
Memorandum

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CC:

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Subject: Broad Beach Foredune Impact Analysis

This memorandum provides an assessment of the impacts to foredune habitat that may have occurred or that could occur as a result of previous and proposed shoreline stabilization efforts at Broad Beach. This material is intended to support the application for a California Coastal Commission (“CCC”) Coastal Development Permit (“CDP”) for the proposed Broad Beach Restoration Project located in Malibu, Los Angeles County, California (“Study Area”; Figure 1). The information included here is based on inferred historical conditions, observed current conditions, and predicted future conditions at Broad Beach. As noted in the previous CDP submittals for the project, detailed records of historical habitat conditions and shoreline stabilization efforts at Broad Beach are lacking, and much information had to be inferred from historic aerial imagery, a sporadic record of photographs from the site, and comparisons with similar habitats in the region. As such, the analysis presented here is subject to a number of caveats which are presented in the following sections. The analysis follows in six parts, each of which contains (1) an assessment of potential foredune impacts based on a chronological sequence of habitat loss and (2) a theoretical assessment of impacts for both previous and proposed shoreline stabilization activities based on the extent of foredune habitat present at Broad Beach in 2005 (i.e., baseline conditions). Although WRA does not believe that the latter analysis represents actual impacts associated with previous and proposed shoreline stabilization activities, it is provided here in response to the CCC’s request to analyze potential impacts based on the baseline extent of foredune habitat at Broad Beach. The analysis presented herein includes:

- 1) An assessment of baseline conditions prior to the installation of the majority of the pre-2010 shoreline stabilization materials,

- 2) An assessment of potential foredune impacts related to the installation of the pre-2010 shoreline stabilization materials,
- 3) An assessment of potential foredune impacts related to the installation of the 2010 emergency rock revetment,
- 4) An assessment of existing conditions at the site,
- 5) An assessment of the potential foredune impacts related to the proposed project (i.e., foredune creation and enhancement), and
- 6) An assessment of the potential foredune impacts related to the proposed alternatives.

The analysis focuses strictly on impacts to foredune habitat¹, impacts to other habitat types are beyond the scope of this analysis. The analysis also focuses only on direct impacts associated with the installation of the revetment materials. The analysis does not include potential indirect impacts or potential direct impacts associated with sand sculpting, staging, or access; such impacts have been assessed by others.

A table summarizing impacts related to each of the six parts listed above is provided at the end of the document (Table 1). All figures referenced in the text have also been included at the end of the document.

The following definitions were used for the purposes of this analysis:

Remnant (or existing) foredune habitat: all undeveloped habitat landward of the 2005 beach-foredune escarpment line.

Created foredune habitat: the portion of the proposed foredune footprint occurring on top of and seaward of the 2010 emergency rock revetment.

Enhanced foredune habitat: the portion of the proposed foredune footprint occurring landward of the 2010 emergency rock revetment.

A more detailed description of these areas is provided in the Conceptual Foredune Creation and Enhancement Plan prepared by WRA (2013a).

¹ For the purposes of this analysis “coastal strand” and “southern foredune” habitats have been treated as a single habitat referred to herein as “foredune”. This is supported by evidence presented by Pickart and Barbour (2007) which suggests that the distinction between coastal strand and foredune vegetation may not have a strong biological relevance. Pickart, A.J. and M.G. Barbour. 2007. Chapter Six. Beach and Dune. In: M.G. Barbour, T. Keeler-Wolf, and A.A. Schoenherr (eds.). Terrestrial Vegetation of California, Third Edition. University of California Press, Berkeley, California.

1. Baseline Conditions

The baseline condition is intended to show the area of foredune habitat that potentially occurred at Broad Beach prior to the installation of the majority of pre-2010 shoreline stabilization materials. A baseline year of 2005 was chosen for this analysis as most pre-2010 shoreline stabilization materials were installed after 2005 (Moffatt and Nichol 2013). The extent of foredune habitat present at Broad Beach in 2005 was estimated from false infrared aerial imagery of the site taken in 2005. The imagery was sourced from the U.S. Department of Agriculture's ("USDA") National Agricultural Imagery Program ("NAIP").

This assessment was based on the approximate location of the beach-dune escarpment visible in false infrared aerial imagery of the site captured in 2005 (WRA 2013b). The approximate location of this line was verified using oblique aerial photographs of the site also captured in 2005 (WRA 2013b). All habitat located landward of the escarpment line and seaward of the residences and associated developed areas was assumed to be remnant foredune habitat. Habitat seaward of the escarpment line was assumed to be beach habitat. This assessment is supported by oblique aerial photographs of the site captured in 1972 and 1979 which show foredune habitat extending from the beach-dune escarpment inland to the edge of development along the beach (WRA 2013b). Based on this analysis, it was estimated that 12.23 acres of remnant foredune habitat occurred at Broad Beach in 2005 within the Study Area shown on Figure 2². As shown in Figures 2d and 2e, it appears that no foredune habitat was present at the western end of the beach in 2005. This determination was based on the approximate location beach-dune escarpment line shown in the 2005 false infrared aerial imagery and as corroborated by the oblique aerial imagery (WRA 2013b). It is expected that any sand accumulation along the narrow strip of beach present at the western end of the site in 2005 would have been regularly washed away by extreme high tides and storm events, thereby preventing the formation of foredune habitat in this area.

The following analyses of impacts associated with previous and proposed shoreline stabilization activities build upon the baseline foredune extent shown in Figure 2. The chronological analysis of impacts builds upon the extent of foredune habitat remaining after each major shoreline stabilization activity such as installation of the pre-2010 revetment materials or installation of the 2010 emergency rock revetment. By comparison, the theoretical analysis of impacts uses the same extent of foredune habitat (i.e., the 2005 baseline extent) for each part of the analysis. For example, the potential impacts to foredune habitat resulting from the installation of the 2010 emergency rock revetment assumes that the 2005 extent of foredune habitat was present at Broad Beach when the 2010 revetment was installed. Similarly, the potential impacts resulting from each of the proposed project alternatives assumes that the 2005 extent of foredune habitat represents the extent of foredune habitat that could be impacted by the proposed project alternatives. As such, the analysis of potential impacts relative to the 2005 baseline extent of foredune habitat represents a theoretical maximum extent of foredune habitat and the

² It should be noted that this acreage is dependent on the size of the 2013 Study Area as shown in Figure 1. Whereas the seaward extent of foredune habitat is determined by the beach-dune escarpment line which is relatively fixed, the inland extent of foredune habitat is defined by the edge of the Study Area which is somewhat arbitrary. Moving the inland edge of the Study Area will affect the acreage of foredune habitat considered present at Broad Beach.

corresponding theoretical maximum impacts to foredune habitat. As noted above, WRA does not believe that this latter analysis represents the actual impacts related to previous and proposed shoreline stabilization activities at Broad Beach. WRA believes that the chronological assessment of habitat loss more accurately represents the potential impacts related to the previous and proposed shoreline stabilization activities at Broad Beach.

2. Pre-2010 Shoreline Stabilization Materials

This assessment focuses on the potential impacts to foredune habitat associated with the installation of shoreline stabilization materials between 2005 and 2010. For this assessment, WRA used the baseline extent of foredune habitat at the site as established above (Baseline Conditions) and the location of the pre-2010 shoreline stabilization materials as provided by Moffatt and Nichol. Using the approximated extent of foredune habitat at the site in 2005 (12.23 acres; Figure 2) as a baseline, WRA overlaid the location of the pre-2010 shoreline stabilization materials and considered all foredune habitat seaward of the pre-2010 shoreline stabilization materials and landward of the beach/dune escarpment line to be foredune habitat potentially impacted by the installation of said revetment materials. This portion of the analysis is the same for both the chronological assessment of impacts and the assessment of impacts relative to the 2005 baseline condition.

Based on this analysis, a maximum of approximately 2.05 acres of remnant foredune habitat could have been permanently impacted by the installation of pre-2010 shoreline stabilization materials (Figure 3). This assessment is based on the assumption that the landward location of the sandbags and other materials represents the inland extent of impacts associated with their installation. This is supported by photographs of their installation and anecdotal evidence from homeowners along Broad Beach indicating that sandbag installation occurred immediately against the beach/dune escarpment. This also assumes that all habitat between the 2005 beach/foredune escarpment line and the shoreline stabilization materials was impacted by the installation of the pre-2010 revetment materials. As such, the 2.05 acres of foredune habitat represents a theoretical maximum impact area. In reality, much of this habitat was likely lost to shoreline erosion. Due to the lack of detailed records associated with the installation of the pre-2010 shoreline stabilization materials, it is difficult to accurately determine what portion of the 2.05-acre loss of foredune habitat was due to natural processes and what portion was due to anthropogenic activity. Given that most shoreline stabilization materials appear to have been installed against the existing beach-dune escarpment (WRA 2013b), it can be assumed that the installation of these materials impacted a negligible area of foredune habitat. Some temporary impacts to foredune habitat may have occurred as a result of staging and access along the seaward edge of foredune habitat (WRA 2013b); impacts related to access and staging are beyond the scope of this analysis.

3. 2010 Emergency Rock Revetment

This assessment focuses on the potential impact to foredune habitat that may have occurred in association with the installation of the 2010 emergency rock revetment.

For the chronological assessment, it was assumed that the 2010 emergency rock revetment was installed abutting the pre-2010 shoreline stabilization materials and that no foredune habitat occurred seaward of the pre-2010 materials (WRA 2013b). As such, the only impacts to foredune habitat associated with the installation of the 2010 revetment would have been those areas within the revetment footprint where pre-2010 shoreline stabilization materials did not occur or where the 2010 revetment footprint extended inland of the pre-2010 materials; such impacts should be considered permanent in nature. These areas totaled approximately 0.08 acre as shown on Figure 4-1. Additional temporary impacts to foredune habitat associated with the installation of the 2010 revetment may have occurred where materials were staged at the seaward edge of foredune habitat; however, such impacts are beyond the scope of this analysis.

For the assessment of impacts relative to the 2005 baseline condition, it was assumed that the 2010 emergency rock revetment was installed on top of foredune habitat. Based on this analysis, any portion of the 2010 revetment that was installed landward of the 2005 beach/dune escarpment line shown in Figure 2 potentially impacted foredune habitat. This theoretical maximum extent of impacts to foredune habitat is shown in Figure 4-2 and totals approximately 1.57 acres. Such impacts, represented by the portion of the revetment footprint inland of the 2005 beach/foredune escarpment, would be considered permanent in nature. Temporary impacts landward of the revetment caused by access and construction activities are beyond the scope of this analysis.

4. Existing Conditions

During a site visit in June 2013, WRA biologists mapped remnant foredune habitat and vegetation communities at Broad Beach as described in the Summer Biological Survey Report (WRA 2013c). The current extent of foredune habitat at Broad Beach, as shown in Figure 5, was determined based on a combination of the location of the inland edge of the 2010 emergency rock revetment (as supplied by Moffatt and Nichol) and observations by WRA biologists of the extent of foredune habitat in areas lacking 2010 revetment materials. In the areas where the 2010 rock revetment was not installed, WRA biologists observed small pocket coves formed from concentrated wave action in these areas. WRA biologists digitized the extent of these pocket coves on aerial imagery from 2012; foredune habitat was considered to extend to the inland edge of the pocket coves. Based on this assessment, WRA determined that approximately 10.09 acres of remnant foredune habitat currently occurs within the Study Area shown on Figure 5. In addition to the current extent of foredune habitat at Broad Beach, Figure 5 also shows the extent of vegetation communities mapped by WRA biologists in June 2013 (WRA 2013c). WRA identified approximately 0.10 acre of native dune mat vegetation, 4.27 acres of vegetation dominated by non-native ornamental species, and 2.89 acres of vegetation dominated by invasive plant species. This assessment of existing conditions provided the basis for the chronological assessment of potential impacts to foredune habitat associated with the proposed project and the project alternatives.

5. Proposed Project

For the chronological assessment of foredune impacts, WRA overlaid the proposed foredune footprint with the existing extent of remnant foredune habitat as described above and shown in Figure 5. The overlap between the proposed dune footprint and the current extent of remnant foredune habitat represents the proposed area of foredune enhancement (WRA 2013a). In this area, invasive plants will be removed and sand will be placed on top of the remnant dune surface to restore dune geomorphology. This area will be planted with native dune and coastal scrub vegetation designed to mimic natural communities in the area while providing the level of sand stabilization required by the project. The resulting habitat is expected to be used by a variety of native plant and wildlife species, providing increased habitat value over the existing degraded foredune habitat. As such, the impacts to foredune habitat associated with the proposed foredune enhancement are temporary as they are considered self-mitigating. The total area of the temporary and beneficial impacts associated with the proposed foredune enhancement was estimated at 2.95 acres (Figure 6-1). Under the chronological impact assessment, impacts to foredune habitat resulting from the installation of the rock revetment are accounted for in the analysis shown in Figure 4-1 which builds on the analysis shown in Figure 3. As such, no additional impacts to foredune habitat are associated with the permanent retention of the 2010 revetment.

For the assessment of impacts relative to the 2005 baseline condition, it was assumed that the 2010 emergency rock revetment was installed on top of foredune habitat. Based on this analysis, any portion of the 2010 revetment that was installed landward of the 2005 beach/dune escarpment line shown in Figure 2 impacted foredune habitat. This theoretical maximum extent of impacts to foredune habitat is shown in Figure 6-2 and includes approximately 1.57 acres of permanent impacts associated with the retention of the 2010 revetment and 3.23 acres of temporary impacts associated with the proposed foredune enhancement.

Proposed Project: Beach Nourishment Failure

This assessment focuses on the area of foredune habitat at Broad Beach that could be lost in the event that follow-up beach nourishment does not occur or is not sufficient for maintaining beach habitat in front of the 2010 emergency rock revetment.

For the chronological assessment of foredune impacts, WRA used the existing extent of foredune habitat shown in Figure 5 as well as the extent of created foredune habitat proposed on top and in front of the 2010 revetment. Using this extent of created and existing (enhanced) foredune habitat, WRA assumed that all foredune habitat seaward of the inland edge of the 2010 revetment would be lost to wave action under conditions of beach nourishment failure. WRA assumed that all existing (enhanced) foredune habitat landward of the 2010 revetment would be preserved. Based on this assessment, WRA estimated that as much as 4.63 acres of created foredune habitat could be lost under beach nourishment failure (Figure 7-1); such impacts would be permanent in nature. The foredune habitat that could be lost under this scenario represents created foredune habitat. Enhanced foredune habitat and remnant foredune habitat would be preserved by the 2010 revetment. This assessment does not take into account sea level rise. Within the Los Angeles region sea level is predicted to increase

between 8.5 and 18 inches by the year 2040 which represents the proposed lifespan of the project (NRC 2012). Under rising sea levels, it would be expected that some portion of the restored dunes occurring on or seaward of the revetment could be lost to wave action, particularly during storm events. However, it is expected that even under rising sea levels, wave action would not completely overtop the revetment and any dune habitat located behind the revetment would be preserved.

For the assessment of impacts relative to the 2005 baseline condition, WRA assumed that the area landward of the 2005 beach/dune escarpment line shown in Figure 2 represents existing foredune habitat at the site. Using the 2005 baseline extent of foredune habitat, WRA assumed that all potential foredune habitat seaward of the inland edge of the 2010 revetment could be lost to wave action under conditions of beach nourishment failure. This theoretical maximum extent of impacts to foredune habitat is shown in Figure 7-2 and includes approximately 4.82 acres of permanent impacts to foredune habitat. Similar to the chronological assessment, it was assumed that an increase in sea level of between 8.5 and 18 inches by the year 2040 would not result in significant impacts to foredune habitat landward of the 2010 revetment.

Proposed Project: Revetment Failure

This assessment focuses on the area of foredune habitat at Broad Beach that could be lost in the event that the 2010 emergency rock revetment fails.

For the chronological assessment of foredune impacts, WRA used the existing extent of foredune habitat shown in Figure 5 as well as the proposed extent of foredune creation and enhancement and assumed that all foredune habitat seaward of the no-project wave uprush limit (as provided by Moffatt and Nichol) would be lost to wave action. WRA assumed that all foredune habitat landward of the no project wave uprush limit would be preserved. Based on this assessment, WRA estimated that as much as 12.36 acres of foredune habitat could be lost under revetment failure (Figure 8-1); such impacts would be permanent in nature. This includes 4.76 acres of created foredune habitat, 2.95 acres of enhanced foredune habitat, and 4.65 acres of remnant (existing) foredune habitat. This assessment is based on the wave uprush limit without consideration of sea level rise. Assuming sea level may rise between 8.5 and 18 inches during the lifespan of the proposed project, additional impacts to foredune habitat would be likely to occur under failure of the revetment. The additional area of impacts would be incurred in remnant foredune habitat.

For the assessment of impacts relative to the 2005 baseline condition, WRA assumed that the area landward of the 2005 beach/dune escarpment line shown in Figure 2 represents existing foredune habitat at the site. Using the 2005 baseline extent of foredune habitat, WRA assumed that all potential foredune habitat seaward of the no-project wave uprush limit could be lost to wave action if the 2010 revetment failed. This theoretical maximum extent of impacts to foredune habitat is shown in Figure 8-2 and includes approximately 12.75 acres of permanent impacts to foredune habitat, including 3.02 acres of created foredune habitat, 4.69 acres of enhanced foredune habitat, and 5.04 acres of remnant (existing) foredune habitat. For the purposes of this assessment, it was assumed that the dune restoration footprint landward of the 2005 beach/foredune escarpment line represents enhanced foredune habitat whereas the dune

restoration footprint seaward of the 2005 beach/foredune escarpment line represents created foredune habitat. Similar to the chronological assessment, it was assumed that an increase in sea level of between 8.5 and 18 inches by the year 2040 could result in additional impacts to foredune habitat under conditions of revetment failure.

6. Project Alternatives

Nine alternatives to the proposed project have been put forth by the project proponents. An analysis of the potential impacts to foredune habitat associated with these alternatives is presented in the following sections. All nine alternatives include the same extent and location of foredune creation and enhancement as included in the proposed project. All of the alternatives also include some level of beach nourishment; however, this varies by alternative. Impacts related to the proposed beach nourishment aspect of the project are beyond the scope of this analysis. Under the chronological assessment of impacts which are based on the existing foredune extent shown in Figure 5, dune creation is not considered an impact to foredune habitat as all dune creation would occur over or landward of the 2010 emergency rock revetment where no foredune habitat currently occurs. For both the chronological and baseline assessments, dune enhancement is considered a temporary impact to foredune habitat given that foredune geomorphology and vegetation will be restored following the placement of sand in these areas. Potential temporary impacts to foredune habitat resulting from staging and access are not included in this analysis, either for the chronological assessment or the baseline assessment.

Alternative 1A

This alternative would involve the removal and/or relocation of portions of the 2010 revetment inland of the 2009 mean high tide line (“MHTL”) combined with beach nourishment and foredune creation and enhancement. Portions of the revetment that extend between 0 and 3 feet beyond the October 2009 MHTL will be removed. Portions of the revetment that extend more than 3 feet beyond the 2009 MHTL will be relocated to the landward side of the revetment.

For the chronological assessment of foredune impacts, WRA used the existing foredune extent shown in Figure 5 and assumed that potential impacts to foredune habitat associated with this alternative include those areas where the revetment will be relocated landward of its current position as well as the area designated for foredune enhancement. These potential impacts are shown on Figure 9-1 and include approximately 0.05 acre of permanent impacts associated with the relocated revetment sections and 2.90 acres of temporary impacts associated with the foredune enhancement.

For the assessment of impacts relative to the 2005 baseline condition, WRA assumed that the area landward of the 2005 beach/dune escarpment line shown in Figure 2 represents existing foredune habitat at the site. Using the 2005 baseline extent of foredune habitat, WRA assumed that areas of revetment removal and areas of foredune enhancement represent temporary impacts to foredune habitat and that areas where the revetment will be retained or relocated represent permanent impacts to foredune habitat. These impacts are shown in Figure 9-2 and include 3.17 acres of temporary impacts and 1.63 acres of permanent impacts.

Alternative 1B

This alternative would involve relocation of portions of the 2010 revetment inland of the 2010 MHTL combined with beach nourishment and foredune creation and enhancement. Where feasible, the 2010 emergency rock revetment would be removed and an improved revetment would be constructed landward of the January 2010 MHTL. Between parcels 31346 and 31022, the temporary emergency revetment would remain in its current position.

For the chronological assessment of foredune impacts, WRA used the existing foredune extent shown in Figure 5 and assumed that potential impacts to foredune habitat associated with this alternative include those areas where the revetment will be relocated landward of its current position as well as the area designated for foredune enhancement. These potential impacts are shown on Figure 10-1 and include approximately 0.86 acre of permanent impacts associated with the relocated revetment sections and 2.14 acres of temporary impacts associated with the foredune enhancement.

