	0.00	0.04
<i>Porites vaughani</i>	0.00	0.00	0.00	0.00
<i>Porites</i> sp. -massive	0.00	0.53	0.51	0.30
<i>Porites</i> sp. - other	0.00	0.00	0.23	0.00
<i>Porites</i> sp. - submassive	0.00	0.00	0.00	0.00
Psammocora	0.00	0.00	0.00	0.00
<i>Psammocora contigua</i>	0.00	0.00	0.00	0.00
<i>Psammocora haimeana</i>	0.00	0.00	0.00	0.00
<i>Psammocora profundacella</i>	0.00	0.00	0.00	0.00
<i>Psammocora superficialis</i>	0.00	0.00	0.00	0.00
<i>Psammocora</i> sp.	0.00	0.00	0.00	0.00
Stylocoeniella armata	0.10	0.30	0.31	0.00
All coral colonies	1.50	3.10	6.71	2.74

APPENDIX F

Density (col/m²) of coral taxa for patch reefs 1–13 surveyed within the Indirect Impacts Zone.

Appendix F.

	1	2	3	4	5	6	7	8	9	10	12	13
<i>Astreopora</i>	0.0	0.7	0.6	0.7	1.8	1.4	0.2	1.3	1.8	2.8	0.1	1.1
<i>Astreopora gracilis</i>	0.0	0.0	0.3	0.2	1.5	0.3	0.1	0.0	0.5	1.6	0.0	0.4
<i>Astreopora listeri</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Astreopora myriophthalma</i>	0.0	0.3	0.0	0.2	0.0	0.6	0.1	0.3	1.3	0.9	0.1	0.2
<i>Astreopora ocellata</i>	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Astreopora randalli</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Astreopora scabra</i>	0.0	0.3	0.0	0.2	0.2	0.4	0.0	1.0	0.0	0.3	0.0	0.4
<i>Astreopora</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Cycloseris</i> sp.	0.0											
<i>Cyphastrea</i>	0.0											
<i>Cyphastrea serailia</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Cyphastrea</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
dendrophylliid sp.	0.0											
<i>Favia</i>	0.0											
<i>Favia fava</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Favia</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Fungia</i>	0.0											
<i>Fungia concinna</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Fungia</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Goniastrea retiformis</i>	0.0											
<i>Heliopora coerulea</i>	0.0											
<i>Homophyllia</i> sp.	0.0											
<i>Leptastrea</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.0	0.0
<i>Leptastrea purpurea</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.0	0.0
<i>Leptastrea transversa</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Leptastrea</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Leptoseris</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
<i>Leptoseris incrustans</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
<i>Leptoseris mycetoseroides</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Leptoseris</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Lobophyllia</i>	0.0	0.3	0.0	0.0	0.0	0.0						
<i>Lobophyllia corymbosa</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Lobophyllia hataii</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
<i>Lobophyllia hemprichii</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Lobophyllia robusta</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Lobophyllia</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Montastraea magnistellata</i>	0.0											
<i>Montipora</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
<i>Montipora informis</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Montipora</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0

Appendix F. Continued.

	1	2	3	4	5	6	7	8	9	10	12	13
<i>Pavona</i>	0.0											
<i>Pavona danai</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Pavona decussata</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Pavona minuta</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Pavona varians</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Pocillopora</i>	0.0											
<i>Pocillopora acuta</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Pocillopora damicornis</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Pocillopora</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Porites</i>	0.4	1.5	0.0	0.5	1.0	1.8	0.4	0.0	0.0	1.1	0.5	2.4
<i>Porites cylindrica</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Porites deformis</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Porites horizontalata</i>	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.2
<i>Porites murrayensis</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4
<i>Porites rus</i>	0.4	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
<i>Porites stephensoni</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.0	0.6
<i>Porites vaughani</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Porites</i> sp. -massive	0.0	1.5	0.0	0.5	1.0	1.7	0.0	0.0	0.0	0.8	0.1	1.1
<i>Porites</i> sp. - other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Porites</i> sp. - submassive	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Psammocora</i>	0.0	1.8	0.0									
<i>Psammocora contigua</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Psammocora haimeana</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Psammocora profundacella</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0
<i>Psammocora superficialis</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Psammocora</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Stylocoeniella armata</i>	0.0											
All coral colonies	0.4	2.3	0.6	1.2	2.8	3.3	1.0	1.6	1.8	4.3	2.5	3.6

APPENDIX G

Density (col/m²) of coral taxa for patch reefs 14–26 within the Indirect Impacts Zone.

Appendix G.

