PART C

TRANSMISSION SYSTEM

CONTENTS:

1 CONSIDERATION OF ALTERNATIVES

1.1 INTRODUCTION

1.1.1 Background

On 31st March 1998, the Executive Council decided that HEC should be invited, without any commitment on the part of Government, to proceed with detailed site investigation and environmental impact assessment studies of an extension to Lamma Power Station for the possible construction of additional electricity generating facilities, with coal and natural gas as fuel options, the latter being the preferred option.

This followed reports from two preceding studies: *Site Search for a New Power Station: Detailed Site Selection* and *Stage I EIA for a New Power Station, Volumes 1 &* 2 prepared by ERM-Hong Kong Ltd. The latter is an approved EIA report placed on the Register under Section 15(1)(f) of the *EIAO* with *Ref. No. EIA-130/BC.*

The studies concluded that an extension to Lamma Power Station was the preferred site for a new power station for both fuel options, and that it is feasible to build and operate a power station at that location without significant adverse impacts on the environment, using natural gas as the preferred fuel and combined cycle technology.

In tandem with the new power station Site Search exercise, HEC also conducted a study on a new power transmission system from Lamma Extension to the load centres on Hong Kong Island. The proposed network is planned to be installed in two stages, covering western and eastern areas of Hong Kong Island respectively. To meet with the commissioning of the first generating unit at Lamma Extension in 2003, the Stage 1 transmission network between Lamma Island and a receiving substation in Central/Wanchai area has to be commissioned by December 2002, and the Stage 2 transmission network and another receiving substation in Quarry Bay/Mt. Parker by 2007.

The field of this EIA proposal covers only the initial stages of the route from the Lamma Extension to the point of land fall at Telegraph Bay on Hong Kong Island.

For the Stage 1 transmission route on Hong Kong Island, the wayleave approval and construction method is similar to many transmission cable projects which HEC have been routinely doing for years. EIA study on the land routes on Hong Kong Island is therefore excluded from the present EIA study report. A Separate EIA study will be carried out if required by Environmental Protection Department through the coordination of Lands Department as part of the Transmission Route application process.

Moreover, the Stage 2 transmission link will not be needed until 2007 and the load growth pattern in Hong Kong Island East has to be further studied, the location of the receiving substation and the load injection arrangement into Hongkong Electric network have yet to be identified. The Stage 2 cable routing cannot be determined now. After the receiving substation is identified and basically agreed with Government HEC will carry out detailed route and landing points selection. EIA study will then be conducted for the selection route.

"This section presents a summary of the Hyder Consulting Ltd. Report on Selection of Stage 1 Transmission Route for the Additional Generating Facilities at Lamma Power Station and three associated *Technical Reports* on the alternative transmission routes proposed which have been submitted to DLO on 8 May 1998.

- *Main Report:* Selection of Stage 1 Transmission Route for the Additional Generating Facilities at Lamma Power Station Extension;
- *Technical Report No. 1*: Routes on Hong Kong Island;
- *Technical Report No. 2*: Submarine Cable Routes; and
- *Technical Report No. 3*: Routes on Lamma Island.

1.1.2 *Study Objectives*

As an integral part of the construction of the proposed Lamma Extension itself, a secure power transmission network must be developed and implemented in parallel. The Site Search Study and Stage 1 EIA mentioned above also covered the preliminary study of Transmission Route from Lamma Extension to the load centre at the northern belt of Hong Kong Island.

The proposed network is planned to be installed in two stages, covering the western and eastern areas of Hong Kong Island respectively.

To meet with the commissioning and commercial operation of the first generating unit at Lamma Extension in 2003, the Stage 1 transmission network between the source and the proposed receiving substation in Wanchai area has to be commissioned by December 2002.

The objective of the transmission route study was to evaluate and identify the optimum transmission method and the preferred Stage 1 transmission route from Lamma Extension to the proposed new receiving substation in Central / Wanchai area. *Figure 1.1a* shows the range of routes considered.

1.1.3 *Approach to Cable Route Selection*

The first step in the preliminary transmission route search involved defining the scope of the search area, which covers the area between Lamma Extension and landfall at Telegraph Bay. Overhead line will not be constructed in the proposed transmission system because of system security, reliability and environmental reasons. Therefore, the transmission route study was confined to the identification and selection of transmission method by means of 275 kV insulated submarine and land cables.

The second step was to search for suitable sites for key locations, such as potential submarine cable landing points, existing HEC tunnel portals and potential new cable tunnel portals which portrayed all environmental and engineering constraints in constraints map. Potential routes were established by linking the key locations by the combination of submarine and underground cables and cables in both existing and new tunnels.

Following by the potential routes identification, the routes were evaluated by a two-stage screening process, i.e. coarse and fine screening until the preferred cable route was identified.

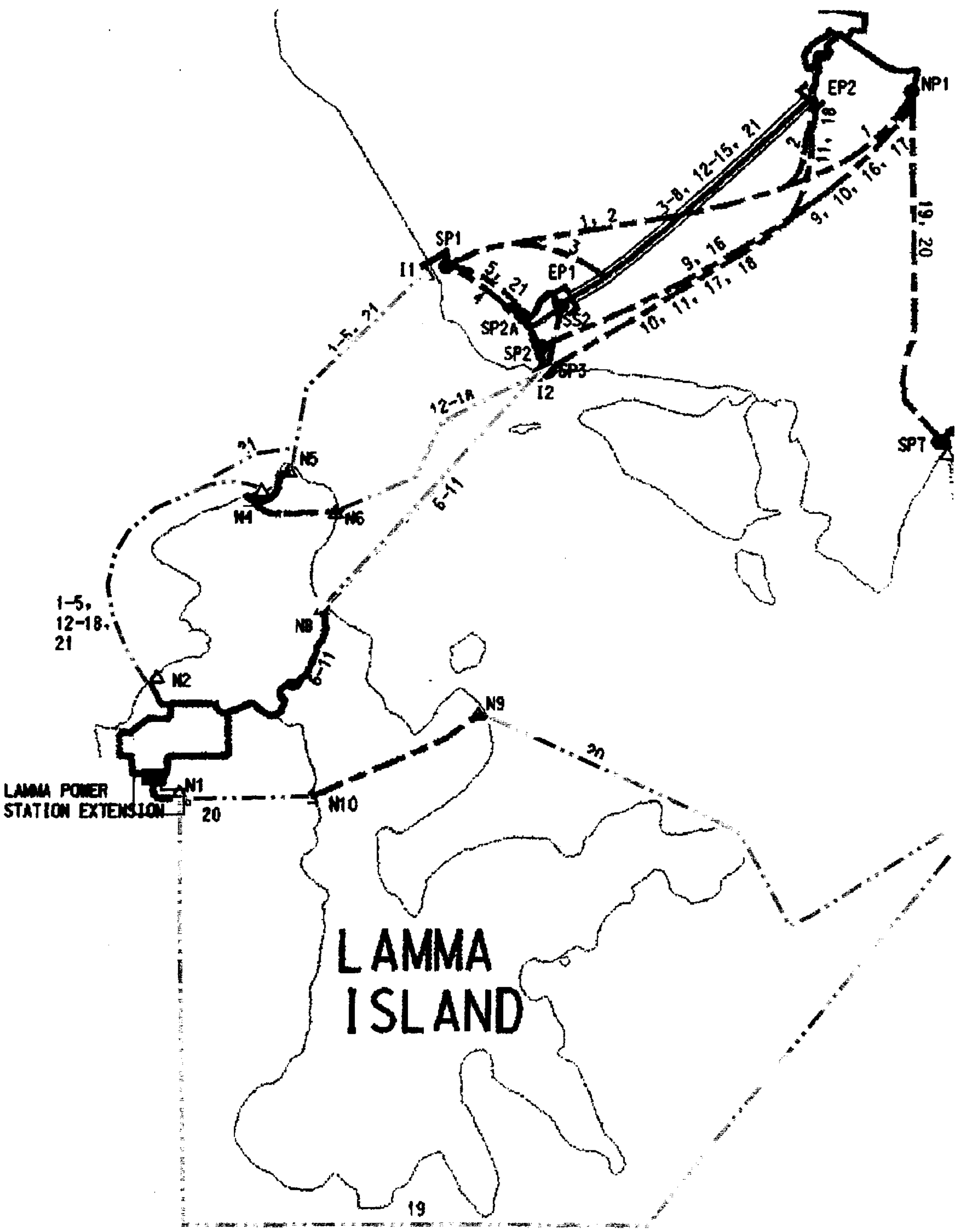

FIGURE 1.1a

SUMMARY OF PROPOSED ROUTE FOR TRANSMISSION LINE

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All potential routes identified were assessed against critical engineering, environmental and operational factors. Subsequently, those routes which were considered to be unacceptable under one or more factors identified, were excluded from the fine-screening evaluation.

The fine evaluation exercises were carried out with the assistance of the computer-aided evaluation technique "Decisionpad", but with different level of input details. This allowed for a very structured evaluation process, provided for a mixture of qualitative and quantitative indices, and permitted a wide variety of "what if" types of sensitivity analysis.

This approach has been very successfully applied in several recent major HKSAR Government studies. The input to the evaluation was prepared as both as planning and environmental constraint maps and also in terms of engineering, planning, environmental and operational parameters, as well as cost and practicability.

1.2 *TRANSMISSION TECHNOLOGY*

1.2.1 *Submarine Cable and the Installation Method*

Design Of Submarine Cable

Several designs of submarine cable have also been considered for the Lamma Extension to cater for large capacitive charging current and increased losses over potentially long transmission distances. As compared with conventional Kraft paper insulated cable of same transmission capacity, Polypropylene laminated paper (PPLP) insulated cable requires a smaller conductor size due to its superior electrical properties and lower insulation losses. However, PPLP cable is generally more expensive than Kraft paper insulated cable of same capacity in terms of capital investment.

The laying of the 275kV submarine cables for Lamma Power Station undertaken by HEC in 1981 and 1986 was one of the largest submarine cable projects ever managed. These cables comprise a 1,300mm^2 copper conductor with oil-filled Kraft paper insulation. lead sheath, double steel wire-armoured and PVC over sheath. Each circuit has a capacity of 550MVA. The performance of these cables has been excellent and there is no defects nor forced outages on the submarine cables.

For standardization and spare holding, the same submarine oil-filled cable, as employed in the existing network, will be used for Lamma Extension.

Submarine Cable Protection

Submarine cables must be properly protected against mechanical damage because it is extremely difficult to retrieve a buried cable and repair at sea without downgrading its quality and performance. Equally, it is too costly to replace the damaged cable completely from both landing points, apart from the difficulty in locating another submarine route with adequate separation from the existing cables in service.

In view of the importance of the submarine cables which are laid across the East Lamma Channel, it was necessary to take measures to prevent damage to the cables from passing ships which cast and drag anchor in trouble. To cope with this problem, the cables had to be buried deep enough to avoid damaging by a casting or dragging stockless anchor weighing 10 ton.

The penetration depth of the anchor was actually measured by HEC. In an experiment carried out in 1980, a 10 ton anchor was cast and dragged. The penetration depths when casting and dragging the anchor in the softest part of the channel were measured.

Based on the experimental results and considering the possibility of hitting a cable directly was very low when casting anchor, the burial depth was decided to be 3.5 m to avoid dragging anchors as a guideline. From HEC's past experience, submarine cables will be buried between 1 m and 3.5 m below the seabed, depending on the risk of external damage.

For economic and efficient laying operation, the separation of cables of the same circuit will be 1.5 m, while the minimum separation of adjacent submarine cable circuits will be 50 m for security reasons.

Submarine Cable Laying Operations

Initially, landing point structures with cable slipway will be constructed at both shores for the landing, anchoring and jointing of submarine cables.

There will be no dredging and dumping operations associated with the cable laying operation, except for extremely hard areas in the seabed and short sections near the landing points.

Since the landing points are in shallow water, a short underwater trench (about 150m long x 3.5m wide x 1.5m deep for each 275 kV circuit) will be excavated before cable laying.

The formation of main cable trench itself will not require dredging. Cables will be laid 3.5 m into the seabed by means of a burying machine. For each trip of laying operation, three cables can be laid at a distance of 1.5 m apart.

Three small trenches on the seabed will be ploughed by the burying machine while it is travelling and the cables laid into the trenches simultaneously. If the seabed is too hard, trenches will be formed with the assistance of high pressure water jets equipped on the burying machine. The maximum pressure of the water jets is about 4 kg/cm^2 and can be regulated according to the hardness of seabed material encountered. In such case, a small amount of sediment will be stirred up - approximately 3 to 4 m^3 per metre travelled (per circuit or 3 cables). The majority of this sediment will subsequently settle back over the cables. Impacts from the physical disruption to the benthic environment generated by the cable laying machine are localised, temporary and transient.

1.2.2 *Land Cables and Their Installation*

Existing Systems

In existing HEC system, the standard transmission land cable is self-contained oil-filled type with either Kraft paper or PPLP insulation and having a circuit capacity of 550 MVA. The oil-filled cable is the most widely used and reliable type of transmission cable throughout the world since the early 1920's. Biodegradable low viscosity mineral or synthetic oil, under pressure, is employed in this type of cable as an impregnating medium and to obviate the formation of voids within the dielectric under all operating conditions.

The adoption of different conductor size cables has been studied and it is concluded that the 550 MVA capacity offers the best balance of cost, security and reliability. For standardisation purposes, the proposed transmission land cable for Lamma Extension will be of the same design as existing ones.

Land Cable Installation

All land cables for Lamma Extension will be buried, for the protection of both the cables and the visual amenity of the area through which they pass. Three cables of the same circuit will be installed in flat formation with cable separation of 300 mm and buried at a depth according to Highways Department's Technical Circular. Minimum separation of adjacent circuits in public road will be 1 m to reduce mutual heating effects and for security reasons.

In order to minimise impacts to visual amenity, noise problem, dust pollution and interruptions to traffic, HEC has established proprietary cable tunnels and a performed cable promenade on Hong Kong Island. The cable tunnels comprise the Wah Fu - Bowan Tunnel (which is 3.1 Km long), the Parker - Nam Fung Tunnel (5.7 Km) and the recently completed Tin Wan Tunnel (1 Km). The performed promenade has been constructed at Deep Water Bay. In addition to the benefits associated with minimising the disruption associated with opening road surfaces or establishing extensive overhead transmission lines, the existing cable installations provide greater protection to the cables and have proved extremely cost-effective. HEC will continue to install land cables for Lamma Extension using similar approach.

1.2.3 Communication Facilities

For Lamma Extension, voice, image, data and computer communication between the station, the system control centre, corporate headquarters and other offices will be indispensable. Optical fibre composite pilot cables will be laid in conjunction with the transmission circuits. For each stage of construction, two to three optical fibre composite pilot cables will be installed. In addition, microwave links between Lamma Extension and suitable sites on Hong Kong Island will be required as backup for the cable network.

1.3 REQUIREMENTS FOR PROPOSED DEVELOPMENT

1.3.1 Transmission Method

Based on land requirement, and technical (including system security, reliability, environmental) and economic considerations, an AC 275 kV transmission system with the following construction method will be adopted :

- a combination of insulated submarine and underground cable system (no overhead line will be installed; and
- tunnel and promenade options, supplemented by direct burial beneath urban roads, will be used as far as possible for the installation of new transmission cables (if appropriate, the use of existing cable tunnels will also be considered).

1.3.2 *Cable Type and Size*

For standardization and spare holding purposes, the proposed transmission network will adopt the same cable types as that widely used in the existing HEC system, with a circuit capacity of 550 MVA. The standard cable types are:

- *Submarine Cable*: single core 1,300mm² copper conductor Kraft paper insulated lead sheath double steel wire armour oil-filled cable; and
- *Land Cable*: single core 1,300mm² copper conductor Kraft paper insulated corrugated aluminum sheath oil-filled cable with nylon jacket.

Typical cable installation details are given in *Annexes C1-1* and *C1-2* to this Report.

The following standard cable installation conditions will be applied:

1.3.3 *Installation Conditions*

- *Submarine Cable:* Three cables of the same circuit will be installed in one go with cable separation of 1.5 m and burial depth between 1.0 m and 3.5 m, depending on site conditions. Minimum separation of adjacent submarine cable circuits will be 50 m. Typical Submarine cable route corridor for three circuits of 275 kV cables and associated communication cables will be 250 to 300 m.
- *Land Cable*: Three cables of the same circuit will be installed in flat formation with cable separation of 300 mm and buried with 1.5 m coverage from ground surface. Minimum separation of adjacent circuits in public road will be 1m. Typical land cable route reserve for two and three circuits of 275 kV cables will be 2.6 m and 4.2 m respectively.

1.4 METHODOLOGY FOR ROUTE SELECTION

1.4.1 *General Approach*

The study was undertaken by a team consisting of specialists in engineering, planning, environmental and marine disciplines, who worked as an integrated study team covering the main issues to be addressed. Determination of the preferred route included the following processes:

- information collection, consolidation and review;
- constraint mapping; and
- potential route identification and route technical evaluation.

Details of each process are reported in the followings paragraphs.

1.4.2 *Information Collection, Consolidation and Review*

Information collection began immediately upon the commencement of the study commenced. Information was collected from the HEC in-house archive, major utility companies and relevant Government departments.

Information Consolidation and Review

This consisted of information collected from HEC regarding past experience, engineering details relating to cable installation, layout of associated facilities and operational constraints in order to determine the main project parameters and priorities.

Utilities and Land Status Check

For the areas likely to be considered in the route evaluation process, a major utilities layout search was undertaken, including:

- Drainage Services Department;
- Highways Department;
- Water Supplies Department;
- The Hongkong Electric Company, Limited;
- Hong Kong Telecom Limited;
- Hutchison Telecommunications (HK) Limited;
- New T & T Hong Kong Limited;
- New World Telephone;
- Wharf Cable Limited;
- Rediffusion (HK) Limited; and
- Hong Kong & China Gas Co. Ltd.

The collected utility layout information was consolidated for assessment and constraint evaluation purposes, and the main elements likely to affect the cable routes plotted on digital 1:1000 scale maps, for further reference and information. Where formal confirmation of utility information was not received from the various agencies in time for inclusion in the final report, engineering judgement was applied by experienced personnel after informal discussion with the agencies concerned.

For specific constraints in relation to routes affecting, or likely to be affected by, the requirements of other major infrastructure projects, informal meetings with the relevant Government Departments were held to ascertain major project criteria.

Particular attention was paid in the initial selection of the list of potential routes to align the routes in such a way as to avoid areas where land issues could be problematical (eg through or under private land).

1.4.3 *Constraint Mapping*

Based on the information collected, an appropriate Constraints Matrix was developed from the following professional assessments for the further route evaluation and assessment exercise.

Engineering Assessment

All of the major engineering issues associated with each potential cable route were examined. These are detailed in the following lists.

<u>Land Cable Requirements</u>

- under roads
- in structural troughs
- adjacent to other utilities

- access for maintenance and repair
- jointing facilities
- hydraulic system limitations and requirements
- construction programme

Cable Tunnel Requirements

- cable spacing and protection
- access for maintenance and repair
- installation difficulties
- ventilation
- jointing facilities
- hydraulic system limitations and requirements
- fire fighting equipment requirement
- geotechnical constraints

Submarine Cable Requirements

- installation and handling criteria
- cross-over of existing submarine utilities
- spacing and depth requirements
- access for maintenance and repair
- jointing facilities
- anchor drop and drag protection.
- cable procurement programme
- installation methods and programme
- landing site requirements

Marine Traffic Impact Assessment (MTIA)

The MTIA examined the potential routes for the submarine cables from three main aspects. Firstly, the potential for damage to the cables from shipping, either as a result of anchoring or stranding. Secondly, the relative difficulties of installation on each route were undertaken in terms of the likely marine traffic regime at the time of installation. Any necessary traffic management arrangements, diversions or restrictions on working periods were determined. Thirdly, the likely overall cost of the cable laying operation was determined, giving consideration to length of route, jointing and landing point restrictions and overall programme constraints.

Given the importance of the waters around Lamma and in the East Lamma Channel to Hong Kong's shipping, it is essential that safety is not compromised by the submarine cable-laying operations. The MTIA therefore also covered the assessment of the submarine cable-laying operations in relation to vessel movements around Lamma Island, to ensure that this could be undertaken in a safe and practical manner.

Assessment on Environmental Issues (AEI)

As the cable is primarily a narrow linear underground feature adjacent to other existing utilities, other than for the submarine section and intermediate/terminal stations, environmental issues will be largely construction related. Therefore, on Hong Kong Island, a relatively simple assessment on the environmental issues was prepared, generally sufficient for conceptual approval. Particular attention was also paid in the initial selection of the list of the potential routes to align the routes in such as way as to avoid locations where the works could encroach into Designated Project Areas under the EIA Ordinance.

The issues related to permanent works such as the tunnel portals, submarine cable landing sites and any roadside cable troughs were dealt with in more detail as appropriate. Generic treatments and environmental mitigation measures were recommended for typical underground installation sections, treated on a site-specific basis.

Given the relatively undeveloped nature of the Lamma Island coastline, it is considered that the landing points will require particular attention, and a more significant AEI was carried out, with the visual impact being a prominent feature. This more detailed environmental study extended to the submarine cable installation proposals. Appropriate mitigation measures were proposed, and considered such matters as seabed contaminated muds, areas of SSSI, on sealife, etc., based on existing information and site inspection.

The assessment on environmental issues took account of all current relevant legislation, guidelines and practice notes, of which the key references for this study are:

- the *Noise Control Ordinance* and subsidiary requirements;
- the *Air Pollution Control Ordinance;*
- the *Water Pollution Control Ordinance* and *Technical Memorandum;*
- the *Marine Sediment Regulations, Dumping at Sea Ordinance* and *Technical Circular No. 1-192: Classification of Dredged Sediments for Marine Disposal;*
- the *Waste Disposal Ordinance;*
- the *Antiquities and Monuments Ordinance;*
- the *Hong Kong Planning Standards and Guidelines;*
- the *Town Planning Ordinance;*
- the *Forests and Countryside Ordinance;*
- the *Wild Animals Protection Ordinance;* and
- the *Foreshore and Seabed Ordinance.*

The assessment followed the *EIA Ordinance (Cap 499), Section 16,* and associated *Technical Memorandum* which provides guidance on the methodology to be adopted for the assessment process. This AEI assessed and evaluated the various proposed transmission route options with the objective of selecting a route that minimises environmental and nuisance impacts to identified sensitive receivers. Any route alterations identified which offered significant environmental gain were also considered during the course of the study.

Planning and Landscape Assessment

The likely planning constraints associated with the various potential routes were identified and evaluated in terms of their likely effect on route location, construction access, wayleave requirements, etc. The latest ODP and OZP's were examined to determine the latest planning intention for the land affected by the works to ensure compatibility with proposed uses, and to determine whether any future development proposals are likely to act as a constraint to the proposed cable routes. Given previous experience in the resolution of land and wayleave acquisition through or beneath private lots, the identification of land status in this respect is important. Wherever possible, the routes under consideration were therefore chosen to avoid private lots. The potential routes traverse several areas where the existing landscape quality is high and there are important conservation objectives already in place. Consequently, as a particular element of the route assessment process, a review of existing landscape quality and issues was undertaken, and amelioration proposals developed for the preferred route.

Key Issues

In the above assessment, the following key issues have been addressed: -

Key Engineering Issues: The assessment covered all general cable system requirement and civil engineering concerns to identify potential constraints and propose engineering solutions. Particular attention was paid to the issue of cables following existing highways, either underground or in structural cable troughs. The likely effects on traffic flows were considered, for both the construction phase and for ongoing operations and maintenance. The engineering key issues which were addressed were as follows:

<u>General Civil Engineering</u>

- landing points for submarine cables - construction options
- road crossings
- elevation changes and limitations on gradients
- access for construction
- construction on steep slopes
- traffic diversion requirements
- generation of construction traffic
- materials handling and spoil disposal issues
- potential for crossing existing submarine water mains to shorten routes
- construction traffic effects

<u>Geotechnical</u>

- any current or proposed slope works which may affect the proposed routes
- identification of any potentially dangerous slope or retaining walls on the routes
- ground conditions at potential landing sites and tunnel portals
- geotechnical conditions along the submarine cable routes

<u>Tunnels</u>

- geological conditions along proposed routes
- portal arrangements
- typical tunnel sections and joining chambers
- effect on adjacent utilities and property
- ventilation
- gradient constraints
- construction method options
- existing tunnel condition & capacity
- likely FSD requirements
- potential for interconnection of new and existing tunnels

Cable System Requirements :

This included security of submarine cables, security of land cable, access for inspection and O&M of cable, and cable hydraulic system, as follows:

Security of Submarine Cable

- sufficient burial depth to prevent damage by dropped or dragged anchor
- adequate separation of cable slipways to avoid all cables damaged in a single accident
- cable rating consideration
- adequate separation from existing & future submarine installations
- sufficient separation from gazetted anchoring and dredging zones

Security of Land Cable

- sufficient burial depth and adequate mechanical protection
- cable rating consideration
- sufficient circuit separation
- cable route should be away from hazardous areas and dangerous slopes
- minimum chance of cable diversion required in future

Access for Inspection and O&M of Cable

- all tunnel portals, landing points, joint bays, manholes and handholes readily accessible from public road for inspection, operation and maintenance
- cable trench able to be re-excavated and cables exposed for maintenance

Cable Hydraulic Profile

- each hydraulic section to have a potential head of less than 45 m to avoid excessive pressure on the metal sheath of cable - this will limit the height of vertical cable shaft and level difference between two joint bays.
- length, gradient and vertical profile of a cable tunnel to be carefully designed to avoid cable oil tanks inside it so that fire-fighting equipment can be eliminated.

Key Marine Issues: The key Marine Impact Assessment issues were as follows:

- *Evaluation of Existing Traffic Patterns*: time lapse video photography of area over at least 48 hours, and examination of the distribution of ocean-going vessels across the East Lamma Channel;

- *Baseline Marine Activity*: visual surveys of all relevant marine activity within the Study Area and evaluation of any impact on cable laying operations;

- *Future Marine Activity within Study Area*: review of future traffic forecasts, and the development of port operations that may limit the cable alignment;

- *Metocean Environment*: examination of the wave, wind and current regime within the area, and any impact on cable-laying operations;

- *Review of Cable Laying Operations*: examination of cable laying vessels in order to determine speed and hence duration of potential obstructions;

- *Assessment of Marine Risk During Construction*: evaluation of likely encounter risk for cable-laying vessel with ocean-going vessels and other craft; and

- *Traffic Management, Aids to Navigation, Contingency Plans and Mitigation Measures*: evaluation of requirement for temporary buoys/lights/"guard vessels" required to maintain safety in the East Lamma Channel, and evaluation of navigable width of channel during cable-laying operations.

Key Environmental Issues: Environmental issues addressed within this initial assessment involved potential impacts on land and in the marine environment, particularly associated with landing points and tunnel portal sites. The key issues included the following:

- dredging of marine muds and potential impacts on fisheries and benthic fauna handling and disposal of contaminated sediments;
- fresh and marine water quality impacts during construction;
- ecological impacts on terrestrial and marine fauna and flora;
- habitat loss or disturbance;
- noise and dust construction impacts;
- archaeological, historical and cultural impacts; and
- landscape and visual impacts on land and coastal areas.

Key Planning & Land Issues included:

- compatibility with the broad planning intention for Hong Kong Island and Lamma Island;
- compatibility of the proposed landing points with *'Coastal Protection Area'*, *'Green Belts'*, *'Open Space'* and *'Promenade'* along the southern coastline of Hong Kong Island and the *'Countryside Conservation Areas'* on Lamma;
- compatibility of the proposed tunnel portals with the *'Green Belts'* on Hong Kong Island;
- compatibility of the Switch Station and associated routes with Central and Wanchai Reclamation;
- compatibility of the alignment of underground routes with the existing/planned urban setting on Hong Kong Island (Wah Fu, Telegraph Bay, Aberdeen, Mid-Level East and Admiralty);
- potential conflict with the planned developments and facilities;
- interface with the *Planning and Development Study of Hong Kong Island South and Lamma Island;*
- interface with the *Infrastructural Works for Housing Development at Telegraph Bay Engineering Feasibility Study;*
- private lots resumption requirement;
- landscape and visual impacts on the *'Green Belts'* and necessary mitigation measures;

- implication of planning procedures (such as rezoning or planning application), if any, on the implementation program of the new electricity supply system;

- co-ordination between the planning procedures and procedures for authorisation under the Foreshore and Sea-bed (Reclamations) Ordinance; and

- anticipated public reaction to the proposal.

Constraints Maps

Several consolidated constraint maps have been produced by Hyder Consulting Limited (available on request), which illustrate the main constraints faced in the route selection process through the project. In addition, a separate Environmental Constraints Map, Figure 1.4a, has been included which identifies the main environmental constraints and concerns of the project.

1.4.4 *Potential Route Identification and Route Evaluation*

Potential routes were identified after construction of the constraints maps with the basic selection criteria as follows:

- minimising environmental/visual impact, landscape disturbance, inconvenience to public;

- engineering and planning feasibility;

- feasibility of a connection between Lamma Extension and the proposed receiving substation at Wanchai area within the project time scale;

- optimising development costs; and

- avoiding private land and sensitive areas.

The identified potential routes were then screened down to a preferred route by a two-stage evaluation exercise. In the evaluation process, the route options were reviewed and assessed, and consultations held with key HEC staff on both the validity of data input assumptions and updating of project information. The routes were judged against a number of engineering, planning, environmental and marine constraints and criteria until the most practical and cost effective route was identified.

Potential Route Identification

Based on the constraints maps, possible key locations such as potential landing points, existing HEC tunnels which have spare room for more cables and potential new tunnel portal location were identified. Potential routes were established by linking the key locations by the combination of submarine, underground cables and tunnel cables in both existing and new tunnels.

Route Evaluation Technique

Following the potential routes identification, the routes were evaluated by a two-stage-screening process (ie coarse and fine screening) until the preferred cable route was identified.

- Screening Evaluation

All potential routes identified were assessed against the critical engineering and operational factors, such as:

- extremely high operational risk, or security of the system (eg potential physical damage to the cables from outside effects such as shipping);
- major construction programme limitations (eg tunnels over 2 km in length which would be difficult to complete in time for the required power supply programme); and
- major environmental effects (eg highly visible structures and permanent environmental or landscape damage) in the fine-screening exercise.

Those routes which were considered to be unacceptable under one or more factor identified, were then excluded from the fine-screening evaluation.

The fine evaluation exercise was carried with the assistance of the computer-aided evaluation technique "Decisionpad". This technique is based upon a spreadsheet type analysis matrix under which up to 250 options can be compared on up to 250 criteria. The principle advantage of this software is that it allows any number of "what if" scenarios to be modelled with weighting criteria. The Decisionpad programme has a proven track record and has been used as the primary site and development option selection tool for a number of studies, including the Hong Kong Science Park Study, Kowloon Point Development Feasibility Study, Lamma Quarry Rehabilitation Study and the Central Kowloon Route Study on Alternatives.

In the fine evaluation exercise, all of the various constraints facing each route shortlisted from the coarse screening were marked in terms of the degree of difficulty or adverse effect for all engineering, environmental, planning and marine traffic issues, and their relative merits compared. A series of evaluations were carried out to compare the relative merits of each route under consideration. This was carried out without reference to overall cost, in order to determine the most desirable route from the point of view of acceptability, programme and technical feasibility. A total of eight routes were reviewed in this way, using a qualitative marking system applied to each and every element of each route according to different degree of desirability.

Selection Criteria

A comprehensive range of selection criteria was developed for each of the engineering, planning, environmental and marine aspects considered to be relevant to the cable route issue. All routes were then evaluated by specialist teams from each discipline, using the route assessment marking system referred to above. These criteria were then grouped into topics, and each topic in relation to its relative importance. Each of the various routes was considered in terms of engineering, environmental, planning and marine issues.

The various weighted marks were then compared with each other in an overall assessment matrix, using the "Decisionpad" system, to determine the combination of route elements that demonstrated the minimum levels of difficulty and adverse effect, and the resulting ranking of routes was reviewed by the assessment team to confirm that no abnormalities or inconsistencies existed in the result. The preferred overall route selected by this process was then re-examined to confirm its selection.

Engineering Issues: The various engineering criteria relevant to the design and construction of each element of the various routes were grouped for the purposes of assessment into the categories shown below in *Table 1.4a*.

