ROUTE 3 CONTRACTORS CONSORTIUM

ROUTE 3 TAI LAM TUNNEL & YUEN LONG APPROACH - SOUTHERN SECTION

FINAL DETAILED ENVIRONMENTAL IMPACT ASSESSMENT

Volume 2 - The Conveyor System

August 1995

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1 INTRODUCTION

1 INTRODUCTION

1.1 Background

The Route 3 Tai Lam Tunnel and Yuen Long Approach (R3 TLT & YLA) is an integral part of an extensive infrastructure and transport link to serve the new Hong Kong international airport at Chek Lap Kok and the proposed container terminals 10 and 11 on Lantau Island. It extends from Ting Kau to Au Tau, including the Northern Link (Au Tau Interchange to Yuen Long) and the connection to the New Territories Circular Road (NTCR). This project is now being undertaken by a franchisee, Route 3 (CPS) Company Limited, that has contracted responsibilities for design and construction to Route 3 Contractors Consortium (R3CC).

The preliminary design for the Tai Lam Tunnel Portal identified the need to remove approximately 6 Mm^3 of excavated spoil material from the area. A Conveyor System was deemed to be the most practical and environmentally acceptable method for transporting the material to a barge loading area. The amended design proposed by R3CC has reduced the spoil handling requirement to around 4.5 Mm^3. However a Conveyor System will still be employed to move the spoil to the barge loading facility.

1.2 Scope of the Study

Environmental impact of the original alignment C was addressed in the Route 3 Country Park Section and Ting Kau bridge, Preliminary Design Stage 2 (PDS2), Environmental Assessment Supplementary Paper for the Conveyor System, subsequently referred to as the EACS. The EACS was undertaken by Freeman Fox Maunsell for the Highways Department according to a brief provided by the Environmental Protection Department (EPD). The study was completed in March 1994.

This report forms Volume 2 of the Detailed Environmental Impact Assessment (DEIA) for the Southern Section of R3 TLT & YLA and is based on the latest conveyor alignment and design provided by R3CC in February to July 1995. It addresses those environmental impacts that may have changed due to revisions in the design of the Conveyor System since the EACS was completed. This study referred to relevant information contained in the EACS where appropriate, rather than reiterated the earlier assessment.

Key issues covered in this report include the following:

- Air quality impact, mainly dust (Section 3)
- Construction and operational noise (Section 4)
- Marine and fresh water impacts (Section 5)
- Visual and landscape issues (Section 6)
- Effect on ecology (Section 7).

Also included in the report are recommendations for mitigation measures to minimise impacts and to ensure compliance with environmentally acceptable standards.

Volume 1 of the DEIA describes the environmental impacts of constructing and operating the Southern Section of R3 TLT & YLA. Volume 3 presents the environmental monitoring and audit (EM&A) programme, including EM&A requirements for the Conveyor System.

2 PROJECT DESCRIPTION

2 PROJECT DESCRIPTION

2.1 Study Area

The study area encompasses the hillsides and coastal area between the South Portal of the Tai Lam Tunnel and the coastal area of Gemini Beaches (Figure 2.1).

This temporary Conveyor System will be installed to transport away all excavated material arising from the construction of the Ting Kau Interchange and Tai Lam Tunnel. Disposal of this material will be by barges which dock at a barge loading jetty, located at Gemini Beaches and linked to the Conveyor System.

2.2 Conveyor System

2.2.1 Alignment

Original Alignment C:

This alignment as described in EACS leads to a barge loading point off the Gemini Headland located between the two Gemini Beaches (Figure 2.2). The small headland at Gemini Beaches provides a natural platform slanting gently towards the sea. The route is some distance from heavily populated areas and major gazetted beaches.

Revised Alignment C:

This alignment as amended by R3CC follows the same line of alignment C from south of Tuen Mun Road and utilises the same barge loading point off Gemini Headland (Figure 2.3). North of Tuen Mun Road the Conveyor System follows a straight path, reaching the processing area west of the original alignment.

The new alignment was designed to eliminate the surge bins/stockpiles originally envisaged along the alignment. This has the advantage that noise, dust and water quality impacts along the alignment will be reduced.

2.2.2 Description of the Conveyor System

The Conveyor

The entire conveyor is about 960 m long and 1.4 m wide, operates continuously at a speed of 3.5 ms^{-1} for 16 hours a day at a maximum rate of 3,000 tonnes per hour for 2 years. The target production rate per day is 30,000 tonnes (15,000 m^3). A conveyor access road will be constructed within the delimited works boundary. It will allow access from the east, but not from the west due to the barrier posed by Tuen Mun Road.

The current design is continuous. The only transfer point is at the head of the conveyor. This is operationally more practical than the PDS2 design, which requires three changes in direction. The PDS2 design requires transfer points involving the dropping of spoil into surge bins or stockpile areas, then reloading onto another conveyor.

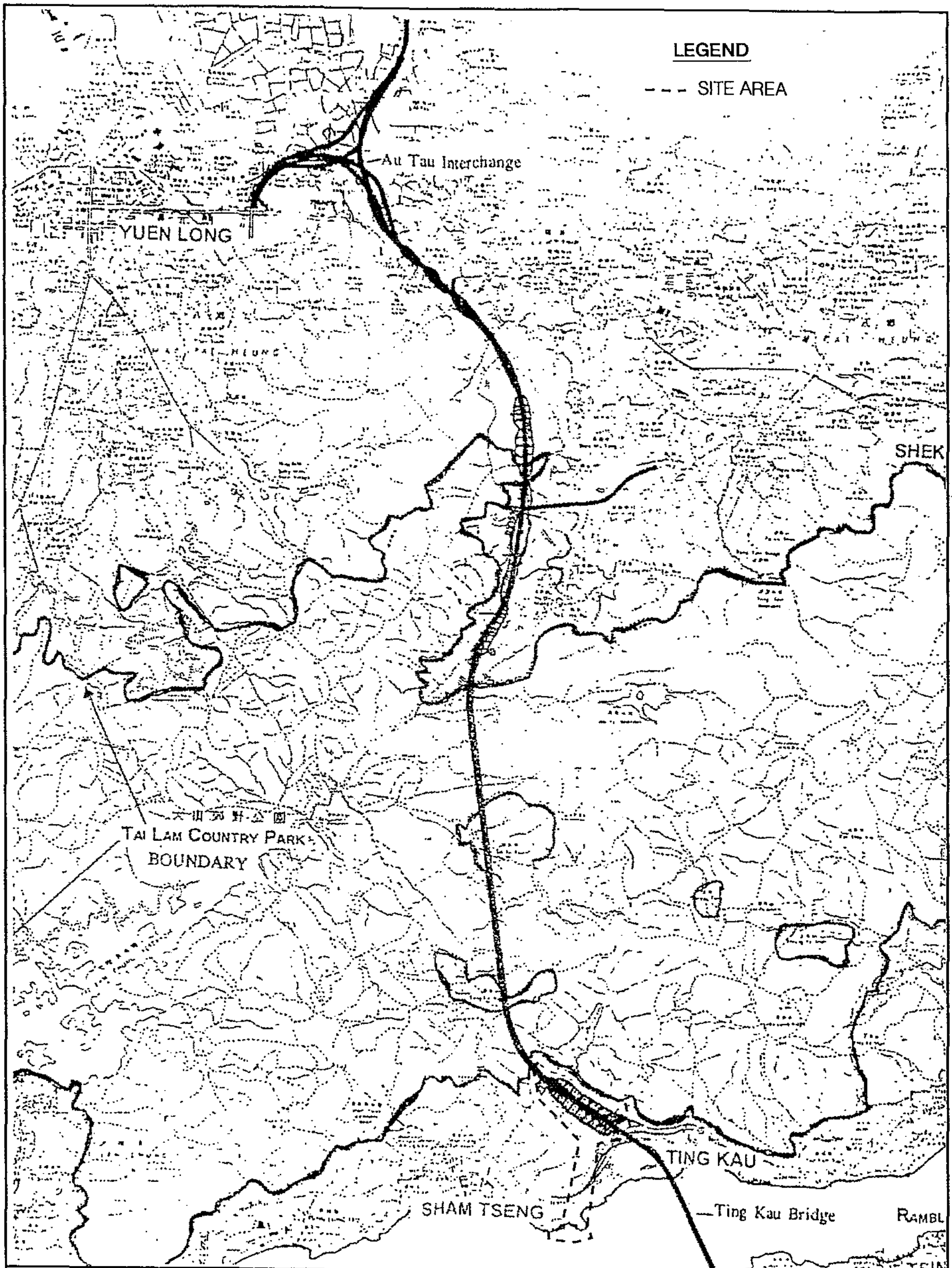

Figure 2.1 Study Area

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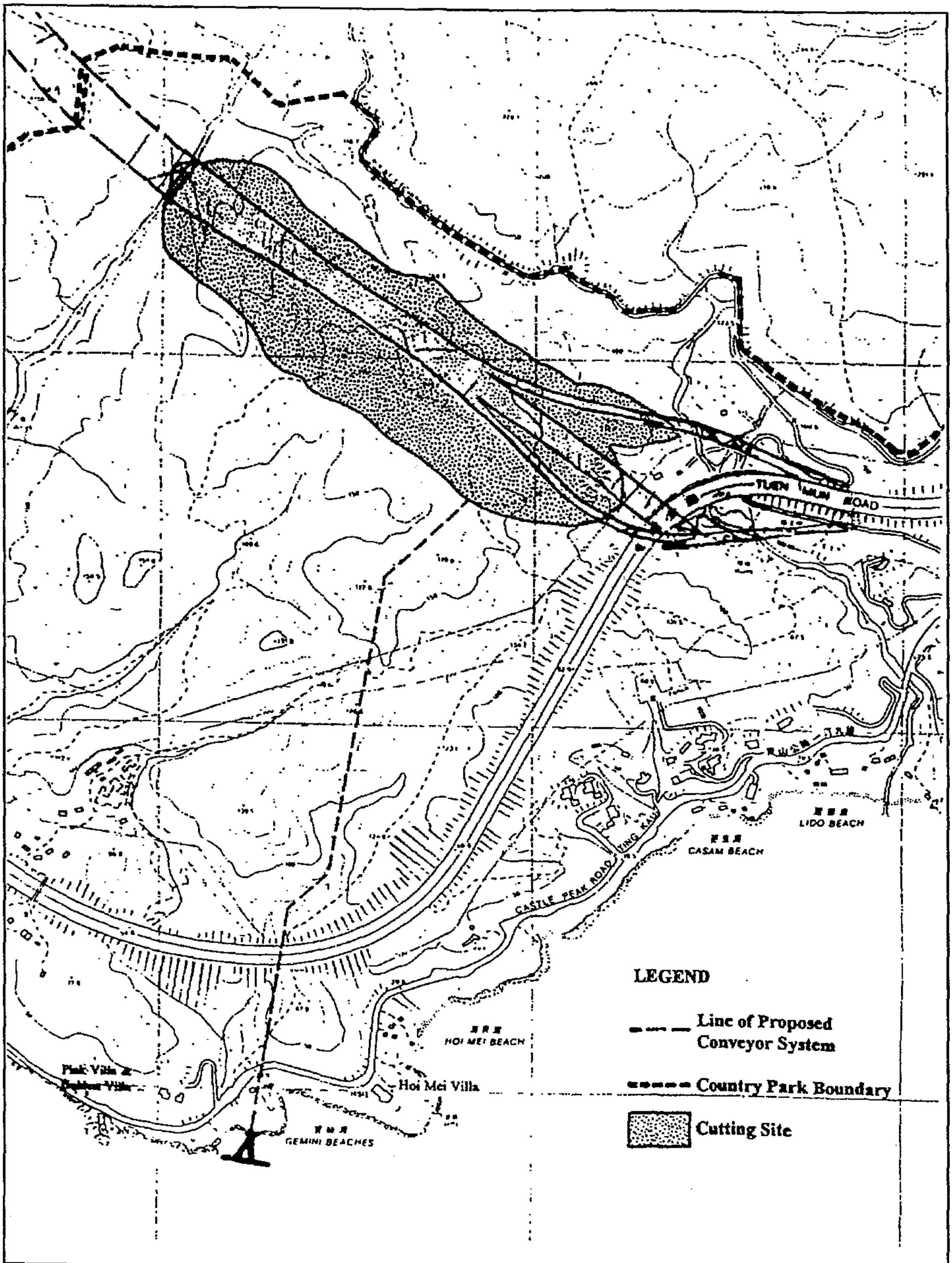

Figure 2.2 Original Alignment C

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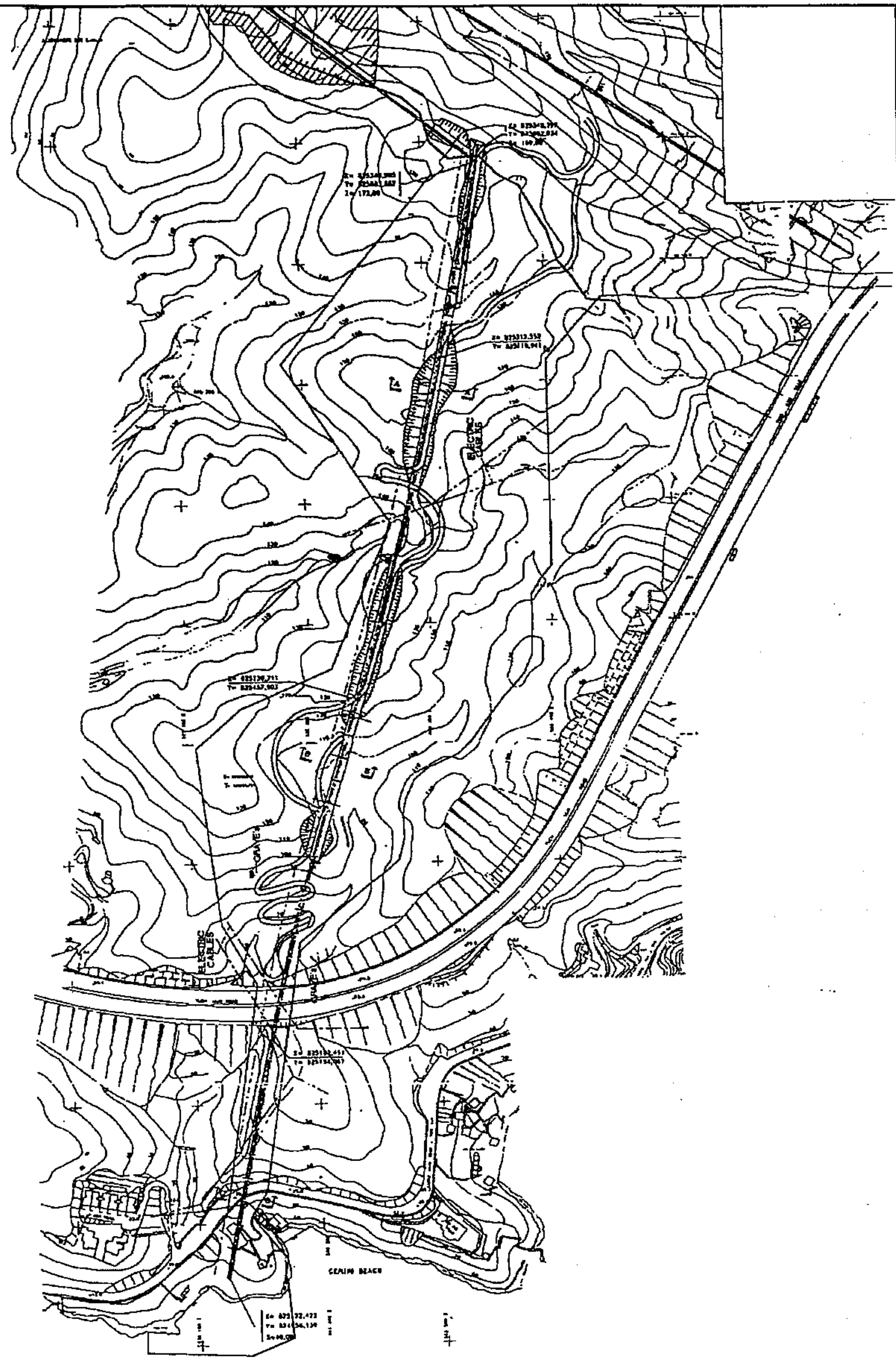

Figure 2.3 Revised Alignment C

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The current design also differs from the PDS2 design in that the conveyor will be erected on trusses where it traverses valleys, rather than on earthen fills. Segments passing through ridges or hills will be erected in culverts using cut and cover methods. Other sections will be on structures, as shown on Figures 2.4 and 2.5. All exposed sections will be covered with a steel roof and canvas sides (Figure 2.6). Where it bridges the Tuen Mun and Castle Peak Roads, it will be fully enclosed.

These changes have the following advantages:

- Less maintenance for one continuous conveyor than for several discontinuous conveyors
- No stockpiling along the alignment due to elimination of transfer points, stockpiling at the head of the conveyor only
- Dust, noise and water quality impacts along the alignment reduced due to elimination of transfer points
- No fill material needed as a result of using steel trusses
- The steel trusses are easier to erect and disassemble than the earthen fill, thus easier to reinstate lost habitats
- Stream flows in the valleys can be maintained more readily as a result of the trusses

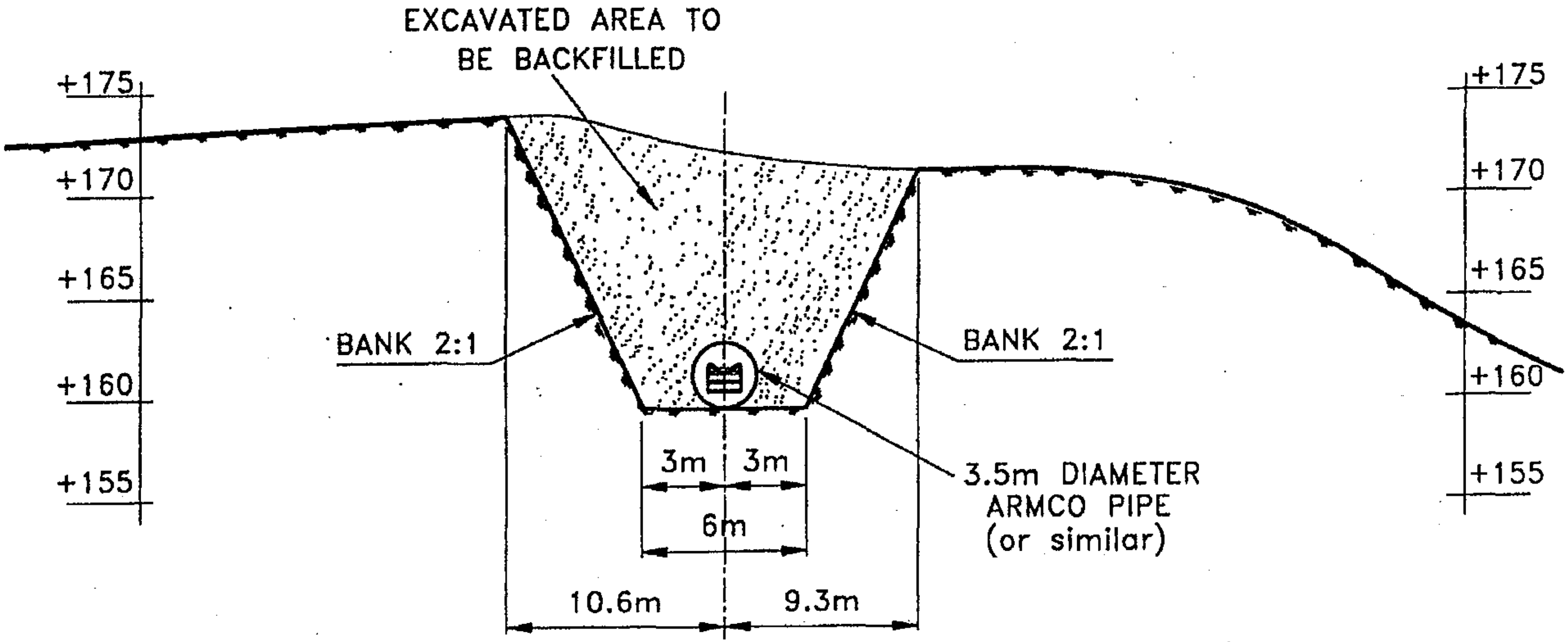
After excavation is completed and the conveyor is decommissioned, the conveyor and access road will be removed and the disturbed vegetation will be reinstated. The steel pipes inserted into the cut and cover sections will remain, but they will be filled with a sand/cement mix.

The Jetty

The jetty (Figure 2.7) will serve two barges. Barge loading will operate 16 hr per day with an approximate loading rate of 5,000 tonnes per hour.

The barge loading operation is not continuous. Due to the conveyor's large size (and thus impractical to turn it on and off regularly) and the large quantity of spoil to be removed from the main cut, it is imperative that the conveyor operates continuously. As a result of the continuous conveyor operation and the discontinuous barge loading operation, there will be a need for a stockpile at Gemini Beaches where the jetty is located.

Instead of loading directly onto barges, a stockpile of maximum 30,000 m^3 will be created. The material will be moved from the stockpile to barges by two underground conveyors (Figure 2.8). For the two underground conveyors to operate effectively, there must be a minimum cover (referred to as the "dead" part) of spoil. This minimum cover is anticipated to be a maximum of 15,000 m^3. In addition, the stockpile must be able to hold the equivalent of one day's maximum production (referred to as the "living" part). This will ensure that should the barges be unable to moor at the jetty, there will be sufficient space to stockpile the spoil as a buffer. This buffer stock will also allow maintenance to be carried out on the conveyor without causing interruption to the barge loading operation. The maximum load, as described earlier, is estimated at 15,000 m^3. The maximum size of the stockpile therefore represents the sum of the "dead" and "living" parts.



~SECTION 'A-A'~
(TYPICAL "AT GRADE" SECTION)

Figure 2.4 Cross Section of the Conveyor System

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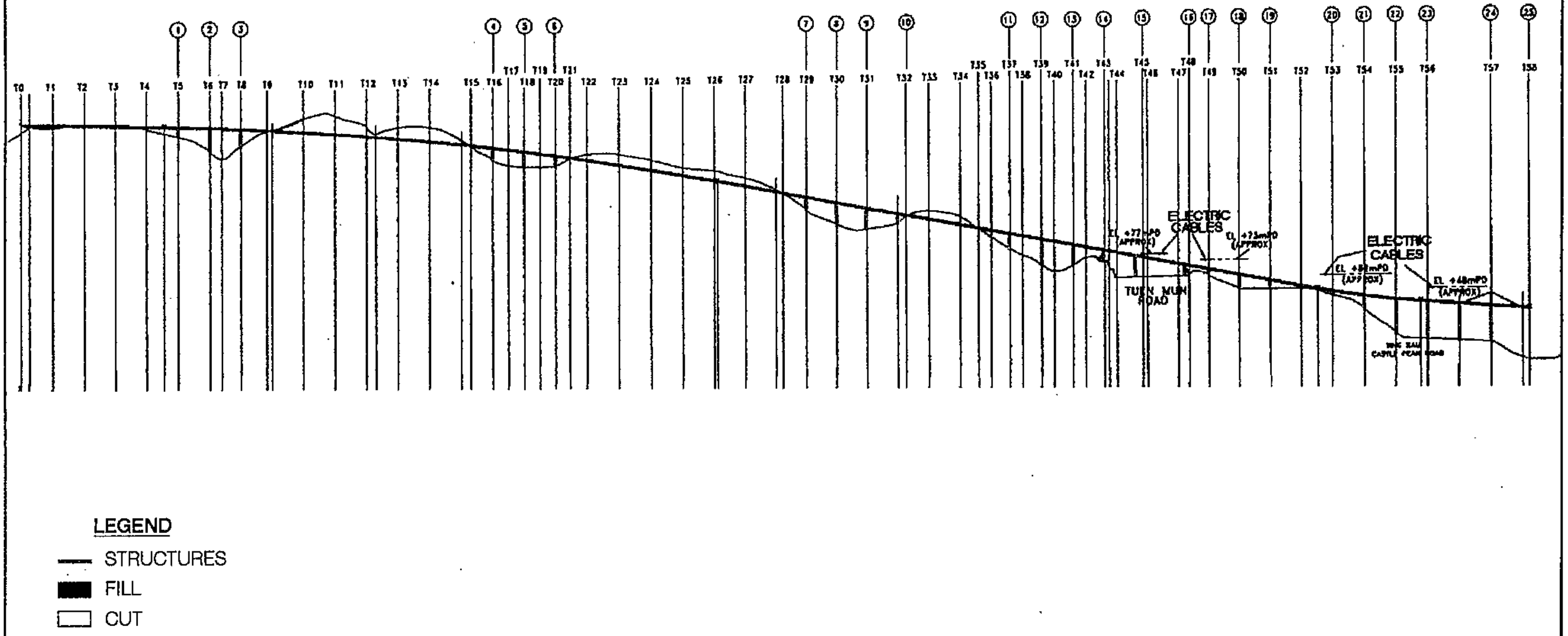