For the assessment of impacts relative to the 2005 baseline condition, WRA assumed that the area landward of the 2005 beach/dune escarpment line shown in Figure 2 represents existing foredune habitat at the site. Using the 2005 baseline extent of foredune habitat, WRA assumed that areas of revetment removal and areas of foredune enhancement represent temporary impacts to foredune habitat and that areas where the revetment will be retained or relocated represent permanent impacts to foredune habitat. These impacts are shown in Figure 10-2 and include 2.48 acres of temporary impacts and 2.5 acres of permanent impacts.

Alternative 2

This alternative would involve relocating portions of the 2010 revetment inland of existing lateral access easements combined with beach nourishment and foredune creation and enhancement. Where feasible, the 2010 emergency rock revetment would be removed and an improved revetment would be constructed landward of the current lateral access easements. Between parcels 31346 and 30970 the temporary emergency revetment would remain in its current position.

For the chronological assessment of foredune impacts, WRA used the existing foredune extent shown in Figure 5 and assumed that potential impacts to foredune habitat associated with this alternative include those areas where the revetment will be relocated landward of its current position as well as the area designated for foredune enhancement. These potential impacts are shown on Figure 11-1 and include approximately 1.31 acres of permanent impacts associated with the relocated revetment sections and 1.86 acres of temporary impacts associated with the foredune enhancement.

For the assessment of impacts relative to the 2005 baseline condition, WRA assumed that the area landward of the 2005 beach/dune escarpment line shown in Figure 2 represents existing foredune habitat at the site. Using the 2005 baseline extent of foredune habitat, WRA assumed that areas of revetment removal and areas of foredune enhancement represent temporary impacts to foredune habitat and that areas where the revetment will be retained or relocated

represent permanent impacts to foredune habitat. These impacts are shown in Figure 11-2 and include 2.48 acres of temporary impacts and 2.54 acres of permanent impacts.

Alternative 3A

This alternative would involve removal of all existing revetment materials and replacement with a vertical seawall located inland of the existing revetment location, combined with beach nourishment and foredune creation and enhancement.

For the chronological assessment of foredune impacts, WRA used the existing foredune extent shown in Figure 5 and assumed that potential impacts to foredune habitat associated with this alternative include the footprint of the seawall and associated rock apron (where these occur landward of the existing revetment location) and the footprint of the proposed foredune enhancement. Where the footprint of the proposed foredune enhancement overlaps with the footprint of the proposed seawall, only impacts associated with the sea wall were considered. Because no foredune habitat currently occurs where the 2010 revetment is located, dune creation in this area was not considered an impact to foredune habitat. The potential impacts associated with this alternative are shown on Figure 12-1 and include approximately 0.9 acre of permanent impacts associated with the seawall and 2.58 acres of temporary impacts associated with the foredune enhancement.

For the assessment of impacts relative to the 2005 baseline condition, WRA assumed that the area landward of the 2005 beach/dune escarpment line shown in Figure 2 represents existing foredune habitat at the site. Using the 2005 baseline extent of foredune habitat, WRA assumed that areas of revetment removal and areas of foredune enhancement (excluding areas occupied by the seawall) represent temporary impacts to foredune habitat and that areas where the seawall and associated rock apron represent permanent impacts to foredune habitat. These impacts are shown in Figure 12-2 and include 4.41 acres of temporary impacts and 0.92 acres of permanent impacts.

Alternative 3B

This alternative is similar to Alternative 3A, including the removal of all existing revetment materials and replacement with a vertical seawall, combined with foredune creation and enhancement. However, under this scenario, leach fields associated with the residences along the beach would be upgraded, requiring that the seawall be installed further seaward.

For the chronological assessment of foredune impacts, WRA used the existing foredune extent shown in Figure 5 and assumed that potential impacts to foredune habitat associated with this alternative include the footprint of the seawall and associated rock apron (where these occur landward of the existing revetment location) and the footprint of the proposed foredune enhancement. Where the footprint of the proposed foredune enhancement overlaps with the footprint of the proposed sea wall, only impacts associated with the sea wall were considered. Because no foredune habitat currently occurs where the 2010 revetment is located, dune creation in this area was not considered an impact to foredune habitat. The potential impacts associated with this alternative are shown on Figure 13-1 and include approximately 0.41 acres

of permanent impacts associated with the seawall and 2.73 acres of temporary impacts associated with the foredune enhancement.

For the assessment of impacts relative to the 2005 baseline condition, WRA assumed that the area landward of the 2005 beach/dune escarpment line shown in Figure 2 represents existing foredune habitat at the site. Using the 2005 baseline extent of foredune habitat, WRA assumed that areas of revetment removal and areas of foredune enhancement (excluding areas occupied by the seawall) represent temporary impacts to foredune habitat and that areas where the seawall and associated rock apron represent permanent impacts to foredune habitat. These impacts are shown in Figure 13-2 and include 4.29 acres of temporary impacts and 0.7 acres of permanent impacts.

Alternative 4

This alternative would involve retaining the revetment materials in their current location combined with the proposed foredune creation and enhancement and a reduced beach nourishment volume.

For the chronological assessment of foredune impacts, WRA used the existing foredune extent shown in Figure 5 and assumed that potential impacts to foredune habitat associated with this alternative are limited to the area of proposed foredune enhancement; these impacts would be temporary in nature. Potential impacts associated with this alternative are shown in Figure 14-1 and total approximately 2.95 acres of temporary impacts to foredune habitat.

For the assessment of impacts relative to the 2005 baseline condition, WRA assumed that the area landward of the 2005 beach/dune escarpment line shown in Figure 2 represents existing foredune habitat at the site. Using the 2005 baseline extent of foredune habitat, WRA assumed that areas of foredune enhancement represent temporary impacts to foredune habitat and that areas in which the 2010 revetment will be retained represent permanent impacts to foredune habitat. These impacts are shown in Figure 14-2 and include 3.23 acres of temporary impacts and 1.57 acres of permanent impacts.

Alternative 5

This alternative would involve the removal of all existing revetment materials combined with the proposed foredune creation and enhancement.

For the chronological assessment of foredune impacts, WRA used the existing foredune extent shown in Figure 5 and assumed that, because no foredune habitat occurs seaward of the existing revetment materials, the proposed foredune creation will not involve permanent impacts to existing foredune habitat at the site. Potential impacts to foredune habitat associated with this alternative are limited to the area of proposed foredune enhancement; these impacts would be temporary in nature. Potential impacts associated with this alternative are shown in Figure 15-1 and total approximately 2.95 acres of temporary impacts to foredune habitat.

For the assessment of impacts relative to the 2005 baseline condition, WRA assumed that the area landward of the 2005 beach/dune escarpment line shown in Figure 2 represents existing

foredune habitat at the site. Using the 2005 baseline extent of foredune habitat, WRA assumed that areas of foredune enhancement and revetment removal represent temporary impacts to foredune habitat. These impacts are shown in Figure 15-2 and include 4.80 acres of temporary impacts.

Alternative 6A

This alternative would involve relocation of an improved rock revetment inland of the current revetment location, combined with the proposed beach nourishment and foredune creation and enhancement.

For the chronological assessment of foredune impacts, WRA used the existing foredune extent shown in Figure 5 and assumed that potential impacts associated with this alternative include permanent impacts where the revetment will be relocated inland of its existing location as well as temporary impacts in the location of the proposed foredune enhancement. Because no foredune habitat currently occurs seaward of the existing revetment, the proposed foredune creation in these areas would not result in impacts to foredune habitat. The potential impacts to foredune habitat associated with this alternative are shown in Figure 16-1 and include 1.59 acres of permanent impacts associated with the relocated revetment and 2.0 acres of temporary impacts associated with the proposed foredune enhancement.

For the assessment of impacts relative to the 2005 baseline condition, WRA assumed that the area landward of the 2005 beach/dune escarpment line shown in Figure 2 represents existing foredune habitat at the site. Using the 2005 baseline extent of foredune habitat, WRA assumed that areas of foredune enhancement and revetment removal represent temporary impacts to foredune habitat and that areas of retained or relocated revetment represent permanent impacts. These impacts are shown in Figure 16-2 and include 2.86 acres of temporary impacts and 2.58 acres of permanent impacts.

Alternative 6B

This alternative is similar to Alternative 6A, including the relocation of an improved rock revetment inland of the current revetment location, combined with the proposed beach nourishment and foredune creation and enhancement. However, under this scenario, leach fields associated with the residences along the beach would be upgraded, requiring that the improved revetment be installed further seaward.

For the chronological assessment of foredune impacts, WRA used the existing foredune extent shown in Figure 5 and assumed that potential impacts associated with this alternative include permanent impacts where the revetment will be relocated inland of its existing location as well as temporary impacts in the location of the proposed foredune enhancement. Because no foredune habitat currently occurs seaward of the existing revetment, the proposed foredune creation in these areas would not result in impacts to foredune habitat. The potential impacts to foredune habitat associated with this alternative are shown in Figure 17-1 and include 0.91 acres of permanent impacts associated with the relocated revetment and 2.48 acres of temporary impacts associated with the proposed foredune enhancement.

For the assessment of impacts relative to the 2005 baseline condition, WRA assumed that the area landward of the 2005 beach/dune escarpment line shown in Figure 2 represents existing foredune habitat at the site. Using the 2005 baseline extent of foredune habitat, WRA assumed that areas of foredune enhancement and revetment removal represent temporary impacts to foredune habitat and that areas of retained or relocated revetment represent permanent impacts. These impacts are shown in Figure 17-2 and include 2.86 acres of temporary impacts and 2.39 acres of permanent impacts.

Literature Cited

Moffatt and Nichol. 2013. Broad Beach Restoration Project: Project Description. Prepared for the Broad Beach Geologic Hazard Abatement District, Malibu, California. Revised April 2013.

WRA, Inc. 2013a. Conceptual Foredune Creation and Enhancement Plan. Broad Beach Restoration Project, Malibu, Los Angeles County, California. Report prepared for Moffatt and Nichol, Long Beach California.

WRA, Inc. 2013b. Supplementary data and analyses for the Broad Beach Restoration Project. Memorandum prepared for Moffatt and Nichol, Long Beach, California.

WRA, Inc. 2013a. Summer 2013 Foredune Biological Surveys, Broad Beach, Malibu, Los Angeles County, California. Report prepared for Moffatt and Nichol, Long Beach, California.

Table 1A. Potential impacts to foredune habitat at Broad Beach related to previous and proposed shoreline stabilization efforts based on a chronological assessment of impacts to foredune habitat. These impacts represent the minimum area of potential impacts. WRA believes that these impacts most accurately represent the actual sequence of events at Broad Beach and the associated impacts to foredune habitat. All impacts are presented in acres. Potential temporary impacts presented are for areas of foredune enhancement where foredune geomorphology and vegetation will be restored in-place. Potential permanent impacts presented are for areas where the existing revetment materials will be retained and areas of proposed revetment relocation or seawall construction. Potential temporary impacts associated with any staging and access that may have occurred on remnant foredune habitat at the site or that could occur with construction of the proposed project or project alternatives are not included in the numbers presented below.

Impact Source	Remnant Foredune		Created Foredune		Enhanced Foredune		Total Foredune Impacts	
	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent
Pre-2010 Materials	0.0	2.05	n/a	n/a	n/a	n/a	0.0	2.05
2010 Revetment	0.0	0.08	n/a	n/a	n/a	n/a	0.0	0.08
Proposed Project	2.95	0.0	n/a	n/a	n/a	n/a	2.95	0.0
Proposed Project: Beach Nourishment Failure	0.0	0.0	0.0	4.63	0.0	0.0	0.0	4.63
Proposed Project: Revetment Failure	0.0	4.65	0.0	4.76	0.0	2.95	0.0	12.36
Alternative 1A	2.90	0.05	0.0	0.0	0.0	0.0	2.90	0.05
Alternative 1B	2.14	0.86	0.0	0.0	0.0	0.0	2.14	0.86
Alternative 2	1.86	1.31	0.0	0.0	0.0	0.0	1.86	1.31
Alternative 3A	2.58	0.9	0.0	0.0	0.0	0.0	2.58	0.9
Alternative 3B	2.73	0.41	0.0	0.0	0.0	0.0	2.73	0.41
Alternative 4	2.95	0.0	0.0	0.0	0.0	0.0	2.95	0.0
Alternative 5	2.95	0.0	0.0	0.0	0.0	0.0	2.95	0.0
Alternative 6A	2.0	1.59	0.0	0.0	0.0	0.0	2.0	1.59
Alternative 6B	2.48	0.91	0.0	0.0	0.0	0.0	2.48	0.91

Table 1B. Potential impacts to foredune habitat at Broad Beach related to previous and proposed shoreline stabilization efforts based on an assessment of potential impacts using the 2005 baseline extent of foredune habitat shown in Figure 2. These impacts represent the maximum theoretical area of potential impacts. WRA believes that these impacts do not accurately represent the actual sequence of events at Broad Beach and the associated impacts to foredune habitat. All impacts are presented in acres. Potential temporary impacts presented are for areas of revetment removal and areas of foredune enhancement where foredune geomorphology and vegetation will be restored in-place. Potential permanent impacts presented are for areas where the existing revetment materials will be retained and areas of proposed revetment relocation or seawall construction. Potential temporary impacts associated with any staging and access that may have occurred on remnant foredune habitat at the site or that could occur with construction of the proposed project or project alternatives are not included in the numbers presented below.

Impact Source	Remnant Foredune		Created Foredune		Enhanced Foredune		Total Foredune Impacts	
	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent
Pre-2010 Materials	0	2.05	n/a	n/a	n/a	n/a	0	2.05
2010 Revetment	0	1.57	n/a	n/a	n/a	n/a	0	1.57
Proposed Project	3.23	1.57	n/a	n/a	n/a	n/a	3.23	1.57
Proposed Project: Beach Nourishment Failure	0	4.82*	n/a	n/a	n/a	n/a	0	4.82
Proposed Project: Revetment Failure	0	5.04	0	3.02	4.69	0	0	12.75
Alternative 1A	3.17	1.63	0	0	0	0	3.17	1.63
Alternative 1B	2.48	2.5	0	0	0	0	2.48	2.5
Alternative 2	2.48	2.54	0	0	0	0	2.48	2.54
Alternative 3A	4.41	0.92	0	0	0	0	4.41	0.92
Alternative 3B	4.29	0.70	0	0	0	0	4.29	0.70
Alternative 4	3.23	1.57	0	0	0	0	3.23	1.57
Alternative 5	4.8	0	0	0	0	0	4.8	0
Alternative 6A	2.86	2.58	0	0	0	0	2.86	2.58
Alternative 6B	2.86	2.39	0	0	0	0	2.86	2.39

*This acreage represents a combination of remnant and created foredune habitat.

Broad Beach
Restoration Project

Malibu, California

Figure 1.

Study Area
Location Map



0 250 500 1,000
Feet

Broad Beach
Restoration Project

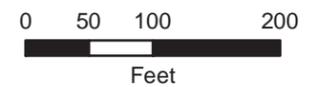
Malibu,
California

Figure 2a.

Broad Beach
Baseline Extent
of Foredune Habitat
(2005)



-  Study Area
-  MHTL - June 2005
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  Remnant Foredune Habitat (12.23 acres)*



* Estimated extent of foredune habitat is based on location of foredune/beach escarpment line visible in infrared imagery.

Broad Beach
Restoration Project

Malibu,
California

Figure 2b.

Broad Beach
Baseline Extent
of Foredune Habitat
(2005)



Study Area

MHTL - June 2005

June 2005 Beach/Foredune Escarpment Line

Development Footprint

Remnant Foredune Habitat (12.23 acres)*



0 50 100 200
Feet

* Estimated extent of foredune habitat is based on location of foredune/beach escarpment line visible in infrared imagery.

Map Date: October 2013
Map By: Michael Rochelle
Base Source: NAIP 2005 IR

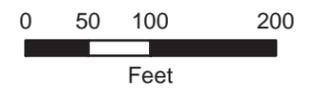
Broad Beach
Restoration Project

Malibu,
California

Figure 2c.

Broad Beach
Baseline Extent
of Foredune Habitat
(2005)

-  Study Area
-  MHTL - June 2005
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  Remnant Foredune Habitat (12.23 acres)*



* Estimated extent of foredune habitat is based on location of foredune/beach escarpment line visible in infrared imagery.

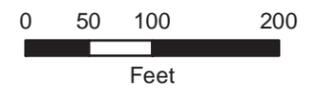
Broad Beach
Restoration Project

Malibu,
California

Figure 2d.

Broad Beach
Baseline Extent
of Foredune Habitat
(2005)

-  Study Area
-  MHTL - June 2005
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  Remnant Foredune Habitat (12.23 acres)*



* Estimated extent of foredune habitat is based on location of foredune/beach escarpment line visible in infrared imagery.

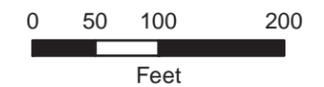
-  Study Area
-  MHTL - June 2005
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  Remnant Foredune Habitat (12.23 acres)*

Broad Beach
Restoration Project

Malibu,
California

Figure 2e.

Broad Beach
Baseline Extent
of Foredune Habitat
(2005)



* Estimated extent of foredune habitat is based on location of foredune/beach escarpment line visible in infrared imagery.

Broad Beach
Restoration Project

Malibu,
California

Figure 3a.

Potential Impacts to
Foredune Habitat
from Pre-2010
Revetment Materials
Relative to 2005
Baseline Conditions



0 50 100 200
Feet

* Remnant foredune habitat based on 2005 extent shown in Figure 2.

** Potential impacts assume that the entire area seaward of the pre-2010 shoreline protection structures and landward of the 2005 beach/ foredune escarpment line was remnant foredune habitat.

Map Date: October 2013
Map By: Michael Rochelle
Base Source: NAIP 2005 IR

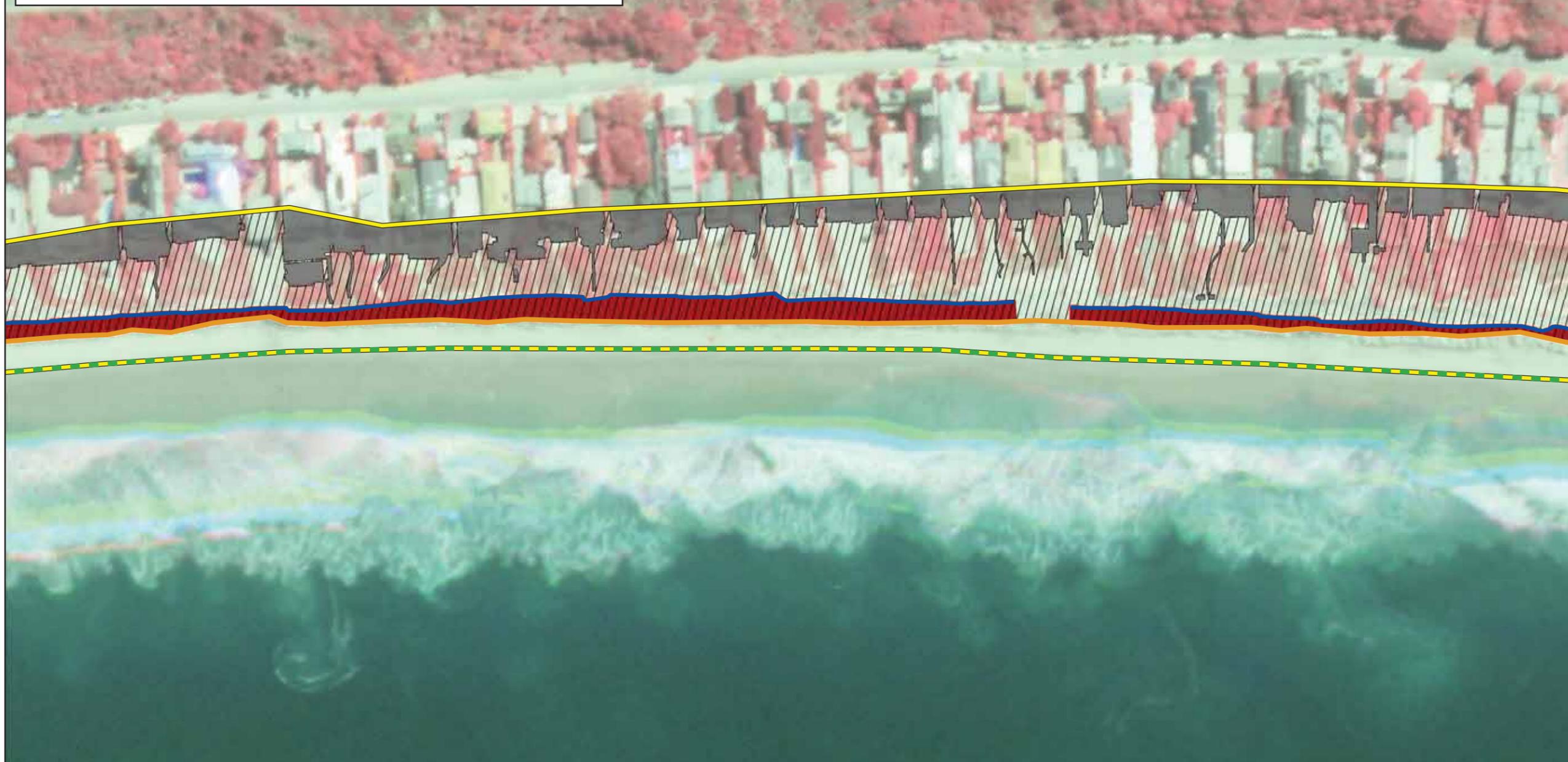
Broad Beach
Restoration Project

Malibu,
California

Figure 3b.