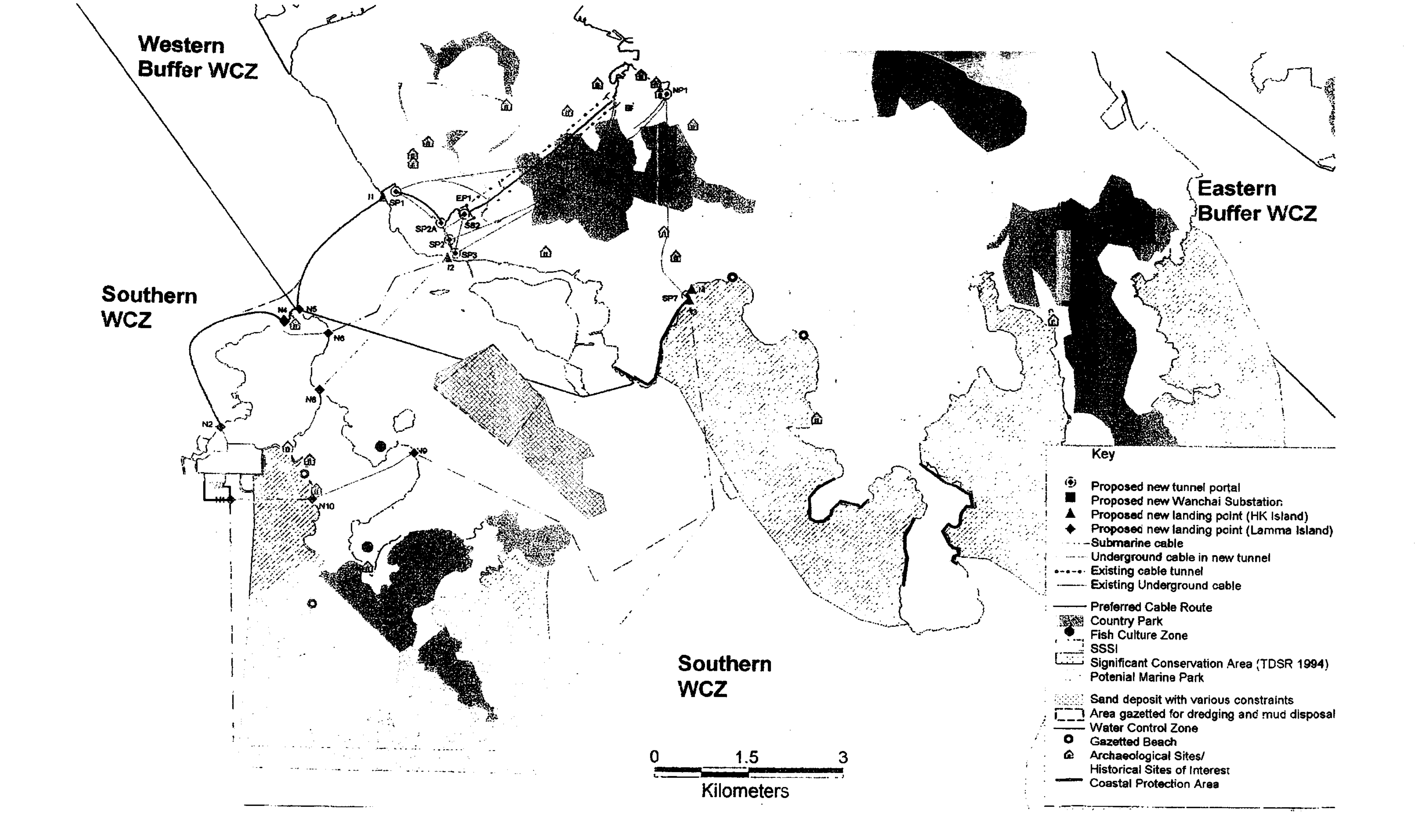

FIGURE 1.4a

ENVIRONMENTAL CONSTRAINTS AND CONCERNS FOR TRANSMISSION ROUTE

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DATE: 09/11/96

Environmental Resources Management

ERM

Table 1.4a ***Engineering Sub-criteria for Weighted Matrix Evaluation***

Engineering Sub-criteria	Relative Importance	Parameters
Geotechnical Conditions	*Highly Important*	Rock conditions for tunnelling; foundation conditions; settlement susceptibility; excavation difficulty; slope stability
Construction Access	*Highly Important*	Land traffic access; sea access; working space availability; material delivery and removal.
Construction Traffic	*Less Important*	Generation of construction traffic; local traffic diversions; lane closures and traffic delays; public transport route disruption.
Construction Restrictions	*Less Important*	Blasting restrictions for tunnelling works; working hour restrictions; weather susceptibility; interface with utilities.
Cable System Requirement	*Most Important*	Security of cable, cable rating, access for O&M, Hydraulic profile
Design Difficulty	*Highly Important*	Modification of existing facilities, sea/land interfaces; geometric and alignment issues; structural systems.
Construction Programme	*Important*	Site establishment; materials acquisition; duration of construction works, spoil removal problems; interfaces.

Environmental Issues: A general weighting was given to environmental impacts of each of the routes. This value was derived from a weighting scale given to the environmental issues of concern as indicated in *Table 1.4b* below. In particular, long term impacts such as a loss of vegetation or damage to sites of archaeological importance, and impacts which resulted in a permanent change to the landscape and visual character of the area have been given a greater weighting compared with short term impacts such as nuisance (eg noise disturbance, dust, footpath disturbance).

Table 1.4b ***Environmental Sub-criteria for Weighted Matrix Evaluation***

Environmental Sub-criteria	Relative Importance	Parameters
Ecological Impact	*Important*	Habitat loss or damage, loss or disturbance to fauna and flora
Landscape and visual Impact	*Most Important*	Impacts on views/ aesthetic quality of the landscape from key visual receptors
Water Quality	*Less Important*	Impacts on freshwater and marine environments
Waste Management	*Less Important*	Waste generation and disposal required from construction
Nuisance Impacts	*Less Important*	Noise and dust impacts/general nuisance during construction only
Archaeological	*Important*	Loss or damage to historical / cultural resources

Planning and Land Issues: The various planning aspects of the project which are considered most likely to have an influence on the selection of the various facilities sites were considered, particularly the restrictions and planning processes which effect the project programme, as summarised in the following *Table 1.4c*.

Table 1.4c *Planning and Land Sub-criteria for Weighted Matrix Evaluation*

Planning Sub-criteria	Relative Importance	Parameters
Land Availability	*Most Important*	Current Land Use Status; Potential conflict with Private Lots; Existing Wayleaves.
Reclamation Requirements	*Most Important*	Potential Limits on Available Areas; Extent of Reclamation Required; Likely Environmental and Landscape Impacts and Objection to the Reclamation;.
Public Acceptability	*Important*	Potential Sources and Extent of Objection; and Anticipated Difficulty in Public Consultation Processes
Compatibility with Planning Intentions	*Important*	Conformity with Current Planning Intention designated in TDSR, Outline Zoning Plans and Outline Development Plans; Need for Planning Permission and Interface with ongoing Government Studies.
Constraint on Future Development	*Less Important*	Likely Constraint on Future Property Development: Strategic Highway Links and Extension of Major Utilities.

Marine Issues: The main issues related to the laying of submarine cables across the busy Lamma Channel were reviewed in terms of the criteria listed in the following *Table 1.4d*.

Table 1.4d *Marine Sub-criteria for Weighted Matrix Evaluation*

Marine Sub-criteria	Relative Importance	Parameters
Construction Difficulty	*Important*	Effect on Marine Traffic of Cable Laying Works; Collision Risk During Construction; Potential Weather Effects on the Works.
Effect on Future Port Planning	*Most Important*	Need for Revision of Permitted Anchorages/Fairways; Limitations on Future Reclamation and/or Dredging Works
Effect on Existing Utilities	*Important*	Requirements for Utility Protection During Construction; Permanent Constraint on Other Utilities.
Programme	*Important*	Restrictions on Construction Operations; Interface with marine Traffic & Work Scheduling

The process evaluated the routes as a whole, from the origin at the Lamma Power Station site, across or around Lamma Island, across the Lamma Channel, and across Hong Kong Island, to determine the optimum overall preferred route.

In the overall assessment process, the criteria which affected the key issues relating to the cable system requirements were used to assist in the assignment of the appropriate marking for each criteria.

1.4.5 *Construction Programme and Relative Costs*

Relative cost indices for the various elements of the cable routes were prepared for use in the overall evaluation process, once the technical issues had been evaluated and compared. These indices included elements for both the cable installation and the civil works, and were used to compare the order of magnitude of likely costs for the routes overall.

According to the site and technical constraints, conditions of approval and consents given by relevant Government Departments, etc., a programme for the implementation and construction of the preferred cable route was then prepared.

1.4.6 *Route Selection Report*

The report preparation process involved the compilation of a Main Report, covering:

- the background to the project;
- the technology involved;
- descriptions of the route elements;
- descriptions of the overall routes;
- a summary of the various constraints on each route;
- the evaluation process;
- recommendation of the optimum route; and
- an implementation programme.

The routes were defined on plans at 1:20,000, 1:10,000 an 1:5,000 scale, with local key issues dealt with at 1:1,000 scale. Details of the preferred route were prepared as 1:1,000 scale digital plans in an AutoCAD compatible format, with relevant major utility information also shown for future planning and design purposes. At the location of significant features or obstructions, and for typical engineering details, larger scale plans were prepared as appropriate.

In addition, the following three Technical Reports were prepared, each containing constraint details of each element of the various routes, covering the following topics:

Technical Report No. 1	*Routes on Hong Kong Island*
Technical Report No. 2	*Submarine Cables Routes*
Technical Report No. 3	*Routes on Lamma Island.*

1.4.7 *Feasible Landing Points and Tunnel Portals*

From the information collection and constraint mapping exercise, possible key locations for landing points and tunnel portals were identified for potential route development. This section described the the key locations assessed and the related constraints.

1.4.8 *Submarine Cable Landing Points on Lamma Island*

The locations of the possible Submarine Cable Landing Points on Lamma Island are shown on *Figure 1.1a*, and the main constraints associated with each location are listed as follows:

N1 - Lamma Extension

Location: This landing point would be located at the south eastern corner of the new reclamation created for the power station extension, facing south, constructed as part of the new sea wall.

Constraints: There are few engineering constraints facing the construction of this facility other than the need to bring in construction materials by sea to Lamma

Island. As some excavation and reclamation works will be required, there may be short term construction phase impacts on water quality. No planning constraints are anticipated.

N2 - Yung Shue Wan South

Location: This landing point would be constructed on the southern shore of Yung Shue Wan, facing north on a steep and rocky coastline.

Constraints: The main constraint will be the need for all construction materials and equipment to be brought in by sea, and the need to form an area of reclamation, with associated gazettal requirements. Some local ecological impacts may be experienced. The site is in a Countryside Conservation Area, although this is not thought to be a problem, given the nature of the existing surroundings.

N4 - Pak Kok Shan Tsuen

Location: This landing point is located on the north shore of Lamma Island at Pak Kok Shan Tsuen, west of the Pak Kok peninsula, adjacent to a small jetty. Its location has been chosen so that submarine cables from Landing Point N2 can be brought ashore to cross the existing 300 mm diameter WSD submarine water main which runs from Sandy Bay on Hong Kong Island and comes ashore at Lamma Island just west of Pak Kok.

Constraints: The construction constraints will be very similar to those for landing point N2, but with deeper water to contend with, and a more exposed aspect. Although the coastal hillside is steep, there is some room for a works area on land. However, all materials will have to be brought in either directly by sea or via the narrow coastal footpath from Yung Shue Wan. The site is also close to existing residential areas, and some local objections may be met. Excavation effects are likely to be minimal.

N5 - Pak Kok Tsui

Location: This landing point is located on the very rocky north eastern shore of Pak Kok peninsula. Its location has been chosen in conjunction with that for landing point N4, so that, having crossed over the WSD water main, the cables can be launched across the Lamma Channel to the Telegraph Bay landing point I1.

Constraints: The construction constraints will be very similar to those for landing point N3, but with deeper water to contend with, and a more exposed aspect. It is likely that most materials will have to be brought in to the bay west of the peninsula or via the narrow coastal footpath from Yung Shue Wan, and then across the peninsula to the site. The site is in a Countryside Conservation Area, but remote from residential areas.

N6 - Nam Tsui

Location: This landing point location is on the eastern coast of Lamma Island, south of the existing HEC submarine cable landing point from which cables run to Wah Fu. Its location was chosen so that a cable tunnel could possibly be constructed from landing point N4, effectively by-passing the WSD water mains. The cable route across the Lamma Channel from N6 to Hong Kong Island would then be to landing point I2 in Kellett Bay, in order to avoid the existing Lamma - Wah Fu cables.

Constraints: The conditions at this location are similar to those for landing point N4, only less exposed and with slightly shallower water. Again, construction access would be mainly from the sea, although the existing HEC access/maintenance road to the adjacent cable landing point could be utilised to some extent. Being close to woodland and scrub on the adjacent hillside, there is potential for long term ecological impact.

N8 - Luk Chau Wan

Location: The site of this landing point is in the bay just north of the existing HEC cable landing point in Luk Chau Wan, on Lamma Island's east coast. The location was chosen so that the potential submarine cable link from Lamma Island to Hong Kong Island at Kellet Bay could be constructed using an overland cable link across Lamma Island from the power station site, thus reducing the length of submarine cables required.

Constraints: The engineering construction constraints would be similar to those for landing point N6, but with more potential for land access from Yung Shue Wan along the existing HEC cable route to the adjacent existing landing point. This proposed landing point, together with the adjacent existing one, would form a platform of reasonable size for a local open space. Visual impacts and nuisance impacts would be minimal in this area and long term landscape impacts would also be minor as the site has already been altered to accommodate the existing landing point. A key concern would be the potential for impacts upon the Fish Culture Zone (FCZ) at Lo Tik Wan.

N9 - Luk Chau Shan

Location: This site is located on the north-eastern tip of the Luk Chau Shan headland, facing the Lamma Channel. The location was chosen to permit submarine cables to be launched in a southerly direction towards the possible landing points I3 or I4 on Hong Kong Island at Deep Water Bay. A cable tunnel from a landing point at Ha Mei Wan (N10) would be needed to link up to the power station site.

Constraints: The main engineering constraints for this site would be the total lack of land access for construction, the steep rocky hillside with no coastal strip and the deep water close inshore. The proposed site is close to a residential area and small temple and therefore potential noise, dust and other nuisance impacts are the key constraints. Excavation and reclamation, although small scale may affect the water quality in the vicinity of the FCZs on eastern Lamma, and the site is visible from ferry routes, with potential for both construction and operational phase visual impacts for residents and visitors to the island. The site is in a Countryside Conservation Area.

N10 - Ha Mei Wan North

Location: This landing point is located at the northern end of Ha Mei Wan on the western side of Lamma Island. It is intended as a landing point for submarine cables laid across Ha Mei Wan from a landing point N1 at the power station site, which would then pass through a cable tunnel to landing point N9 on the east Lamma coast.

Constraints: The coast is less steep and rocky than on the eastern side of Lamma Island, with shallower water. It is also more protected from the prevailing NE monsoon. However, there is no land access, so materials will have to be brought in by sea. This site is visible from the main tourist trail, and landscape and visual impacts are therefore a key concern, as are water quality impacts, particularly at gazetted bathing beaches, and disturbance to marine ecology. The site is in a Countryside Conservation Area, and a Significant Area for Marine Conservation, and will therefore attract significant objection.

1.4.9 *Submarine Cable Landing Points on Hong Kong Island*

The locations of the possible Submarine Cable Landing Points on Hong Kong Island are shown on Figure 1.1a, and the main constraints associated with each location are listed as follows:

I1 - Telegraph Bay

Location: This potential Landing Point is located at existing seawall of Telegraph Bay. The area is currently unoccupied, consisting of a sloping sea wall fronting a level area reclaimed by filling. The necessary area would be a typical landing point layout formed by extending out a short section of additional reclamation (approx. 40m wide by 20m deep) to accommodate the joint bays between the submarine and land cables.

The cables themselves would be jointed underground, and the oil storage tanks required to supply the oil to the cables would also be constructed underground, leaving a level paved area after completion, with appropriate sloping sea wall protection and the cables themselves being laid in reinforced concrete protective culverts incorporated into the face of the sea wall down to below sea bed level.

Constraints: There are few engineering constraints associated with this Landing Point location, except the lack of existing road access to the works area, for both construction and post-completion operation and maintenance and gazettal procedures. The proposed location is approximately 600m from existing residential blocks within a Noise Control Designated Area, and construction noise mitigation practices will be necessary. It is also more than 100m from the seawater intake point at the south-east of the proposed location. Planning interface with the proposed Highway Route 7 will be required.

I2 - Kellett Bay

Location: This potential Landing Point is located adjacent to the existing Hong Kong & China Gas Co. site at Kellett Bay on Tin Wan Praya Road close to the entrance to Wah Kwai Estate. The area is currently unoccupied, consisting of a sloping sea wall fronting a sloping area reclaimed by filling. The necessary area would be formed by extending out a short section of additional reclamation (approx. 40m wide by 20m deep) with sloping sea wall frontage and cable ducts as at site I1.

Constraints: There are few engineering constraints associated with this Landing Point location. Existing road access to the works area for both construction and post-completion operation and maintenance is good. Some local land construction traffic will be generated, but the volumes will be small. This site is very close to residential areas (50m from Wah Kwai Estate) and therefore the key issue will relate to potential noise and dust impacts to the local population.

I3 - Deep Water Bay "A"

Location: This potential landing point is on the west coast of Deep Water Bay, just south of Manly Villa. The existing coastline is very steep and rocky.

Constraints: The landing point site is at the base of a steep rocky hillside, with no road access to the site, so all construction works will have to be accessed from the sea. Permanent access facilities for operations and maintenance may have to be provided. The area has been declared as a Coastal Protection Area by the Planning Department, and a *Significant Area for Marine Conservation* in the TDSR thus the associated ecological and landscape constraints will be key issues. The proposed site is close to residential and recreational areas and therefore potential construction noise, dust and other nuisance during construction will also be a key constraint. In planning terms, there are significant constraints for I3.

I4 - Deep Water Bay "B"

Location: This landing point site is also on the western coast of Deep Water Bay, slightly north of I3, on a relatively gently sloping section of coast immediately south of the Ocean Park Veterinary Hospital.

Constraints: This location will be in slightly shallower water than I3, and it may be possible for some temporary limited access to be provided through the Ocean Park facilities, which include a small jetty. The creation of a level area will be easier than for I3. However, most construction materials will still probably have to be delivered by sea.

A permanent road access link would be physically possible though the Ocean Park complex. Environmental and planning impacts here are expected to be similar to the Deep Water Bay "A" site at I3.

1.4.10 *Tunnel Portals on Lamma Island*

The locations of the possible Tunnel Portals on Lamma Island and the main constraints associated with each location are listed as follows:

PN4 - Pak Kok Shan Tsuen

Location: This tunnel portal would be located in the steep hillside just south of the landing point at N4, adjacent to the existing costal footpath.

Constraints: The constraints at this site would be similar to the landing point N4, but with more disturbance to local residents being caused during construction, particularly if drilling and blasting operations are used.

PN6 - Nam Tsui

Location: This portal would be located in the steep hillside immediately west of the landing point N6.

Constraints: The constraints at this site would be similar to the landing point N6, but with more visual intrusion as it faces across to Hong Kong Island's southern shore. Disturbance to local vegetation and wildlife in the adjacent woodlands would be a problem during construction, particularly if drilling and blasting operations are used. Access for materials and construction plant would be difficult, and the primary access would need to be from the sea. Maintenance of Water Quality Standards in the adjacent bay would be an ongoing constraints during removal of spoil from the site.

PN9 - Lok Chau Shan

Location: This portal would be located in the very steep hillside behind landing point N9.

Constraints: The constraints at this site would be very similar to the landing point N9, as it faces across to Hong Kong Island's southern shore. Disturbances to the existing steep slope would be significant. Access for materials and construction plant would be difficult, and the primary access would need to be from the sea. As for PN8, Maintenance of Water Quality Standards in the adjacent bay would be an ongoing constraint during removal of spoil from the site. Views from the local ferry routes would need to be considered.

PN10 - Ha Mei Wan North

Location: This portal would be located in the hillside immediately east of the landing point N10 at Ha Mei Wan.

Constraints: As for the adjacent landing site N10, the planning and environmental issues would be key constraints to this site, being adjacent to recreational facilities and environmentally sensitive areas. Access for construction would also be difficult.

1.5 FEASIBLE CABLE ROUTES

Based on the evaluation of the key locations, the preferred connection points for the cables were identified, and then feasible cable routes both for land and submarine sections developed for further study.

1.5.1 *Submarine Cable Routes from Lamma Island to Hong Kong Island South*

Six sections of potential submarine cable routes were identified, as follows:

N5 - I1: This route runs from the proposed landing point N5 on the eastern side of the Pak Kok peninsula in a north-easterly direction a distance of approximately 2.4 kilometres to the proposed landing point I1 on Hong Kong Island at Telegraph Bay. This submarine cable sector is part of Routes 1, 2, 3, 4 and 5.

N8 - I2: This route runs from the proposed landing point N8 at Luk Chau Wan on the eastern side of Lamma Island in a north-easterly direction a distance of approximately 3.0 kilometres to the proposed landing point I2 on Hong Kong Island at Kellett Bay. This submarine cable sector is part of Route 6, 7, 8, 9, 10 and 11.

N6 - I2: This route runs from the proposed landing point N6 on the eastern side of Lamma Island at Nam Tsui in a north-easterly direction a distance of approximately 2.45 kilometres to the proposed landing point I2 on Hong Kong Island at Kellett Bay. This submarine cable sector is part of Route 12, 13, 14, 15, 16, 17, and 18.

N1 - I3/4: This route runs from the proposed landing point N1 on the south-eastern corner of the proposed new reclamation at the power station site on Lamma Island in a southerly direction adjacent to the dredged approach channel to the existing Lamma power station, around the southern side of Lamma Island to a point approximately 500 metres south-west of Ngan Chau (Round Island); thence in a northerly direction to either landing point I3 or I4 on Hong Kong Island at Deep Water Bay, a total distance of approximately 18.0 kilometres. This submarine cable sector is part of Route 19.

N9 - I3/4: This route runs from the proposed landing point N9 on the eastern coast of Lamma Island at Luk Chau in an east-south-easterly direction, parallel to the limit of the inshore traffic zone across to Wong Chuk Kwok headland, the most easterly point of Lamma Island; south-south east a distance of approximately 1 kilometre to avoid the restricted area; north-east across the Lamma Channel to a point approximately 500 metres south-west of Ngan Chau (Round Island); thence in a northerly direction to either landing point I3 or I4 on Hong Kong Island at Deep Water Bay, a total distance of approximately 10.2 kilometres. The circuitous route is required to avoid an area of designated fill resources identified within the East Lamma Channel. This submarine cable sector is part of Route 20.

N2 - I1: This route runs from the proposed landing point N2 on the southern side of Yung She Wan and around the northern coast of Lamma Island directly across the Lamma Channel in a north-easterly direction to the proposed landing point I2 on Hong Kong Island at Telegraph Bay, a total distance of approximately 5.6 kilometres. This submarine cable section is part of Route 21.

Constraints: The constraints related to the potential routes for submarine cables are generally very similar in all respects. The alignment is dictated by the presence of existing submarine utilities such as water mains and telephone cables. The routes have been chosen to avoid these where possible, except for routes 19 and 20 which will inevitably involve the crossing of the telephone cables in Deep Water Bay and its approaches, and route 21, which entails the crossing of the WSD Sandy Bay - Pak Kok Water Main. Environmental effects are generally limited and transient, and the effects on marine traffic are considered to be manageable.

1.5.2 *Land and Submarine Cable Routes on Lamma Island*

Cable routes from the Lamma Extension to a landing point suitable for the crossing of the Lamma Channel to Hong Kong Island, as described above, include both land and submarine portions, and these route sections are described below.

Lamma Power Station Extension (LPSX) - N2: Routes 1-5, 12-18 and 21

Location: This route runs from the power station extension site, which is south of the existing facility, as underground cables beneath the road around the east and west sides of the existing power station to a point at the base of the rock slope north of the existing power station, a distance of approximately 700 metres. The cables will then enter a series of holes drilled 250 metres through the rock outcrop, to emerge at the southern side of Yung Shue Wan at landing point N2.

Constraints: The major constraints associated with this route relate to the laying of cables under existing carriageways around and through the existing power station facility, as well as the directional drilling exercise that will be required.

N4 - N5: Routes 1-5

Location: This section of route runs between landing points N4 and N5, along the waterfront on the north coast of Lamma west of Pak Kok. The route will probably take the form of a structural cable trough along the rocky shoreline and over the existing WSD 300 mm diameter water mains.

Constraints: The major constraints associated with this route relate to the laying of cables along the coastline under or adjacent to the existing footpaths, and the physical crossing of the WSD water mains.

PN4 - PN6: Routes 12-18

Location: This section of route consists of a cable tunnel approximately 750 metres long from the portal at PN4 on the northern coast through the headland to portal PN6 on the eastern coast, with short underground connections to the adjacent landing points.

Constraints: The major constraints associated with this route relate to the inaccessibility of the portals for construction access, relatively poor ground conditions and the proximity to local residential areas, as well as potential environmental issues related to nearby woodland.

LPSX - N8: Routes 6-11

Location: This section of cable route involves an underground cable installation around the eastern side of the existing power station facility and then follows the existing underground cable route through the residential area of Long Tsai Tsuen and across Lamma Island to the eastern coast, where it swings north of the existing HEC cable landing facility and runs down the hillside to the proposed landing point N8.

Constraints: The major constraints associated with this route relate to the inevitable disruption of the existing road through the residential area and the associated local objections, as well as environmental and landscape problems.

PN10 - PN9: Route 20

Location: This section of route consists of a cable tunnel approximately 1,750 metres long from the portal at PN10 on the western coast through the island to portal PN9 on the eastern coast, connected by underground cable to the adjacent landing points. The tunnel would be similar in form to that for the tunnel from PN4 to PN6.

Constraints: The major constraints associated with this route relate to the inaccessibility of the portals for construction access, the proximity to local recreational areas villages and the development of an environmentally acceptable method of spoil removal.

N2 - N4: Routes 1-5 and 12-18 (Submarine Cable)

Location: This route is integral to the crossings of the Lamma Channel from landing points N5 and/or N6, and runs from the proposed landing point N2 on the southern side of Yung Shue Wan and around the northern coast of Lamma Island to the proposed landing point N4 on Lamma Island at Pak Kok Shan Tsuen, a total distance of approximately 3.2 kilometres.

Constraints: The major constraints associated with this route relate to the narrowness of the available channel between Lamma Island and the designated Western Anchorage, as well as temporary interference with local pleasure craft, fishing boats and ferries during construction.

N1 - N10: Route 20 (Submarine Cable)

Location: This route is integral to the crossings of the Lamma Channel from landing point N8, and runs from the proposed landing point N1 on the south-eastern corner of the proposed new reclamation at the power station site on Lamma Island in an easterly direction; around the southern side of the power station to the proposed landing point N10 on the west coast of Lamma Island at Ha Mei Wan, a total distance of approximately 1.8 kilometres.

Constraints: The major constraints associated with this route are likely to be environmental, as it passes through a productive fish fry breeding area.

1.5.3 *Alternative Overall Cable Routes*

Altogether, twenty one overall cable routes were considered in the assessment, many of which have common sections and connection points. These routes have therefore been given unique reference numbers, marked as Route 1 to Route 21, for the purposes of identification, as shown on *Figure 1.1a*. Only two sites are considered as suitable for the emergence of the cable routes on the North side of Hong Kong, i.e. the existing HEC Cable Tunnel Portal at Bowen Road (EP2), and the possible new tunnel portal at Kennedy Road (NP1) and these involve only three routes presently identifiable from the tunnel portals (Routes A, B and C). All routes utilise the final section from a common location on Queen's Road East at the junction of Anton Street through to Tamar and new Wanchai substation, so this section is common to all routes considered in the general overall route assessment exercise.

1.6 BROAD ASSESSMENT OF ALTERNATIVE CABLE ROUTES

1.6.1 *Route Assessment Variables*

The assessment variables which had the most significant impact on the comparison of the various cable routes were the overall lengths of the routes, the number and nature of major interfaces such as landing points, tunnel portals or access shafts, cable joints, etc. and the lengths of sections requiring particular installation techniques, such as submarine cables, underground cables in major carriageways, structural cable troughs and cable tunnels. In addition, the relative impact of the works on the public and the general environment varied significantly amongst the cable routes.

1.6.2 *Cost of Alternative Cable Routes*

Cost comparisons for the various cable routes were made in very general terms, using a cost index system for comparison purposes to assist in the overall assessment process. Costs were based on typical linear costs for the cables and the cable route elements such as tunnels and troughs, and specific estimates made for elements such as portals and shafts, which varied from location to location.

These costs were not included in the basic technical assessment exercise, but used for review purposes where similar overall technical criteria existed.

1.6.3 *Comparison of Alternative Cable Routes*

The Stage 1 coarse screening exercise reduced the list of possible cable routes from twenty-one down to a shortlist of eight potential cable routes, which were then assessed and evaluated in detail in terms of their constraints and opportunities (i.e. Second Stage Assessment). A summary of the criteria input, the weightings of the various engineering, planning, environmental and marine issues assessment criteria, the grouping of the various cable route elements and the results of the "Decisionpad" assessment process for the shortlisted overall cable route alternatives is given in *Annex C1-3*, which also contains a summary of the main features of the eight shortlisted cable routes.

The relative marking of the routes based on the criteria and weightings assigned to each element of each route are presented as well as the result of the overall assessment process.

1.7 RECOMMENDED CABLE ROUTE

1.7.1 *The Preferred Cable Route*

Based on the assessment process described above, the cable route from Lamma Extension to the Wanchai substation, which offers the best technical solution with minimum disruption and environmental effect, is *Route 5*. In fact, according to the information collected, this route is found to be fallen out all environmental sensitive area as well as all EIA Ordinance Categories and Designated Project Areas. This recommendation takes into account the variables affecting all sectors of the routes from Lamma Island to Hong Kong Island.

The preferred route is shown in *Figure 1.7a*, and is considered to be entirely feasible, with the minimum of environmental impact over its length and straightforward planning issues.

The second ranking route in terms of preference is *Route 4*, with a longer underground section in carriageway than Route 5, a slightly shorter tunnel, but with the additional difficulties associated with constructing an access shaft adjacent to Pok Fu Lam Road.

The third ranking route in terms of preference is *Route 12*. Essentially this route has no tunnelling on Hong Kong Island, but requires a tunnel across the north eastern corner of Lamma Island, effectively exchanging the engineering difficulties for environmental ones.

The various components of the preferred route from Lamma Island to Hong Kong South are given below: -

Lamma Extension to Landing Point N 2 : Underground cables under existing roads within the power station complex, approximate length 1,000 metres, followed by formation of cable ducts in rock through the existing hillside north of the power station to a Submarine Cable Landing Point N2 in Yung Shue Wan, a length of approximately 250 metres.

Landing Point N2 to Landing Point N4 : Submarine Cables approximately 3.2 km in length between landing points N2 in Yung Shue Wan and N4 at Pak Kok Shan Tsuen.

