

17. LAMMA SOUTH ISLAND LANDFILL

17.1 Basic Information

Project Title

17.1.1 Lamma South Island Landfill (LSIL) – marine site M.12.

Nature of Project

17.1.2 The Project would form a new marine based waste disposal site in waters located off the south of Lamma Island (*Figure 17.1*).

17.1.3 The LSIL would require the construction of an artificial island of approximately 450ha in size. The site would be designated as a public filling area for the receipt of inert C&D material; once the reclamation is completed, the site would be developed as a landfill for subsequent operation for the disposal of waste. Construction works would be as described in Part A; Section 3.2.

Location and Scale of Project

17.1.4 The LSIL is located approximately 1km to the south of Lamma Island and near the southern fringe of SAR waters. It would cover a site area of some 450ha. Approximately 215Mcum of fill material will be required to construct the artificial island, with a final site formation level to +6mPD. The capacity of the landfill site would be in the order of 65Mcum.

17.1.5 Seabed levels in this area vary from 20 to 22m below Chart Datum. There would be a need to dredge some 10Mcum of muds for the construction of seawalls for the artificial island.

History of Site

17.1.6 The LSIL falls within the Hong Kong Island South & Lamma Island Planning and Development Study, and is on the boundary of the South West New Territories Development Strategy Review area. The site area currently includes designated shipping anchorages at south Lamma.

17.1.7 There are no development recommendations for the site, although there is the possibility that a future breakwater will be developed to the east-northeast. The coastal marine waters around south Lamma have been proposed for protection as a Marine Reserve / Park.

Number and Types of Designated Projects Covered

17.1.8 The LSIL would qualify as a Designated Project under the five categories listed in Part A, Section 2.1.

17.2 Outline Of Planning and Implementation Programme

17.2.1 An outline for the planning and implementation of this site is summarised in Part A; Section 3.3 and an outline programme is shown in *Figure 17.2*. Assuming landfill operations start in 2020, the LSIL would be full during the period 2030 to 2035, depending upon the rate of waste arisings and the number of other landfills operating concurrently.

17.2.2 The site is currently not covered by any statutory town plans. As described in Section 3.3, Town Planning Ordinance procedures to cover the site would be required and the reclamation would need to be gazetted under the Foreshore & Sea-bed (Reclamations) Ordinance.

17.2.3 This site falls within the boundary of the South West New Territories Development Strategy Review. No recommendations for this area were made under this strategy.

17.2.4 The Recommended Development Strategy formulated under the South West New Territories Development Strategy Review identified the potential of Cheung Chau and Lamma as tourist and recreation developments; this recognised their mountain scenery, appealing coastal areas and the large number of archaeological and historical sites.

17.2.5 Lamma Island lies to the north of this site and is covered by the Lamma Island OZP Plan no. S/I – LI/3 issued in October 2001. The general planning intentions of the Lamma Island OZP are to conserve the natural landscape, the cultural heritage, the rural character and the car-free environment of Lamma Island; and to enhance the role of Lamma Island as a leisure destination. The Island has been subject to further investigation under the Planning and Development Study on Hong Kong Island South and Lamma Island.

17.2.6 The site is immediately south of a potential Marine Park, recommended under the Strategy Review.

17.3 Possible Impacts on the Environment

17.3.1 Possible impacts on the environment during the construction, operation and aftercare phases of the LSIL are outlined below. *Figure 17.1* provides details of identified sensitive receivers. The individual assessments are summarised in *Tables 17.1 and 17.2*.

Air Quality

17.3.2 The reclamation and landfill development has the potential to cause the following air quality impacts:

- Dust (TSP / RSP) and exhaust emissions from on-site plant during construction and operation.
- Gaseous emissions during landfill operation and aftercare arising from non-point source emissions and gas flaring / utilisation (including emissions of methane, carbon dioxide, carbon monoxide, sulphur dioxide, nitrous oxides, etc.).
- Odours arising during the operation of the landfill from waste decomposition and leachate treatment.

17.3.3 No Air Sensitive Receivers (ASRs) are found within a 500m radius from the boundary of this site. Thus, no significant air quality impacts associated with reclamation, operation and construction of the landfill facility within the site are anticipated.

17.3.4 The site lies in an open marine area, with no known developments (existing or planned) within 5km of the site boundary. The build-up of air pollutants is not anticipated.

17.3.5 This is a marine site and marine vessels will be used for waste delivery to the site. The amount of air pollutants resulting from the territory-wide waste delivery (per kg waste handled) to the site is anticipated to be lower, compared to a land based site that relies solely on road transport. The estimated cumulative distance to be travelled from the existing and planned (South East Kowloon RTS to be commissioned in 2012) marine RTSs to the site is approximately 290km. Given the likely distance to be travelled and the benefit of the use of marine transport, the regional impacts from waste transportation are considered to be neutral.

Noise

17.3.6 The reclamation and landfill development has the potential to cause the following noise impacts:

- Construction – from dredging, tipping, piling works and general construction activities;
- Operation – from the use of fixed plant, marine vessels, waste reception area, pumping plant, possible helicopter noise etc.

17.3.7 No noise sensitive receivers are found within a 300m radius from the boundary of this site. Thus, no significant noise impacts associated with reclamation, operation and construction of the landfill facility within the site are anticipated.

- 17.3.8 Although not anticipated at this stage, it is possible that activities could continue beyond normal working hours during the construction and operation phases. This would depend upon working arrangements for fill delivery, day-to-day landfill operations and the overall construction programme. However, as this is an offshore site with no NSRs in the vicinity, the more stringent requirements for noise emissions during the evening and night-time periods are not expected to be an issue for this site.
- 17.3.9 Potential operational phase noise impacts would need to be considered in subsequent studies in the event that the island reclamation is used for other land uses (in addition to landfill) or a separate afteruse is developed on top of the landfill following completion of the landfilling operations.
- 17.3.10 The site can only be accessed by marine traffic during both operation and construction phase. Noise from land based waste delivery vehicles is not a concern for this site.

