EXECUTIVE SUMMARY

Project Title

The project title is Supplementary Environmental Impact Assessment (EIA) for Sand Supply and Delivery for 'Bangunan Peranginan' Water Chalet and Service Suite Project on Government Lot of 43.1 acres, Pekan Sungai Manyala, Port Dickson, Negeri Sembilan Darul Khusus". This Supplementary EIA report was prepared to assess the potential impacts of bringing in the sand by sea on the marine environment as well as to recommend mitigation measures to minimize these impacts.

Project Proponent

The project is to be implemented by:

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Environmental Consultant

Environmental consultants involved in the project are as follows.

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Background

The project proponent intends to construct the Hibiscus Water Homes on the foreshore area off Pantai Dickson, Port Dickson, Negeri Sembilan. The area to be reclaimed is 5.6 acres (2.3 ha) and the volume of sand required is 100,000 cubic meters. In this connection, the Department of Environment originally stipulated that all fill materials for the reclamation should consist of marine sand and would need to be transported by land. However, the project proponent suggested carrying out the reclamation works from sea by way of barge.

Existing Environment

The project area is located within the Fisheries Protected Area (Tanjung Tuan to Pulau Perjudi) declared under Section 65 of the Fisheries Act 1985 (Amended 1991). The foreshore area that is to be reclaimed consists largely of sand intersperses with muddy sand and currently enclosed with a rock revetment, internally lined with geomembrane.

A total of 10 species of hard coral, 16 species of gorgonians (sea whips and sea fan) and four (4) species of soft coral were recorded at Zone 1 (Tg. Tuan), Zone 2 (Tg. Gemuk to Teluk Pelanduk) and Zone 3 (Pulau Perjudi). The highest number of species was recorded at Zone 1 (51 species), followed by Zone 2 (42 species) and Zone 3 (28 species). Gorgonian was found extensively inhabited the study area.

Coral reefs also support a diverse range of fish fauna, where a total of 15 fish species belonging to nine (9) families were recorded. The highest species diversity recorded at Zone 1, followed by Zone 3 and Zone 2. The most common species of fish found include *Chromis* sp., *Neopomacentrus* sp., *Neopomacentrus azysron* and *Istigobius decoratus*.

A total of eight (8) groups of invertebrates were recorded, namely Sponges, Crinoids, Bryozoans, Hydroids, Mollusk, Arthropods, Sea Pen and Ascidians. These groups consisted of more than 20 species. Zone 1 was the most diverse, which represented by more than 15 species, while Zone 2 and Zone 3 was only comprised by more than 10 species each. Among the invertebrate species recorded were *Cenometra* sp., *Callyspongia* sp., *Oligometra* sp., *Lamprometra* sp. and *Triphyllozoon* sp.

The seagrass patch i.e. Tropical eelgrass (*Enhalus acoroides*) and Dugong grass (*Thalassia hemprichii*) was reported from Teluk Pelanduk and Pantai Dickson. Moreover, seaweed also was found in Tg. Tuan, Teluk Pelanduk and Pantai Dickson. A total of 19 species was identified, where seven (7) species from Rhodophyta, seven (7) species from Chlorophyta and five (5) species from Phaeophyta. The major species found were *Padina australis* and *Sargassum* sp. Pantai Dickson was recorded highest number of seaweed species (14 species), followed by Tg. Tuan (10 species) and Teluk Pelanduk (6 species).

Fishermen from Teluk Pelanduk reported that Spinner dolphin (*Stenella longirostris*) and Indo-Pacific Humpback dolphin (*Sausa chinensis*) commonly sighthed off Pulau Perjudi and Tg. Tuan. Furthermore, they also stated that the Hawksbill Turtle (*Eretmochelys imbricata*) or locally known as '*penyu karah/sisek*' commonly observed off Tg. Tuan area.

There were two (2) fish landing points located within the impact zone include Teluk Pelanduk and Pantai Cermin. A total of 26 fishermen operated from Teluk Pelanduk, while Pantai Cermin only recorded a total of seven (7) fishermen. There were a total of 26 units of vessels at these landing points. Out of 26 units, only one (1) was inboard vessel, while the rest was outboard vessels. The main fishing gears used was drift nets, portable traps, longlines and hooks and lines. Most fishing activity was conducted off Tg. Tuan Prohibited Fishing Area (approximately 2km from shoreline) up to the Indonesian border.

Sand Supply and Delivery Mechanism

The construction of proposed Hibiscus Water Homes would involve the supplying and delivery of sand to the work site from a vessel. The supply and delivery of the marine sand will be undertaken by Extrarich Marine Sdn. Bhd., which owns the concession to the sand source and also obtained permission to supply sand to the construction sites by sea from Marine Department Malaysia. The sand source is a marine sand deposit located off Sg. Udang, Melaka.