	14	15	16	17	18	19	20	21	22	25	26
<i>Astreopora</i>	0.9	0.4	0.5	0.8	1.8	3.0	1.1	0.1	1.6	2.1	5.1
<i>Astreopora gracilis</i>	0.0	0.4	0.2	0.5	0.6	1.0	0.7	0.1	0.3	0.0	0.0
<i>Astreopora listeri</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Astreopora myriophthalma</i>	0.0	0.0	0.0	0.2	0.6	0.5	0.3	0.0	0.3	0.0	2.5
<i>Astreopora ocellata</i>	0.4	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
<i>Astreopora randalli</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Astreopora scabra</i>	0.4	0.0	0.2	0.0	0.3	0.5	0.0	0.0	0.3	0.0	0.0
<i>Astreopora</i> sp.	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.5	2.1	2.5
<i>Cycloseris</i> sp.	0.0										
<i>Cyphastrea</i>	0.0	0.0	0.0	0.2	0.0						
<i>Cyphastrea serailia</i>	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Cyphastrea</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
dendrophylliid sp.	0.0										
<i>Favia</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
<i>Favia fавus</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Favia</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
<i>Fungia</i>	0.0										
<i>Fungia concinna</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Fungia</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Goniastrea retiformis</i>	0.0										
<i>Heliopora coerulea</i>	0.0	0.6									
<i>Homophyllia</i> sp.	0.0										
<i>Leptastrea</i>	0.0	0.0	0.2	0.0	0.9	0.0	0.0	0.3	0.0	0.0	0.0
<i>Leptastrea purpurea</i>	0.0	0.0	0.2	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0
<i>Leptastrea transversa</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
<i>Leptastrea</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Leptoseris</i>	0.0	0.0	0.2	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
<i>Leptoseris incrustans</i>	0.0	0.0	0.2	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
<i>Leptoseris mycetoseroides</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Leptoseris</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Lobophyllia</i>	0.4	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.0	1.2
<i>Lobophyllia corymbosa</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Lobophyllia hataii</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Lobophyllia hemprichii</i>	0.4	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	1.2
<i>Lobophyllia robusta</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
<i>Lobophyllia</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Montastrea magnistellata</i>	0.0										
<i>Montipora</i>	0.0	0.0	0.0	0.1	0.0						
<i>Montipora informis</i>	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Montipora</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix G. Continued.

	14	15	16	17	18	19	20	21	22	25	26
<i>Pavona</i>	0.00	0.0									
<i>Pavona danai</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Pavona decussata</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Pavona minuta</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Pavona varians</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Pocillopora</i>	0.00	0.0									
<i>Pocillopora acuta</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Pocillopora damicornis</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Pocillopora</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Porites</i>	0.46	0.20	0.00	1.30	0.31	1.03	0.74	0.00	1.30	0.86	0.0
<i>Porites cylindrica</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Porites deformis</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Porites horizontalata</i>	0.00	0.00	0.00	0.87	0.00	1.03	0.00	0.00	0.00	0.00	0.0
<i>Porites murrayensis</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.0
<i>Porites rus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Porites stephensoni</i>	0.46	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.0
<i>Porites vaughani</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Porites</i> sp. -massive	0.00	0.20	0.00	0.43	0.00	0.00	0.74	0.00	0.19	0.86	0.0
<i>Porites</i> sp. - other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Porites</i> sp. - submassive	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Psammocora</i>	0.00	0.0									
<i>Psammocora contigua</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Psammocora haimeana</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Psammocora profundacella</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Psammocora superficialis</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Psammocora</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
<i>Stylocoeniella armata</i>	0.00	0.18	0.00	0.43	0.0						
All coral colonies	1.85	0.60	1.11	2.74	3.09	4.62	2.22	0.88	3.15	3.43	7.0

APPENDIX H

Mean density of coral colonies (col/m²) for all coral taxa within the Direct Impacts Zone

Appendix H.