Water Quality

Baseline Conditions at the Site

- 17.3.11 The site would fall wholly within the Southern Water Control Zone (WCZ). Broadly representative water quality data for the area is available from two of EPD's routine marine water quality monitoring stations: SM18 some 5km to the west and SM19 5km to the east. There is no sediment quality monitoring station at these locations, although there is one such station (ref. SS3) also around 5km distant to the northwest of the site (near the potential new Lamma Breakwater waste disposal site (Site M6).
- 17.3.12 As with the North Lamma site, the marine waters around the South Lamma site are also influenced by discharges from the Pearl River, albeit to a lesser extent. The mean TIN concentration for the year 2000 at station SM7 (north Lamma) was 0.24mg/L compared with levels at SM18 and SM19 (south Lamma) of 0.13mg/L. There were similar trends at these locations for nitrate-nitrogen and TKN. As with north Lamma waters, the WQO for TIN at stations SM18 and SM19 was exceeded (non-compliance), whilst those for dissolved oxygen and un-ionised ammonia were fully complied with (EPD, 2001).
- 17.3.13 It is also of note that levels of BOD, *E.coli* and faecal coliforms were relatively low at the southern locations compared with station SM7. This could be due to factors such as sewage discharges into the West Lamma channel and greater flushing capacity (increasing oceanic influence) in the waters around south Lamma. Generalised data shows that the ebb tide current through the area is the strongest, and particularly during the wet season. The flood tide current is relatively weak – especially in the wet season due to southward flow from the Pearl River.
- 17.3.14 EPD data at station SS3 shows marine sediment quality to be good at this location, with all tested parameters within the Lower Chemical Exceedance Level. The sediment quality around the site is considered to be of similarly good quality.

Key Issues and Sensitive Receivers

- 17.3.15 The project has the potential to cause the following water quality impacts:
- Sediment loss to the water column during dredging / reclamation;
 - Runoff with elevated levels of suspended solids from the site during landfill construction (post-reclamation); and
 - Change in the hydrodynamic regime (i.e., change in flushing capacity and sediment deposition / erosion patterns).
- 17.3.16 Identified Water Sensitive Receivers (WSRs) present in the vicinity of the site are:
- Cooling water intake for HEC Lamma Power Station;
 - Gazetted beach near the Power Station at Hung Shing Ye;
 - Gazetted beach at Lo So Shing; and

- Secondary contact recreation sub-zone around the west and south Lamma coastline.

17.3.17 In addition, there are a range of aquatic and inter-tidal ecological receivers within the vicinity of the site that may be sensitive to any decline or change in the water quality or sediment deposition / erosion patterns. Impacts upon these are discussed under the “Ecology” and “Fisheries” subsections. The sensitive receivers include:

- Green Turtle nesting habitat at Sham Wan beach;
- Core habitat area for the Black Finless Porpoise at Ha Mei Tsui; and
- General Marine and coastal waters around the proposed South Lamma Marine Park / Reserve.

17.3.18 The locations and uses of these sensitive receivers are shown in *Figure 17.1*.

Reclamation and Site Formation

17.3.19 Reclamation and site formation activities, if not carefully controlled, may potentially lead to adverse water quality impacts from increased suspended solids levels in the water column and reduced dissolved oxygen levels. Sediment may be carried by the prevailing flood tide current towards WSRs at Ha Mei Wan to the north. However, water circulation in this bay area is negligible and it is considered that sediment would not reach either of the gazetted beaches. Given the stronger water current at the mouth of the bay, it is considered that there is more potential for any sediment plume that may form to be transported towards the water intake for the Lamma Power Station. The placement of fill for island construction is likely to lead to localised increases in suspended solid levels. The hydrodynamic and water quality modelling indicated that there would be no WQO exceedance in Phase 1 construction. Increases are however predicted at MP6 (21.22%), FP1 (19.58%), NS4 (22.61%) and NS5 (23.04%) in the dry season and at NS5 (16.86%) in the wet season. No WQO exceedance is predicted in Phase 2 construction, however, increased levels of SS are predicted at MP6 (17.26%), FP1 (15.61%), NS4 (18.84%) in the dry season and at NS5 in both the dry (17.72%) and wet (22.48%) seasons. In Phase 3 construction, WQO exceedance is predicted at MP6 (38.10%), FP1 (33.78%), NS4 (38.19%) and NS5 (44.30%). An increased level of SS is also predicted at NS5 (17.25%) in the wet season.

Hydrodynamic and Water Quality Impacts Following Island Formation

17.3.20 It is predicted that the presence of the island would cause a significant increase (45.50%) in the accumulated flow through the East Lamma Channel, and a decrease (26.56%) through the West Lamma Channel during the dry season. In the wet season a significant flow (23.48%) is predicted for the Tathong Channel and reductions (approximately 9%) would occur at East and West Lamma Channels. The two velocities were predicted to increase significantly in the area between the island and Lamma Island during the neap flood tide of the wet season. The overall current magnitude is predicted to reduce by 2.5% and 12.32%, on average, to the northeast and north west of the site respectively.

17.3.21 In the hydrodynamic and water quality modelling, 22 sensitive receivers that are close to the site were selected for presentation. Of 22 indicator points, 17 chosen indicator points (MP6, FP1, GT1, CW4, FC4, FC3, GB5, SC2, FP5, GT2, SC3, FP6, NS4-6, NS8-9) are located in the Southern WCZ. The remaining 5 indicator points are located in Mainland waters (MF8-9, MF13-15) and classified as Category 2 in the Mainland Sea Water Standard.

17.3.22 According to the dry season water quality modelling results, the predicted 90%ile DO for depth average and bottom layer ranged from 6.20 to 7.03mg/L and are above the WQO of 4mg/L and 2mg/L respectively as well as the Mainland standard of 5mg/L. The largest reduction in 90%ile depth averaged DO was found at FC4 (Fish Culture Zone at Sok Kwu Wan) with difference of 3.96%. For the 90%ile bottom DO, where there were decreases in the predicted values, the reduction were all below 1%, except for FC4 (Fish Culture Zone at Sok Kwu Wan) where the difference was 4.11%.