Three (3) options were available for sand supply and delivery to the work site. For Option 1, the sand will be transported by Trailing Suction Hopper Dredgers (TSHD) or Tug Boat and Dumb Barge (TBDB).

The TSHD or TBDB will berth near the armour rock revetment and sand will be pumped directly into the deposition area using the "rainbow method". The rainbow method involved the pumping of the wet sand directly onto the site from the barge using a vacuum sand pump. There is no slurry or excess water, however sand will have to be moist to enable rainbowing to be carried out.

Option 2 would involve the delivery of dry sand up to the revetment using TBDB. The sand will then be delivered to the site using a conveyor belt.

As for Option 3, TSHD or TBDB will be parked at the designated ship parking area (located 1nm opposite the project area) and the sand will be pumped through fixed submerged HDPE/reinforced fibre pipeline (14 inch diameter) and there will be no slurry i.e. only wet sand as the distance is short and the volume of sand is small.

Two (2) types of vessels will be employed i.e. tug boats and dumb barge. It is estimated that the sand supplying and delivery of 100,000 m^3 will be complete within ten (10) days with two (2) barges make two trips daily.

The actual route of the TSHD or TBDB would depend on the supply mechanism employed and would need to be endorsed by the Marine Department. It would need to take into account the water depth, underwater sand banks, rocks and coral reef areas at the project site. The barge will also need to adhere strictly to the route.

Potential Impact Analysis

The various activities associated with the operation of the proposed sand supply and delivery can potentially bring about environmental impacts on different aspects of the marine environment particularly on water quality and consequently on the immediate coastal environment. However, it is important to note that the impacts described below are considered very short term since the sand supply and delivery operations were expected to be completed within ten (10) days. The common and option-specific impacts identified are as follows.

Common Impacts

The three (3) options outlined for the sand supply and delivery would have an impact on the marine environment particularly on water quality due to increased suspended solids arising from the pipeline installation, movement of barges, accidental spillage and leakage during sand pumping.

The movements and pipeline installation would also lead to the release of biogenic and chemogenic products as well metal ions into the water columns. The release of biogenic and chemogenic products to the water column will exert an immediate oxygen demand and has the potential to cause serious short-term damage to the marine ecosystem. Disturbance of the sediments can also release metal ions to the water column.

High suspended sediments in the water (>80mg/L) known to have an impact to the aquatic organisms since increase of suspended solids would reduce dissolved oxygen concentrations. Furthermore, sedimentation is a major factor mediating the death of corals and invertebrates.

The barge movements and pipeline installation works could also affect the marine productivity. High level of turbidity (particularly suspended soilds) in the water can retard primary production, while high levels of silt can abrade and clog fish gills causing severe hemorrhaging, osmotic imbalance and respiratory difficulties. As consequences, food-web in the area was disrupted and causing imbalance to the aquatic communities.

The pipeline installation would directly affect benthic communities through burial and disruption of the benthos. Crustaceans such as shrimps and molluscs (gastropod and bivalves), which have limited mobility would be seriously affected due to resuspension of sediments. This in turn, would reduce the abundance these organisms. However, the footprint of the pipeline can be considered small and loss of the benthic communities along the pipeline route is minimal.

As for coral reef, increased suspended solids from the pipeline installation will result in sedimentation on the coral surface, which consequently leads to recolonization and mortality. Besides that, barges movement can also destroy the coral reefs, if not carefully planned, since the corals area have shallow water depth.

High level of sedimentations generated from barge movement and installation of pipeline activities could reduce light penetration that seagrass needs for photosynthesis process. On the other hand, seaweeds could survive under the condition of heavy sedimentation. Seaweed is an opportunistic beneficiary of the detrimental effects of sediments on other organisms such as corals and herbivorous fishes. This situation could lead to the imbalance of diversity in the area.

There is potential for marine mammals and turtles disturbed by noise and vibration resulted from pipeline installation, sand pumping activities (machinery noises) and tug boat movement (engine noises). High underwater noise levels can affect in injury and changes of behavior criteria in marine mammals and severe sound waves can induce stress and may cause abandonment of habitats such as nursery and calving sites. As for turtles, a major impact would be the work lighting. Adult turtles, specifically nesting females, for instance, avoid light and the presence of lights can affect foraging behaviour.