Figure 2.5 Longitudinal Section along Conveyor System

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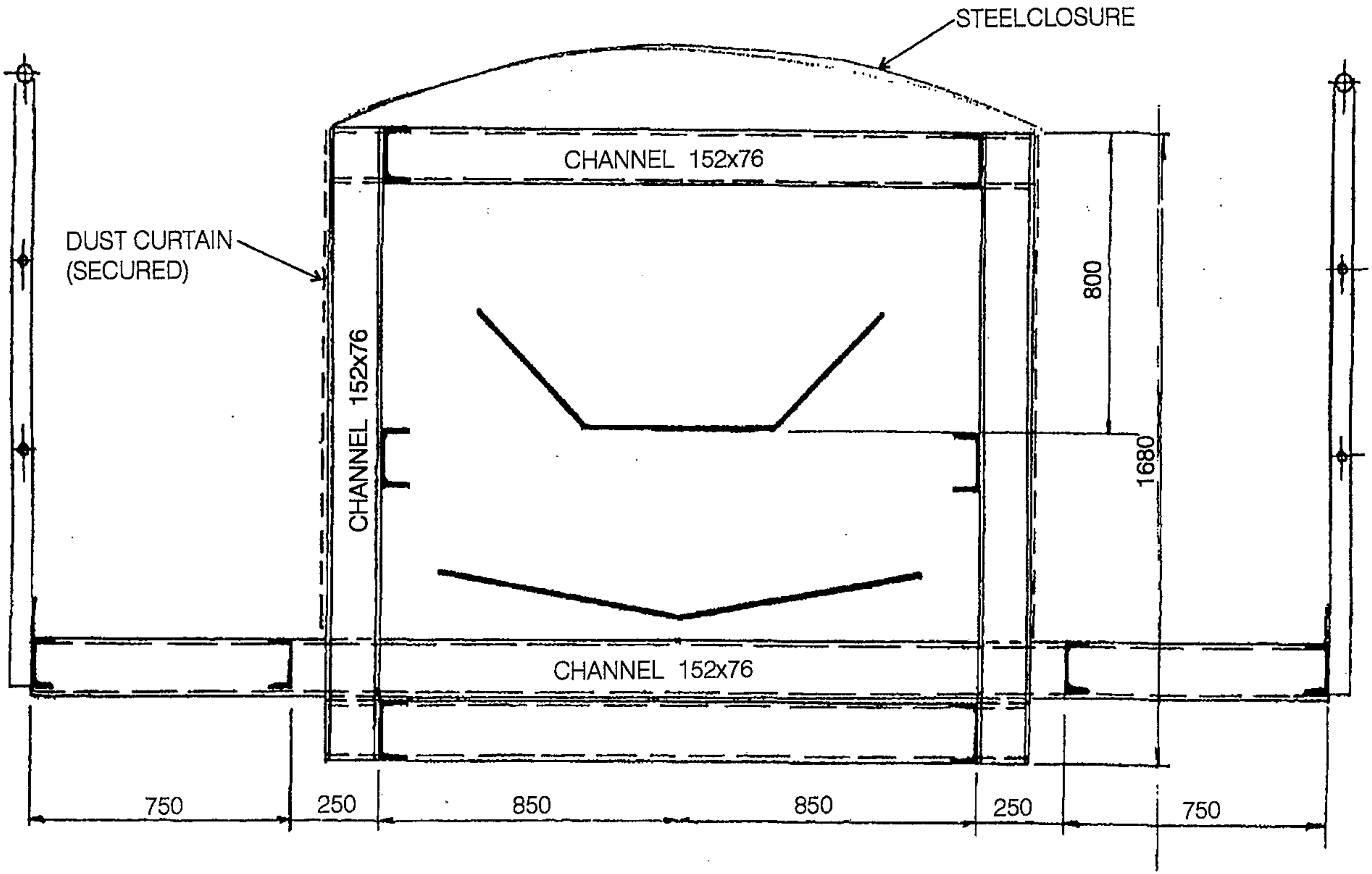

Figure 2.6 Cross Section of Conveyor System with Enclosure

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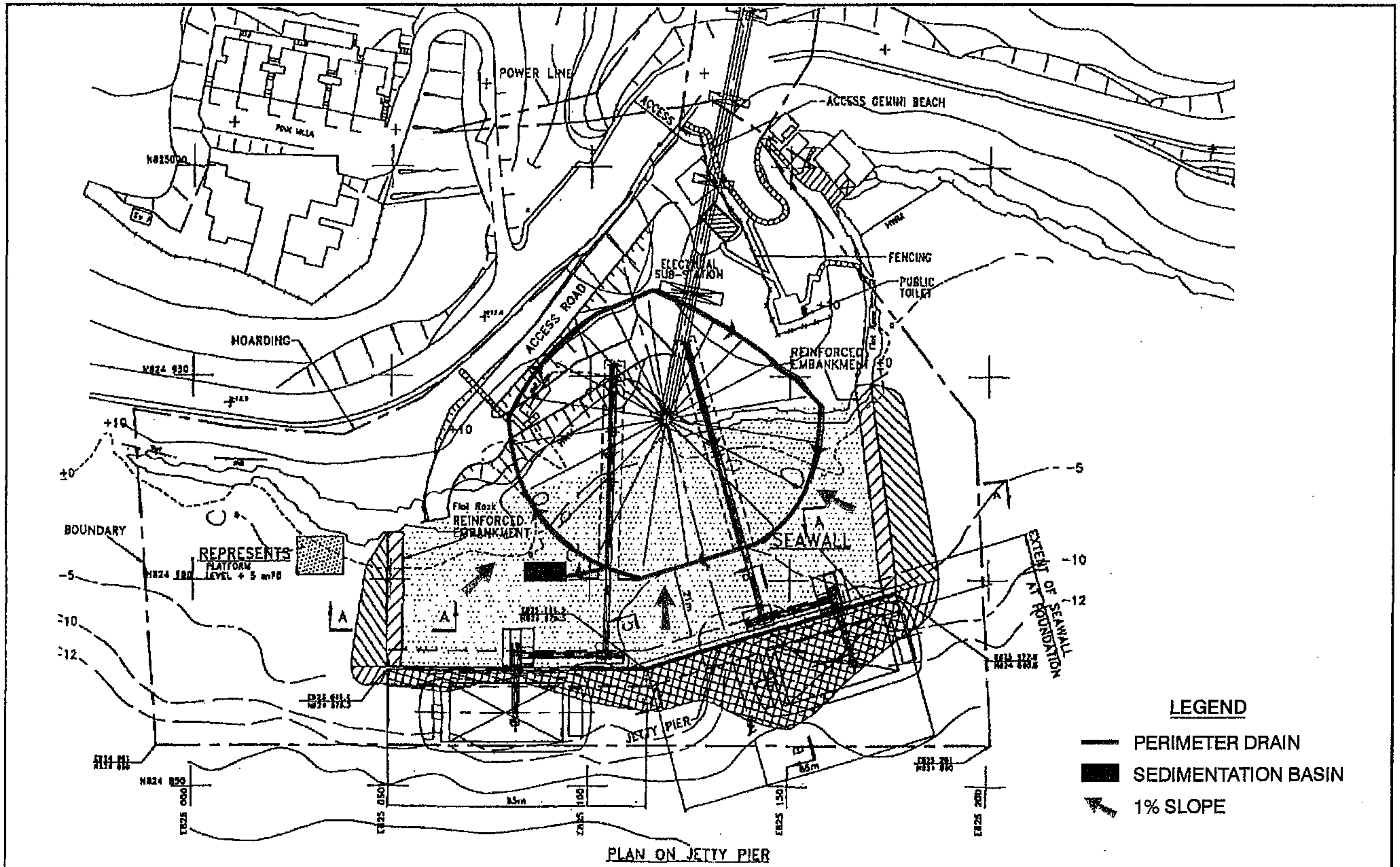

Figure 2.7 Jetty Layout

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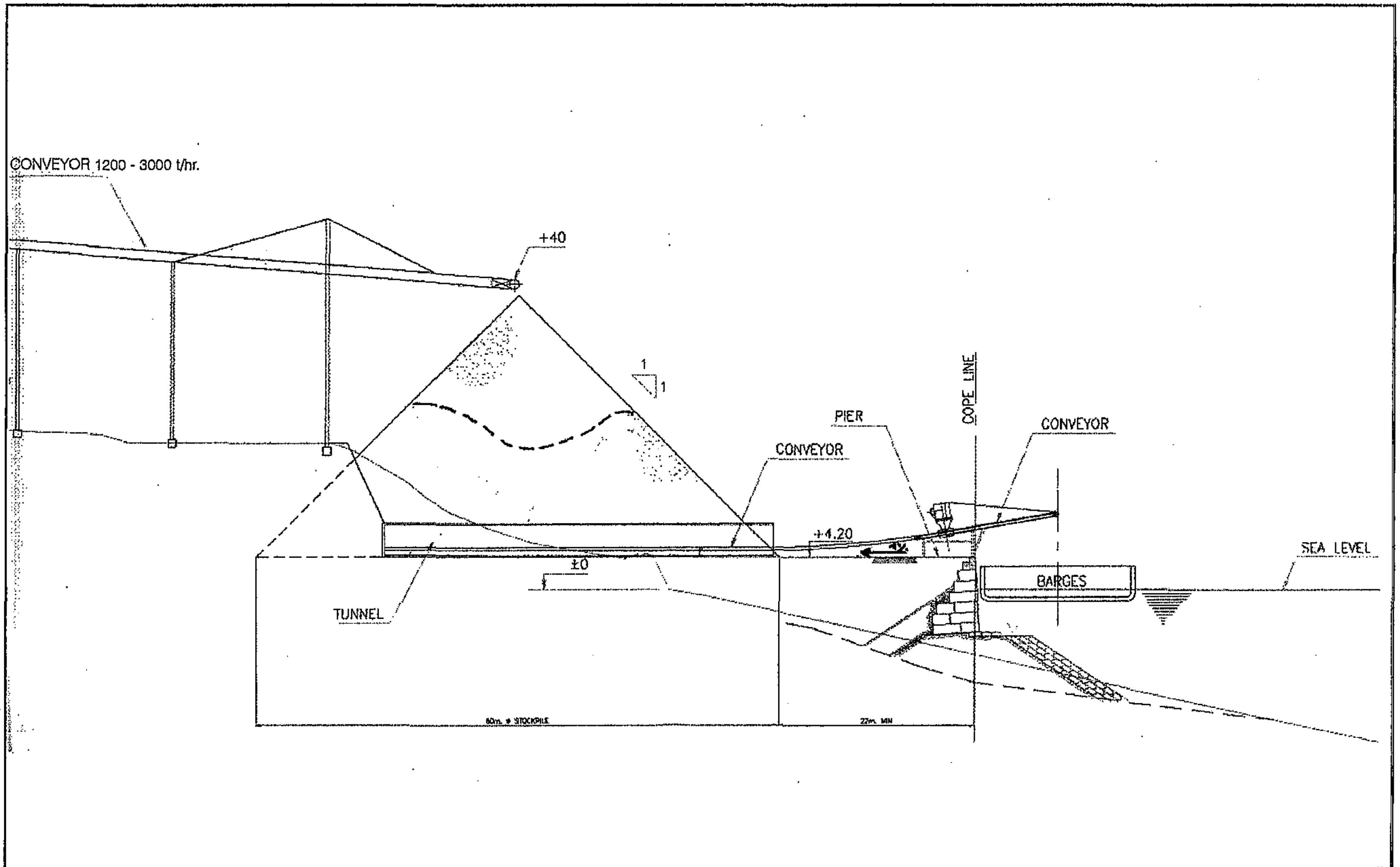

Figure 2.8 Cross-Section Through Jetty Showing Conveyor Arrangement

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The jetty will be on fill behind a seawall as opposed to the PDS2 design which was on piles. It will be constructed directly on rock. Recent site surveys reveal that the area has little marine mud. Dredging will not be required. The pier will consist of pell mell rubble, concrete blocks and select fill. The seawall and embankments will be constructed first. A 1 m filter layer comprising of river sand, granular or similar material, and a layer of geotextile, as shown in Figures 2.9 and 2.10, will be installed on one side of the seawall prior to placement of other fill materials. The present design, as opposed to the PDS2 piled structure, was chosen for the following reasons:

- *The need to stockpile*: The need to stockpile spoil adjacent to the barge loading area has been explained above. The stockpile will be integrated into the jetty structure. This will ensure that the stockpile's movement, and possible spillage into the sea, will be constrained. The piled structure in the PDS2 design would be unable to confine the stockpile. The land area presently available is not large enough to hold the stockpile. The stockpile and barge loading area will, however, remain well within the gazetted area.

- *Drainage*: The integrated stockpile and barge loading area will allow for controlled drainage of surface water. A drainage system (Figure 2.7) will be installed along the perimeter to collect and recycle all water used for dust suppression. It drains into a sedimentation basin designed to retent the first 10 minutes of surface run-off during a 1 in 10 year storm event (The EPD Practice Notes PN 1/94 specifies a minimum retention period of 5 minutes). The jetty surface will have a 1% slope falling towards the stockpile such that surface run-off will not flow into the marine environment over the surface. The jetty fill behind the seawall, due to its porous nature, will act as a filter to filter out sediments from the surface water prior to seepage to the marine environment. An extra 1 m filter layer, consisting of granular material and a layer of geotextile will also be installed. Such controlled drainage of run-off water would be extremely difficult to achieve with a piled structure. Details of the drainage design is attached in Appendix A.

- *Rock seabed*: As the seabed consists of hard rock it would be difficult to drive piles into it to the extent required. Impact to the seabed and surrounding environment from pile driving (noise and sediment release) would be substantial during the construction and decommissioning stages. Blasting may be required to remove the piles during decommissioning, making reinstatement of the seabed difficult.

- *Surface current and wave action*: The possibility of only reclaiming the area required for the stockpile and piling the rest for the barge loading area was considered. Piling was ruled out due to difficulty of driving the piles through hard rock, as described above. However, a free standing pier was considered, one which would have piles sitting on the seabed. The Marine Impact Assessment (MIA) carried out by others indicates that surface currents in the vicinity of the jetty are strong, up to 4 knots (aligned east-west). There is indication of a significant amount of wave action on the barges and the jetty. A free standing structure will be more susceptible to movement in extreme conditions. This may well hinder the safety and quick operation of barge loading. The current and wave action would also preclude the use of a pontoon type jetty. As the pontoon moves up and down with the tide and wave action, it would be extremely difficult to convey spoil from the stockpile to the barges. The seawall allows for extensive mooring bollards to be installed, which have been highlighted as a requirement in the MIA. Impact absorbers can also be attached more readily to the seawall. In light of the above, a free standing structure is not preferred and the more stable filled platform is adopted.

The shape of the jetty has been the subject of careful consideration. It has been revised several times to minimise environmental impacts and to ensure that there is sufficient draw for the barges to operate. The perimeter of the jetty will be fenced to prevent unauthorized access. The whole platform will be approximately 125 m x 40 m. The main channel south of the jetty is approximately 1 km wide and 30 m deep (at its deepest). The temporary jetty pier will extend the existing headland slightly south and may create a more sheltered area of water to the immediate east (Gemini Beaches). The latest proposal has been shown in Figure 2.7 and Chapter 5 provides the water quality impact assessment.

2.2.3 Construction and Decommissioning of the Jetty

The jetty will be constructed according to the following sequences such that environmental impact is minimal.

Development of Seawall Foundation

A rubble mound foundation of pell mell rubble will be deposited on the seafloor. This will be protected from scouring by placing armour rock, by derrick barge, on the slope facing the sea. Levelling stone and toe blocks will also be installed.

Erection of the Seawall

Pre-cast blocks will be placed on the foundation by a derrick barge and a team of divers. Connection between the blocks will not be required. A 1 m layer of pell mell rubble backfill will be placed behind the seawall to act as a filter layer. To prevent the sliding of the seawall a berm-stone will be installed. Precast blocks are preferred over pell mell rubble because of the anticipated difficulty of mooring the barges due to the strong currents and wave action predicted.

Erection of Reinforced Embankments

The construction of these will be concurrent with the seawall foundations rubble mound works. Embankments will be constructed at both ends of the seawall. They will consist of pell mell rubble, geotextile (for filtering) and armour rock and are designed to protect the jetty from severe tides and currents.

Jetty Backfilling

After the seawall and embankments are completed fill will initially be placed around the perimeter of the area and will systematically work towards the centre. Material will be brought into the filling area by 24-tonne dumptrucks.

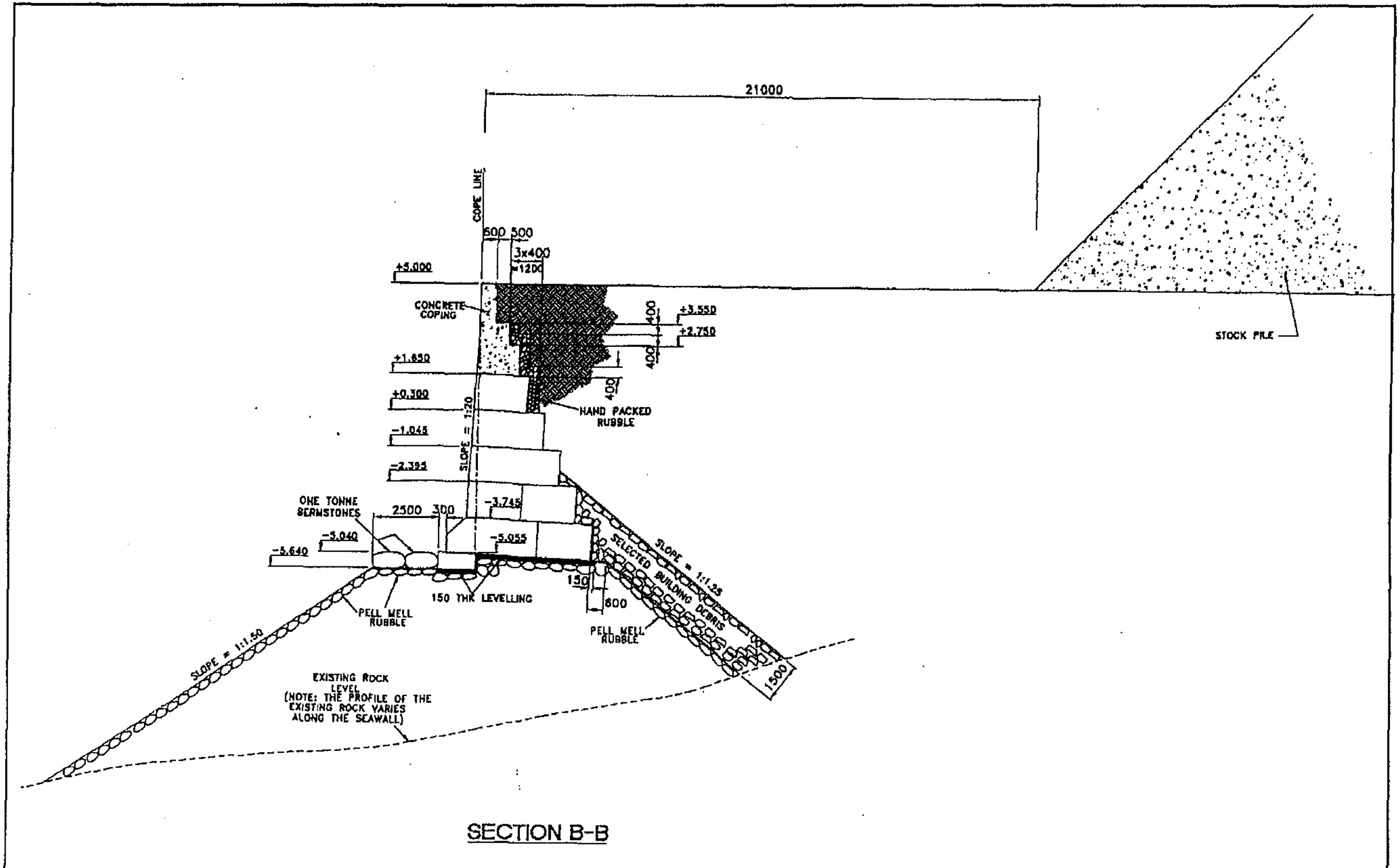

Figure 2.9 Typical Cross Section of Sea Wall (Section B-B)

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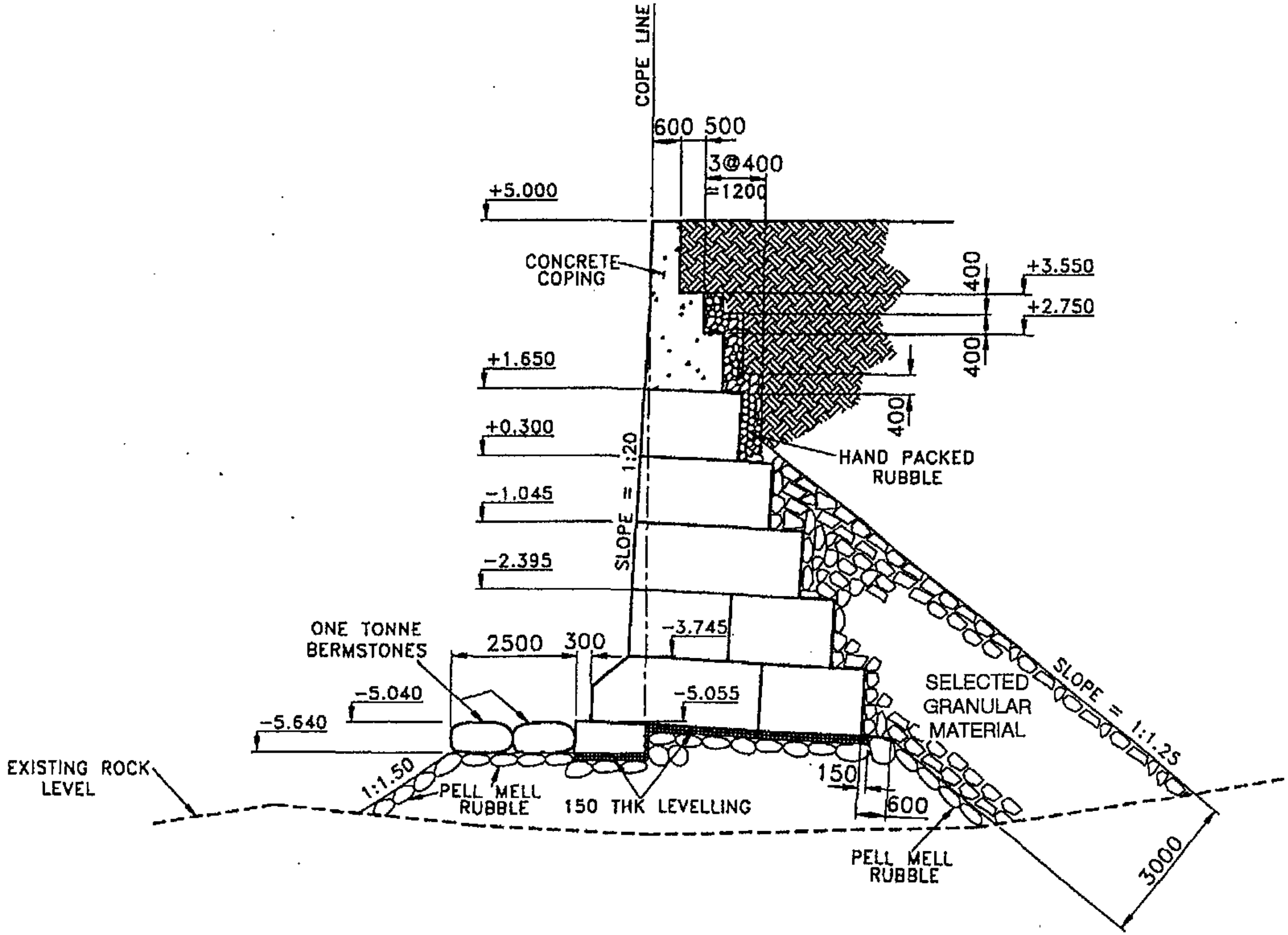

SECTION C-C

Figure 2.10 Typical Cross Section of Sea Wall (Section C-C)

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Decommissioning of the Jetty

The structures at Gemini Beaches will be removed and the area reinstated. The filled platform will be removed in a reversed fashion to its construction. The rubble/block embankments and seawall will be the last to be removed from the area. This will contain the majority of the suspended solids and minimise dispersion into the marine environment during decommissioning. The beach front will be reinstated, where necessary, to its original condition.

2.2.4 Summary of Major Differences between Current Proposal and the PDS2 Design

- The alignment is amended north of the Tuen Mun Road
- The conveyor is continuous thus eliminating the need for transfer points on the route
- The new alignment will require cutting and covering for sections passing through ridges or hills
- The conveyor will be erected on steel trusses where it traverses valleys, rather than on earthen fills
- There will be no surge bins/stockpiles along the conveyor route
- The amount of spoil to be moved is 4.5 Mm^3, 25% less than the PDS2 design
- The jetty will be on fill rather than piles, thus site formation will be required
- The spoil will be rehandled at the jetty, stockpile size will be 30,000 m^3
- The Conveyor System service road will not follow the conveyor alignment, because the gradients are too steep
- The conveyor and loading facilities will operate between 0700-2300 hours.

The advantages of this new proposal are that noise, dust and water quality impacts along the alignment will be reduced and visual impact in the cut and cover section will be more transient.

In light of the extent of changes between the current proposal and the PDS2 design and concerns expressed by EPD regarding potential environmental impacts of the stockpile, R3CC will, in consultation with EPD, review the requirements for, and the environmental performance of, the stockpile after the first six months of operation.

3 AIR QUALITY

3 AIR QUALITY

3.1 Legislation and Guidelines

The Air Pollution Control Ordinance (APCO) (Cap. 311, 1983) provides powers for controlling air pollutants from stationary and mobile sources, including fugitive dust emissions from construction sites. It encompasses a number of Air Quality Objectives (AQOs). Currently AQOs stipulate concentrations for a variety of pollutants, of which dust (in terms of total suspended particulates (TSP)) is relevant to this study. The AQOs for TSP are listed in Table 3.1.

Table 3.1 Hong Kong Air Quality Objectives

Pollutant	Average concentration in micrograms per cubic metre[1]		
	1-Hour	24-Hour[2]	Annual[3]
TSP	500[4]	260	80

1 Measured at 298 K and 101.325 kPa.
2 Not to be exceeded more than once per year.
3 Arithmetic mean.
4 In additional to the 24-hour and annual average AQOs, it is generally accepted that an hourly average TSP concentration of 500 μgm^{-3} should not be exceeded. Such a control limit is particularly relevant to construction work and has been imposed on a number of construction projects in Hong Kong in the form of contract clauses.

3.2 Existing Environment

EPD's monitoring program shows no air quality monitoring station in the Ting Kau area. Since both Castle Peak Road and Tuen Mun Road run through the area, moderate dust level in the area due to traffic emissions would be expected. Baseline measurements of 24-hr TSP were carried out at Lido Green at Lido Beach from May to October 1994 by Axis Environmental Consultants Ltd for Highways Department. The monitoring station was at a distance from the Conveyor System. Background TSP levels were found to range from 57 to 84 μgm^{-3}, with an increasing trend due to a number of construction projects in the area.

3.3 Sensitive Receivers

The same air quality sensitive receivers were adopted for assessing both construction and operational impacts of the Conveyor System. These include eight receivers at the Pink/Golden Villas west of the Gemini Beaches, the Marine Traffic Control Station (MTCS) at Gemini Point (south of Homi Villa), and an isolated residence at Sham Tseng Tsuen near the conveyor alignment (Figure 3.1). The closest distance between a receiver and the alignment was approximately 50 m. The locations and elevations of the selected sensitive receivers are tabulated in Table 3.2.