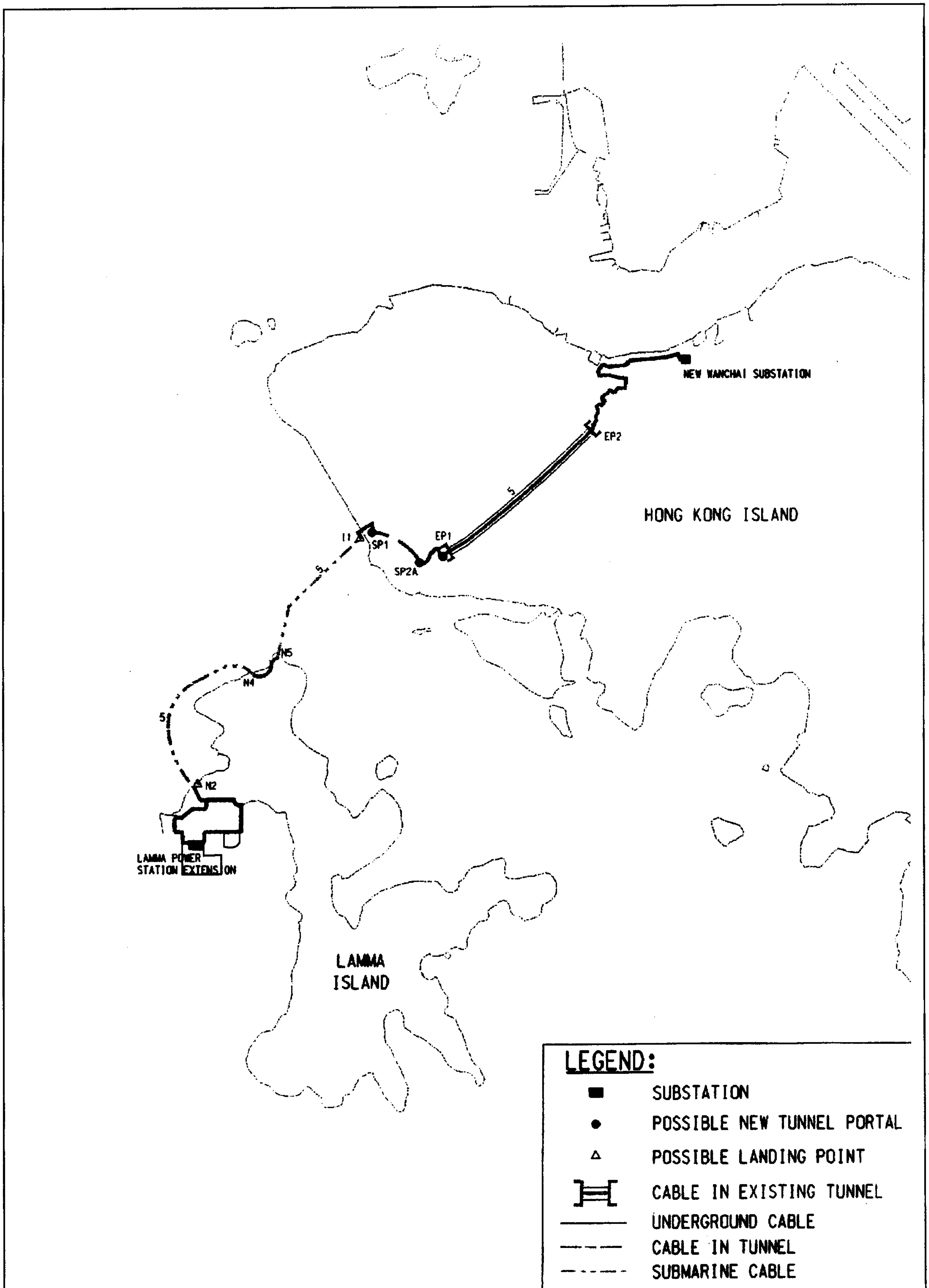


FIGURE 1.7a

PREFERRED TRANSMISSION ROUTE

FILE: C1830/C1830Z17
DATE: 29/10/98

Environmental Resources Management

ERM

Landing Point N4 to Landing Point N5 : Land cables along the waterfront in a 260 m structural cable trough between submarine cable landing points N4 & N5, crossing the Sandy Bay/Lamma water main in front of the new WSD pumphouse at Pak Kok Shan Tsuen.

Landing Point N5 to Landing Point I1 : Submarine Cables approximately 2.4 km in length from landing point N5 at Pak Kok Peninsula to landing point I1 at the southern end of Telegraphy Bay.

1.7.2 *Implementation Issues for the Preferred Cable Route*

The main engineering and planning issues associated with the preferred route are relatively straightforward. However, in the design and construction of the works, the appropriate opportunities should be taken to produce a sensitive design which incorporates the necessary considerations to mitigate the environmental effects, and to incorporate beneficial features wherever possible. Implicit in this approach will be the need to both incorporate landscaping elements and to produce a low-profile, low-visibility end product. This has been achieved in the past, and some of the existing elements of HEC's system such as landing points at Wah Fu are almost invisible. Where visibility is unavoidable, it is designed to enhance the local environment, such as the coastal walkway at Deep Water bay.

1.8 SUMMARY AND CONCLUSIONS

It is concluded that the optimum route which should be adopted for the installation of the Stage 1 cable system from the proposed Lamma Extension to the proposed Wanchai Substation at Marsh Road is *Route 5* which offers the best technical solution with minimum disruption and environmental effect.

2 PROJECT DESCRIPTION

2.1 INTRODUCTION

2.1.1 *Background*

The electricity generated from the proposed Lamma Extension project will be transmitted via a new transmission system linking the Lamma Extension to load centres on Hong Kong Island.

This assessment deals with Stage 1 transmission system from the Lamma Extension power station to the landing point at Telegraph Bay on Hong Kong Island. A broad assessment of the environmental impacts of the transmission line was undertaken by Hyder Consulting Limited and reported in *Selection of Stage 1 of the Transmission Route for the Additional Generating Facility at Lamma Power Station Extension*, and in three additional *Technical Reports*, which are summarised in detail in the preceding Section of this Report. These Reports recommended that no overhead lines should be used for the proposed transmission system because of system security, reliability and environmental concerns. Therefore, the transmission route study was confined to the identification and selection of transmission methods by means of 275 kV insulated submarine and land cables.

2.2 PROPOSED ROUTE

The proposed Stage 1 transmission route from Lamma Extension to Hong Kong South is as follows:

- *Lamma Extension to Landing point N2*: Underground cables passing under the existing power station complex for about 1 km, followed by the formation of cable ducts in rock through the existing hillside north of the power station to submarine cable landing point N2 in Yung Shue Wan (250 m);

- *Landing Point N2 to Landing Point N4:* Submarine Cables (3.2 km) between landing points N2 in Yung Shue Wan and N4 at Pak Kok Shan Tsuen;

- *Landing Point N4 to Landing Point N5:* Land cables along the waterfront for 260 m in a structural cable trough between cable landing points N4 & N5, crossing the Sandy Bay/Lamma water main in front of the new WSD pumphouse at Pak Kok Shan Tsuen; and

- *Landing Point N5 to Landing Point I1*: Submarine Cables (2.4 km) from landing point N5 at Pak Kok Peninsula to landing point I1 at the existing seawall of Telegraph Bay.

2.3 *INSTALLATION METHODOLOGY*

A feasibility study for the installation of transmission cables were conducted by Hyder Consulting Limited for Stages 1 and 2 of the project. A summary of the study recommendations is presented below.

Land Cable Installation

The Hyder Reports considered several methods of cable installation on land, and a summary of each is provided in *Annex C1-1*.

The Reports recommended that all land cables should be buried for protection of both the cables and the visual amenity of the surrounding area, using tunnels, promenades and direct burial beneath urban roads as far as possible.

Land cable installation will be carried out in sections of about 300 to 400 m, with surface trenches being excavated. Three cables of the same circuit will be laid in flat formation with cable separation of 300 mm and buried at a depth according to Highways Department's Technical Circular. A minimum separation of 1 m will be maintained between adjacent circuits in public roads, to reduce mutual heating effects and for security reasons.

Tunnel cable installation can be carried out in much longer sections of about 1000 m, but in this case only a 250 m section of drilled duct is required between the Lamma Extension and Landing Point N2.

Submarine Cable Installation

The Hyder Reports considered several methods of cable installation in water, which are summarised in *Annex C1-2*.

The Reports recommended that an initial landing point structure should be constructed at both shores with cable slipways for the landing, anchoring and joining of submarine cables.

The cable installation will involve ploughing of three small cable trenches by means of water jets equipped on the burying machine. The maximum pressure of the water jets is about 4 kg/cm^2 and can be regulated according to the hardness of seabed material encountered. While ploughing will mobilise sediment from the seabed, it is expected that most of this sediment will subsequently settle back over the cables or in the near vicinity. Impacts from the physical disruption to the benthic environment generated by the cable laying machine are expected to be localised, temporary and transient, but these impacts have been examined in more detail in the EIA Study.

The installation of the cables only require dredging in extremely hard areas of seabed and short sections near the landing points.

3 SCOPE OF THE ASSESSMENT

3.1 INTRODUCTION

This Section describes the scope of the assessment work undertaken in the EIA Study for the transmission cable system for the Lamma Extension project. This component includes the provision of transmission cables from the proposed power station on the Lamma Extension to a landing point on Hong Kong island, and includes the laying of submarine cables, the formation of landing points on both islands, and the provision of a cable trough and drilled ducts on Lamma Island, which are described in *Section 2*.

The scope and contents of the assessments for the proposed power station and gas pipeline components of the project are described in *Section* 3 of Part B, and *Section* 3 of Part D, respectively.

3.2 ASSESSMENT AREAS ADDRESSED

The EIA Study Brief requires assessments to be undertaken, where relevant and appropriate, for both the construction and operational phases of the overall project in the following technical areas:

- air quality impacts;
- water quality impacts;
- noise;
- landscape and visual impacts;
- waste management impacts;
- land contamination;
- aquatic (marine) and terrestrial ecological impacts;
- fisheries impacts; and
- hazards to life.

Six of these areas are considered relevant to the transmission system component of the project, including ecological impacts, for which separate assessments of marine and terrestrial impacts have been undertaken.

Air Quality

The air quality assessment in *Section 4* deals with the potential impacts of dust emissions from construction of the landing points for the transmission system. The greenhouse gas assessment in Part B of this Report deals with HEC's *overall* operations in future years, so no separate assessment is provided here of the greenhouse gas impacts of the proposed transmission system.

Water Quality

A qualitative water quality assessment was undertaken (see *Section 5*) of impacts on the local flow regime of the landing points for the transmission cables, and impacts associated with dredging for the formation of these landing points. Given the scale of these works, quantitative assessment was not required. It was considered that impacts during system operation (eg maintenance and repair) would be minimal.

Noise

The impacts of construction noise associated with formation of the tunnel and landing points were assessed, and the result are reported in *Section 6*.

Marine Ecology

Section 7 provides an assessment of potential impacts on marine ecological resources during the construction and operation of the project, including an evaluation of the results of field surveys in areas potentially affected by the project. Both direct (eg habitat loss) and indirect (eg pollution) impacts were evaluated for the construction phase of the project. As with water quality, operational impacts were considered to be negligible.

Fisheries

The fisheries impact assessment (*Section 8*) also considered both direct and indirect impacts on fisheries resources during the construction phase.

Terrestrial Ecology

An assessment of construction impacts on terrestrial ecological resources is provided in *Section 9*, based on surveys of habitat and species in the vicinity of the sites proposed for the landing points and cable trough.

Landscape and Visual

An assessment of the visual appearance and landscape impacts of the landing points is presented in *Section 10*.

Areas Not Considered

For the transmission system there are considered to be no impacts requiring assessment in the areas of waste management, land contamination or hazards to life.

4 CONSTRUCTION DUST IMPACT

4.1 INTRODUCTION

This section presents the construction dust impact arising from the laying of the new transmission cables, tunnelling works for the transmission cables and construction works at the landing points on Lamma Island and Hong Kong Island. Suitable mitigation measures will be recommended for ensuring that the associated impacts will be within the statutory criteria.

4.2 AIR SENSITIVE RECEIVERS

Representative Air Sensitive Receivers (ASRs) have been identified according to the criteria set out in the EIAOTM and through site inspections and review of landuse plans of the study area. Domestic premises and recreational areas are identified as the main ASRs.

On Lamma Island, the laying of cable and tunnel works are carried out in remote areas and only the village houses at Kam Lo Hom (near the existing Power Station) may be potentially affected. There are other ASRs at Ko Long and Wang Long located at more than 500m from the sites. For the scale of construction works concerned, no adverse impacts are expected when the separation distance exceeds 500 m, and hence no further assessment will be necessary at Ko Long and Wang Long.

On Hong Kong Island, the nearest receivers to the landing point are Waterfall Bay and Pok Fu Lam. Their distances to the construction site are over 500 m. In view of the large separation distances concerned, no significant impacts are expected.

4.3 POTENTIAL SOURCES OF IMPACT

For construction works on Lamma Island that could potentially affect ASR at Kam Lo Hom, the significant construction activities are dredging and materials handling of spoil.

Dredging is the major dust generating activity for the construction of the landing points. A total of five landing points have been identified for the transmission route. Marine sediment, which is in high moisture content, will be dredged at landing points. It is estimated that approximately 8,000 m^3 of marine sediment will be dredged for each cable landing point and a total of about 40,000 m^3 of marine sediment will arise from the construction of cable landing points (four on Lamma Island and one on Hong Kong Island) between December 1999 and July 2000. Due to the high moisture content of the dredged materials and the low dredging rate, dust impact from dredging will be low.

Excavation will be carried out at the north of Lamma Power Station for the transmission route tunnel. It is expected that about 250 m^3 of excavated materials will be generated between mid 2000 and mid 2001. With such an average excavation rate (less than 1 m^3 per day), the dust emission from the site will also be low.

The excavated spoils would be used for the seawall and platform formation. These spoils will be transported by barge to the site of the power station and hence haul road emission is not expected. Fugitive dust emissions would be generated through handling of spoils.

4.4 ASSESSMENT METHODOLOGY

The USEPA approved air dispersion model, *Fugitive Dust Model* (FDM), was used for predicting the likely dust impacts at the ASRs. The potential dust impacts from material handling was modelled. Emission factors and their particle size distributions have been estimated in accordance with *USEPA - Compilation of Air Pollutant Emission Factors, AP-42, 5th Edition, 1995* (AP-42) and are shown in *Table 1.4 a.*

The construction works will be carried out in daytime and worst case daytime meterological conditions: stability class 'D' with wind speed of 1 - 3 ms^{-1} blowing directly towards the sensitive receivers, has been assumed in the FDM model. Surface roughness of the site is assumed to be 60 cm.

Table 1.4 a ***Dust Emission Factors***

Construction Activities	Emission Factors[(i)]	Remarks
Material handling of excavated material	0.126 $u^{1.3}$ g Mg^{-1}	• density of 1.94 Mgm^{-3} • moisture content of 4.8 % • handling rate: 250 m^3 per annum • 12 working hours a day and 6 days a week

Note:
(i) Reference to AP-42, 5th edition.

4.5 EVALUATION OF IMPACT

The predicted TSP levels at various distances from the site are shown in *Table 1.5 a* below. Background air quality at Tai Yuen Village identified in Part B Section 4.8 has been used for cumulative air quality assessment.

Table 1.5 a ***Predicted Hourly TSP Levels at Ground Level (μgm^{-3})***

Distance from the Site (m)	Predicted Hourly TSP Level	Cumulative Hourly TSP Level with Background[(i)]
2	1.3	55
3	1.1	55
4	0.8	54
5	0.6	54
10	0.3	54
30	0.06	54
50	0.02	54
Dust Criteria	**500[(ii)]**	**500[(ii)]**

Note:
(i) Background TSP level is 54 μgm^{-3} based on Part B Section 4.8
(ii) Hourly TSP criteria is based on EIAOTM

The results show the marked reduction of predicted dust levels with distance. For the nearest ASRs at Kam Lo Hom which is 350 m from the work sites, the potential dust impact is predicted to be 54 μgm^{-3} which is essentially equal to the background concentration. As shown in Figure 4.3e of Part B, Section 4.3 entitled "Wind Rose for Cheung Chau Meterological Station (1971 - 1991)", the prevailing wind directions are predominantly easterly and northeasterly. Since the ASRs are located to the northeast of the site, the actual dust impact at the ASRs is expected to be negligible.

In view of the low predicted maximum hourly TSP concentrations, it can be concluded that no exceedance of the 24 hour *Air Quality Objective* for TSP of 260 μgm^{-3} would result, without any further modelling.

4.6 *MITIGATION MEASURES*

Dust control measures for construction sites have been specified in the *Air Pollution Control (Construction Dust) Regulation* and the relevant control measures are stated below to minimize air quality impacts during the construction work:

- any debris or materials shall be covered entirely by impervious sheeting or stored in a debris collection area sheltered on the top and the 3 sides;
- all dusty materials shall be sprayed with water prior to any loading, unloading or transfer operation so as to keep the dusty materials wet; and
- water spray shall be provided during material handling and excavation.

4.7 *SUMMARY AND CONCLUSIONS*

This assessment has indicated that the dust impact due to the construction work of the transmission route tunnel and dredging at landing points are within the statutory criteria. Predicted dust levels at receptors at approximately 350 m from the work sites are very low and virtually equal to the background concentration. Modelling results confirm the view that for receptors beyond 500 m from the work sites, the potential dust impact is negligible. Good site practices are recommended to ensure compliance with statutory requirements.

5 WATER QUALITY

5.1 INTRODUCTION

This Section provides an assessment of the impacts on water quality of constructing and operating the transmission system for the Lamma Extension project and, in particular, of laying the transmission cables from the Lamma Extension reclamation to Hong Kong Island. Given the nature and relatively limited scale of the project with respect to the marine environment, this assessment has been carried out in a qualitative (rather than quantitative) manner to describe the expected extent and duration of any impacts.

The main purpose of this work was to assess the acceptability of predicted impacts to water quality from the construction and operation of the transmission system. The predicted impacts have been assessed with reference to the relevant environmental legislation and standards.

5.2 LEGISLATION AND STANDARDS

The following legislation are applicable to evaluating water quality impacts associated with the construction and operation of the transmission system:

- *Environmental Impact Assessment Ordinance (Cap. 499)*, and the *Technical Memorandum on EIA Process (EIAO TM)*, especially *Annexes 6* and *14*; and
- *Water Pollution Control/Ordinance (WPCO)*.

5.2.1 Water Pollution Control Ordinance

The WPCO is the principal legislation for the control of water pollution and water quality in Hong Kong. Under the WPCO, Hong Kong waters are divided into 10 Water Control Zones (WCZs). Each WCZ has a designated set of statutory Water Quality Objectives (WQOs). The impacts from the construction and operation of the transmission system will fall within the Western Buffer and Southern WCZs.

The WQOs for the Western Buffer and Southern WCZs are presented in *Annex C5-1*, and are applicable as evaluation criteria for assessing compliance of any discharges during the construction and operation transmission system.

5.3 BASELINE CONDITIONS

5.3.1 Hydrodynamics

The route for the submarine cables extends along the northern portion of the western coast of Lamma Island, past the northern coast and across the East Lamma Channel to the coast of Hong Kong Island. These areas are very different in terms of hydrodynamics. Along the western and northern coasts of Lamma Island peak tidal currents are below 0.5 ms^{-1} because these areas are outside the main tidal streams. The section crossing the East Lamma Channel will be subject to higher tidal currents because the East Lamma Channel is one of the main flow paths into and out of the western harbour and is relatively narrow.

5.3.2 *Water Quality*

The route for the transmission cables from the Lamma Extension to Hong Kong Island passes around the northern shore of Lamma Island and across the East Lamma Channel. EPD routine monitoring station WM1, which is in the Western Buffer WCZ, is in the immediate vicinity of the cable route in the East Lamma Channel. Water quality data for Station WM1 is presented in *Table 5.3a* below. Station SM7 may be taken to be representative of the earlier part of the cable route, data is also presented in *Table 5.3a*. The locations of the stations are shown in *Figure 5.3a*.

Table 5.3a ***EPD Routine Water Quality Monitoring in the Western Buffer and Southern WCZs***

WQ Parameter	WM1	SM7
Temperature Surface (°C)	23.7 (17.5-28.2)	23.4 (16.6-28.3)
Temperature Bottom (°C)	22.2 (17.0-28.0)	22.3 (16.6-27.2)
DO Surface (mg L^{-1})	6.4 (4.7-8.1)	7.1 (6.3-8.7)
DO Bottom (mg L^{-1})	5.5 (2.9-7.2)	6.4 (5.1-7.2)
BOD (mg L^{-1})	0.6 (0.4-1.1)	0.4 (0.2-0.7)
SS (mg L^{-1})	4.8 (3.0-8.1)	9.4 (3.0-12.5)
TIN (mg L^{-1})	0.19 (0.04-0.38)	0.20 (0.05-0.47)
NH_3-N (mg L^{-1})	0.08 (0.01-0.26)	0.03 (0.01-0.05)
E.coli (cfu 100mL^{-1})	277 (79-2267)	14 (1-147)

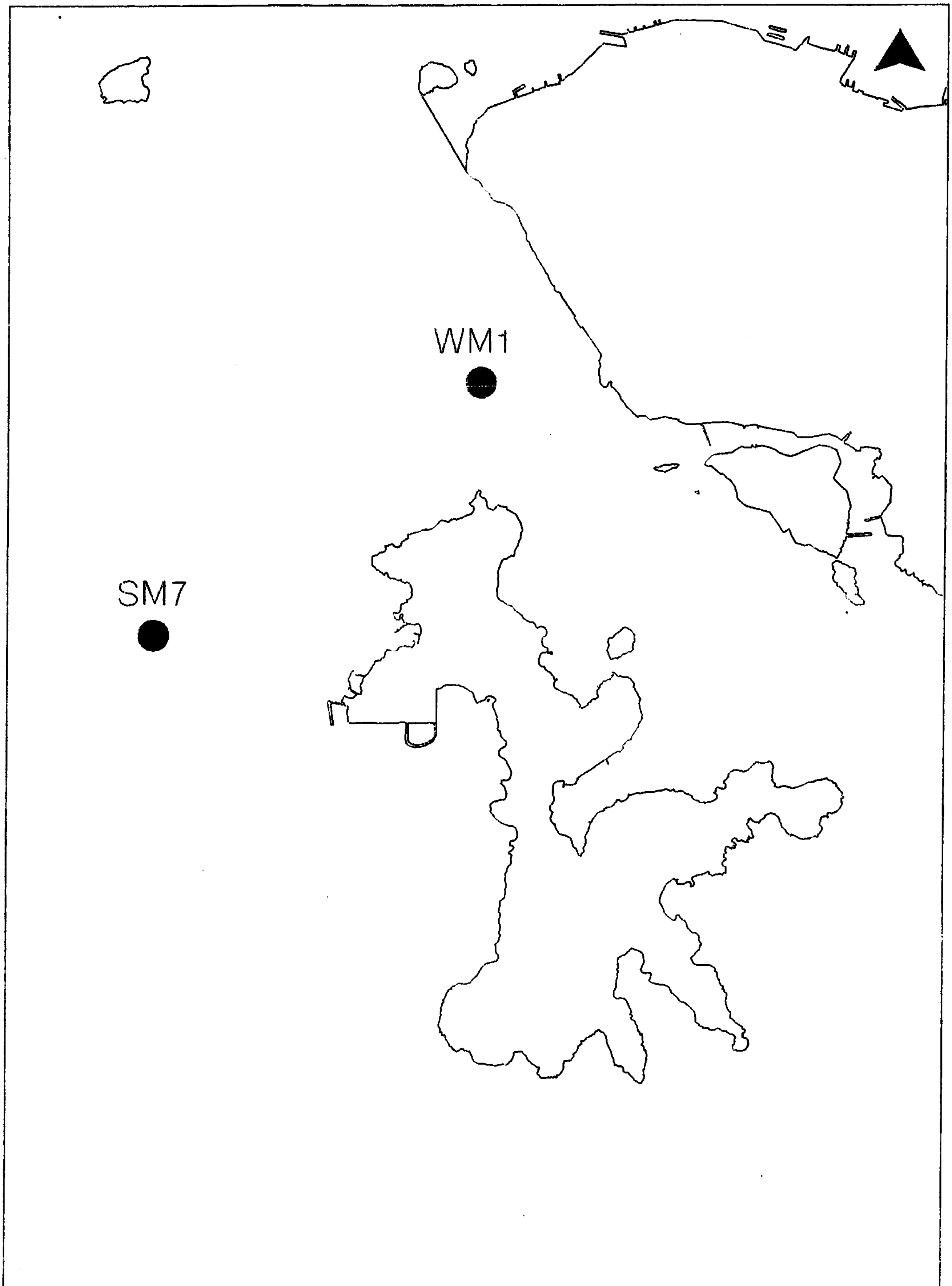
Notes:
1. Data presented are depth-averaged, except as specified.
2. Data presented are annual arithmetic mean except for *E.coli* which are geometric means.
3. Data Enclosed in brackets indicate the ranges.

Water quality at Station WM1 is good which is a reflection of the high tidal currents through the East Lamma Channel which provides a good exchange of water. Water quality at Station SM7 is similarly good, primarily because of its remoteness from any sewage discharges, as shown by the low *E. coli* concentrations.

5.4 CONSTRUCTION PHASE

5.4.1 *Assessment Methodology*

The Lamma Extension project will be served by a transmission link from the power station to Hong Kong Island. The submarine sections of the cable will be laid using jet ploughing, while at the landing points the cable will be laid in pre-dredged trenches. The route of the transmission cables is shown in *Figure 5.4a*.



SCALE 1:65,000

FIGURE 5.3a

EPD ROUTINE MONITORING STATIONS

Environmental Resources Management

ERM

USTN FILE: ermhk/c1830/mon2.dgn
DATE: 10/98

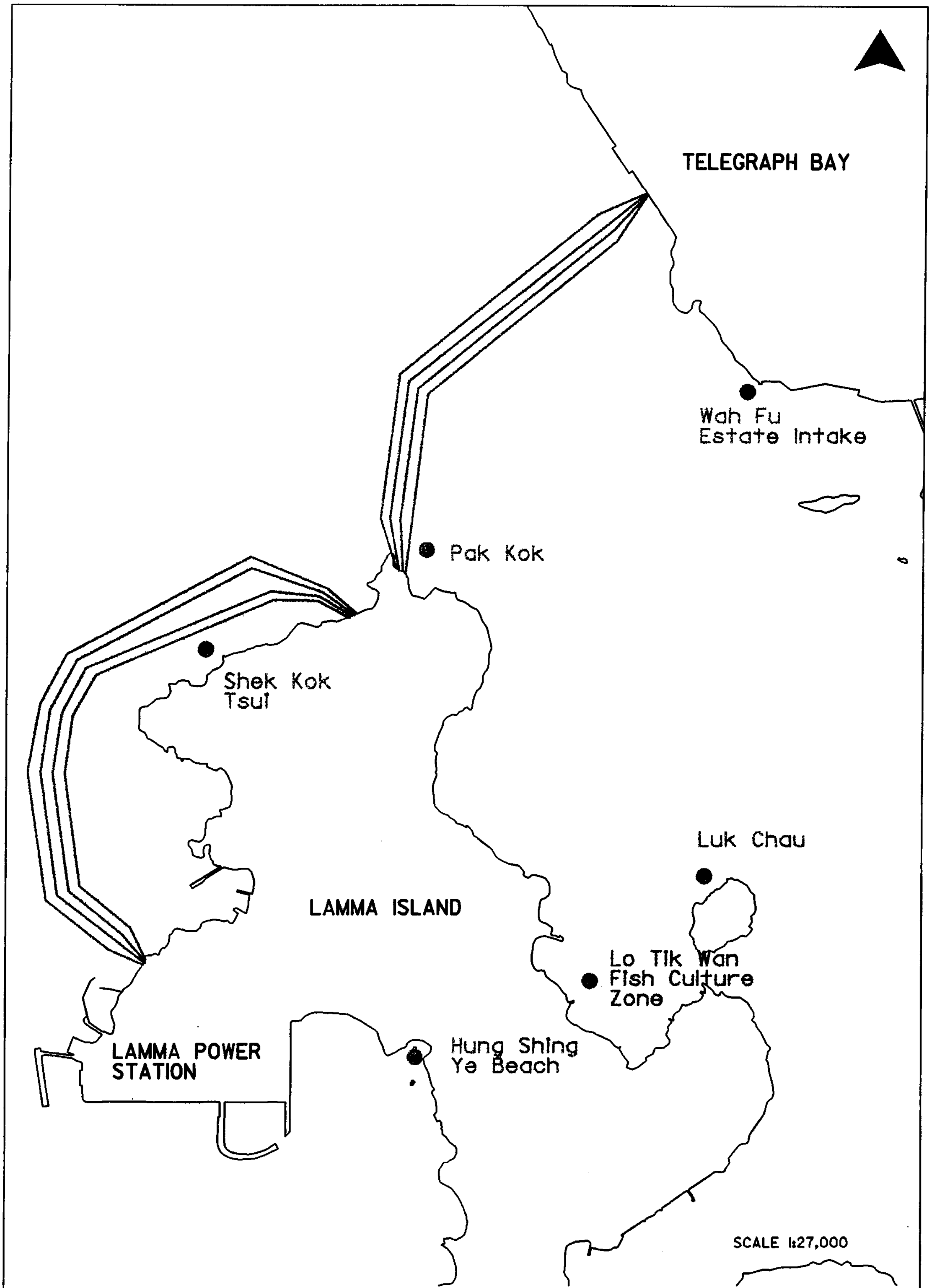


FIGURE 5.4a

TRANSMISSION CABLE ROUTE AND LOCATIONS OF SENSITIVE RECEIVERS

USTN FILE: ermhk/c[illegible]/cable.dgn
DATE: [illegible]

Environmental Resources Management

ERM

The following is a description of the typical cable laying methodology which is useful in assessing the impacts of the cable laying operations on water quality.

- Preparation

Prior to cable laying, four trenches at each of the cable landing points will be dredged. Each of the trenches will be 150 m long, 1.5 m deep and 3.5 m wide. The landing point structures will be constructed by a civil contractor, each structure will be approximately 18 ha in plan area. Sea bed excavations for the trenches and landing point structures will be carried out by a single small grab dredger, working slowly. The total dredged volume is expected to be approximately 8,000 m^3.

The transmission cables will be coiled and loaded onto the cable laying barge and transported by sea from the cable manufacturer's works to Hong Kong.

- Cable Landing at Start Point

The cable laying barge will be moored by anchor wire ropes as close as possible to the landing points. Cables will be paid out from the laying barge and pulled towards shore by means of a winch set up on the landing point. Buoys will be attached to the cable at 1 m intervals to allow the cable to float on the surface of the sea while it is pulled ashore.

- Cable Laying and Burying

After the cables have been pulled ashore at the landing point, three cables will be set in the cable troughs of the burying machine which is outfitted with the following equipment:

- A towing wire rope;
- A cable for power supply to the water pump motor;
- A control cable for monitoring the working conditions of the burying machine;
- 3 high pressure jet delivery hoses; and
- An hydraulic hose for control of the nozzle frame.

Cable guide equipment will be attached to the towing wire rope between the burying machine and the laying barge, so that the cables to be laid and buried are supported and guided into the burying machine. The burying machine is then lowered into the sea using a crane set on the sea bed. When the cable laying barge is advanced by winding the anchor wires, the burying machine will be towed by the laying barge. As the burying machine proceeds, it will plough three small trenches of 3.5 m depth in the sea bed by the water jetting method and the three cables will be laid in each of the trenches simultaneously. The trenches will be allowed to backfill by settling of the sediment disturbed during the ploughing process and by natural sedimentation.

The speed of the jet plough will be the same as that of the advancing cable laying barge which will be less than 100 m $hour^{-1}$. The cable laying operation will last approximately four weeks, one week for each of the four sets of three cables.

- Cable Landing at the Opposite Shore

When the cable laying barge reaches the opposite shore, the cables will be detached from the burying machine and paid out from the cable laying barge to form a loop line on the sea surface. Buoys will be attached to the cable in the same manner as at the cable landing start point.

The assessment of the impacts to water quality from the transmission cable laying will be made by qualitative assessment only, with reference to the above described methods of laying the cables, nearby sensitive receivers and the expected form of the impacts.

5.4.2 *Identification of Impacts*

The impacts to water quality during cable laying will occur as a result of disturbance of sea bed sediments during the jet ploughing of the submarine sections of the cable and dredging for the landfall approaches. These impacts will be from the localised, short term, increases in suspended sediment concentrations and subsequent settlement of the disturbed sediment back onto the sea bed. The locations of the nearest sensitive receivers to the cable route are shown in *Figure 5.4a*.

5.4.3 *Prediction and Evaluation of Impacts*

In order to compare the magnitude of possible impacts from the jet ploughing with conventional dredging the potential sediment release rates have been calculated. A conservative loss rate of 20% has been assumed. The calculation of the sediment release rates are as follows:

release rate = cross section area of "V" shaped trench * loss rate * number of trenches * speed of plough * material density

where:

trench depth	=	1 to 3.5 m
trench width	=	0.3 m
cross sectional area	=	0.15 to 0.53 m^2
loss rate	=	20%
number of trenches	=	3
speed of plough	=	0.028 $m\ s^{-1}$
in situ dry density	=	600 $kg\ m^{-3}$
release rate	=	1.5 to 5.3 $kg\ s^{-1}$

By way of comparison, small grab dredgers used for the dredging at the new reclamation site were calculated to have a loss rate of 3.0 $kg\ s^{-1}$, as defined is *Section 5.4.2* of Part B of this Report. Therefore, the rate of sediment release during cable laying operations should (at worst) be less than the rate of release during operation two small grab dredgers. However, during grab dredging, sediment is released throughout the water column whereas during cable laying sediment is released at the bottom of the water column. This difference is important because it results in suspended sediment resettling faster following cable laying than grab dredging. This is because at high concentrations the suspended sediment tends to form large flocs, the process of flocculation, which have a settling velocity much higher than individual sediment particles. Also, the sediment starts closer to the sea bed. This is also significant because tidal currents are much lower nearer to the sea bed than higher up the water column, particularly in the deeper waters of the East Lamma Channel. This would mean that the sediment would be transported much shorter distances from the dredging site. In summary the impacts from cable laying would be much less severe than grab dredging.

The impacts to water quality from jet ploughing would be in the form of the sea bed sediments suspended into the water column. These suspended sediments would form a dense cloud in the immediate vicinity of the cable laying operations and, due to the high concentrations and nearness of the release to the sea bed, would settle back onto the sea bed rapidly. The effect would thus be of short duration and localised to the immediate vicinity of the operations.