Impact on the fish landing is predicted as negligible since the study is a Fisheries Prohibited Area where fishing is prohibited. However, the movement of the barges will interfere with fishing route from the Pantai Cermin fish landing points. Further, recreational fishing are carried out from Teluk Pelanduk and, as fishing boats, the disruption to their movements can be problematical. There will be no impact on aquaculture since there are no such activities undertaken in the vicinity of the project area.

There is potential for discharge from worker's toilets and solid wastes such as floatables from the vessel. Plastic bags, in particular, are a major source of concern where turtles are concerned.

Option 1 and 2

Among the major impacts identified for Option 1 and 2 are as follows:

a. Resuspension of sediment due to propeller wash

THSD or TBDB propellers can disturb the sea bottom directly, or indirectly through the wash or turbulence produced, especially in shallow waters. This can cause sediments to be resuspended, hence, increase the turbidity level in the water column.

b. Shoreline erosion due to vessel wash

The movement of THSD or TBDB can potentially affect the coastline through the generation of waves. The waves created by THSD or TBDB may contribute to shoreline erosion.

However, the magnitude of the waves generated by the THSD and TBDB are related to the speed of the vessel, the size and displacement of the vessel and the distance between the vessel and the coastline.

c. Damage to the marine habitats

The THSD or TBDB could cause extensive environmental degradation by grounding especially during low tide or physically strike or hit the coral reef areas. In addition, the barge anchors have direct physical impact on the seabed communities and marine habitats when anchors are dragged along the seabed uprooting the seagrass beds and destroying the coral reefs. Further, the fixed mooring chains can also scour an area of seabed around the mooring (including anchors and floats).

Option 3

The option-specific impact for the 3rd Option would be pipeline breach i.e. leakage or burst. This impact is considered far more severe as compared to the above and presents serious environmental risks. The pipeline is expected to be buried under seabed bottom and therefore any leakage even minor is difficult to monitor and manage.

Mitigation Measures

Given the scenario above, it appears that the proposed project would potentially have a significant degree of impact on the environment. The general and option-specific mitigation measures identified are as follows.

General

- The rock revetment at the reclamation area must be lined within by geomembrane to prevent any leakage of sediment from the filled area.
- The reclaimed area must be surrounded by silt-curtains till the revetment is completed and determined to be safe from an environmental standpoint.
- The machinery associated with sand pumping activities must be inspect and maintain properly to avoid any spillage and leakage during the sand pumping process.

Option 1 and 2:

- Barge and tug boat movements must be limited within specific channels. Barges cannot be allowed freedom of movement within the project area.
- Barges and tug boats movement routes must have a buffer zone of at least 500 m for the corals and other marine habitats.
- Barges must operate during daylight hours only.

- The areas within which a barge is working must be confined within double layer silt-curtain/ floating silt trap with a length of at least 650m.
- The barge must only supply sand during high tide and a minimum of 2m under vessel clearance maintained at all times.
- No sewage, wastewater, bilge oil or any other oil discharge is permitted during the supply and delivery of the sand
- The vessel speed within the project area should not exceed 4 knots.
- All channels should be clearly marked by buoys to ensure that there is no conflict with fishing boat traffic
- In terms of the fishing route, consultation with all relevant fishery organizations should take place at an early stage.
- On-board toilets should not be used during barge movements and sand delivery.
- No disposal of solid wastes from the vessel should be allowed.

Option 3: Sand Pumped through Fixed Pipeline from the Barge

- Barge and tug boat movements must be limited within the anchorage area.
- The pipeline alignment routes must be such that there is a buffer zone of at least 500m for the corals and other marine habitats.
- The pipeline should be laid in an area where the character of the seafloor will allow it to sink into the sediments (self-burial) at best.
- The installation of pipeline should be carried out carefully to minimize the suspended solid arising from the installation works.
- It is recommended that the pipeline be abandoned after the operation since the removal of pipeline will again deteriorate the water quality.

Environmental Monitoring Programme

The main environmental element that would be affected due to sand supply and delivery activity to the project site would be water quality of the immediate environment. The water quality monitoring (both *in situ* and *ex situ*) should be undertaken before, at the end and after the sand is delivered to the project site. Sampling points would need to be located along the barge or pipeline route. Sampling points would need to be located at the reclamation site as well as along the barge or pipeline route.

There would be at least four (4) sampling points for Option 1 and 2 and five (5) sampling point for Option 3. The water quality parameters to be tested are pH, dissolved oxygen, temperature, salinity, turbidity, total suspended solids and oil and grease. The monitoring reports are to be submitted to the Department of Environment, Negeri Sembilan periodically. In addition, the role of the Environmental Officer should include monitoring the movement of all barges and pipeline installation activity to ensure compliance to the requirements relating to the time, tide and interferences to fishing boat traffic.