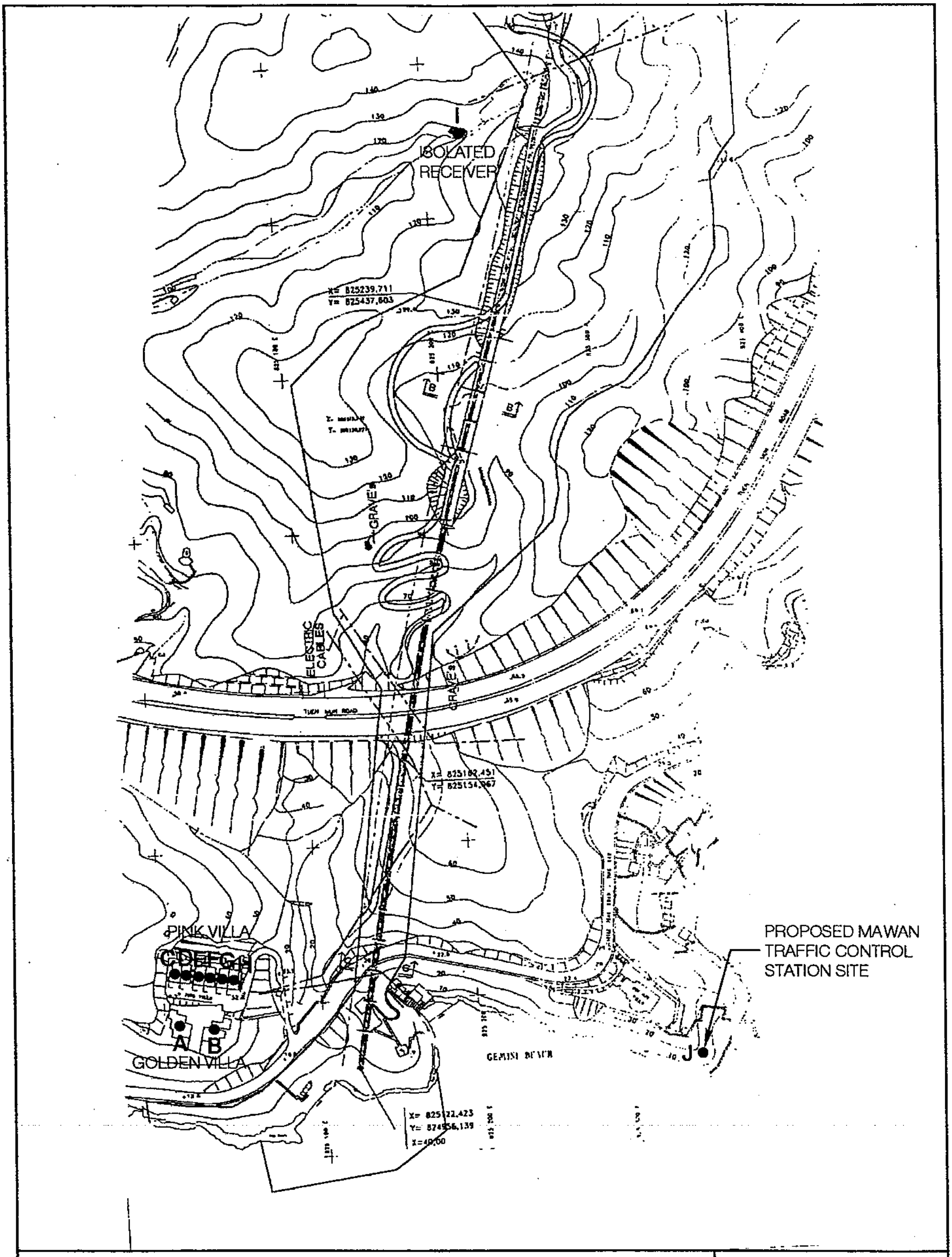

Figure 3.1 Potential Air Quality Sensitive Receivers

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Table 3.2 Representative Air Sensitive Receivers

Receiver	Location	Height (mPD)		
		G/F	1/F	2/F
A	Golden Villa, Block A (G/F-1/F)	36.5	40.5	-
B	Golden Villa, Block B (G/F-1/F)	36.5	40.5	-
C	Pink Villa, Block A (G/F-2/F)	41.5	44.5	48.5
D	Pink Villa, Block B (G/F-2/F)	39.3	43.3	47.3
E	Pink Villa, Block C (G/F-2/F)	38.1	42.1	46.1
F	Pink Villa, Block D (G/F-2/F)	36.9	40.9	44.9
G	Pink Villa, Block E (G/F-2/F)	35.7	39.7	43.7
H	Pink Villa, Block F (G/F-2/F)	34.5	38.5	42.5
I	Isolated Residence, Sham Tseng Tsuen	121.5	-	-
J	Marine Traffic Control Station, Gemini Point	21.5	-	-

3.4 Construction Phase

3.4.1 Assessment Methodology

Dust Emissions

The major pollutant of concern during the construction phase of the Conveyor System is particulate matter (dust). Vehicle and plant exhaust emissions from the site should not constitute a considerable source of air pollutants based on previous experience.

Dust will mainly be generated by site formation activities. Site formation will last 3 months with 25 working days per month. Approximately 50,000 m^3 of fill material will be required and will be transported to the site by trucks. There would be approximately 150 haulage trips per day. The average round trip distances within the site and on the access road were estimated at 100 m and 240 m respectively. The working hours will be from 0700 to 1900. Dust emission sources include the following:

- End-tipping of fill material from the trucks
- Bulldozing fill material
- Trucks travelling on the unpaved site and the access road
- Wind erosion of open site

Dust emissions were predicted based on typical values and emission factors from USEPA *Compilation of Air Pollutant Emission Factors (AP-42)*. Material silt content and moisture content were taken as 6.9 and 7.9 percent respectively, which are the geometric means for overburden in Western surface coal mining from *AP-42*. Silt content of surface material on unpaved roads on site was taken as 5.0%, based on results from a particle size analysis of samples of typical site road surface material. Rainfall data were taken from the Royal Observatory weather records. Average wind velocity was calculated from the wind data of the Shell Tsing Yi Installation meteorological station, which is the closest station to the site.

In addition, the following assumptions were adopted for dispersion modelling:

- The speed of haulage trucks travelling within the site area is 20 $kmhr^{-1}$
- A 50% reduction of dust generated from wind erosion would result from twice daily watering with complete coverage of all open site area according to *AP-42*.
- An estimated mitigation efficiency of 70% was taken for regular watering of the site roads and active site areas to reduce the dust generated from vehicle movements on dusty roads and earth movements.
- A vehicle washing facility at the site exit is provided.

Table 3.3 presents the predicted dust emissions from various site formation activities.

Table 3.3 Predicted Dust Emissions During the Construction Phase of the Conveyor System

Activity	TSP (kg day^{-1})
End-tipping of fill material from haul trucks	0.16
Bulldozing fill material	12.94
Haul trucks on unpaved site roads	3.75
Haul trucks on unpaved access road	8.99
Wind erosion of open site	0.77
Total emission	27

Dispersion Modelling

The AAQuIRE (Ambient Air Quality in Regional Environments) system developed by CES was used to model the dispersion of TSP. AAQuIRE performs multiple runs of the USEPA approved Fugitive Dust Model (FDM) to assess potential impacts from construction activities. 1-hr and 24-hr average TSP concentrations at the selected sensitive receivers were predicted.

Sequential hourly wind speed and direction from the Shell Tsing Yi Installation meteorological station were combined with surface observations from the Royal Observatory to obtain the best available hourly sequential data set for years 1991 to 1993 (the latest data available). Dispersion modelling was undertaken for 120 predefined separate meteorological categories. At each receiver the 1-hr average TSP concentration was predicted for each category. The concentration predictions for the 120 meteorological categories were then compared with each sequential hourly meteorological data set to produce time-sequenced hourly pollutant concentrations. These sequential hourly concentrations allowed realistic 1-hour and 24-hour averages to be generated at each receiver, rather than relying on the simplistic 'worst-case' approach.

To incorporate the background dust level in the area and the cumulative dust impacts from other construction activities, a dust level of 80 μgm^{-3} was added to the predictions for 1-hour and 24-hour average TSP levels. Calculations of the dust emission factors for different activities are tabulated in Table CO_EMT4.XLS in Appendix B.

3.4.2 Impacts on Sensitive Receivers

Table 3.4 shows the predicted maximum 1-hour and maximum 24-hour average TSP concentrations at the selected sensitive receivers during the construction phase.

Dust levels at all sensitive receivers were predicted by modelling to comply with the 1-hour average TSP guideline level and the 24-hour average TSP AQO. These values are considered conservative, because the model did not fully account for topography and some receivers were considerably higher than the sources. The EM&A programme will indicate if acceptable levels are exceeded. R3CC will then work with EPD to evaluate the need for additional mitigation measures.

The results also show considerable differences in the dust levels (particularly 1-hour TSP) at the SRs at Pink/Golden Villas. This is due to a wide range of distances between the SRs and the stockpiling area (i.e 140 to 250 m). Fast deposition of dust also contributed to the differences in dust levels at different SRs.

The construction of the Conveyor System will require small cuttings (up to 12 m) at four sites. Excavated spoil will be kept on site and used as fill material for cut and cover sections. This may cause temporary dust nuisance to the isolated receiver at Sham Tseng Tsuen. However, due to the small scale of construction activity in the area and the proposed mitigation measures (Section 3.6), dust levels would be kept within guideline and statutory AQO limits.

Table 3.4 Predicted TSP Concentrations at SRs During the Construction Phase with the Adoption of Dust Suppression Measures

Receiver	Floor	TSP Concentration (with background) (microgram per cubic metre)	
		Max 1-hour	Max 24-hour
A	G/F	339	159
A	1/G	339	159
B	G/F	407	180
B	1/F	407	180
C	G/F	226	130
C	1/F	226	130
C	2/F	226	130
D	G/F	232	132
D	1/F	232	132
D	2/F	232	132
E	G/F	240	135
E	1/F	240	135
E	2/F	240	135
F	G/F	259	136
F	1/F	259	136
F	2/F	259	136
G	G/F	283	137
G	1/F	283	137
G	2/F	283	137
H	G/F	318	144
H	1/F	318	144
H	2/F	318	144
I	G/F	89	83
J	G/F	168	93

3.5 Operational Phase

3.5.1 Assessment Methodology

Dust Emissions

The major pollutant of concern from the operation of the Conveyor System is particulate matter (dust). Vehicle and plant exhaust emissions should not constitute a considerable source of air pollutants. Dust emission sources include the following:

- Loading of material from main conveyor onto stockpile
- Loading of material from conveyors onto barges
- Wind erosion from loading conveyors
- Wind erosion of stockpile
- Wind erosion of open site

Dust emissions were predicted based on typical values and emission factors from USEPA *Compilation of Air Pollutant Emission Factors (AP-42)*. The material to be moved is mainly crushed granite, but no reference data for silt content was available on this. Material silt content was taken as 1.6%, which is the geometric mean for crushed limestone in stone quarrying and processing from *AP-42*. The actual silt content is likely to be lower. Site investigation by the contractor reveals that the majority of the material has a moisture content of 3 to 4% and 3.5% was taken in this assessment. In addition, prior to reaching the main conveyor the spoil will have been processed close to the South Portal in a crushing facility using water curtains and sprays. This will result in a reduction of silt content and an increase in moisture content. Rainfall data were taken from the Royal Observatory weather records. Average wind velocity was calculated from the wind data of the Shell Tsing Yi Installation meteorological station.

The conveyor and barge loading will operate 16 hours per day from 0700 to 2300 hr. The conveyor will transport spoil at a maximum rate of 3,000 tonnes per hour. The whole length of the main conveyor will be covered with steel boards on the top and secured dust curtains on the sides. The drop height for loading the material from the main conveyor onto the stockpile was assumed to be not more than 15 m. The drop height for transfering the material from the underground conveyor to the barge was assumed to be not more than 5 m. Table 3.5 presents the predicted quantities of dust generated each day from different activities. Loading material from the main conveyor onto the stockpile is apparently the most dusty activity.

Table 3.5 Predicted Dust Emissions During the Operational Phase of the Conveyor System

Activity	TSP (kg day^{-1})
Loading of material from main conveyor onto stockpile	27
Loading of material from conveyors onto barges	9
Wind erosion from loading conveyors	0.02
Wind erosion of stockpile	0.76
Wind erosion of open site	0.78
Total emission	38

Dispersion Modelling

The same model for construction impact assessment described in Section 3.4.1 was used for predicting dust dispersion. Calculations of the dust emission factors for different activities are tabulated in Table OP_EMT5.XLS in Appendix A.

3.5.2 Impacts on Sensitive Receivers

Table 3.6 shows the predicted maximum 1-hour and 24-hour average TSP concentrations at the selected sensitive receivers.

The results show considerable differences in the dust levels at the SRs at Pink/Golden Villas. This is due to a wide range of distances between the SRs and the stockpiling area (i.e 140 to 250 m). Fast deposition of dust also contributed to such differences.

Dust levels at all selected sensitive receivers were predicted by modelling to comply with the 1-hour average TSP guideline level and the 24-hour average TSP AQO. Because of possible variation in the moisture content of the material to be handled by the Conveyor System, a spray curtain will be installed at the head of the main conveyor to reduce the dust impacts. The spray curtain provides a physical seal to cover the whole dropping distance from the head of the main conveyor down to the stockpile and effectively prevents dust from escaping to the environment. Such spray systems at transfer points and on material handling operations have been estimated to reduce emissions by 70% to 95% according to *AP-42*.

3.6 Mitigation Measures

Modelling has shown that dust emissions from both the construction and operational phases of the Conveyor System will comply with the 1-hr TSP guideline and 24-hr TSP AQO limits. Nevertheless, R3CC has committed to the following dust suppression measures to reduce dust nuisance:

- Cover the main conveyor with a steel roof and canvas sides.
- Water site roads and open site areas regularly (during construction).
- Install a spray curtain of water/surfactant at the drop point from the conveyor to the

stockpile.

- Minimise the drop heights from the conveyor to the stockpile and from the stockpile to the barges.
- Provide a vehicle wash facility (during construction).
- Use water spray curtains at the drop point from the loading conveyors to the barges.

The following additional mitigation measures would be implemented if air quality monitoring determines that they are necessary:

- Wet exposed stockpile areas with water spray.
- Install side enclosure and cover aggregate or dusty material storage piles
- Restrict the Conveyor System access road to service traffic only and locate site exit points away from sensitive receivers.

3.7 Conclusion

Dust levels at representative sensitive receivers during the construction and operation of the Conveyor System were predicted to comply with guideline and AQO limits. R3CC is committed to a number of mitigation measures to minimise dust nuisance and will implement additional measures should environmental monitoring and audit reveal that these are necessary.

Table 3.6 Predicted TSP Concentrations at Sensitive Receivers During the Operational Phase

Receiver	Floor	TSP Concentration (with background) (microgram per cubic metre)	
		Max 1-hour	Max 24-hour
A	G/F	221	166
A	1/G	223	166
B	G/F	281	205
B	1/F	287	206
C	G/F	202	154
C	1/F	174	136
C	2/F	137	114
D	G/F	207	158
D	1/F	185	143
D	2/F	146	119
E	G/F	207	158
E	1/F	193	148
E	2/F	153	123
F	G/F	191	149
F	1/F	189	146
F	2/F	154	125
G	G/F	162	132
G	1/F	171	136
G	2/F	148	122
H	G/F	136	116
H	1/F	150	126
H	2/F	137	118
I	G/F	81	81
J	G/F	107	91

4 NOISE

4 NOISE

4.1 Legislation

The Noise Control Ordinance (NCO) provides for the control of construction noise. Assessment procedures and standards are set out in two *Technical Memoranda (TM)* associated with the Ordinance: the *Technical Memorandum on Noise from Construction Work other than Percussive Piling* and the *Technical Memorandum on Noise from Percussive Piling.* The former is relevant for this assessment.

Under the existing provisions, there is no control of noise from powered mechanical equipment (PME) other than percussive piling equipment between the daytime hours of 0700 and 1900 on normal weekdays. However, EPD has suggested in Practice Note PN 2/93 (issued May 1993) a daytime noise limit of 75 dB(A) $L_{eq\ (30\ min)}$ at the facades of NSRs. For activities outside the hours of 0700 to 1900, contractors are required to obtain a Construction Noise Permit (CNP). The applicable noise limits for the noise sensitive receivers (NSRs) are given in the Table 4.1.

Table 4.1 Acceptable Noise Limits

Time Period	Acceptable Noise Level dB(A)	
	Pink/Golden Villas	Isolated NSR on Sham Tseng Tsuen
All days during the evening (19.00-23.00), and general holidays and Sundays during the daytime and evening (07.00-23.00)	65	60

Construction of the Conveyor System and its operation are both under the control of construction noise in the NCO, which defines construction work as "any work in connection with or for the construction... of the whole or any part of any...tunnel... or any road, slope, embankment...", or "any work in connection with or for the extraction from the earth of any matter whatsoever."

4.2 Existing Background Noise

As reported in the EACS, the ambient noise near Pink Villas was dominated by the traffic along Castle Peak Road, with a minor contribution from Tuen Mun Road. Daytime spot noise measurements were carried out near Pink Villa producing the following results (Table 4.2).

Table 4.2 Background Noise Measurements near Pink Villa

Monitored Noise Level dB(A)			
$L_{10\ (5\ min)}$	$L_{50\ (5\ min)}$	$L_{90\ (5\ min)}$	$L_{eq\ (5\ min)}$
75	61	56	71

NOTE: From Table 3.2 in *Route 3 Preliminary Design Stage 2: TLT & YLA Environmental Impact Assessment (Conveyor System Supplementary Paper)*. Noise measurements taken at roadside, Castle Peak Road, during daytime

The L_{90} of 56 dB(A) indicates a low background noise level. Traffic noise on Castle Peak Road dominates the noise environment.

No baseline noise information for the Sham Tseng Tsuen area is available. However, the ambient noise condition is currently under investigation.

4.3 Noise Sensitive Receivers

Most of the NSRs in the area are either located at a considerable distance from the Conveyor System, or are screened by topography. Potential NSRs that have been identified that are likely to be affected by noise from the construction and operation of the Conveyor System and barging point are shown in Figure 4.1.

- Pink Villa (which includes two units known formerly as "Golden Villas") is a small development of eight 2-storey residential units atop a steep slope overlooking Castle Peak Road.
- An isolated dwelling northeast of (and accessible from) Sham Tseng Tsuen is located in a quiet valley, shielded from Tuen Mun Road by topography.
- Homi Villa, located close to the barging point, is a former residential property currently undergoing renovation into an observation point for the Lantau Fixed Crossing. It is no longer considered a noise sensitive receiver.
- A Marine Traffic Control Station is proposed at Gemini Point (south of Homi Villa), but is not considered a noise sensitive receiver as it will be air-conditioned.

4.4 Assessment Methodology

The noise from construction and operation of the conveyor and the stockpile barging point was calculated using the procedures outlined in the *TM on Noise from Construction Work other than Percussive Piling*. It should be noted that the procedures assume complete utilisation of all equipment over the whole period, and do not take into account noise attenuation through topography and vegetation. Resulting predictions are therefore considered conservative.

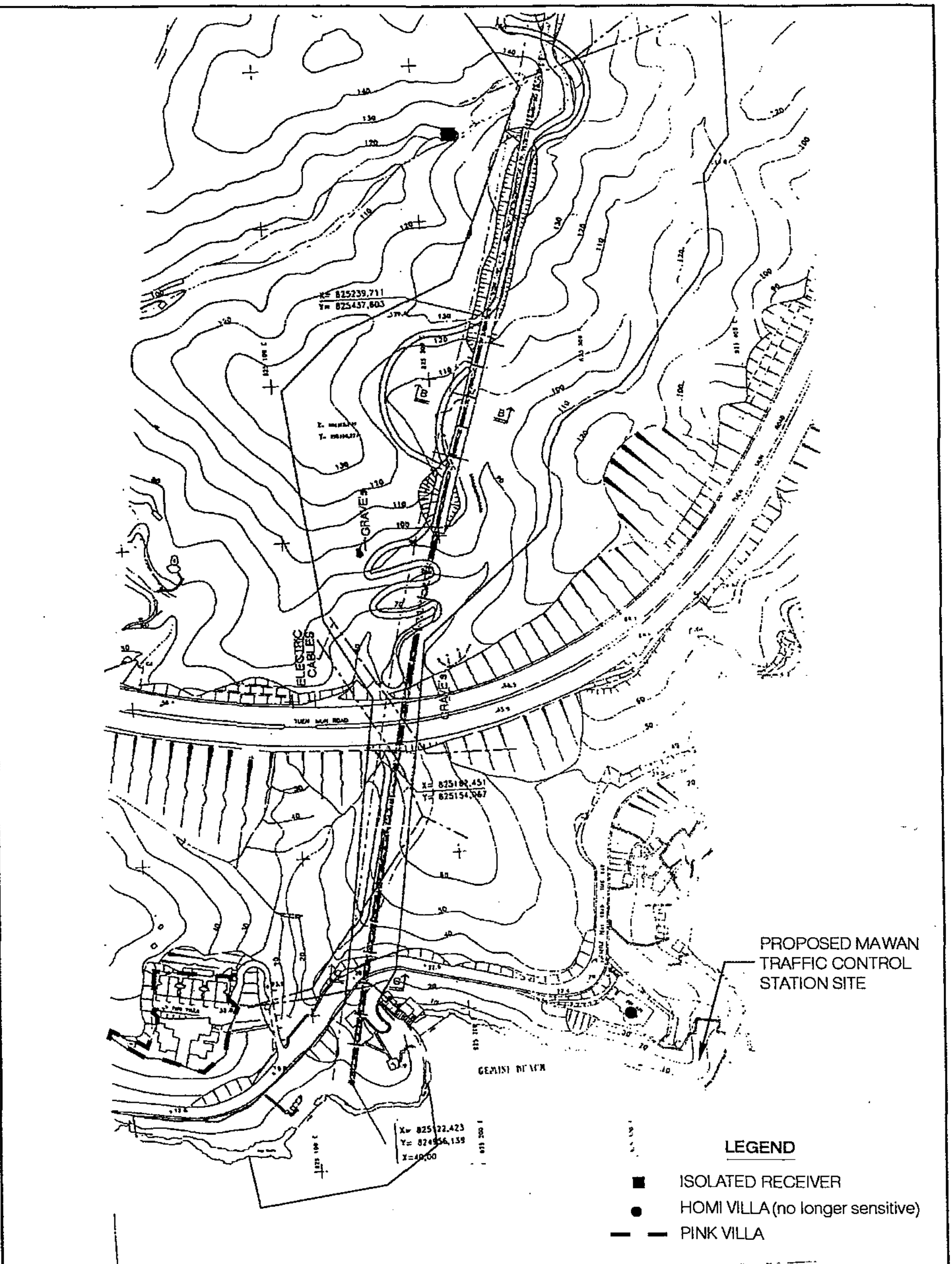

Figure 4.1 Potential Noise Sensitive Receivers

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4.5 Potential Impacts During Construction of the Conveyor

4.5.1 Construction Methods

Construction of the Conveyor System

Construction of the conveyor system will entail the following tasks:

- Formation of a maintenance/access track
- Construction of foundations and erection of supports for the Conveyor System
- Installation of conveyor components.

Evening and night time construction works are not expected except during erection of the conveyor span over Tuen Mun Road and Castle Peak Road. These activities should not impact concurrently on the SR's.

A. Formation of the maintenance/access track: Formation of the access track will involve site clearance and earthworks to form the roadbed, road formation, and finishing. Proposed equipment are presented in Table 4.3.

Table 4.3 Conveyor Maintenance/Access Road: Construction Tasks and Equipment

Construction Task	PME Requirements: Equipment, Number, and Assumed SWL (dB(A))		
Site clearance/excavation	Bulldozer (CNP 030)	1	115
	Excavator/loader (CNP 081)	2	112
	Dumptruck (CNP 067)	4	117
Road formation/levelling	Grader (CNP 104)	1	113
	Vibratory roller (CNP 186)	1	108

B. Foundation for the Conveyor System: Supports for the Conveyor System will require foundations made up of concrete spread footings at intervals of about 20 m. The need for piling is not anticipated. Installation of the footings will require clearing the ground, excavating, fixing reinforcement, concreting and backfilling. Construction tasks and proposed equipment are presented in Table 4.4.

Table 4.4 Conveyor Foundations: Construction Tasks and Equipment

Construction Task	PME Requirements: Equipment, Number, and Assumed SWL (dB(A))		
Site clearance/excavation	Excavator/loader (CNP 081)	2	112
	Dumptruck (CNP 067)	2	117
Reinforcement	Mobile crane (CNP 048)	1	112
	Compressor (CNP 002)	1	100
	Bar bender/cutter (CNP 021)	1	90
Concreting	Concrete mixer truck (CNP 044)	2	109
	Vibratory poker (CNP 170)	2	113
Backfilling	Roller (CNP 185/186)	1	108

C. Placement of Conveyor System components: The support structures for the Conveyor System will be built on the foundations, using trucks to deliver the components and cranes to place them. The structure may be secured using a rock drill and hand-held equipment (Table 4.5).

Table 4.5 Conveyor System Support Placement: Construction Tasks and Equipment

Construction Task	PME Requirements: Equipment, Number, and Assumed SWL (dB(A))		
Delivery of components	Lorry (CNP 141)	1	112
Placement of components	Mobile crane (CNP 048)	1	112
Securing of structural elements	Rock drill (CNP 183)	1	116
	Power pack for hand-held items of PME (CNP 168)	3	100

The conveyor deck and belt will be delivered by trucks and placed using cranes. Components may be assembled using hand-held equipment (Table 4.6).

Table 4.6 Conveyor Deck and Belt Placement: Construction Tasks and Equipment

Construction Task	PME Requirements: Equipment, Number, and Assumed SWL (dB(A))		
Delivery of components	Lorry (CNP 141)	1	112
Placement of components	Mobile crane (CNP 048)	1	112
Assembly of components	Power pack for hand-held items of PME (CNP 168)	3	100

Construction of Barging Point Seawall

The construction of the barging point will involve filling of the platform and construction of a seawall. The following tasks and equipment are anticipated (Table 4.7).

Table 4.7 Barging Point Seawall: Construction Tasks and Equipment

Construction Task	PME Requirements: Equipment, Number, and Assumed SWL (dB(A))		
Mobilisation	none	---	---
Sloping seawall (rock)	Derrick barge (CNP 061)	1	104
	Tugboat (CNP 221)	1	110
Platform filling (sand)	Dumptrucks (CNP 067)	8	117

The platform for the stockpile and loading conveyors will be built of concrete. Equipment to be used is listed in Table 4.8.

