Bunbury Reef Enhancement Study:

Clam Reef and Hungry Hollow

Prepared for

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ACRONYMS AND ABBREVIATIONS

AHD	Australian Height Datum
LIDAR	light detection and ranging
GDA94	Geocentric Datum Of Australia 1994
JONSWAP	Joint North Sea Wave Project
WW3	WaveWatch III

EXECUTIVE SUMMARY

Western Australia has some of the most powerful and consistent waves in the world. These waves can cause erosion, which negatively affects communities, as well as create positive recreational benefits for surfing. The Bunbury Coast is an ideal place for reef enhancements with a suitable wave climate and the presence of multiple rocky outcroppings. Two existing reef breaks (Clam Reef and Hungry Hollow) are naturally existing reef shelves that can be enhanced to improve surf breaks, protect the beach from erosion and benefit nearshore habitat. The purpose of this study is to provide a detailed evaluation of two existing reefs (Clam Reef and Hungry Hollow) and potential reef modifications to understand how potential changes to small existing reef platforms could alter patterns of erosion, enhance reef habitat and nearshore ecology, as well as to improve recreational surf quality.

The effects of small-scale triangle shaped reef modifications at two locations on the Bunbury Coast were evaluated with detailed high-resolution, two-dimensional wave modeling. Offshore wave conditions were generated with a large-scale climate wave model, validated with observed wave conditions. These offshore conditions forced two small-scale, high-resolution wave models to characterize existing and potential changes to breaking wave characteristics and potential erosion protection with and without reef modifications at Clam Reef and Hungry Hollow. The surfability evaluation examined the wave peel angle, length of ride and breaking wave speed using a non-hydrostatic (individual wave resolving) model that simulated individual wave propagation, refraction, and breaking. Erosion potential was evaluated by comparing changes in the location and magnitude of wave energy dissipation with and without reef modifications using a wave model that evaluated both wave breaking and wave run-up. Model runs considered changes to erosion potential and surf quality for typical small conditions (1.25m waves), swell conditions (2.0m waves), and extreme storm conditions (3.5m waves).

Erosion results demonstrate that reef modifications at both Clam Reef and Hungry Hollow reduced sediment erosion potential by causing the waves to break farther offshore thus moving the location of peak wave energy dissipation further offshore. This reduced the wave energy at the shoreline behind the reef, reducing the potential for local erosion. The reef modifications had limited impact on erosion reduction and transport patterns along the shore beyond about 75 meters of the reef in either direction.

Recreationally, the reef modifications enhanced wave surfability by increasing the angle of the breaking waves (peel angle increased) and reducing the speed that it breaks for most of the wave conditions considered. The peak potential wave peel angle based on the reef modification geometry was approximately 45 degrees for a waves approaching the coast from a due west direction. The predicted breaking angles from the high resolution wave modeling indicate that reef modifications can increase the breaking wave angles by up to 10 degrees under typical wave conditions. The high resolution wave modeling results indicate that the reef

modifications will enhance surfability at both Clam Reef and Hungry Hollow. Overall, the high-resolution wave modeling suggests that Clam Reef and Hungry Hollow would be ideal sites for multi-purpose artificial reef enhancements.

In summary, results of this artificial reef study showed three key findings for both reefs with slight differences. Modeling results for both artificial reefs show:

1. **Improved wave energy dissipation inside the reef during large erosive swell events indicating they would be effective at reducing erosion;**
2. **Improved surfability by changing the angle of the breaking waves (peel angle);**
3. **Expanded and longer offshore reef slopes that likely expand fish habitat.**