The nearest sensitive receivers to the jet ploughing for cable laying operations are the corals along the northern coastline of Lamma Island, see *Figure 5.4a*. Despite their proximity to the cable laying operations there would be unlikely to be any impacts at these areas because of the highly localised nature of the impacts. This would be especially true because of the low tidal currents in this area.

At the cable landing points dredging of a trench will be required which will be carried out by a single dredger only. This dredging will be of short duration because the quantities of material to be removed are low (approximately 8000 m^3 at each landing point). Also, the dredger would be working relatively slowly, resulting in a lower than normal loss rate which would reduce impacts on the surrounding environment. The closest sensitive receivers to the cable landing points are again the corals on the northern shore of Lamma Island and due to the low rate of working of the dredgers would not receive unacceptable suspended sediment concentrations.

Potential impacts on other water quality parameters such as dissolved oxygen and nutrient concentrations are also considered to be small because the sediment is unlikely to be contaminated or in suspension for a long enough time.

It is therefore concluded that construction operations would not give rise to unacceptable water quality impacts.

5.4.4 *Mitigation of Environmental Impacts*

The impacts from the cable laying operation were assessed to be very localised and of short duration. No particular operational constraints are presented here as mitigation measures.

5.5 OPERATIONAL PHASE

5.5.1 *Identification and Evaluation of Impacts*

The only impacts that may occur during the operational phase would result from maintenance and repair activities, for which the impacts are expected to be similar in nature and probably lesser in scale and period than during construction. Therefore, no further assessment is considered necessary here, and no mitigation measures or environmental monitoring and audit are required.

5.6 SUMMARY AND CONCLUSIONS

A transmission system will be constructed from the Lamma Extension to Hong Kong Island. The majority of the transmission submarine cables will be laid using jet ploughing, while under water trenches will be dredged at the shore approaches or hard sea-bed surface.

A qualitative water quality assessment of the impacts during construction and operation of the submarine cables of the transmission system was carried out. The assessment concluded that the construction and operation of submarine cables would only cause localised and short duration impacts on water quality near to the sea bed.

6 *NOISE*

6.1 INTRODUCTION

This section addresses the potential noise impacts which could be associated with the construction of the power transmission system along the preferred cable route from the plant extension on Lamma Island to the cable landing point at Telegraph Bay on Hong Kong Island. While these construction activities will be of very limited duration compared to those associated with the plant extension itself, the preferred cable route passes relatively close to existing residences at a few points, so that the potential for noise impact must be considered.

6.2 LEGISLATION AND STANDARDS

The relevant noise control legislation and standards for general construction activities were discussed in Part B Section 6.2 in relation to the construction of the plant extension. It is considered that all construction activities involved in the laying of transmission lines between the Lamma plant extension and the Telegraph Bay cable landing point on Hong Kong Island will be able to be carried out during normal daytime working hours (0700 to 1900 hrs). The appropriate noise criterion for these activities, as prescribed in the *Technical Memorandum on Environmental Impact Assessment Process* (*EIAO TM*), is therefore 75 $L_{Aeq,30\,min}$ when the noise is received at domestic premises.

A construction noise permit (CNP) application would, however, be required should any construction work be necessary during restricted hours - 1900 to 0700 hours Monday to Saturday or at any time on Sundays or public holidays.

6.3 BASELINE CONDITIONS

Baseline noise conditions in the communities to be affected do not enter into the noise impact assessment procedure for general construction work carried out during normal daytime hours. The potential noise impact will be assessed against the same criteria of 75dB(A) $L_{Aeq,30\,min}$ irrespective of the existing baseline conditions. However it is considered that the prevailing noise climate on Lamma Island will be rural in character while those on Hong Kong Island will be influenced by urban noise sources.

6.4 CONSTRUCTION PHASE IMPACTS

6.4.1 *Scope of Construction Work Along Preferred Cable Route*

A complete project description of the Transmission System was provided in *Section 2*, so that only a summary of key elements is given here from the perspective of their potential for construction noise impacts.

Lamma Extension to Landing Point N2

Cable will be laid in underground trenches (cable troughs) for about 1000 m through the existing plant, connecting the plant extension to a tunnel portal in the hillside in the plant's northwest corner. The cable tunnel consists of 18 microhorizontal bore-holes each of 250mm diameter to be drilled from the power station end where most of the works will be carried out. The conventional trenching and backing filling operations will create insignificant noise impact within the surrounding community due to the large setback distances and hillside shielding involved.

From the face of the hillside in the northwest corner of the plant, a cable tunnel will be bored unidirectionally so as to emerge on the northwestern face of the hillside (Kam Lo Hom) well to the southwest of Yung Shue Wan. In this way, work at the tunnel's seaward portal will be minimized.

Landing Point N2

A cable landing area roughly 70 m wide by 26 m deep will be created at N2 through reclamation. This will be accomplished by placing rock that will be barged to the site. From N2 a submarine cable will be run to landing point N4 at Pak Kok Shan Tsuen near the northern end of Lamma Island.

Landing Point N4

The submarine cable will come ashore at Pak Kok Shan Tsuen. Here, as at N2, a cable landing area (65 m by 27 m) will be created by reclamation.

A small group of residences is located from 80 to 160 m to the east of the cable landing site in Pak Kok Tsui. The recently completed WSD Pump House Works Area is positioned between these residences and N4.

Landing Point N4 to Landing Point N5

From N4 a land cable will run within a structural cable trough along the water's edge to N5 on the Pak Kok Peninsula - a distance of about 260 m. This structure will be largely above ground so that a limited amount of excavation work, and likely little or no drilling and blasting, are expected to be involved.

Landing Point N5

The depth of water at cable landing site N5 on the Pak Kok Peninsula is considerably greater than at landing sites N2 and N4. Therefore, during the detailed design phase, it could be concluded that piling will be necessary to construct the 56 m by 33 m cable landing area required . Two isolated residences are located on a hilltop, overlooking this cable landing site from a distance of only 40 to 50 m.

Landing Point I1

From N5, a submarine cable will cross the channel from Lamma Island to Hong Kong Island, coming ashore at Landing Point I1 at the southern end of Telegraph Bay. An area of approximately 40 m by 25 m will be required and space will be made available with the existing rubble mound seawall and the newly completed Telegraph Bay reclamation.

6.4.2 *Construction Noise Estimation Procedure*

Unlike the construction programme planned for the Lamma Plant Extension itself, which will involve many PME's working simultaneously over a period of many years, the levels of activity to be involved in the construction of the Transmission System on Lamma Island will be relatively minor and short-lived.

Typically, they will involve one or two PME's working intermittently at a given construction site at a given time. While at this stage the general nature of the work, and the equipment that will be required to carry it out, is fairly well known (*Reference Hyder Reports and Nov 9/98 tel con - C. Wakefield with John Costello of Hyder*), official lists of PME's have not been compiled. It has therefore been necessary to make conservative, professional judgements about the specific types and numbers of PME's that would be employed and the extent to which they would be utilized (i.e., their usage factors). From that point, the procedure used to estimate the potential construction noise exposures at the various Noise Sensitive Receivers (NSRs) has been as outlined in *Section 6.4.1* of *Part B - "The New Power Station"*.

6.4.3 *Predicted Construction Noise Impacts*

Lamma Extension to Landing Point N2

Since this work will be carried out entirely within the existing plant boundaries or within the Kam Lo Hom hillside, it is not expected to create any noise impact at the nearest NSRs (the village of Ko Long on the other side of Kam Lo Hom), and certainly not to approach the daytime noise criterion of 75 $L_{Aeq, 30\ min}$.

Landing Point N2

Once the cable tunnel emerges from the western side of Kam Lo Hom hill, the major construction activity involving PME's will be the reclamation of a 40 m by 20 m cable landing area on the shoreline below the tunnel portal. This work is expected to be carried out with a single barge-mounted crane, unloading rock from a barge and placing it in the water. Compaction work will also be required once the level of the rock extends above sea level. However, since the nearest residences in Ko Long are almost 500 m away and shielded from N2 by the northern shoulders of Kam Lo Hom hill, construction noise exposures received will be well below 75 dB(A). A similar situation will exist at the nearest NSRs in Yung Shue Wan, which, while perhaps not all benefiting from hillside shielding, are between 500 and 700 m away from Landing Point N2.

Landing Point N4

The construction activities that will take place at Landing Point N4 near Pak Kok San Tsuen are similar to those required at N2. Here, however, residences are located in Pak Kok Shui, 80 to 160 m from the construction site, with essentially no inherent noise shielding between them. If it is assumed that this work would principally involve the following PMEs:

- one barge-mounted diesel-powered crane (CNP 048 in GW-TM) with sound power level (SWL) of 112 dB(A) ,
- one vibratory roller (CNP 186) with SWL of 108 dB(A) ,

then , at a minimum setback distance of 97 m from the "notional centre" of the construction site to the nearest NSR, the projected construction noise level is 67 $L_{Aeq,30\ min.}$ after a 3 dB(A) facade reflection correction is added. Since this is 8 dB(A) below the daytime criterion of 75 dB(A), there should be sufficient "headroom" to accommodate any reasonable variations in the types and numbers of PMEs to be employed and in their usage factors.

Landing Point N4 to Landing Point N5

The structural cable trough between N4 and N5 near the northern tip of the Pak Kok Peninsula will pass within 30 m of the nearest residence in Pak Kok Tsui. At this location the cable trough is to be constructed on concrete piers largely over the water. There will then be a need to construct footings and columns and place the horizontal (likely precast) concrete trough elements. This will involve some caisson construction and form work, likely utilizing a barge-mounted crane. However, the overall level of activity would be expected to be significantly lower than would have been associated with the recent construction of the WSD Pump House Works Area at a similar setback distance from the nearest NSR.

In order for such construction work to generate a facade-corrected noise level of 75 $L_{Aeq, 30\,min}$ at the minimum setback distance of 30 m from the cable trough, the combined, rated SWLs of all simultaneously-active PMEs would need to be 110 dB(A) or more. Assuming all PME's be in operation at the same time, then 110 dB(A) would represent their maximum allowed SWL output. It is expected, however, that the need for simultaneous operations of all equipment would be relatively low (excluding a generator or compressor, should either be required). Applying such a usage factor increases the total allowable rated SWL to 113 dB(A). Since this range of SWL's is comparable to that created by many commonly used PMEs (e.g., a barge-mounted crane is rated at 112 dB(A)), it is to be expected that such work will, at least during the most active periods, result in construction noise levels approaching or exceeding the 75 $L_{Aeq, 30\,min.}$ criterion. The duration of this work, in the immediate vicinity of the closest NSR, will, however, be quite limited.

Landing Point N5

The closest NSRs to the cable landing site at N5 (two residences) are within 30 to 40 m of the site and it appears they will receive little or no noise shielding at their locations on a hilltop overlooking the northern tip of Lamma Island. Therefore, if the principal heavy construction activities were to be limited, as they will be at N2 and N4, to the creation of a cable landing area (using a barge-mounted crane and a vibratory roller or similar equipment), then the facade-corrected noise exposure at the closest NSRs (distance to "Notional Source Centre" about 40 m) would be approximately 75 dB(A), thereby equalling the daytime criterion.

The deeper water at N5 may, however, demand that piles be driven before the cable landing area can be constructed. If non-percussive piling techniques were to be used, their noise would be treated the same as barge-mounted crane and compactor noise under the GW-TM. Therefore, should these two major activities overlap in time to some degree, their noise contributions would need to be combined and, as such, the 75 dB(A) criterion could well be exceeded. In addition, if the non-percussive piling technique was one of the "Large Diameter Bored' types (CNP 165 or 165) or the "Earth Auger" type (CNP 167), then piling noise alone could exceed the 75 dB(A) criterion by 1 to 2 dB(A).

If percussive piling was to be used, then its impact would need to be assessed separately under the *PP-TM* as described in *Part B, Section 6.2.3*. The noise criterion specified for daytime percussive piling occurring after 1 October, 1999 is the Acceptable Noise Level, or ANL, less 10 dB(A). Since for residences without central air conditioning (no doubt the case on Lamma Island), the ANL is 85 dB(A), the applicable limit for percussive piling in this situation would be 75 dB(A). To avoid exceeding this criterion at the 40 m setback distance from the "Notional Source Centre" to the NSRs, the total SWL produced by the percussive piling operation would have to be 115 dB(A) or less. Table 2 of the *PP-TM* indicates that only the "Internal Drop Hammer" and "Drop Hammer Driving Concrete Pile" have rated SWLs near this target, while the Diesel, Hydraulic and Steam-Powered group of hammers produce SWLs in the 122 to 135 dB(A) range.

Landing Point I1 - Telegraph Bay

The preferred cable landing point on Hong Kong Island is within the large, recently reclaimed area near the existing seawall of Telegraph Bay. This site is also within a "Noise Control Designated Area" because of the large scale residential development that currently exists, or in future will exist, throughout this area. This designation has no effect on the noise limits for normal daytime construction activities, but imposes a penalty of -15 dB(A) on the *Basic Noise Levels*, or BNL's, allowed during the evening and nighttime. Since cable landing point I1 is presently approximately 600m away from the nearest residential development at Waterfall Bay to the south, noise created by the opening of armour rock of rubble mound seawall for construction of the cable slipway will not create significant noise impacts and will be well below the 75dB(A) criterion for daytime activities. This situation could of course change, if new residential development should occur much closer to Landing Point I1 prior to the completion of the cable landing point.

6.5 SUMMARY OF MITIGATION MEASURES

Landing Point N4 to Landing Point N5

It is expected that the 75 $L_{Aeq,30\ min.}$ construction noise criterion may, at times, be approached or marginally exceeded at the nearest Pak Kok Tsui residences during the construction of the structural cable trough between Landing Points N4 and N5. It is also expected that these minor exceedances will be short-lived and could be avoided through the selection of principal PME's that are only 3 to 5 dB(A) quieter than the standard equipment, or through the application of modest source noise controls to standard PME's.

Landing Point N5

Noise from the general construction of a cable landing site at N5 is projected at times to just reach the 75 dB(A) criterion at the nearest residences assuming that the two principal PME's are a barge-mounted crane and a vibratory roller and that they may sometimes operate simultaneously. Exceedance of this criterion could be avoided through selection of somewhat (3 dBA or more) quieter PME's particularly the barge-mounted crane, or the application of comparably effective source noise controls to these pieces of equipment.

Should piling be required to enable a cable landing site to be constructed at N5, this would require some attention to avoid exceeding noise criteria, due either to the piling alone, or, if their schedules should overlap, to the combined noise output of piling and site formation activities. If, in the former case of no schedule overlap, the piling is to be non-percussive, then a method should ideally be selected which has a rated SWL of 113 dB(A) or less - otherwise, offsetting source noise controls would be required. If, percussive piling is considered, then the method selected should have a rated SWL of 115 dB(A) or less, - otherwise offsetting source noise controls would be required.

If there is some compelling reason to carry out non-percussive piling and general site formation activities simultaneously, and it is feasible to do so, then additional noise mitigation measures would be required. Since independently, the two operations are projected to each create noise levels close to the 75 dB(A) criterion, achieving this criterion while both are active would require each to be mitigated by approximately a further 3 dB(A). This could be achieved through equipment/process selection or source controls or a combination of the two approaches.

6.6 *EM&A REQUIREMENTS*

While no substantial exceedances of the EIAO-TM's 75 $L_{Aeq, 30 min.}$ criterion for general daytime construction noise are expected, there will be a need for some limited noise monitoring at the nearest Pak Kok Tsui residences to Cable Landing Points N4 and N5. This might reasonably consist of a 30 to 60 minute measurement twice per week during the periods of site formation at N4 and N5 and while the centre of activity of structural trough construction between N4 and N5 is within about 40 m of the nearest residences. This monitoring would include any pile driving activity at N5 should this be required.

6.7 *SUMMARY AND CONCLUSIONS*

The levels of construction activity (all daytime) to be associated with the installation of the Lamma Extension transmission line across the northern end of Lamma Island will be quite modest compared to those associated with construction of the plant extension itself. However, near Cable Landing Points N4 and N5, the close proximity of the work sites to small numbers of residences is expected to result in daytime noise exposures approaching or slightly exceeding the 75 dB(A) criterion for general construction works contained in the EIAO-TM. Therefore, modest mitigation measures will need to be considered and a limited environmental noise monitoring program carried out.

If pile driving should be required at Cable Landing Site N5, and if it is decided to employ percussive piling techniques, then the selection of one of the "quiet" types of piling rigs would be necessary in order to avoid exceeding the applicable noise criterion - also 75 dB(A) - since the use of diesel, hydraulic or steam-powered piling rigs would result in this limit being exceeded by from 7 to 20 dB(A).

7 MARINE ECOLOGY

7.1 INTRODUCTION

This section of the report presents the findings of the marine ecological impact assessment. The report presents the baseline information on the potentially affected existing marine ecological resources and also presents the findings of various field surveys conducted for the assessment.

The objectives of the assessment are as follows:

- to establish the ecological importance of the habitats affected by the works associated with the laying of the submarine transmission cables and the construction of their associated landing points;
- to identify marine ecological sensitive receivers;
- to assess the scale of possible marine ecological impacts from the laying of the submarine transmission cables and associated construction work;
- to highlight any significant or unacceptable impacts to marine ecological resources from the transmission cables and associated works;
- to identify any necessary mitigation measures and evaluate residual impacts; and
- to assess the need for a marine ecological monitoring and audit programme.

7.2 BASELINE CONDITIONS

7.2.1 Literature Review

The availability of literature on the marine ecology of the waters surrounding the existing power station is variable. As with the majority of Hong Kong it appears that certain areas have been comprehensively studied whereas others have not. In order to supplement the existing data a number of comprehensive ecological field surveys have been undertaken. The findings of the field surveys are presented below together with information on marine ecological resources gathered through a desk-top review of available literature.

Soft Benthos Assemblages

As part of the Lamma Dredging Audit study[1], surveys investigating the baseline conditions of the benthic communities found in and around the proposed Lamma Borrow Area were conducted (*Part B - Figure 10.3a*). Of the eight sampling stations selected to conduct this investigation, two of the stations lie within the habitat predicted to be affected by the works associated with the laying of the submarine transmission cables. Species composition of the benthic grabs collected for each station has not been provided, however, it was reported that polychaetes were the most common organism within the grab samples (28

(1) BCL (1994) Lamma Dredging Audit Baseline Survey. Draft Final Baseline Report to CED.

species) followed by crustaceans (25 species). *Table 7.2a* contains summary information for the two stations that lie within the affected area[2].

Table 7.2a ***Summary Information from Grab Survey in December 1993 and January 1994***

Station	Mean Number of Individuals (m^{-2})	Mean Density of Individuals ($station^{-1}$)	Mean Biomass ($g\ m^{-2}$)
S5	225	220	2.6
S6	66.7	70	2.4

Table 7.2a indicated that the two sites (S5 and S6) are different from each other in terms of benthic community abundance. Station S5 has a high abundance of individuals in comparison with Station 6. A mean of 225 individuals per grab were collected at Station S5 which is more than double the Hong Kong average of 101.4 m^{-2} as recorded by Shin and Thompson in 1982[3]. However, the biomass for Station 5 was considerably lower than the average for Hong Kong (35.2 g m^{-2}) as reported in the Shin and Thompson study. This suggests that the majority of individuals recorded were low weight invertebrates, probably polychaetes.

Hard Surface Assemblages

During Hong Kong wide surveys of the physical and ecological effects of dredging[4], subtidal surveys were undertaken by divers using SCUBA at several stations around Hong Kong. The results from a number of these surveys provide information on the subtidal assemblages around Lamma (*Part B, Figure 10.3a*). As the primary objective of these studies was to provide baseline information to assess the effects of dredging at the Lamma Channel Borrow Site, these stations were located within or close to the Lamma Channel itself. Therefore, only a small number of these survey areas are applicable to the current Study as the remaining areas are considered to be outside of the predicted impact range of the works associated with the proposed power station extension. Of those areas studied, the results of the surveys at Pak Kok, Luk Chau and Telegraph Bay are considered to be the most relevant.

At each of the three sites mentioned above dive transects were surveyed perpendicular to the shore with seabed profiles, photoquadrat and quadrat analysis conducted at each of the transects. The surveys at the Hong Kong Island site located to the north of Telegraph Bay found that the rocky shallow area had an abundant cover of sea urchins, gastropods and Bryozoa. However, at greater depths (maximum - 8 mPD) soft mud sediments associated with low numbers of organisms (3 solitary sea whips) were recorded. South Telegraph Bay was reported as having a sand and shell fragment substrate interspersed with rocks at depth below - 8 mPD. Few organisms were recorded at this depth.

The surveys on Lamma Island at Pak Kok and Luk Chau revealed habitats supporting assemblages of higher abundances. Pak Kok was found to have a generally rocky substrate with the occasional patches of sand. Sea urchins, gastropods, holothurians (sea cucumbers) and Bryozoa were common to depths of - 8 mPD. Below these depths, soft corals (*Dendronephthya* spp) and gorgonian sea whips were common. Scleractinia hard corals (*Tubastrea aurea*) were also recorded at this site. The survey revealed that this site supported some hard corals (cover = 1.26 %) as well as patches of abundant soft corals (cover = 11.83 %).

(2) BCL (1994) *ibid*
(3) Shin PKS & Thompson GB (1982) *op cit.*
(4) Binnie Consultants Limited (1995) Marine Ecology of Hong Kong - Report on Underwater Dive Surveys (October 1991 - November 1994) - Volume II. For the Geotechnical Engineering Office, Civil Engineering Department.

Luk Chau was found to have lower abundances of soft corals than recorded at Pak Kok, however, some encrusting hard corals were recorded on the transect (coral cover < 0.5 %). The survey at this site found that the substrate was commonly boulders to a depth of - 2 mPD, with sand at depths between -2 to -6 mPD. Sea urchins, barnacles and gastropods were commonly found on the boulders. Low numbers of epifauna associated with the sandy habitat were found below -2 mPD. A further dive survey was conducted on Luk Chau as part of a later study[5]. The results of this survey showed that diversity and abundance of invertebrates were low with bare rock and coralline algae making up the highest percentage of total cover.

Others

A discussion of marine mammal use of the area is presented in *Part B, Section 10* and *Part D Section 5.*

7.2.2 *Field Surveys*

Introduction

The preliminary transmission route launching and landing sites were selected as part of a previous study[6]. The sites are presented in *Part B Figure 10.3b* and are termed L1 - L4. A number of field surveys (intertidal and subtidal) were undertaken in the vicinity of the proposed launching and landing sites to determine the ecological value of the habitats through characterisation of the fauna and flora present there. Particular focus was placed on the identification of hard corals during the subtidal surveys.

Methodology

Intertidal

Intertidal rocky shore surveys were undertaken during August 1998 at the proposed launching and landing points, L1 to L4, to characterise the assemblages present in the intertidal region. Seasonal changes in the intertidal region are generally more marked than in the subtidal region hence two season surveys were conducted.

Rocky shore organisms originated in purely marine habitats and have evolved and adapted to live on intertidal shores. The extent of their adaptations to this habitat will dictate where they are found on the shore. The more adapted the species is to terrestrial conditions the higher it will be found on the shore, causing zonation patterns. The survey design involved sampling throughout all of the intertidal zones so that the vertical range of all species was represented. At each site three 10 m wide horizontal (belt) transects were set up along the shore (no less than 50 m apart) and surveyed at three heights up the shore at 50 cm intervals perpendicular to the waterline starting at 1.0 m above Chart Datum. Previous studies of Hong Kong's rocky shores have shown that 10 quadrats (50 x 50 cm) randomly placed along each transect will produce accurate, unbiased samples of the community. On each transect, 10 quadrats (50 x 50 cm) were placed randomly to assess the abundance and distribution of flora and fauna. All animals found in each quadrat were identified and recorded to species level

(5) Binnie Consultants Limited (1994) Lamma Dredging Audit Baseline Survey - Draft Final Baseline Report. For Geotechnical Engineering Office, Civil Engineering Department.

(6) Hyder Consulting (1998) Report on Selection of Stage 1 Transmission Route for the Additional Generating Facilities at Lamma Power Station Extension. *Technical Report No.2 Submarine Cable Routes*. Submitted to The Hongkong Electric Co., Ltd. May 1998.

so that density m^{-2} could be determined. Sessile organisms such as barnacles, oysters and algae in each quadrat were not counted but estimated as percentage cover on the rock surface. The size of 50 - 100 individuals of a representative herbivorous mollusc (*Acanthopleura japonica* in this study) were recorded. If the population is dominated by large individuals it indicates that there is some kind of stress affecting them. This is manifested by the lack of recruits (juveniles < 20 mm) to the population. The data gathered will determine whether the population is under any kind of stress and whether juveniles are recruiting to the population.

Subtidal

Dive surveys were undertaken at the proposed submarine transmission cable launching and landing sites, L1 through to L4, during July 1998. As the primary purpose of these surveys was to identify areas of ecological value within these sites, the design focussed on trying to cover as much subtidal habitat as possible. Specifically, the surveys were focussed on investigating the occurrence and abundance of hard corals within the area. The rationale behind this was based on the conclusion that hard corals are more ecologically important than soft corals as hard corals are reef building and are hosts to diverse coral reef communities[7]. In addition, hard corals are more susceptible to damage from sedimentation due to their immobile nature. The flexible structure of soft corals essentially reduces the likelihood of deposition of sediments onto the corals by allowing movement to release the sediment, whereas, prolonged deposition onto hard corals can have either lethal or sub-lethal effects (see *Part B Section 10.3*)[8]. Furthermore, hard corals have slower generation times than soft corals and therefore take longer to re-colonise areas once damaged[9].

In order to investigate for the presence of hard corals, six transects (30 m length x 1 m wide) were surveyed with a 50 m interval between transects. A tape measure was laid down the middle of the transect and represented the line transect. The width of 0.5 m either side of the line constituted the belt transect. The location of the transects were deliberately restricted to the depths of 2 to 5 m below Chart Datum as any hard corals of ecological importance are likely to be found within this depth range[10]. Below these depths, high turbidity in the water column in the waters of this area restricts light penetration, which hard corals are dependant on for growth[11]. The actual depth of each survey was decided on a site by site basis, selecting areas where the organisms, particularly hard corals were most abundant and / or assemblages were most diverse.

Within the belt transect all mobile organisms greater than 1 cm were identified and the abundance of each class was recorded and ranked on a pre-determined scale of relative abundance (high > 75 % of individuals, medium 25 - 75 % and low < 25 %). Along the line transect the nature of the substrate was recorded at 0.5 m intervals. Any sessile organisms (eg corals) at these intervals were identified and recorded. From this information percentage cover for each substrate / organism type was calculated.

In order to provide a visual reference to aid in the characterisation of the subtidal environment, photographs were taken during every dive survey. Due to the difficult conditions of the diving, site photographs were limited to ten per site and were taken at specific intervals along the line transect. The location of the area to be photographed was determined prior to the survey using a random

(7) Scott PJB (1984) The Corals of Hong Kong. Hong Kong University Press.
(8) Binnie Consultants Limited (1995) *op cit.*
(9) Scott PJB (1984) *op cit.*
(10) Binnie Consultants Limited (1995) *op cit.*
(11) Scott PJB (1984) *op cit.*

number generator ensuring that no bias towards selection was made underwater. Where possible, supplementary to these random photographs, a selection of substrates and organisms representative of the habitat within the belt transect were photographed in order to provide a photographic record, and to facilitate taxonomic verification.

Results

Intertidal - Wet Season

In total, 18 species of animals and 10 species of macroalgae were recorded at the four launching and landing sites. Except for L3 - Pak Kok and L4 - east of Pak Kok where comparatively low animal species numbers (< 10 for some transects) were recorded, the number of animal species at the surveyed sites was greater than or equal to 10 and was highest at L1 - Yung Shue Wan (transect A) where a total of 15 species were recorded (*Figure 7.2a*). The number of macroalgal species generally ranged from 4 to 8 except for one of the transects at site L1 in Yung Shue Wan where only 3 species were recorded.

Animals recorded on the shores at the surveyed sites were largely molluscs and crustaceans. The most abundant were herbivorous molluscs, including the chiton (*Acanthopleura japonica*), the limpets (*Cellana grata, C. toreuma, Patelloida pygmaea, P. saccharina, Siphonaria atra* and *S. sirius*), the snails (*Monodonta labio* and *Planaxis sulcatus*) and the nerite (*Nerita albicilla*) on the mid and low shore, and the periwinkles (*Nodilittorina radiata, N. trochoides* and *N. vidua*) at high shore (*Figure 7.2b*). The predatory gastropod *Thais clavigera* (the common dogwhelk) was also recorded in the low shore region.

The most diverse and abundant mobile faunal assemblages were recorded at sites L1 - Yung Shue Wan and L2 - West of Pak Kok (*Figure 7.2c*). Of the four sites, the lowest diversity (in terms of number of species) and lowest abundance of mobile fauna was recorded at site L3 - Pak Kok (*Table 7.2b*). The site at Pak Kok would be the most affected by the construction works due to the presence of the high shore cable route as well as the landing and launching point reclamation. Sea anemones were also occasionally observed on the high shore area. Sessile filter-feeding barnacles such as the stalked barnacle (*Capitulum mitella*) and the acorn barnacles (*Balanus amphitrite* and *T. squamosa*) were common on the shores of the majority of sites. The percentage cover of barnacles was low at the majority of sites (< 10 %) (*Figure 7.2c*).

Although ten species of macroalgae were recorded they were sparsely distributed. Such a pattern is typical for Hong Kong rocky shores during the summer months when the survey was undertaken. Low spring tides coincide with the hot noon time period and desiccation stresses prevent widespread growth of algae on the shore. Of the algae present, encrusting algae were the most abundant with *Neogoniolithon misakiense, Corallina* sp. and *Hildenbrandia occidentalis* having the highest percentage cover. Although L3 at Pak Kok recorded the lowest density of mobile organisms the shores supported the highest cover of algae of the four sites (33 %) (*Figure 7.2c*).

The population structures of the herbivorous chiton *Acanthopleura japonica* showed distinct differences between the sites surveyed (*Figure 7.2d*). All four sites exhibited evidence of recruitment (ie contained organisms of < 20 mm). The largest range of sizes was recorded at site L2 (10 - 70 mm) and the smallest at L4 (15 - 45 mm). This indicates that conditions for chiton recruitment and growth are most favourable at site L2 and least favourable at site L4.

Table 7.2b ***Density (m^{-2}) of Intertidal Flora and Fauna Recorded During the Wet Season at the Launching and Landing Sites***

Species	L1	L2	L3	L4
Chiton				
Acanthopleura japonica	10.5	13.6	10.1	15.0
Limpet				
Cellana grata	1.3	0.40	0.58	0.98
Cellana toreuma	8.0	9.0	6.2	10.4
Patelloida saccharina	89.3	72.0	53.3	64.6
Patelloida pygmaea	0.98	0.27	-	-
Siphonaria atra	1.8	1.1	0.13	0.89
Siphonaria sirius	0.09	0.40	-	-
Snail				
Monodonta labio	0.40	9.3	-	15.6
Nerita albicilla	0.40	0.76	1.1	0.04
Nodilittorina radiata	2.3	6.9	3.3	4.4
Nodilittorina trochoides	12.5	1.5	9.0	9.0
Nodilittorina vidua	2.8	4.3	-	0.44
Thais clavigera	3.3	1.1	1.5	0.40
Barnacle				
Balanus amphitrite	6.1	0.19	0.36	0.99
Capitulum mitella	0.44	0.46	4.9	0.80
Tetraclita japonica	4.8	0.01	0.30	0.08
Tetraclita squamosa	0.28	-	0.28	6.5
Sea anemone				
Anthopleura japonica	-	0.10	-	-
Macroalgae				
Endoplura aurea	-	-	0.29	0.37
Ralfsia expansa	0.08	3.6	-	1.5
Hapalospongidion gelatinosum	-	-	0.87	1.5
Hildenbrandia occidentalis	1.5	0.72	5.6	0.96
Hildenbrandia rubra	0.04	0.77	7.8	-
Neogoniolithon misakiense	5.6	12.9	12.7	14.3
Corallina sp	1.9	4.9	5.1	3.5
Pseudulvella applanata	-	3.1	-	-
Gloeocapsa sp	-	0.73	-	-
Kyrtuthrix maculans	-	0.42	0.58	2.2

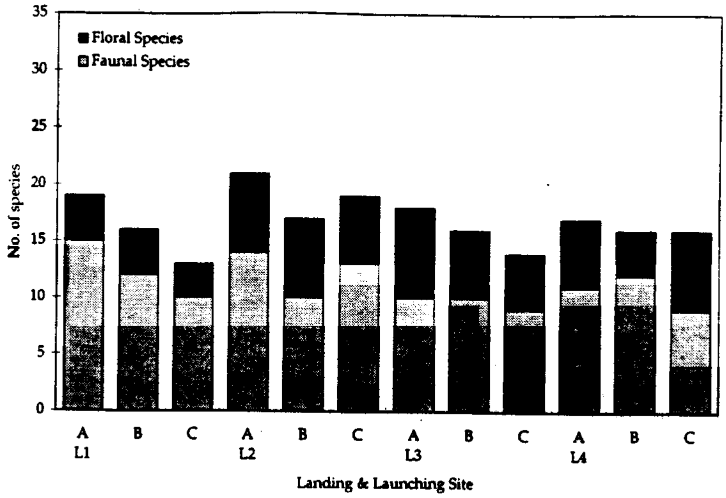


Figure 7.2a: Total number of animal and algal species of each transect sampled during wet season surveys of sites on the northern coast of Lamma Island.