Table 4.8 Barging Point Platform: Construction Tasks and Equipment

Construction Task	PME Requirements: Equipment, Number, and Assumed SWL (dB(A))		
Delivery	Concrete mixer truck (CNP 044)	1	109
Placement	Concrete pump (CNP 047)	1	109
Consolidation	Compressors (CNP 002)	1	100
	Poker vibrators (CNP 170)	2	113

The conveyors and hoppers that will permit spoils from the stockpile to be loaded on the barges will be delivered, placed using a mobile crane, then assembled (Table 4.9).

Table 4.9 Barging Point Conveyor System Placement: Construction Tasks and Equipment

Construction Task	PME Requirements: Equipment, Number, and Assumed SWL (dB(A))		
Delivery of components	Derrick barge (CNP 061)	1	112
Placement of components	Mobile crane (CNP 048)	1	112
Assembly of components	Power pack for hand-held items of PME (CNP 168)	3	100

Decommissioning of Barging Point

Backfill will be removed first and transported onto derrick barges. The seawall and embankments will then be removed. This will involve the removal of pell mell rubble, geotextiles, precast blocks and levelling and berm stones. Equipment requirements are shown in the following Table 4.10:

Table 4.10 Decommissioning of Barging Point: Tasks and Equipment

Construction Task	PME Requirements: Equipment, Number, and Assumed SWL (dB(A))		
Backfill removal	24-tonne dumptrucks (CNP 067)	2	117
	Excavator/loaders (CNP 081)	2	112
	Derrick barge (CNP 061)	1	104
	Tugboat (CNP 221)	1	110
Seawall and embankment removal	Derrick barge (CNP 061)	1	104
	Tugboat (CNP 221)	1	110

4.5.2 Impact Assessment and Mitigation Measures

Predicted facade noise levels, based on the above equipment requirements, are provided below. Where predicted noise levels exceed the daytime guideline and evening NCO criteria, possible mitigation measures to reduce noise to acceptable levels are discussed.

Construction of the Conveyor System

A. Formation of Maintenance/Access Track: Predicted noise levels at the NSRs are presented in Table 4.11.

Table 4.11 Conveyor Maintenance/Access Road: Unmitigated Noise Level

Construction Activity	Facade Noise Level (L_{eq})			
	Pink Villa		Isolated Sham Tseng Tsuen Residence	
	Closest distance	L_{eq} dB(A)	Closest distance	L_{eq} dB(A)
Site clearance/excavation	80 m	80	49 m	85
Road formation/levelling	80 m	70	49 m	75

The main contributor to the high noise level associated with the site clearance and excavation is the use of 4 dumptrucks, each assumed to operate at 117 dB(A) according to the *Technical Memorandum*. The contractor will use 20- and 24-tonne dumptrucks for this work, an SWL of 105 dB(A) can be assumed in accordance with the monitored noise levels for 20-tonne and 24-tonne dumptrucks reported in Table 12 (items 19-24) of *BS 5228 (Noise control on construction and open sites).*

- *Pink Villa:* With a sound power level (SWL) of 105 dB(A) for 20- and 24-tonne dumptrucks, a facade noise level of 75 dB(A), appropriate for daytime activity, was predicted to be achieved near Pink Villa.

- *Isolated NSR:* Even with the use of 20- to 24-tonne dumptrucks, the facade noise level at the isolated NSR would be over 75 dB(A) as long as the group of PME remains within about 80 m. This high residual noise level is mainly attributable to the use of a bulldozer. Thus, additional mitigation measures will be needed to achieve the daytime criterion of 75 dB(A) along a 200-m section of the access road passing nearest this isolated NSR.

  The TM methodology assumes that all items of PME are operating at all times. In practice, the proportion of time during which PME is actually operating is less than 100 percent, and can be controlled to reduce monitored noise levels. To achieve compliance with the 75 dB(A) daytime guideline limit, R3CC will reduce the actual operating times of PME to 40% (i.e., about 12 minutes in a given 30-minute period) while working along the 200-m section of the access road passing the isolated NSR.

Daytime activities associated with the road formation and levelling were predicted to generate noise levels less than the 75 dB(A) criterion.

B. Foundation for the Conveyor System: Predicted noise levels at the NSRs are presented in Table 4.12.

Table 4.12 Conveyor Foundations: Unmitigated Noise Level

Construction Activity	Facade Noise Level (L_{eq})			
	Pink Villa		Isolated Sham Tseng Tsuen Residence	
	Closest Distance	L_{eq} dB(A)	Closest distance	L_{eq} dB(A)
Site clearance/excavation	80 m	77	49 m	82
Reinforcement	80 m	69	49 m	73
Concreting	80 m	74	49 m	78
Backfilling	80 m	64	49 m	69

Site clearance and excavation: The main contributor to the high noise level associated with this activity is the use of 2 dumptrucks, each assumed to operate at 117 dB(A) according to the *Technical Memorandum*. The contractor will use 20- and 24-tonne dumptrucks for this work, an SWL of 105 dB(A) can be assumed in accordance with the monitored noise levels for 20-tonne and 24-tonne dumptrucks reported in Table 12 (items 19-24) of *BS 5228 (Noise control on construction and open sites).*

- *Near Pink Villa:* With a reduced sound power level (SWL) of 105 dB(A) for dumptrucks, a facade noise level of 75 dB(A), appropriate for daytime activity, was predicted to be achieved.

- *Near isolated NSR:* Even with the use of 20- and 24-tonne dumptrucks, the facade noise level at the isolated NSR is over 75 dB(A) as long as the group of PME remains within about 55 m of the isolated NSR. Thus, additional measures are required. R3CC will reduce the number of operating excavators from 2 to 1 which will achieve a facade noise level of 74 dB(A). Alternatively, quietened equipment can be used when excavating the two closest supports. For example, reducing the SWL of the excavators from 112 dB(A) to 110 dB(A) will allow the full set of the above mentioned equipment to operate within the daytime noise limit of 75 dB(A) near this NSR.

Reinforcement activity: No exceedance of daytime noise levels was predicted.

Concreting activity: The impacts of this activity differ at the two NSRs under consideration.

- *Near Pink Villa:* No exceedance of daytime noise levels was predicted.

- *Near isolated NSR:* To meet the daytime noise criterion of 75 dB(A), it is necessary to reduce equipment levels from two each to one each.

Backfilling: No exceedance of the daytime criterion was predicted at Pink Villa or the isolated NSR.

<u>C. Placement of Conveyor System</u>; Predicted noise levels at the NSRs are presented in the following Table 4.13.

Table 4.13 Placement of Conveyor System Supports, Deck and Belt: Unmitigated Noise Level

Construction Activity	Facade Noise Level (L_{eq})			
	Pink Villa		Isolated Sham Tseng Tsuen Residence	
	Closest distance	L_{eq} dB(A)	Closest distance	L_{eq} dB(A)
Conveyor System Supports:				
Delivery of components	80 m	68	49 m	73
Placement of components	80 m	68	49 m	73
Securing of structural elements	80 m	73	49 m	77
Conveyor Deck and Belt:				
Delivery of components	80 m	68	49 m	73
Placement of components	80 m	68	49 m	73
Assembly of components	80 m	61	49 m	66

Near Pink Villa: No activities were predicted to generate noise exceeding the daytime guideline. However, during the evening, restrictions will be necessary. Noise from construction activities is controlled by the Noise Control Ordinance between the hours of 19:00 and 07:00. For example, delivery and placement of components should not be carried out closer than 120 m to Pink Villa during the evening. The use of exceptionally loud equipment, such as the rock drill for securing of the conveyor supports, will be subject to the conditions set down in the grant of the Construction Noise permit and will therefore either not be used or strictly controlled (by screening or reducing the on-time). The Noise Control Ordinance will be fully complied with.

Near isolated NSR: Only prolonged use of a rock drill for securing of structural elements was predicted to result in exceedances of the daytime noise guideline. As the use of the rock drill is restricted to brief periods, the daytime noise guideline is achievable.

Construction of Barging Point

Predicted noise levels at the NSRs associated with this activity are presented in the following Table 4.14.

Table 4.14 Barging Point Construction: Unmitigated Noise Levels

Construction Activity	Facade Noise Level (L_{eq})	
	Pink Villa	
	Closest Distance	L_{eq} dB(A)
Sloping seawall	80 m	67
Platform filling	75 m	83

Only platform filling was predicted to generate noise exceeding the daytime criterion at Pink Villa. The high noise level associated with filling is the result of using 8 dumptrucks, each operating at 117 dB(A) according to the *Technical Memorandum*. The contractor will use 20- and 24-tonne dumptrucks for this work, an SWL of 105 dB(A) can be assumed in accordance with the monitored noise levels for 20-tonne and 24-tonne dumptrucks reported in Table 12 (items 19-24) of *BS 5228 (Noise control on construction and open sites).* With a reduced SWL of 105 dB(A), a facade noise level below 75 dB(A) was predicted.

Evening activity will require the adoption of mitigation measures for both activities. Noise reduction measures for the tugboat, such as the use of accoustic muffling around the engine housing and exhaust which are capable of reducing the SWL from 110 dB(A) to 107.5 dB(A), will be adopted or strict controls will be placed on their use. During filling, only two 20- or 24-tonne dumptrucks will be used in the evening.

The isolated residential NSR near Sham Tseng Tsuen is well shielded by topography from the noise of barging point construction or operation.

Decommissioning of Barging Point

Predicted noise levels associated with this activity are presented in the following Table 4.15. Only Pink Villas is considered, since the isolated NSR near Sham Tseng Tsuen is shielded by topography and distance from barging point noise.

Table 4.15 Decommissioning of Barging Point: Unmitigated Noise Levels

Activity	Facade Noise Level (L_{eq})	
	Pink Villa	
	Closest Distance	L_{eq} dB(A)
Backfill removal	75	79
Seawall and embankment removal	80	67

Backfill removal was predicted to generate noise exceeding the daytime criterion at Pink Villa. The high noise level associated with this activity is primarily the result of using dumptrucks, each assumed to operate at 117 dB(A) according to the *Technical*

Memorandum. The contractor will use 20- and 24-tonne dumptrucks for this work, an SWL of 105 dB(A) can be assumed in accordance with the monitored noise levels for 20-tonne and 24-tonne dumptrucks reported in Table 12 (items 19-24) of *BS 5228 (Noise control on construction and open sites)*. With a reduced SWL of 105 dB(A), a facade noise level below 75 dB(A) was predicted.

The need for evening activity is not anticipated, since decommissioning does not form part of the critical path in the construction programme.

The isolated residential NSR near Sham Tseng Tsuen is well shielded by topography from the noise at the barging point.

Summary of Mitigation Measures

The mitigation measures discussed above are summarised in Table 4.16.

Table 4.16 Summary of Committed Mitigation Measures during Conveyor System Construction

Task	NSR	Mitigation Measures
Maintenance/Access Road: Site clearance and excavation	Pink Villa	20- and 24-tonne dumptrucks (105 dB(A))
	Isolated NSR	20- and 24-tonne dumptrucks (105 dB(A)) and construction management to reduce "on-time" to 40 percent while operating within 200 m of the isolated NSR
Conveyor Foundations: Site clearance and excavation	Pink Villa	20- and 24-tonne dumptrucks (105 dB(A))
	Isolated NSR	20- and 24-tonne dumptrucks (105 dB(A)) and either reduced number of excavators (from 2 to 1) or quietened excavators (110 dB(A))
Conveyor Foundations: Concreting activity	Isolated NSR	Reduce numbers of operating equipment from 2 each to 1 each
Construction of Barging Point: Platform filling (daytime)	Pink Villa	20- and 24-tonne dumptrucks (105 dB(A))
Construction of Barging Point: Sloping seawall (evening)	Pink Villa	Quietened tugboats (107.5 dB(A)) Restrictions to 2 20- or 24- tonne dumptrucks operating
Construction of Barging Point: Platform filling (evening)	Pink Villa	20- and 24-tonne dumptrucks (105 dB(A)) and reduced number of dumptrucks (from 8 active to 2 active)
Decommissioning of Barging Point	Pink Villa	20- and 24-tonne dumptrucks (105 dB(A))

4.6 Operational Activities Along the Conveyor

4.6.1 Operational Activities and Equipment

A conveyor will transport spoil from the main cutting near the tunnel to a jetty at Gemini Beaches. Excavated spoils will be stockpiled at the jetty and removed by barge.

The Tender Document states that a single continuous belt will be used. The conveyor will be completely enclosed within a fixed structure where it passes over Tuen Mun Road and Castle Peak Road, and where it passes below grade. At other points along its alignment, it will be covered by a steel roof and canvas sides to allow for control of dust while maintaining access. It will operate 16 hours a day from 0700 to 2300 hours. The conveyor belt will be driven by an engine located in an enclosed drive house at the main conveyor head near the main cut.

To carry the spoil away from the jetty, a fleet of barges will be employed with an approximate capacity of 2,500 tonnes. There will be one barge about every 30 minutes. Only one barge can be loaded at any one time. Due to swift currents, a barge will not berth when the barging point is already occupied, and only one barge will be manoeuvered at the barging point at one time. Loading activity will take place between 0700 and 2300 hrs every day. Each barge will be towed by one tugboat with a proposed power of 855 HP.

4.6.2 Predicted Noise Impact: Conveyor

The supplier has measured the noise from the conveyor at about 60 dB(A) at a distance of 20 m from the belt. The belt was 850 m in length (most of which was visible at the measurement location) and 1.5 to 2 m above ground. During measurement, the conveyor was laden and operating at a speed of 2 to 3 ms^{-1}. The noise meter was located less than 2 m in front of a reflective surface, so that the monitoring result represents a facade noise level. On the basis of the manufacturer's measurement, an approximate conveyor SWL of 74 dB(A) was adopted for this assessment.

The conveyor passes within about 80 m of Pink Villa, and is covered as it passes over Castle Peak Road. At the isolated NSR near Sham Tseng Tsuen, only a short 60-m segment of the covered conveyor is above ground. In the assessment, the conveyor is treated as a line source. Anticipated facade noise levels due to operation of the conveyor are shown in the following Table:

Table 4.17 Impact of Conveyor Noise

NSR	Facade Noise Level (L_{eq})	
	Closest Distance	L_{eq} dB(A)
Isolated NSR	49 m	55
Pink Villas[1]	83 m	54

NOTE: [1] Total facade noise level at Pink Villas during operation of the Conveyor System includes additional contributions from other sources. See next section on barging point noise.

4.6.3 Predicted Noise Impact: Barging Point

Equipment requirements for barging point operations are as shown in the following table:

Table 4.18 Barging Point Equipment

Task	Requirements: Equipment, Number, and Assumed SWL (dB(A))		
Transport of spoil to jetty	Conveyor system	1	76
Removal of spoil from jetty	Tugboat (CNP 221)	1	110
	Barge	1	nil

In addition, the operation of the stockpile will involve noise from sources other than the PME listed in Table 4.18. An assessment of the noise arising from the barging point operation (excluding the main conveyor and barge movement) was undertaken by others, taking into account the noise from barge loading. (Excerpts from that study are included as Appendix C). That study found that the barging point loading is expected to generate a facade noise level of 64 dB(A) at Pink Villas.

Anticipated facade noise levels due to operations at the jetty are shown in the following table:

Table 4.19 Impact of Jetty Operations

NSR	Facade Noise Level (L_{eq}), dB(A)	
	Barge Loading	Barge Manoeuvering
Pink Villas[1]	64	63

NOTE: [1] Total facade noise level at Pink Villas during operations at the jetty includes an additional contribution from the conveyor. See next section on cumulative impacts.

4.6.4 Predicted Cumulative Noise Impact: Conveyor and Barging Point Operation

Cumulative noise levels at Pink Villa due to conveyor operation and the barging point activities are predicted in the following table:

Table 4.20 Barging Point Operation: Predicted Noise Levels

Activity	Facade Noise Level (L_{eq})	
	Pink Villa	
	Closest Distance	L_{eq} dB(A)
Barge Loading		
Conveyor	83 m	54
Spoil transferring from stockpile to barge		64[1]
	Total	65
Manoeuvering of Empty/Laden Barge		
Conveyor	83 m	54
Tugboat	120 m	63
	Total	64

NOTE: [1] From study prepared by others. See Appendix C.

Calculations show that noise level at Pink Villa from barging point activities comply with daytime guideline limit and the NCO limit for evening hours. Noise monitoring will be conducted regularly during the operation of the conveyor system and barging point to check actual operating noise levels. A CNP will be required for evening operations.

4.6.5 Mitigation Measures

During operation, mitigation measures include:

- restricting the conveyor operating hours to between 0700 - 2300 and subsequent use of barges and tugs;

An EM&A programme will be carried out at the isolated receiver & Pink/Golden Villa (see Volume 3).

Construction Noise Permits (CNPs) will be required for construction works involving the use of powered mechanical equipment between the hours of 7 pm and 7 am or at any time on a general holiday (including Sundays). The CNP is a statutory document, issued under Section 8 of the Noise Control Ordinance, and may impose conditions such as permitted hours of operation, type and number of equipment items allowed to be used, noise control measures to be adopted, and any other measure deemed necessary by the Noise Control Authority in order to protect nearby noise sensitive receivers from excessive noise exposure.

4.7 Conclusion

During the construction and operation of the Conveyor System, noise levels at the sensitive receivers were predicted to comply with the 75 dB(A) daytime guideline limit with implementation of committed mitigation measures. These measures include the use of 20- or 24-tonne dumptrucks, reduction of equipment operating time on site when near sensitive receivers, reduction of the number of plant items (e.g. dumptrucks and excavators) deployed especially during evening hours, and use of quietened tugs during construction of the Conveyor System. During operation, conveyor noise, noise at the barge point as well as the cumulative noise from conveyor and barge point were predicted to meet daytime guideline and evening NCO limits. Construction Noise Permits will be required for work in the evening. R3CC will comply with CNP conditions. Noise monitoring will be carried out as part of the EM&A programme at the sensitive receivers.

5 WATER QUALITY

5 WATER QUALITY

5.1 Legislation

The control of water quality in Hong Kong is mainly governed by the Water Pollution Control Ordinance (WPCO) which was enacted in 1980 and amended in 1990. This legislation enables the Government to declare Water Control Zones (WCZ) within which discharge of effluent is controlled through licenses, and to establish WQOs for each zone or subzone.

A TM issued in 1990 under the WPCO is used as a guide for setting standards in licenses for effluent discharged to foul sewers, storm water drains, inland and coastal waters within WCZs. The study area is located in the Western Buffer WCZ. Standards for effluent discharged into the inshore waters of the Western Buffer WCZ are summarized in Table 5.1.

Table 5.1 TM Standards for the Western Buffer Water Control Zone

Determinand	Standard[1]
pH (pH unit)	6 - 9
Temperature (degree Celsius)	40
Suspended Solids (mg l^{-1})	30
Biochemical Oxygen Demand (mg l^{-1})	20
Chemical Oxygen Demand (mg l^{-1})	80
Oil & Grease (mg l^{-1})	20
Sulphide (mg l^{-1})	5
Total Nitrogen (mg l^{-1})	100
Total Phosphorus (mg l^{-1})	10
Total Surfactants (mg l^{-1})	15
E. coli (count per 100 ml)	1000

5.2 Existing Condition and Sensitive Receivers

5.2.1 Marine Water

There are several gazetted bathing beaches along the stretch of coast. The Gemini Beaches and Hoi Mei Wan are in close proximity to the barge jetty and may be affected by the proposed works. One of the Gemini Beaches (on the west) will be lost and filled up as the stockpile area. This beach will be reinstated after the Conveyor System is decommissioned.

Gemini Beach was graded by the EPD as "acceptable" in 1990 and "poor" in 1992, 1993 and 1994 based on bacteria concentrations and associated health risk level. According to the EPD report on *Bacteriological Water Quality of Bathing Beaches in Hong Kong 1994,* the ranking of beaches at Tsuen Wan should remain poor until the provision of sewerage and a new treatment facility along the coastal strip between Tsing Lung Tau and Ting Kau, to be commissioned in 1999.

Moreover, it should be recognised that *E. coli* concentration fluctuates greatly in the environment and is also affected greatly by other factors like light intensity, turbidity and weather. In 1994 the *E. coli* counts at Gemini Beaches ranged from a minimum of approximately 40 per 100 ml to a maximum of approximately 4,000 per 100 ml. Bacteria concentration tends to be lower on a sunny day when the mortality rate is high. On the other hand, increase in turbidity will lower the mortality rate of the bacteria resulting in higher concentration. After a first flush of a rainy storm, the bacteria concentration has been found to be very high as most of the pollutants in the drainage system are flushed into the marine environment. In view of the fact that *E. coli* at the Gemini Beaches is already high and there are other cofactors affecting the bacteria concentration, the temporary erection of the jetty is considered not likely to cause considerable deterioration of water quality at the remaining Gemini Beaches.

As a result of the temporary and localised nature of the potential effect of Route 3 on marine water quality and the distance between the the works and the Sham Tseng/Ting Kau Sewerage Improvements and STW, cumulative impacts are not considered in this report.

5.2.2 Fresh Water

There are a number of streams/catchments close to the Conveyor System (Figure 5.1). Streams that will be most affected are the East Stream and West Stream. The former flows in a south-southwesterly direction to Gemini Beaches from a small densely vegetated catchment above Tuen Mun Road. The latter originates in the adjacent catchment to the north which is similar in character and size. It flows in a west to east loop before joining East Stream between Tuen Mun and Castle Peak Roads. After joining together, the stream flows through vegetated southern facing slopes that form the back drop to the western Gemini Beach (Figure 5.2). These streams are normally very shallow and flows are weak in winter.

Several site visits were carried out in the vicinity of the beach to investigate pollutant sources entering the Gemini Beaches. A site visit on 13 June 1995 showed that there was refuse, mainly construction wastes, floating on water close to the shoreline. These wastes were likely generated from other construction sites along the coast and transported to the beach since construction of the jetty had not started in June.

Following a signifcant rainfall event (16 July 1995), it was observed that there was only one source of surface water running along the side of the staircase leading to the eastern Gemini Beach. No sign of pollution (silts/odour/colour) was observed in the surface run-off. There was no squatter or other facilities in the nearby upstream region that may contribute to pollution. During subsequent site visits (21, 22 July 1995), following periods of dry weather, no surface water inflow to the beach was observed. The fresh water surface inflow to the beach is therefore temporary and occurs only for short periods following rainfall events.

At the western Gemini Beach, site visits showed that the main inflow was the stream flowing through vegetated southern facing slopes as mentioned before. Water sample was collected on 20 July near a box culvert below Castle Peak Road (Figure 5.1); preliminary results showed *E. coli* level of 140 count per 100 ml, which is below the TM standard for *E. coli*. Preliminary report is attached in Appendix D.