	Wharf base				Wharf Face				Direct Impacts Zone
	East	South	West	Entire base	East	South	West	Entire face	
All coral colonies	1.120	1.013	1.176	1.067	5.833	4.092	4.039	4.352	3.440
<i>Astreopora</i>	0.000	0.113	0.000	0.068	0.000	0.062	0.067	0.053	0.057
<i>Astreopora gracilis</i>	0.000	0.007	0.000	0.004	0.000	0.013	0.000	0.009	0.008
<i>Astreopora listeri</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Astreopora myriophthalma</i>	0.000	0.007	0.000	0.004	0.000	0.000	0.000	0.000	0.001
<i>Astreopora ocellata</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Astreopora randalli</i>	0.000	0.027	0.000	0.016	0.000	0.004	0.067	0.013	0.014
<i>Astreopora scabra</i>	0.000	0.007	0.000	0.004	0.000	0.000	0.000	0.000	0.001
<i>Astreopora</i> sp.	0.000	0.067	0.000	0.040	0.000	0.044	0.000	0.031	0.033
<i>Cycloseris</i> sp.	0.000	0.007	0.000	0.004	0.000	0.000	0.000	0.000	0.001
<i>Cyphastrea</i>	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.002	0.001
<i>Cyphastrea serailia</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Cyphastrea</i> sp.	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.002	0.001
dendrophylliid sp.	0.000	0.013	0.000	0.008	1.974	1.250	0.106	1.185	0.858
<i>Favia</i>	0.000	0.007	0.000	0.004	0.154	0.013	0.000	0.033	0.025
<i>Favia fавus</i>	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.002	0.001
<i>Favia</i> sp.	0.000	0.007	0.000	0.004	0.154	0.011	0.000	0.031	0.024
<i>Fungia</i>	0.000	0.007	0.000	0.004	0.000	0.002	0.000	0.002	0.002
<i>Fungia concinna</i>	0.000	0.007	0.000	0.004	0.000	0.000	0.000	0.000	0.001
<i>Fungia</i> sp.	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.002	0.001
<i>Goniastrea retiformis</i>	0.000								
<i>Heliopora coerulea</i>	0.000								
<i>Homophyllia</i> sp.	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.002	0.001
<i>Leptastrea</i>	0.120	0.020	0.039	0.044	2.731	1.525	2.976	1.934	1.409
<i>Leptastrea purpurea</i>	0.120	0.020	0.039	0.044	0.000	1.503	2.976	1.498	1.094
<i>Leptastrea transversa</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Leptastrea</i> sp.	0.000	0.000	0.000	0.000	2.731	0.022	0.000	0.436	0.315

Appendix H. Continued.

	Wharf base				Wharf Face				Direct Impacts Zone
	East	South	West	Entire base	East	South	West	Entire face	
<i>Leptoseris</i>	0.000	0.007	0.000	0.004	0.000	0.031	0.000	0.021	0.016
<i>Leptoseris incrustans</i>	0.000	0.007	0.000	0.004	0.000	0.015	0.000	0.010	0.009
<i>Leptoseris mycetoseroides</i>	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.002	0.001
<i>Leptoseris</i> sp.	0.000	0.000	0.000	0.000	0.000	0.013	0.000	0.009	0.007
<i>Lobophyllia</i>	0.000	0.133	0.000	0.080	0.000	0.080	0.000	0.055	0.062
<i>Lobophyllia corymbosa</i>	0.000	0.020	0.000	0.012	0.000	0.016	0.000	0.011	0.011
<i>Lobophyllia hataii</i>	0.000	0.007	0.000	0.004	0.000	0.000	0.000	0.000	0.001
<i>Lobophyllia hemprichii</i>	0.000	0.100	0.000	0.060	0.000	0.016	0.000	0.011	0.024
<i>Lobophyllia robusta</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Lobophyllia</i> sp.	0.000	0.007	0.000	0.004	0.000	0.049	0.000	0.034	0.026
<i>Montastrea magnistellata</i>	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.001	0.001
<i>Montipora</i>	0.000								
<i>Montipora informis</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Montipora</i> sp.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Pavona</i>	0.040	0.000	0.392	0.086	0.000	0.007	0.000	0.005	0.027
<i>Pavona danai</i>	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.001	0.001
<i>Pavona decussata</i>	0.000	0.000	0.392	0.078	0.000	0.000	0.000	0.000	0.022
<i>Pavona minuta</i>	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.002	0.002
<i>Pavona varians</i>	0.040	0.000	0.000	0.008	0.000	0.002	0.000	0.001	0.003
<i>Pocillopora</i>	0.520	0.027	0.314	0.183	0.855	0.502	0.721	0.590	0.477
<i>Pocillopora acuta</i>	0.000	0.020	0.078	0.028	0.000	0.027	0.067	0.029	0.028
<i>Pocillopora damicornis</i>	0.520	0.000	0.235	0.151	0.000	0.475	0.654	0.430	0.352
<i>Pocillopora</i> sp.	0.000	0.007	0.000	0.004	0.855	0.000	0.000	0.131	0.096

Appendix H. Continued.

	Wharf base				Wharf Face				Direct Impacts Zone
	East	South	West	Entire base	East	South	West	Entire face	
<i>Porites</i>	0.440	0.367	0.431	0.394	0.120	0.450	0.169	0.356	0.367
<i>Porites cylindrica</i>	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.002	0.001
<i>Porites deformis</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Porites horizontalata</i>	0.000	0.007	0.000	0.004	0.000	0.049	0.000	0.034	0.026
<i>Porites murrayensis</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Porites rus</i>	0.000	0.053	0.000	0.032	0.000	0.071	0.067	0.059	0.052
<i>Porites stephensoni</i>	0.000	0.027	0.000	0.016	0.000	0.000	0.000	0.000	0.004
<i>Porites vaughani</i>	0.000	0.013	0.000	0.008	0.000	0.000	0.000	0.000	0.002
<i>Porites</i> sp.	0.000	0.007	0.000	0.004	0.000	0.009	0.000	0.006	0.006
<i>Porites</i> sp. - submassive	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.005	0.003
<i>Porites</i> sp. -massive	0.440	0.260	0.431	0.330	0.120	0.313	0.102	0.251	0.273
<i>Psammocora</i>	0.000	0.053	0.000	0.032	0.000	0.047	0.000	0.032	0.032
<i>Psammocora contigua</i>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
<i>Psammocora haimeana</i>	0.000	0.020	0.000	0.012	0.000	0.002	0.000	0.002	0.004
<i>Psammocora profundacella</i>	0.000	0.000	0.000	0.000	0.000	0.009	0.000	0.006	0.004
<i>Psammocora</i> sp.	0.000	0.033	0.000	0.020	0.000	0.033	0.000	0.023	0.022
<i>Psammocora superficialis</i>	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.002	0.001
<i>Stylocoeniella armata</i>	0.000	0.260	0.000	0.156	0.000	0.118	0.000	0.082	0.102