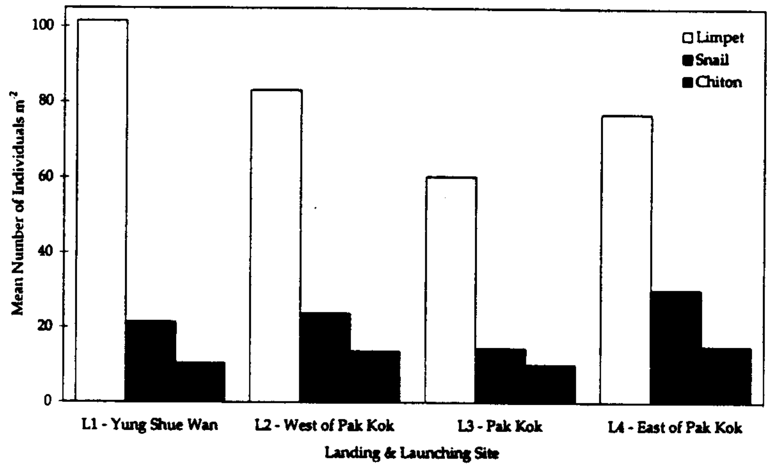


Figure 7.2b: Mean number of mobile molluscs m^{-2} recorded during wet season surveys of sites on the northern coast of Lamma Island.

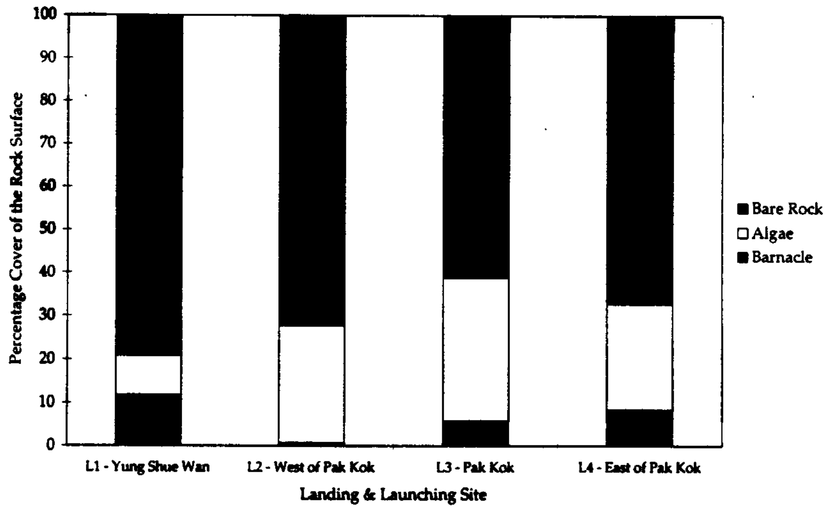
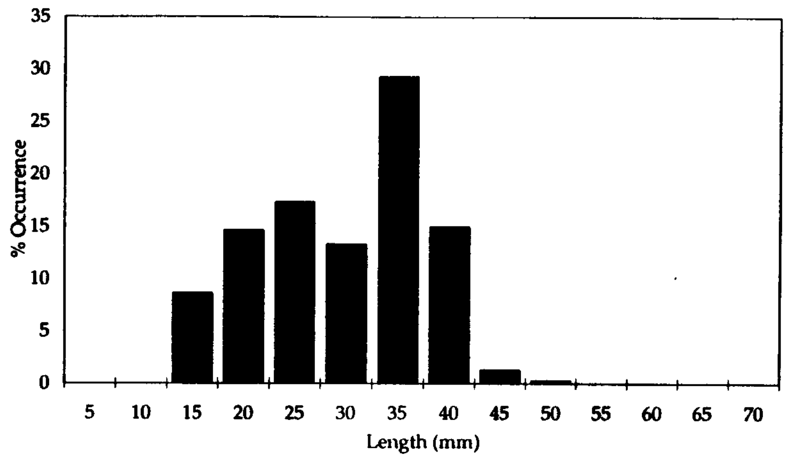
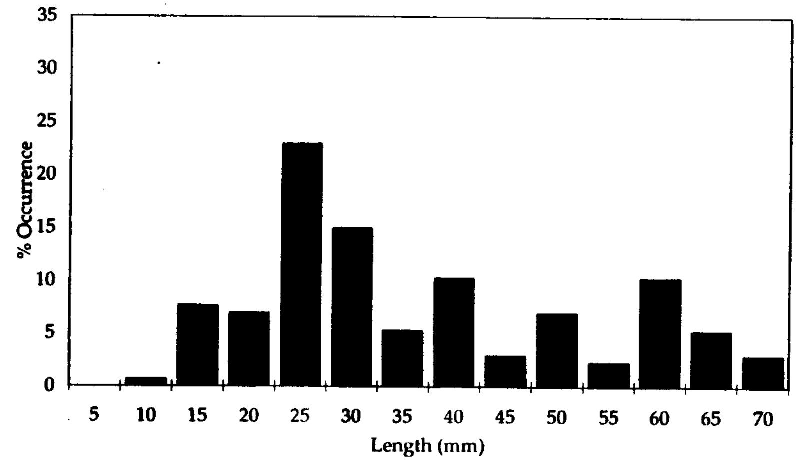


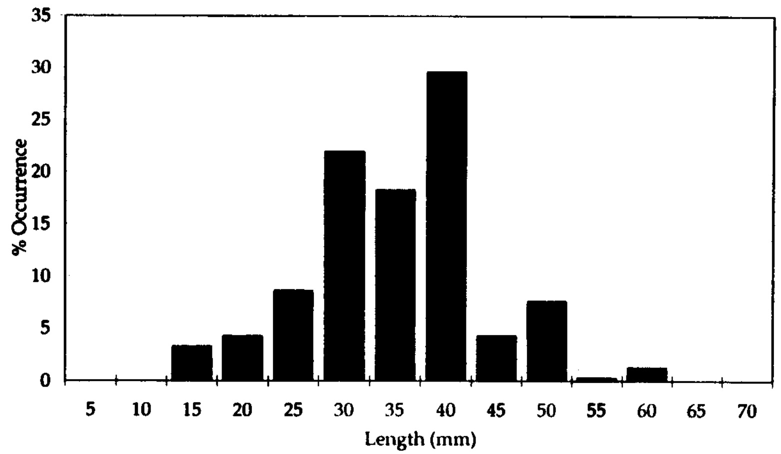
Figure 7.2c: Percentage cover on the rock surface of sessile invertebrates and macroalgae. Records were made during wet season surveys of sites on the northern coast of Lamma Island.



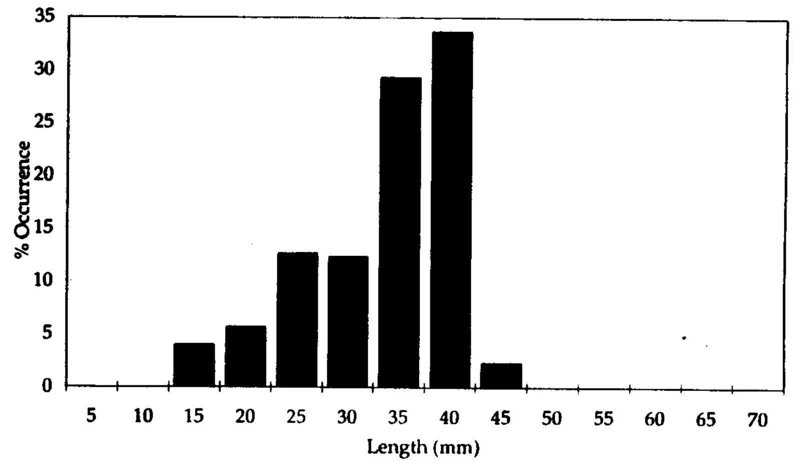
(i) Population structure of chitons from launching and landing site L1 - Yung Shue Wan



(ii) Population structure of chitons from launching and landing site L2 - West of Pak Kok



(iii) Population structure of chitons from launching and landing site L3 - Pak Kok



(iv) Population structure of chitons from launching and landing site L4 - East of Pak Kok

Figure 7.2d: Population structure of the herbivorous mollusc, *Acanthopleura japonica*, sampled during the wet season on shores on the northern coast of Lamma Island.

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DATE: 24-10-98

Environmental Resources Management

ERM

Subtidal - Wet Season

The majority of the substrate at launching and landing site L1 was either sand and shell debris (mean cover 47.7 %) or rocks that were encrusted with the barnacle, *Balanus* spp (mean cover 33.3 %) (*Figure 7.2e*). Hard corals of the Faviidae family were found, however, they represented a mean cover for the site of only 0.83 %. A colony of the encrusting hard coral *Psammocora superficialis* was also identified but only made up 0.28 % of the mean cover (*Table 7.2c*).

Table 7.2c ***Mean Percentage of Line Transect Cover by Coral Colonies Recorded During the Wet Season at the Launching and Landing Sites (L1 to L4)***

Coral Colony	Site			
	L1	L2	L3	L4
Hard Coral				
Psammocora superficialis	0.83%	0%	0%	0.56%
Family Faviidae	0.99%	0%	0.28%	0%
Soft Coral				
Dendronephthya spp	0%	0.28%	0%	0%

Site L2 was characterised by two distinct areas of substrate type. The eastern habitat of the site was predominantly made up of sand and shell debris (mean cover 69.4 %), whereas the western habitat was found to have a more diverse bottom habitat, with the majority of the substrate recorded being rock encrusted with the barnacle, *Balanus* spp (mean cover 21.9 %) (*Figure 7.2e*). Turf algae was also recorded at the western end of the survey site. No hard corals were found on any of the line transects, however, a single soft coral, *Dendronephthya* spp, was found representing a mean cover for the site of only 0.28% (*Table 7.2c*).

For site L3, the majority of the northern habitat of the site was recorded as sand and shell debris (mean cover 72.5 %) (*Figure 7.2e*). As recorded at site L2, a shift to a greater amount of rocky substrate encrusted with the barnacle, *Balanus* spp was found to the south of the site (mean cover 26.2 %). Very little hard coral was found on the line transects at this site, with only one colony of the family Faviidae recorded mean cover of 0.28 % (*Table 7.2c*).

The substratum of site L4 was found to differ from the other sites surveyed. Rocks encrusted with the barnacle, *Balanus* spp, made up the majority of the cover (mean cover 81.9 %) (*Figure 7.2e*). The remainder of the substrates recorded consisted of either sand and shell debris (mean cover 10.56 %) or bare rock (mean cover 6.94 %). Two areas of coral cover, identified as the encrusting hard coral *Psammocora superficialis*, were also recorded amounting to a mean cover of 0.56 % for the site (*Table 7.2c*). Photographs of representatives of substrates or organisms of interest within the belt transects at each of the launching and landing sites are shown in *Annex C7 - 1*. It must be noted, however, the photographs of the representative substrates and / or organisms of interest were taken within the entire area of the belt transects and are, therefore, not a visual representation of the results of the line transect survey.

The highest abundance of mobile organisms recorded at the four sites were from the class Gastropoda. The majority of the Gastropoda recorded were dogwhelks (family Muricidae) with medium to low abundances of tusk shells (family

Trochidae) and turban shells (family Turbinidae), and low abundances of the slipper limpet (family Calyptraeidae) (*Table 7.2d*).

Table 7.2d ***Mean Number of Mobile Individuals (> 1 cm) m^{-2} Recorded During the Wet Season for each Launching and Landing Site***

Fauna	Site			
	L1	L2	L3	L4
Decapoda	0.12	0.03	0.21	0.02
Gastropoda	2.97	3.06	1.89	5.71
Holothuroidea	0.18	0.07	0.07	0
Echinoidea	0.03	0.32	0.40	3.31
Asteroidea	0	0	<0.01	0

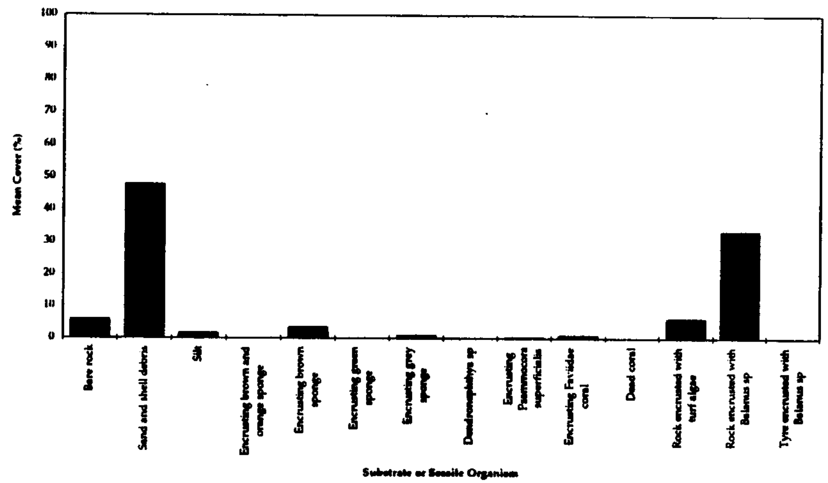
Individuals from the family Paguridae (hermit crabs) or portunid swimming crabs (*Charybdis* spp) were the most common decapods recorded. The lowest number of hermit and swimming crabs was recorded site L4 with a mean number of 0.02 individuals m^{-2}. Similarly, low numbers of sea cucumbers *Holothuria leucospilota* were recorded at all sites.

One similar feature of the four sites was the high numbers of sea urchins recorded throughout the belt transects. The most abundant of these were from the order Diadematoida (*Diadema* sp), with low numbers of another urchin species, *Anthocidaris crassispina,* also recorded. Site L4 had particularly high numbers of *Diadema* sp with a mean of 3.31 individual recorded in comparison with the other sites (mean number range of 0.03 - 0.40).

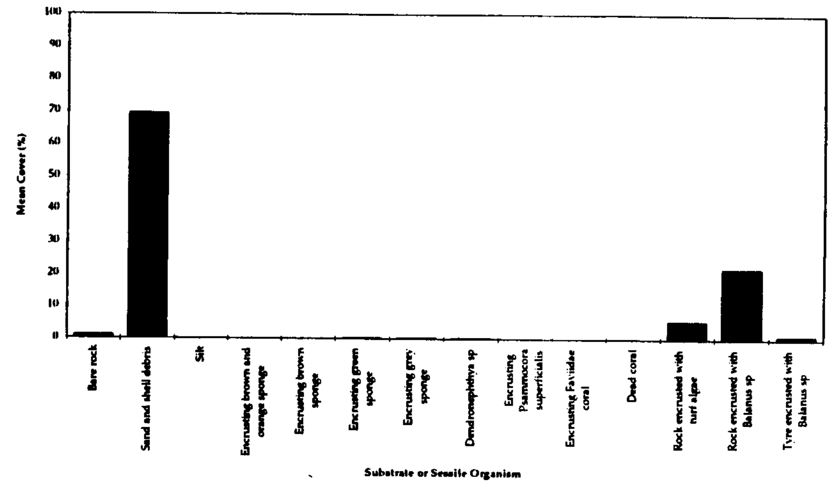
Intertidal - Dry Season

In total, 21 species of animals and 13 species of macroalgae were recorded at the four launching and landing sites. Except for L3 - Pak Kok and L4 - east of Pak Kok where comparatively low animal species numbers (< 13 for some transects) were recorded, the number of animal species at the surveyed sites was greater than or equal to 13 and was highest at L4 - East of Pak Kok (transect B) where a total of 17 species were recorded (*Figure 7.2f*). The number of macroalgal species generally ranged from 5 to 7 except for one of the transects at site L1 in Yung Shue Wan where only 4 species were recorded. As with the wet season results animals recorded on the shores at the surveyed sites were largely molluscs and crustaceans (*Figure 7.2g*).

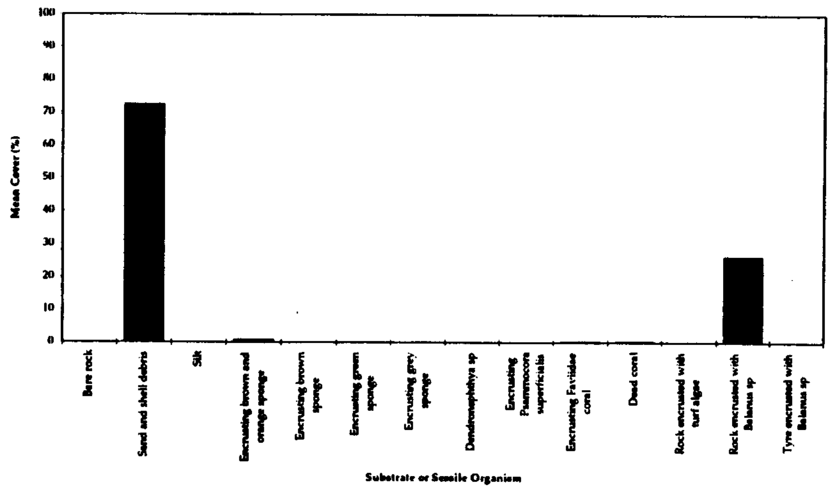
The most diverse and abundant mobile faunal assemblages were recorded at sites L1 - Yung Shue Wan and L4 - East of Pak Kok (*Figure 7.2f*). Of the four sites, the lowest diversity (in terms of number of species) and lowest abundance of mobile fauna were recorded at site L2 - West of Pak Kok (*Figure 7.2g*). The site at Pak Kok (L3) showed comparable mobile fauna abundance with those of L1 and L4, despite its relatively low species diversity. This location would be the most affected by the construction works due to the presence of the high shore cable route as well as the landing and launching point reclamation. Sea anemones were also occasionally observed on the high shore area. Sessile filter-feeding barnacles such as the stalked barnacle (*Capitulum mitella*) and the acorn barnacles (*Tetraclita japonica* and *T. squamosa*) were common on the shores of the majority of sites. The percentage cover of barnacles was generally low at the majority of sites (< 5 %) (*Figure 7.2h*).



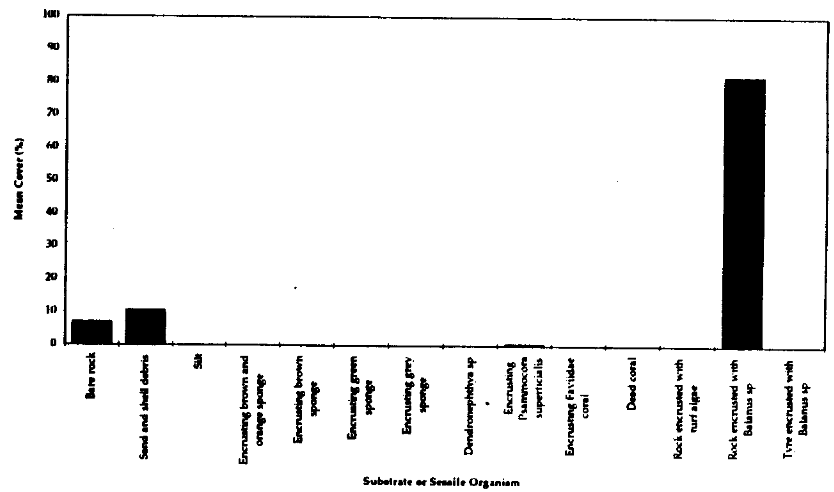
(i) Mean cover (%) for substrate or sessile organism for site L1 - Yung Shue Wan



(ii) Mean cover (%) for substrate or sessile organism for site L2 - West of Pak Kok



(iii) Mean cover (%) for substrate or sessile organism for site L3 - Pak Kok



(iv) Mean cover (%) for substrate of sessile organism for site L4 - East of Pak Kok

Figure 7.2e: Mean cover (%) for substrate or sessile organism recorded during the wet season subtidal surveys at the launching and landing sites on the northern coast of Lamma Island.

FILE: C1830/MARINE/Subtidal/Mean Cover Graphs (L1 - L4).doc
DATE: 24-10-98

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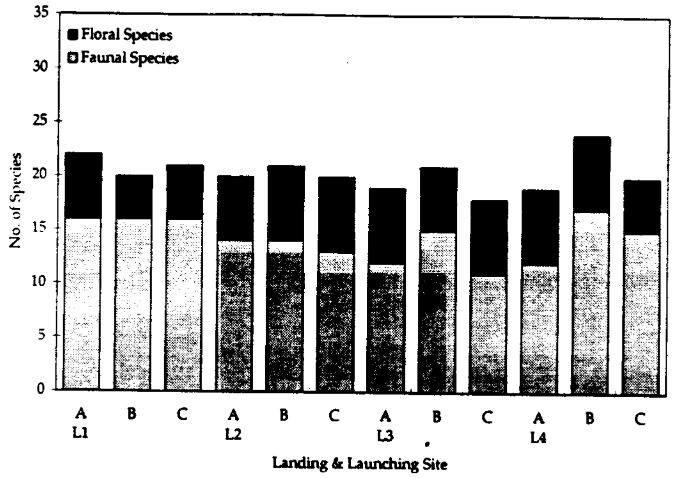


Figure 7.2f: Total number of animal and algal species of each transect sampled during dry season surveys of sites on the northern coast of Lamma Island.

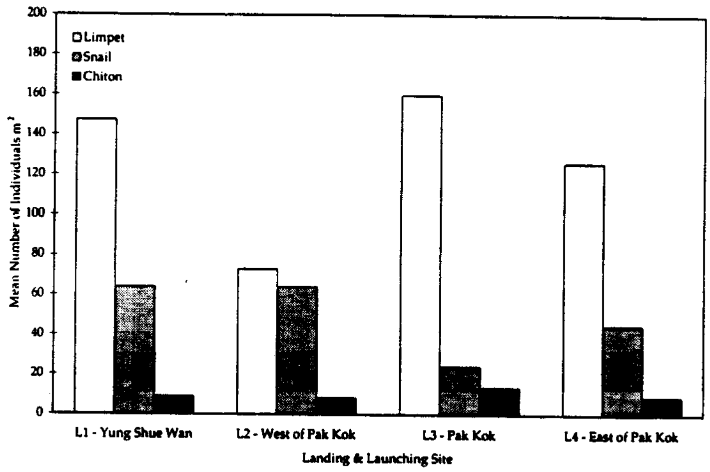


Figure 7.2g: Mean number of mobile molluscs m^{-2} recorded during dry season surveys of sites on the northern coast of Lamma Island.

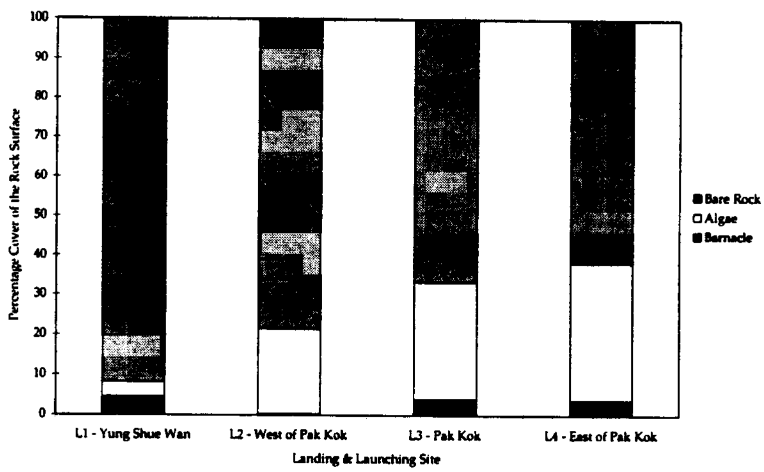


Figure 7.2h: Percentage cover on the rock surface of sessile invertebrates and macroalgae. Records were made during dry season surveys of sites on the northern coast of Lamma Island.

Although thirteen species of macroalgae were recorded most of them were sparsely distributed. Of the algae present, encrusting algae were the most abundant with *Neogoniolithon misakiense*, *Corallina* sp., *Hildenbrandia occidentalis*, *H. rubra* and *Ralfsia expoansa*, having the highest percentage cover. Emerging stands of algal species typical of the dry season such as the red (*Dermonema frappierii*) and brown algae (*Endarachne binghamiae* and *Sargassum hemiphyllum*) were recorded from sites L2 and L3 west of and at Pak Kok. The site at East of Pak Kok (L4) showed the highest algal species diversity (11) and percentage cover (35%). Lowest algal cover (4%) was recorded at Yung Shue Wan (L1) which was also a site of highest mobile fauna abundance (*Figure 7.2h*).

The population structures of the herbivorous chiton *Acanthopleura japonica* showed some observable differences between the sites surveyed (*Figure 7.2i*). All four sites exhibited evidence of recruitment (ie contained organisms of < 20 mm). The ranges of sizes recorded at the surveyed sites were broadly similar, ie 15 - 75 mm, except for L3 where an individual as small as 3 mm was recorded, L2 (10 - 70 mm) and the smallest at L4 (15 - 45 mm). This indicates that conditions for chiton recruitment and growth during the dry season are similarly favourable at all the studied sites.

Table 7.2e ***Density (m^{-2}) of Intertidal Flora and Fauna Recorded During the Dry Season at the Launching and Landing Sites***

Species	L1	L2	L3	L4
Chiton				
Acanthopleura japonica	8.9	8.3	13.4	9.1
Limpet				
Cellana grata	1.2	1.1	1.6	0.71
Cellana toreuma	11.5	11.4	14.2	9.6
Patelloida saccharina	124.7	55.2	143.1	114.7
Patelloida pygmaea	8.4	3.7	-	0.09
Siphonaria atra	0.76	0.53	0.49	0.44
Siphonaria sirius	0.31	0.80	0.22	0.49
Siphonaria japonica	0.40	-	-	0.09
Snail				
Chlorostoma argyrostoma	-	-	-	0.76
Lunella coronata	-	-	-	0.09
Monodonta labio	3.2	17.6	1.4	17.2
Nerita albicilla	0.53	7.1	1.7	1.6
Nodilittorina radiata	39.9	29.0	9.6	7.0
Nodilittorina trochoides	14.5	4.5	7.4	8.7
Nodilittorina vidua	3.1	2.8	0.36	8.7
Planaxis sulcatus	-	1.1	-	0.13
Thais clavigera	2.7	1.8	3.6	0.76

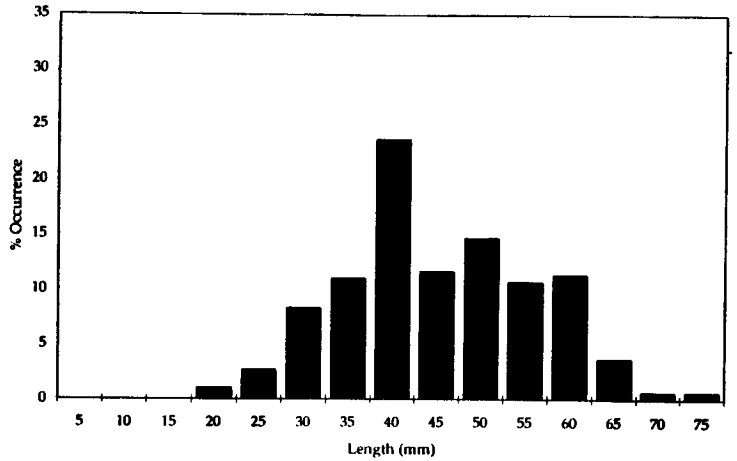
Species	L1	L2	L3	L4
Barnacle				
Balanus amphitrite	-	-	0.04	-
Capitulum mitella	0.22	0.23	2.8	0.68
Tetraclita japonica	1.2	-	0.67	0.24
Tetraclita squamosa	3.2	0.16	0.47	2.81
Sea anemone				
Anthopleura japonica	-	0.01	-	0.02
Macroalgae				
Endoplura aurea	0.17	0.49	0.62	2.5
Ralfsia expansa	0.22	5.5	-	1.8
Hapalospongidion gelatinosum				
Hildenbrandia occidentalis	0.80	0.06	4.22	1.01
Hildenbrandia rubra	0.38	7.71	5.6	14.9
Neogoniolithon misakiense	1.71	2.2	11.0	7.5
Corallina sp	0.16	0.24	5.5	2.5
Pseudulvella applanata	-	0.32	-	0.07
Gloeocapsa sp	-	4.6	-	0.88
Kyrtuthrix maculans	0.02	-	1.3	1.5
Dermonema frappierii	-	-	0.36	-
Endarachne binghamiae	-	-	0.07	-
Sargassum hemiphyllum	-	-	-	1.1

Subtidal - Dry Season

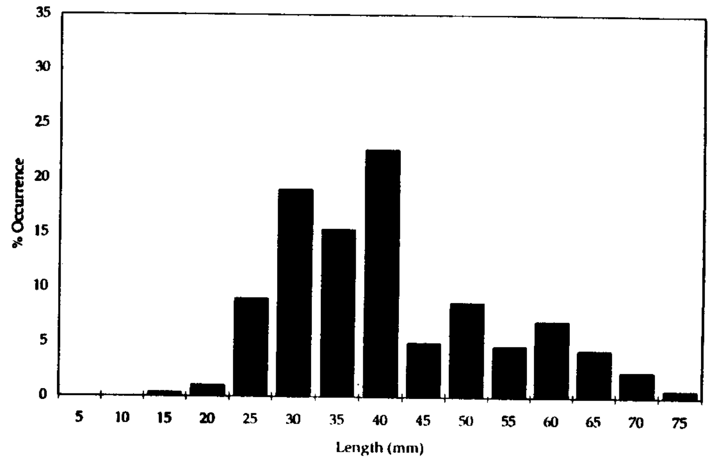
Surveys were conducted of the subtidal assemblages at sites L 2 to L3 during the dry season. The survey at L1 could not be completed due to the encroachment onto the survey transect of construction activities at a nearby works site.

Table 7.2f ***Mean Percentage of Line Transect Cover by Coral Colonies Recorded During the Dry Season at the Launching and Landing Sites (L2 to L4)***

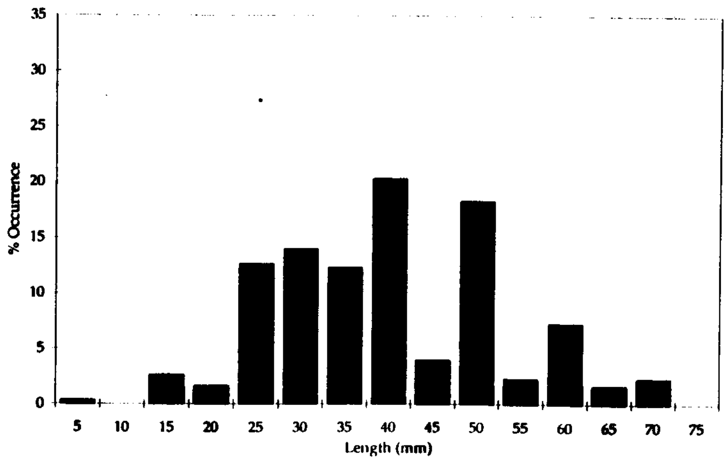
Coral Colony	Site			
	L1	L2	L3	L4
Hard Coral				
Psammocora superficialis		0.28%	0%	0%
Family Faviidae		2.22%	0.83%	0.56%
Goniopora spp		0.28%	0%	0%
Pavona spp		0.28%	0%	0%
Soft Coral				
Dendronephthya spp		0%	0%	0%



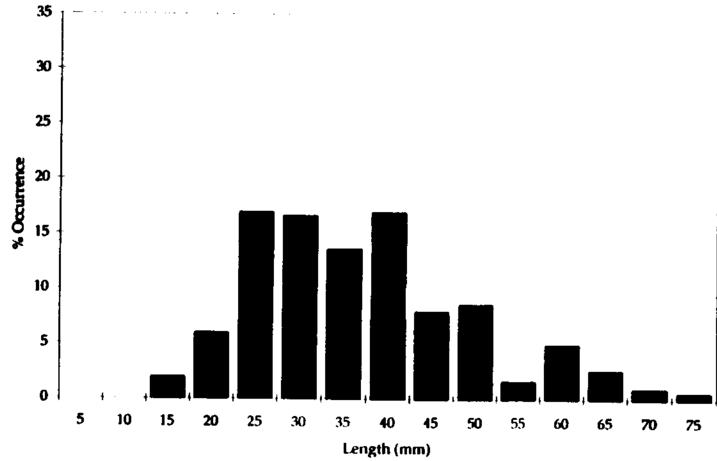
(i) Population structure of chitons from launching and landing site L1 - Yung Shue Wan



(ii) Population structure of chitons from launching and landing site L2 - West of Pak Kok



(iii) Population structure of chitons from launching and landing site L3 - Pak Kok



(iv) Population structure of chitons from launching and landing site L4 - East of Pak Kok

Figure 7.21: Population structure of the herbivorous mollusc, *Acanthopleura japonica*, sampled during the dry season on shores on the northern coast of Lamma Island.