Residual Impact

The proposed mitigation and abatement measures as outlined above, if carried as recommended, would have little or no way of long-term residual impacts to the surrounding environment.

Summary and Conclusion

The three (3) options outlined for the sand supply and delivery could have an impact on the marine environment particularly on water quality due to increased suspended solids. However, review of the three (3) options suggest that Option 2 (supply of dry sand by barge and delivery by conveyer belt) has the least impact and is the most easily mitigated. The environmental impacts that have been predicted are short term and would not appreciably affect the marine environment if the proposed mitigation and abatement measures outlined in the report are carried out as recommended. Therefore, no long-term residual impact to the surrounding environment is likely.

RINGKASAN EKSEKUTIF

Tajuk Projek

Tajuk projek adalah Tambahan Penilaian Kesan Alam Sekitar (EIA) bagi Pembekalan dan Penghantaran Pasir untuk Projek 'Bangunan Peranginan 'Chalet atas Air dan Suite Servis' di atas Lot Tanah Kerajaan seluas 43,1 ekar, Pekan Sungai Manyala, Port Dickson, Negeri Sembilan Darul Khusus". Laporan Tambahan EIA disediakan untuk menilai impak pembekalan pasir melalui jalan laut yang berkemungkinan memberi kesan ke atas persekitaran marin serta menberi cadangan langkah-langkah penebatan untuk meminimumkan kesan impak negatif.

Pemilik Projek

Projek ini akan dilaksanakan oleh:

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Orang yang dihubungi:		En. Wong Fok Ten

Perunding Alam Sekitar

Perunding alam sekitar yang terlibat dalam projek ini adalah seperti berikut:

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Latar Belakang Projek

Pemilik projek bercadang untuk membina 'Hibiscus Water Homes' di kawasan pesisir pantai di Pantai Dickson, Port Dickson, Negeri Sembilan. Penebusgunaan tanah meliputi kawasan seluas 5.6 ekar (2.3 hektar) dan jumlah isipadu pasir yang diperlukan adalah 100,000 meter persegi. Oleh itu, Jabatan Alam Sekitar pada asalnya telah mensyaratkan bahawa bahan penimbus yang digunakan untuk kerja-kerja penebusgunaan haruslah terdiri daripada pasir laut dan perlu dibawa melalui jalan darat. Walau bagaimanapun, pemilik projek telah mencadangkan kerja-kerja penebusgunaan tersebut dijalankan melalui laut dengan menggunakan barj.

Keadaan Alam Sekitar Sedia Ada

Projek yang dicadangkan berada di dalam Kawasan Perlindingan Perikanan (Tanjung Tuan - Pulau Perjudi) yang diisytiharkan di bawah Seksyen 65 Akta Perikanan 1985 (Pindaan 1991). Sebahagian besar kawasan pesisir pantai yang akan ditambak merupakan jenis sedimen pasir berlumpur dan pada masa ini, kawasan tersebut telah dilingkungi dengan batu dan dasarnya dijajar daripada geomembran.

Bagi terumbu karang, sebanyak 10 spesies 'hard coral', 16 spesies 'gorgonians' dan empat (4) spesies 'soft coral' dijumpai di Zon 1 (Tg. Tuan), Zon 2 (Tg.Gemuk - Teluk Pelanduk) dan Zon 3 (Pulau Perjudi). Jumlah spesies yang terbanyak djumpai di Zon 1 (51 spesies), diikuti oleh Zon 2 (42 spesies) dan Zon 3 (28 spesies). 'Gorgonians' adalah kumpulan yang paling banyak direkodkan di kawasan kajian.

Terumbu karang juga menjadi habitat bagi pelbagai jenis ikan, di mana sebanyak 15 spesies ikan daripada sembilan (9) 'Family' telah direkodkan. Kepelbagaian spesies yang tinggi dicatatkan di Zon 1, diikuti oleh Zon 3 dan Zon 2. Spesies ikan yang biasa dijumpai di kawasan kajian adalah *Chromis* sp., *Neopomacentrus* sp., *Neopomacentrus azysron* dan *Istigobius decoratus*.

Sebanyak lapan (8) kumpulan invertebrata dijumpai, iaitu 'Sponges', 'Crinoids', 'Bryozoans', 'Hydroids', Molluska, Arthropoda, 'Sea Pen' dan 'Ascidians'. Kumpulan - kumpulan ini mempunyai lebih daripada 20 spesies. Zon 1 mencatatkan bilangan spesies yang terbanyak (lebih daripada 15 spesies), manakala Zon 2 dan Zon 3 hanya merekodkan lebih daripada 10 spesies setiap satu. Antara spesies invertebrata yang dijumpai ialah *Cenometra* sp., *Callyspongia* sp., *Oligometra* sp., *Lamprometra* sp. dan *Triphyllozoon* sp.