Potential Impacts to
Foredune Habitat
from Pre-2010
Revetment Materials
Relative to 2005
Baseline Conditions

- Study Area
- Pre-2010 Shoreline Protection Structures
- MHTL - June 2005
- June 2005 Beach/Foredune Escarpment Line
- Development Footprint
- Remnant Foredune Habitat (12.23 acres)*
- Potential Impacts to Foredune Habitat (2.05 acres)**



0 50 100 200
Feet

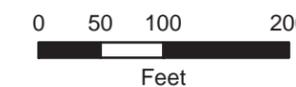
* Remnant foredune habitat based on 2005 extent shown in Figure 2.
 ** Potential impacts assume that the entire area seaward of the pre-2010 shoreline protection structures and landward of the 2005 beach/ foredune escarpment line was remnant foredune habitat.

Broad Beach
Restoration Project

Malibu,
California

Figure 3c.

Potential Impacts to
Foredune Habitat
from Pre-2010
Revetment Materials
Relative to 2005
Baseline Conditions



* Remnant foredune habitat based on 2005 extent shown in Figure 2.

** Potential impacts assume that the entire area seaward of the pre-2010 shoreline protection structures and landward of the 2005 beach/foredune escarpment line was remnant foredune habitat.

Broad Beach
Restoration Project

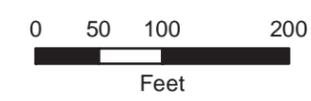
Malibu,
California

Figure 3d.

Potential Impacts to
Foredune Habitat
from Pre-2010
Revetment Materials
Relative to 2005
Baseline Conditions



-  Study Area
-  Pre-2010 Shoreline Protection Structures
-  MHTL - June 2005
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  Remnant Foredune Habitat (12.23 acres)*
-  Potential Impacts to Foredune Habitat (2.05 acres)**



* Remnant foredune habitat based on 2005 extent shown in Figure 2.
 ** Potential impacts assume that the entire area seaward of the pre-2010 shoreline protection structures and landward of the 2005 beach/ foredune escarpment line was remnant foredune habitat.

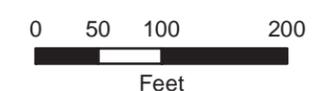
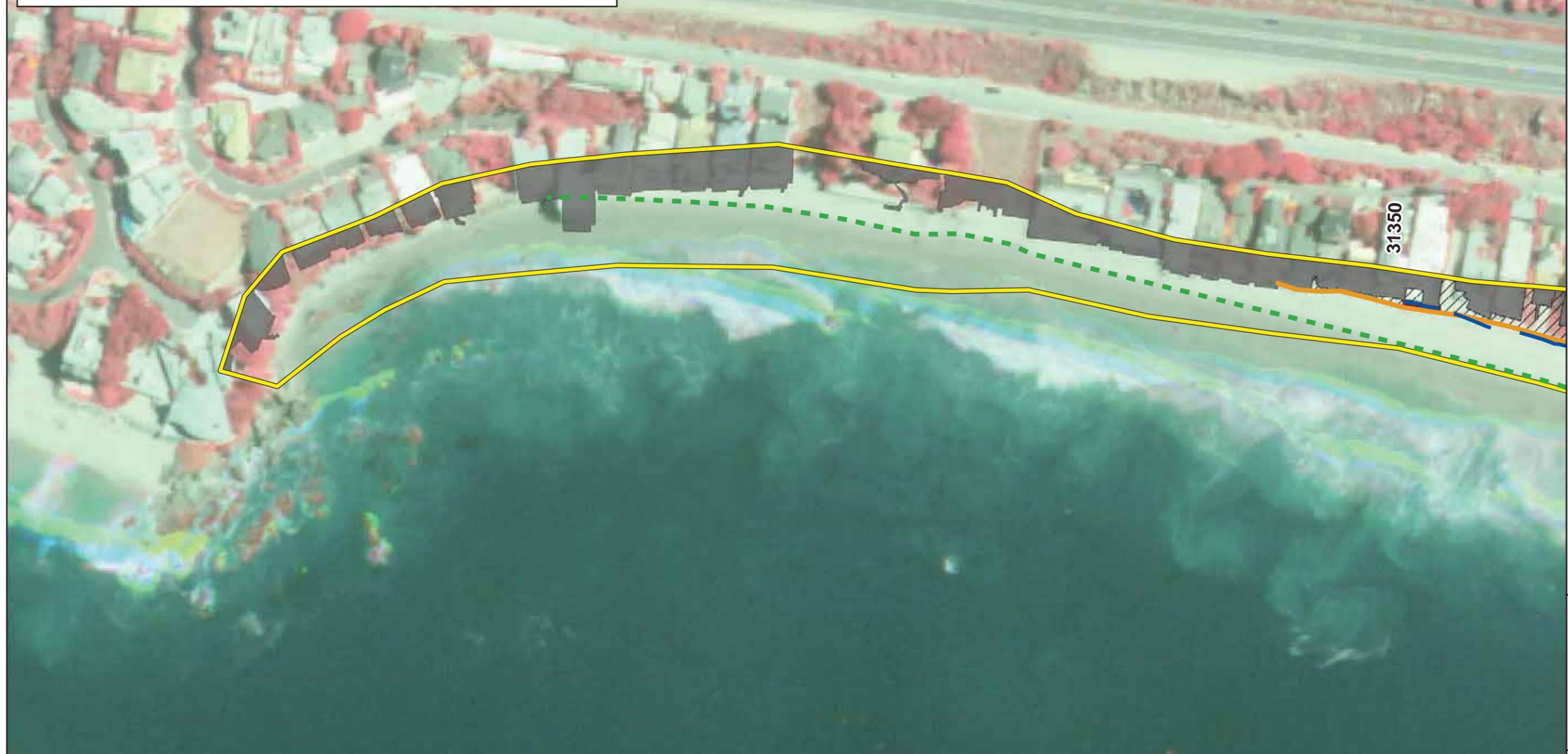
Broad Beach
Restoration Project

Malibu,
California

Figure 3e.

Potential Impacts to
Foredune Habitat
from Pre-2010
Revetment Materials
Relative to 2005
Baseline Conditions

- Study Area
- Pre-2010 Shoreline Protection Structures
- MHTL - June 2005
- June 2005 Beach/Foredune Escarpment Line
- Development Footprint
- Remnant Foredune Habitat (12.23 acres)*
- Potential Impacts to Foredune Habitat (2.05 acres)**



* Remnant foredune habitat based on 2005 extent shown in Figure 2.
 ** Potential impacts assume that the entire area seaward of the pre-2010 shoreline protection structures and landward of the 2005 beach/ foredune escarpment line was remnant foredune habitat.

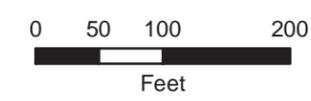
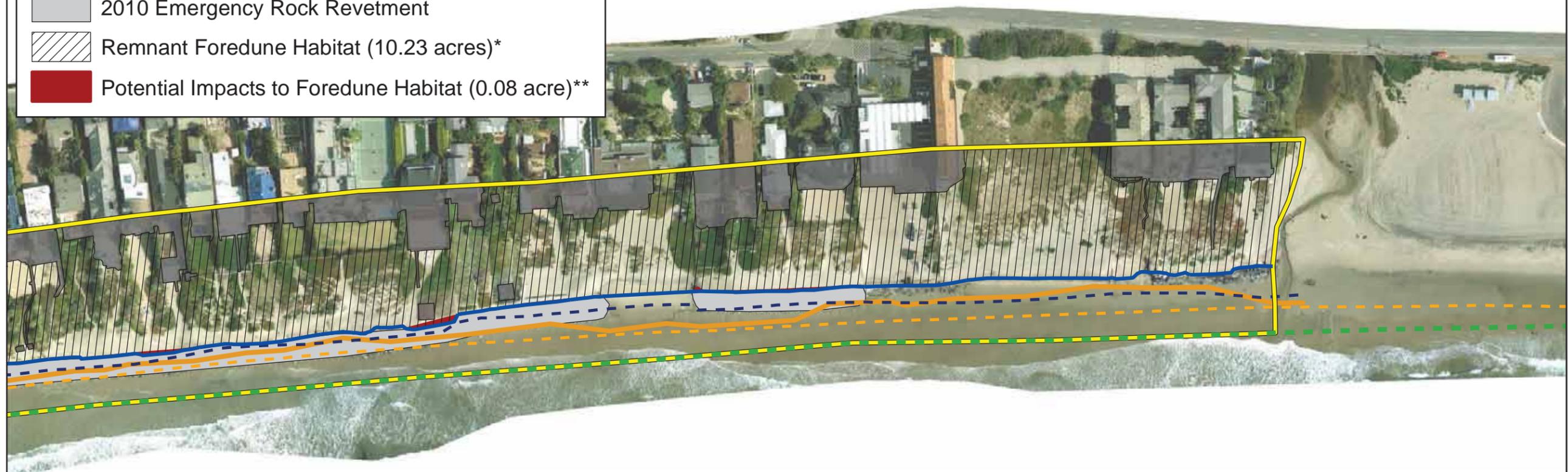
Broad Beach
Restoration Project

Malibu,
California

Figure 4-1a.

Potential Impacts to
Foredune Habitat from
2010 Emergency Rock
Revetment
Relative to 2009
Conditions

-  Study Area
-  MHTL - June 2005
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Pre-2010 Shoreline Protection Structures
-  Development Footprint
-  2010 Emergency Rock Revetment
-  Remnant Foredune Habitat (10.23 acres)*
-  Potential Impacts to Foredune Habitat (0.08 acre)**



* Remnant foredune habitat based on 2010 foredune extent (i.e., foredune habitat remaining after installation of Pre-2010 Shoeline Protection Structures).
 ** Potential impacts assume that all foredune habitat seaward of the pre-2010 shoreline protection structures was lost to wave action. Impacts are those areas where the 2010 emergency rock revetment occurs landward of pre-2010 shoreline protection structures or where such structures were not installed.

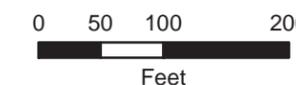
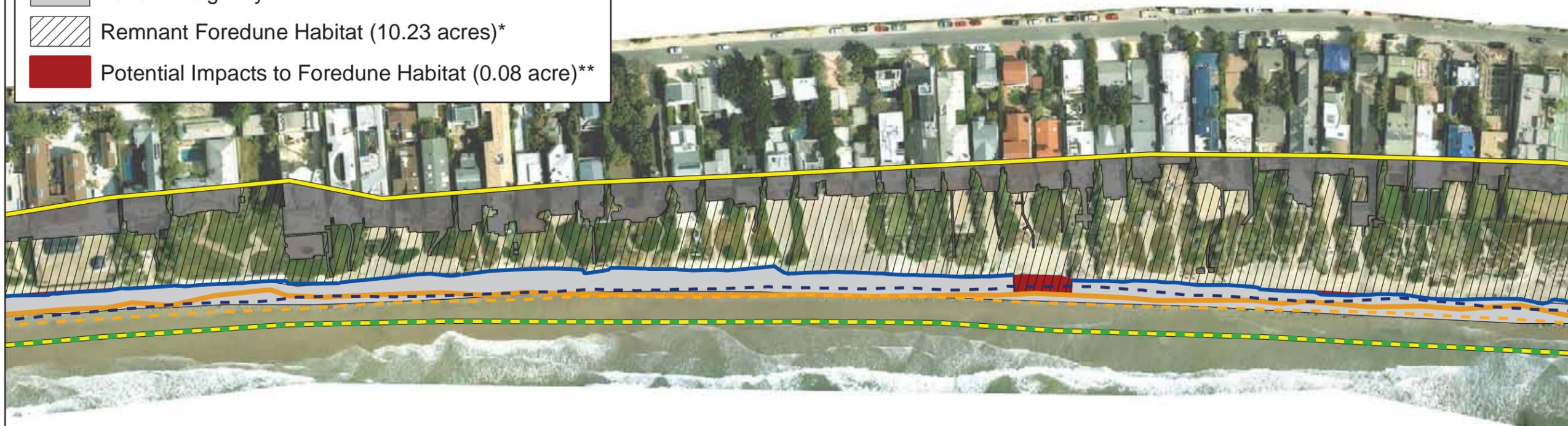
Broad Beach
Restoration Project

Malibu,
California

Figure 4-1b.

Potential Impacts to
Foredune Habitat from
2010 Emergency
Rock Revetment
Relative to 2009
Conditions

-  Study Area
-  MHTL - June 2005
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Pre-2010 Shoreline Protection Structures
-  Development Footprint
-  2010 Emergency Rock Revetment
-  Remnant Foredune Habitat (10.23 acres)*
-  Potential Impacts to Foredune Habitat (0.08 acre)**



* Remnant foredune habitat based on 2010 foredune extent (i.e., foredune habitat remaining after installation of Pre-2010 Shoeline Protection Structures).
 ** Potential impacts assume that all foredune habitat seaward of the pre-2010 shoreline protection structures was lost to wave action. Impacts are those areas where the 2010 emergency rock revetment occurs landward of pre-2010 shoreline protection structures or where such structures were not installed.

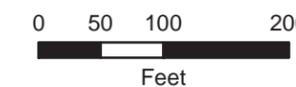
Broad Beach
Restoration Project

Malibu,
California

Figure 4-1c.

Potential Impacts to
Foredune Habitat from
2010 Emergency
Rock Revetment
Relative to 2009
Conditions

-  Study Area
-  MHTL - June 2005
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Pre-2010 Shoreline Protection Structures
-  Development Footprint
-  2010 Emergency Rock Revetment
-  Remnant Foredune Habitat (10.23 acres)*
-  Potential Impacts to Foredune Habitat (0.08 acre)**



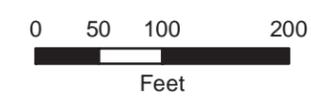
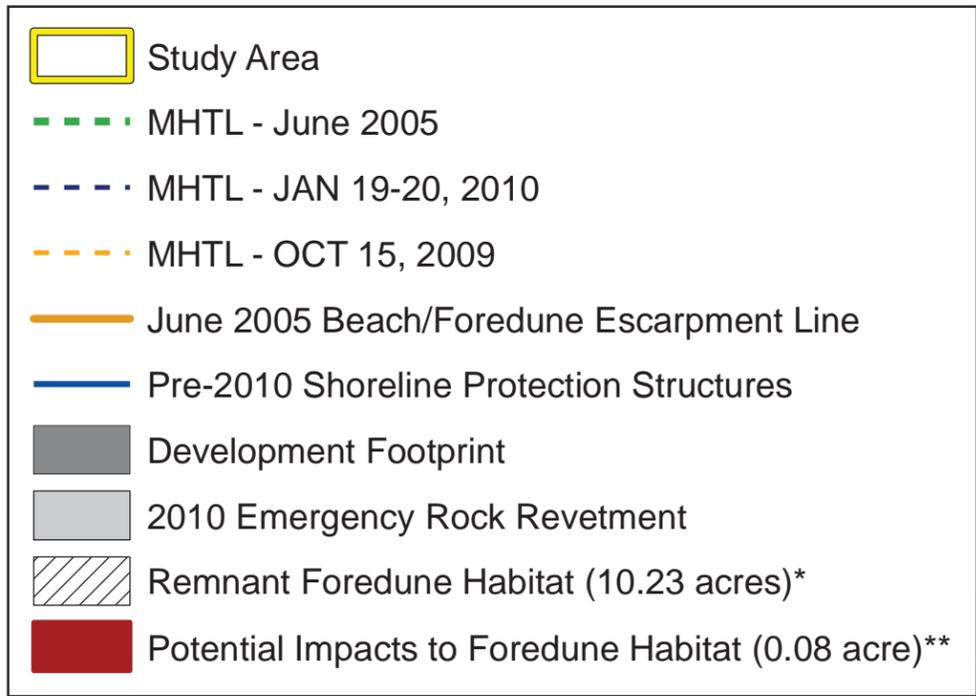
* Remnant foredune habitat based on 2010 foredune extent (i.e., foredune habitat remaining after installation of Pre-2010 Shoeline Protection Structures).
 ** Potential impacts assume that all foredune habitat seaward of the pre-2010 shoreline protection structures was lost to wave action. Impacts are those areas where the 2010 emergency rock revetment occurs landward of pre-2010 shoreline protection structures or where such structures were not installed.

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Restoration Project

Malibu,
California

Figure 4-1d.

Potential Impacts to
Foredune Habitat from
2010 Emergency Rock
Revetment
Relative to 2009
Conditions



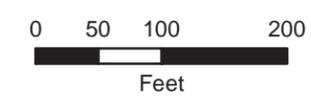
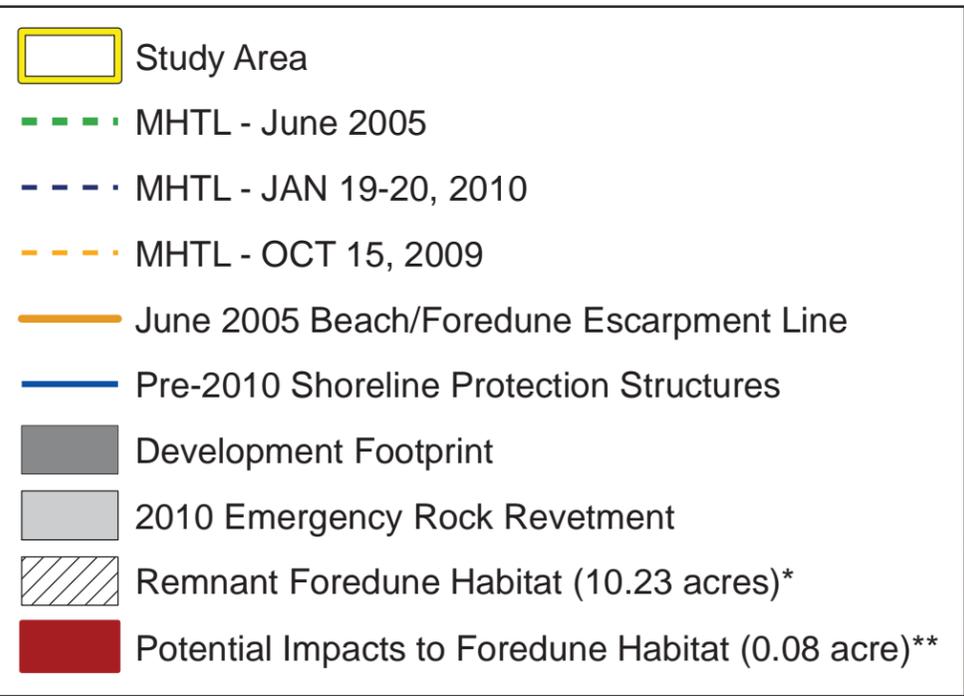
* Remnant foredune habitat based on 2010 foredune extent (i.e., foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures).
 ** Potential impacts assume that all foredune habitat seaward of the pre-2010 shoreline protection structures was lost to wave action. Impacts are those areas where the 2010 emergency rock revetment occurs landward of pre-2010 shoreline protection structures or where such structures were not installed.

Broad Beach
Restoration Project

Malibu,
California

Figure 4-1e.

Potential Impacts to
Foredune Habitat from
2010 Emergency
Rock Revetment
Relative to 2009
Conditions



* Remnant foredune habitat based on 2010 foredune extent (i.e., foredune habitat remaining after installation of Pre-2010 Shoeline Protection Structures).
 ** Potential impacts assume that all foredune habitat seaward of the pre-2010 shoreline protection structures was lost to wave action. Impacts are those areas where the 2010 emergency rock revetment occurs landward of pre-2010 shoreline protection structures or where such structures were not installed.