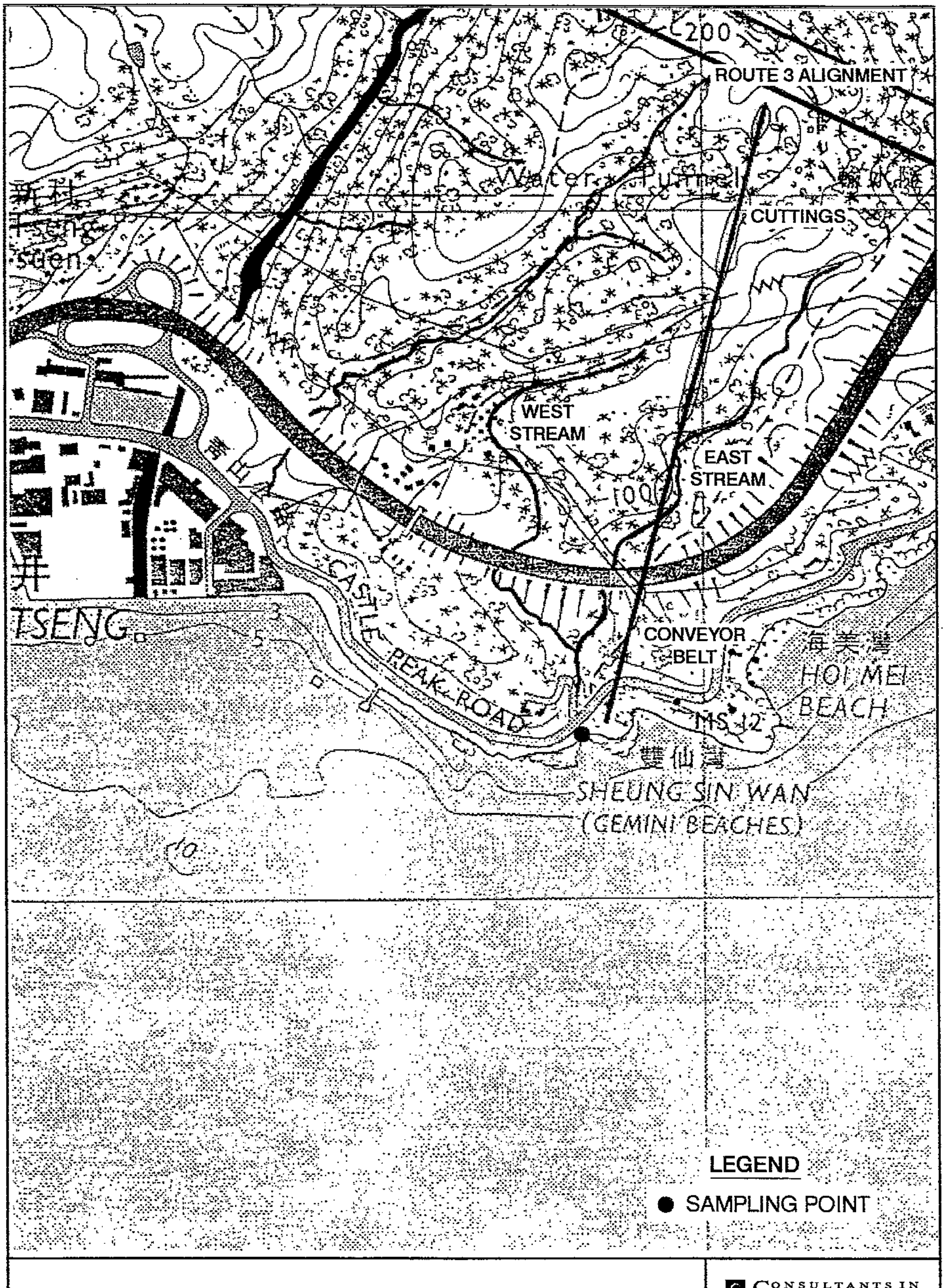

Figure 5.1 Fresh Water Streams in Study Area

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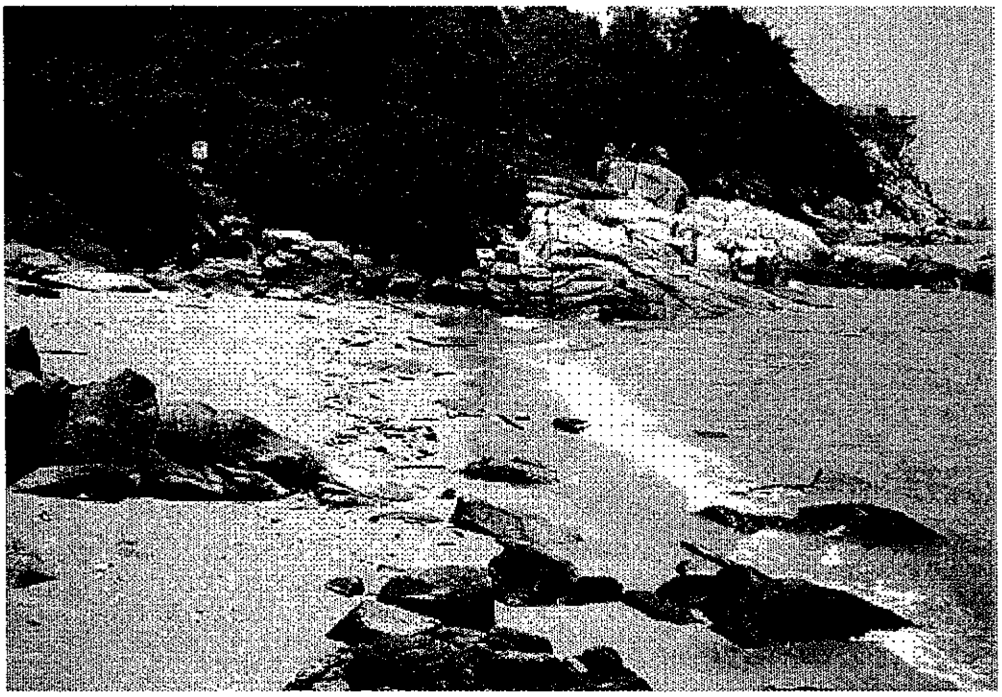

Figure 5.2 Site Visit (13/6) Photos at Western Gemini Beach

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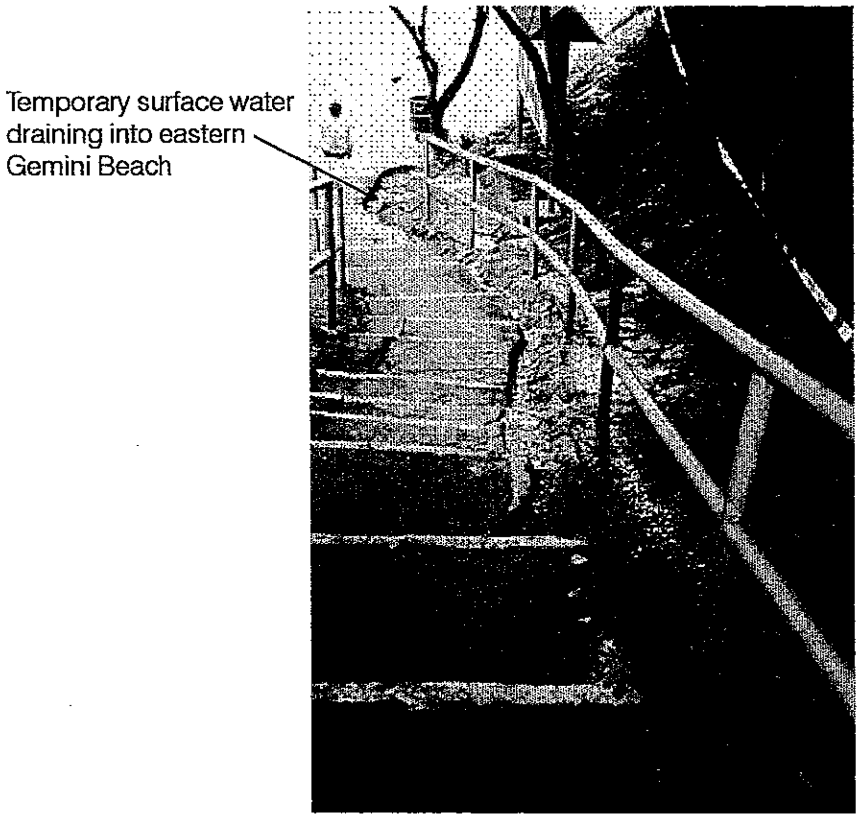

Eastern Gemini Beach

Figure 5.3 Site Visit (16/7/95) Photos at Eastern Gemini Beach

5.3 Potential Impacts of Construction

5.3.1 Marine Water

The details of the proposed stockpile platform construction have been provided in Chapter 2. The stockpile platform will be on fill rather than piles. A small scale of site formation, approximately 5,000 m^2 in area, will be required at the Gemini Beaches. Geological survey results show that the seabed in the site formation area is mostly covered by rock, thus no dredging is needed. A seawall will be built first on the southern boundary. This will take approximately 6 weeks. Two reinforced embankment slopes will be constructed on the two sides of the stockpile platform. Then, fill materials of about 50,000 m^3 will be placed over a two month period.

Since the amount of fill materials is small, and the majority of these materials will be confined and cannot escape into the surrounding marine environment, only a slight increase in suspended solids at close proximities is expected during the construction of the sea wall and embankment slopes. Also, it must be emphasized that the construction impact of this work is only minimal when compared to that from the construction of the Ting Kau Bridge, which has a much larger scale of work spanning over a longer period.

5.3.2 Fresh Water

Generally, stream/catchments will be affected by the construction of the conveyor due to the removal of vegetation causing higher levels of sediments in surface run-off. However a large proportion of the conveyor will be built on a structure, thus minimal vegetation removal should be expected.

Impacts on the fresh water quality would be mainly at the stream catchment areas where cutting takes place. In particular, the East Stream could be affected by the Conveyor System because it will lie amid its catchment area over certain sections (Figure 5.1). If the construction work starts during the rainy season, soil could be washed down into the stream, particularly at the cutting sections. Consequently it could cause a short-term increase in turbidity levels of fresh and marine water receiving bodies.

A small number of plant will be used on the construction site, thus the requirement for chemical storage such as oil, fuel and lubricants should not be substantial. As a result, the chance of spillage and leakages of these chemical will be small. Thus the impact on fresh water should not be of major concern.

5.4 Potential Impacts of Operation

5.4.1 Marine Water

Impact Caused by Operation of the Conveyor System

Generally, the operational impact on marine water quality will be similar to those described in the EACS. It will be associated with the stockpile, the possible spillage of oil and fuel, and dust to the waters surrounding the facility. Water quality impacts as a result of sediment from dust suppression and spoil handling activities are possible.

Impact Caused by the Stockpile Platform - current in the Ma Wan main channel

The stockpile platform lies on a site formed between Sham Tseng and Ting Kau at the northern edge of the main waterway (about 1 km wide and 30 m deep), where the main tidal stream flows through. During flood tide, seawater flows in a northerly direction from the Ma Wan Channel between Ma Wan and Tsing Yi, towards the site for the jetty and then turns west to north Ma Wan towards Urmstrom Road. During ebb tide, water flowing from Urmstrom Road passes north Ma Wan in an easterly direction, the current then turns south and flows through the Ma Wan Channel. At the northern edge of this main channel, water depth (5 - 10 m) is considerably less than that of the main channel. The cross sectional area of the channel cut off by the jetty will be approximately 300 m^2. This represents approximately 1% of the total channel area. Due to the small size of the jetty (roughly 130 m x 40 m) and the geometry of the main water channel, the introduction of the stock pile area should not have a noticeable effect on the main stream tidal current. As a result water quality in the main channel will not be measurably impacted.

However, the small sheltered area already formed at Gemini Beaches by the Hoi Mei headland will be accentuated. In this area the water current is likely to decrease for a duration of 2 to 3 years during the operation of the Conveyor System. This may temporarily affect the flushing capacity of Gemini Beaches to disperse the existing contaminants in the water. Due to the minor and temporary nature of the predicted flow reduction, it has not been quantitatively modelled.

Although no water quality modelling was carried out for the assessment, modelling results from another nearby project are available and can be referenced to indicate the extent of impact of the jetty on water current. Hydrodynamic modelling was carried out for a proposed Ting Kau Bridge alignment. Layout of the modelled causeway is shown in Figure 5.4. The worst case scenario Wet Season Neap Tide predicted that there would be a 2 % reduction in the tidal flow by the proposed layout. Although the modelled layout for the proposed Ting Kau Bridge alignment is to a certain extent different from the proposed jetty layout, it is considered that the Ting Kau Bridge will have a higher impact on its neighbouring beaches and can provide an upper bound of marine water quality impact for this study.

For the Conveyor System, intrusion of the jetty into the main water channel will be about 1 %, which is comparatively less than the obstruction or intrusion in the Ting Kau Bridge proposal. Therefore, reduction of tidal current caused by the jetty is likely to be much less than 2 %.

Impact Caused by the Stockpile Platform - floating debris

Deposition of debris on the beach may increase as a result of increasing construction activities in the area. The site visit showed that there was refuse, mainly construction wastes, floating on water close to the shoreline or resting on the beach. These wastes were likely generated from other construction sites along the coast and transported to the beach (construction of the jetty had not started at that time). R3CC will regularly clean the beach area if this occurs, thus reducing the effect on the amenity of the beach. The overall impact on the amenity of the beach is expected to be minimal.

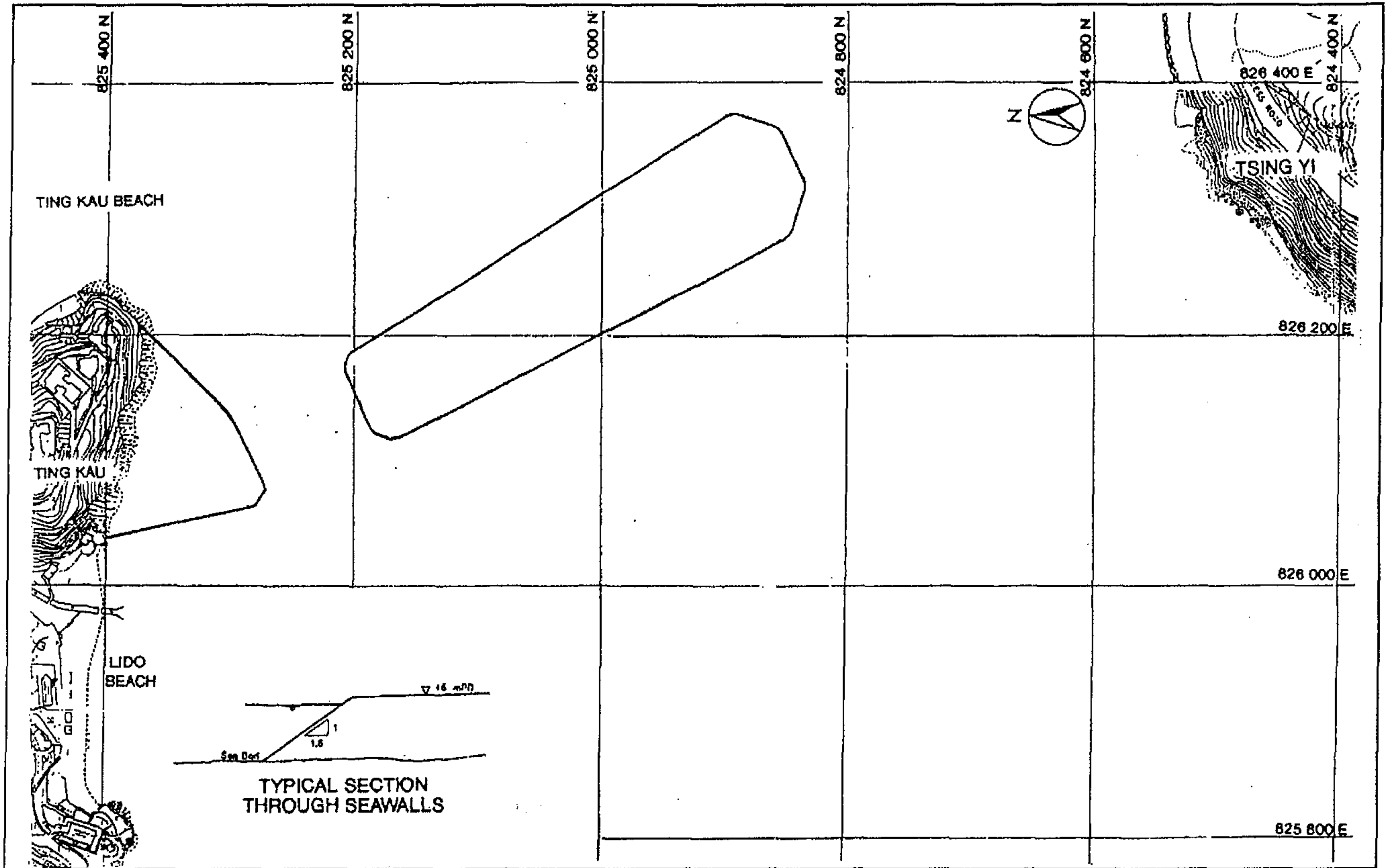

Figure 5.4 Layout of Causeway for Water Quality Modelling of a Ting Kau Bridge Proposal

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Impact Caused by the Stockpile Platform - E. coli levels in the remaining Gemini Beach

The effect of the proposed stockpile platform on *E. coli* levels at Gemini Beaches has not been quantitatively modelled. As previously described the extension of the existing headland south may reduce the flushing capacity of the eastern Gemini Beach and subsequently affect existing *E. coli* levels. High *E. coli* levels at the beach are, however, a regional problem rather than a local problem. A site visit was carried out on 13 June 1995 and the only water flowing into the east Gemini Beach is a small temporary water stream which is rather clean and silt free (Figure 5.3).

Water quality monitoring programme for the Conveyor System has been designed to detect any changes in the *E. coli* levels at the eastern Gemini Beach. If the proposed monitoring detects increasing *E. coli* levels at the beach, there may be three reasons. Firstly, the pollution loading entering the stream may have increased, due to effluents from upstream sources. Secondly, *E. coli* levels in the surrounding Ma Wan channel may have increased. Thirdly, the flushing capacity of the beach may be impaired due to physical existence of the jetty.

In view of the complexities in differentiating impact on *E. coli* levels arising from the stockpile platform from those associated with variable regionally high *E. coli* contamination and surface water inflow to the beach, R3CC proposes to divert the East/West stream draining into western Gemini Beach. The water from the stream will be collected and diverted westward, to the edge of the jetty near the southwest corner, away from the eastern Gemini Beach. This will offset any potential increases in E. coli level by moving an existing source of contamination away from the beaches.

The water quality monitoring programme for the Conveyor System has been designed to detect any changes in *E. coli* levels at the remaining Gemini Beach and identify whether these are attributable to inflows from the stream, higher main channel *E. coli* levels or the physical existence of the jetty. The monitoring program includes control stations in the Ma Wan main channel and in the stream flowing into the remaining Gemini Beach. Details of the proposed monitoring programme are produced in Volume 3 of this DEIA.

5.4.2 Fresh Water

During operation, the Conveyor System is not expected to affect the water quality of either the East or West stream measurably. There may be some minor changes in the turbidity and suspended solids levels during rainfall events as more sediment is washed into these streams from exposed ground surfaces. This affect is expected to be short-term as revegetation will quickly cover the exposed construction areas.

5.5 Mitigation Measures

5.5.1 Marine Water

Construction

The contractor will build the jetty using the best practical filling technology to minimize any release of fine sediments into the adjacent water column, as discussed in Section 2. The seawall will be constructed first and filling will occur behind the seawall. As a result all fill material and associated fine sediment will be contained within the seawall.

Operation

The contractor will observe the guidelines listed in the Practice Note for Professional Personal PN 1/94 on *Construction Site Drainage* where possible to minimize the impact on marine water quality.

A drainage system will be installed to collect and recycle the water used for dust suppression as well as to collect rainfall run-off. The jetty surface will have a 1% slope falling towards the stockpile and drainage system such that surface run-off will not flow into the marine environment over the surface. The drainage system will intercept any sediment laden run-off due to rain. The drain and sedimentation basin have been designed to accommodate the 1 in 10 year storm event with a retention time of 10 minutes. Design calculations are provided in Appendix A. The jetty fill behind the seawall will in itself act as a filter to filter out the sediments from surface run-off prior to seepage to the marine environment.

Regular cleaning and maintenance of the drainage channel and sediment traps will be carried out. Fuel and lubricant will be stored in a bunded area and run-off from the area will be discharged via an oil interceptor, which will be cleaned and maintained regularly.

A 1 m filter layer comprising of river sand, granular material or similar material will be installed on one side of the sea wall prior to placement of other fill materials as shown in Figures 2.9 and 2.10. This will provide a barrier for any potential spills entering the marine water.

R3CC will divert the East/West stream draining into western Gemini Beach westward, to the edge of the jetty near the southwest corner, away from the eastern Gemini Beach so as to offset any potential increases in E. coli level in the remaining Gemini Beach.

Environmental monitoring will be carried out to ensure that water quality will not deteriorate measurably. EPD has been monitoring the *E. coli* concentrations at the gazetted beaches along the coast at frequency of three to four times a month during bathing season (ie. March to October inclusively) and the frequency is reduced to 2 to 3 times per month during non-bathing season. *E. coli* monitoring will be carried out by R3CC to supplement EPD's measurement once every two weeks over the whole year. In addition, regular monitoring of suspended solids and turbidity levels will be carried out close to Gemini Beaches throughout the year as specified in Volume 3 of this DEIA.

5.5.2 Fresh Water

- Hydroseeding and revegetation of exposed slopes will be started as soon as practical once major earthworks have been completed
- Stream sedimentation will be controlled during construction using erosion control mats as required on exposed cut and fill slopes
- Earthen berms will be constructed to intercept and divert overland flows from construction disturbance areas and prevent their contamination of stream courses.

6 LANDSCAPE & VISUAL IMPACTS

6 LANDSCAPE AND VISUAL IMPACTS

The new alignment differs slightly from the original alignment in terms of its position and the requirement for four cuttings. Due to the small change between the original alignment and the new alignment, most of the assessment contained in the EACS is still valid. Thus, the following assessment is largely based upon information provided by the earlier assessment.

6.1 Legislation and Guidelines

There is no legislation in Hong Kong which specifically relates to the landscape and visual impact of development. However, a degree of control is achieved through the requirement to address visual issues as part of the environmental review and assessment process.

6.2 Baseline Conditions

6.2.1 Study Area

The study area shown on Figure 6.1 comprises coastland rising into the foothills of the Tai Lam Country Park in the vicinity of Ting Kau Village. The area surrounding Ting Kau Village is a coastal strip with diverse vegetation and some influence from surrounding urban fringe developments, but strongly associated with adjacent coast waters, and the higher ground to the north, as an area of steep uninhabited hill slopes supporting vegetation consisting of sparse scrub and grassland.

6.2.2 Coastal Strip - Ting Kau

The character area encompasses the lower aspects of the hill slopes and coastal areas between the Tuen Mun Road to the north, Hoi Mei Beach to the west and Approach Beach to the east on the mainland.

Visual Envelope and Existing Views

The visual envelope for Ting Kau Coastal Strip is restricted by the landform and vegetation cover that encloses and limits views both within, and to the area.

The main zone of visual influence is southwards. The view is one of a well wooded enclave scattered with residential properties set against the steeply sloping grassland covered hills to the north. Dominant features within the view are the linear elevated structure, and the shotcrete coated regraded slopes of the Tuen Mun Road and to a lesser extent the alignment and shotcrete slopes associated with the Shek Lunk Kung catchwater.

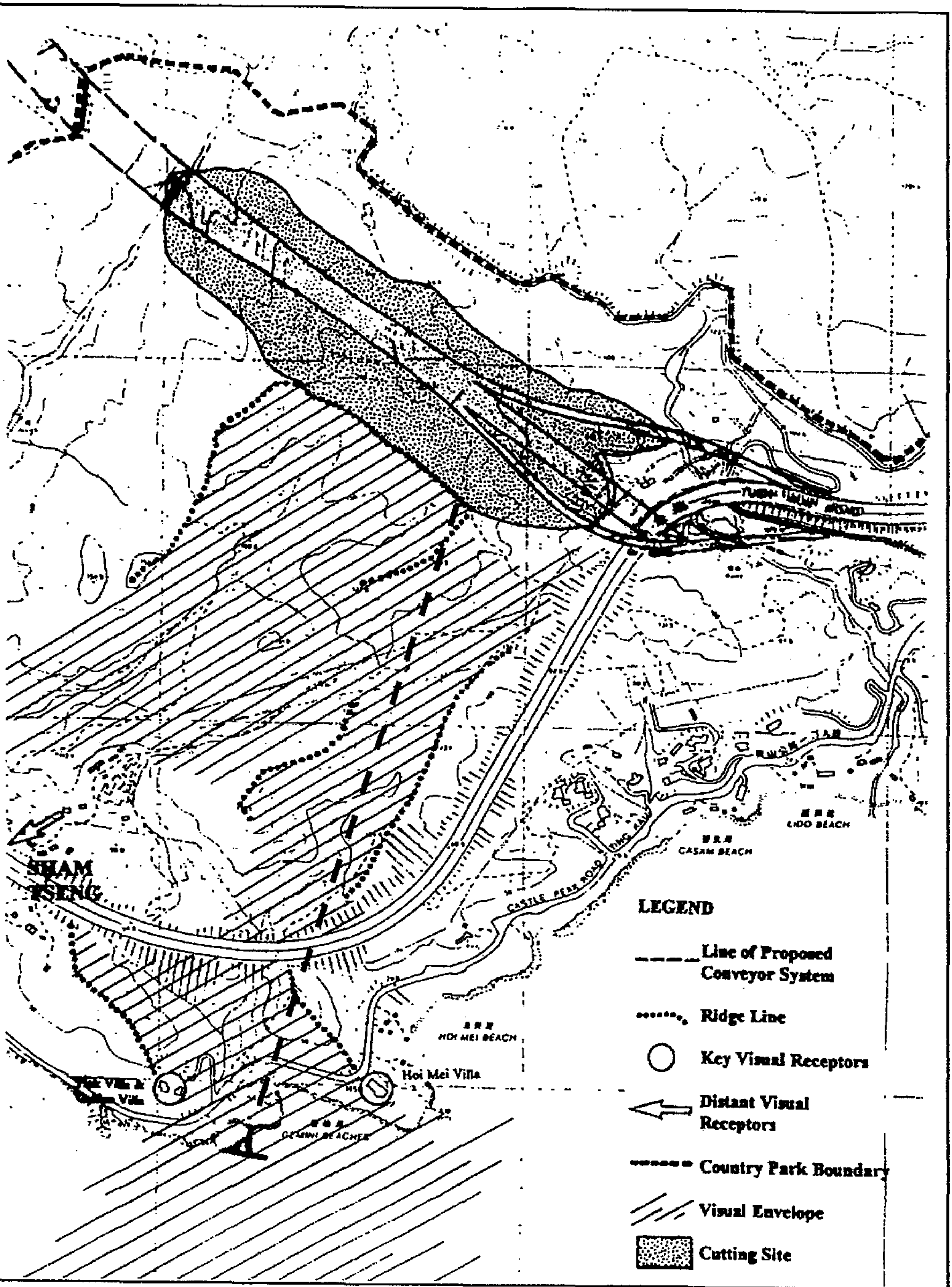

Figure 6.1 Visual Envelope

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Views within the area are restricted by the topography and more significantly the mature tree cover and residential properties. More extensive views can be experienced along the coastal margins, across the Rambler Channel to the Island of Tsing Yi, Ma Wan and Lantau in the foreground and smaller islands beyond. The views are heavily influenced by the extensive shipping activities in the surrounding waters, but do not encompass major docking or industrial facilities.

Landscape Character

The resultant landscape character of this area is one of a pleasant, well vegetated south facing coastal land with a well developed infrastructure and settlement pattern of scattered low rise properties. The area is of good quality and one that would be sensitive to change.

6.2.3 Steep Hill Slope - above Tuen Mun Road near Sham Tseng and Ting Kau

The character area encompasses the rising ground with a coastal aspect above the Tuen Mun Road.

Visual Envelope and Existing Views

Due to the abrupt nature of the topography, the visual envelope is distinct, limited by the sharp ridge lines of the surrounding hillsides. Views from the character area, due to its elevated nature, are extensive, across the busy Rambler Channel, to the islands to the south, such as Tsing Yi and Lantau, as well as oblique views along the hill slopes to either side of the study area. These extensive views are mirrored by the slopes visibility from a wide area, of predominantly transient visual receivers. The initial coastal ridge line forms an important barrier, screening views to the character area from the heart of the Tai Lam Country Park.

Landscape Character

The resultant landscape character of the steep hill slope (above Tuen Mun road in vicinity of Sham Tseng and Tin Kau) is one of remote, uninhabited steeply sloping hillside slopes facing the busy coastal waters, with an open aspect and extensive views. Human influence within the heart of the area is limited, however the lower aspects of the slopes are heavily influenced by the existing Tuen Mun Road corridor. The denuded nature of the landscape quality results in a landscape capable of absorbing change, but the elevated nature of much of the character area renders it visually prominent over a wide area, to a potentially large number of visual receivers.

6.3 Potential Impacts During Construction and Operation of the Conveyor

6.3.1 Identification of Impact

The main elements of the Conveyor System in terms of potential landscape and visual impacts are:

- Temporary bridging structures over the existing roads
- Barge loading jetty off the Gemini Beaches promontory.
- Stockpile located on the loading jetty.

The majority of the activity will be localised, contained within the conveyor belt corridor and of the barge loading jetty.

6.3.2 Landscape Impact

The need to undertake four cuttings along the ridge lines would result in disturbance to the landscape. Significant, localised and short term impact (for the duration of conveyor operation) will occur in areas associated with cuttings (between northern section and Tuen Mun Road), the temporary bridge and the jetty. The loss of woodland and shrub woodland will reduce the landscape character of the small stream valley. In the long term, it is expected that the final restoration of the scheme will reinstate the former landform.