Rumput laut iaitu *Enhalus acoroides* dan *Thalassia hemprichii* telah direkodkan di Teluk Pelanduk dan Pantai Dickson. Selain itu, rumpai laut juga telah dijumpai di Tg. Tuan, Teluk Pelanduk dan Pantai Dickson. Sejumlah 19 spesies telah dikenalpasti, di mana tujuh (7) spesies dari Rhodophyta, tujuh (7) spesies daripada Chlorophyta dan lima (5) spesies daripada Phaeophyta. Spesies utama di kawasan kajian ialah *Padina australis* dan *Sargassum* sp. Pantai Dickson telah mencatatkan jumlah spesies rumpai laut yang tertinggi (14 spesies), diikuti oleh Tg. Tuan (10 spesies) dan Teluk Pelanduk (6 spesies).

Nelayan Teluk Pelanduk melaporkan bahawa spesies ikan lumba – lumba i.e. *Stenella longirostris* dan *Sausa chinensis* kebiasaannya dilihat di kawasan sekitar Pulau Perjudi dan Tg. Tuan. Tambahan pula, penyu karah/sisek *(Eretmochelys imbricata*) juga sering diperhatikan di kawasan Tg. Tuan.

Terdapat dua (2) kawasan pendaratan ikan yang terletak di dalam zon impak projeck iaitu Teluk Pelanduk dan Pantai Cermin. Sebanyak 26 nelayan beroperasi dari Teluk Pelanduk, manakala Pantai Cermin hanya mencatatkan tujuh (7) nelayan sahaja. Terdapat sejumlah 26 unit bot di Teluk Pelanduk dan Pantai Cermin, Daripada jumpah tersebut hanya satu (1) bot merupakan bot berenjin dalam, manakala selebihnya adalah enjin sangkut. Peralatan menangkap ikan yang digunakan ialah pukat hanyut, bubu, rawai dan pancing. Kebiasannya nelayan menjalankan aktiviti penangkapan ikan kira – kira 2km dari Kawasan Perlindingan Perikanan (Tg. Tuan) sehingga ke sempadan Indonesia.

Mekanisma Pembekalan dan Penghantaran Pasir

Kerja-kerja penebusgunaan bagi pembinaan projek melibatkan pembekalan dan penghantaran pasir ke tapak kerja manggunakan kapal. Extrarich Marine Sdn. Bhd, akan bertanggungjawab membekal dan menghantar pasir laut ke tapak projek. Syarikat tersebut merupakan pemilik konsesi sumber pasir dan juga telah mendapatkan kebenaran daripada Jabatan Laut untuk membekal pasir laut ke tapak projek. Sumber pasir yang digunakan adalah pasir laut daripada perairan Sg. Udang, Melaka.

Terdapat tiga (3) opsyen pembekalan dan penghantaran pasir ke tapak projek. Untuk mekanisma 1, pasir akan diangkut oleh 'Trailing Suction Hopper Dredgers' (TSHD) atau 'Tug Boat' dan 'Barge Dumb' (TBDB).

TSHD atau TBDB akan berlabuh berhampiran kawasan lapis lindung batu dan pasir akan dipam terus ke kawasan projek menggunakan kaedah 'rainbow'. Kaedah ini membabitkan pengepaman pasir basah daripada barj terus ke tapak penebusgunaan tanah dengan menggunakan pam vakum. Kaedah ini tidak melibatkan sebarang pelimpahan air, akan tetapi pasir perlu berada dalam keadan lembap agar kaedah 'rainbow' dapat dijalankan.

Untuk opsyen 2, ia akan melibatkan pembekalan pasir kering ke kawasan yang dilingkungi dengan batu oleh TBDB. Pasir tersebut akan diangkut ke tapak penebusguna tanah dengan menggunakan tali konveyor.

Untuk opsyen 3, TSHD atau TBDB akan berada di kawasan tempat letak kapal yang ditetapkan (1 batu notika bertentangan tapak projek) dan pasir akan dipam melalui saluran paip bertetulang gentian/HDPE (14 inchi sengkang) tetap yang tenggelam. Ia juga tidak melibatkan sebarang pelimpahan air iaitu hanya pasir kering sebab jaraknya adalah pendek dan isipadu pasir yang diperlukan adalah sedikit.