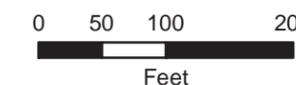
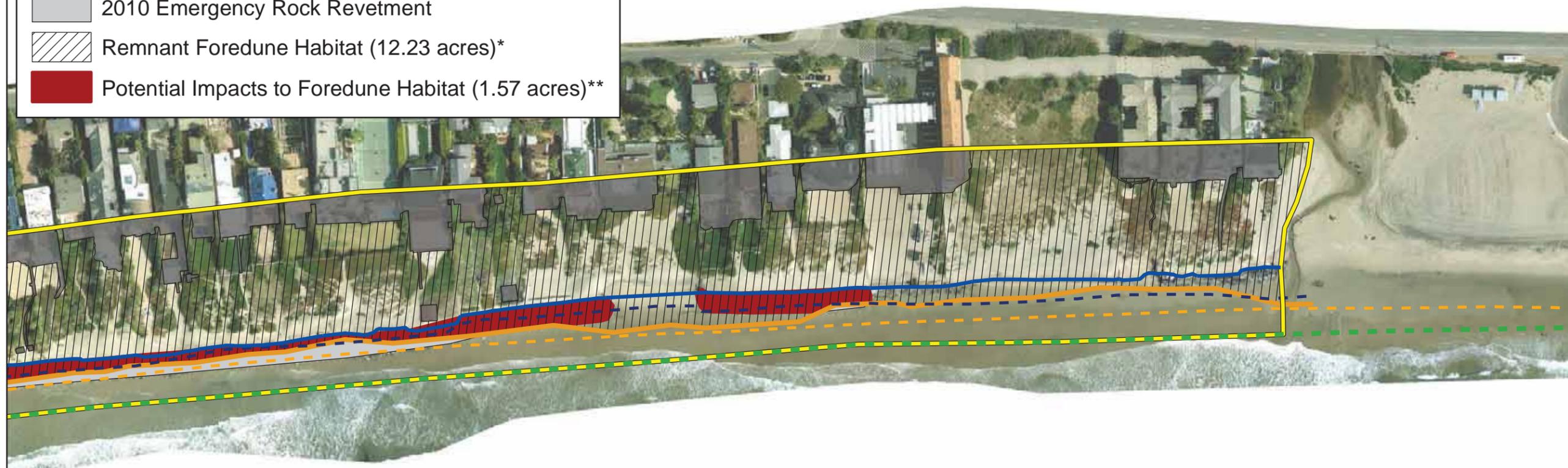
Broad Beach
Restoration Project

Malibu,
California

Figure 4-2a.

Potential Impacts to
Foredune Habitat from
2010 Emergency
Rock Revetment
Relative to 2005
Baseline Conditions

- Study Area
- MHTL - June 2005
- MHTL - JAN 19-20, 2010
- MHTL - OCT 15, 2009
- June 2005 Beach/Foredune Escarpment Line
- Pre-2010 Shoreline Protection Structures
- Development Footprint
- 2010 Emergency Rock Revetment
- Remnant Foredune Habitat (12.23 acres)*
- Potential Impacts to Foredune Habitat (1.57 acres)**



* Remnant Foredune habitat based on 2005 foredune extent shown in Figure 2.

** Potential impacts assume that any area seaward of the pre-2010 shoreline protection structures and landward of the 2005 beach/foredune escarpment line was remnant foredune habitat.

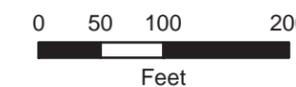
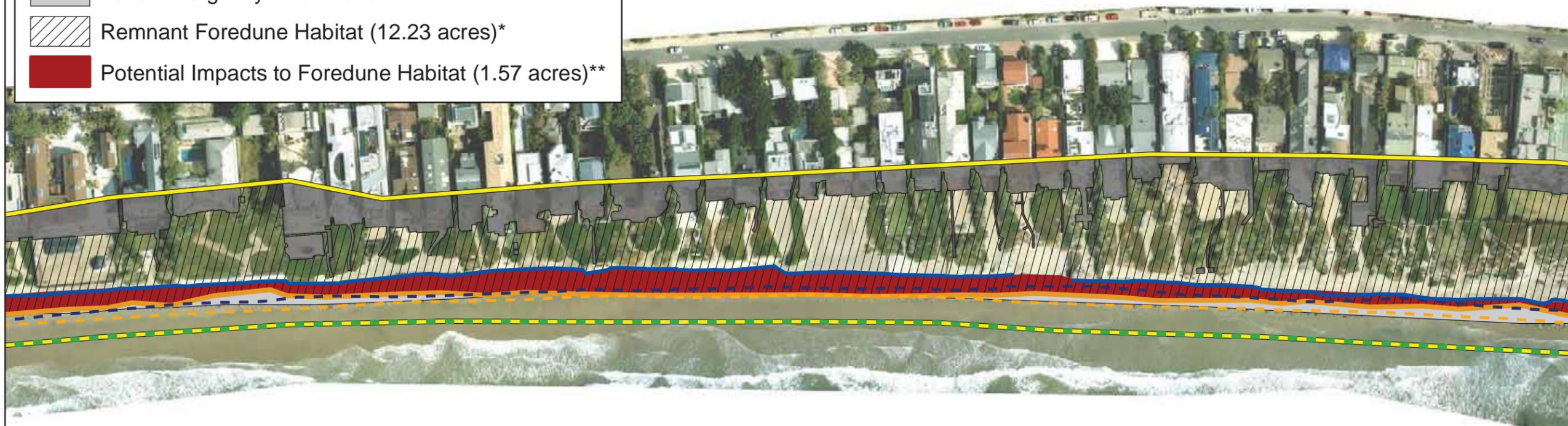
Broad Beach
Restoration Project

Malibu,
California

Figure 4-2b.

Potential Impacts to
Foredune Habitat from
2010 Emergency
Rock Revetment
Relative to 2005
Baseline Conditions

- Study Area
- MHTL - June 2005
- MHTL - JAN 19-20, 2010
- MHTL - OCT 15, 2009
- June 2005 Beach/Foredune Escarpment Line
- Pre-2010 Shoreline Protection Structures
- Development Footprint
- 2010 Emergency Rock Revetment
- Remnant Foredune Habitat (12.23 acres)*
- Potential Impacts to Foredune Habitat (1.57 acres)**



* Remnant Foredune habitat based on 2005 foredune extent shown in Figure 2.

** Potential impacts assume that any area seaward of the pre-2010 shoreline protection structures and landward of the 2005 beach/foredune escarpment line was remnant foredune habitat.

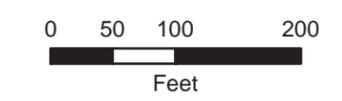
Broad Beach
Restoration Project

Malibu,
California

Figure 4-2c.

Potential Impacts to
Foredune Habitat from
2010 Emergency
Rock Revetment
Relative to 2005
Baseline Conditions

-  Study Area
-  MHTL - June 2005
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Pre-2010 Shoreline Protection Structures
-  Development Footprint
-  2010 Emergency Rock Revetment
-  Remnant Foredune Habitat (12.23 acres)*
-  Potential Impacts to Foredune Habitat (1.57 acres)**



* Remnant Foredune habitat based on 2005 foredune extent shown in Figure 2.

** Potential impacts assume that any area seaward of the pre-2010 shoreline protection structures and landward of the 2005 beach/foredune escarpment line was remnant foredune habitat.

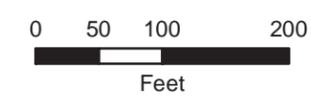
Broad Beach
Restoration Project

Malibu,
California

Figure 4-2d.

Potential Impacts to
Foredune Habitat from
2010 Emergency
Rock Revetment
Relative to 2005
Baseline Conditions

-  Study Area
-  MHTL - June 2005
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Pre-2010 Shoreline Protection Structures
-  Development Footprint
-  2010 Emergency Rock Revetment
-  Remnant Foredune Habitat (12.23 acres)*
-  Potential Impacts to Foredune Habitat (1.57 acres)**



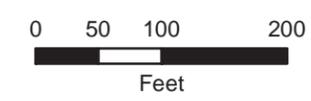
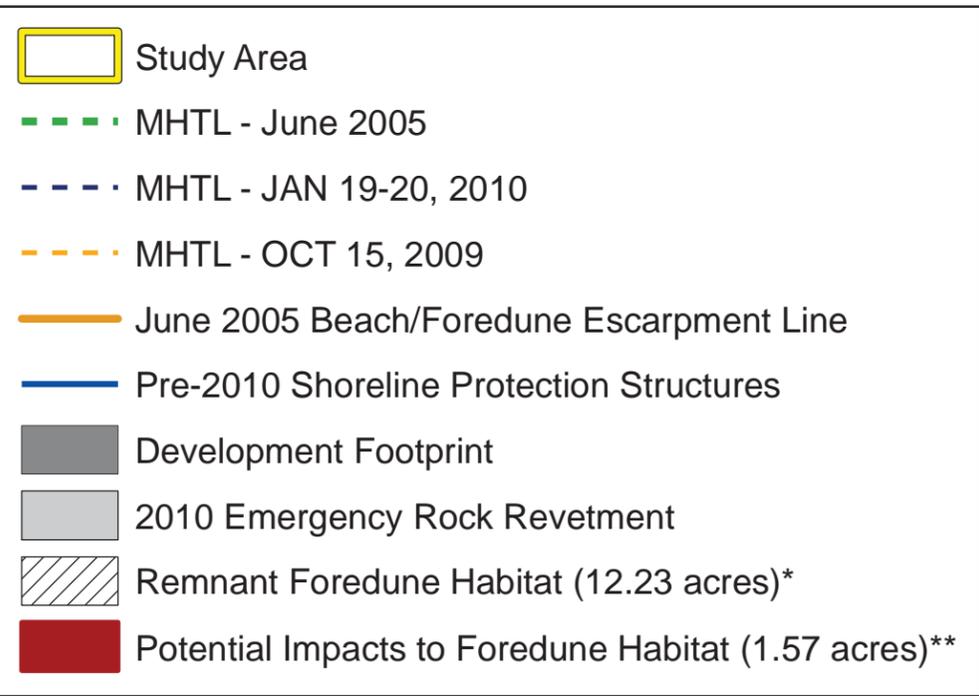
* Remnant Foredune habitat based on 2005 foredune extent shown in Figure 2.
 ** Potential impacts assume that any area seaward of the pre-2010 shoreline protection structures and landward of the 2005 beach/foredune escarpment line was remnant foredune habitat.

Broad Beach
Restoration Project

Malibu,
California

Figure 4-2e.

Potential Impacts to
Foredune Habitat from
2010 Emergency
Rock Revetment
Relative to 2005
Baseline Conditions



* Remnant Foredune habitat based on 2005 foredune extent shown in Figure 2.

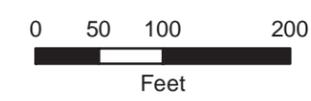
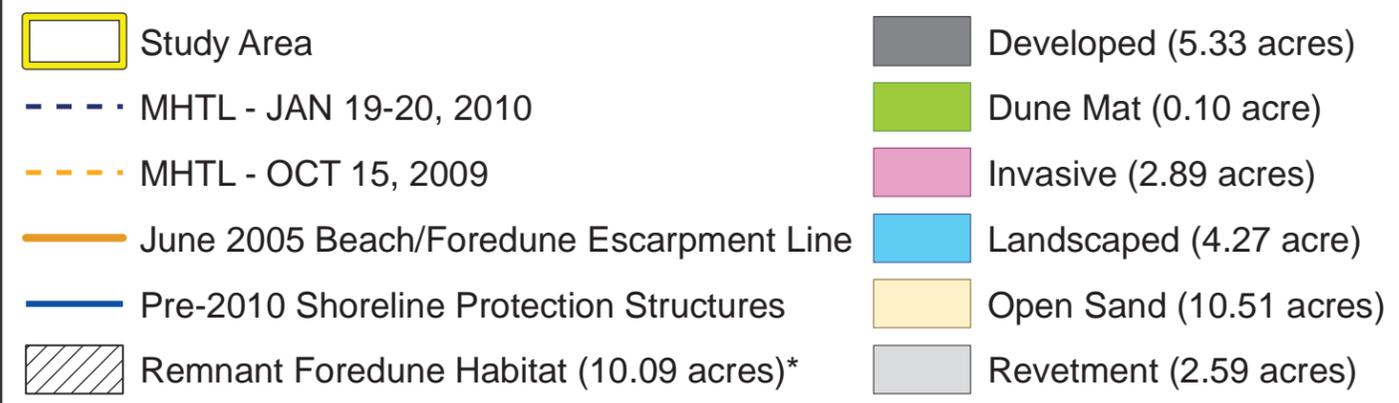
** Potential impacts assume that any area seaward of the pre-2010 shoreline protection structures and landward of the 2005 beach/foredune escarpment line was remnant foredune habitat.

Broad Beach
Restoration Project

Malibu,
California

Figure 5a.

Broad Beach
Existing Conditions
(2013)



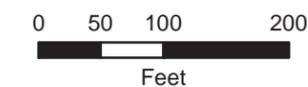
* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

Broad Beach
Restoration Project

Malibu,
California

Figure 5b.

Broad Beach
Existing Conditions
(2013)

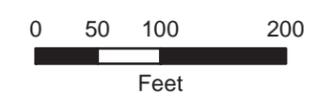
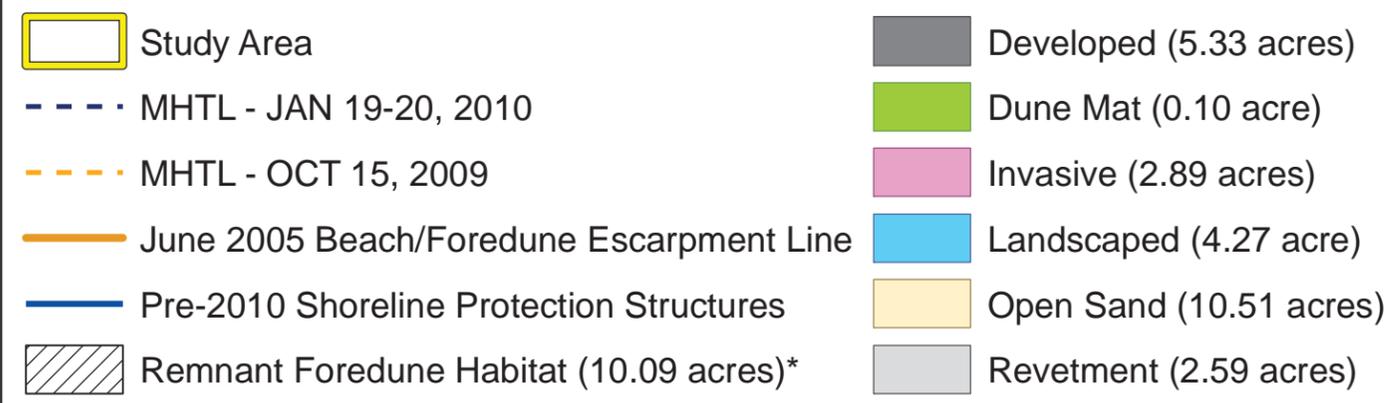


* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

Broad Beach
Restoration Project

Malibu,
California

Figure 5c.
Broad Beach
Existing Conditions
(2013)

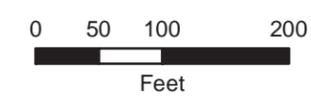
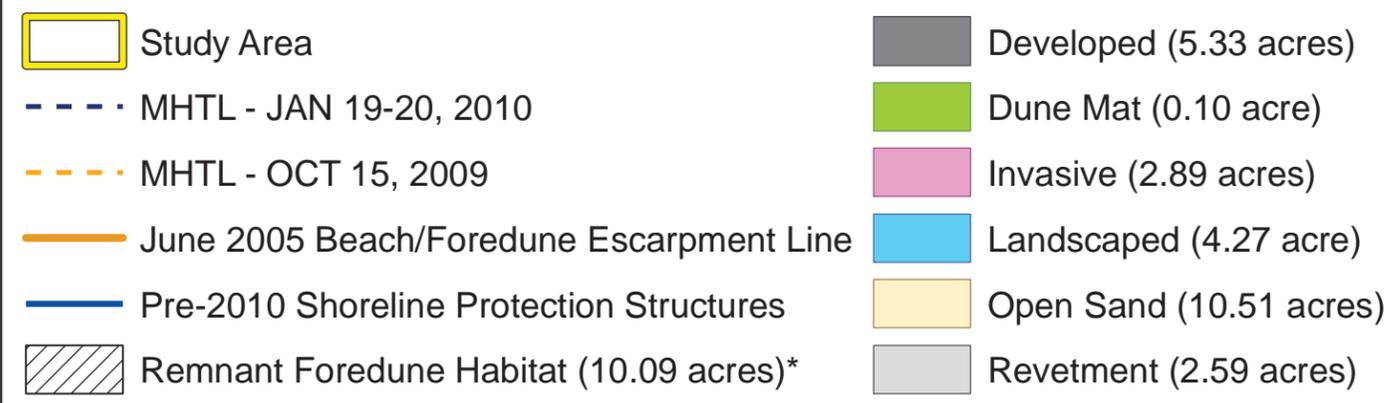


* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

Broad Beach
Restoration Project

Malibu,
California

Figure 5d.
Broad Beach
Existing Conditions
(2013)

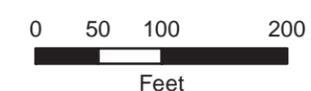
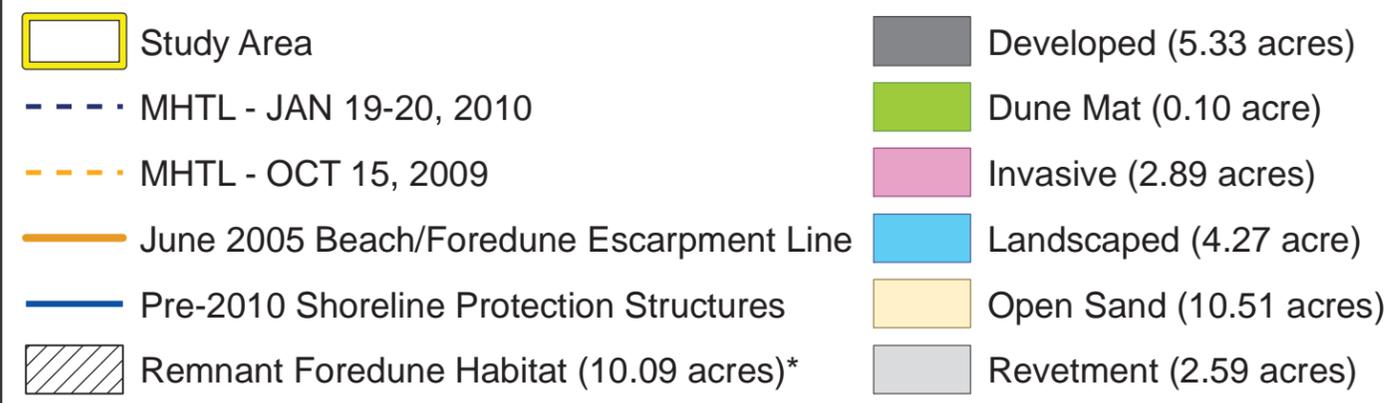


* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

Broad Beach
Restoration Project

Malibu,
California

Figure 5e.
Broad Beach
Existing Conditions
(2013)



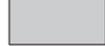
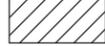
* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

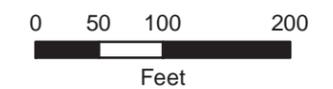
Broad Beach
Restoration Project

Malibu,
California

Figure 6-1a.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Relative to 2013
Existing Conditions

-  Study Area
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  2010 Emergency Rock Revetment
-  Proposed Dune Restoration Footprint (7.71 acres)
-  Remnant Foredune Habitat (10.09 acres)*
-  Potential Impacts to Remnant Foredune Habitat (2.95 acres)**



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

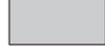
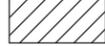
** Potential impacts are due to enhancement of existing degraded foredune habitat and are temporary in nature.

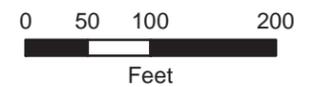
Broad Beach
Restoration Project

Malibu,
California

Figure 6-1b.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Relative to 2013
Existing Conditions

-  Study Area
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  2010 Emergency Rock Revetment
-  Proposed Dune Restoration Footprint (7.71 acres)
-  Remnant Foredune Habitat (10.09 acres)*
-  Potential Impacts to Remnant Foredune Habitat (2.95 acres)**



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

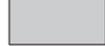
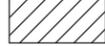
** Potential impacts are due to enhancement of existing degraded foredune habitat and are temporary in nature.