6.3.3 Visual Impact

A temporary visual intrusion may be suffered by receivers throughout the visual envelopes identified above. The severity of the intrusion is dependent on the proximity of the construction works and the sensitivity of the visual receptors. The proposed Marine Traffic Control Station (MTCS) at Gemini Point (south of Homi Villa) lies on the eastern side of the jetty shown on Figure 4.1 and the direct line of sight on the marine fairway will not be blocked by the stock piles or other facilities on the platform.

Impact on Immediate Viewers

Receivers that will suffer visual intrusion/obstruction from the conveyor belt and/or its associated structures include:

- Residents in Golden Villa and Pink Villa to the north of Castle Peak Road
- Footpath users on the coastal slopes within the study area
- Visitors to Gemini Beaches
- Visitors to the Tai Lam Country Park (views from coastal facing slopes only)
- Transient traffic on the Tuen Mun Road and Castle Peak Road
- Marine traffic in the immediate vicinity of the Gemini Beaches promontory

Generally, residents immediately adjacent to the route will be subject to the most severe intrusion from the construction and operation.

The need for artificial illumination will be temporary and of low intensity as it is proposed to be used for the site inspection and maintenance purposes. Thus the impact on the permanent residents within the properties surrounding the Gemini Beaches and the MTCS will be minimal.

Impact on Distant Viewers

Views from the outskirts of the residential area of Sham Tseng (to the west), scattered residential properties and footpath users both on the mainland and from islands to the south would form the main receiver groups from outside the study area. The high volume of waterborne and vehicular traffic in the vicinity create a further transient receiver group.

These receivers may all incur visual intrusion. Generally, the severity will be reduced the further the distance from the structures and intervening topography. Some parts of the Conveyor System and associated structures would be seen as an intrusive element as it follows the ridge line at certain points and will therefore break the existing skyline. However, these more distant viewers have already suffered from intrusive human elements such as major industrial, residential and infrastructure development. In view of this, the introduction of a further temporary artificial feature would not significantly alter the perception of the existing visual quality of the area to these more distanced viewers.

6.4 Long Term Residual Impacts

The adoption of a sympathetic landscape restoration programme will minimise the long term residual effects of the temporary Conveyor System, which should in time return to its semi-natural state.

6.5 Mitigation Measures

General mitigation measures recommended in the EACS for both the construction and operation phases remain valid for the new alignment. These measures include:

- Colour and materials used for structures/buildings should reflect the colours and materials of the surrounding landscape
- Detailed attention to the gradients and the profile of regraded slopes, and earth modelling to ensure they reflect the gradients of the natural slopes in the vicinity.
- Avoid the usage of chunam or shotcrete on regraded slopes
- Screen planting
- Restrict volume of traffic along access road

Based upon these broad principles, the following mitigation measures specifically for the construction and operational works should also be considered as recommended in the EACS:

Construction Phase

- Restrict the volume of construction traffic along the conveyor route (including service vehicles)

- Restrict the construction working areas to a minimum, siting them if possible in visually isolated positions, such as valleys not visible from the main receivers

- Enclose the working areas with hoardings to define boundary edge and screen low level construction activities from surrounding receptors

Operational Phase

- Provide hoardings and/or vegetation planting to shelter the visual sensitive receivers from both night-time artificial illumination and the view. This should occur within the curtilage of the properties to screen the view at source and with liaison with the property owners.

- Plant fast growing shrubs and trees to screen the temporary bridges and barge jetty. The tree/shrub planting will aid slope stability and reduce dust pollution on the surrounding landscape. Tree planting should be limited to the lower hill slopes, extending the existing areas of trees and scrub. Planting should not be in a linear belt, as it would be out of context with the existing landscape.

Final Restoration

Once operation is complete the landscape will at the minimum be returned to its original quality, and where possible enhancement of the vegetation cover will occur. This will involve:

- The removal of all man-made features associated with the temporary conveyor system except where culverts will be filled.

- Artificial slopes, cuttings and embankments will be graded out to form a more continuous natural slope

- The re-graded slopes will be planted with the woodland mix B as outlined in box below:

Hydroseed with grass and tree seed Plant trees on 100% of area Pit plant 75% tree/shrub whips, 25% light standard trees Density 1.5m staggered centres maximum

The composition of the shrub species will correspond with the existing vegetation present in the area as identified in the 'Supplementary Flora and Fauna Surveys for TLT and YLA' Winter 1994-5 Survey Results - Conveyor Alignment.

7 ECOLOGY

7 ECOLOGY

This section addresses key ecological issues of loss of woodlands and mitigation measures.

7.1 Legislation

Hong Kong Government regulations relevant to the present project include the following:

- The Forests and Countryside Ordinance (Cap. 96), which protects both natural and planted forests
- The Forestry Regulations, which provide for protection of specified local wild plant species
- The Wild Animals Protection Ordinance (Cap. 170), which provides for protection of listed species of wild animals (excluding fish and marine invertebrates) by prohibiting the disturbance, taking or removal of animals and/or their nests or eggs.
- Country Parks Ordinance (Cap 208) which protects areas within Tai Lam Country Park from development disturbance.
- The Animals and Plants (Protection of Endangered Species) Ordinance (Cap 187).

7.2 Existing Ecological Resource

7.2.1 Endangered/Protected Flora

Vegetation field surveys were carried out to cover portions of the Route 3 alignment in May 1993; August, September, October, November, December 1994; January, February and March 1995. Based on autumn 1994 survey findings, the reach of East Stream immediately above Tuen Mun Road was selected for detailed survey to identify species composition and determine conservation significance. Samples were collected from plants which could not be identified in the field for later identification and preparation as herbarium specimens. Species identification was verified using the AFD herbarium.

Three protected plant species were recorded in the study area. One was *Arundina chinensis* (Bamboo orchid). All members of the orchid family (Orchidaceae), to which *A. chinensis* belongs, are protected under both the Forestry Regulations (Cap. 96) and the Animals and Plants (Protection of Endangered Species) Ordinance (Cap. 187). Bamboo orchids were found in groups alongside Sham Tseng Stream (see Figure 7.1 for specification of stream names for the purposes of this report) near the catchwater (Figure 7.1). Based on the updated work map this location was outside the works area boundaries of the conveyor and would not be affected by construction.

Two species found on or near the works areas, *Enkianthus quinqueflorus* and *Rhododendron simsii*, are protected under the Hong Kong Forestry Regulations (Cap. 96). *Enkianthus quinqueflorus* (New Year Flower) was commonly found in shrub-grassland and shrub-woodland on the slopes within and without the works areas. It was flowering at the time of the field surveys, thus was readily located.

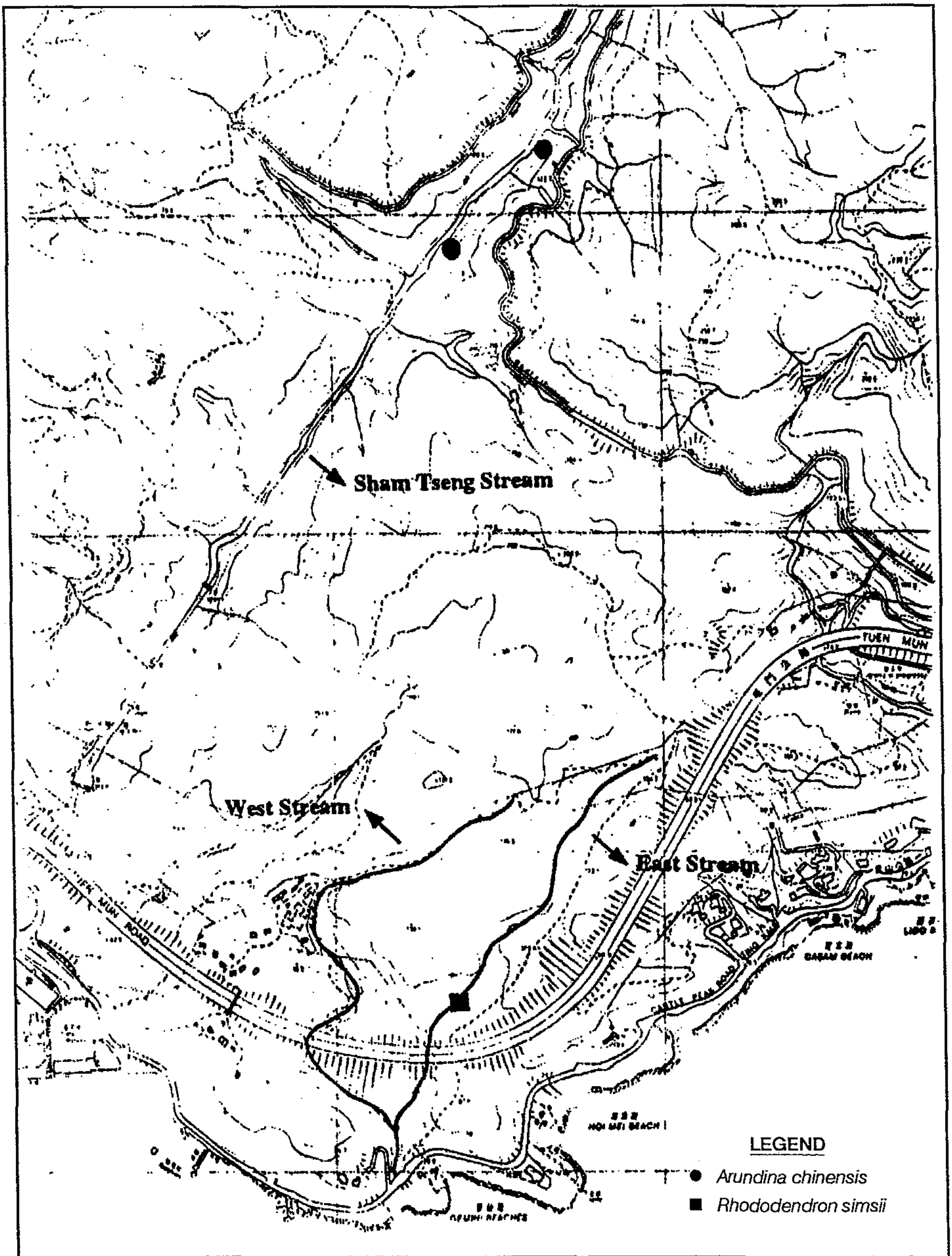

Figure 7.1 Locations of *Arundina chinensis* and *Rhododendron simsii*

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Rhododendron simsii (Red Azalea) was found only in the ravine woodland along East Stream near the southern end of the conveyor alignment (Figure 7.1). Although *R. simsii* distribution was limited within the conveyor works area, the species is locally common and widespread. It is found in diverse habitats, typically on hill slopes throughout the Territory. Although *R. simsii* is common and widespread in Hong Kong, it is protected under the Forestry Regulations by virtue of the fact that all members of the *Rhododendron* genus are protected to prevent excessive harvesting for ornamental and medicinal use.

7.2.2 Woodland and Shrub-Woodland

In general, the vegetation along the conveyor alignment was similar in composition and characteristic to the neighbouring area of the South Portal (Figures 7.2a and 7.2b). The hill tops and ridges were mostly covered with plantations of *Lophostemon confertus, Acacia auriculiformis,* and *Melaleuca quinquenervia.* The ridges were planted with these species to control erosion and to establish vegetative cover on areas which had been repeatedly burned.

Most hill-slopes supported shrublands and shrub-grassland. Shrubland was dominated by *Rhaphiolepis indica, Baeckea frutescens, Litsea rotundifolia* var. *oblongifolia,* and *Enkianthus quinqueflorus,* while shrub grasslands consisted of *Miscanthus sinensis, Dicranopteris linearis,* and *Lepidosperma chinensis* with other climbers such as *Gnetum montanum, Smilax* spp., and *Dalbergia* spp. Natural woodland was scattered and confined to the bottom of the ravines along the streams. In these more mesic areas natural woodlands had been less affected by hill fires than had the ridges and hill slopes. The ravine vegetation was more complex structurally and supported a greater diversity of species than did grassland or shrubland habitats on the site. Woodland and shrub-woodland were differentiated on the basis of the greater proportion of tree species in woodland, some of which exceeded 15.0 cm in diameter at breast height. Woodlands were considered to be areas of woody vegetation in which trees and shrubs formed a more or less continuous cover with an interlocking canopy. This definition of woodland habitat was specified in *Land Utilization in Hong Kong,* a Hong Kong government publication.

A focused study was carried out in the East Stream ravine (Figure 7.2a) to describe vegetation composition and determine its conservation significance. This site was dominated by *Lithocarpus glaber,* and supported sub-dominant species including *Ternstroemia microcarpa, Itea chinensis, Sapium discolor, Gordonia axillaris, Schefflera octophylla,* and *Acronychia pedunculata* (Figure 7.2a; Table 7.1). In addition, there was a bamboo forest dominated by *Phyllostachys nidularia* between the ravine woodland and shrub-grassland. The structure of this ravine forest was simple.

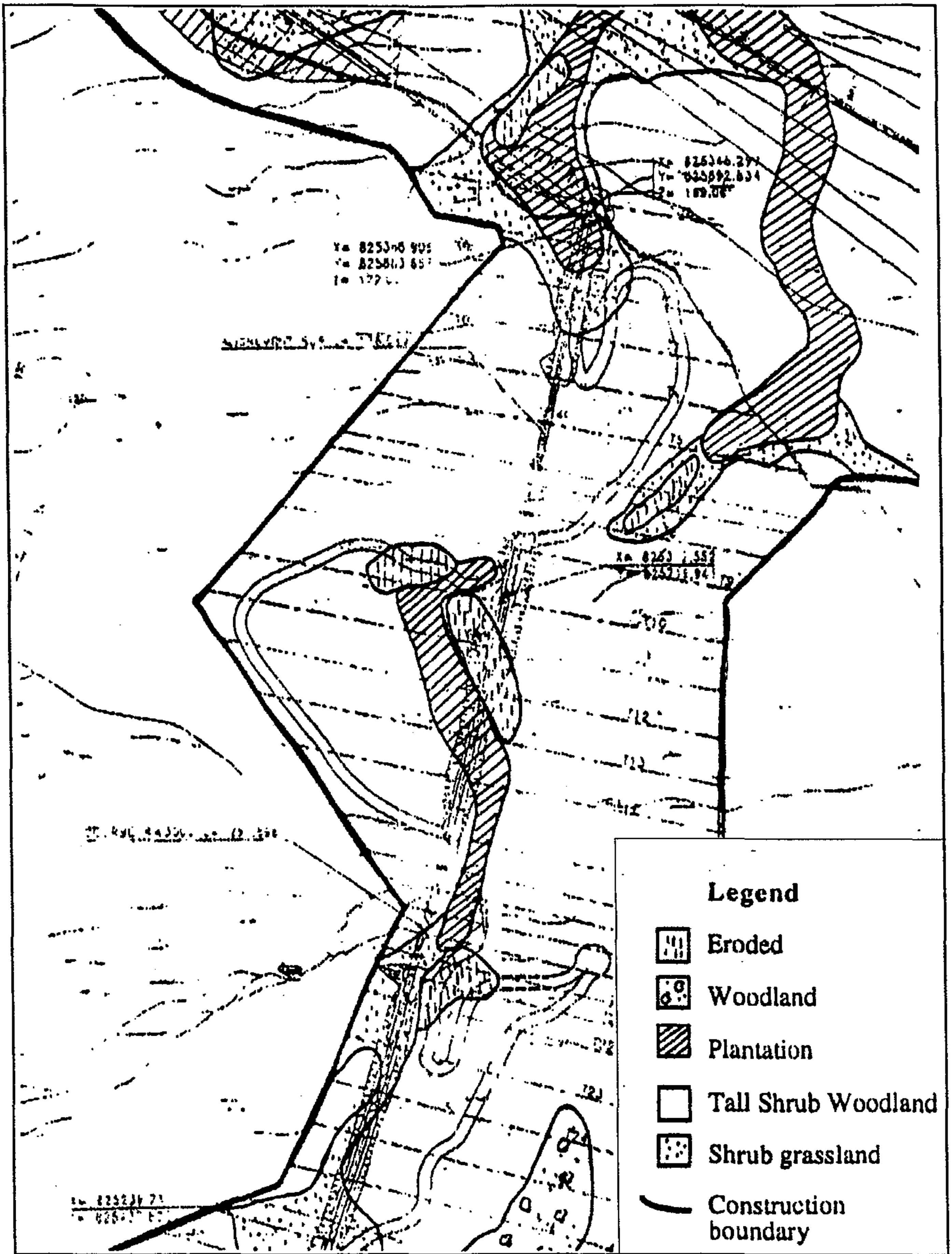

Figure 7.2A Habitat Map for Conveyor System, Southern Section

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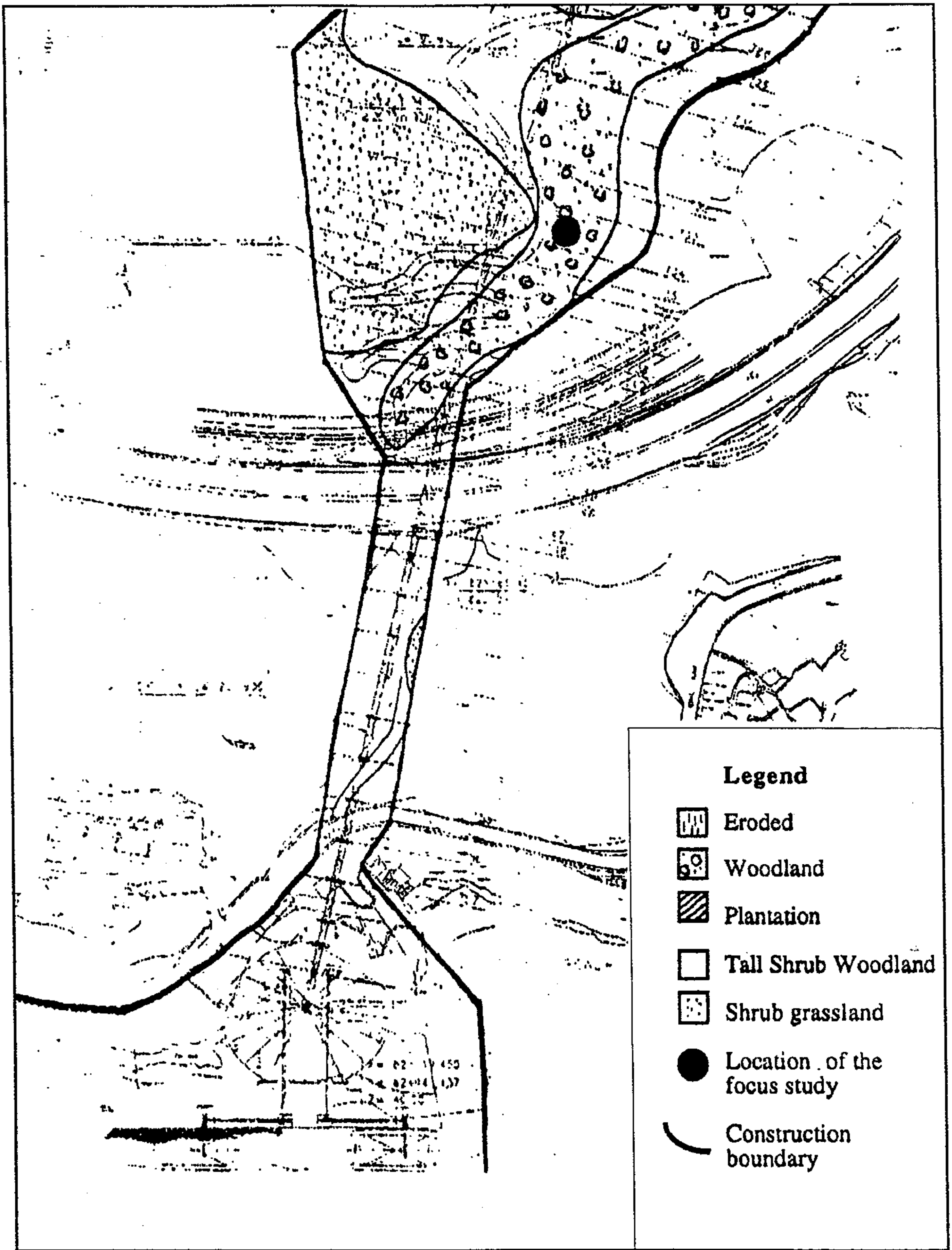

Figure 7.2B Habitat Map for Conveyor System, Northern Section

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Table 7.1 Dominant Tree Species Measured in the Ravine Woodland within the Conveyor Works Area of the Route 3 Project (Focused Study)

Scientific Name	Mean dbh(cm)	Total Trees Sampled (trunks)
Ternstroemia microcarpa	19.9	6(9)
Lithocarpus glaber	17.7	11(27)
Sapium discolor	13.4	4(5)
Acronychia pedunculata	18.6	2(2)
Itea chinensis	9.1	3(5)
Ilex viridis	8.6	1(1)
Gordonia axillaris	9.5	6(9)
Pinus massoniana	10.5	1(1)

7.2.3 Stream Ecology

Freshwater habitats within the detailed works boundary were sampled during February, 1995. Two streams (West Stream and East Stream) would be affected by the construction of the conveyor system and the associated access (Figure 7.1). East Stream flows in a south-southwesterly direction to Gemini Beach from a small, densely vegetated catchment above Tuen Mun Road. West Stream originates in the adjacent catchment to the north which is similar in character and size, and describes a west to east loop before joining East Stream between Tuen Mun and Castle Peak Roads. Both streams pass beneath Tuen Mun Road in box culverts. The reach of West Stream immediately south of Tuen Mun Road was relocated to a new channel at the time of the highway construction project to accommodate an earthen fill.

Non-systematic surveys were used to sample the fauna of the stretches of East Stream which will be affected, to a greater extent than West Stream, by construction of the conveyor. Fish and aquatic invertebrates were captured by hand, using hand-nets, or with minnow seines. Captured individuals were released immediately following identification. Individuals which could not be identified in the field were preserved in formalin for later identification using a stereoscopic microscope. Because the catchment area is small, stream water levels during the dry season were low, and the upper reaches were dry. The stream course above Tuen Mun Highway was narrow and was surrounded by dense, and overhanging vegetation. Initially of a shallow gradient with long stretches of still water, the stream course became steeper nearer Tuen Mun Road. In the steeper reaches the stream ran over areas of steep bare rock into small pools. Flow was controlled in one place by a small concrete dam. The substrate of the runs and pools consists of fine gravel and mud, with (towards the end of the dry season) large amounts of leaf litter. Between Tuen Mun and Castle Peak Roads, the stream ran into a bowl-shaped valley where sediment build-up behind an old dam has formed a marshy area. From the marsh the stream flowed under Castle Peak Road in a culvert to west Gemini Beach.

The uppermost reaches of West Stream were visited but were not surveyed because they were dry, precluding the presence of any aquatic fauna of note. The lower reaches of West Stream are located outside the works limits of the conveyor project.

Aquatic Fauna

Only one species of fish was recorded during sampling, the flat-headed leach *Oreonectes platycephalus.* Large numbers of *O. platycephalus* were feeding on the sand and mud in pools along the upper stream course. This species is widely distributed in the upper parts of streams on Hong Kong Island and in the New Territories (Chong and Dudgeon 1992). Small numbers of large tadpoles (5-6 cm) were also recorded, possibly the Chinese Bullfrog (*Rana tigrina rugulosa*). Larval and adult aquatic invertebrates were collected. They occurred in relatively low densities, probably because sampling was conducted during winter and because of the ephemeral nature of the upper reaches of the stream. The species collected include *Perla* sp. (Plecoptera), *Notonecia* sp. (Hemiptera), *Ganonema* sp. (Trichoptera), *Neocaridina serrata* (Atuidae), and an unidentified dragonfly larva (Odonata: Anisoptera). With the exception of the unidentified dragonfly larvae, these species are known to be common throughout the territory, and therefore not considered to be rare or threatened. The potential of the stream as dragonfly habitat is limited by the ephemeral nature of the upper reaches. The only known stream in the nearby area which supports a diverse dragonfly community is the reach of Sham Tseng Stream above the WSD catchwater in Tai Lam Country Park (K. Wilson, Fisheries Officer, AFD, pers. comm.).

7.2.4 Avifauna

Birds were recorded during all daylight hours over all four seasons between May 1993 and March 1995. Surveys were non-systematic, and covered all available habitats. Bird species recorded on all portions of the Route 3 project north of Ting Kau Beach and south of the south portal are listed in Table 7.2 (Freeman Fox Maunsell 1993a, 1993b, 1995). Thirty-eight species representing 24 families were recorded in total.

Fourteen species of recorded birds typically prefer thicker cover which occurs on more densely wooded sites such as stream valleys (Table 7.2). Ting Kau Stream and the two streams described in Section 7.2.3 (West and East Streams) provided habitat for these woodland-specific species. Of these streams, the only wetland or ravine/valley habitats within the conveyor works boundary were the two East and West Streams, portions of which are ephemeral. These streams were smaller than Ting Kau Stream, but were less disturbed by agricultural, horticultural, and recreational uses. Vegetative cover was less affected by human uses, so its physical structure was more dense and complex than that in the Ting Kau drainage. The ravine vegetation was also more diverse and complex than surrounding upland vegetation. Because bird species diversity is related to both horizontal physical structure of vegetation (Roth 1976 in DeGraaf 1991) and vertical structure (MacArthur and MacArthur 1961 in DeGraaf 1991), the two streams in the conveyor works area probably provided bird habitat superior to the surrounding upland hillslopes.

Knopf and Samson (1994) reviewed the implications of riparian vegetation management for conservation of riparian-obligate bird species in North American ecosystems. Their analysis highlighted the importance of riparian vegetation as both a discrete habitat type of greater structural and floristic diversity than surrounding upland vegetation, and a corridor linking markedly different habitats at extremes of local elevation gradients. They noted the importance of riparian habitats for bird movements within seasons, and during seasonal migrations.

Of importance to the proposed conveyor system, Knopf and Samson (1994) discussed the significance of riparian vegetation in terms of beta diversity of bird communities (habitat relations to bird species diversity across landscapes). In the context of the relatively xeric upland and ridge habitats which dominate the immediate vicinity of the conveyor, the ravine and stream valley vegetation is structurally and floristically distinct. Its integrity is preserved to some degree by its mesic conditions which preclude penetration of low intensity hill fires which destroy virtually all surrounding vegetation on a periodic basis. In other areas which are less prone to hill fire the distinction between hill slope vegetation and riparian vegetation is not as marked. For example, the streamside vegetation immediately west of the conveyor alignment in the drainage flowing to Sham Tseng is an extension of the hill slope vegetation and is not distinguishable from it. Similarly, the woodland vegetation of hill slopes in the Ting Kau stream valley extended downslope to the stream banks with no identifiable boundary in the riparian zone (Freeman Fox Maunsell 1995).