- 17.3.23 The predicted average dry season salinity ranged from 33.89 to 34.00ppt. The differences in salinity levels caused by the presence of the island were minimal (less than 1%) at all the selected indicator points as compared to the WQO requirements that change due to any waste discharge should not exceed 10% of natural ambient level.
- 17.3.24 The predicted dry season SS levels indicator points were in the range of 3.65 to 4.37mg/L. Comparing to the baseline water quality results, the percentage differences in SS level are considered small at all indicator points (within 8%) and are well below the WQO of 30% as well as the Mainland standard that man-made increment should not exceed 100mg/L.
- 17.3.25 The predicted *E.coli* levels in the dry season ranged from 1 to 18count/100ml. The increase in average *E.coli* levels caused by the presence of the island were significant at NS9, GB5 and FC4 but the predicted *E.coli* levels at these 3 indicator points (11, 15 and 18count/100ml respectively) were still well within the WQO of 610cfu/100mL and the Mainland standard of 200count/100ml. The predicted average *E.coli* levels are 1count/100mL for most of the indicator points.
- 17.3.26 The predicted average dry season UIA (0.00253 – 0.00358mg/L) at all indicator points were very small as compared to the WQO of 0.021mg/L and the Mainland standard of 0.020mg/L.
- 17.3.27 The predicted dry season TIN levels (0.0750 – 0.0912mg/L) at the indicator points in Mainland were well below the Mainland standard of 0.3mg/L. Since the Hong Kong WQO of TIN is an annual mean value, the predicted mean TIN levels at the indicator points in Hong Kong waters for the dry and wet seasons were averaged to represent the annual mean values. All of the 17 indicator points in Hong Kong waters have breached the WQO of 0.1mg/L with calculated annual mean values ranged from 0.1390 to 0.1941mg/L. However, the calculated averaged baseline concentrations at these stations have also exceeded the WQO.
- 17.3.28 According to the water quality modelling results for the wet season, the predicted average 90%ile DO for depth averaged and bottom layers ranged from 4.97 to 6.29mg/L and the values are above the WQOs of 4mg/L and 2mg/L respectively as well as the Mainland standard of 5mg/L. Comparing to the baseline water quality results, the percentage differences for 90%ile depth-averaged DO were minimal with differences of less than 1.5% at all indicator points. The percentage differences in 90%ile bottom DO were also small with values from 0.19 to 3.93%.
- 17.3.29 The predicted average salinity in the wet season ranged from 20.19 to 30.50ppt. Compared to the baseline water quality results, the percentage differences in salinity caused by the presence of the island were minimal (less than 2%) at all of the selected indicator points. The differences were well below the WQO requirement that change due to any waste discharge should not raise the natural ambient level by 10%.
- 17.3.30 The predicted SS levels in the wet season at the indicator points were in the range of 3.06 to 5.58mg/L. The differences were less than 3% which are small as compared to the WQO requirement that any waste discharge should not raise the natural ambient level by 30% as well as the Mainland standard that man-made increment should not exceed 100mg/L.
- 17.3.31 The predicted wet season *E.coli* levels indicator points were low and ranged from 1 to 16count/100mL which are well below the WQO of 610cfu/100ml. The increase in average *E.coli* levels caused by the presence of the island were significant at GB5, FC4 and NS9 but the actual values at these 3 indicator points were very small (8, 9 and 12count/100ml respectively) and were well within the WQO of 610cfu/100mL as well as the Mainland standard of 200count/100mL.
- 17.3.32 The predicted average wet season UIA (0.00250 – 0.00522mg/L) at all indicator points were low and well below the WQOs of 0.021mg/L for annual mean and the Mainland standard of 0.020mg/L. It is predicted that the island would increase the UIA levels at most of the indicator points with the largest increase at NS5 (Fishery Nursery/Spawning Ground South of Lamma Island) with value of 4.76%.

17.3.33 The predicted wet season TIN levels (0.1095 – 0.2798mg/L) at the indicator points in Mainland were below the Mainland standard of 0.3mg/L. Meanwhile, the predicted TIN levels (0.186 – 0.291mg/L) were relatively higher as compared to the dry season data. All stations in Hong Kong waters were breached the WQO of 0.1mg/L as discussed in Section 17.3.27 above.

Cumulative Impacts

17.3.34 Two other projects in the vicinity of the site with potential for a cumulative effect on hydrodynamics / water quality are the ongoing extension of the Lamma Power Station and the potential establishment of a Waste-to-Energy Incineration Facility (WEIF) adjoining the Power Station extension.

17.3.35 The Power Station extension is due to be fully completed by the year 2012. It was concluded in the EIA Study for the Lamma Power station extension that development of the extension in isolation and in tandem with the potential WEIF would not lead to any adverse hydrodynamic / water quality impacts. Ultimately the siting of a WEIF at Lamma was not recommended on environmental grounds.¹ Although there are ongoing studies for the development of a “waste to energy facility” for the HKSAR, for the purpose of this assessment it is assumed that any future facility would not be located at Lamma Island. As such, this precludes the potential for cumulative hydrodynamic / water quality impacts.

Waste Management / Disposal Impacts

17.3.36 For construction of the “island” on which the landfill would be located, inert C&D material would be brought in exclusively by marine vessel, from a network of barging points in the SAR. The location of barging points would vary during the filling process, according to the source of materials at any given time.

17.3.37 Whilst various options for construction that avoid dredging have been investigated, it is anticipated that muds would need to be excavated to facilitate construction of the outer seawall, prior to public filling. Excavated muds would then be disposed of within the area to be reclaimed with public fill. Following this, the “island” would act as a major recipient of municipal solid waste and other landfilled waste streams.

17.3.38 Anticipated volumes of materials are as follows:

- Volume of public fill that could be accepted for island construction: 215Mcum
- Volume of muds be dredged for outer seawall: 10Mcum

17.3.39 Various potentially polluting materials may be stored, handled and transported to / from the site. Examples may include chemicals for waste water/leachate treatment, waste oils, fuel for plant working on the site, etc. These would be managed as described in Section 5.5.