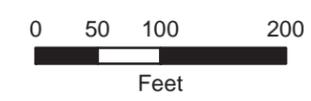
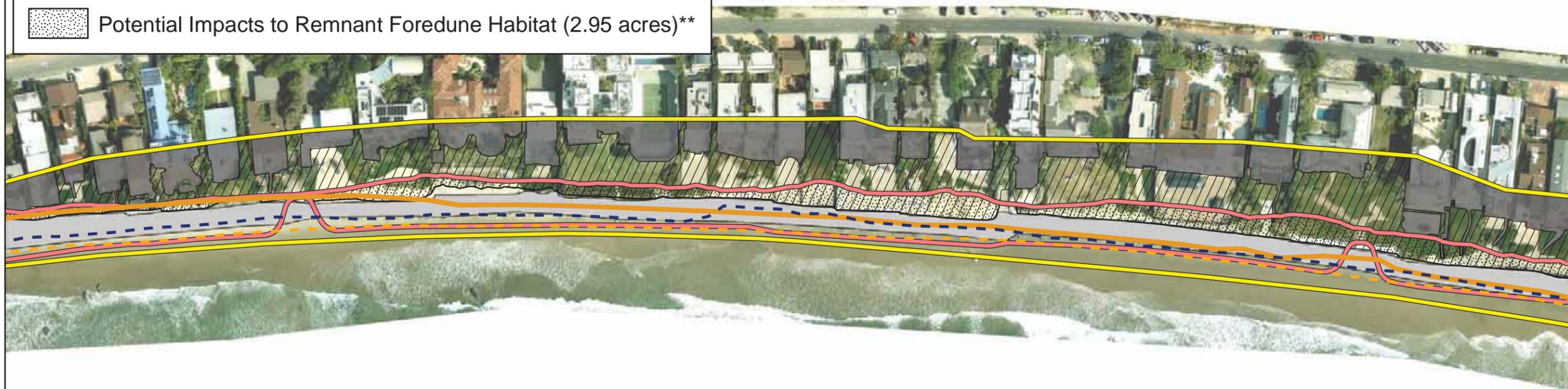
Broad Beach
Restoration Project

Malibu,
California

Figure 6-1c.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Relative to 2013
Existing Conditions

-  Study Area
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  2010 Emergency Rock Revetment
-  Proposed Dune Restoration Footprint (7.71 acres)
-  Remnant Foredune Habitat (10.09 acres)*
-  Potential Impacts to Remnant Foredune Habitat (2.95 acres)**



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

** Potential impacts are due to enhancement of existing degraded foredune habitat and are temporary in nature.

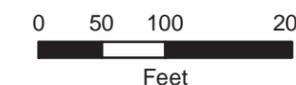
Broad Beach
Restoration Project

Malibu,
California

Figure 6-1d.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Relative to 2013
Existing Conditions

- Study Area
- MHTL - JAN 19-20, 2010
- MHTL - OCT 15, 2009
- June 2005 Beach/Foredune Escarpment Line
- Development Footprint
- 2010 Emergency Rock Revetment
- Proposed Dune Restoration Footprint (7.71 acres)
- Remnant Foredune Habitat (10.09 acres)*
- Potential Impacts to Remnant Foredune Habitat (2.95 acres)**



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

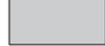
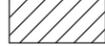
** Potential impacts are due to enhancement of existing degraded foredune habitat and are temporary in nature.

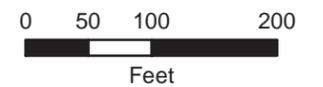
Broad Beach
Restoration Project

Malibu,
California

Figure 6-1e.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Relative to 2013
Existing Conditions

-  Study Area
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  2010 Emergency Rock Revetment
-  Proposed Dune Restoration Footprint (7.71 acres)
-  Remnant Foredune Habitat (10.09 acres)*
-  Potential Impacts to Remnant Foredune Habitat (2.95 acres)**



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

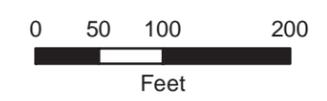
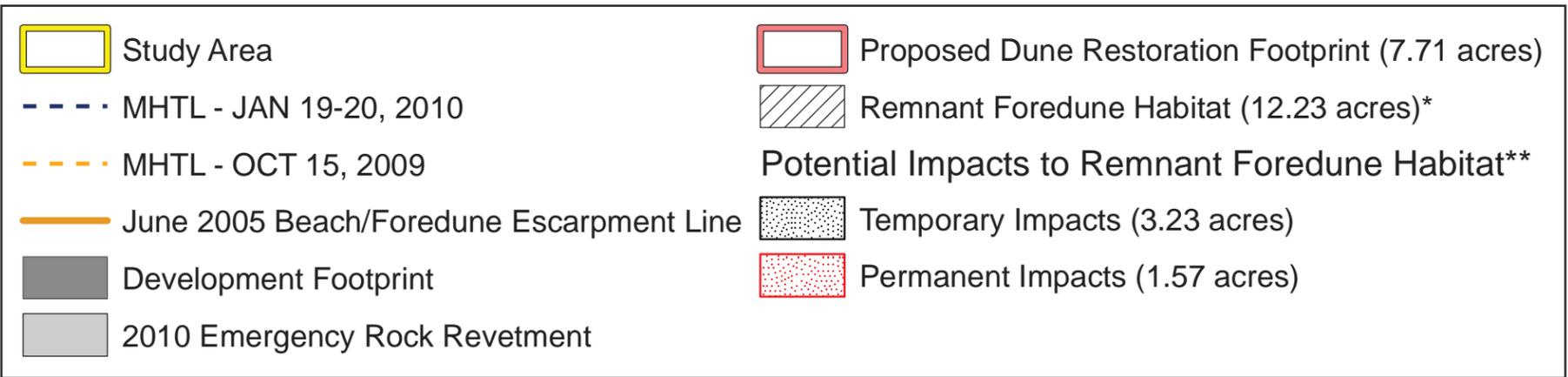
** Potential impacts are due to enhancement of existing degraded foredune habitat and are temporary in nature.

Broad Beach
Restoration Project

Malibu,
California

Figure 6-2a.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Relative to 2005
Baseline Conditions



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

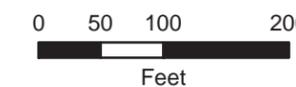
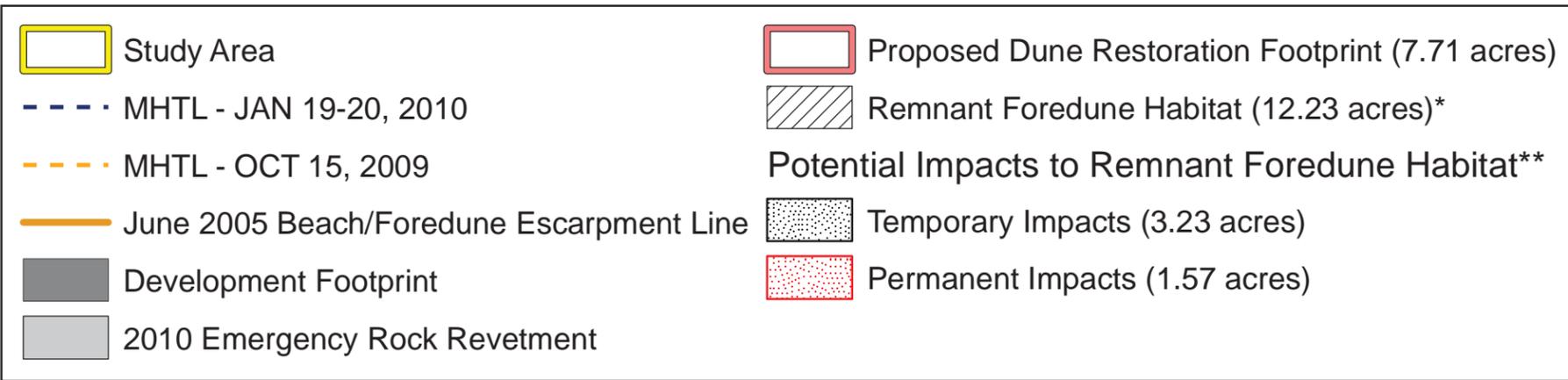
** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to retention of the rock revetment in the project design.

Broad Beach
Restoration Project

Malibu,
California

Figure 6-2b.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Relative to 2005
Baseline Conditions



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

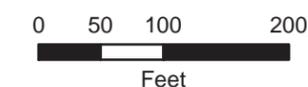
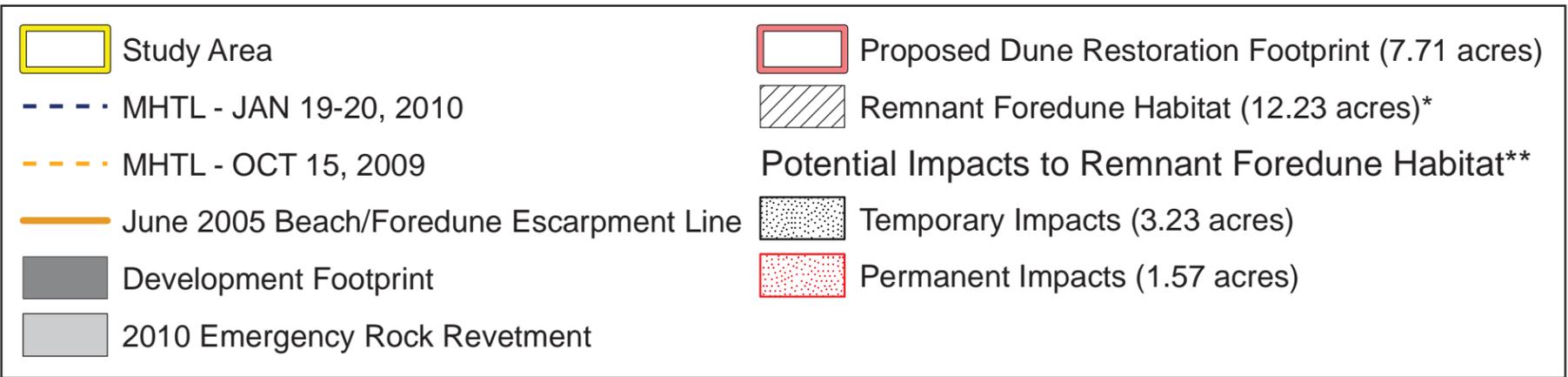
** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to retention of the rock revetment in the project design.

Broad Beach
Restoration Project

Malibu,
California

Figure 6-2c.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Relative to 2005
Baseline Conditions



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

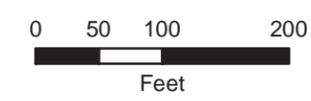
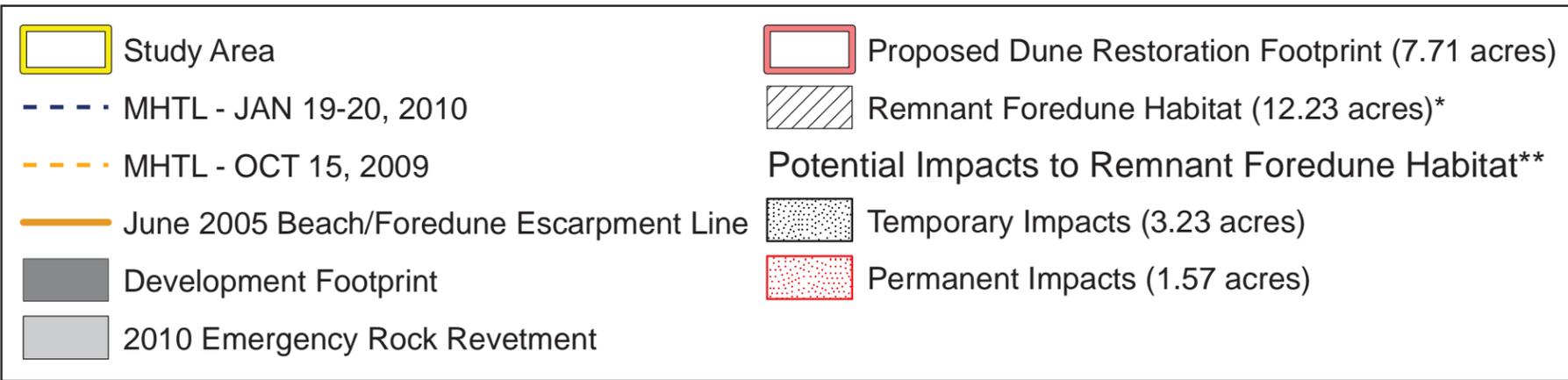
** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to retention of the rock revetment in the project design.

Broad Beach
Restoration Project

Malibu,
California

Figure 6-2d.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Relative to 2005
Baseline Conditions



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

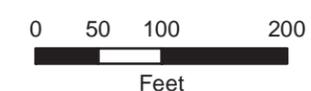
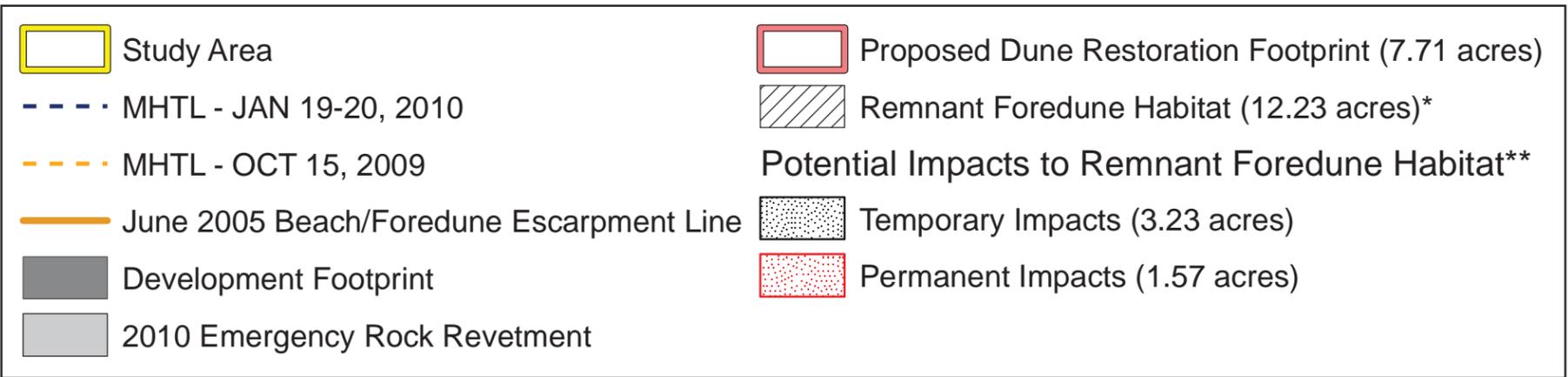
** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to retention of the rock revetment in the project design.

Broad Beach
Restoration Project

Malibu,
California

Figure 6-2e.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Relative to 2005
Baseline Conditions



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to retention of the rock revetment in the project design.

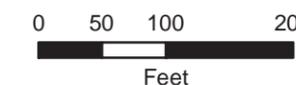
Broad Beach
Restoration Project

Malibu,
California

Figure 7-1a.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Beach Nourishment
Failure Relative to
2013 Existing Conditions

-  Study Area
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  Proposed Dune Restoration Footprint (7.71 acres)
-  Remnant Foredune Habitat (10.09 acres)*
-  Loss of Created Foredune Due to Beach Nourishment Failure (4.63 acres)**



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.
 ** All foredune habitat to the landward edge of the 2010 emergency rock revetment may be lost; this represents foredune habitat to be created on top or in front of the 2010 emergency rock revetment.

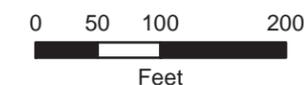
Broad Beach
Restoration Project

Malibu,
California

Figure 7-1b.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Beach Nourishment
Failure Relative to
2013 Existing Conditions

-  Study Area
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  Proposed Dune Restoration Footprint (7.71 acres)
-  Remnant Foredune Habitat (10.09 acres)*
-  Loss of Created Foredune Due to Beach Nourishment Failure (4.63 acres)**



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.
 ** All foredune habitat to the landward edge of the 2010 emergency rock revetment may be lost; this represents foredune habitat to be created on top or in front of the 2010 emergency rock revetment.

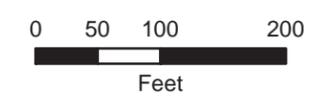
Broad Beach
Restoration Project

Malibu,
California

Figure 7-1c.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Beach Nourishment
Failure Relative to
2013 Existing Conditions

-  Study Area
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  Proposed Dune Restoration Footprint (7.71 acres)
-  Remnant Foredune Habitat (10.09 acres)*
-  Loss of Created Foredune Due to Beach Nourishment Failure (4.63 acres)**



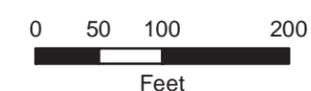
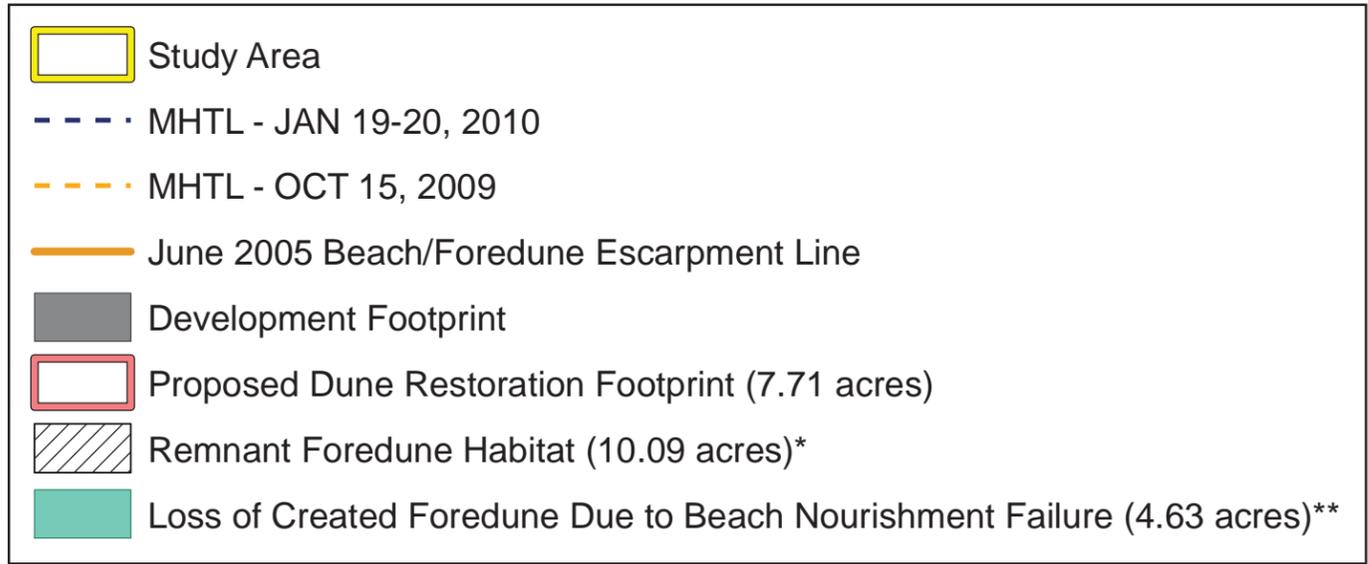
* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.
 ** All foredune habitat to the landward edge of the 2010 emergency rock revetment may be lost; this represents foredune habitat to be created on top or in front of the 2010 emergency rock revetment.