Dua (2) jenis kapal akan digunakan iaitu 'tug boat' and 'dumb' barj. Dianggarkan bahawa pembekalan dan penghantaran pasir sebanyak 100,000 m^3 akan siap dalam tempoh sepuluh (10) hari dengan dua (2) barj membuat dua perjalanan setiap hari.

Perjalanan sebenar TSHD atau TBDB adalah bergantung kepada mekanisma penghantaran pasir and ia perlu mendapatkan kebenaran daripada Jabatan Laut. Ia perlu mengambil perhatian perkara-perkara seperti kedalaman air, beteng pasir, batu dan terumbu karang di kawasan tapak projek. Barj perlulah mematuhi sepenuhnya laluan yang ditetapkan itu.

Analisis Potensi Impak

Pelbagai aktiviti berkaitan dengan operasi pembekalan dan penghantaran pasir akan memberi kesan terhadap kualiti air yang seterusnya juga memberi impak kepada persekitaran pantai. Walau bagaimanapun, adalah penting dinyatakan bahawa impak yang diketengahkan di bawah dianggap amat jangka pendek oleh kerana operasi penghantaran pasir dapat disempurnakan dalam masa sepuluh (10) hari. Berikut adalah impak am dan spesifik yang telah dikenalpasti.

Impak Am

Tiga (3) opsyen yang diutarakan untuk operasi pembekalan dan penghantaran pasir akan akan memberi kesan kepada persekitaran marin terutamanya kepada kualiti air melalui peningkatan jumlah pepejal terampai akibat daripada kerja-kerja pemasangan paip, pergerakan barj, pertumpahan pasir dan kebocoran semana pengepaman pasir.

Selain itu, pergerakan barj dan pemasangan paip juga akan menyumbang produk 'biogenic' dan 'chemogenic' termasuk ion logam ke dalam air. Produk 'biogenic' dan 'chemogenic' yang wujud di dalam air akan menyebabkan peningkatan permintaan oksigen yang mendadak dan ianya berupaya untuk memberi kesan jangka pendek yang serius kepada ekosistem marin. Gangguan kepada mendapan juga boleh melepaskan ion - ion logam terus ke dalam air.

Jumlah pepejal terampai yang tinggi di dalam air (>80mg/L) boleh meberi kesan kepada organisma akuatik kerana peningkatan jumlah pepejal terampai akan mengurangkan kepekatan oksigen terlarut. Selain itu, pemendapan juga merupakan faktor utama yang menyebabkan kematian batu karang dan haiwan invertebrata. Pergerakan barj dan kerja - kerja pemasangan paip boleh menjejaskan produktiviti marin.

Tahap kekeruhan yang tinggi di dalam air boleh melambatkan pertumbuhan pengeluar primer, manakala tahap kelodak yang tinggi boleh menyebabkan insang ikan tersumbat dan seterusnya mengakibatkan pendarahan teruk, ketidakseimbangan osmotik dan kesukaran untuk bernafas. Oleh itu, sistem rantaian makanan di kawasan tersebut akan terganggu dan komuniti akuatik menjadi tidak seimbang.

Aktiviti pemasangan paip akan memberi kesan secara langsung kepada komuniti bentik melalui penguburan dan ganguan. Krustasia seperti udang dan moluska (gastropoda dan bivalvia), yang mempunyai pergerakan yang terhad akan terjejas kerana 'resuspension' sedimen. Ini seterusnya akan menyebabkan jumlah organisma bentik berkurangan. Walau bagaimanapun, tapak kawasan paip adalah agak kecil dan kehilangan komuniti bentik di sepanjang laluan paip adalah minima.

Peningkatan pepejal terampai hasil daripada pemasangan paip akan menyebabkan pemendapan berlaku pada permukaan terumbu karang, yang seterusnya membawa kepada 'recolonization' dan kematian. Selain itu, pergerakan barj juga boleh memusnahkan terumbu karang, jika tidak dirancang dengan teliti, kerana kawasan batu karang tersebut mempunyai kedalaman air yang cetek.

Jumlah mendapan yang tinggi akibat aktiviti pergerakan barj dan pemasangan paip boleh mengurangkan penembusan cahaya yang diperlukan oleh rumput laut untuk proses fotosintesis. Sebaliknya bagi rumpai laut, ia boleh hidup di dalam keadaan mendapan yang tinggi. Rumpai laut merupakan 'opportunistic beneficiary', di mana ia boleh menerima kesan negatif pada organisma lain (batu karang, ikan herbivor) akibat sedimen yang tinggi. Keadaan ini boleh membawa kepada ketidakseimbangan ekosistem di kawasan itu.