APPENDIX I

Colony count estimates for all coral taxa within the Direct Impacts Zone

Appendix I.

	Wharf base				Wharf Face			
	East	South	West	Entire base	East	South	West	Entire face
Surface area	74	291	62	428	226	958	210	1395
Colony estimates								
All coral colonies	83	295	73	457	1321	3922	849	6071
<i>Astreopora</i>	0	33	0	29	0	60	14	74
<i>Astreopora gracilis</i>	0	2	0	2	0	13	0	13
<i>Astreopora listeri</i>	0	0	0	0	0	0	0	0
<i>Astreopora myriophthalma</i>	0	2	0	2	0	0	0	0
<i>Astreopora ocellata</i>	0	0	0	0	0	0	0	0
<i>Astreopora randalli</i>	0	8	0	7	0	4	14	19
<i>Astreopora scabra</i>	0	2	0	2	0	0	0	0
<i>Astreopora</i> sp.	0	19	0	17	0	43	0	43
<i>Cycloseris</i> sp.	0	2	0	2	0	0	0	0
<i>Cyphastrea</i>	0	0	0	0	0	2	0	2
<i>Cyphastrea serailia</i>	0	0	0	0	0	0	0	0
<i>Cyphastrea</i> sp.	0	0	0	0	0	2	0	2
dendrophylliid sp.	0	4	0	3	447	1198	22	1654
<i>Favia</i>	0	2	0	2	35	12	0	45
<i>Favia favius</i>	0	0	0	0	0	2	0	2
<i>Favia</i> sp.	0	2	0	2	35	10	0	43
<i>Fungia</i>	0	2	0	2	0	2	0	2
<i>Fungia concinna</i>	0	2	0	2	0	0	0	0
<i>Fungia</i> sp.	0	0	0	0	0	2	0	2
<i>Goniastrea retiformis</i>	0	0	0	0	0	0	0	0
<i>Heliopora coerulea</i>	0	0	0	0	0	0	0	0
<i>Homophyllia</i> sp.	0	0	0	0	0	2	0	2

Appendix I.

	Wharf base				Wharf Face			
	East	South	West	Entire base	East	South	West	Entire face
<i>Leptastrea</i>	9	6	2	19	618	1462	626	2698
<i>Leptastrea purpurea</i>	9	6	2	19	0	1440	626	2090
<i>Leptastrea transversa</i>	0	0	0	0	0	0	0	0
<i>Leptastrea</i> sp.	0	0	0	0	618	21	0	608
<i>Leptoseris</i>	0	2	0	2	0	29	0	30
<i>Leptoseris incrustans</i>	0	2	0	2	0	14	0	15
<i>Leptoseris mycetoseroides</i>	0	0	0	0	0	2	0	2
<i>Leptoseris</i> sp.	0	0	0	0	0	13	0	13
<i>Lobophyllia</i>	0	39	0	34	0	77	0	77
<i>Lobophyllia corymbosa</i>	0	6	0	5	0	15	0	15
<i>Lobophyllia hataii</i>	0	2	0	2	0	0	0	0
<i>Lobophyllia hemprichii</i>	0	29	0	26	0	15	0	15
<i>Lobophyllia robusta</i>	0	0	0	0	0	0	0	0
<i>Lobophyllia</i> sp.	0	2	0	2	0	47	0	47
<i>Montastrea magnistellata</i>	0	0	0	0	0	2	0	2
<i>Montipora</i>	0	0	0	0	0	0	0	0
<i>Montipora informis</i>	0	0	0	0	0	0	0	0
<i>Montipora</i> sp.	0	0	0	0	0	0	0	0
<i>Pavona</i>	3	0	24	37	0	7	0	7
<i>Pavona danai</i>	0	0	0	0	0	2	0	2
<i>Pavona decussata</i>	0	0	24	34	0	0	0	0
<i>Pavona minuta</i>	0	0	0	0	0	3	0	3
<i>Pavona varians</i>	3	0	0	3	0	2	0	2
<i>Pocillopora</i>	39	8	20	78	194	481	152	823
<i>Pocillopora acuta</i>	0	6	5	12	0	26	14	40
<i>Pocillopora damicornis</i>	39	0	15	65	0	455	138	599
<i>Pocillopora</i> sp.	0	2	0	2	194	0	0	183

Appendix I.