17.3.40 Only marine vessels will be used to deliver waste to the site. As such, the GHG emission rate (per kg waste handled) is expected to be low compared to using road transport. Based on the information contained in the Preliminary Marine Review (March 2002), the cumulative distance to be travelled is around 290km. In view of this, the impacts associated with GHG emissions are considered to be insignificant (neutral).

Ecology

Baseline Conditions

17.3.41 There are a number of ecological resources of conservation interest and significance in the vicinity of the site.

¹ CDM (1998). Feasibility Study of Waste-to-Energy Incineration Facilities: Site Assessment Report – Lamma Island. Submitted to EPD, July 1998.

- 17.3.42 The Green Turtle *Chelonia mydas* is the only turtle species known to breed locally, with nesting only reported thus far at the sandy beach at Sham Wan, south Lamma.² The Green Turtle is protected under the Wild Animals Protection Ordinance, Cap.170 and is listed under Appendix I of CITES. The beach at Sham Wan and the nearby shallow waters were designated a SSSI in June 1999, whilst (since 1999) approximately 0.5ha of the nesting area including the beach is a “Restricted Area” between June and November.
- 17.3.43 The Black Finless Porpoise frequents the waters around the site and generally around south Lamma throughout the year. Seasonal distribution data collated by the AFCD shows that the waters around Mei Ha Tsui are a very important part of the species’ core habitat between September and May.³ The Chinese White Dolphin prefers waters further to the west, although there have been occasional sightings in the West Lamma Channel around 5km from the site.⁴
- 17.3.44 Inter-tidal resources at southwest Lamma were investigated under the HEC Power Station Extension study. The macroinvertebrate and macroalgae community around Ha Mei Tsui was relatively diverse amongst the six west coast survey locations. The most abundant species were the Chiton *Acanthopleura japonica*, the Limpet *Patelloida saccharina*, and the macroalgae *Neogoniolithon misakiense*. None of the intertidal community species are of particular conservation significance.
- 17.3.45 The Power Station Extension study described the shallow sub-tidal waters at southwest Lamma, as being characterised by steep rocky substrate comprised of boulders. This substrate character (combined with the peninsula status of the location and the water current) appears to be conducive to coral establishment as the greatest coral diversity on the west Lamma coast is to be found in this area. Hard coral of the genus *Tubastrea* was reported as abundant on the southwest-facing coast, whilst three species of soft coral, three of sea whip, one sea pen and one sea fan were also observed in the 1998 survey. Other abundant coral reef associates reported in large numbers were the sea cucumber *Colochirus crassus* and the long-spined sea urchin *Diadema setosum* (ERM, 1999). It was concluded that the coastal sub-tidal habitat around Ha Mei Wan, southwest Lamma, is of “high ecological value”.
- 17.3.46 Nearby, at the mouth of Sham Wan, a separate dive survey identified hard coral of the genus *Acropora* at depths of up to 5mPD, concluding that the conservation value of this location was high.⁵
- 17.3.47 The sub-tidal benthic community at the site is not likely to be as diverse as the shallow coastal waters. The greater offshore water depth (around 20m) will limit the community type, whilst the substrate will not be characterised by boulders as at Ha Mei Tsui. The seabed is likely to be more homogenous, comprised of relatively uniform silty sand as at EPD’s sediment monitoring station SS3 (“Water Quality” subsection refers). It is anticipated that polychaetes, molluscs and crustaceans will be the most abundant groups in the benthic community at the site (see also “Fisheries” subsection).
- 17.3.48 Fisheries resources of ecological significance in the area are present south of Cheung Chau and south of Lamma Island. These areas are important spawning and nursery grounds for a range of fish and crustacean species.⁶ These waters also support the squid *Loligo* sp., the lion-head fish *Collichthys lucida* and the tiger-tooth croaker *Otolithes argenteus* that comprise the most common and numerically important prey species of the Finless Porpoise.⁷

² AFCD (2001). AFCD Website. Conservation: Protection of Green Turtles. [www.afcd.gov.hk/con_new/turtle.htm].

³ AFCD (2001). AFCD Website. Conservation: Finless Porpoise. [www.afcd.gov.hk/con_new/finpor.htm].

⁴ AFCD (2001). AFCD Website. Conservation: Chinese White Dolphin. [www.afcd.gov.hk/con_new/cdp_distri4.htm].

⁵ Binnie (1995). Marine Ecology of Hong Kong. Report on Dive Surveys – Volume I. Fill Management Study –Phase IV. Submitted to CED, HKSAR Govt.

⁶ ERM (1998). Fisheries Resources and Fishing Operations in Hong Kong Waters. Report to AFCD, HKSAR Govt.

Direct Habitat Loss

- 17.3.49 The site footprint covers a surface area of 450ha and the site is entirely sub-tidal. It is anticipated that there will be no benthic species of particular ecological significance in the area.
- 17.3.50 As regards open waters, distribution data for the Black Finless Porpoise collated by AFCD shows that the marine waters in this area are part of the core habitat for this species. The Finless Porpoise can be found in the area of the site throughout the year.
- 17.3.51 The marine waters in this area are also important for the Green Turtle. Given the location of the site relative to the turtle's nesting ground at Sham Wan, there is a high chance that the site would be directly in the line of the female turtle's approach to Sham Wan as it migrates back for egg laying. The waters may also be important to the Green Turtle as a breeding ground.