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DATE: 11-12-98

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The majority of the substrate at site L2 was largely sand and shell debris (mean cover 46.4 %) or rocks that were encrusted with the barnacle, *Balanus* spp (mean cover 50.0 %) (*Figure 7.2j*). Of the three surveyed sites, L2 supported the highest diversity of hards corals with species of *Goniopora, Pavona* and the Faviidae family being recorded, representing mean cover of 2.5% (*Table 7.2f*). A colony of the encrusting hard coral *Psammocora superficialis* was also identified and made up only 0.28% of the mean cover.

For site L3, the majority of the northern habitat of the site was recorded as sand and shell debris (mean cover 63.8 %) (*Figure 7.2j*). As recorded at site L2, rocks encrusted with the barnacle, *Balanus* spp constituted most of the remaining substrate surface (mean cover 31.7 %). Very little hard coral was found on the line transects at this site, with only one colony of the family Faviidae recorded mean cover of 0.83 % (*Table 7.2f*).

The substratum of site L4 was found to differ from the other sites surveyed. Rocks encrusted with the barnacle, *Balanus* spp, made up the majority of the cover (mean cover 74.4 %) (*Figure 7.2j*). The remainder of the substrates recorded consisted of either sand and shell debris (mean cover 22.7 %) or bare rock (mean cover 2.22 %). Two areas of coral cover, identified as the encrusting hard coral *Psammocora superficialis*, were also recorded amounting to a mean cover of 0.56 % for the site (*Table 7.2f*).

The highest abundance of mobile organisms recorded at the four sites were from the class Gastropoda (*Table 7.2g*). The majority of the Gastropoda recorded were dogwhelks (family Muricidae) with medium to low abundances of turban shells (family Turbinidae) and low abundances of cowries (family Cyraeidae). The highest densities of gastropods were recorded at site L2.

Table 7.2g ***Mean Number of Mobile Individuals (> 1 cm) m^{-2} for each Launching and Landing Site***

Fauna	**Site**			
	L1	**L2**	**L3**	**L4**
Decapoda		0.38	0.32	0.13
Gastropoda		2.34	1.87	0.68
Holothuroidea		0.31	0.13	0.22
Echinoidea		0.64	0.44	2.52
Asteroidea		-	-	-
Octopoda		-	0.01	-

Individuals from the family Paguridae (hermit crabs) or portunid swimming crabs (*Charybdis* spp) were the most common decapods recorded. The lowest number of hermit and swimming crabs was recorded site L4 with a mean number of 0.13 individuals m^{-2}. Similarly, low numbers of sea cucumbers *Holothuria leucospilota* were recorded at all sites.

One similar feature of the four sites was the high numbers of sea urchins recorded throughout the belt transects. The most abundant of these were from the order Diadematoida (*Diadema* sp), with low numbers of another urchin species, *Anthocidaris crassispina*, also recorded. Site L4 had particularly high numbers of *Diadema* sp with a mean of 2.52 individual m^{-2}.recorded in comparison with the other sites (mean number range of 0.44 - 0.64).

Survey Findings

A comparison of these findings with other subtidal surveys throughout Hong Kong indicates that each area is of low ecological value. Although both hard and soft corals were recorded within each of the launching and landing sites, the percent cover recorded by these colonies is well below the numbers that have been defined in other studies as areas of high conservation value. The results indicate that site L1 has the highest overall percent cover by corals (both hard and soft) with a total of 1.82 %. A comparison with an area of high conservation value, ie the coral colonies at Ping Chau emphasises the low ecological value of the sites on Lamma. The surveys at Ping Chau recorded coral covers (both hard and soft) of 55.9 % and 61.9 % in different areas[12].

Desspite the generally low ecological value of the landing and launching sites avoidance, as far as practicable, of impacts to the few patches of hard corals is a concern for this Study. Consequently, the survey data has been examined to identify transects located within the survey sites where impacts should be avoided as far as practically possible, these include:

- Site L1 - Yung Shue Wan, transects 1, 2 and 5; and
- Site L3 - Pak Kok, transect 4.

No areas of site L2 were regarded as sensitive and site L4 will not be impacted by the construction activities. It is noted here that these recommendations are made on the basis of ecological value of individual transects within a site, and not on the basis of the value of the site as a whole. In comparison to other sites in Hong Kong, none of the sites surveyed have been identified as being of high or medium ecological value.

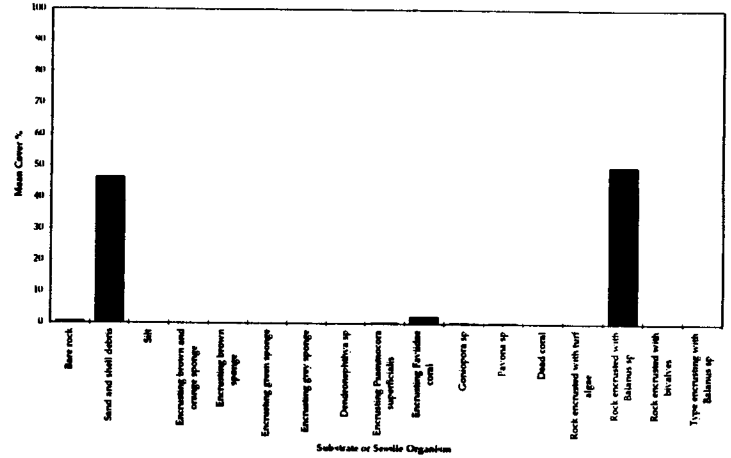
7.2.3 *Ecological Importance*

According to the Technical Memorandum of the *EIAO (EIAO TM) Annex 8* the ecological value / importance of a habitat can be evaluated using the following criteria:

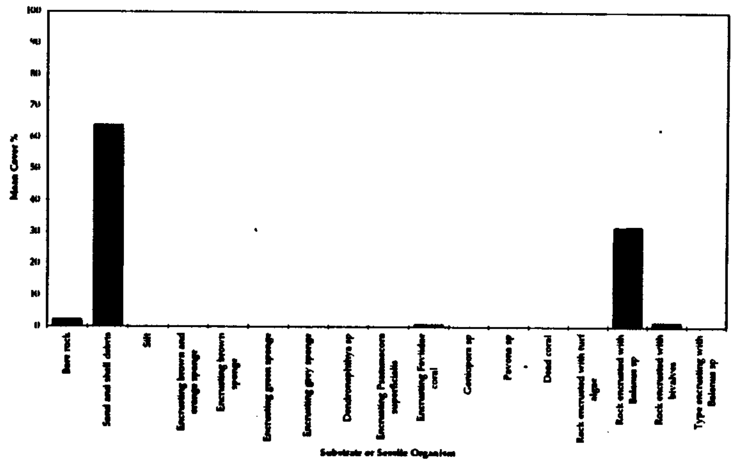
- Naturalness;
- Size;
- Diversity;
- Rarity;
- Re-creatability;
- Ecological Linkage;
- Potential value;
- Nursery Ground;
- Age; and,
- Abundance.

The criteria listed above have been applied to the information gathered or reviewed on the marine ecology the launching and landing sites, and is presented below (*Table 7.2f*).

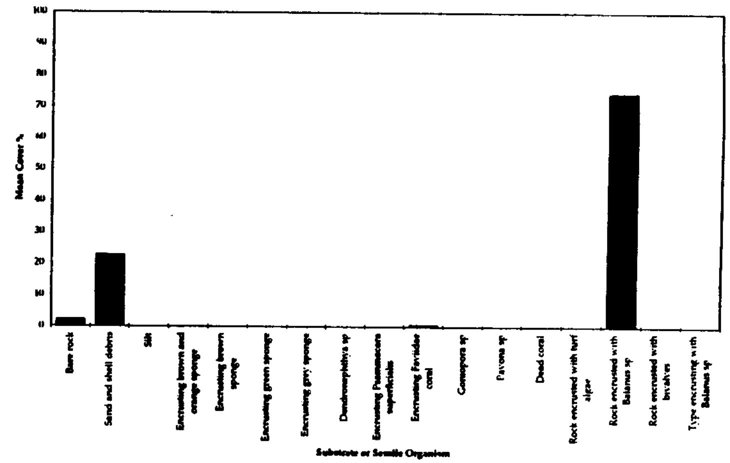
(12) Binnie Consultants Limited (1996) Ping Chau Quantitative Survey Final Report, For the Geotechnical Engineering Office, Civil Engineering Department.



(ii) Mean cover (%) for substrate or sessile organism for site L2 - West of Pak Kok



(iii) Mean cover (%) for substrate or sessile organism for site L3 - Pak Kok



(iv) Mean cover (%) for substrate of sessile organism for site L4 - East of Pak Kok

Figure 7.2j: Mean cover (%) for substrate or sessile organism recorded during the dry season subtidal surveys at the launching and landing sites on the northern coast of Lamma Island.

FILE: C1830/MARINE/Subtidal/Dry Mean Cover Graphs (L1 - L4).doc
DATE: 11-12-98

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Table 7.2f ***Ecological Value of Subtidal and Intertidal Hard Surface Assemblages at the proposed the Launching and Landing Sites***

Criteria	Intertidal	Subtidal
Naturalness	Assemblages typical of undisturbed locations.	Modified through poor water quality (evidence of sediment deposition).
Size	The areas of potential disturbance are: • landing point I1 - 25 x 40 m^2 • landing point N2 - 26 x 70 m^2 • landing point N4 - 27 x 65 m^2 • landing point N5 - 33 x 56 m^2 • cable trough between N4 and N5 - 5.5 x 260 m^2.	The areas of potential disturbance are: • landing point I1 - 25 x 40 m^2 • landing point N2 - 26 x 70 m^2 • landing point N4 - 27 x 65 m^2 • landing point N5 - 33 x 56 m^2 • cable trough between N4 and N5 - 5.5 x 260 m^2.
Diversity	Typical of other semi-exposed rocky shores in Hong Kong.	Hong Kong Island site very poor diversity, however, Lamma sites have a higher diversity although still poor in comparison to other sites in Hong Kong.
Rarity	No species were found that are considered rare.	Some isolated colonies of hard corals were present at some of the sites.
Re-creatibility	Given that the seawall designs satisfy the ecological requirements of the assemblages, post construction colonisation of the landing and launching points should occur.	Given that the seawall designs satisfy the ecological requirements of the assemblages, post construction colonisation of the landing and launching points should occur.
Ecological Linkage	The predominant habitat types are not linked to any highly valued habitat in close proximity.	The predominant habitat types are not linked to any highly valued habitat in close proximity.
Potential Value	Unlikely that the site can develop any conservation interest due to water quality of the surrounding area	Unlikely that the site can develop any conservation interest due to water quality of the surrounding area
Nursery Area	None identified in the review.	None identified in the review.
Age	n/a for these assemblages as the life cycle of the fauna and flora is very short.	The subtidal fauna is generally short lived apart from the isolated colonies of hard corals which are slow growing and long lived.
Abundance	Abundances appear to be similar to other semi-exposed rocky shores in Hong Kong.	Compared to nearby sites on the Hong Kong Island shore the sites on Lamma Island appear to support more abundant subtidal fauna.
SUMMARY	The shores support assemblages of a diversity that is typical to other semi-exposed shores in Hong Kong and appear to be relatively undisturbed **Ecological Value - Low.**	The habitat appears to support assemblages that are of lower diversity and abundance when compared to other areas of Hong Kong. In the context of the western harbour area the assemblages are some of the more abundant and diverse. **Ecological Value - Low** (except for transects detailed above in *Section 7.1.2*).

The above assessment based on the TM criteria has led the intertidal habitat of the launching and landing sites to be classified as of low ecological value. Similarly, the subtidal habitats of the area have been classified as of low ecological value when compared to others in Hong Kong.

Following the TM criteria employed above, an assessment of the ecological value of the soft bottom marine habitat affected by the submarine transmission cable route is presented below in *Table 7.2g*.

Table 7.2g ***Ecological Value of the Soft Bottom Benthic Assemblages Along the Submarine Transmission Cable Route***

Criteria	Subtidal
Naturalness	The channel is one of the busiest shipping thoroughfares into Hong Kong. The assemblages are expected to be undisturbed as the west Lamma Channel fairway is deep and has not been maintenance dredged.
Size	12 cables will be laid as transmission routes each requiring a trench 0.3 m wide.
Diversity	Low compared to other sites around Lamma Island and elsewhere in Hong Kong.
Rarity	No species were found that are considered rare.
Re-creatibility	Once the trenches backfill naturally recolonisation of the benthic fauna is expected to occur returning the sites to pre-cable laying conditions.
Ecological Linkage	The surrounding environment contains many other areas of soft substrate.
Potential Value	Unlikely that the site can develop conservation interest.
Nursery Area	None identified in the review.
Age	The fauna, though less abundant, appear to be typical of those present in Hong Kong's soft benthos. The sediments along the proposed cable routes are constantly accreting and eroding and the fauna present there are typically short lived.
Abundance	Abundances appear to be lower than other areas around Lamma Island and elsewhere in Hong Kong.
SUMMARY	The sediments support low diversity and abundance assemblages of infaunal organisms containing species that are typical to Hong Kong. **Ecological Value - Low**

7.3 *IMPACT ASSESSMENT*

A total of 12 cables will be laid as transmission links for the power station extension. As each of these cables will be laid between 1 to 3.5 m deep, depending on the hardness of the seafloor and the location of the route, impacts associated with the submarine transmission cables are only expected to occur during the construction phase.

7.3.1 *Direct Impacts*

As a result of the construction of the landing and launching points small areas of the rocky shores on the northern coast of Lamma Island will be lost, these areas are (*Figure 7.3a*):

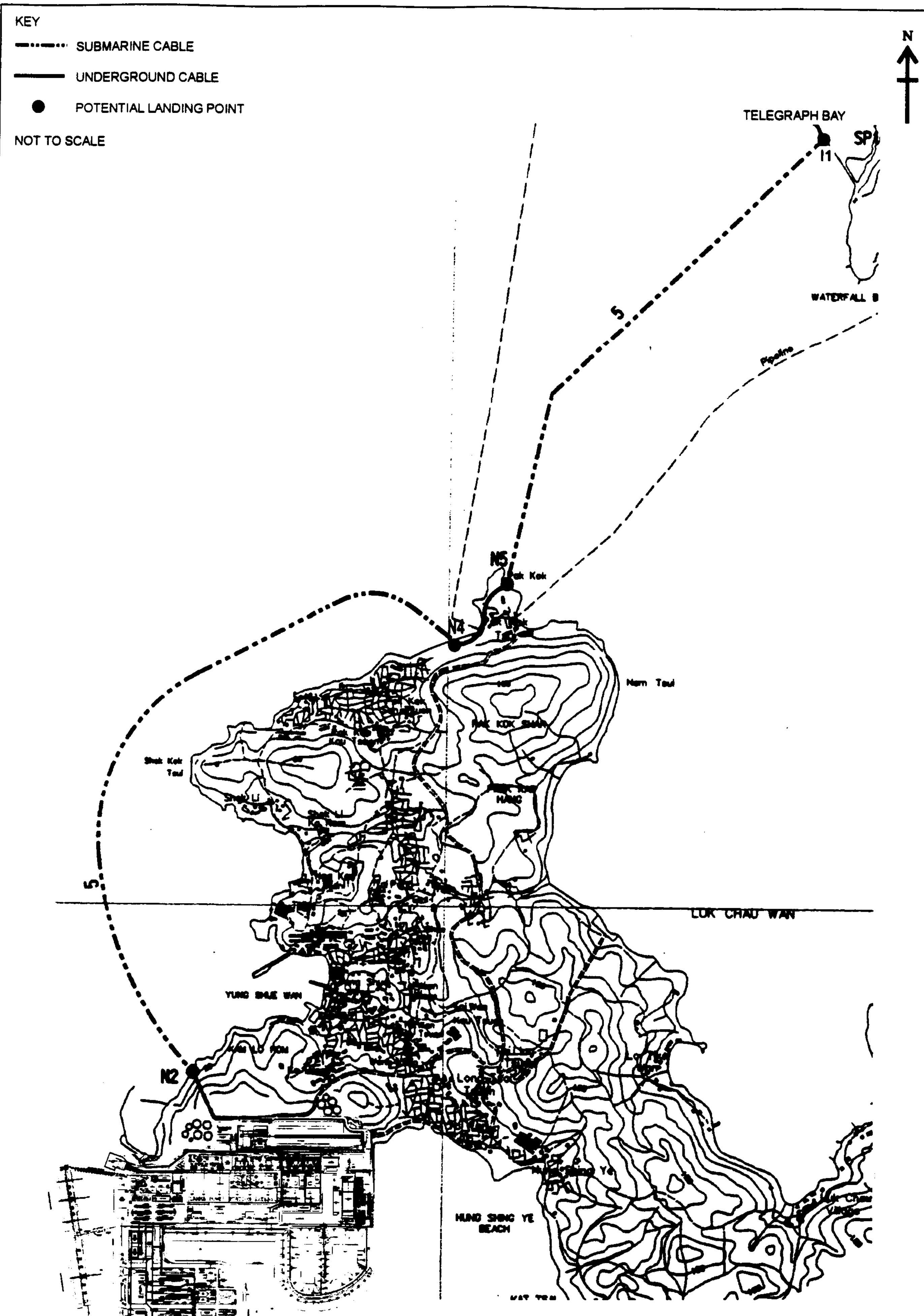

FIGURE 7.3a

NETWORK OF NEW CABLE SYSTEM

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DATE: 19/10/98

- landing point I1 - 25 x 40m^2
- landing point N2 - 26 x 70m^2
- landing point N4 - 27 x 65m^2
- landing point N5 - 33 x 56m^2
- cable trough between N4 & N5 - 5.5 x 260m^2

The landing point (I1) on Hong Kong Island is located at Telegraph Bay. This landing point will be located on an existing seawall on which few organisms of ecological value or conservation importance are expected to be found. For this reason the impact of construction of this landing point to marine ecological resources is considered to be low. At present the position of the I1 landing point has not been finalised. Assuming the landing point remains on the artificial seawall at Telegraph Bay, the conclusions of this assessment do not change.

The intertidal and subtidal rocky shores of N2 (site L1 - Yung Shue Wan), N4 (site L2 - West of Pak Kok) and N5 (site L3 - Pak Kok) will effectively be lost as a result of the construction and will be replaced by artificial seawalls. The artificial seawalls can, however, support a rich assemblage of intertidal fauna and flora. Organisms present on intertidal shores in Hong Kong rely on larval settlement for recruitment. Assuming that there is a regular supply of larvae brought to the area, recolonisation of new seawalls resulting from the reclamation will occur. The design of the seawall will be critical in determining the extent to which the community re-establishes post reclamation. The more heterogeneous the seawall, the more diverse a community the habitat can support. Assuming successful recolonisation of the landing and launching point seawalls no adverse impacts are predicted during the operation phase of the submarine transmission cables.

Short term disturbances to the soft bottom assemblages along the cable route are also predicted to occur within the dredging area during the dredging operations associated with the cable laying. After the dredging operations have been completed it is expected that the epibenthic and infaunal benthic assemblages will recolonise.

7.3.2 *Indirect Impacts*

Indirect impacts to marine ecological resources are predicted to occur through changes in water quality associated with cable laying. These changes are predicted to be in the form of elevations in suspended solids, and consequent depletions in dissolved oxygen and increases in nutrients. The relationship between impacts to these water quality parameters and marine ecological resources are discussed in full in *Section 10.4*. Mathematical water quality modelling has not been conducted for the following reasons (for further details see Section on *Water Quality Impacts*):

- sediment release rates are expected to be relatively low, especially near to the coastal areas where cable trenches will be shallow;

- sediment will be released at the bottom of the water column which will restrict its dispersion prior to settling; and,

- cable laying activities will be of a short duration lasting approximately four weeks (one week for one trip of simultaneous laying of 3 cables).

It is predicted that the indirect impacts to marine ecological resources as a result of the cable laying activities will be minimal when :

- only a single dredger will be operated at any of the sites at any one time;
- the dredging rate will be low; and
- the volume of material to be removed will be low.

7.4 *IMPACT EVALUATION SUMMARY*

7.4.1 *Marine Ecology Sensitive Receivers*

Information presented in the review of literature and in the results of the comprehensive field surveys has indicated that the Study Area (defined in *Figure 8.2a* of *Part C Section 8*) does not contain any marine ecology sensitive receivers apart from isolated patches of soft and hard corals present at low densities. Marine ecological sensitive receivers include only habitats of high ecological value where it is considered crucial to the environmental acceptability of the project that construction and operational activities of the transmission system do not cause impacts. The following sections discuss and evaluate the impacts to all marine ecological habitats.

7.4.2 *Impacts Summary*

From the information presented above, the marine ecological impact associated with the construction of the submarine transmission cables and associated landing and launching points is considered to be low. An evaluation of the potential impacts in accordance with the *EIAO TM Annex 8 Table 1* is presented as follows:

- *Habitat Quality*: Impacts are predicted to occur to the low ecological value intertidal and subtidal assemblages identified during reviews of available information and during detailed field surveys due to construction of the launching and landing points.

- *Species:* The only organisms of ecological interest recorded in hard bottom habitats during the field surveys were sparse patches of soft corals and isolated colonies of hard corals. Percentage cover of these corals is very low compared with other recognised sites of conservation importance (eg Ping Chau). No organisms of conservation value were recorded in previous surveys of soft bottom benthic assemblages along the cable routes.

- *Size:* The reclamation areas for the three launching and landing points are of small size (< 1 ha) and affect the low ecological value intertidal and subtidal hard surface assemblages. Small areas of soft bottom seabed will be disturbed during the cable laying process.

- *Duration:* Impacts to assemblages within the three launching and landing points are permanent. However, given adequate seawall design, assemblages of a similar composition are predicted to recolonise over time. Impacts to the assemblages inhabiting the soft bottom assemblages along the cable routes will be short term (approximately four weeks - one week for one trip of simultaneous laying of 3 cables).

- *Reversibility:* Impacts to assemblages within the three launching and landing points are irreversible. However, given adequate seawall design, assemblages of a similar composition are predicted to recolonise over time. Impacts to the assemblages inhabiting the soft bottom assemblages along the cable routes will be reversible.

- *Magnitude:* Impacts to the ecologically sensitive habitats defined in this review will be of low magnitude during construction of the launching and landing points and laying of the submarine transmission cables.

7.5 *SUMMARY OF MITIGATION MEASURES*

In accordance with the guidelines in the TM on marine ecology impact assessment the general policy for mitigating impacts to marine ecological resources, in order of priority, are:

Avoidance:	Potential impacts should be avoided to the maximum extent practicable by adopting suitable alternatives (refer to *Part C - Section 1*).
Minimisation:	Unavoidable impacts should be minimised by taking appropriate and practicable measures such as constraints on intensity of works operations (eg dredging rates) or timing of works operations.
Compensation:	The loss of important species and habitats may be provided for elsewhere as compensation. Enhancement and other conservation measures should always be considered whenever possible.

The previous discussion (*Section 7.2.2*) has indicated that where possible, areas where hard corals are present, will be avoided thus minimising disturbances to marine ecological resources during construction of the landing and launching points. The loss of intertidal and subtidal assemblages at the landing and launching points is expected to be mitigated through provision of seawalls that provide adequate surfaces for colonisation once construction works have ceased. In order to assist in rehabilitating the area after construction of the landing and launching points for the transmission system it is recommended that a seawall design such as the rubble mound at Chek Lap Kok is used. It is has been demonstrated that marine organisms have recolonised these seawalls after construction[13]. It is anticipated that assemblages of soft corals and gorgonians, similar to those recorded in the field surveys, will settle on and recolonise the newly constructed seawalls of the landing and launching points.

Works operations associated with jet ploughing and grab dredging for the transmission cables are not expected to cause unacceptable perturbations to water quality. Consequently, any impacts to marine ecological resources are predicted to be short term and of low severity not requiring any specific mitigation measures.

7.6 *RESIDUAL IMPACT*

Taking into consideration the ecological value of the habitats discussed in the previous sections and the resultant mitigation requirements the residual impact can be determined. The residual impacts occurring as a result of construction of the transmission system are as follows:

(13) Binnie Consultants Ltd (1997) Chek Lap Kok Qualitative Survey Final Report. For the Geotechnical Engineering Office, Civil Engineering Department, December 1997.

- The loss of small areas of the subtidal soft bottom assemblages present along the cable route. The residual impact is considered to be acceptable as the habitat is of low ecological value and it is anticipated that assemblages of similar nature to pre-dredging/jet ploughing conditions will recolonise the sediments; and

- The loss of small areas of hard bottom habitat that supports very low densities of soft and hard corals at the landing and launching points. The residual impact is considered to be acceptable as the corals to be lost occur is small isolated patches. The loss of these organisms is compensated by the provision of seawalls that have been demonstrated to become recolonised by assemblages of similar nature after construction.

7.7 *ENVIRONMENTAL MONITORING AND AUDIT REQUIREMENTS*

As no impacts of concern to water quality are predicted to occur, the development and implementation of a monitoring and audit programme specifically designed to assess the effects of the construction activities on marine ecological resources is not deemed necessary.

7.8 *SUMMARY AND CONCLUSIONS*

Literature reviews of existing information coupled with extensive field surveys of marine ecological resources have been undertaken for this impact assessment. Information on baseline conditions indicate that intertidal and subtidal hard surface habitats are of low ecological value. Soft bottom habitats identified in the review were regarded as of low ecological value.

Potential impacts to marine ecological resources may arise from direct disturbances to habitats, or through changes to key water quality parameters, as a result of the following proposed activities:

- Construction of Launching and Landing Points for transmission cables; and
- Laying of transmission cables (jet ploughing and grab dredging are involved).

Small areas of natural intertidal and subtidal hard surface assemblages will be lost permanently as a result of the reclamations for the landing and launching points. However, it is anticipated that given adequate seawall design, assemblages typical of those lost will recolonise after construction. Subtidal soft bottom assemblages along the cable route will be lost as a result of the dredging/jet ploughing operations. These assemblages are, however, of low ecological value and predicted to recolonise the area after laying of the transmission cables. As indirect impacts arising from the proposed dredging works are predicted to be largely confined to the specific dredging areas, they are not expected to cause adverse impacts to any marine ecological resources of concern.

8 FISHERIES

8.1 INTRODUCTION

This Section of the EIA Report presents the findings of a desk-top assessment of the potential impacts on existing fisheries resources, fishing operations and fish culture activities of the laying of the submarine transmission cables for the Lamma Extension project and the construction of their associated landing points.

The objectives of the assessment are as follows:

- to establish the importance to Hong Kong's fisheries of the habitats affected by the works associated with the laying of the proposed submarine cables and the construction of the landing points;
- to identify fisheries sensitive receivers;
- to assess the scale of potential impacts on fisheries from the works associated with the laying of the cables and the construction of their associated landing points, and identify any significant or unacceptable impacts;
- to identify any necessary mitigation measures and residual impacts; and
- to assess the need for a fisheries monitoring and audit programme.

For information of the criteria for fisheries assessment as well as the legislation and standards that apply to fisheries resources and operations please refer to *Section 11.2* of Part B of this Report.

8.2 BASELINE CONDITIONS

Capture Fisheries

The Submarine Transmission Cable Route Study Area (STCR) has been selected based on the proposed landing sites. The preliminary transmission route landing sites were selected as part of a previous study[14]. The STCR Study Area consists of four AFD Fishing Zones (*Table 8.2a* and *Figure 8.2a*).

Table 8.2a Fishing Zones Within the Submarine Transmission Cable Route Study Area

Code	Fishing Zone	Area (Ha)
0086	Telegraph Bay	255.05
0096	Pak Kok	873.35
0097	Po Law Tsui	402.88
0102	Luk Chau	351.32

(14) Hyder Consulting (1998) Report on Selection of Stage 1 Transmission Route for the Additional Generating Facilities at Lamma Power Station Extension. *Technical Report No.2 Submarine Cable Routes*. Submitted to The Hongkong Electric Co., Ltd. May 1998.

Two of the Fishing Zones within the STCR Study Area are discussed above for the LPSE Study Area (see *Section 11.3* of Part B), therefore, the values quoted above apply for these zones. The Fishing Zones of Telegraph Bay and Luk Chau were added due to their proximity to the cable routes. A total of 50 vessels are recorded as operating during 1996 to 1997 within the Luk Chau Fishing Zone, with only 2 of those vessels being over 15 m in length. Production values for the Luk Chau zone are generally low and the subsequent ranking places it at 111 in terms of value per hectare in comparison to the other fishing zones in Hong Kong. The Luk Chau zone also has a recorded fry fishery with a rank of 70 out of 89 which is low. Fishermen operating in the Telegraph Bay Fishing Zone did not report any fry catches. The weight of catches report by fishermen from this zone ranked 129 out of 179 (kg ha^{-1}) and 143 out of 179 in value (HK$ ha^{-1}).

No species of high value were recorded within the top five species caught in the Luk Chau zone. However, from the Telegraph Bay Fishing Zone the White Herring (*Ilisha elongata*), the Yellow Croaker (*Pseudosciaena crocea*) and the Silver Shrimp (*Acetes japonica*) were recorded in the top five species caught and are regarded as high value species.

Fisheries Resources - Spawning and Nursery Areas

The waters of the STCR Study Area have not been identified as a spawning or nursery area for commercial fisheries resources.

Culture Fisheries

One FCZ lies within the STCR Study Area and one in close proximity, namely Lo Tik Wan and Sok Kwu Wan (*Figure 8.2a*). Information from the AFD Annual Report 1996-97 indicates that the FCZ at Lo Tik Wan consists of 124 licensed rafts with a total licensed area of 32,526 m^2 making it the third largest FCZ in Hong Kong for that period. The FCZ at Sok Kwu Wan has a higher number of licensed rafts (226) but with a similar licensed area as Lo Tik Wan (31,129 m^2). There are no figures available for production of individual FCZs, although production in the whole of Hong Kong in 1996 totalled 3,000 t valued at $173 million. The main species cultured were the spotted grouper (*Epinephelus chlorostigma*), gold-lined seabream (*Rhabdosargus sarba*), mangrove snapper (*Lutjanus argentimaculatus*) and the pompano (*Trachinotus blochii*).

8.2.1 *Sensitive Receivers*

Fish Culture Zones

Based on the above review of baseline fisheries conditions in the STCR Study Area, several fisheries sensitive receivers may be affected by the works associated with the transmission cables, namely the Fish Culture Zones at Lo Tik Wan and Sok Kwu Wan. Due to their location these FCZs could potentially be impacted by the dredging works for this project.

8.2.2 *Fisheries Importance*

As the STCR Study Area incorporates two of the Fishing Zones in the LPSE Study Area (see *Section 11.3* of Part B), the same characterisation of importance can be applied here. In addition, there are two Fish Culture Zones (FCZs) within the STCR Study Area at Lo Tik Wan and close to the STCR Study Area at Sok Kwu Wan. As these are gazetted FCZs their importance to fisheries is high.