The upland habitats in the conveyor works area did not support bird communities of particular conservation importance. This was probably a result of the eroded nature of the ridges and hill tops and many of the hill slopes due to periodic wild fire, and the relatively poor vegetative cover. Birds typically observed in the upland sites were habitat generalists such as Black-eared Kites, bulbuls, Tree Sparrows, Rufous-backed Shrikes, corvids, and sturnids.

In contrast, birds of the ravine or upland woodland habitats tended to be less abundant throughout the general area due to their narrower habitat preferences. This has important conservation implications in terms of the linear island nature of the wooded belts and the susceptibility of their avifaunas to loss of critical habitats: Birds which are dependent on ravine or woodland vegetation will likely be unable to adapt to other habitats when their preferred habitats are lost. Examples of such species are the cuckoos, Collared Scops Owl, Violet Whistling Thrush, and Black-naped Oriole. Localised losses of woodland or ravine habitats for these species may reduce potential for recolonisation of other woodland sites, and may lead to local extinctions (Dobkin and Wilcox 1986 in Knopf & Samson 1994).

Table 7.2 Birds recorded on Route 3 Project Areas Between Ting Kau Beach and the South Tunnel Portal Between Spring 1993 and Winter 1994-5

Common Name (Scientific Name)	Abund	Status
Black-Eared Kite (*Milvus lineatus*)	II	R
Crested Goshawk (*Accipiter trivirgatus*)	II	R
Chinese Francolin (*Francolinus pintadeanus*)	I	R
Moorhen (*Gallinula chloropus*)	I	R
Spotted Dove (*Streptopelia chinensis*)	IV	R
Large Hawk Cuckoo (*Cuculus sparverioides*)*	II	SV
Koel (*Eudynamis scolopacea*)*	III	R
Indian Cuckoo (*Cuculus micropterus*)*	II	SV
Greater Coucal (*Centropus sinensis*)*	III	R
Red-winged Crested Cuckoo (*Clamator coromandus*)*	II	SV
Collared Scops Owl (*Otus bakkamoena*)*	I	R
White-breasted Kingfisher (*Halcyon smyrnensis*)	II	R
House Swift (*Apus affinis*)	IV	R
Barn Swallow (*Hirundo rustica*)	IV	SV
Tree Sparrow (*Passer montanus*)	IV	R
Richard Pipit (*Anthus richardi*)	II	R, PM, WV
Olive-backed Pipit (*Anthus hodgsoni*)	II	WV
Grey Wagtail (*Motacilla cinerea*)	II	WV
Crested Bulbul (*Pycnonotus jocusus*)	IV	R
Chinese Bulbul (*Pycnonotus sinensis*)	IV	R
Magpie Robin (*Copsychus saularis*)	II	R
Violet Whistling Thrush (*Myiophoneus caeruleus*)*	II	R
Grey-backed Thrush (*Turdus hortulorum*)*	II	WV
Yellow-bellied Prinia(*Prinia flaviventris*)	III	R
Plain Prinia (*Prinia inornata*)	II	R
Common Tailor Bird (*Orthotomus sutorius*)*	III	R
Black-faced Laughing Thrush (*Garrulax perspicillatus*)*	III	R
Hwamei (*Garrulax canorus*)*	III	R
Great Tit (*Parus major*)*	II	R
Japanese White Eye (*Zosterops japonica*)*	III	R
Rufous-backed Shrike (*Lanius schach*)	III	R
Black Drongo (*Dicrurus macrocerus*)	II	SV
Black-naped Oriole (*Oriolus chinensis*)*	I	SV
Magpie (*Pica pica*)	III	R
Collared Crow (*Corvus torquatus*)	II	R
Jungle Crow (*Corvus macrorhynchus*)	II	R
Black-necked Starling (*Sturnus nigricollis*)	III	R
Crested Mynah (*Acridotheres cristatellus*)	IV	R
* species preferring thick cover typical of ravine or upland woodlands		
Key to symbols: ABUND: I = 1 II = 2-10 III = 11-50 IV = +50	STATUS: R = resident SV = summer visitor WV = winter visitor PM = passage migrant	

7.2.5 Reptiles and Amphibians

Specific surveys for reptiles and amphibians were conducted in May 1993, and supplemented with incidental observations between May 1993 and March 1995. No reptile or amphibian was recorded in the proposed works area during winter surveys. The Checkered Keelback (*Xenochrophis piscator*) was recorded near the alignment in the Ting Kau Stream valley during autumn 1994 (Freeman Fox Maunsell 1995).

7.2.6 Mammals

Small mammals captured near the conveyor alignment were reported in Freeman Fox Maunsell (1995) as the White-bellied House Mouse (*Mus musculus homourus*) and the Chestnut Rat (*Niviventer fulvescens*). Other widespread murids such as Sladens Rat (*Rattus koratensis*) and the Buff-breasted Rat (*R. rattus flavipectus*) may also occur on the study area, but were not captured. The stream habitats may support shrews in addition to rodents. Small mammals were trapped under permit reference AFCON 90/51 dated 13 September 1994.

Mid-sized mammals recorded on the works area include the Chinese Porcupine (*Hystrix brachyura*), the Barking Deer (*Muntiacus reevesi*), the Wild Boar (*Sus scrofa*), and civets (probably the Small Indian Civet, *Viverricula indica*). Porcupines were recorded on the ridge tops in plantation habitats both during this survey and during May 1993 (Freeman Fox Maunsell 1993a). The Porcupine is considered to be an inhabitant of heavily wooded areas such as Victoria Peak and Tai Po Kau (Goodyer 1992). Its occurrence in sparsely wooded upland habitats on the conveyor alignment suggests that its habitat preferences may be less restricted than earlier thought.

Barking Deer faeces were recorded in ravine habitats along East Stream near Tuen Mun Road. Barking Deer were also recorded from vocalisations near the proposed south tunnel portal during May 1993 (Freeman Fox Maunsell 1993a). The species is considered common and widespread, although not often seen in Hong Kong. It would be expected that Barking Deer would favour more densely vegetated habitats such as the ravine woodlands on the study area.

Wild Boar and Small Indian Civets would be expected to use a wide range of habitat types throughout the conveyor works area. Boar use habitats from coastal mud flats to xeric ridges. Signs of boar rooting were seen in the Ting Kau drainage and in the ravines in the East and West Stream drainages. Civets are omnivorous and wide ranging on a daily basis. They would also use virtually all habitats on the conveyor alignment. Civet activity could be expected to centre on burrow locations, but no burrows were recorded in the proposed disturbance area.

Active burrows were observed during autumn 1994 just beyond the eastern boundary of the works area along the top of the Tuen Mun Road cut slope (Freeman Fox Maunsell 1995). These were probably constructed by Chinese Ferret Badgers (*Melogale moschata*). No other burrow sites were recorded along the proposed alignment.

7.3 Potential Impacts of Construction

7.3.1 Freshwater Habitats

Construction of approximately the first 280 metres of the access road and adjacent conveyor above Tuen Mun Road will affect East Stream and its catchment. Although the conveyor alignment was shifted west in the final design, potential for habitat degradation remains in the lower reach of East Stream. Further up the catchment, impacts will result from removal of hill slope vegetation and potentially high levels of sediment runoff into the stream. Because the stream is small it will be susceptible to impacts from sedimentation which could lead to filling of the stream bed, which would in turn cause direct loss of aquatic fauna and habitats. The stream fauna was low in diversity and no species of conservation significance were recorded. Therefore, the biodiversity conservation significance of loss of stream fauna would not be great. However, the relatively undisturbed nature of the stream course and associated vegetation above Tuen Mun Road is an increasingly uncommon combination in Hong Kong. This suggests that loss of this resource could be important in a Territorial context, and that special measures for control of sedimentation must be implemented during construction.

The uppermost reaches of West Stream may be similarly affected by vegetation removal and earthworks leading to sediment runoff and filling of the stream bed. The conveyor alignment passes across the ridge line at this location, and stream sedimentation could result if earthworks are not carefully controlled during the wet season. The potential for disturbance to West Stream is limited because the proposed disturbance at the head of the valley covers a very small area.

7.3.2 Vegetation

Protected Flora

Two protected plant species were identified in the study area (Section 7.2.1). Potential impacts on these species will include loss of individual plants and destruction of their habitats. Because both species are common and widely distributed in Hong Kong, the significance of these losses in terms of Territorial biodiversity conservation is slight. The potential long-term impact would be loss of natural habitat for establishment and growth of the species. Re-contouring and revegetation of the works area after project completion will provide habitats which are expected to be suitable for establishment of these species. Only one individual *R. simsii* was located within the works area. This shrub can be manually transplanted to an area secure from construction disturbance.

Woodland and Shrub-Woodland

The construction of the Conveyor System would lead to an estimated total loss of 1.0 ha of plantations and 0.5 ha of ravine secondary forest; 8.4 ha of shrub-woodland; 1.6 ha of shrub-grassland; and 0.3 ha of eroded area. Estimated habitat losses for the preliminary (1993) and final (February 1995) conveyor alignments are compared in Table 7.3. The habitat loss area estimations were based on the following assumptions:

- All vegetation beneath the conveyor alignment will be destroyed
- All vegetation within the construction boundary (as delineated on the February 1995 design) will be destroyed

The second assumption is recognised to be conservative in that some areas within the works area boundary may be unaffected. Therefore, habitat loss calculations represent a worst-case situation. If there are areas within the works boundary which will not be affected, these should be delineated on plans and by fencing prior to onset of construction.

Table 7.3 Comparison of Estimated Loss of Habitats (ha) Along Conveyor Alignments According to the Preliminary (1993) and Final (February 1995) Designs

	Conveyor System	
	Prelims.	Final
Woodland[1]	1.2	1.5
Shrub-woodland[2]	NE*	8.4
Shrub-grassland[3]	0.1	1.6
Agri/Disturbance[4]	NE	0.3
Fish Ponds	NE	-
Marsh	NE	-

Prelims. = Preliminary design of Route 3 alignment; Final= finalized design of the alignment
NE = Not estimated in Initial EIA
1 includes plantations and ravine woodland in south study area
2 includes shrubland habitats in north study area because of presence of pine plantations among this habitat
3 includes fernland/grassland habitats in north study area
4 includes cultivated lands, buildings and roads

The most severe impact would be loss of 0.5 ha of the floristically diverse ravine woodland dominated by *Lithocarpus glaber* and its associated riparian habitat (Figure 7.1). Distribution of *Lithocarpus glaber* is restricted in Hong Kong because of lack of efficient seed dispersal agents and slow tree growth (Dudgeon & Corlett 1994). These characteristic are common among most species of Fagaceae, the oak family. The existing ravine woodland supported many individuals of *L. glaber* which probably grew as sprouts of relict trees from primary forests which were logged or burnt by wildfire. This is evidenced by multi-trunked trees of *L. glaber* and other species in all local ravine habitats.

Overall, there was an apparent increase in habitat loss based on the final alignment design. This apparent increase was primarily due to the constraints of assumption 2 above. For example, no construction boundary was indicated on the preliminary design, therefore habitat loss could not be accurately predicted.

Specification of support structures rather than earthen fill to traverse valleys will greatly reduce the requirement for changes in landform during construction and following completion of the project. This will contribute substantially to preservation of existing habitats. In spite of this measure, predicted losses of habitats (including shrub-woodland and shrub-grassland) increased over those estimated in earlier reports due to the more accurate delineation of the construction works boundary in the final design. The preliminary assessment underestimated the extent of habitat losses, and the figures shown in Table 7.3 are considered a more accurate representation of potential habitat losses.

7.3.3 Impacts on Avifauna

As indicated above for aquatic fauna and vegetation and below for herpetofauna, ravine habitats are most important for bird life. The selected conveyor alignment is appropriately located along the ridgeline where possible. Earthen fills have been eliminated where possible in favour of steel structural supports. These design features will largely avoid impacts to birds due to loss of important ravine habitats.

The primary impact on birds will result from losses of ravine vegetation in the East Stream ravine near Tuen Mun Road. The floristic and structural diversity of this habitat is an important determinant of bird habitat availability, and may relate directly to local bird species and population numbers.

7.3.4 Impacts on Reptiles and Amphibians

The conveyor alignment primarily follows natural ridgelines and hills, thereby avoiding the more mesic or aquatic habitats which are important particularly to amphibians. Loss of upland habitats would not be expected to cause severe or long-term impacts to either reptiles or amphibians. However, loss of ravine habitats and streams in particular would be expected to threaten local populations of amphibians in particular due to the paucity of such habitat along the alignment.

7.3.5 Impacts on Mammals

Burrowing mammals such as Ferret Badgers and Porcupines may suffer loss of habitat due to construction of the conveyor system. Impacts of habitat losses will be short-term, however, and will be mitigated to some extent following revegetation of the conveyor corridor. Without exercise of appropriate caution in excavating any encountered burrow systems, burrowing mammals may be destroyed during the construction process. Manual excavation of burrow systems followed by capture and release into secure areas will reduce this potential impact.

More mobile mammals such as Barking Deer will avoid the construction project, and will abandon areas east of the alignment between the conveyor and Tuen Mun Road. This will result in habitat losses in an area which is currently remote and relatively secluded. Following completion of the project these habitat losses will be reversed to some extent by revegetation. However, because of the Barking Deer preference for dense woodland cover, revegetation will only mitigate habitat losses for this species over the long term.

7.4 Impact Avoidance and Habitat Loss Mitigation Measures

The Conveyor System will be a temporary facility which will be removed following completion of the tunnel excavation. Therefore, impacts to ecological resources will consist of short-term construction disturbances and long-term but temporary habitat losses. Successful stabilisation of eroding ridges and upland slopes by extensive plantings of tree species in the past demonstrates that habitat restoration has potential for success on this site. Mitigation of impacts will, therefore, rely to a large extent on habitat restoration following removal of the Conveyor System. This and other mitigation measures to be implemented during the construction and operational phases are outlined below. These measures in combination with changes in the design (steel structures as opposed to earthen fills, and realignments to avoid ravines) are considered adequated to mitigate impacts of the project.

7.4.1 Freshwater Habitats

Mitigation of impacts to freshwater habitats will depend on minimising vegetation loss and provision of effective erosion control measures during construction. This can be achieved through the protection of the fresh water resource as described in Section 5.5.2.

7.4.2 Vegetation

The impacts of habitat loss will be significant in terms of woodland and riparian habitats. Although loss of the ravine forest habitats cannot be completely mitigated by plantation, the recovery of forest from an ecological viewpoint can be facilitated through plantations of local trees. Local species, such as *Artocarpus hypargyrea, Sapium discolor,* and *Schefflera octophylla* provide food for some local mammals and avifauna, and should be included in plantations (Table 7.4).

Loss of shrub-woodland and grass-shrubland can be mitigated in the fill area and on cut slopes through effective erosion control and revegetation. In addition to those fill areas and cut slopes within the works boundary, approximately 80.5 ha are available for Route 3 compensatory planting outside the works area (Figure 7.3). Planting in these areas would not only partially mitigate habitat losses due to construction of the conveyor, but would also potentially enhance existing habitats along the boundaries of Tai Lam Country Park. Because of the conservation significance of the Country Park and the risk that nearby construction activity would degrade overall conservation resource value, it is important to provide extensive compensatory planting between the conveyor alignment and the Country Park boundary.

The Construction Requirements specify that off-site compensatory planting will be carried out for all nature woodland lost at a ratio of 3:1 (area plated : area lost).

One potential location for such planting is the hill north of Sham Tseng along the west side of the conveyor alignment (28.5 ha). A second potential location is the hill slope west of Ma On Kong (52 ha) between the Route 3 alignment and the boundary of Tai Lam Country Park. These are both eroded hill slopes which border on the alignment of Route 3. Revegetation on these areas would enhance vegetation establishment and succession. The two areas are more than large enough to accommodate woodland planting in a ratio of 3 ha planted for each 1 ha lost. Loss of woodland habitat of 1.5 ha will be mitigated by effective establishment of 4.5 ha of new woodland on the recommended sites. As specified in the Route 3 Environmental Impact Assessment (Freeman Fox Maunsell 1993a), plant species indigenous to the site which provide cover and forage value for wildlife will be selected for use in revegetation. A list of such species which occurred on the site prior to disturbance is given in Table 7.4. Species to be used in revegetation will be selected from this list according to availability at local renders.

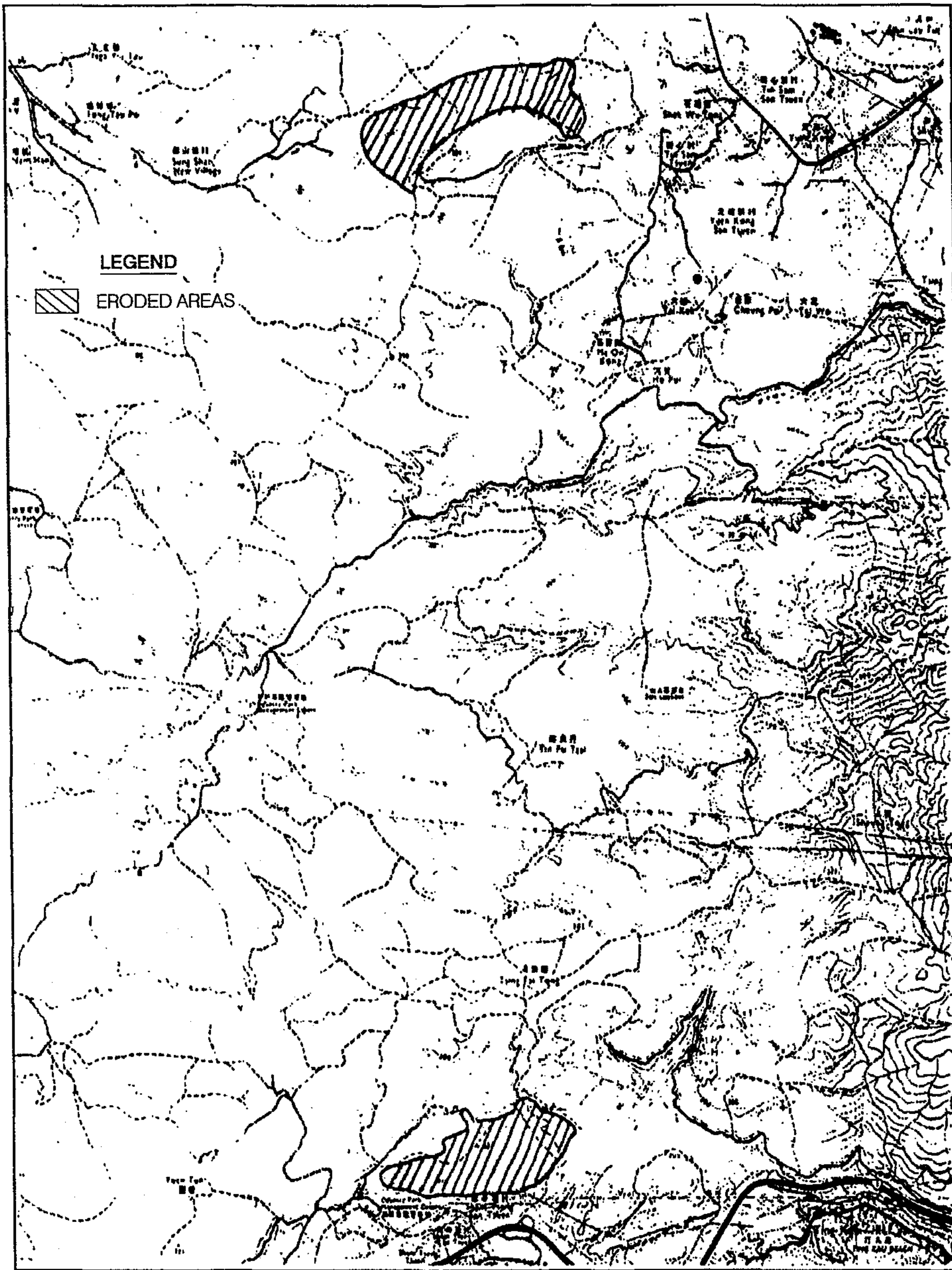

Figure 7.3 Locations of the Eroded Hillsides Available for Compensatory Planting

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Table 7.4 Native Plants Recorded on the Study Area During 1993 and 1994 Which Provide Forage Sources for Birds (after Corlett 1992) and Are Recommended for Use in Revegetation

Species	Habit	Birds	Attract	Period
Bridelia tomentosa	small tree	4	xxx	Dec-Mar
Celtis sinensis	tree	2	xxx	Jun-Aug
Cinnamomum camphora	large tree	5	xxx	Nov-Jan
Diospyros morrisiana	tree	2	xx	Dec-Jan
Ficus superba	tree	3	xx	irregular
Macaranga tanarius	tree	5	xxx	Jun-Jul
Machilus breviflora	tree	1	x	Oct-Jan
Mallotus paniculata	small tree	3	xxx	Dec-Jan
Melastoma candidum	shrub	4	xx	Nov-Jan
Melastoma sanguineum	shrub	8	xxx	Nov-Jan
Psychotria rubra	shrub	8	x	Oct-Jan
Rhaphiolepis indica	shrub	2	xxx	Aug-Nov
Rhodomyrtus tomentosa	shrub	6	xxx	Nov-Dec
Rhus chinensis	small tree	8	x	Oct-Dec
Sapium discolor	tree	12	xxxx	Nov-Jan
Sapium sebiferum	tree	3	xx	Jan-Mar
Schefflera octophylla	tree	7	xxxx	Jul-Sep
Sterculia lanceolata	tree	4	xxxx	

Note
BIRDS = number of bird species known to eat the fruit
ATTRACT = relative attractiveness to birds
PERIOD = main fruiting period

The Territorial distribution of the three protected species, *Arundina chinensis, Enkianthus quinqueflorus,* and *Rhododendron simsii,* is decreasing in extent due to harvest of plants and urbanisation which are causing loss of seed sources and loss of preferred habitats, respectively. Because of the wide distribution of these species on the project site habitat preservation through adjustment of the alignment is not possible. Therefore, loss of individual plants will be avoided where possible by marking and/or fencing to protect areas where these species occur. Construction works will be confined to the minimum possible land area to avoid unnecessary habitat destruction. This will be addressed during operations through consultation with construction project managers. Riparian habitats are particularly sensitive, and will be fenced to avoid losses wherever possible.

An alternative preservation measure is transplantation of individual plants. Individuals of *E. quinqueflorus* and the single *R. simsii,* for example, may be transplanted to nearby shrubland habitats which will not be disturbed. The exact number of *E. quinqueflorus* is not known at this stage, but will be estimated by the EM&A plant ecologist. Transplanting should be conducted during the initial site survey, prior to commencement of earthworks.

To facilitate replacement or increase of local biodiversity, native plant species are recommended for use in plantations along the conveyor alignment for revegetation of cut and fill slopes during and after the operational phase (Table 7.4).

7.4.3 Avifauna

Impacts to bird life have been largely avoided through proposed alignment of the conveyor through non-sensitive ridge habitats. Construction of the conveyor on metal structures rather than on earthen fills also greatly reduces potential habitat losses, particularly in the ravines where habitats were more complex and of greater value to bird life. At the lower reach of the East Stream impacts were further reduced by re-alignment of the conveyor to avoid encroachment of construction works onto the ravine woodland vegetation. Shifting the alignment westward in this area reduced potential loss of important habitat. Although further realignment in this area is not possible, fencing or other demarcation methods should be used to prevent encroachment into the ravine and avoid loss of woodland. Restoration of 4.5 ha of woodland habitat will compensate over 5-20 years for losses of woodland habitats along the alignment. Removal of the Conveyor System followed by re-contouring and replanting of disturbed areas will also restore habitats lost.

7.4.4 Mammals

As indicated in Section 7.3.5 above, all burrow systems encountered during construction should be hand excavated, resident mammals captured and then released to secure areas such as Tai Lam Country Park.

Habitat loss provisions indicated for vegetation and avifauna will be effective in limiting the impact of habitat losses for mammals. Construction of the conveyor on steel support structures rather than earthen fill will reduce the barrier effect of the alignment, and permit movements of some mammals. The supported structure will be more beneficial to species which are highly mobile at night such as Barking Deer and Wild Boar. Civets (probably the Small Indian Civet, *Viverricula indica*) are also active nocturnally, and would also benefit from elevation of the conveyor. Operation of the conveyor system between the hours from sunset to 2300 hrs would partially negate the advantage to nocturnal mobility conferred by the metal support structures due to the presence of humans, lighting, and generation of noise by the conveyor. From 2300 hrs to 0700 hrs the conveyor system would not be operated (except possibly for routine maintenance) and the impacts on animal mobility would probably be diminished. It is possible that nocturnal mammals would habituate to the early evening operation of the conveyor. This has occurred in many cases internationally where animal movements were restricted only for a short period by construction of man-made, linear facilities in animal activity areas (mountain lions in California, caribou in Alaska).

7.4.5 Summary of Mitigation Measures with Timetable

Mitigation measures to be implemented are listed below in Table 7.5 together with a timetable for implementation.

Table 7.5 Summary of Mitigation Measures with Timetable

Mitigation Measure	Implementation Schedule
Freshwater Habitat Protection • hydroseeding & revegetation • installation of erosion control measures • construction of earthen berms	• upon completion of earthworks • as needed
Vegetation Impact Mitigation • cut-fill slope revegetation • off-site planting • site demarcation for protected species • transplantation of *E. quinqueflorus* and *R. simsii*	• upon completion of earth works • at outset of construction works • during site investigation works • following initial site survey, prior to earthwork
Avifauna Impact Mitigation • demarcation of protection areas	• following initial site survey, prior to earthwork
Mammal Impact Mitigation • burrow survey • burrow excavation	• during site investigation surveys • prior start of earthworks

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8 CONCLUSIONS

8 CONCLUSIONS

This report examined the environmental impacts resulting from construction and operation of the Conveyor System. The assessment considered dust, noise, fresh and marine water pollution, landscaping issue and ecology. Mitigation measures were proposed.

8.1 Air Quality

During construction, dust impact on the receivers in Pink/Golden Villas, the isolated residence at Sham Tseng Tsuen, and the MTCS would mainly be caused by the site formation activity. During operation, dust impact would mainly be caused by the stockpiling and stockpile erosion. With implementation of mitigation measures, 1-hour and 24-hour TSP concentrations were predicted to comply with guideline and AQO limits at all sensitive receivers.