Broad Beach
Restoration Project

Malibu,
California

Figure 7-1d.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Beach Nourishment
Failure Relative to
2013 Existing Conditions



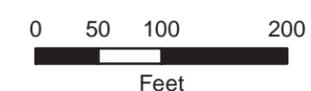
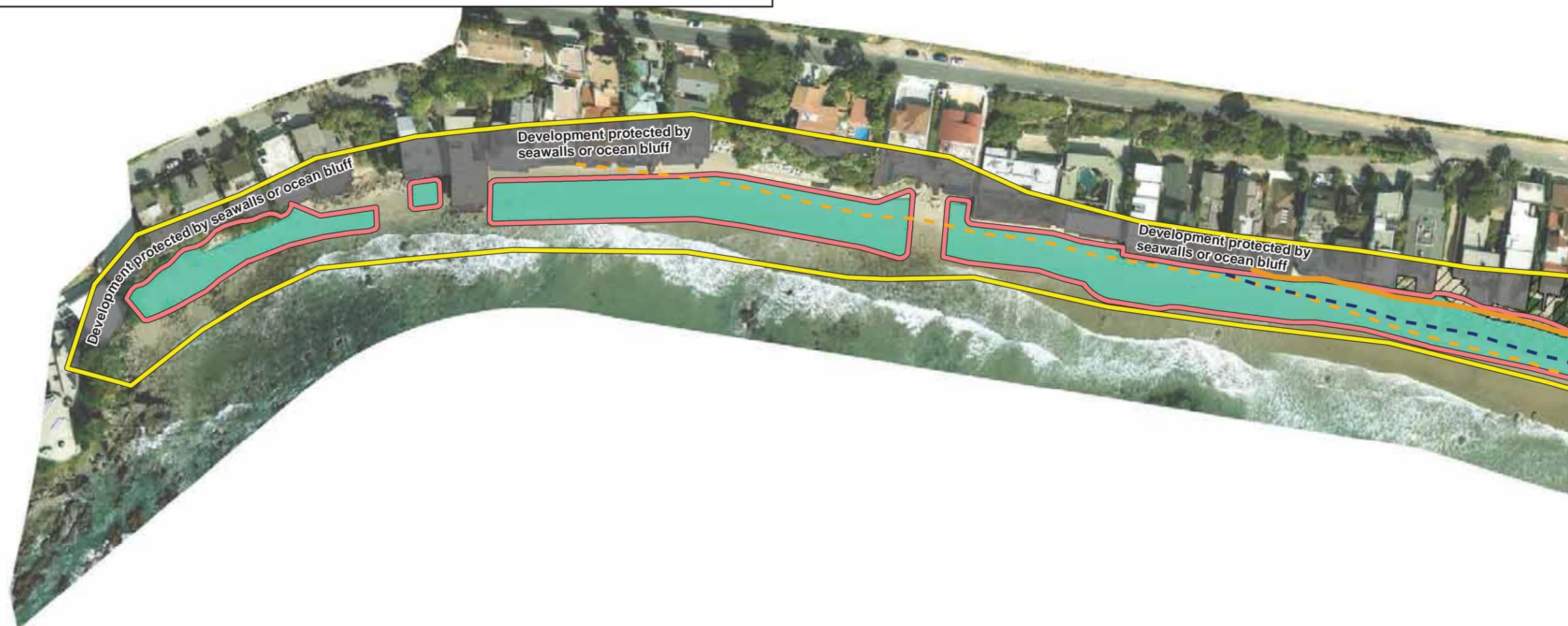
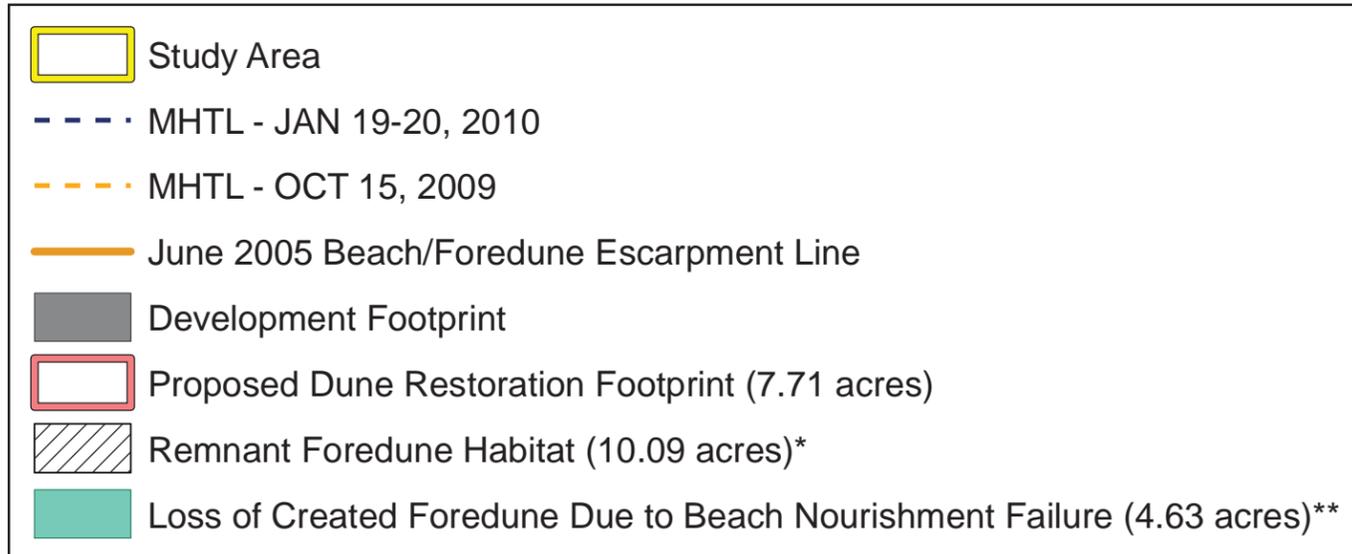
* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.
 ** All foredune habitat to the landward edge of the 2010 emergency rock revetment may be lost; this represents foredune habitat to be created on top or in front of the 2010 emergency rock revetment.

Broad Beach
Restoration Project

Malibu,
California

Figure 7-1e.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Beach Nourishment
Failure Relative to
2013 Existing Conditions



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.
 ** All foredune habitat to the landward edge of the 2010 emergency rock revetment may be lost; this represents foredune habitat to be created on top or in front of the 2010 emergency rock revetment.

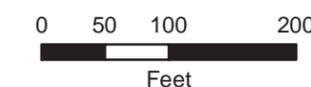
Broad Beach
Restoration Project

Malibu,
California

Figure 7-2a.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Beach Nourishment
Failure Relative to
2005 Baseline Conditions

-  Study Area
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  Proposed Dune Restoration Footprint (7.71 acres)
-  Remnant Foredune Habitat (12.23 acres)*
-  Loss of Created and Existing Foredune Due to Beach Nourishment Failure (4.82 acres)**



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

** All foredune habitat to the landward edge of the 2010 emergency rock revetment may be lost; this represents foredune habitat to be created on top of the revetment and the extent of potential existing foredune habitat in front of the revetment based on 2005 conditions.

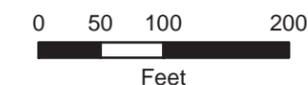
Broad Beach
Restoration Project

Malibu,
California

Figure 7-2b.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Beach Nourishment
Failure Relative to
2005 Baseline Conditions

-  Study Area
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  Proposed Dune Restoration Footprint (7.71 acres)
-  Remnant Foredune Habitat (12.23 acres)*
-  Loss of Created and Existing Foredune Due to Beach Nourishment Failure (4.82 acres)**



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

** All foredune habitat to the landward edge of the 2010 emergency rock revetment may be lost; this represents foredune habitat to be created on top of the revetment and the extent of potential existing foredune habitat in front of the revetment based on 2005 conditions.

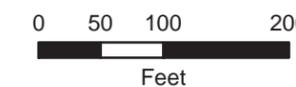
Broad Beach
Restoration Project

Malibu,
California

Figure 7-2c.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Beach Nourishment
Failure Relative to
2005 Baseline Conditions

-  Study Area
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  Proposed Dune Restoration Footprint (7.71 acres)
-  Remnant Foredune Habitat (12.23 acres)*
-  Loss of Created and Existing Foredune Due to Beach Nourishment Failure (4.82 acres)**



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

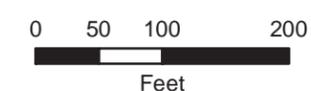
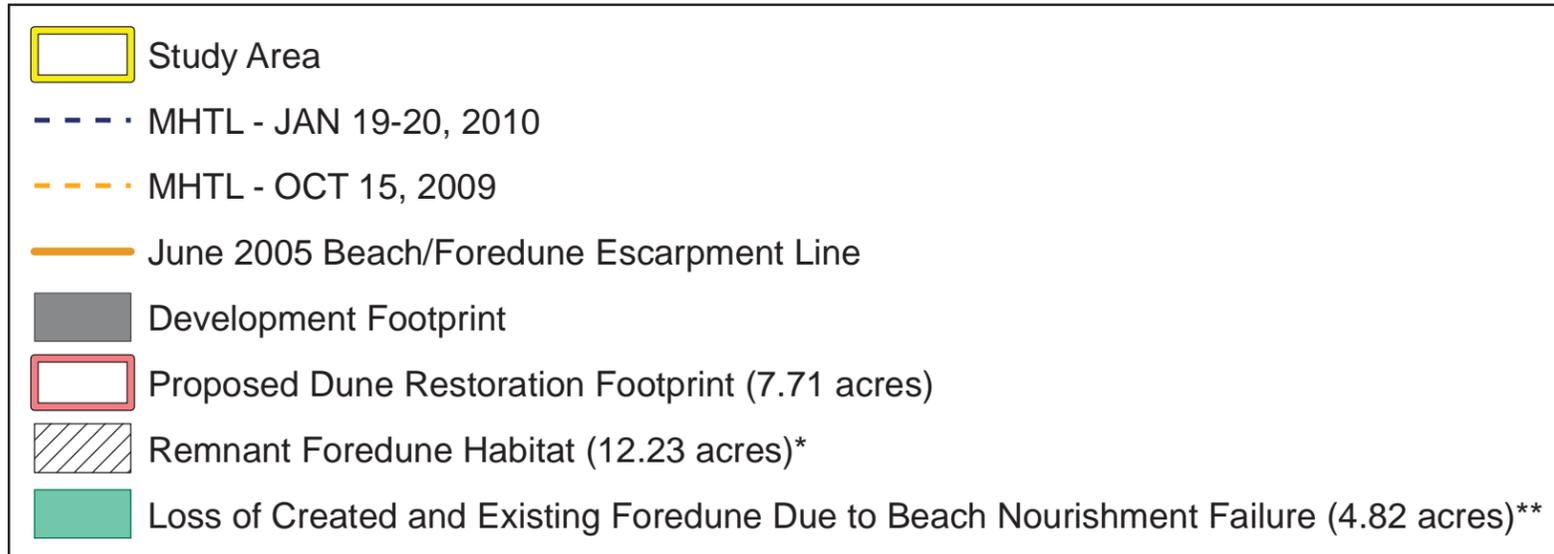
** All foredune habitat to the landward edge of the 2010 emergency rock revetment may be lost; this represents foredune habitat to be created on top of the revetment and the extent of potential existing foredune habitat in front of the revetment based on 2005 conditions.

Broad Beach
Restoration Project

Malibu,
California

Figure 7-2d.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Beach Nourishment
Failure Relative to
2005 Baseline Conditions



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

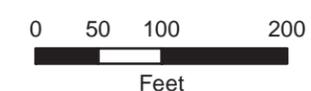
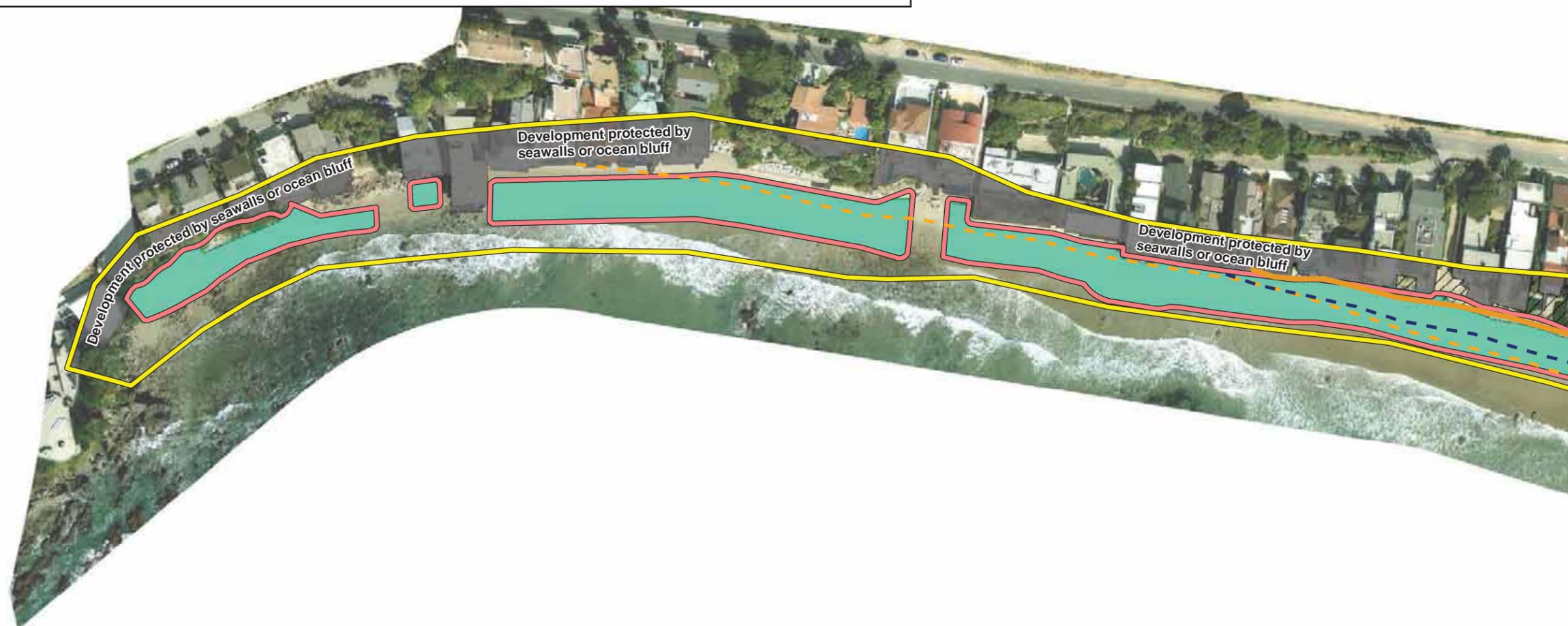
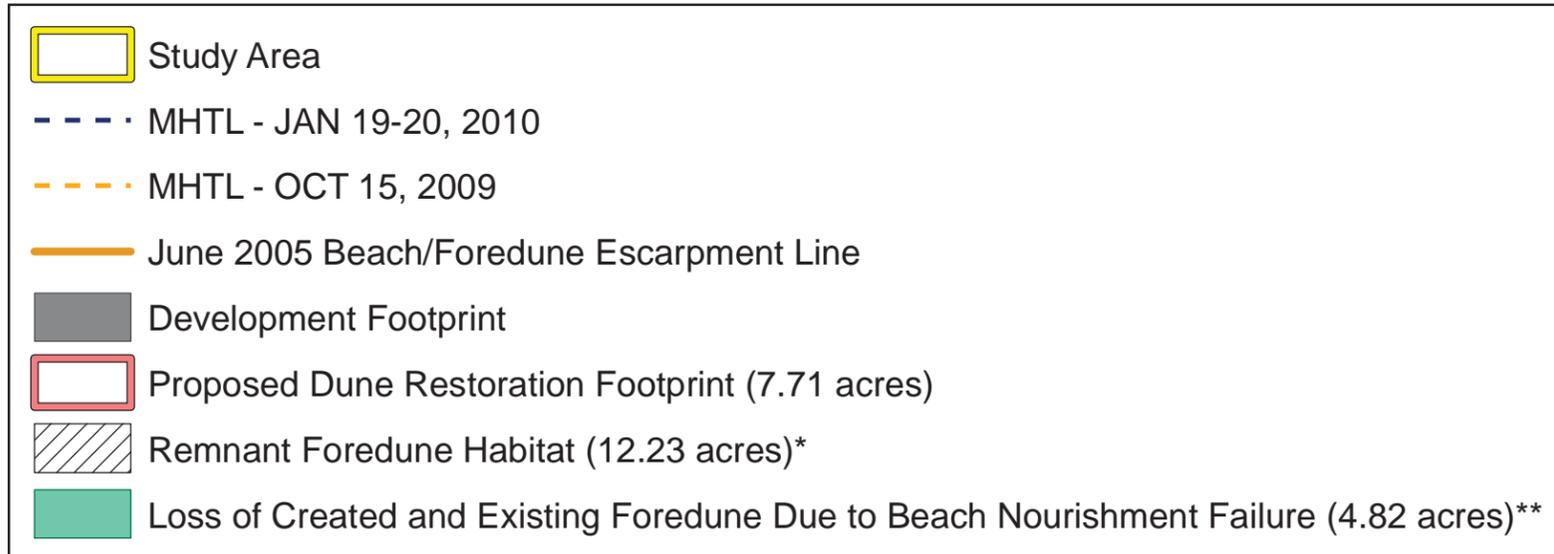
** All foredune habitat to the landward edge of the 2010 emergency rock revetment may be lost; this represents foredune habitat to be created on top of the revetment and the extent of potential existing foredune habitat in front of the revetment based on 2005 conditions.

Broad Beach
Restoration Project

Malibu,
California

Figure 7-2e.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Beach Nourishment
Failure Relative to
2005 Baseline Conditions



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

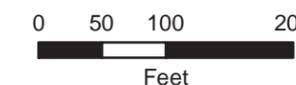
** All foredune habitat to the landward edge of the 2010 emergency rock revetment may be lost; this represents foredune habitat to be created on top of the revetment and the extent of potential existing foredune habitat in front of the revetment based on 2005 conditions.

Broad Beach
Restoration Project

Malibu,
California

Figure 8-1a.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Revetment Failure
Failure Relative to
2013 Existing Conditions



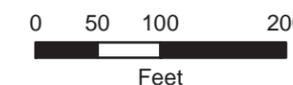
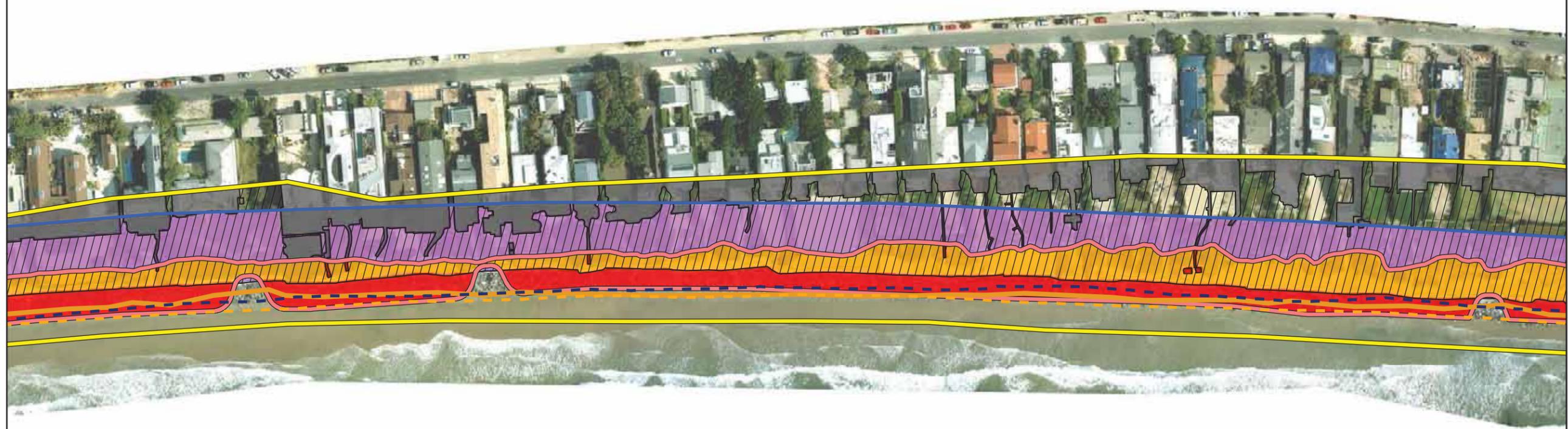
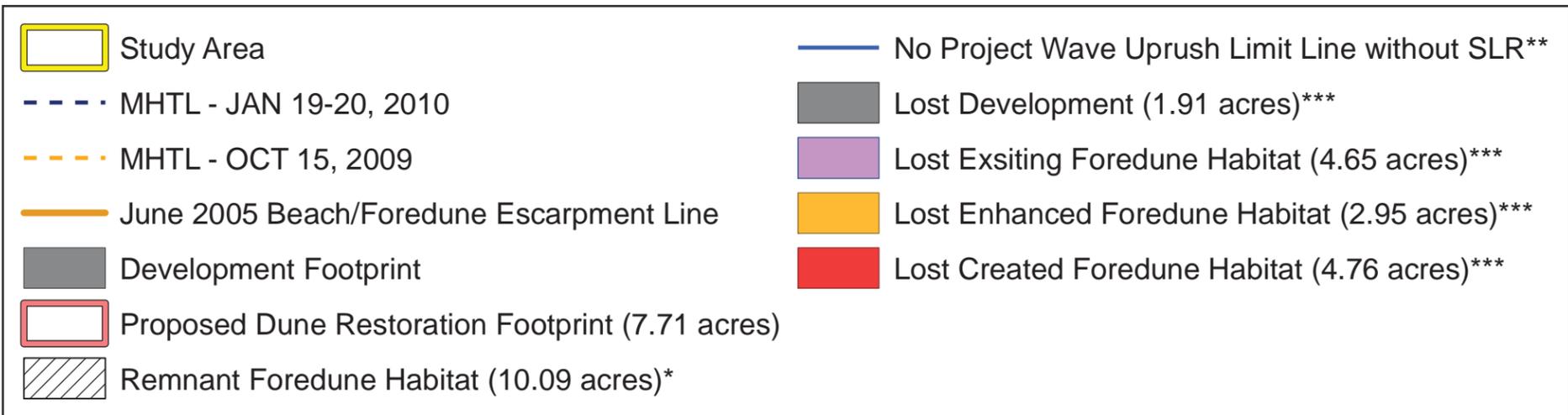
* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.
 ** No Project Wave Uprush Limit provided by Moffatt and Nichol
 *** All habitat & development up to No Project Wave Uprush Limit may be lost. Additional losses may occur under conditions of sea level rise.

Broad Beach
Restoration Project

Malibu,
California

Figure 8-1b.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Revetment Failure
Failure Relative to
2013 Existing Conditions



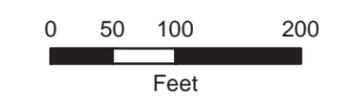
* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.
 ** No Project Wave Uprush Limit provided by Moffatt and Nichol
 *** All habitat & development up to No Project Wave Uprush Limit may be lost. Additional lossess may occur under conditions of sea level rise.