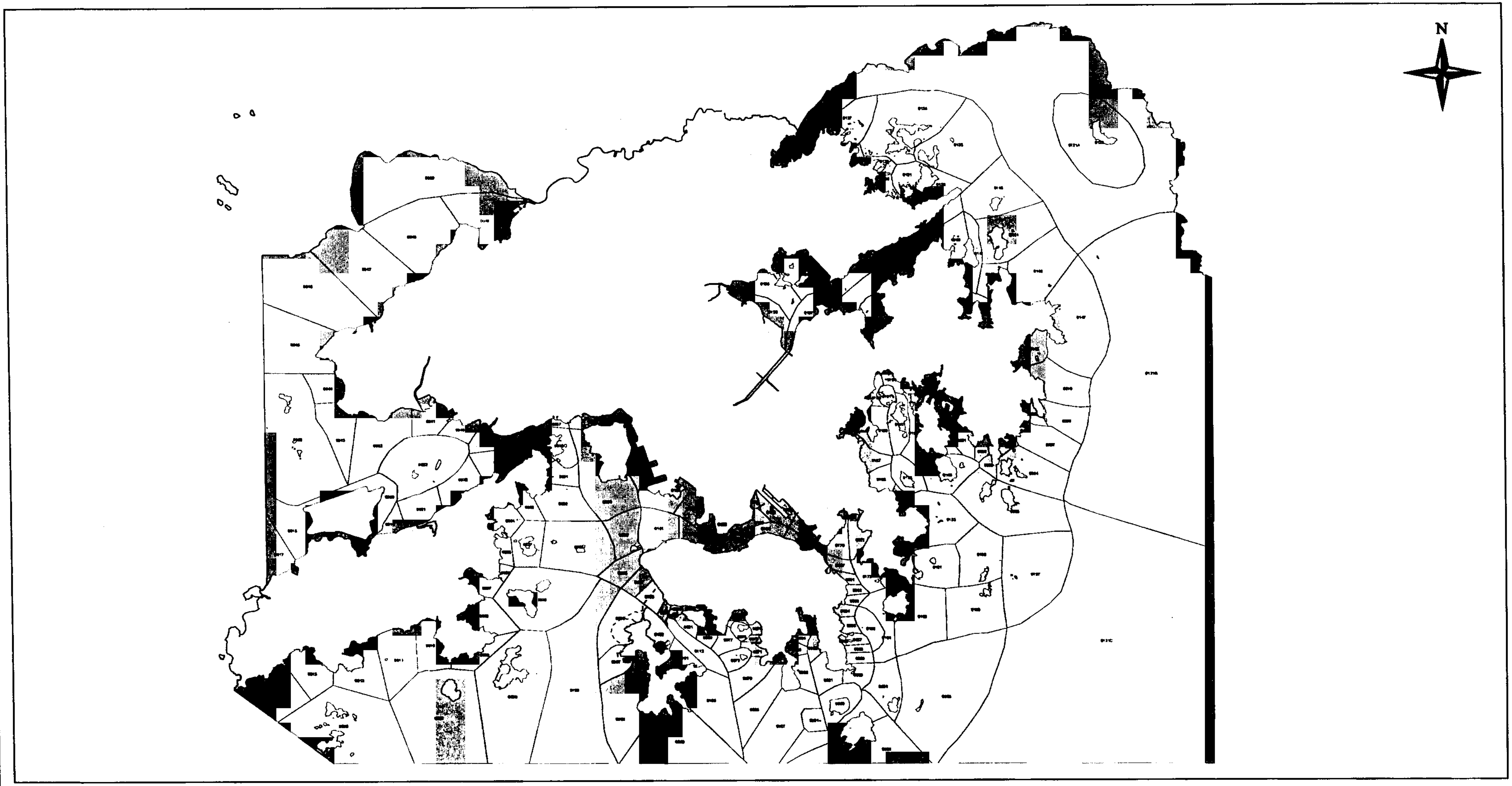

Figure 8.2a AFD FISHING ZONES AND FISH CULTURE ZONES WITHIN THE SUBMARINE TRANSMISSION CABLE ROUTE STUDY AREA

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KEY

- Submarine Transmission Cable
- Proposed Lamma Power Station Extension
- AFD Fishing Zones Within the Study Area
- AFD Fishing Zones
- ● Lo Tik Wan Fish Culture Zone
- ▲ Sok Kwu Wan Fish Culture Zone

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8.3 ASSESSMENT OF IMPACTS

A total of 12 cables will be laid as transmission links for the power station extension. Each of these cables will be laid between 1 to 3.5 m deep, depending on the hardness of the seafloor and the location of the route. Impacts associated with the submarine transmission cables are only expected to occur during the construction phase.

Direct Impacts

Direct impacts due to the deployment of the transmission cable occur through the loss of coastal habitat which supports fisheries resources. Short term impacts are also predicted to occur within the dredging area during the dredging operations associated with the cable laying. After the dredging operations have been completed it is expected that the benthic fauna will recolonise and support fisheries resources at pre-deployment levels.

Indirect Impacts

Indirect impacts to the fisheries resources in the STCR Study Area are predicted to occur through changes in water quality associated with cable laying. These changes are predicted to be in the form of elevations in SS, and consequent depletions in dissolved oxygen and increases in nutrients. The impacts of changes to these key water quality parameters on fisheries resources are discussed in full in Part B *(Section 11.3)*. Mathematical water quality modelling has not been conducted in order to assess the impact effect of cable laying activities for the following reasons:

- sediment release rates are expected to be relatively low (1.5 - 5.3 kg s^{-1}), especially near to the coastal areas where cable trenches will be shallow;

- sediment will be released at the bottom of the water column which will restrict its dispersion prior to settling; and

- cable laying activities will be of a short duration lasting approximately four weeks (one week for one trip of simultaneously laying 3 cables).

On the basis of these expectations, it is predicted that the indirect impacts to the fisheries resources within the Study Area as a result of the cable laying activities will be minimal. Similarly, the indirect impacts to fisheries resources as a result of the construction of the landing points is also expected to be low for the following reasons:

- only a single dredger will be operated at any of the sites at any one time;
- the dredging rate will be low (maximum rate = 3 kg s^{-1}); and
- the volume of material to be removed will be low (8000 m^{-3} $point^{-1}$).

Changes to water quality parameters are predicted to be localised and within environmentally acceptable limits. The Fish Culture Zones at Lo Tik Wan and Sok Kwu Wan are not predicted to be affected.

8.4 EVALUATION OF IMPACTS

The impact evaluation is presented below in accordance with the *EIAO TM (Annex 9)*:

- *Nature of impact:* Short term impacts will occur to fisheries resources in the STCR Study Area as a result of the dredging activities and cable laying operations. These activities are not expected to be of concern as the associated impacts are both short term and of a low magnitude.

- *Size of affected area:* The area directly impacted through the construction of transmission cable landing points is small and mainly confined to the intertidal region. The area affected as a result of the dredging associated with the cable laying will be disturbed in the short term but is predicted to recolonise as soon as the cable has been laid.

- *Size of fisheries resources and production:* The Fishing Zones containing the reclamations for the landing points, and those where dredging activity will occur, are areas of average fisheries production. Hence impacts to fisheries production are expected to be small.

- *Destruction and disturbance of nursery and spawning grounds:* The nursery and spawning grounds identified in this impact assessment are to the south of the STCR Study Area and will not be affected by the construction of the landing points or the laying of the transmission cables.

- *Impact on fishing activity:* The Fishing Zones containing the reclamations for the landing points, and those where dredging activity will occur are areas of average fishing activity. Therefore, impacts to fishing operations are expected to be minimal due to the short term and localised nature of works. Such short term disturbances to fishing operations do not typically invoke claims for *ex gratia* allowances, however, these disturbances may still be the subject of claims. Decisions on the payment of such allowances rests with the Planning Environment and Lands Bureau.

- *Impact on aquaculture activity:* Impacts to water quality are predicted to be low and of a short duration. Consequently impacts to the Fish Culture Zones of Lo Tik Wan and Sok Kwu Wan are expected to be within environmentally acceptable levels.

8.5 *SUMMARY OF MITIGATION MEASURES*

In accordance with the guidelines in the TM on fisheries impact assessment the general policy approaches for mitigating impacts to fisheries, in order of priority, are avoidance, minimisation and compensation.

Impacts to fisheries resources and fishing operations have largely been avoided during construction through constraints on the works operations associated with the jet ploughing and grab dredging for the transmission cables. These constraints were recommended to control water quality impacts to within acceptable levels, are also expected to control impacts to fisheries resources. Hence, no fisheries-specific mitigation measures are required during construction.

8.6 *RESIDUAL IMPACT*

The only residual impact identified that may affect commercial fishing operations is the disturbance to fishing activity during the 4 weeks of cable laying. The magnitude of this residual impact is low since the main area affected by the cable laying is a main fairway where fishing operations are restricted and the duration of the impact is very short (4 weeks).

8.7 EM&A REQUIREMENTS

The dredging operations include constraints which act as appropriate mitigation measures to control environmental impacts to within acceptable levels. As no impacts of concern to the water quality are predicted to occur, the development and implementation of a monitoring and audit programme specifically designed to assess the effects of the activities on commercial fisheries resources is not deemed necessary.

8.8 SUMMARY AND CONCLUSIONS

Reviews of existing information on commercial fisheries resources and fishing operations located within the STCR Study Area have been undertaken for this impact assessment. Information from a recent study on fishing operations in Hong Kong indicates that fisheries production values from these areas are highly variable within the Study Area.

Potential impacts to fisheries resources and fishing operations may arise from disturbances to benthic habitats on which the fisheries resources depend, or through changes to key water quality parameters, as a result of both the construction of landing points and the laying of the transmission cables.

As impacts arising from all other proposed dredging works (ie non-reclamation) are predicted to be largely confined to the specific dredging areas, they are not expected to cause adverse impacts to any fishing grounds or species of importance to the fishery. While no special mitigation measures are required for fisheries resources, constraints on dredging operations recommended to control impacts to water quality to within acceptable levels are also expected to mitigate impacts to fisheries resources.

9 TERRESTRIAL ECOLOGY

9.1 INTRODUCTION

This Section provides an assessment of the potential impacts on terrestrial ecological resources of the areas surrounding the submarine cable landing points on both Hong Kong and Lamma Islands, in accordance with the requirements of *Annexes 8* and *16* of the *EIAO TM.* Mitigation measures are also recommended where necessary to minimise any adverse impact. The assessment of the submarine cables is given in *Section 7 Marine Ecological Impacts* of *Part C.*

The surface structures associated with the new submarine cable route comprise:

- landing point I1 - 25 m x 40 m;
- landing point N2 - 26 m x 70 m;
- landing point N4 - 27 m x 65 m;
- landing point N5 - 33 m x 56 m; and
- the cable trough between N4 & N5 - 5.5 m x 260 m.

Landing point I1 on Hong Kong Island is located at Telegraph Bay. Since this landing point will be on an existing rubble mound seawall, there will be no terrestrial ecological impact. This assessment therefore focuses only on the three landing points and their immediate vicinity. These are illustrated in *Figure 9.1a.*

9.2 LEGISLATION AND STANDARDS

There are a number of international and local requirements and guidelines which provide the regulatory framework for the protection of species and habitats of ecological importance. Those relevant to this assessment are:

- *Forests and Countryside Ordinance (Cap 96),* 1996 revision;
- *Wild Animals Protection Ordinance (Cap 170),* 1996 revision;
- *Town Planning Ordinance (Cap 131),* 1996 revision;
- *Hong Kong Planning Standards and Guidelines (Chapter 10)*; and
- *Environmental Impact Assessment Ordinance* (Cap. 499) & *Technical Memorandum on Environmental Impact Assessment Ordinance (EIAO TM).*

The *Forests and Countryside Ordinance (Cap. 96)* prohibits felling, cutting, burning or destroying of trees and growing plants in forests and plantations on Government land. Its subsidiary regulations prohibit the possession of listed rare and protected plant species.

The *Wild Animals Protection Ordinance (Cap 170)* prohibits hunting of all wild animals in Hong Kong. Additional protection is provided for protected wild animals (including most mammals, all birds and turtles, and some snakes, amphibians and insects). No person may possess, buy, sell, export or wilfully disturb any protected wild animal or a nest or egg of any protected wild animal.

The Town Planning Ordinance (TPO) provides for the development of statutory plans to control development and the designation of areas including Coastal Protection Areas, Sites of Special Scientific Interest (SSSIs), Conservation Areas and Green Belts which promote conservation or protection of the environment.

Chapter 10 of the Hong Kong Planning Standards and Guidelines (HKPSG), 1994 covers "Conservation", and provides guidance on the conservation of natural landscape and habitats, historic buildings, archaeological sites and other antiquities.

Annex 16 of the *EIAO TM* sets out the general approach and methodology for assessment of ecological impacts arising from a project or proposal, including the identification, prediction and evaluation of potential ecological impacts. *Annex 8* lists criteria to be used for evaluating impacts.

9.3 ASSESSMENT METHODOLOGY

A desktop literature review *(Annex C9-2, C9-3)* and consultation with ERM's in-house professional ecologist who has undertaken extensive research survey works on Lamma, found no records of ecological important resources on the proposed landing point areas. The desktop research was supplemented by establishing a terrestrial ecological profile of the area surrounding the potential landing points, based on ecological surveys undertaken between July and December 1998, covering possible seasonal variation of the ecological conditions. The areas to be directly affected by construction, as well as the habitat types in the surrounding areas, were surveyed on foot by experienced ecologists to record habitat, plant and animal wildlife information.

The importance of the ecological resources identified was assessed using the *EIAO TM* criteria. The potential impacts due to the construction of the landing points were then assessed (following the *Annex 16* guidelines) and the impacts evaluated (based on the criteria *Annex 8*).

9.4 BASELINE CONDITIONS

9.4.1 *Habitat/Vegetation*

As shown in *Figure 9.1a,* landing point N2 is situated on a northwest facing shore north of the Lamma power station, while N4 and N5 are on the north and northeast facing shores east of Pak Kok village near the northern tip of Lamma Island (Pak Kok Tsui). All three potential landing points are located on rocky and sandy shore bound by shrubland or tall shrubland. N4 and N5 are also quite close to village orchard or major foot paths, while N2 is located on natural shoreland, although the power station is just on the other side of the peninsula.

Habitats identified during the site surveys include tall shrubland, shrubland/grassland mixture, sandy beach, rocky shore, village/orchard and agricultural field, plantation and artificial grassland, as shown in the habitat maps in *Figures 9.4a* to *9.4c*. *Plates 9.4a* to *9.4c* provide a photographic record of the habitats at the landing points. No legally protected species were identified during the surveys. Two individuals of a locally uncommon coastal tree species, *Celtis biondii,* was found near N4 (*Figure 9.4b*). This species has a widespread distribution (through Central China, South China and Japan). There were two

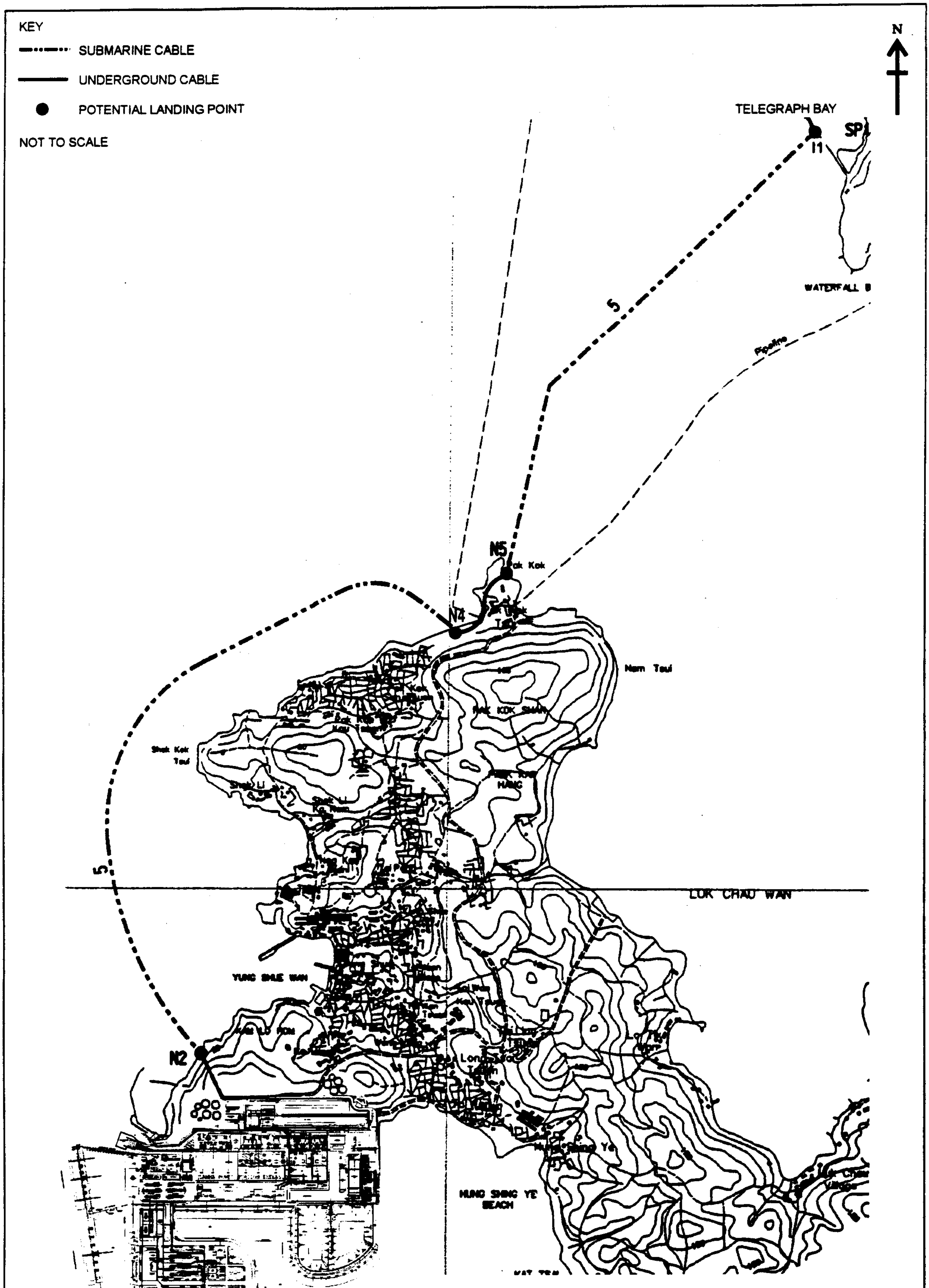

FIGURE 9.1a

NETWORK OF NEW CABLE SYSTEM

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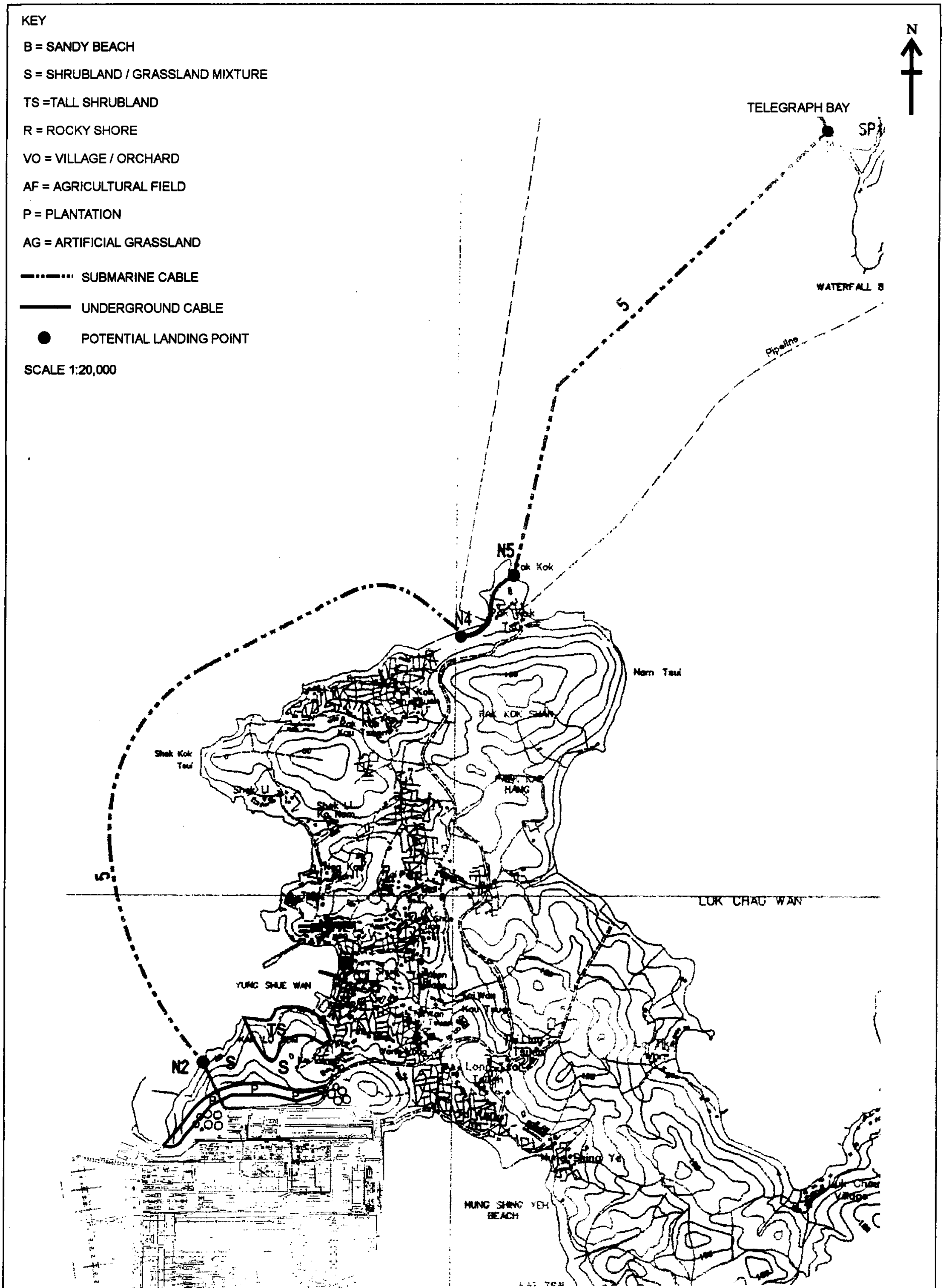

FIGURE 9.4a

HABITAT MAP OF LANDING POINT N2

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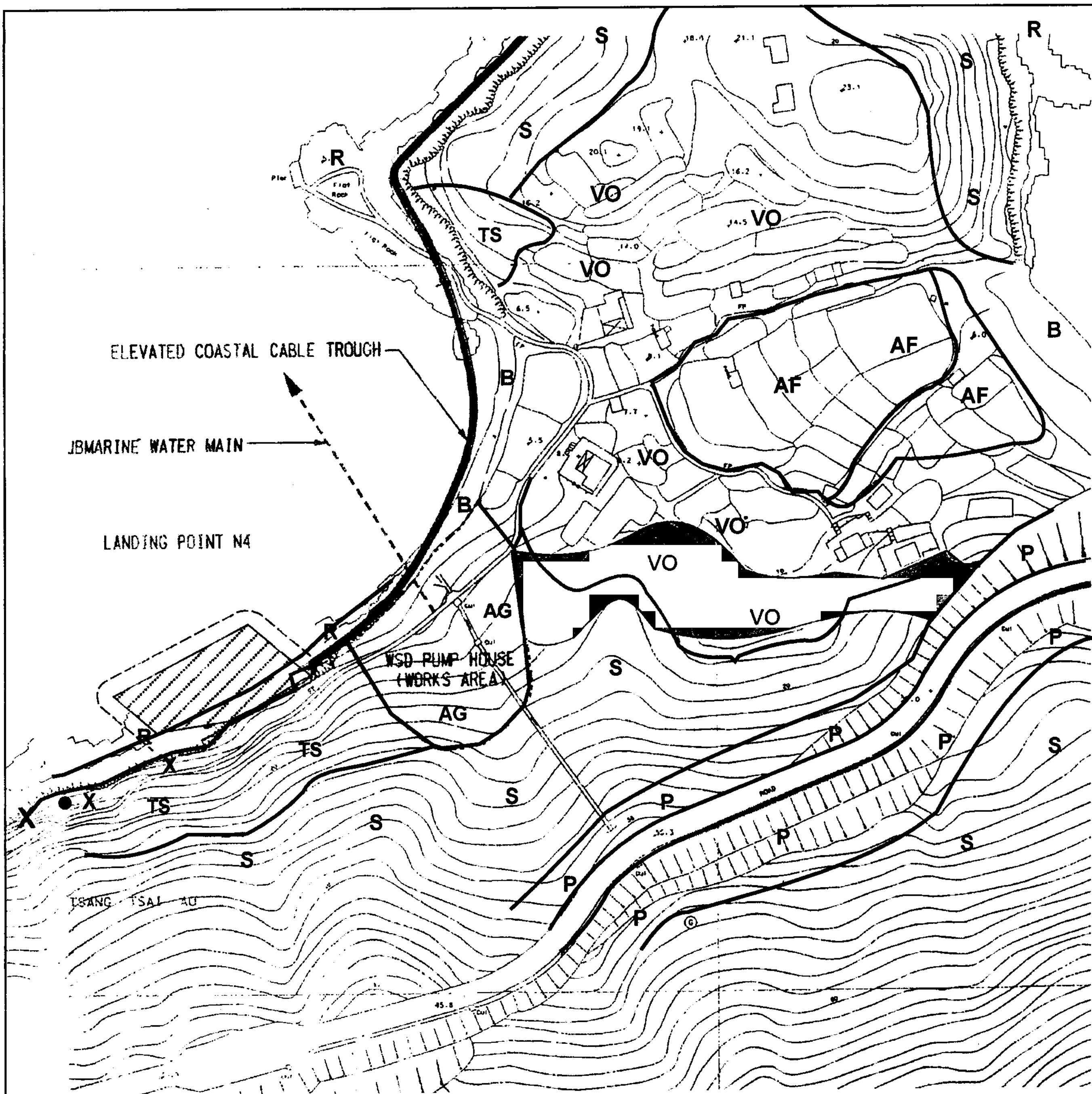

KEY

B = SANDY BEACH

S = SHRUBLAND / GRASSLAND MIXTURE

TS =TALL SHRUBLAND

R = ROCKY SHORE

VO = VILLAGE / ORCHARD

AF = AGRICULTURAL FIELD

P = PLANTATION

AG = ARTIFICIAL GRASSLAND

X = CELTIS BIONDII

SCALE 1:1800

☐ *RHAPIS EXCELSA*

■ AREA WITH *VITIS BALANSAEANA*

● *PTEROSPERMUM HERTEROPHYLLUM*

X = *PTERIS DISPAR (3 INDIVIDUALS)*

FIGURE 9.4b

HABITAT MAP OF LANDING POINT N4

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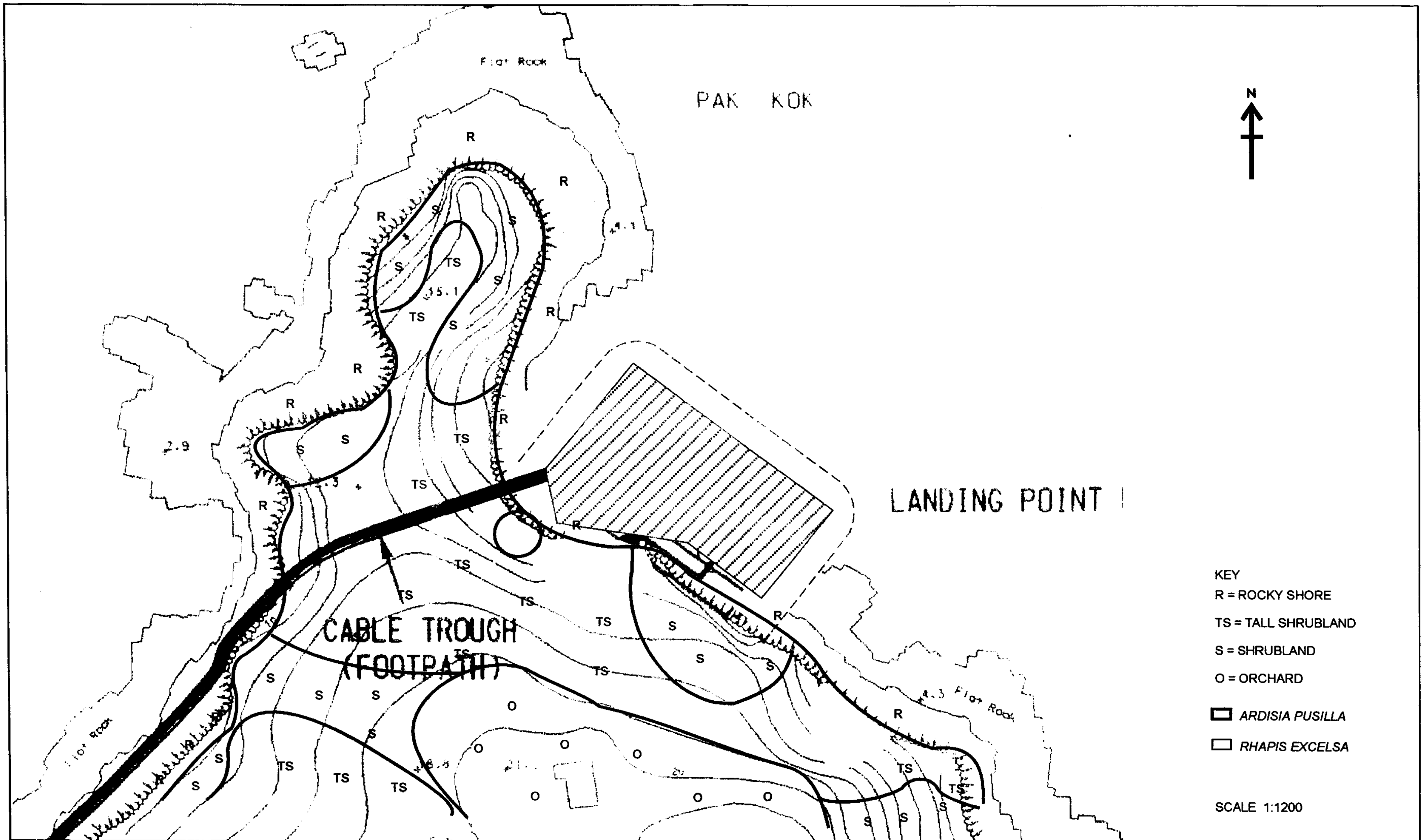

FIGURE 9.4c

HABITAT MAP OF LANDING POINT N5

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PLATE 9.4a

POTENTIAL LANDING POINT N2 ON LAMMA ISLAND

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PLATE 9.4b

POTENTIAL LANDING POINT N4 ON LAMMA ISLAND

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DATE: 14/10/98

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PLATE 9.4c

POTENTIAL LANDING POINT N5 ON LAMMA ISLAND

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DATE: 14/10/98

locally restricted species found: a coastal climbing plant *Vitis balansaeana* in the village/orchard and shrubland/grassland habitat, and Lady Palm *Rhapis excelsa* in the tall shrubland and shrubland habitats near N4 and N5 (*Figures 9.4b & 9.4c*). Although restricted in distribution, these two plants were found abundant in places that they occur, e.g. *Vitis balansaeana* on Ping Chau and Sha Chau, and *Rhapis excelsa* on Green Island, as in the study Area (see *Figures 9.4b & 9.4c*).

A description of each habitat type is given below and the lists of the plant species recorded are presented in *Annex C9-1*.

Shrubland/Grassland

This is the dominant habitat type occupying the hillside behind N2 and N5 and is also important at higher altitude above N4. The plant communities comprise mainly grass and woody plant about 0.5 to 2.5 m tall, with a moderate species richness, but are typical of other fire-maintained secondary shrubland elsewhere in Hong Kong. *Rhodomytus tomentosa, Cratoxylum cochinchinense, Litsea rotundifolia* and *Schefflera octophylla* are the dominant woody plant species while the grasses community is dominated by *Dicranopteris linearis, Ischaemum barbartum, Miscanthus sinensis* and *Cymbopogon goeringii*. Species typically found along coastlines are also common near the shore (e.g. *Hibiscus tiliaceus, Pandanus tectorius* and *Cerbera manghas*).

Some common bird species were recorded in this habitat type (see *Section 9.4.2*). No other evidence of animal wildlife was observed in this habitat type during the surveys.

Tall Shrubland

A total of 77 plant species were recorded in this habitat, which is the dominant habitat type, behind landing points N4 and N5, as well as where the underground cable will pass through. This habitat type is basically similar to shrubland/grassland habitat but it has less grassy species and greater heights. Heights of the vegetation range from 2 to 5 m. The plant community found was moderately species rich and resembled similar habitat type elsewhere in Hong Kong. Coastal plant species are also common here (such as *Hibiscus tiliaceus, Pandanus tectorius* and *Cerbera manghas*).

Two additional rare species, *Pteris dispar* (*P. semipinnata* var. *dispar*) and *Ardisia pusilla*, were found with scarce abundance, as well as one additional restricted species *Pterospermum heterophyllum* found in occasional abundance (see *Figures 9.4b & 9.4c*). *Pteris dispar* is rare in Hong Kong and has been found mainly in coastal shrubland, while *Ardisia pusilla* is also rare and restricted to ravine habitats. *Pterospermum heterophyllum* is restricted to lowland forest and can reach a height of 20 m in well-grown forest.

During the surveys, quite a few common bird species were observed (see *Section 9.4.2*). No other evidence of animal wildlife was observed in this habitat type during the surveys.