Terdapat potensi bagi mamalia dan penyu marin diganggu oleh bunyi bising dan getaran akibat daripada aktiviti pemasangan paip, pengepaman pasir (bunyi mesin) dan pergerakan bot tunda (bunyi enjin). Tahap bunyi bising di bawah air yang tinggi boleh menyebabkan kecederaan dan perubahan tingkah laku pada mamalia marin dan getaran bunyi yang amat kuat boleh mendatangkan tekanan yang boleh mengakibatkan ketinnggalan tempat nurseri. Bagi penyu, cahaya daripada barj juga menberi kesan terutamanya kepada penyu betina dewasa yang bertelur. Ia akan mengelak kawasan terang dan cahaya yang disediakan di kawasan kerja pada waktu malam boleh menjejaskan tingkah laku penyu untuk mencari makanan.

Kesan tidak signifikan diramalkan untuk perikanan kerana aktiviti penangkapan ikan adalah dilarang dalam Kawasan Perlindungan Perikanan. Walau bagaimanapun, pergerakan barj berkemungkinan mengganggu laluan bot nelayan dari Pantai Cermin. Di sampling itu, perikanan rekreasi dijalankan di Teluk Pelanduk dan sebagai bot nelayan pergerakan bot tersebut juga akan terjejas. Tiada impak dijangkakan kepada akuakultur kerana tiada aktiviti tersebut di kawasan tapak prejek.

Di samping itu, bahan kumbahan daripada tandas pekerja dan sisa pepejal daripada kapal juga boleh memberi kesan kepada persekitaran marin terutamanya plastik bag dan kesannya terhadap penyu.

Opsyen 1 dan 2

Impak utama yang diramalkan untuk Opysen 1 dan 2 adalah seperti berikut:

a. 'Resuspension' sedimen akibat daripada pergolakan kipas ('propeller wash')

Kipas TSHD atau TBDB boleh merosakan dasar laut secara langsung atau tidak langsung melalui pergolakan yang dihasilkan terutamanya di kawasan cetek. Keadaan ini akan meningkatkan tahap kekeruhan air akibat daripada ganguan terhadap mendapan sedimen.

b. Hakisan pesisiran pantai akibat daripada pergerakan barj ('vessel wash')

Pergerakan TSHD atau TBDB berpotensi untuk memberi kesan kepada persisiran pantai akibat daripada janaan ombak yang dapat menghakis pantai. Walau bagaimanapun, jarak penjanaan ombak oleh TSHD atau TBDB adalah bergantung kepada kelajuan kapal, size dan berat kapal serta jarak kapal dengan pesisiran pantai.

c. Kerosakan kepada habitat marin

TSHD atau TBDB boleh membawa kepada kemorosotan alam sekitar yang besar akibat daripada keterdamparan barj terutamanya pada masa air surut atau perlanggaran dengan terumbu karang. Di sampling itu juga, pengheretan sauh barj di sepanjang dasar laut akan menbantun rumpai laut dan membinasa terumbu karang serta merosakkan komuniti organisma yang hidup di dasar laut dan habitat marin yang lain. Rantai tambatan kekal juga boleh merosakan kawasan dasar laut disekeliling kawasan tambatan tersebut (termasuk suah dan boya).

Opsyen 3

Impak yang diramaklan untuk opsyen ketiga adalah kebocoran atau pecahan kepada paip. Impak ini dianggap jauh lebih mudarat daripada impak di atas dan berisiko serius terhadap alam sekitar. Paip tersebut dijangka akan tertimbus di dasar laut dan jikalau terdapat sebarang kebocoroan walaupun minor ia sukar untuk dipantau dan dikawal.

Langkah – Langkah Penebatan

Berdasarkan senario di atas, ternyata bahawa projek yang dicadangkan berpotensi mempunyai kesan signifikan ke atas alam sekitar. Oleh itu, beberapa langkah-langkah penebatan telah dikenal pasti secara am dan spesifik.

Langkah Penebatan Am

- Batu 'revetment' di kawasan tapak penebusgunaan tanah harus dijajar dengan geomembran untuk mengelak sebarang kebocoran sedimen daripada kawasan tersebut.
- Kawasan tapak penebusgunaan tanah harus dirangkumi dengan struktur perangkap sedimen sehingga 'revetment' telah dibina sepenuhnya dan selamat dari sudut pandangan alam sekitar.
- Bagi mesin yang digunakan dalam aktiviti pembekalan dan penghantaran pasir, ia mesti diperiksa dengan kerap bagi mengelakkan sebarang kebocoran serta meminimumkan bunyi dan getaran.