Broad Beach
Restoration Project

Malibu,
California

Figure 8-1c.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Revetment Failure
Failure Relative to
2013 Existing Conditions



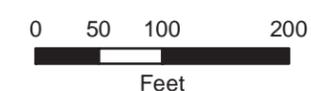
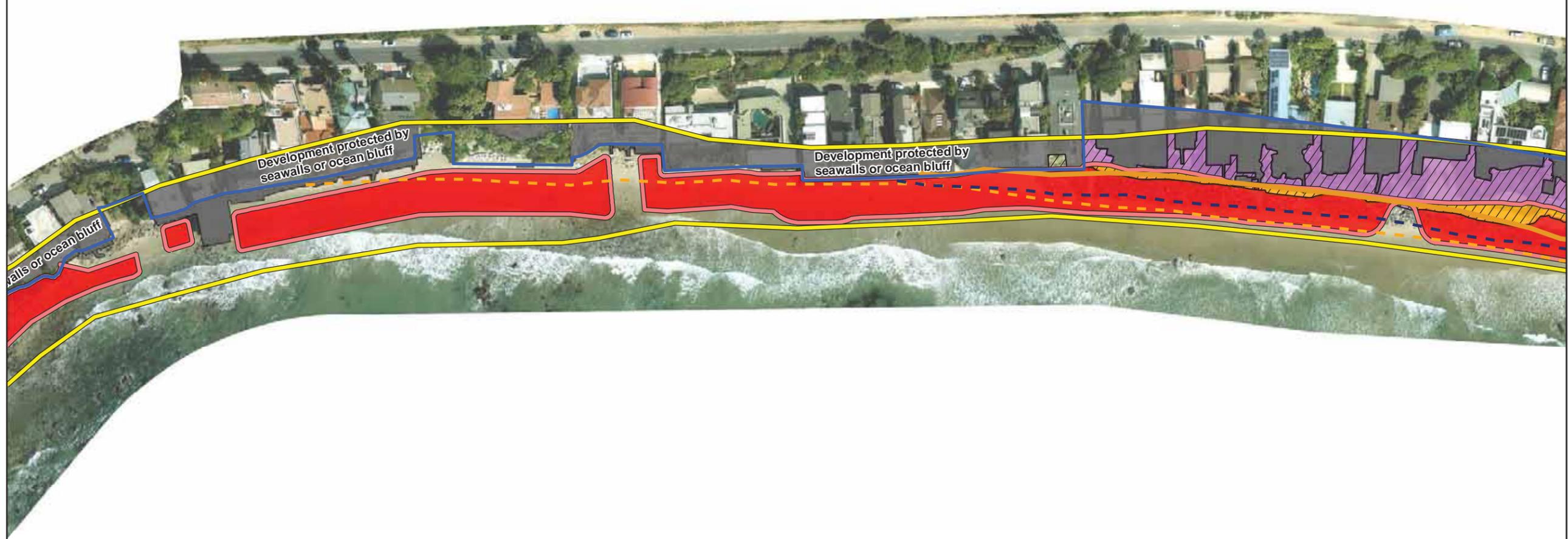
* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.
 ** No Project Wave Uprush Limit provided by Moffatt and Nichol
 *** All habitat & development up to No Project Wave Uprush Limit may be lost. Additional losses may occur under conditions of sea level rise.

Broad Beach
Restoration Project

Malibu,
California

Figure 8-1d.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Revetment Failure
Failure Relative to
2013 Existing Conditions



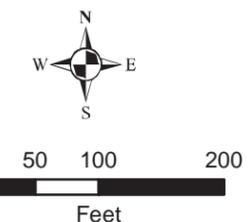
* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.
 ** No Project Wave Uprush Limit provided by Moffatt and Nichol
 *** All habitat & development up to No Project Wave Uprush Limit may be lost. Additional losses may occur under conditions of sea level rise.

Broad Beach
Restoration Project

Malibu,
California

Figure 8-1e.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Revetment Failure
Failure Relative to
2013 Existing Conditions



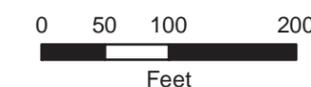
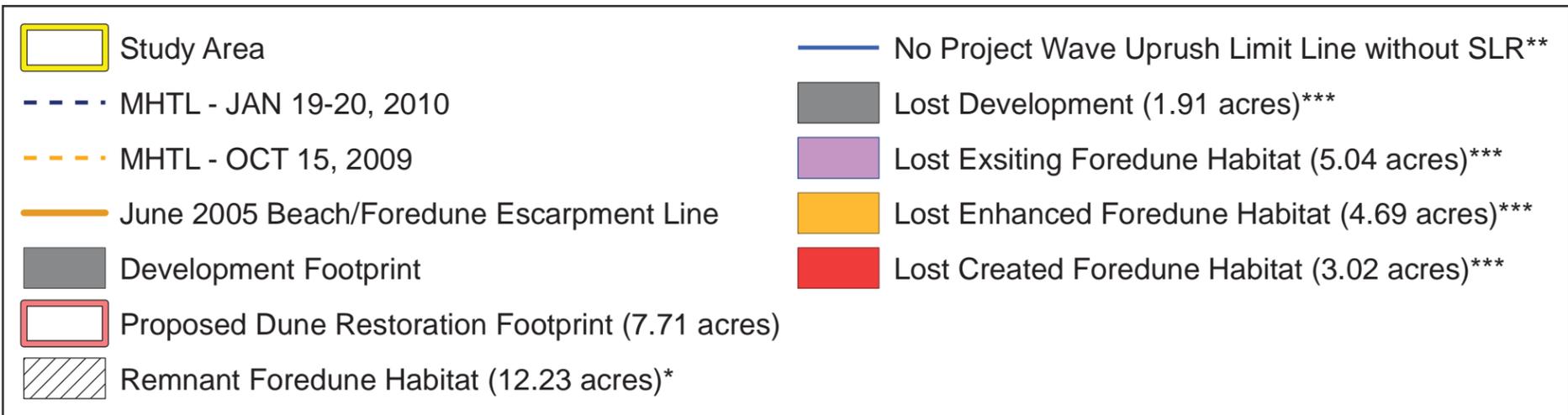
* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.
 ** No Project Wave Uprush Limit provided by Moffatt and Nichol
 *** All habitat & development up to No Project Wave Uprush Limit may be lost. Additional losses may occur under conditions of sea level rise.

Broad Beach
Restoration Project

Malibu,
California

Figure 8-2a.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Revetment Failure
Failure Relative to
2005 Baseline Conditions



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

** No Project Wave Uprush Limit provided by Moffatt and Nichol

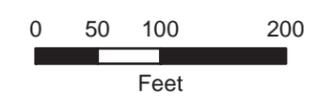
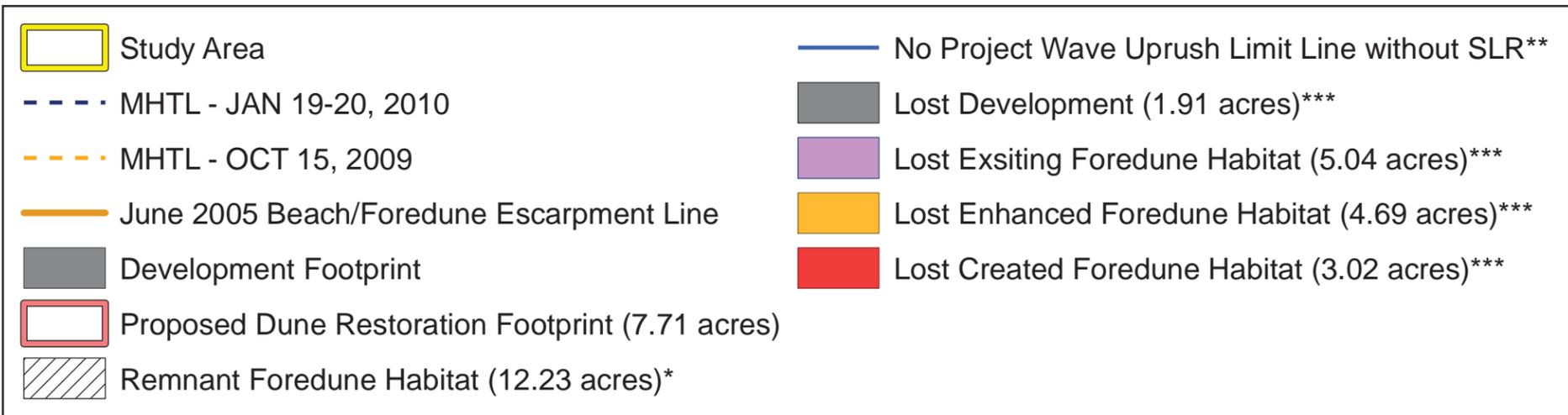
*** All habitat & development up to No Project Wave Uprush Limit may be lost. Additional losses may occur under conditions of sea level rise.

Broad Beach
Restoration Project

Malibu,
California

Figure 8-2b.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Revetment Failure
Failure Relative to
2005 Baseline Conditions



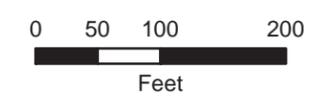
* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.
 ** No Project Wave Uprush Limit provided by Moffatt and Nichol
 *** All habitat & development up to No Project Wave Uprush Limit may be lost. Additional losses may occur under conditions of sea level rise.

Broad Beach
Restoration Project

Malibu,
California

Figure 8-2c.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Revetment Failure
Failure Relative to
2005 Baseline Conditions



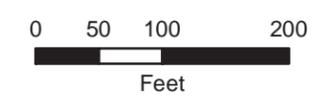
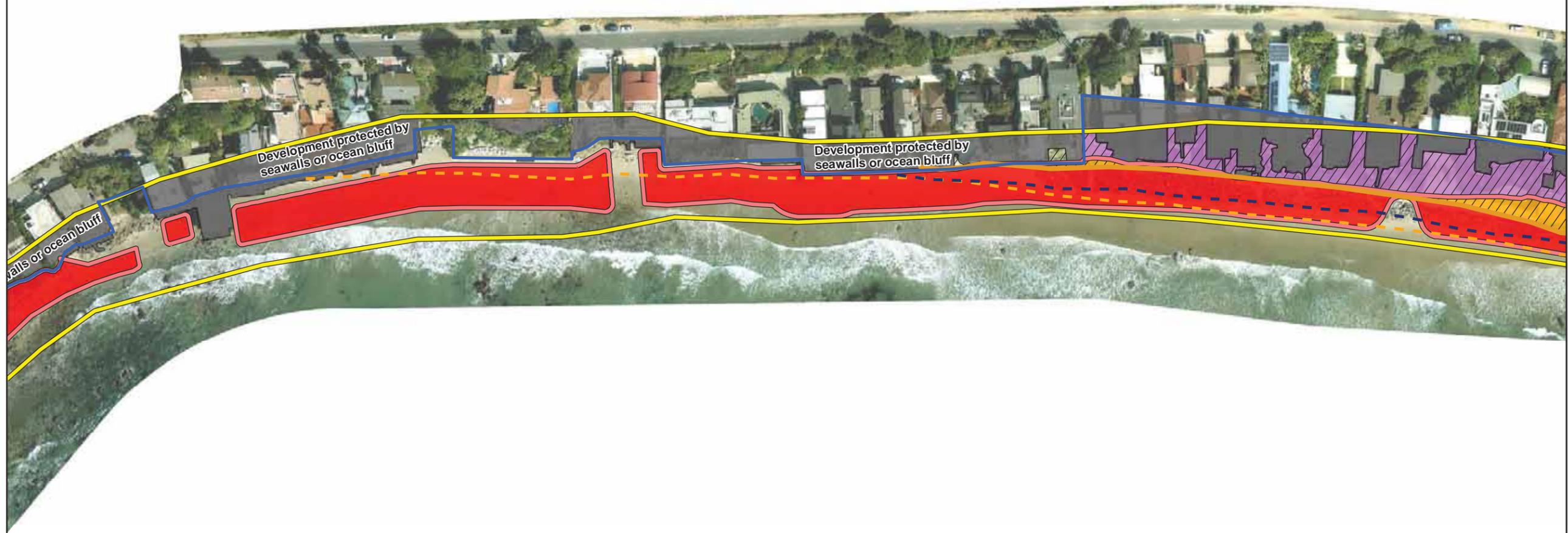
* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.
 ** No Project Wave Uprush Limit provided by Moffatt and Nichol
 *** All habitat & development up to No Project Wave Uprush Limit may be lost. Additional losses may occur under conditions of sea level rise.

Broad Beach
Restoration Project

Malibu,
California

Figure 8-2d.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Revetment Failure
Failure Relative to
2005 Baseline Conditions



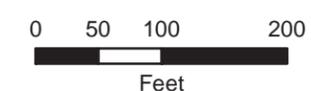
* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.
 ** No Project Wave Uprush Limit provided by Moffatt and Nichol
 *** All habitat & development up to No Project Wave Uprush Limit may be lost. Additional losses may occur under conditions of sea level rise.

Broad Beach
Restoration Project

Malibu,
California

Figure 8-2e.

Potential Impacts to
Foredune Habitat from
the Proposed Project
Under Conditions of
Revetment Failure
Failure Relative to
2005 Baseline Conditions



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.
 ** No Project Wave Uprush Limit provided by Moffatt and Nichol
 *** All habitat & development up to No Project Wave Uprush Limit may be lost. Additional losses may occur under conditions of sea level rise.

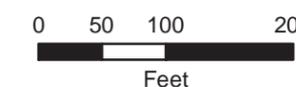
Broad Beach
Restoration Project

Malibu,
California

Figure 9-1a.

Potential Impacts to
Foredune Habitat
Under Alternative 1A
Relative to 2013
Existing Conditions

- Study Area
- MHTL - JAN 19-20, 2010
- MHTL - OCT 15, 2009
- June 2005 Beach/Foredune Escarpment Line
- Development Footprint
- 2010 Emergency Rock Revetment
- Proposed Dune Restoration Footprint (7.71 acres)
- Alternative 1A Revetment Relocation
- Remnant Foredune Habitat (10.09 acres)*
- Potential Impacts to Remnant Foredune Habitat****
- Temporary Impacts (2.90 acres)
- Permanent Impacts (0.05 acre)



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to relocation of revetment.

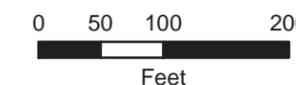
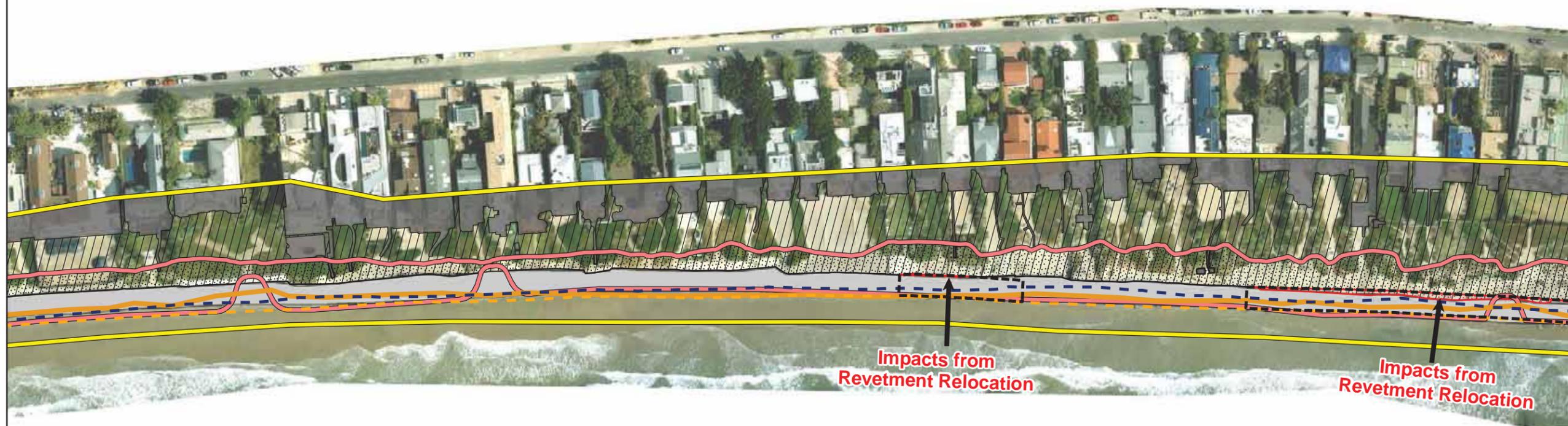
Broad Beach
Restoration Project

Malibu,
California

Figure 9-1b.

Potential Impacts to
Foredune Habitat
Under Alternative 1A
Relative to 2013
Existing Conditions

- Study Area
- MHTL - JAN 19-20, 2010
- MHTL - OCT 15, 2009
- June 2005 Beach/Foredune Escarpment Line
- Development Footprint
- 2010 Emergency Rock Revetment
- Proposed Dune Restoration Footprint (7.71 acres)
- Alternative 1A Revetment Relocation
- Remnant Foredune Habitat (10.09 acres)*
- Potential Impacts to Remnant Foredune Habitat****
- Temporary Impacts (2.90 acres)
- Permanent Impacts (0.05 acre)



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

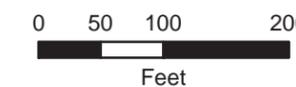
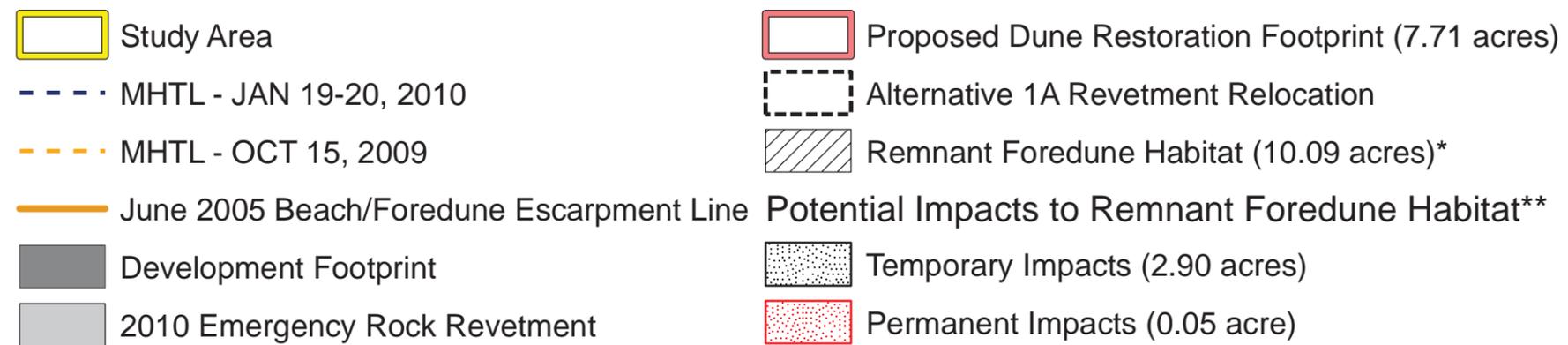
** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to relocation of revetment.

Broad Beach
Restoration Project

Malibu,
California

Figure 9-1c.

Potential Impacts to
Foredune Habitat
Under Alternative 1A
Relative to 2013
Existing Conditions



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to relocation of revetment.

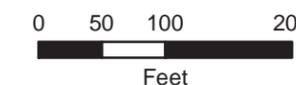
Broad Beach
Restoration Project

Malibu,
California

Figure 9-1d.

Potential Impacts to
Foredune Habitat
Under Alternative 1A
Relative to 2013
Existing Conditions

- | | |
|--|--|
| Study Area | Proposed Dune Restoration Footprint (7.71 acres) |
| MHTL - JAN 19-20, 2010 | Alternative 1A Revetment Relocation |
| MHTL - OCT 15, 2009 | Remnant Foredune Habitat (10.09 acres)* |
| June 2005 Beach/Foredune Escarpment Line | Potential Impacts to Remnant Foredune Habitat** |
| Development Footprint | Temporary Impacts (2.90 acres) |
| 2010 Emergency Rock Revetment | Permanent Impacts (0.05 acre) |



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to relocation of revetment.

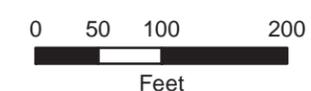
Broad Beach
Restoration Project

Malibu,
California

Figure 9-1e.

Potential Impacts to
Foredune Habitat
Under Alternative 1A
Relative to 2013
Existing Conditions

- | | |
|--|--|
| Study Area | Proposed Dune Restoration Footprint (7.71 acres) |
| MHTL - JAN 19-20, 2010 | Alternative 1A Revetment Relocation |
| MHTL - OCT 15, 2009 | Remnant Foredune Habitat (10.09 acres)* |
| June 2005 Beach/Foredune Escarpment Line | Potential Impacts to Remnant Foredune Habitat** |
| Development Footprint | Temporary Impacts (2.90 acres) |
| 2010 Emergency Rock Revetment | Permanent Impacts (0.05 acre) |



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

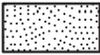
** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to relocation of revetment.