Rocky Shore

Rocky shore is the dominant habitat at N2 and N4 and is also important in N5. It is merely a transition from shrubland to marine environment, dominated by rocky substratum in exposed areas. Dominate species were absent because of the sparse coverage of the vegetation. Grasses adapted to open environment (e.g. *Heteropogon contortus, Ischaemum barbartum* and *Cymbopogon goeringii*) as well as species adapted to coastal environment (e.g. *Pandanus tectorius, Scaevola sericea* and *Hibiscus tiliaceus*) were the most common species recorded. The sparse coverage of plants in this habitat type suggests that its potential value to support rare or important terrestrial animals is low. Although birds may feed on tidal organism at low tide, limited birds were observed during the surveys (see Section 9.4.2).

Sandy Beach

Sandy beaches are present in more sheltered parts of the shore near the three landing points. However, most of them are too small to support any vegetation, with the exception of the one southeast of N5. This kind of habitat is characterized by low diversity community dominated by a few beach plants (*Wedelia biflora* and *Vitex rotundifolia*) and coastal shrubs (e.g. *Pandanus tectorius, Scaevola sericea* and *Hibiscus tiliaceus*). Since the habitat is relatively sheltered from wave action, a considerable amount of litter has accumulated. The habitat is very low in structural complexity, as the dominant plants are all creepers and climbers. This habitat is therefore unlikely to support large animals. No evidence of animals was observed on these beaches during the site surveys.

Village/Orchard and Agricultural Field

The area to the south of N5 and east of N4 is village orchards and agricultural fields (Pak Kok Tsui). The agricultural field is largely abandoned but a small portion is still under active cultivation. The village is partly abandoned. In addition to this patch of farmland, to the east of N4 is another patch of orchard.

Species found inside orchards and around villages were mostly common fruit trees including *Dimocarpus longan, Artocarpus heterophyllus* and *Musa paradisiaca*. Growing together with the fruit trees were other native lowland forest trees including *Bischofia javanica* and *Sterculia lanceolata*. Although this habitat was relatively low in floristic diversity, the orchards were mostly bordered by shrubland and thus may be utilized by wildlife inhabiting in the surrounding.

The abandoned agricultural field was densely covered by grassy species and was structurally and floristically simple as well as small in size. This suggests that such habitat type is unlikely to be ecologically important in supporting large animals. No animal wildlife was observed utilizing this habitat type during the surveys.

Plantation

Both sides of the concrete road above the Pak Kok Tsui village are franked by plantation woodlands comprising primarily exotic species including *Acacia confusa* and *Casuarina equisetalis*. The plantations have an average height of 5 to 7 m and form a closed canopy. The understorey growth is very poor and the subcanopy is quite open. Owing to the simple structural complexity and poor species diversity of the plantation, it is considered that the utilization of this habitat by wildlife would be limited.

Artificial Grassland

An area of grassland (0.3 to 0.5 m tall) covers a cut slope behind the water pump house which is located some 20 m from the N4 site. The grassland was probably recently planted and comprises *Paspalum* sp., *Digitata* sp., *Cynodon dactylon* and

Prexalis clementidae. The habitat is structurally simple and composed mainly of exotic species. Due to the simple structural complexity and poor species diversity, utilization of this habitat by wildlife is considered limited.

9.4.2 *Animal Wildlife*

As discussed above, neither mammal nor reptile, nor any sign of their presence (such as trails, burrows), was observed or noted during the field surveys.

Bird species recorded during the surveys within the immediate vicinity of Landing Points N2, N4, and N5 include Olive-backed Pipit *(Anthus hogdsoni)*, Crested Bulbul (*Pycnonotus jocosus)*, Chinese Bulbul (*Pycnonotus sinensis)*, Chinese Bush Warbler (*Cettia diphone)*, Yellow-browed Warbler (*Phylloscopus inornatus)*, Common Tailorbird *(Orthotomus sutorius)*, Spotted Dove (*Streptopelia chinensis)*, Oriental Turtle Dove (*Streptopelia orientalis)*, Magpie (*Pica pica)*, Magpie Robin (*Copsycus saularis)*, Stonechat (*Saxicola torquata)*, and Violet Whistling Thrush (*Myiophoneus caeruleus)*, all of which occur in a wide variety of habitats, or are locally abundant in Hong Kong.

The Pak Kok area, largely due to its reasonably diverse habitats, supported a range of bird species including both resident, and summer and winter visitor species. There are more species present in the winter season than the summer season. The areas of shrubland and tall shrubland were particularly productive, with bird species present that prefer largely undisturbed woodland and shrubland. Grey-backed Thrush (*Turdus hortularum*), Pale Thrush (*Turdus pallidus)*, Red-flanked Bluetail (*Tarsiger cyanurus)*, Siberian Rubythroat (*Luscinia calliope)*, and Pallas's Warbler (*Phyllocsopus proregulus)*, all are good indicators of mature, undisturbed shrublands or woodlands, were recorded in the tall shrubland area near Landing Point N4. A single Common Buzzard (*Buteo buteo)* was noted foraging over N5 and a single Black Kite (*Milvus milgrans)* was recorded flying over N2. The habitats at landing Points N4 and N5, however, supported very low numbers and diversity of birds, despite being adjacent to areas of shrubland and tall shrubland.

9.4.3 ***Evaluation of Ecological Importance***

On the basis of the field surveys and discussions presented above, the resources present around the three landing points are considered to be of low ecological importance, medium to low structural complexity and moderate flora diversity. Very few species of birds were observed during the field surveys, and all of them were common and widespread. Rare and restricted plants were found but there were no legally protected species present.

The low ecological importance of the habitats affected by the landing points is determined based on the following considerations, in accordance with the criteria in *Table* 2 of *Annex 8* of the *EIAO TM:*

- *Naturalness*: Although the habitat types are not man-made, their proximity to villages indicates that they are subject to considerable human disturbance.

- *Size*: The area that will be directly affected is limited and the landing points and cable trough will affect only relatively small areas of terrestrial vegetation at the fringe of the coastal areas.

- *Diversity*: Plant species diversity is moderate and animal diversity is low.

- *Rarity*: Three locally uncommon or rare plants were found comprising *Celtis biondii* and *Pteris dispar* to the west of landing point N4, and *Ardisia pusilla* to the west of landing point N5, as well as three locally restricted plants, *Vitis balansaeana, Rhapis excelsa* and *Pterospermum heterophyllum* which were found in the tall shrubland and/or shrubland habitats near landing points N4 and N5.

- *Re-creatability*: The predominant vegetation type (shrubland/tall shrubland community) is secondary and can recover easily from disturbance.

- *Fragmentation*: The predominant habitat types are not fragmented.

- *Ecological linkage*: The predominant habitat types are not linked to any highly valued habitat in close proximity.

- *Potential value*: Medium to low potential value. It will take a considerable period (30-40 years) for vegetation succession to transform the shrubland/tall shrublands into woodland that supports significant populations of birds and mammals. Human disturbance will also limit the animal species to common or widespread species. Plant species diversity is also unlikely to increase significantly after a long period of time in such an island environment.

- *Nursery/breeding ground*: No signs of nursery/breeding grounds for terrestrial animals were found in the surveys.

- *Age*: Predominant habitat is young (about 10 to 20 years) or frequently disturbed secondary shrubland.

- *Abundance/Richness of wildlife*: Low wildlife richness and abundance.

In addition, it should be noted that the plant community of the predominant habitats (i.e. shrubland/tall shrubland and rocky shore) is typical of similar habitat elsewhere in Hong Kong. These habitats are therefore not considered to be of high conservation importance.

Based on *Table 3* of *Annex 8*, only the plant species *Celtis biondii, Pteris dispar* and *Ardisia pusilla* are considered important as these are locally uncommon or rare. However, these species have a regionally widespread distributions.

9.5 ASSESSMENT OF IMPACTS

The construction method of the landing points and cable trough between N4 and N5 is described in *Volume 1, Part C, Section 2.3*. Only small areas of terrestrial habitats are expected to be directly lost due to direct landtake at the landing points and cable trough. Indirect impacts may result from increased human activities (such as trampling of vegetation) during the construction phase. No impact on terrestrial ecology is expected during the operational phase.

The provision of Landing Sites N2, N4 and N5 will not result in the direct loss of any habitat considered to be important for the bird community within the adjacent areas. The only potential negative impact will be in disturbance to the nearby shrubland at Landing Points 4 and 5. This is not considered to be significant given that these sites are on the edge of the shrubland areas, and areas of similar habitat, with low levels of disturbance are present within the immediate area.

Potential impacts on terrestrial ecology evaluated according to *Table 1* of *Annex 8* of the *EIAO TM* are given below:

- Habitat quality: There will be direct loss of habitat including rocky shore, shrubland and tall shrubland (see maps) from resumption for the landing points and for construction of the cable trough linking N4 to N5. However, the impact is considered low as the habitat quality is low.

- Species: There may be potential direct or indirect impact to the wildlife inhabiting the areas. With the adjustment of the landing point locations and cable trough alignment, the specimens of the locally uncommon or rare plant species, *Celtis biondii* , *Pteris dispar* and *Ardicia pusilla*, as well as any direct impact on the restricted plants *Vitis balansaeana*, *Pterospermum heterophyllum* and *Rhapis excelsa*, will be avoided.

- Size/Abundance: Approximate terrestrial habitat loss at rocky/sandy shore is 500 m^2, and shrubland/tall shrubland is 250 m^2, based on grid count method using 1:1000 survey sheets. The area lost is considered small and hence the numbers of wildlife that may be affected is expected to be limited.

- Duration: The duration of impact is limited to the construction phase of about one year.

- Reversibility: The loss of the low ecological importance habitats would be permanent.

- Magnitude: The scale of habitat loss is small and the impact is considered limited.

Therefore the overall terrestrial ecological impact is considered low, but the potential indirect impact on the uncommon or rare plant species in the vicinity of the work site should be minimised through good construction practice.

9.6 *SUMMARY OF MITIGATION MEASURES*

As discussed in the previous section, only low ecological impact is directly attributable to the construction works. The following mitigation measures in relation to protecting the important plant species and minimising disturbance to the surrounding environment through good construction practice , are recommended.

- Avoidance of impact on the uncommon and rare plant species *Celtis biondii* , *Pteris dispar* and *Ardicia pusilla*, and the restricted plants *Vitis balansaeana*, *Pterospermum heterophyllum* and *Rhapis excelsa*, by locating the landing points N4 & N5 and the connecting cable trough in areas outside where these plant species are located (*Figures 9.4b & 9.4c, Part C, Volume 2*), as well as close monitoring of the construction activity.

- The erection of fences along the boundary of construction sites before the commencement of works to prevent tipping, vehicle movements, and encroachment of personnel into adjacent wooded areas, particularly where the rare, uncommon and restricted plant species are located.

- Regular checking to ensure that the work site boundaries are not exceeded and that no damage occurs to surrounding areas.

- The prohibition and prevention of open fires within the work site boundary during construction and provision of temporary fire fighting equipment in the work area during construction.

9.7 EVALUATION OF RESIDUAL IMPACTS

With the implementation of the recommended mitigation measures, no adverse residual terrestrial ecological impacts from construction of the landing points and cable trough are anticipated.

9.8 SUMMARY AND CONCLUSIONS

Based on recent field surveys, the areas in which the submarine cable landing points and cable trough will be located are considered to have limited ecological value.

The sympathetic design of the landing points and cable trough, as well as good construction practice, will avoid and minimise disturbance to the surrounding environment, particularly the rare, uncommon and restricted plant species, and no residual adverse impacts are anticipated.

10 *LANDSCAPE AND VISUAL IMPACTS*

10.1 INTRODUCTION

This Section provides an assessment of the landscape and visual impacts of surface structures associated with the transmission cable system to be constructed for the Lamma Extension project. These surface structures are the four cable landing points at the following locations: Landing Point I1 at Telegraph Bay on Hong Kong Island, Landing Point N2 to the north of the existing Power Station on Lamma Island, and Landing Points N4 and N5 at Pak Kok on Lamma Island (see *Figure 39* in *Annex C10-1*). The material on relevant legislation, standards and assessment methodologies in *Section 7* of *Part B* of this Report (in relation to the proposed Power Station) is also relevant to this part of the assessment.

10.2 ASSESSMENT OF IMPACTS

10.2.1 *Landing Point I1*

Landing Point I1 at Telegraph Bay on Hong Kong Island is located on an existing sea wall which runs along an Open Space identified as a promenade area in the Pok Fu Lam Outline Zoning Plan (see *Figure 40* in *Annex C10-1*). This long band of Open Space is on a reclaimed land and separates large areas of future Residential, Government, Institution and Community developments planned on the same reclaimed land from the sea. The Landing Point I1 would have similar appearance as the existing sea wall and therefore no landscape impact on any existing land formation is expected (see *Figure 45* in *Annex C10-1*).

The Landing Point I1, being located on an existing sea wall and on the edge of a flat reclaimed land, is expected to have limited visual impact to the surrounding developments on Hong Kong Island. The view of the Landing Point from the sea will be limited to occasional boats in the area and the design of its appearance similar to the existing sea wall would avoid any adverse visual impact from the sea.

10.2.2 *Landing Point N2*

The landing point N2 is located to the north of the existing Power Station and south of Yung Shue Wan (see *Figure 41* in *Annex C10-1*). It is separated from the Power Station by the Po Lo Tsui headland which is defined as a Countryside Conservation Area in the Lamma Island ODP. This large conservation area extends from the sea in the north and west to the levels of +80 mPD in the south. The relatively steep hills separate the Landing Point N2 on the western coast from the villages of Yung Shue Wan in the east.

The landscape impact of the construction of Landing Point N2 will be local and confined to the loss of natural coastline features in the immediate surrounding area provided that no access is required from inland for its construction. (see *Figure 42* in *Annex C10-1*)

The location of the Landing Point N2 is screened from the surrounding villages by the topography of the headland. The potential visual impact would be limited to transient viewers from the boats travelling in and out of the Yung Shue Wan Bay.

10.2.3 *Landing Points N4 and N5*

The Landing Points N4 and N5 are located at Tsang Tsai Mu and Pak Kok Tsui at the northern tip of Lamma Island (see *Figure 41* in *Annex C10-1*). It is on the coast of a Countryside Conservation Area, covering the hills of Pak Kok Shan. The location is close to an access road and other land use areas. There is also a proposed cable trough running on the surface from Landing Point N4 to Landing Point N5.

The landscape impact of the construction of Landing Points N4 and N5 themselves will be local, however, the construction of the cable trough that will run on the surface first along the coastline to Pak Kok Tsui and then across the headland to the Landing Point N5 will extend the landscape impact to the existing landscape features along its route (see *Figures 43 & 44* in *Annex C10-1*).

The visual impact of the proposed landing points and the cable trough will be limited mainly to views from the sea, with the exception of the part of the cable trench over the land to the Landing Point N5.

The existence of rare species in the vicinity of landing points N4 and N5 had been identified. Reference can be made to Sections 9.4.1 and 9.5 under Terrestrial Ecology.

10.3 *MITIGATION MEASURES*

The visual impact of the Cable Landing Point I1 is considered negligible as it would have similar appearance as the existing sea wall and therefore no mitigation is required.

The proposed landing points on Lamma Island are located in relatively remote locations and would be viewed either from the sea and other islands at considerable distances, or by a few local residents and hikers who may occasionally frequent the areas. Although the expected impacts of the landing points and associated cable trough are not considered to be significant, the facilities will be located in areas zoned Open Space and Countryside Conservation Areas. For this reason, the following landscaping mitigation measures are recommended to minimise the potential impacts (see also *Figures 43 to 47* in *Annex C10-1*):

- Although the size of the landing points varies (N2 is 26 x 70 m, N4 is 27 x 65 m and N5 is 33 x 56 m), each has a finished platform level at +6.00 mPD. With the Low Water Level at +1.00 mPD, the platforms will be a maximum of some 5 m above the water level at low tide. In order to minimise the visual impact of the landing points, the exposed sides of the platforms and the cable slipways should be screened with irregularly arranged boulders of varying sizes to mimic the natural coastline features. The horizontal platform surface should be finished with natural materials such as stone pavings or tiles.

- The cable trough in between Landing Points N4 and N5 is 5.5 m wide and 260 m long. The walkway that is formed above the cable trough should be shielded by boulders (or, where practicable, shrub planting) from potential viewers from the sea and horizontal surfaces be finished with natural materials such as stone paving.

- Appropriate compensatory landscaping should be provided for any disruption to existing vegetation to blend in with the surrounding setting.

- As a planning gain, parts of the landing points N4 and N5 and the cable trough between the landing points can be used for amenity and recreational purposes. Some low maintenance fixtures, matching with the natural environment, will be built or placed on the landing points for public use. A detailed Amenity Plan shall be submitted to the Authority for approval before commencement of the construction work. Since the exact landing points and cable route alignment are yet to be finalised, the management/maintenance responsbilities cannot be defined at this stage. HEC will resolve any management and maintenance requirements of the proposed mitigation meaures during the processing stage of wayleave agreements. If required by Government, HEC commit to bear the management and maintenance responsibilities of these facilities.

- The transmission route alignment and location of landing points were chosen with due consideration of the existence of rare plant species in their vicinity. By locating the landing points N4 & N5 and the connecting cable trough away from these rare plants, the impact on these plants are avoided. Reference can be made to Section 9.6 under Terrestrial Ecology.

10.4 *SUMMARY AND CONCLUSIONS*

It is concluded that there will be no significant landscape and visual impact associated with the proposed landing points and cable trough on Lamma Island, through application of appropriate mitigation measures such as design, construction material, landscaping and screen planting.

11 SUMMARY & CONCLUSIONS

11.1 INTRODUCTION

This Section provides a summary of the results and conclusions of technical assessments of the transmission system of the Lamma Extension project, as described in detail in the previous Sections of this Part of the EIA Report.

These assessments have evaluated potential environmental impacts along the proposed route of the new transmission cables required to supply electricity to Hong Kong Island, including the four proposed landing points on Hong Kong and Lamma Islands. For the purpose of this assessment, only those sections of the cable route from the power station up to the landing point on Hong Kong Island will be assessed. Further transmission network development on Hong Kong Island will be assessed separately.

11.2 CONSTRUCTION DUST ASSESSMENT

The potential air quality impacts of constructing the tunnel, landing points and cable trough on Lamma Island, and the landing point on Hong Kong Island, have been assessed (see *Section 4*). This assessment dealt with the generation and dispersion of airborne dust, and evaluated the resulting impacts on identified air sensitive receivers (ASRs).

The predicted dust levels at the nearest air sensitive receivers, at approximately 350m from the work sites are very low and similar to the existing background concentrations. Modelling results have confirmed the view that the potential dust impact is negligible.

11.3 WATER QUALITY ASSESSMENT

The water quality assessment presented in *Section 5* addressed the potential construction and operational impacts associated with the transmission cable system.

Construction Impacts

Impacts to water quality during cable laying will occur as a result of disturbance of seabed sediments during cable burying by using jet ploughing along the submarine sections of the cable route and dredging for the landfall approaches as well as hard seabed surface. Potential impacts arise from increases in levels of suspended solids (SS) and associated effects on dissolved oxygen and nutrient levels.

A conservative estimate was made of the likely rate of sediment release from jet ploughing of the cable trenches . Based on a comparison of this estimate with release rates from grab dredging, and the expectation of faster flocculation and settling of sediments released only at the bottom of the water column, elevations in SS concentrations were predicted to be very localised and of short term duration, and no dispersion modelling was considered necessary.

Similarly, the impacts of dredging near the landing points are also expected to be small and of short duration. The amount of material to be dredged is only about 8,000 m^3 and the dredging would be carried out quite slowly.

Potential impacts on other water quality parameters such as dissolved oxygen and nutrient concentrations are also considered to be small because the sediment is unlikely to be contaminated or in suspension for a long enough time.

Operational Impacts

The only impacts that may occur during the operational phase would result from system maintenance and repair, for which the impacts are expected to be similar in nature and lesser in scale and period than during construction. Therefore, no further assessment is considered necessary here, and no mitigation measures are required.

Conclusions

It was therefore concluded that construction and operation of the transmission system would not give rise to any unacceptable water quality impacts, and no mitigation is required.

11.4 *CONSTRUCTION NOISE ASSESSMENT*

Section 6 contains an assessment of the potential noise impacts during construction of the tunnel, landing points and cable trough on Lamma Island, and the landing point on Hong Kong Island.

The predictions showed that for a small number of residences located close to the Cable Landing points N4 and N5 (Pak Kok Tsui), the day time noise exposure is expected to be close or slightly exceed the 75 dB(A) limit for general construction works contained in the EIAO-TM. Therefore, modest mitigation measures will need to be considered and a limited environmental noise monitoring programme carried out.

If pile driving should be required at Landing Site N5, and if it is decided to employ percussive piling techniques, then the selection of one of the "quiet" types of piling rigs would be necessary in order to avoid exceeding the applicable noise limit - also 75dB(A) - since the use of diesel, hydraulic or steam-powered piling rigs would result in this limit being exceeded by 7 to 20dB(A).

In conclusion, the predicted impacts of the project would be acceptable, provided that the recommended mitigation measures were implemented. In particular, carefull timing of construction activities may be required to prevent cumulative impacts from exceeding acceptable levels.

11.5 *MARINE ECOLOGY ASSESSMENT*

The assessment of potential impacts on marine ecological resources (habitats and species) which is presented in *Section 7* has considered both the direct and indirect potential impacts of laying the submarine transmission cables and constructing the associated landing points.

11.5.1 *Baseline Conditions*

The baseline conditions for the assessment were established by literature review and from the results of comprehensive two season field surveys has indicated that the area potentially affected by the transmission system does not contain any marine ecology sensitive receivers (defined as habitats of high ecological value) apart from isolated patches of soft and hard corals present at very low densities.

The ecological values of marine habitats in the potentially affected areas were then evaluated using the criteria in Annex 8 of the *EIAO TM*, with the following results:

- intertidal habitat at the proposed landing and launching points: *low* ecological value, supporting assemblages of a diversity which is typical to Hong Kong;
- subtidal habitat at the proposed landing points: *low* ecological value, with lower diversity and abundance than other areas; and
- soft bottom habitat along the cable route: *low* ecological value, supporting a low diversity and abundance of infaunal organisms that are typical to Hong Kong.

11.5.2 *Impact Assessment*

Direct impacts during construction will include the loss of habitat at the sites of the three landing points on Lamma Island and along the routes of the cable trough and the submarine cables. As the landing point on Hong Kong Island will be located on an existing sea wall, no impact will occur.

Intertidal and subtidal rocky shores will effectively be lost at the landing points and replaced by artificial seawalls. These seawalls could, however, support a rich assemblage of intertidal fauna and flora through recolonisation, provided a suitable (heterogeneous) seawall design is adopted. Assuming successful recolonisation can be achieved, no adverse impacts are expected.

Short terms impacts are also predicted during trench formation associated with the cable laying, especially where jet ploughing is required. After these works have been completed, it is expected that the epibenthic and infaunal benthic assemblages will recolonise the affected areas.

Indirect impacts are expected to arise from increases in pollution associated with the laying of the submarine cables. Although water quality modelling has not been conducted to assess the impacts of cable laying activities, the expected impacts on marine resources are considered to be minimal because sediment will be released at relatively low rates (especially near the coastal areas) and close to the bottom of the water column, which will restrict its dispersion prior to settling. Also, cable laying activities will be of short duration, lasting approximately four weeks (one week for one trip of simultaneously laying three cables) for each of the 12 transmission cables.

Indirect impacts from construction of the landing points are also expected to be low because only a single dredger will be operated at any of the sites at any one time, dredging rates will be low, and the volume of material to be removed is relatively small.

The residual impacts occurring as a result of the construction of the transmission system are that small areas of natural intertidal and subtidal hard surface assemblages will be lost permanently as a result of the reclamations for the landing and launching points. However, it is anticipated that given the use of rubble mound seawalls, assemblages typical of those lost will recolonise after construction thus reducing the magnitude of the residual impact to acceptable levels. Subtidal soft bottom assemblages along the cable route will be lost as a result of the dredging/jet ploughing operations. These assemblages are, however, of low ecological value and predicted to recolonise the area after laying of the transmission cables thus reducing the magnitude of the residual impact to acceptable levels. As indirect impacts arising from the proposed dredging works are predicted to be largely confined to the specific dredging areas, they are not expected to cause adverse impacts to any marine ecological resources of concern.

11.6 FISHERIES IMPACT ASSESSMENT

The fisheries impact assessment (*Section 8*) considered both the direct and indirect impacts on fisheries resources, fishing operations and fish culture activities associated with the laying of transmission cables and associated works. Potential impacts associated with the loss of habitat which supports fisheries and increased pollution during construction of the transmission system were evaluated in the assessment.

Impacts associated with the submarine transmission cables are only expected to occur during the construction phase.

11.6.1 Baseline Conditions

A desk top study was undertaken to establish the baseline conditions for the assessment. The study area includes four Fishing Zones and one Fish Culture Zone (FCZ), with another FCZ in relative close proximity. The only nursery and spawning ground identified in this impact assessment is to the south of both the areas affected by the construction of the landing points, and the area affected by the laying of transmission cables.

11.6.2 Impact Assessment

Direct impacts due to the deployment of the transmission cable will occur through the loss of habitat which supports fisheries resources. Short term impacts are also predicted to occur in the vicinity of dredging at the landing points and trench forming operations associated with the cable laying. After these works are completed it is expected that the benthic fauna will recolonise and support fisheries resources at current levels.

Indirect impacts may occur due to changes in water quality associated with cable laying and construction of the landing points. These changes may include elevations in SS, and consequent depletions of dissolved oxygen and increases in nutrients. Although water quality modelling has not been conducted to assess these impacts, they are considered to be minimal for the same reasons that are provided for the marine ecology assessment (see above). On this basis it is predicted that the indirect impacts to fisheries resources as a result of cable laying activities will be minimal.

The only residual impact identified that may affect commercial fishing operations is the disturbance to fishing activity during the 4 weeks of cable laying. The magnitude of this residual impact is low since the main area affected by the cable laying is a main fairway where fishing operations are restricted and the duration of the impact is very short (4 weeks).

Based on an evaluation of impacts in accordance with the *EIAO TM*, it was concluded that potential impacts to fisheries resources and fishing operations arising from the transmission system would not be unacceptable.

11.7 *TERRESTRIAL ECOLOGY ASSESSMENT*

The technical assessment in *Section 9* examined the potential impacts on terrestrial ecological resources of establishing the transmission cable landing points on Lamma Island. Since the landing point on Hong Kong Island will be located on a concrete seawall, no impacts will occur.

Baseline Conditions

A desktop study of the available literature found no records of ecological importance for the areas in the vicinity of the landing points. Field surveys were undertaken between July and December 1998 to establish a terrestrial ecological baseline for these areas. On the basis of these field surveys, the resources around the three landing point sites were considered of low ecological importance, medium to low structural complexity, and moderate flora diversity.

The plant community of the predominant habitats (ie shrubland/tall shrubland and rocky shore) is typical to Hong Kong, and not considered to be of high conservation importance. However specimens of the locally uncommon or rare plant species, *Celtis biondii, Pteris dispar* and *Ardicia pusilla*, as well as locally restricted plants *Vitis balansaeana, Pterospermum heterophyllum* and *Rhapis excelsa* were found in the vicinity of the landing points.

Common bird species including resident species as well as summer and winter visitors were observed during the field surveys, with more species recorded in the shrubland habitats.

The assessment of low ecological importance for the habitats has been based on the approach outlined in *Annex 8* of the *EIAO TM*, as follows:

- Naturalness: Although the habitat types are not man-made, their vicinity to villages indicates that they are subject to considerable human disturbance over time.
- Size: The area that will be directly affected is very limited because the landing points and cable trough will affect only relatively small areas of terrestrial vegetation at the fringe of the coastal areas.
- Diversity: Plant species diversity is moderate and animal diversity is low.
- Rarity: Three locally uncommon or rare plants were found comprising *Celtis biondii* and *Pteris dispar* to the west of landing point N4, and *Ardisia pusilla* to the west of landing point N5, as well as three locally restricted plants, *Vitis balansaeana, Rhapis excelsa* and *Pterospermum heterophyllum* which were found in the tall shrubland and/or shrubland habitats near landing points N4 and N5.

- Re-creatability: The predominant vegetation type (shrubland/tall shrubland community) is secondary and can recover easily from disturbance.
- Fragmentation: The predominant habitat types are not fragmented.
- Ecological linkage: The predominant habitat types are not linked to any highly valued habitat in close proximity.
- Potential value: Medium to low potential value. It will take a considerable period (30-40 years) for vegetation succession to transform the shrubland/tall shrublands into woodland that supports significant populations of birds and mammals. Human disturbance will also limit the animal species to common or widespread species. Plant species diversity is also unlikely to increase significantly after a long period of time in such an island environment.
- Nursery/breeding ground: No signs of nursery/breeding grounds for terrestrial animals were found in the surveys.
- Age: Predominant habitat is young (about 10 to 20 years) or frequently disturbed secondary shrubland.
- Abundance/Richness of wildlife: Low wildlife richness and abundance.

In addition, it should be noted that the plant community of the predominant habitats (i.e. shrubland/tall shrubland and rocky shore) is typical of similar habitat elsewhere in Hong Kong. These habitats are therefore not considered to be of high conservation importance.

Based on *Table* 3 of *Annex 8*, only the plant species *Celtis biondii*, *Pteris dispar* and *Ardisia pusilla* are considered important as these are locally uncommon or rare. However, these species have a regionally widespread distributions.

Impact Assessment

Only small areas of terrestrial habitat (approximately 0.07 ha) are expected to be directly lost due to landtake at the landing points and the cable trough. Indirect impacts may result from increased human activities (such as trampling of vegetation) during the construction phase. No impact on terrestrial ecology is expected during the operational phase.

Potential impacts on terrestrial ecology evaluated according to *Table 1* of *Annex 8* of the *EIAO TM* are given below:

- Habitat quality: There will be direct loss of habitat including rocky shore, shrubland and tall shrubland (see maps) from resumption for the landing points and for construction of the cable trough linking N4 to N5. However, the impact is considered low as the habitat quality is low.
- Species: There may be potential direct or indirect impact to the wildlife inhabiting the areas. With the adjustment of the landing point locations and cable trough alignment, the specimens of the locally uncommon or rare plant species, *Celtis biondii* , *Pteris dispar* and *Ardicia pusilla*, as well as any direct impact on the restricted plants *Vitis balansaeana*, *Pterospermum heterophyllum* and *Rhapis excelsa*, will be avoided.

- Size/Abundance: Approximate terrestrial habitat loss at rocky/sandy shore is 500 m^2, and shrubland/tall shrubland is 250 m^2, based on grid count method using 1:1000 survey sheets. The area lost is considered small and hence the numbers of wildlife that may be affected is expected to be limited.

- Duration: The duration of impact is limited to the construction phase of about one year.

- Reversibility: The loss of the low ecological importance habitats would be permanent.

- Magnitude: The scale of habitat loss is small and the impact is considered limited.

Conclusions

Therefore the overall terrestrial ecological impact is considered low. With the sympathetic design of the landing points and cable trough to avoid the rare, uncommon and restricted plant species, as well as implementation of good construction practice such as preventing unnecessary encroachment on adjacent wooded areas by site personnel, disturbance to the surrounding environment will be minimised.

11.8 Landscape and Visual Impact Assessment

A qualitative assessment was undertaken of the potential landscape and visual impacts of the landing points for the transmission cable system (see *Section 10*).

The landing point on Hong Kong Island will be on the existing seawall of Telegraph Bay and its appearance will not alter significantly after construction. For the other landing points on Lamma Island, the landscape impact would be related to the loss of natural coastal features. These facilities are all located at relatively remote locations on Lamma Island and would be viewed either from the sea or other islands at considerable distances, or by the few local residents who may occasionally frequent the development areas.

Given the small scale, remote locations and horizontal nature of the landing points and cable trough, the potential landscape and visual impacts due to loss of the small coastal areas in the context of the surrounding coastline are not considered significant, given the application of the following mitigation measures to minimise potential impacts on the Countryside Conservation Area:

- the surface materials of the landing points should mimic the natural coastal features using irregularly arranged boulders instead of concrete;

- the cable trough that would be formed as a walkway should be shielded by boulders (or shrub planting) from potential viewers from or across the sea; and

- appropriate landscaping should be provided for any disruption to existing vegetation to blend in with the surrounding setting.

As a planning gain, parts of the the landing points N4 and N5 and the cable trough between the landing points can be used for amenity and recreational purposes. Some low maintenance fixtures, matching the natural environment, will be built or placed on the landing points for public use. A detailed Amenity Plan will be submitted to the Authority for approval before commencement of the construction works.

Conclusions

With the implementation of the recommended mitigation measures, no unacceptable impacts were identified during the landscape and visual assessment .

11.9 CONCLUSIONS

A detailed and comprehensive assessment of the potential impacts of the transmission cable system for the Lamma Extension project has been completed. No unacceptable or insurmountable impacts (including cumulative impacts associated with other projects and activities) are expected from the proposed development, provided the recommended mitigation measures are adopted and implemented.