Water Quality / Hydrodynamics

- 17.3.52 Given the sensitivity of the area for Green Turtle breeding, any change in water quality could have adverse impacts upon the use of the area by this species. Likewise, a change in beach morphology from sediment deposition from dredging / reclamation activities, or any other disturbance, may be sufficient to disturb the Green Turtle. Similarly, the Finless Porpoise, for which the area forms part of the core habitat, could be driven out by dredging and reclamation activities. Any deterioration in water quality would drive fish from the area due to their sensitivity to increased suspended sediment levels, resulting in reduced feeding opportunities for the Green Turtle and Finless Porpoise in these waters.
- 17.3.53 The model predicts that increases in suspended solids would be negligible in the area (< 2.0mg/L), including off the Ha Mei Tsui peninsula that forms part of the core area for Finless Porpoise sightings (FP1). Negligible increases in sediment levels are also predicted during the construction phase near to the Sham Wan SSSI (close to NS5 – "Fisheries" sub-section refers) and the southern edge of the potential South Lamma Marine Reserve / Park (MP6). The predicted worst-case scenario increase, under Phase 3 construction dry season, is no greater than 1.5mg/L and would not affect the ecological receivers in the area.

Marine Vessel Disturbance

- 17.3.54 The Sham Wan "Restricted Area" was established in order to protect the nesting Green Turtle from any form of disturbance during their nesting season. It is noted that any development and human activities that change the natural environment of the nesting site and/or cause obstructions to their migratory route may deter nesting and return of turtles.
- 17.3.55 Particular threats to the turtle include illumination (possibly from the new waste facility) that may deter the female from egg laying and / or if eggs are laid the hatchlings may be disorientated when approaching the sea (hatchling orientation towards the sea is guided by moonlight). There is also potential for construction and operational debris from the site to wash ashore at Sham Wan, thus impinging the movement of nesting females and hatchlings. Vessel movement in the area may also affect the turtles through increased potential for vessel collision and vessel engine noise / vibration.
- 17.3.56 From a study conducted on behalf of the AFCD, it is known from data on strandings of Black Finless Porpoise specimens that vessel collision is a significant cause of death (Jefferson, 2001). As the south Lamma area is part of the core habitat for Finless Porpoise any increase in marine traffic required for site formation / reclamation activities and facility operation could lead to an increase in incidences of vessel collision.

⁷ Jefferson, T.A. (2001). Conservation Biology of the Finless Porpoise in Hong Kong Waters. Submitted to AFCD, HKSAR Government.

17.3.57 The Finless Porpoise may also be prone to adverse impact from general disturbance associated with facility development and operation, including vessel noise / vibration.

Fisheries

17.3.58 There are two fishing zones in the vicinity of the site: Ha Mei (zone 0098) and Tai Kok (zone 0099). Available data indicates that both of these zones are similarly popular in terms of the number of fishing vessels utilising the zone compared with other fishing zones to the north ("North Lamma" report refers). Likewise, the productivity of these two zones is similar on a unit area basis. In terms of value ranking for adult fish, Tai Kok ranks 50 / 210 zones compared with 66 / 210 for Ha Mei. Ha Mei has slightly better ranking for fry fish 45 / 89 compared with 49 / 89 for Tai Kok. The overall value of both Tai Kok and Ha Mei were high for the HKSAR, ranking 84th and 70th respectively out of 210 fishing zones (ERM, 1999).

17.3.59 The most commonly caught species in these two zones were the same, including the scad *Caranx* spp., the sardine *Sardinella jussieu*, and the croaker *Argyrosomus* spp. The catch of Mantis shrimp *Oratosquilla* spp. – a commercially valuable species – was the 5th most important in terms of species weight in both zones (*ibid.*). Other commercially important species for which the south Lamma area is a known spawning ground include the coastal mud shrimp *Solenocera crassicornis*, and the Jinga shrimp *Metapenaeus affinis*. The marine waters are also an important nursery area for the shrimp *Metapenaeopsis barbata* and *M.palmensis*, and croaker and grouper fry, amongst others (ERM, 1998). Due to their importance as a nursery area for commercial fish species it has been proposed that the waters around south Lamma be designated as a Fisheries Protection Area (*ibid.*).

17.3.60 Construction of the LSIL has potential to create adverse impacts on fisheries resources in the area. Marine dredging works may affect fisheries in the area; particularly on the ebb tide when the current from the West Lamma Channel may transport sediment south from the works area into productive fisheries grounds. General reclamation and site formation activities may also lead to adverse impacts from sediment dispersal away from the works location. Despite these *potential* impacts, the model predicted only a slight and insignificant increase in suspended solids levels in open water nursery / spawning area (NS4 & NS5) close to the site. These worst-case scenario predicted increases above the baseline were during Phase 3 construction dry season and amount to 1.52mg/L at NS4 and 1.75mg/L at NS5. Under the worst-case scenario (i.e., NS5) a total sediment concentration of 5.70mg/L is predicted - significantly lower than the generally accepted threshold for "adult fish" of 50mg/L. Even taking a precautionary approach whereby the permissible sediment concentration at spawning / nursery areas is far lower than for adult fish (say, 50% lower, or 25mg/L), no adverse impacts would arise.

Cultural Heritage

17.3.61 There is no immediate evidence of archaeological remains in this area. However there are a significant number of archaeological sites on Lamma. The presence of sites on land strongly suggests that seafarers would have used the natural harbours of the islands and the waters around the site for several thousand years.

17.3.62 Recognising the likelihood of archaeological remains in this area and the lack of archaeological data currently available for this site, a detailed marine archaeological investigation should be carried out in any future studies.

Landscape and Visual

17.3.63 *Landscape Planning Designations* - this area of landscape is not covered by any planning designations reflecting landscape/landscape values and so there will be no impact on these values.

17.3.64 *Landscape Resources* - the site lies in a marine area, so that the only landscape resource affected will be an area of offshore water. Given the low sensitivity of this resource, there will be no significant impacts on landscape resources.