	Wharf base				Wharf Face			
	East	South	West	Entire base	East	South	West	Entire face
<i>Porites</i>	33	107	27	169	27	431	35	497
<i>Porites cylindrica</i>	0	0	0	0	0	2	0	2
<i>Porites deformis</i>	0	0	0	0	0	0	0	0
<i>Porites horizontalata</i>	0	2	0	2	0	47	0	47
<i>Porites murrayensis</i>	0	0	0	0	0	0	0	0
<i>Porites rus</i>	0	16	0	14	0	68	14	82
<i>Porites stephensoni</i>	0	8	0	7	0	0	0	0
<i>Porites vaughani</i>	0	4	0	3	0	0	0	0
<i>Porites</i> sp.	0	2	0	2	0	9	0	9
<i>Porites</i> sp. - submassive	0	0	0	0	0	6	0	6
<i>Porites</i> sp. -massive	33	76	27	141	27	300	21	350
<i>Psammocora</i>	0	16	0	14	0	45	0	45
<i>Psammocora contigua</i>	0	0	0	0	0	0	0	0
<i>Psammocora haimeana</i>	0	6	0	5	0	2	0	2
<i>Psammocora profundacella</i>	0	0	0	0	0	9	0	9
<i>Psammocora</i> sp.	0	10	0	9	0	32	0	32
<i>Psammocora superficialis</i>	0	0	0	0	0	2	0	2
<i>Stylocoeniella armata</i>	0	76	0	67	0	113	0	114

APPENDIX J

Mean density of coral colonies (col/m²) and colony estimates for all coral taxa within the 30 m and 20 m
Indirect Impacts Zones

Appendix J.

	Reef flat	Sand	Indirect Impacts Zone	Reef flat	Sand	30 m Indirect Impacts Zone	Reef flat	Sand	20 m Indirect Impacts Zone
Substrate area (m²)				979	6066	7045	619	3574	4193
	Colony density			Colony estimates					
All coral colonies	2.289	0.833	1.106	2241	5055	7794	1417	2978	4639
<i>Astreopora</i>	0.000	0.249	0.202	0	1509	1424	0	889	847
<i>Astreopora gracilis</i>	0.000	0.126	0.102	0	762	719	0	449	428
<i>Astreopora listeri</i>	0.000	0.005	0.004	0	31	29	0	18	17
<i>Astreopora myriophthalma</i>	0.000	0.028	0.023	0	171	161	0	101	96
<i>Astreopora ocellata</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Astreopora randalli</i>	0.000	0.008	0.006	0	47	44	0	27	26
<i>Astreopora scabra</i>	0.000	0.003	0.002	0	16	15	0	9	9
<i>Astreopora</i> sp.	0.000	0.079	0.065	0	482	455	0	284	271
<i>Cycloseris</i> sp.	0.000	0.000	0.000	0	0	0	0	0	0
<i>Cyphastrea</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Cyphastrea serailia</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Cyphastrea</i> sp.	0.000	0.000	0.000	0	0	0	0	0	0
dendrophylliid sp.	0.011	0.000	0.002	11	0	15	7	0	9
<i>Favia</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Favia fava</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Favia</i> sp.	0.000	0.000	0.000	0	0	0	0	0	0
<i>Fungia</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Fungia concinna</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Fungia</i> sp.	0.000	0.000	0.000	0	0	0	0	0	0
<i>Goniastrea retiformis</i>	0.011	0.000	0.002	11	0	15	7	0	9

Appendix J. Continued.

	Indirect Impacts Zone			30 m Indirect Impacts Zone			20 m Indirect Impacts Zone		
	Reef flat	Sand		Reef flat	Sand		Reef flat	Sand	
<i>Heliopora coerulea</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Homophyllia</i> sp.	0.000	0.000	0.000	0	0	0	0	0	0
<i>Leptastrea</i>	0.167	0.021	0.048	163	124	338	103	73	201
<i>Leptastrea purpurea</i>	0.167	0.021	0.048	163	124	338	103	73	201
<i>Leptastrea transversa</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Leptastrea</i> sp.	0.000	0.000	0.000	0	0	0	0	0	0
<i>Leptoseris</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Leptoseris incrustans</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Leptoseris mycetoseroides</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Leptoseris</i> sp.	0.000	0.000	0.000	0	0	0	0	0	0
<i>Lobophyllia</i>	0.000	0.008	0.006	0	47	44	0	27	26
<i>Lobophyllia corymbosa</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Lobophyllia hataii</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Lobophyllia hemprichii</i>	0.000	0.005	0.004	0	31	29	0	18	17
<i>Lobophyllia robusta</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Lobophyllia</i> sp.	0.000	0.003	0.002	0	16	15	0	9	9
<i>Montastrea magnistellata</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Montipora</i>	0.022	0.000	0.004	22	0	29	14	0	17
<i>Montipora informis</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Montipora</i> sp.	0.022	0.000	0.004	22	0	29	14	0	17
<i>Pavona</i>	0.278	0.000	0.052	272	0	367	172	0	218
<i>Pavona danai</i>	0.022	0.000	0.004	22	0	29	14	0	17
<i>Pavona decussata</i>	0.256	0.000	0.048	250	0	338	158	0	201
<i>Pavona minuta</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Pavona varians</i>	0.000	0.000	0.000	0	0	0	0	0	0