Langkah Penebatan Spesifik untuk Opsyen 1 dan 2

- Barj mestilah berada dalam kawasan yang ditetapkan dan tidak dibenarkan untuk bergerak secara bebas di kawasan tapak projek.
- Perjalanan barj mesti mempunyai zon 'buffer' sekurang-kuranhya 500 m daripada kawasan terumbu karang dan habitat marin.
- Barj mesti beroperasi pada waktu terang sahaja.
- Kawasan tempat kerja barj perlu disepit dengan struktur perangkap sedimen yang menpunyai panjang sekurang-kurangya 650m.
- Barj hanya dibenarkan untuk membekal pasir semasa air pasang sahaja dan "vessel under clearance" sebanyak 2m (minima) perlu dijaga sepanjang masa.
- Tiada pembuangan kumbahan, kekotoran, minyak ruang kapal dan nyahcas sebarang minyak dibenarkan semasa pembekalan dan penghantaran pasir.
- Kelajuan barj di kawasan tapak projek harus tidak melebihi 4 knot.
- Semua laluan atau saluran harus diletakkan pelampung bagi mengelakkan konflik lalu lintas dengan bot nelayan.

- Bagi perjalanan kapal nelayan, perundingan dengan semua agensi perikanan yang releven perlu dijalankan lebih awal
- Tandas di atas barj tidak harus digunakan semasa pergerakan barj dan penghantaran pasir.
- Pembuangan sisa pepejal daripada barj adalah tidak dibenarkan.

Langkah Penebatan Spesifik untuk Opsyen 3

- Pergerakan barj mestilah terhad di kasawan yang ia dilabuhkan sahaja.
- Kawasan perjalanan paip mesti mempunyai zon 'buffer' sekurang-kuranhya 500 m daripada kawasan terumbu karang dan habitat marin.
- Pemasangan paip perlulah diletakkan di kawasan dasar laut yang membolehkan ia tenggelam ke dalam sedimen ('self-burial')
- Kerja-kerja pemasangan paip perlu dijalankan dengan berhati-hati agar dapat meminimumkan jumlah pepejal terampai di dalam air.
- Adalah disokong bahawa selepas operasi pembekalan dan penghantaran pasir selesai, paip tersebut dibiarkan di situ kerana kerja-kerja pembuangan paip akan membawa kepada kemerosotan kualiti air.

Program Pemantauan Alam Sekitar

Elemen utama alam sekitar yang akan terjejas akibat daripada pembekalan dan penghantaran pasir ke tapak projek adalah kualiti air. Pemantauan kualiti air (*in situ* dan *ex situ*) perlu dijalankan sebelum, pada masa akhir dan selepas penghataran pasir ke kawasan tapak projek. Lokasi persampelan perlu meliputi kawasan penebusgunaan tanah serta di sepanjang laluan barj atau paip. Sekurang-kurangnya empat (4) kawasan persampelan untuk opsyen 1 dan 2 dan lima (5) kawasan persampelan untuk opsyen 3. Parameter kualiti air yang akan dikaji adalah pH, keterlarutan oksigen suhu, saliniti, turbiditi, jumlah pepejal terampai dan *oil and grease*. Laporan pemantauan akan dikemukakan kepada Jabatan Alam Sekitar, Negeri Sembilan secara berkala. Di samping itu, peranan Pegawai Alam Sekitar perlu merangkumi pemantauan pergerakan semua barj dan kerja pemasangan paip agar pelaksanaan tata syarat seperti masa, air pasang surut dan penyampukan trafik bot-bot nelayan dapat dipastikan.

Kesan Tinggalan

Langkah - langkah tebatan yang dicadangkan seperti di atas, jika dijalankan sewajarnya, akan mempunyai sedikit atau tiada kesan tinggalan kepada persekitaran marin.

Kesimpulan

Tiga (3) opsyen pembekalan dan penghantaran pasir yang diutarakan akan memberi kesan terhadap persekitanran marin terutamanya kepada kualiti air akibat daraipada penigkatan pepejal terampai di dalam air. Walau bagaimanapun, sorotan ketiga-tiga opsyen tersebut menyarankan bahawa opsyen kedua (pembekalan pasir kering dengan barj dan diangkut menggunakan tali konveyor) memberi kesan yang paling minima dan dapat ditebat secara mudah. Impak alam sekitar yang telah dijangkakan merupakan kesan jangka pendek dan ia tidak akan menjejaskan alam sekitar sekiranya langkah-langkah penebatan dijalankan seperti yang dicadangkan. Di sampling itu juga, tiada kesan tinggalan jangka panjang kepada persekitaran marin.