- 17.3.65 *Landscape Character*- the site is located in the Southern Coastal Waters LCA, immediately to the south of Lamma Island (*Figure 17.4*). The landscape of this part of Hong Kong is open and in exposed offshore waters with little sense of containment other than distant islands in PRC waters and the distant islands of Lantau, Lamma and Cheung Chau. The area is given some landscape context by the proximity of Lamma Island. Shipping introduces movement and certain artificial elements into what is otherwise a predominantly natural setting (*Figure 17.3*).
- 17.3.66 There exists potential for substantial impacts on landscape character resulting from construction / operation works, which will introduce new elements which are incompatible with the existing natural landscape. During the afteruse phase of the landfill, these impacts are likely to be reduced, as the completed island is restored. The character of the island is however generally inconsistent with the open, natural character of the other landscape, and the island's proximity to Lamma will further emphasise its artificial characteristics. As a consequence of this, the long-term impact on landscape character will remain as moderate to substantial.
- 17.3.67 *VSRs* - *VSRs* affected by the proposals are identified in *Tables 17.3 and 17.4*. The extent of the project visual envelopes is shown in *Figure 17.5*.
- 17.3.68 Because of the location of the island there are no areas of large population close to the site. Key residential *VSRs* in the area are found at Stanley and Nam Tam. They are however approximately 7km and 10km from the site respectively (*Figure 17.6*). Recreational *VSRs* will be affected, such as visitors to Shan Tei Long, Chung Hom Kok Park, Fa Peng Beach and those engaged in marine or other water sport activities. Other *VSRs*, such as travellers on vessels using the fairways and shipping lanes, although transient, will also be affected.
- 17.3.69 These *VSRs* will experience works on the landfill (shipping, marine vessels and partially constructed island) as artificial elements contrasting with the coherent qualities of the existing landscape, and resulting visual impacts will be substantial to moderate for close *VSRs*. The impact of the island is greatly reduced by the viewing distance of the majority of *VSRs*. After the restoration of the landfill, the visual impact of the island will be reduced to slight to insubstantial for most *VSRs* given the remote location of the island. The exception to this is the *VSR* group at Shan Tei Long where the visual impact will remain moderate to substantial.

Landfill Gas

- 17.3.70 There are no sensitive receivers (targets) or pathways within 500m of the site and therefore no potential off-site landfill gas hazard. Landfill gas would have safety implications for those working on the site. In the event that the reclamation on which the landfill would be constructed is also developed for other afteruses, the potential operational phase landfill gas hazards would need to be considered for those developments.
- 17.3.71 Given the remote location of the site and the lack of any sizeable population nearby, the direct off-site use of LFG as an energy source in surrounding communities, is not considered practical. However, it will be used as an on-site energy source.

17.4 Environmental Protection Measures to be Incorporated into Design and Further Environmental Implications

- 17.4.1 Environmental design measures have been identified in Part A (Section 3.8) and generic approaches to mitigating impacts on different environmental parameters are outlined in Part A (Section 5). Whilst the specific requirement for environmental mitigation would be dependent upon the findings of an EIA, the following environmental protection measures are site-specific to Lamma South artificial island site.

Air Quality

- 17.4.2 No specific air quality mitigation measures are recommended at this stage, other than good site practice as described in Part A (Section 5).

Noise

- 17.4.3 No specific noise mitigation measures are recommended at this stage, other than good site practice as described in Part A (Section 5).

Water Quality

- 17.4.4 Mitigation is likely to be required to prevent impacts during dredging and filling for the reclamation. Construction procedures, defining the rates and method of dredging and filling taking in to account the hydrodynamics of the surrounding waters and tidal effects (ebb and flood) should be defined in the EIA. If significant impacts are predicted, a silt curtain may be installed around the immediate works area to prevent dispersion of sediments.

Waste Management

- 17.4.5 No specific waste management mitigation measures are recommended at this stage, other than good site practice as described in Part A (Section 5).

Ecology

- 17.4.6 It is proposed that marine vessel movements to and from the LSIL should avoid the waters around southwest Lamma due to the importance of the area as a habitat for the Finless Porpoise. In particular, vessel movement from the north should ideally approach the site via the East Lamma Channel.

Fisheries

- 17.4.7 There are no particular measures that are proposed for fisheries resource protection.

Cultural Heritage

- 17.4.8 There are no particular measures that are proposed for protection of cultural heritage resources.

Landscape & Visual

- 17.4.9 *Mitigation Measures* - Landscape and visual mitigation measures are outlined in Section A of the Report and are illustrated in *Figure 17.8*.

17.5 Summary

17.5.1 A summary of the SEA for the LSIL is provided in *Tables 17.1 and 17.2*:

Table 17.1: Evaluation Summary for Lamma South Island Landfill SEA

| | Impacts | Score | Commentary |
|--------------------------------------|---|-------|--|
| <i>Air Quality Assessment</i> | | | |
| 1 | Distance to areas of air sensitive land use | O | There are no air sensitive receivers (ASRs) within 500m of the site. |
| 2 | Presence of topographic features which could decrease or exacerbate impacts | O | The site does not lie within any airshed and generally experiences wind. It is unlikely that dust or odours would accumulate around the site. |
| 3 | Occurrence of meteorological conditions which could exacerbate impacts | O | Winds blow both towards and away from ASRs. No prevailing wind direction has been identified. |
| 4 | Cumulative Impacts of relevant emissions (TSP (construction), NO _x , CO, SO ₂ – LFG Flare) taking into account ambient conditions | O | The site is located in open marine waters to the southern HKSAR waters fringe, with no known developments that have relevant emissions within 5km from the site. |
| 5 | Total Emissions of Air Pollutants from the territory-wide waste transportation between the RTSs and the site | O | Waste will be delivered to the site by marine vessel and the cumulative distance to be travelled is estimated to be 290km. |
| 6 | Overall Impact | O | 'Neutral'. |
| <i>Noise Assessment</i> | | | |
| 1 | Distance to areas of noise sensitive land use | O | There are no noise sensitive receivers (NSRs) within 300m of the site. |
| 2 | Topographic Features (Only applicable if there are NSRs within 300m) | O | The site is located within open marine waters with no NSRs located within 300m from the site boundary. Therefore, this criterion is not applicable. |
| 3 | Cumulative Impacts of developments within 300m | O | There are no known developments (existing or planned) within 300m of the site. |
| 4 | Overall Impact | O | 'Neutral'. |