Appendix J. Continued.

	Indirect Impacts			30 m Indirect Impacts			20 m Indirect Impacts		
	Reef flat	Sand	Zone	Reef flat	Sand	Zone	Reef flat	Sand	Zone
<i>Pocillopora</i>	0.700	0.010	0.140	685	62	983	433	37	585
<i>Pocillopora acuta</i>	0.033	0.000	0.006	33	0	44	21	0	26
<i>Pocillopora damicornis</i>	0.667	0.010	0.133	653	62	939	413	37	559
<i>Pocillopora</i> sp.	0.000	0.000	0.000	0	0	0	0	0	0
<i>Porites</i>	1.100	0.490	0.604	1077	2971	4256	681	1750	2533
<i>Porites cylindrica</i>	0.033	0.010	0.015	33	62	103	21	37	61
<i>Porites deformis</i>	0.000	0.003	0.002	0	16	15	0	9	9
<i>Porites horizontalata</i>	0.000	0.013	0.010	0	78	73	0	46	44
<i>Porites murrayensis</i>	0.000	0.008	0.006	0	47	44	0	27	26
<i>Porites rus</i>	0.144	0.208	0.196	141	1260	1380	89	742	821
<i>Porites stephensoni</i>	0.011	0.095	0.079	11	575	558	7	339	332
<i>Porites vaughani</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Porites</i> sp.	0.000	0.018	0.015	0	109	103	0	64	61
<i>Porites</i> sp. - submassive	0.000	0.000	0.000	0	0	0	0	0	0
<i>Porites</i> sp. -massive	0.911	0.136	0.281	892	824	1981	564	486	1179
<i>Psammocora</i>	0.000	0.003	0.002	0	16	15	0	9	9
<i>Psammocora contigua</i>	0.000	0.003	0.002	0	16	15	0	9	9
<i>Psammocora haimeana</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Psammocora profundacella</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Psammocora</i> sp.	0.000	0.000	0.000	0	0	0	0	0	0
<i>Psammocora superficialis</i>	0.000	0.000	0.000	0	0	0	0	0	0
<i>Stylocoeniella armata</i>	0.000	0.054	0.044	0	327	308	0	192	183

APPENDIX K

Percent cover of major benthic classes for the south wharf face transects (Direct Impacts Zone).

Appendix K.

	1 m			5 m			9 m		
	1	2	3	1	2	3	1	2	3
Cover type									
Hard coral	0.5	0.5	1.4	0.0	0.4	0.3	1.3	0.6	0.8
Soft coral	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Sponges	0.0	0.4	0.4	2.7	5.4	2.1	3.0	6.9	2.4
Dead coral	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other hardbottom	99.5	96.7	97.9	97.3	94.3	97.6	95.7	92.5	96.9
Sand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Debris	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

APPENDIX L

Percent cover of major benthic classes for the east and west wharf side transects (Direct Impacts Zone).

Appendix L.

	East		West	
	1 m	5 m	1 m	5 m
	1	2	1	2
Cover type				
Hard coral	1.0	0.0	2.9	1.6
Soft coral	0.0	0.9	0.0	0.0
Sponges	0.0	4.5	0.0	0.0
Dead coral	0.0	0.0	0.0	0.0
Other hardbottom	99.0	94.6	97.1	98.4
Sand	0.0	0.0	0.0	0.0
Debris	0.0	0.0	0.0	0.0

APPENDIX M

Percent cover of major benthic classes for the transects at the base of the wharf (Direct Impacts Zone).

Appendix M.

	South side			East side	West side
	<u>1</u>	<u>2</u>	<u>3</u>	<u>1</u>	<u>1</u>
Cover type					
Hard coral	0.6	0.6	0.3	0.3	1.0
Soft coral	0.0	0.0	0.0	0.0	0.0
Sponges	0.3	0.0	0.6	0.0	0.0
Dead coral	0.0	0.0	0.0	0.0	0.0
Other hardbottom	3.1	0.0	1.9	72.4	65.5
Sand	55.9	8.0	54.3	25.6	30.5
Debris	40.1	91.4	43.0	1.7	3.0

APPENDIX N

Percent cover of major benthic classes for seafloor transects within the 30 m Indirect Impacts Zone.