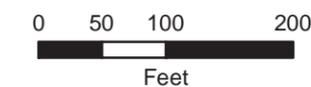
Broad Beach
Restoration Project

Malibu,
California

Figure 9-2a.

Potential Impacts to
Foredune Habitat
Under Alternative 1A
Relative to 2005
Baseline Conditions

- | | |
|---|--|
|  Study Area |  Proposed Dune Restoration Footprint (7.71 acres) |
|  MHTL - JAN 19-20, 2010 |  Alternative 1A Revetment Relocation |
|  MHTL - OCT 15, 2009 |  Remnant Foredune Habitat (12.23 acres)* |
|  June 2005 Beach/Foredune Escarpment Line | Potential Impacts to Remnant Foredune Habitat** |
|  Development Footprint |  Temporary Impacts (3.17 acres) |
|  2010 Emergency Rock Revetment |  Permanent Impacts (1.63 acres) |



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

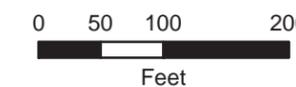
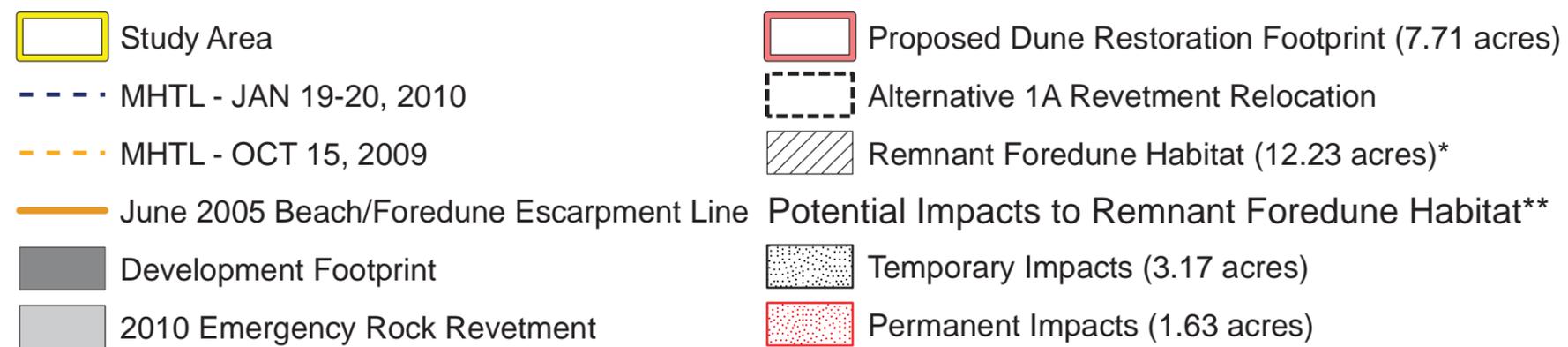
** Temporary impacts are due to revetment removal or enhancement of existing degraded foredune habitat. Permanent impacts are due to retained and relocated sections of revetment.

Broad Beach
Restoration Project

Malibu,
California

Figure 9-2b.

Potential Impacts to
Foredune Habitat
Under Alternative 1A
Relative to 2005
Baseline Conditions



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

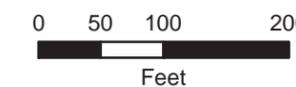
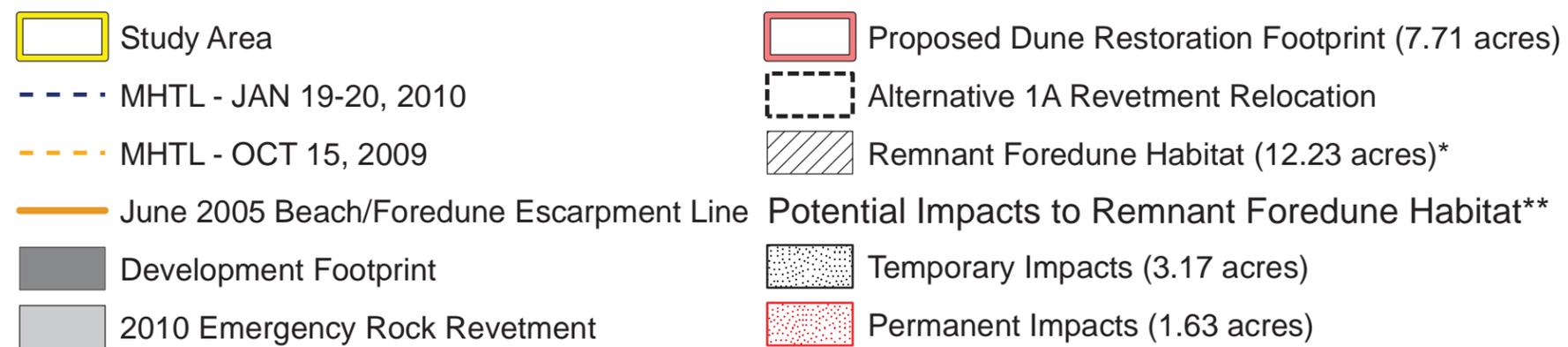
** Temporary impacts are due to revetment removal or enhancement of existing degraded foredune habitat. Permanent impacts are due to retained and relocated sections of revetment.

Broad Beach
Restoration Project

Malibu,
California

Figure 9-2c.

Potential Impacts to
Foredune Habitat
Under Alternative 1A
Relative to 2005
Baseline Conditions



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

** Temporary impacts are due to revetment removal or enhancement of existing degraded foredune habitat. Permanent impacts are due to retained and relocated sections of revetment.

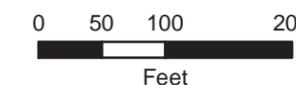
Broad Beach
Restoration Project

Malibu,
California

Figure 9-2d.

Potential Impacts to
Foredune Habitat
Under Alternative 1A
Relative to 2005
Baseline Conditions

- | | |
|---|--|
|  Study Area |  Proposed Dune Restoration Footprint (7.71 acres) |
|  MHTL - JAN 19-20, 2010 |  Alternative 1A Revetment Relocation |
|  MHTL - OCT 15, 2009 |  Remnant Foredune Habitat (12.23 acres)* |
|  June 2005 Beach/Foredune Escarpment Line | Potential Impacts to Remnant Foredune Habitat** |
|  Development Footprint |  Temporary Impacts (3.17 acres) |
|  2010 Emergency Rock Revetment |  Permanent Impacts (1.63 acres) |



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

** Temporary impacts are due to revetment removal or enhancement of existing degraded foredune habitat. Permanent impacts are due to retained and relocated sections of revetment.

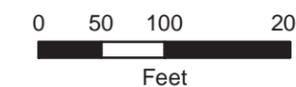
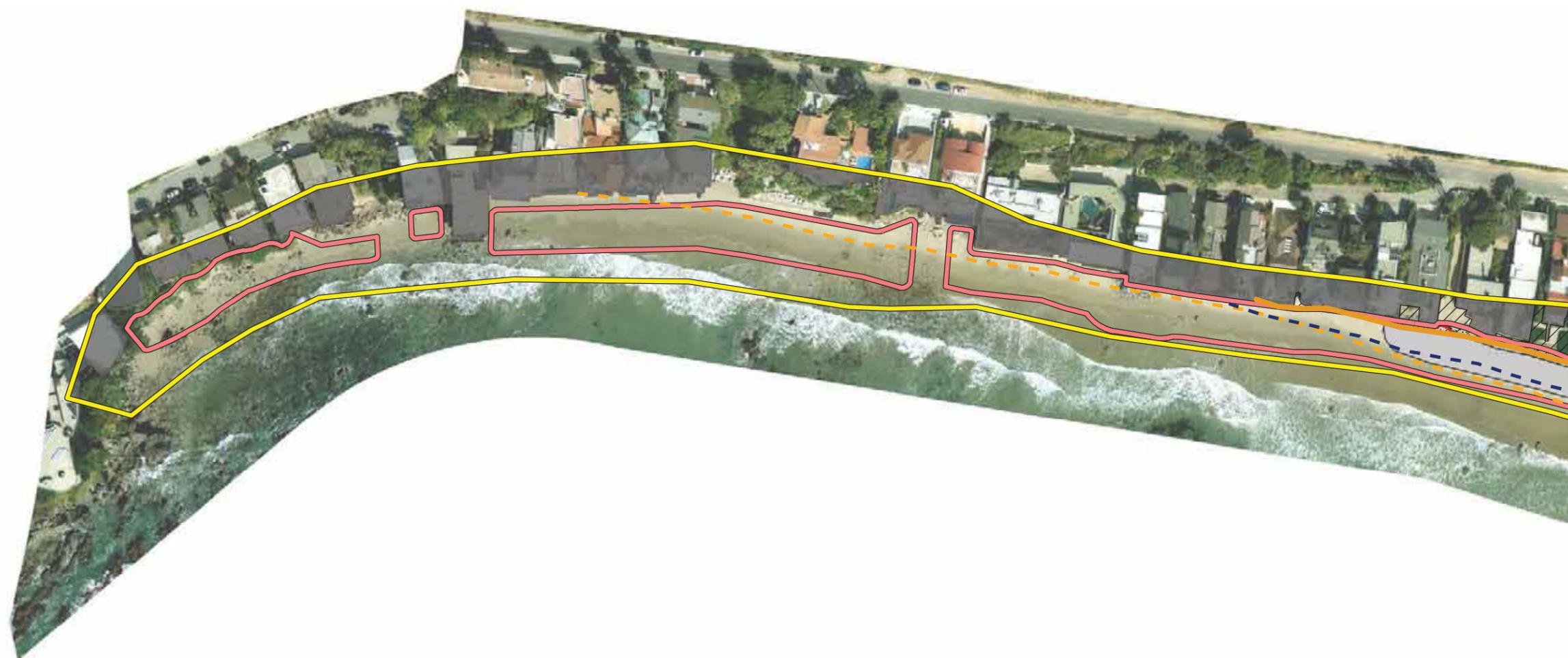
Broad Beach
Restoration Project

Malibu,
California

Figure 9-2e.

Potential Impacts to
Foredune Habitat
Under Alternative 1A
Relative to 2005
Baseline Conditions

- | | |
|--|--|
| Study Area | Proposed Dune Restoration Footprint (7.71 acres) |
| MHTL - JAN 19-20, 2010 | Alternative 1A Revetment Relocation |
| MHTL - OCT 15, 2009 | Remnant Foredune Habitat (12.23 acres)* |
| June 2005 Beach/Foredune Escarpment Line | Potential Impacts to Remnant Foredune Habitat** |
| Development Footprint | Temporary Impacts (3.17 acres) |
| 2010 Emergency Rock Revetment | Permanent Impacts (1.63 acres) |



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

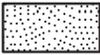
** Temporary impacts are due to revetment removal or enhancement of existing degraded foredune habitat. Permanent impacts are due to retained and relocated sections of revetment.

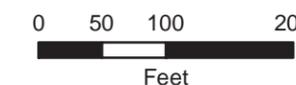
Broad Beach
Restoration Project

Malibu,
California

Figure 10-1a.

Potential Impacts to
Foredune Habitat
Under Alternative 1B
Relative to 2013
Existing Conditions

- | | |
|---|--|
|  Study Area |  Proposed Dune Restoration Footprint (7.71 acres) |
|  MHTL - JAN 19-20, 2010 |  Alternative 1B Revetment Relocation |
|  MHTL - OCT 15, 2009 |  Remnant Foredune Habitat (10.09 acres)* |
|  June 2005 Beach/Foredune Escarpment Line | Potential Impacts to Remnant Foredune Habitat** |
|  Development Footprint |  Temporary Impacts (2.14 acres) |
|  2010 Emergency Rock Revetment |  Permanent Impacts (0.86 acre) |



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

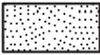
** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to relocation of revetment.

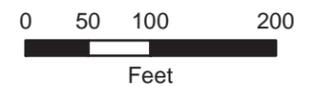
Broad Beach
Restoration Project

Malibu,
California

Figure 10-1b.

Potential Impacts to
Foredune Habitat
Under Alternative 1B
Relative to 2013
Existing Conditions

- | | |
|---|--|
|  Study Area |  Proposed Dune Restoration Footprint (7.71 acres) |
|  MHTL - JAN 19-20, 2010 |  Alternative 1B Revetment Relocation |
|  MHTL - OCT 15, 2009 |  Remnant Foredune Habitat (10.09 acres)* |
|  June 2005 Beach/Foredune Escarpment Line | Potential Impacts to Remnant Foredune Habitat** |
|  Development Footprint |  Temporary Impacts (2.14 acres) |
|  2010 Emergency Rock Revetment |  Permanent Impacts (0.86 acre) |



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

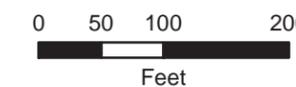
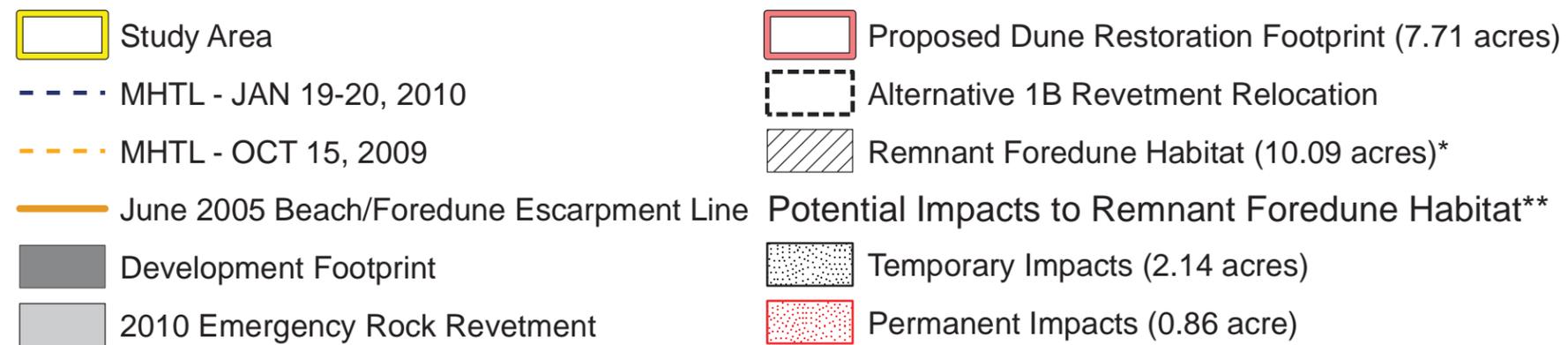
** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to relocation of revetment.

Broad Beach
Restoration Project

Malibu,
California

Figure 10-1c.

Potential Impacts to
Foredune Habitat
Under Alternative 1B
Relative to 2013
Existing Conditions



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to relocation of revetment.

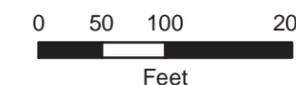
Broad Beach
Restoration Project

Malibu,
California

Figure 10-1d.

Potential Impacts to
Foredune Habitat
Under Alternative 1B
Relative to 2013
Existing Conditions

- Study Area
- MHTL - JAN 19-20, 2010
- MHTL - OCT 15, 2009
- June 2005 Beach/Foredune Escarpment Line
- Development Footprint
- 2010 Emergency Rock Revetment
- Proposed Dune Restoration Footprint (7.71 acres)
- Alternative 1B Revetment Relocation
- Remnant Foredune Habitat (10.09 acres)*
- Potential Impacts to Remnant Foredune Habitat****
- Temporary Impacts (2.14 acres)
- Permanent Impacts (0.86 acre)



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to relocation of revetment.

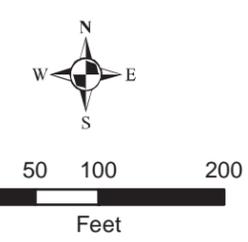
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Figure 10-1e.

Potential Impacts to
Foredune Habitat
Under Alternative 1B
Relative to 2013
Existing Conditions

- Study Area
- MHTL - JAN 19-20, 2010
- MHTL - OCT 15, 2009
- June 2005 Beach/Foredune Escarpment Line
- Development Footprint
- 2010 Emergency Rock Revetment
- Proposed Dune Restoration Footprint (7.71 acres)
- Alternative 1B Revetment Relocation
- Remnant Foredune Habitat (10.09 acres)*
- Potential Impacts to Remnant Foredune Habitat****
- Temporary Impacts (2.14 acres)
- Permanent Impacts (0.86 acre)



* Remnant foredune habitat remaining after installation of Pre-2010 Shoreline Protection Structures and 2010 Emergency Rock Revetment, including areas of pocket cove formation where revetment materials were not installed or were installed but failed.

** Temporary impacts are due to enhancement of existing degraded foredune habitat. Permanent impacts are due to relocation of revetment.

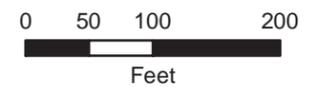
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California

Figure 10-2a.

Potential Impacts to
Foredune Habitat
Under Alternative 1B
Relative to 2005
Baseline Conditions

- Study Area
- MHTL - JAN 19-20, 2010
- MHTL - OCT 15, 2009
- June 2005 Beach/Foredune Escarpment Line
- Development Footprint
- 2010 Emergency Rock Revetment
- Proposed Dune Restoration Footprint (7.71 acres)
- Alternative 1B Revetment Relocation
- Remnant Foredune Habitat (12.23 acres)*
- Potential Impacts to Remnant Foredune Habitat****
- Temporary Impacts (2.48 acres)
- Permanent Impacts (2.50 acres)



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

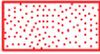
** Temporary impacts are due to revetment removal or enhancement of existing degraded foredune habitat. Permanent impacts are due to retained and relocated sections of revetment.

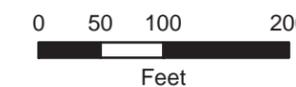
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Figure 10-2b.

Potential Impacts to
Foredune Habitat
Under Alternative 1B
Relative to 2005
Baseline Conditions

-  Study Area
-  MHTL - JAN 19-20, 2010
-  MHTL - OCT 15, 2009
-  June 2005 Beach/Foredune Escarpment Line
-  Development Footprint
-  2010 Emergency Rock Revetment
-  Proposed Dune Restoration Footprint (7.71 acres)
-  Alternative 1B Revetment Relocation
-  Remnant Foredune Habitat (12.23 acres)*
- Potential Impacts to Remnant Foredune Habitat****
-  Temporary Impacts (2.48 acres)
-  Permanent Impacts (2.50 acres)



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

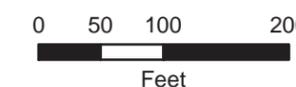
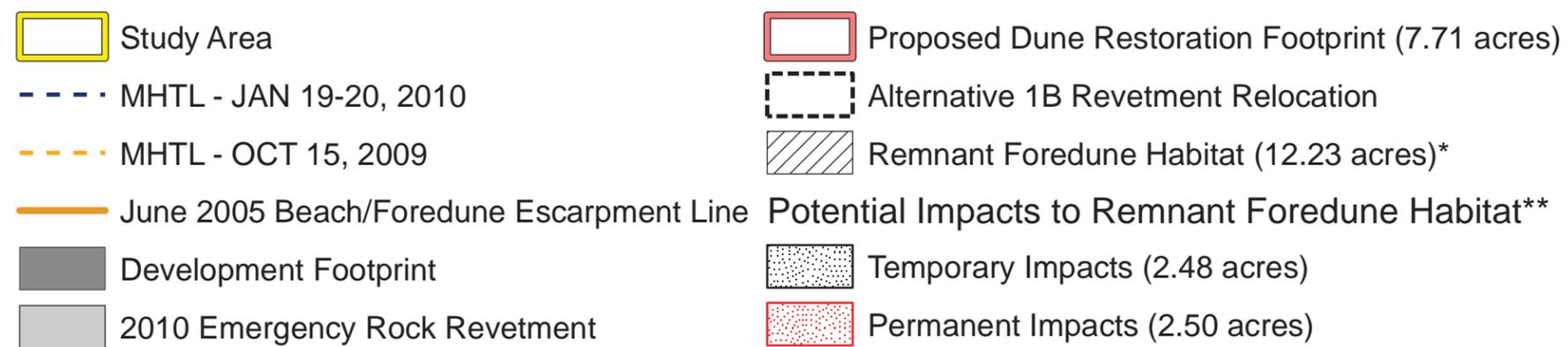
** Temporary impacts are due to revetment removal or enhancement of existing degraded foredune habitat. Permanent impacts are due to retained and relocated sections of revetment.

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Figure 10-2c.

Potential Impacts to
Foredune Habitat
Under Alternative 1B
Relative to 2005
Baseline Conditions



* Remnant foredune habitat based on 2005 foredune extent shown in Figure 2.

** Temporary impacts are due to revetment removal or enhancement of existing degraded foredune habitat. Permanent impacts are due to retained and relocated sections of revetment.