| | Impacts | Score | Commentary |
|------------------------------------|---|-------|---|
| Water Quality Assessment | | | |
| 1 | Water Course Diversion | O | Artificial island. Not relevant. |
| 2 | Potential for sediment contaminant release | O | None. EPD routine sediment quality monitoring data collected near the site shows that the marine sediment is not contaminated. |
| 3 | Potential impacts on WSRs (including increase or exceedance of WQO) | -- | Dredging and reclamation activities during construction would cause WQO exceedances in the dry season. It is predicted that TIN standard in the operational phase would be breached, however, it was also breached in the baseline scenario and the elevation due to the presence of island was not significant, therefore, the island would not be the cause of the exceedance. |
| 4 | Potential Impacts on Groundwater | O | Artificial island. Not relevant. |
| 5 | Potential Cumulative Impacts | O | Given that the reclamation works for the ongoing Lamma Power Station extension will be complete some time before 2010, and the conclusion that the Lamma WEIF is too environmentally sensitive, no cumulative impacts are anticipated. |
| 6 | Overall Impact | - | There is some potential for adverse water quality impact on WSRs in south Ha Mei Wan and more potential for impact upon the secondary contact recreation sub-zone at south Lamma. However, the impact potential is moderate and impacts are not anticipated for the other evaluation criteria, so overall: 'Negative – Low' . |
| Waste Management Assessment | | | |
| 1 | Balance of Materials (surplus/deficit of public fill needed for landfill development) | + | The site could accommodate major volume of public fill (215Mcum) negating the need to import filling material for site formation. Dredged muds will be incorporated with the fill materials within the island footprint. |
| 2 | GHG emissions from mode of transport for delivery of waste to the site from RTSS | O | Waste will be delivered to the site via marine vessel. The distance travelled from marine RTS(s) to the site has been estimated to be 290km. |
| 3 | Overall Waste Impact | + | 'Positive' . |

| | Impacts | Score | Commentary |
|------------------------------|--|--------|--|
| Ecological Assessment | | | |
| 1 | Potential for secondary environmental impacts on "Areas of Absolute Exclusion" | -- | The Sham Wan SSSI and "Restricted Area" is located 1km north of the site. There is potential that sediment would be transported north towards the coastal areas during reclamation and dredging works. The area has also been proposed as a Marine Park. |
| 2 | Affects an important habitat | -- | The waters in the area are part of the core habitat for the Finless Porpoise and are used as a breeding / feeding area by the Green Turtle. The area of usage by these species includes the footprint of the site. There are also coral communities of high conservation value located at Ha Mei Tsui (southwest Lamma) and at the tip of Sham Wan (south Lamma). |
| 3 | Affects a species of conservation importance | -- | Both the Finless Porpoise and the Green Turtle are listed under Appendix I of CITES and are protected under the Wild Animals Protection Ordinance (Cap. 170). These species would be susceptible to impact from habitat loss and injury / disturbance related to vessel movement. |
| 4 | Potential for Cumulative Ecological Impacts on species / habitat of recognised value | 0 | There are no concurrent works in the vicinity of the site that have potential to create cumulative ecological impacts. |
| 5 | Overall Ecological Impact | -- | The site would be immediately adjacent to the proposed Lamma South Marine Park, and is approximately 1km south of the Green Turtle Restricted Area at Sham Wan. The area is the most important in the HKSAR for the Green Turtle and is near to a core habitat for the Finless Porpoise. There are also coral communities of high conservation value on the south-facing Lamma coastline. Given this conservation value, the site is considered as having ' Negative – High ' impact potential. |
| Fisheries Assessment | | | |
| 1 | Potential for secondary environmental impacts on "Areas of Absolute Exclusion" | 0 | There are no existing "Areas of Absolute Exclusion" that would be affected by the works. |
| 2 | Affects an important mariculture / fisheries resources (including spawning / nursery ground) | - / -- | The waters around the site are an important spawning and nursery ground for a range of commercially important fish and crustaceans. The same area has been proposed for protection as fisheries spawning ground. The two fishing zones in the vicinity of the artificial island are ranked highly in terms of fisheries productivity in the HKSAR. These areas may be put under some stress from the predicted increase in sediment levels during construction works. |
| 3 | Potential for Cumulative Fisheries Impacts on sites of recognised value | 0 | There are no anticipated cumulative impacts. |
| 4 | Overall Impact | - | The waters off south Lamma around the site are of fisheries importance as a spawning and nursery ground for species of commercial value. However, there are no impacts on protected areas or cumulative effects, so overall: ' Negative – Low '. |

| | Impacts | Score | Commentary |
|-------------------------------------|--|-------|--|
| Cultural Heritage Assessment | | | |
| 1 | Important cultural (Declared, Deemed or Graded sites) / archaeological sites | 0 | There are no known sites of cultural heritage significance. |
| 2 | Potential for archaeological value | - | No marine based deposits of archaeological interest have been found in the vicinity of the site, although there is evidence of land based archaeological finds nearby on Lamma Island. This suggests that sea-faring people have used the coastal area of Lamma Island for several thousands of years. Recognising the lack of archaeological data currently available, it is considered that the likelihood of archaeological remains in this area is reasonable. A detailed marine archaeological investigation should be carried out in any future studies. |
| 3 | Potential for Cumulative Heritage Impacts on sites of recognised value | 0 | The nearest sites of cultural heritage value are land based, (on Lamma Island). Therefore they would not be affected by this development. |
| 4 | Overall Impact | - | The potential impacts on cultural heritage are considered to be ' Negative – low '. Whilst there is not direct evidence of cultural heritage remains around the site, the occurrence of remains on nearby Lamma Island increases the potential for marine archaeological finds. |