Appendix N.

	Reef flat (W)		Sand flat											Reef flat (E)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Cover type																
Hard coral	1.5	0.4	0.0	0.6	0.4	0.2	1.0	0.2	5.4	0.2	1.3	4.8	1.3	0.6	0.0	3.5
Soft coral	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sponges	0.0	0.0	0.4	0.0	0.2	0.2	0.0	0.0	0.6	0.0	0.2	0.8	0.4	0.8	0.0	0.0
Dead coral	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other hardbottom	82.9	65.0	11.1	9.0	2.5	17.3	5.0	3.8	15.0	9.8	16.9	14.8	19.4	21.3	54.4	94.2
Sand	15.4	33.1	87.7	86.9	90.4	70.5	69.7	69.8	46.3	71.3	64.2	70.0	71.9	74.8	44.2	1.9
Debris	0.2	1.5	0.8	3.5	6.5	11.7	24.2	26.3	32.5	18.8	17.5	9.6	7.1	2.5	1.5	0.4

APPENDIX O

Percent cover of major benthic classes for seafloor transects that targeted hardbottom habitat within the
30 m Indirect Impacts Zone.

Appendix O.

Cover type	Aggregate reef		Mixed sand/HB	
	1	2	1	2
Hard coral	13.0	16.5	3.5	1.7
Soft coral	0.0	0.0	0.0	0.0
Sponges	1.4	0.3	1.5	0.4
Dead coral	0.0	0.0	0.0	0.0
Other hardbottom	53.1	36.4	35.4	27.5
Sand	32.1	45.5	59.4	64.6
Debris	0.4	1.4	0.2	5.8

APPENDIX P

Percent cover of major benthic classes for seafloor transects that targeted hardbottom habitat within the
20 m Indirect Impacts Zone.

Appendix P.

	Reef flat (W)			Sand flat												Reef flat (E)			
	1	2	A	3	4	5	6	7	8	9	10	11	12	13	14	15	16	B	
Cover type																			
Hard coral	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	10.0
Soft coral	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sponges	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.3	0.6	0.0	0.9	0.0	0.0	0.0	0.3
Dead coral	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other hardbottom	96.5	80.8	91.9	11.6	12.9	2.8	12.2	0.0	0.3	2.8	2.8	9.4	5.3	7.5	13.1	37.2	93.8	89.7	
Sand	3.2	17.0	5.6	87.2	81.8	88.8	70.3	65.3	60.6	48.4	69.6	65.7	80.6	82.1	83.4	60.6	0.9	0.0	
Debris	0.3	2.2	0.0	1.3	5.3	8.4	17.5	34.7	39.1	48.1	27.6	24.5	13.4	10.3	2.5	2.2	0.6	0.0	

APPENDIX Q

Density (ind/m²) of macroinvertebrate taxa observed within belt transects placed on the wharf (Direct Impacts Zone).

Appendix Q.

	East side		South side									West side	
	1	2	1	2	3	5	6	7	9	10	11	1	2
Seastars	0.00	0.00	0.02	0.00	0.02	0.00	0.01	0.02	0.02	0.01	0.01	0.05	0.00
<i>Culcita novaeguineae</i>	0.00	0.00	0.02	0.00	0.01	0.00	0.01	0.01	0.02	0.01	0.01	0.00	0.00
<i>Linckia multifora</i>	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.05	0.00
Urchins	0.00	0.00	0.15	0.00	0.00	0.16	0.00	0.00	0.05	0.02	0.00	0.02	0.00
<i>Diadema</i> sp.	0.00	0.00	0.09	0.00	0.00	0.09	0.00	0.00	0.02	0.02	0.00	0.00	0.00
<i>Echinometra mathaei</i>	0.00	0.00	0.01	0.00	0.00	0.04	0.00	0.00	0.02	0.00	0.00	0.02	0.00
<i>Echinometra</i> sp. A	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Echinostrephus aciculatus</i>	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Echinothrix diadema</i>	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Parasalenia gratiosa</i>	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sea cucumbers	0.22	0.00	0.04	0.00	0.00	0.01	0.00	0.00	0.08	0.01	0.00	0.00	0.00
<i>Actinopyga echinites</i>	0.19	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
<i>Actinopyga varians</i>	0.03	0.00	0.02	0.00	0.00	0.01	0.00	0.00	0.05	0.00	0.00	0.00	0.00
<i>Bohadschia argus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
<i>Holothuria atra</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Holothuria leucospilota</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Thelanota anax</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Edible mollusks	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Octopus cyanea</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Tectus niloticus</i>	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
All macroinvertebrates	0.25	0.00	0.22	0.00	0.02	0.17	0.01	0.02	0.15	0.04	0.01	0.07	0.00

APPENDIX R

Density (ind/m²) of macroinvertebrate taxa observed within belt transects placed on the seafloor at the base of the wharf (Direct Impacts Zone).