| | Impacts | Score | Commentary |
|---|--|--------|---|
| Landscape and Visual Impact Assessment | | | |
| 1 | Implications for Landscape Planning and Designations | 0 | This area of seascape is not covered by any planning designations reflecting landscape/seascape values and so there will be no impact on these values. Overall impacts will therefore be Neutral. |
| 2 | Impacts on Landscape Resources | 0 | As the site lies in a marine area, there will be no significant impacts on landscape resources. Overall impacts will therefore be Neutral. |
| 3 | Impacts on Landscape Character | -- | The open, natural character of the south coast of Lamma Island will be lost as well as the isolated character of the Southern Coastal Waters Landscape Character Area. The impact on this character area will be exacerbated by the proximity of the island to Lamma Island which will have the effect of emphasizing the artificial characteristics of the landfill island. Resulting overall impacts on landscape character will be Negative – High. |
| 4 | Visual Impacts | - / -- | The location of the island is a considerable distance from most populated areas and as a result will have a slight to moderate impact on their visual amenity. Recreational receivers will be most impacted by the site receiving substantial to moderate impacts. During the afteruse phase, the impacts will reduce to slight to insubstantial for most VSRs, given their relative viewing distances. Again the exception is the recreational VSRs in close proximity to the site. Resulting overall visual impacts will be Negative – Low / High. |
| 5 | Overall Impact | - / -- | Overall, landscape and visual impacts will be 'Negative – Low / High' for the following reasons: <ul style="list-style-type: none"> • Being a marine site, no significant landscape resources are affected. • There are no significant landscape designations covering the disposal site. • The open, natural and isolated landscape character of the coastline to the south of Lamma will be significantly compromised. • There are low numbers of residential visual receivers close to the island, and the impact on these receivers will not generally be very high. |
| Landfill Gas Assessment | | | |
| 1 | Distance between the new / extended landfill and SRs | 0 | The nearest sensitive receivers are >250m from the project site. |
| 2 | Number of Receivers within 250m (i.e. the LFG Consultation Zone) | 0 | There are no sensitive receivers within 250m of the site. |
| 3 | Man Made/Natural Pathways for LFG Migration | 0 | None. |
| 4 | Additional Utilisation of LFG to Reduce Greenhouse Gas Emissions | 0 | There are no potential users of LFG (other than on-site use) |
| 5 | Overall Landfill Gas Impact | 0 | 'Neutral' . |

Table 17.2: Summary for Lamma South Island Landfill SEA

| Overall Impacts | Score | Commentary |
|-----------------------------------|--------------|-----------------------|
| Overall Air Quality Impact | O | Neutral |
| Overall Noise Impact | O | Neutral |
| Overall Water Quality Impact | - | Negative – Low |
| Overall Waste Management Impact | + | Positive |
| Overall Ecological Impact | - - | Negative – High |
| Overall Fisheries Impact | - | Negative – Low |
| Overall Cultural Heritage Impact | - | Negative – Low |
| Overall Landscape & Visual Impact | - / - - | Negative – Low / High |
| Overall Landfill Gas Impact | O | Neutral |

**Table 17.3 Assessment of Significance of Visual Impacts for Lamma South Island Landfill Phase During Construction / Operation Phase
(Note: All impacts adverse unless otherwise noted)**

| Identity No. of VSR | Key Visually Sensitive Receiver (VSR) | Approx Minimum Distance Between VSR and Source(s) | Nos. of VSRs (order of magnitude only) | Magnitude of Impact During Construction / Operation (Negligible, Small, Intermediate, Large) | VSR Sensitivity (Low, Medium, High) | Impact Significance before Mitigation Measures (Insubstantial, Slight, Moderate, Substantial) | Significance of Residual Impacts (Insubstantial, Slight, Moderate, Substantial) |
|--------------------------|---|---|--|--|-------------------------------------|---|---|
| <i>Residential VSRs</i> | | | | | | | |
| VR 65 | Stanley | 7km | High | Intermediate | High | Moderate to Substantial | Slight |
| <i>Recreational VSRs</i> | | | | | | | |
| VR 66 | Shan Tei Long (Mt. Stenhouse), Lamma Island | 2km | Few | Large | High | Substantial | Substantial |
| VR 67 | Chung Hom Kok Park | 7km | Few | Intermediate | High | Moderate to Substantial | Moderate to Slight |
| VR 55 | Cheung Chau | 10km | Few | Small | High | Moderate | Slight to Insubstantial |
| VR 11 | Area for Boating, Fishing, Diving and other water sports activities | 0.5km - 10km (varies) | Few | Large | High | Substantial to Moderate | Substantial to Moderate |
| <i>Travelling VSRs</i> | | | | | | | |
| VR 49 | Maritime Vessels | 0.5km - 10km (varies) | Few | Intermediate | Low | Slight to Moderate | Slight |

Table 17.4 Assessment of Significance of Visual Impacts for Lamma South Island Landfill During Afteruse Phase
(Note: All impacts adverse unless otherwise noted)

| Identity No. of VSR | Key Visually Sensitive Receiver (VSR) | Approx Minimum Distance Between VSR and Source(s) | No.s of VSRs (order of magnitude only) | Magnitude of Impact During Afteruse Phase (Negligible, Small, Intermediate, Large) | VSR Sensitivity (Low, Medium, High) | Impact Significance before Mitigation Measures (Insubstantial, Slight, Moderate, Substantial) | Significance of Residual Impacts (Insubstantial, Slight, Moderate, Substantial) |
|--------------------------|---|---|--|--|-------------------------------------|---|---|
| <i>Residential VSRs</i> | | | | | | | |
| VR 65 | Stanley | 7km | High | Intermediate | High | Moderate to Substantial | Slight to Insubstantial |
| <i>Recreational VSRs</i> | | | | | | | |
| VR 66 | Shan Tei Long (Mt. Stenhouse), Lamma Island | 2km | Few | Large | High | Substantial | Moderate to Substantial |
| VR 67 | Chung Hom Kok Park | 7km | Few | Intermediate | High | Moderate to Substantial | Slight |
| VR 55 | Fa Peng Beach | 10km | Few | Small | High | Moderate | Insubstantial |
| VR 11 | Area for Boating, Fishing, Diving and other water sports activities | 0.5km - 10km (varies) | Few | Large | High | Substantial | Slight |
| <i>Travelling VSRs</i> | | | | | | | |
| VR 49 | Maritime Vessels | 0.5km - 10km (varies) | Few | Moderate | Moderate | Moderate | Insubstantial |