Appendix R.

	East	South			West
	4	4	8	12	4
Seastars	0.00	0.04	0.00	0.02	0.00
<i>Calcita novaeguineae</i>	0.00	0.04	0.00	0.02	0.00
<i>Linckia multifora</i>	0.00	0.00	0.00	0.00	0.00
Urchins	0.02	0.00	0.00	0.00	0.22
<i>Diadema</i> sp.	0.00	0.00	0.00	0.00	0.00
<i>Echinometra mathaei</i>	0.02	0.00	0.00	0.00	0.22
<i>Echinometra</i> sp. A	0.00	0.00	0.00	0.00	0.00
<i>Echinostrephus aciculatus</i>	0.00	0.00	0.00	0.00	0.00
<i>Echinothrix diadema</i>	0.00	0.00	0.00	0.00	0.00
<i>Parasalenia gratiosa</i>	0.00	0.00	0.00	0.00	0.00
Sea cucumbers	0.28	0.00	0.00	0.01	0.02
<i>Actinopyga echinites</i>	0.20	0.00	0.00	0.00	0.00
<i>Actinopyga varians</i>	0.02	0.00	0.00	0.00	0.02
<i>Bohadschia argus</i>	0.02	0.00	0.00	0.01	0.00
<i>Holothuria atra</i>	0.02	0.00	0.00	0.00	0.00
<i>Holothuria leucospilota</i>	0.02	0.00	0.00	0.00	0.00
<i>Thelanota anax</i>	0.00	0.00	0.00	0.00	0.00
Edible mollusks	0.00	0.00	0.00	0.00	0.00
<i>Octopus cyanea</i>	0.00	0.00	0.00	0.00	0.00
<i>Tectus niloticus</i>	0.00	0.00	0.00	0.00	0.00
All macroinvertebrates	0.30	0.04	0.00	0.04	0.24

APPENDIX S

Density (ind/m²) of macroinvertebrate taxa observed within belt transect surveyed on the reef flat and sand flat within the 30 m Indirect Impacts Zone

Appendix S.

	Reef flat (W)		Sand flat													Reef flat (E)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Seastars	0.00	0.03	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Culcita novaeguineae</i>	0.00	0.03	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Linckia multifora</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Urchins	0.12	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
<i>Diadema</i> sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Echinometra mathaei</i>	0.08	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
<i>Echinometra</i> sp. A	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
<i>Echinostrephus aciculatus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Echinothrix diadema</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Paraselenia gratiosa</i>	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sea cucumbers	0.03	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.37
<i>Actinopyga echinites</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.33
<i>Actinopyga varians</i>	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
<i>Bohadschia argus</i>	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
<i>Holothuria atra</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02
<i>Holothuria leucospilota</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Thelanota anax</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Edible mollusks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Octopus cyanea</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Tectus niloticus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
All macroinvertebrates	0.15	0.07	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.42

APPENDIX T

Density (ind/m²) of macroinvertebrate taxa observed during surveys of transects placed on hardbottom habitat within the 30 m Indirect Impacts Zone.

Appendix T.

	Mixed sand/HB		Aggregate reef	
	1	2	3	4
Seastars	0.02	0.02	0.01	0.00
<i>Culcita novaeguineae</i>	0.02	0.02	0.01	0.00
<i>Linckia multifora</i>	0.00	0.00	0.00	0.00
Urchins	0.00	0.00	0.00	0.00
<i>Diadema</i> sp.	0.00	0.00	0.00	0.00
<i>Echinometra mathaei</i>	0.00	0.00	0.00	0.00
<i>Echinometra</i> sp. A	0.00	0.00	0.00	0.00
<i>Echinostrephus</i> <i>aciculatus</i>	0.00	0.00	0.00	0.00
<i>Echinothrix diadema</i>	0.00	0.00	0.00	0.00
<i>Parasalenia gratiosa</i>	0.00	0.00	0.00	0.00
Sea cucumbers	0.00	0.00	0.01	0.00
<i>Actinopyga echinites</i>	0.00	0.00	0.00	0.00
<i>Actinopyga varians</i>	0.00	0.00	0.00	0.00
<i>Bohadschia argus</i>	0.00	0.00	0.00	0.00
<i>Holothuria atra</i>	0.00	0.00	0.00	0.00
<i>Holothuria leucospilota</i>	0.00	0.00	0.00	0.00
<i>Thelanota anax</i>	0.00	0.00	0.01	0.00
Edible mollusks	0.00	0.00	0.00	0.00
<i>Octopus cyanea</i>	0.00	0.00	0.00	0.00
<i>Tectus niloticus</i>	0.00	0.00	0.00	0.00
All macroinvertebrates	0.02	0.02	0.03	0.00