8.2 Noise

Construction of the Conveyor System has the potential to cause noise nuisance to nearby NSRs at Pink Villa and the isolated residence near Sham Tseng Tsuen. Nuisance may arise from a concentration of PME along the linear conveyor alignment or at the barging point. Near Pink Villa, construction activities are amenable to mitigation to bring their noise levels within daytime and evening noise limits. Near the isolated NSR, daytime limits will be attainable, but evening works will have to be closely monitored to ensure compliance with NCO limits.

During operation of the conveyor, Pink Villa will be exposed to noise from the conveyor itself and the barging point. The noise impact of the conveyor combined with the noise associated with barging point operations and movement of spoil alone was predicted to comply with NCO limits for evening operation, provided the conveyor sound power level is below 82 dB(A). This will be achieved by appropriate equipment selection and maintenance by the contractor. At the isolated NSR near Sham Tseng Tsuen, the operation of the conveyor was predicted to comply with daytime guideline and evening NCO limits.

8.3 Water Quality

During the construction phase, the key issue will be the prevention of sediment, waste materials, chemicals, spoil and dust etc. from entering the water course through the stream catchment and also marine water as a result of site formation. Because the site formation work will only take place over a period of two months and be on a small scale, the marine water quality impact will be temporary and relatively insignificant in comparison with much larger scale reclamations carried out in Hong Kong, such as Western Harbour Crossing, Western Kowloon Reclamation and Central and Wanchai Reclamation.

During the operational phase, similar impacts are expected to occur. The causes of these impacts would mainly due to activities directly related to and/or associated with marine transportation of spoil materials, eg, spoil handling, stockpiling and dust suppression. The stockpile platform shall not greatly impact on the tidal current and will therefore have minimal impact on water quality at the remaining Gemini Beach.

8.4 Landscaping and Visual Issues

The Conveyor System will cause a number of impacts at local level. This effect can be reduced by implementing the mitigation measures outlined above. In general, the summary of potential landscape and visual impacts outlined by the EACS remains valid for this study (Table 8.1).

Table 8.1 Summary of Potential Landscape and Visual Impacts

Element	Construction	Operational	Residual
Landform	Low (Locally Mod)	Low (locally Mod)	Low
Landscape character	Moderate	Moderate	Positive
Visual receivers	Low (locally severe)	Low (locally severe)	-

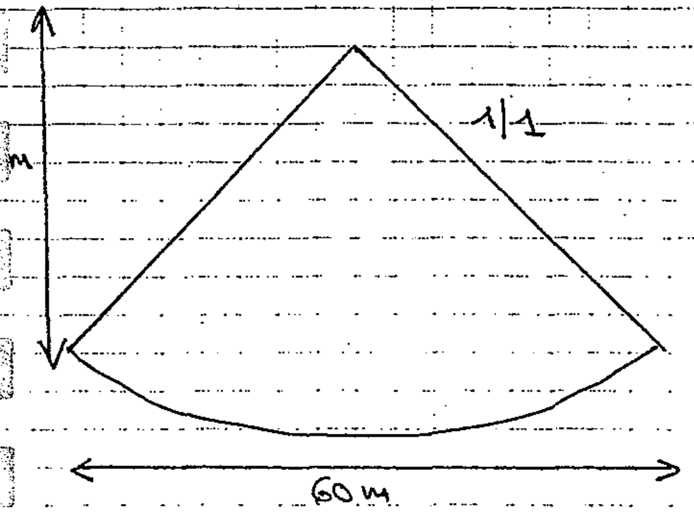
8.5 Ecology

The estimated habitat loss includes 1.5 ha of woodland mainly in a ravine, and 8.4 ha of shrubland. A protected species, *Rhododendron simsii,* which is located in the ravine may be disturbed and cleared. Loss of ravine habitats may have adverse effects on avifauna as well as on local populations of amphibians. Mammals, especially burrowing mammals, may suffer habitat loss during construction phrase. Mitigation measures will be implemented to minimise impacts, including:

- compensatory planting in a ratio of 3:1 (replacement area to lost area of woodland) using native species as proposed in the DEIA;
- transplanting individuals of *Enkianthus quinqueflorus* and *Rhododendron simsii* to nearby suitable sites;
- hand excavation of mammal burrows and capture and release of mammals into secure areas such as Tai Lam Country Park;
- avoidance of night operations to minimise disturbance to nocturnal mammals;
- Avoidance of sedimentation of Sham Tseng Stream by erosion control, earthen berms, hydroseeding and revegetation of exposed slopes.

APPENDIX A
DETAILS OF SEDIMENTATION BASIN DESIGN

STOCKPILE - DRAINAGE



Catchment area: $A = 30^2 \times \pi$

$= 2827\ m^2$

Longest distance: $L = \sqrt{30^2 + 30^2} = 42$ m

$H = \frac{h \times 100}{L} = \frac{30 \times 100}{42.4} = 70.75$

time of concentration:

$$t = 0.14465 \times \left[\frac{42.4}{(70.7)^{0.2} \times (2827)^{0.1}} \right]$$

$= \underline{1.182\ mn}$

For a 10 years return period: Mean Rainfall

$\underline{\underline{i = 270\ mm/hr}}$

Volume runoff 80% coefficient $V = 0.8 \times 0.27 \times 2827/60$

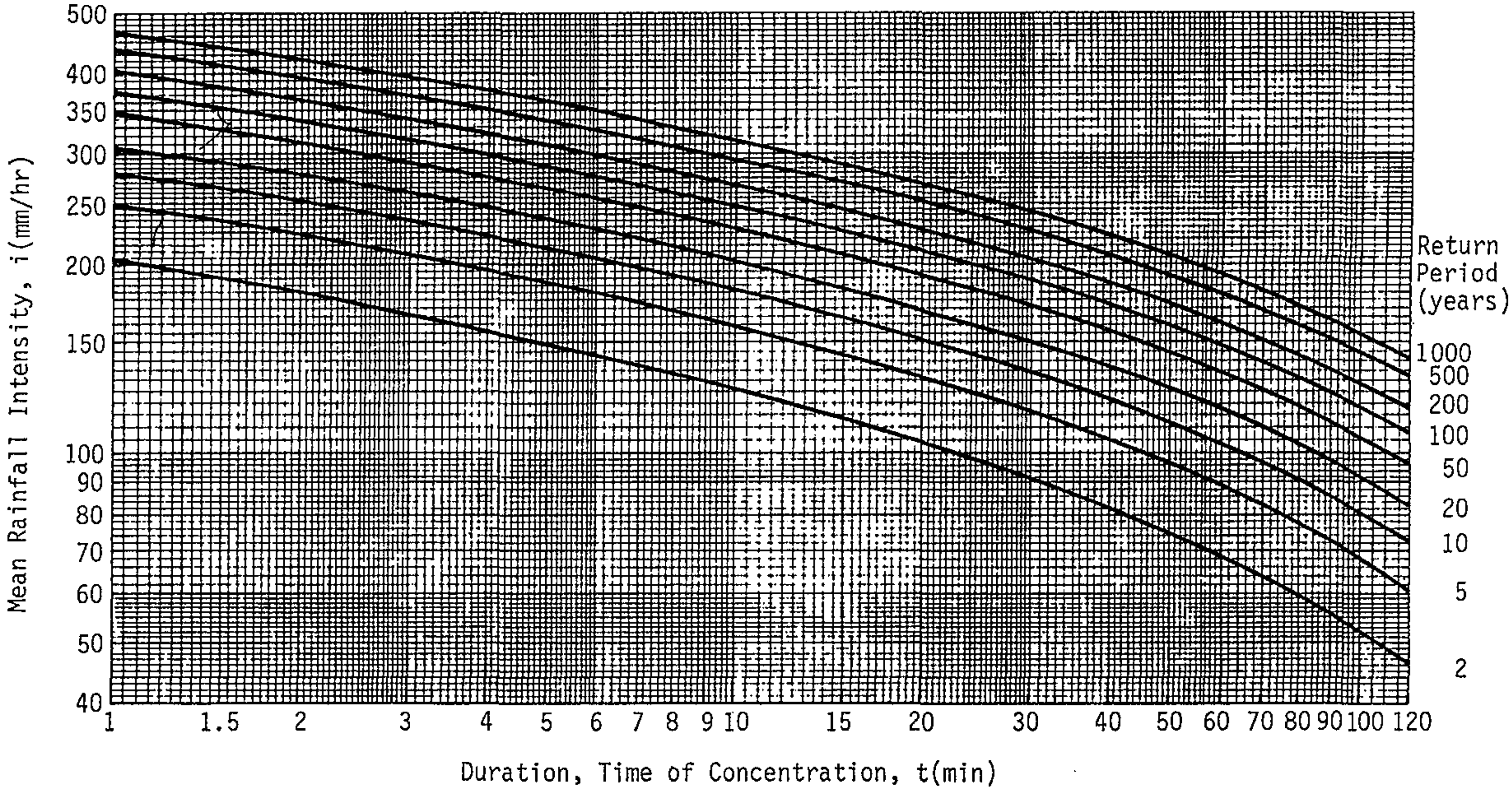
$= \underline{\underline{10.2\ m3/mn}}$

- Volume of basin: retention time 10 mn $\Rightarrow$ $\underline{\underline{V = 102\ m3}}$
  - ↳ 8.5 × 5 × 2.40 ok.
- Drainage channel $i = 10200$ l/mn

  $p = 1\%$

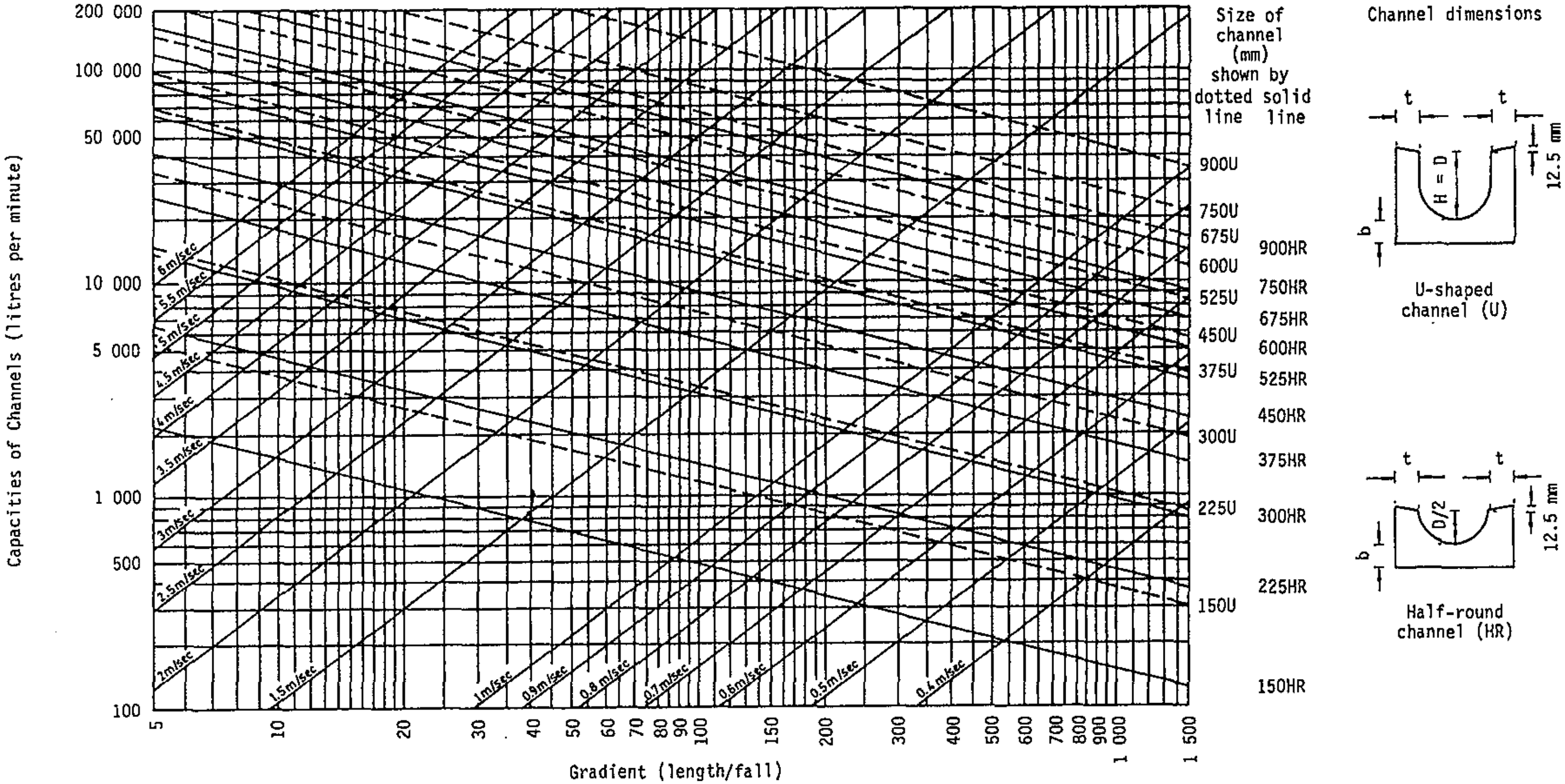
  ↳ 375 U Channel

  $v = 2\ m/s < 4\ m/s$



Note : The intensity-duration rainfall curves are from Peterson & Kwong (1981) - A design rainstorm profile for Hong Kong, Technical Note No. 58, Royal Observatory, Hong Kong. Data from tilting siphon records 1947-1980 (Royal Observatory) and instantaneous rate-of-rainfall records 1952-1980 (King's Park).

Figure 8.2 - Curves Showing Duration and Intensity of Rainfall in Hong Kong for Various Return Periods



DESIGN METHOD USING CHART

(a) Normal channel
Solution

1. Runoff → 3. Channel size, 2. Gradient, 4. Velocity

Example :

1. Enter Runoff = 4 000 litre/min.
2. Enter Gradient = 1 in 40
3. Read channel required = 225 U or 300HR
4. Read velocity = 2.2 m/sec. (<4 m/sec. ∴OK)

(b) Stepped channel
Solution

2. Runoff → 3. Channel size, 1. Velocity, 4. Gradient

Example :

1. Enter Velocity = 5 m/sec.
2. Enter Runoff = 20 000 litre/min.
3. Read required channel size = 300U
4. Read required gradient = 1 in 14

Figure 8.7 - Chart for the Rapid Design of Channels

APPENDIX B
CALCULATION OF EMISSION FACTORS

96530	Route 3 - Conveyor System, Construction Phase		
	Total area	7700	
Activity	Description	TSP	Remarks
1	**End-tipping of filling material from haul truck**		
	particle size multiplier	0.73	*from AP-42*
	material silt content (%)	6.9	*from AP-42, Western surface coal mining, overburden*
	average wind speed (m/s)	3.45	*from RO SHL 1991 data*
	drop height (m)	2	*estimated*
	material moisture content (%)	7.9	*from AP-42, Western surface coal mining, overburden*
	truck capacity (cu.m)	5	*from Engineer*
	E (kg/Mg)	1.1820E-04	*calculated as in AP-42*
	E (kg/day)	0.16	*calculated*
2	**Bulldozing surcharge material**		
	Number of dozer	4	*from Engineer*
	material silt content (%)	6.9	*from AP-42, Western surface coal mining, overburden*
	material moisture content (%)	7.9	*from AP-42, Western surface coal mining, overburden*
	percentage of time bulldozing (%)	50	*estimated*
	mitigation efficiency (%)	70	*estimated mitigation efficiency of watering every 1.5 hrs*
	E(kg/hr)	1.0785E+00	*calculated as in AP-42*
	E(kg/day)	12.94	*calculated*
3	**Haul truck on unpaved site road**		
	particle size multiplier	0.8	*from AP-42*
	silt content of road surface material (%)	5	*estimated*
	mean vehicle speed (km/hr)	20	*reduced speed by speed control*
	mean vehicle weight (Mg)	15	*from Engineer*
	mean number of wheel	10	*from Engineer*
	number of days with >= 0.254 mm	120	*from RO 1991 data*
	mitigation efficiency (%)	70	*estimated mitigation efficiency of watering every 1.5 hrs*

	E (kg/VKT)	2.4968E-01	*calculated as in AP-42*
	Average trip distance - to and fro (km)	0.1	*estimated*
	No. of vehicle trip per day	150	*calculated*
	E (kg/day)	3.75	*calculated*
4	**Site erosion**		
	silt content (%)	1.6	*from AP-42*
	no. of day with >=0.25mm rainfall	120	*from RO 1991 data*
	time with > 5.4 m/s wind speed (%)	14.21	*from RO SHL 1991 data*
	mitigation efficiency (%)	50	*estimated mitigation efficiency of twice daily watering*
	E (kg/day/hectare)	1.0008E+00	*calculated as in AP-42*
	E (kg/day/sq.m)	1.0008E-04	*calculated*
	E (kg/day)	0.77	*calculated*
5	**Haul truck on unpaved access road**		
	particle size multiplier	0.8	*from AP-42*
	silt content of road surface material (%)	5	*estimated*
	mean vehicle speed (km/hr)	20	*reduced speed by speed control*
	mean vehicle weight (Mg)	15	*from Engineer*
	mean number of wheel	10	*from Engineer*
	number of days with >= 0.254 mm	120	*from RO 1991 data*
	mitigation efficiency (%)	70	*estimated mitigation efficiency of watering every 1.5 hrs*
	E (kg/VKT)	2.4968E-01	*calculated as in AP-42*
	Average trip distance - to and fro (km)	0.24	*estimated*
	No. of vehicle trip per day	150	*calculated*
	E (kg/day)	8.99	*calculated*

Item	96530 - Route 3 Conveyor System, Operation Phase Description	TSP w/ mitigation	Remarks
Scenario A			
1	**Drop from main conveyor to stockpile**		
	particle size multiplier	0.77	*from AP-42 for TSP*
	material silt content (%)	1.6	*from AP-42, stone quarrying and processing*
	average wind speed (m/s)	3.45	*from RO SHL 1991 data*
	drop height (m)	10	*estimated*
	material moisture content (%)	0.7	*from AP-42, stone quarrying and processing*
	E (kg/Mg)	9.4629E-03	*calculated as in AP-42*
	E (kg/day)	454.22	*calculated*
2	**Drop from conveyors to barges**		
	particle size multiplier	0.77	*from AP-42 for TSP*
	material silt content (%)	1.6	*from AP-42, stone quarrying and processing*
	average wind speed (m/s)	3.45	*from RO SHL 1991 data*
	drop height (m)	5	*estimated*
	material moisture content (%)	0.7	*from AP-42, stone quarrying and processing*
	E (kg/Mg)	4.7314E-03	*calculated as in AP-42*
	E (kg/day)	227.11	*calculated*
3	**Wind erosion of stockpile**		
	material silt content (%)	1.6	*from AP-42*
	no. of day with >=0.25mm rainfall	120	*from RO 1991 data*
	time with > 5.4 m/s wind speed (%)	14.21	*from RO SHL 1991 data*
	E (kg/day/hectare)	2.0016	*calculated as in AP-42*
	E (kg/day)	0.76	*calculated*
4	**Wind erosion of open site**		
	material silt content (%)	1.6	*from AP-42*
	no. of day with >=0.25mm rainfall	120	*from RO 1991 data*
	time with > 5.4 m/s wind speed (%)	14.21	*from RO SHL 1991 data*
	E (kg/day/hectare)	2.0016	*calculated as in AP-42*
	E (kg/day)	0.78	*calculated*
	Wind erosion of uncovered conveyors to barges		
5	material silt content (%)	1.6	*from AP-42*
	no. of day with >=0.25mm rainfall	120	*from RO 1991 data*
	time with > 5.4 m/s wind speed (%)	14.21	*from RO SHL 1991 data*
	width of conveyor (m)	1	*estimated*
	E (kg/day/hectare)	2.0016	*calculated as in AP-42*
	E (kg/day)	0.02	*calculated*

Scenario B			
1	Drop from main conveyor to stockpile		
	particle size multiplier	0.77	*from AP-42 for TSP*
	material silt content (%)	1.6	*from AP-42, stone quarrying and processing*
	average wind speed (m/s)	3.45	*from RO SHL 1991 data*
	drop height (m)	2	*reduce drop height using telescopic chute or rock ladder*
	material moisture content (%)	0.7	*from AP-42, stone quarrying and processing*
	mitigation efficiency (%)	70	*by applying water/surfactant curtain*
	E (kg/Mg)	5.6777E-04	*calculated as in AP-42*
	E (kg/day)	27.25	*calculated*
2	Drop from conveyors to barges		
	particle size multiplier	0.77	*from AP-42 for TSP*
	material silt content (%)	1.6	*from AP-42, stone quarrying and processing*
	average wind speed (m/s)	3.45	*from RO SHL 1991 data*
	drop height (m)	5	*estimated*
	material moisture content (%)	0.7	*from AP-42, stone quarrying and processing*
	mitigation efficiency (%)	70	*by applying water/surfactant curtain*
	E (kg/Mg)	1.4194E-03	*calculated as in AP-42*
	E (kg/day)	68.13	*calculated*
3	Wind erosion of stockpile		
	material silt content (%)	1.6	*from AP-42*
	no. of day with >=0.25mm rainfall	120	*from RO 1991 data*
	time with > 5.4 m/s wind speed (%)	14.21	*from RO SHL 1991 data*
	E (kg/day/hectare)	2.0016	*calculated as in AP-42*
	E (kg/day)	0.76	*calculated*
4	Wind erosion of open site		
	material silt content (%)	1.6	*from AP-42*
	no. of day with >=0.25mm rainfall	120	*from RO 1991 data*
	time with > 5.4 m/s wind speed (%)	14.21	*from RO SHL 1991 data*
	E (kg/day/hectare)	2.0016	*calculated as in AP-42*
	E (kg/day)	0.78	*calculated*
	Wind erosion of uncovered conveyors to barges		
5	material silt content (%)	1.6	*from AP-42*
	no. of day with >=0.25mm rainfall	120	*from RO 1991 data*
	time with > 5.4 m/s wind speed (%)	14.21	*from RO SHL 1991 data*
	width of conveyor (m)	1	*estimated*
	E (kg/day/hectare)	2.0016	*calculated as in AP-42*
	E (kg/day)	0.02	*calculated*

APPENDIX C
ROUTE 3 - COUNTRY PARK SECTION
GEMINI BEACH STOCKPILING SITE
NOISE IMPACT ASSESSMENT STUDY -
FINAL STUDY (EXTRACTS)

Report No: 21689/2

For:

Dragages et Travaux Publics (HK) Ltd
9 & 10/F Tung Wai Commercial Building
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Wanchai
Hong Kong

ROUTE 3 -COUNTRY PARK SECTION

GEMINI BEACH STOCKPILING SITE

NOISE IMPACT ASSESSMENT STUDY

FINAL REPORT

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March 1995

ARUP

CONTENTS

AIMS

To study the potential noise emission in the proposed site with respect to aggregates stockpiling operation which includes :

i) noise emanating from the primary conveyor belt system transporting aggregates of approximately size 250mm to the stockpiling site;
ii) impact noise emission from the aggregates when dropping from the primary conveyor belt system onto the stockpile; and
iii) impact noise emission from the aggregates when dropping from the underground secondary conveyor belt system onto a barge.

To assess the noise impact on the noise sensitive receivers (NSRs) in the neighbourhood caused by the proposed activities.

To propose, where required, noise mitigation measures to reduce the operational noise impact to meet with the requirements of the Noise Control Ordinance.

SUMMARY

Noise survey was conducted on 1 March 1994 at the Lamma Quarry site in Lamma Island. The noise measurements were made at both the stockpile point and the barge loading point.

Calculations indicate that the operations of the stockpiling and barge loading would result in noise levels of 64dB(A) and 61B(A) Leq at the identified noise sensitive receivers (NSR 1 & NSR 2). Noise predictions show that the facade noise levels at the worst affected NSRs due to these activities will be within the acceptable noise levels for daytime and evening.

It is recommended that barge loading should be restricted to daytime and evening (0700 - 2300hrs). The stockpiling can be carried on at night-time provided that the conveyor and stockpile are acoustically enclosed.

1 INTRODUCTION

Arup Acoustics was commissioned by Dragages et Travaux Publics (HK) Ltd to carry a stúdy on the potential noise emission in the proposed Gemini Beach site with respect to stockpiling and barge loading operations. The operations will involve the use of primary conveyor belt systems to transport the aggregates to the stockpiling point at the Gemini Beach site. A secondary underground conveyor belt system will then transport and load the aggregates onto a barge.

This report presents the results of the noise survey at the Lamma Quarry site and assesses the noise impacts on the adjacent noise sensitive receivers (NSRs). Noise monitoring is recommended for the proposed activities on site to ensure compliance with the statutory requirements.

2 SITE AND NOISE SURVEYS

2.1 Date and Time

The site inspection (Figure 1) was conducted on 27 February 1995 at Gemini Beach and two NSRs were identified for the noise assessment. A night-time noise survey was conducted at the site on 28 and 29 March 1995. The noise measurements of the stockpiling and barge loading operations at the Lamma Quarry site (see Appendix 4) were made on 2 March 1995, between 0900hr to 1100hr.

2.2 Instrumentation

The instrumentation used by Arup Acoustics for the noise surveys is listed below.

MANUFACTURER	TYPE
Bruel and Kjaer	Modular Precision Sound Level Meter Type 2231
Bruel and Kjaer	1/2" Prepolarised Condenser Microphone Type 4155
Bruel and Kjaer	Noise Calibrator Type 4230
Bruel and Kjaer	Foam Windshield Type UA0237

The sound level meter was calibrated before use and further checks on completion of the survey confirmed that there had been no significant drift of calibration.

2.3 Weather Conditions

Light winds prevailed during both surveys but the conditions did not adversely affect the measurements.

2.4 Survey Personnel

The surveys were conducted by Mr Sam Tsoi, Mr Wilson Ho, Mr Paul Malpas and Mr Raj Patel of Arup Acoustics.

2.5 Survey Method

The microphone was positioned at 1.2m above ground level. The sound level meter was used to determine the equivalent continuous sound pressure level L_{eq} (Appendix 1).

2.6 Survey Locations

Noise measurements were made at the stockpiling point with the conveyor belt system in operation. The noise level emitted from loading the barge was also measured taken into account of safety and minimum interference to the activities. The distances of the microphones from the noise sources were listed in Appendix 2.

The noise measurement locations at Gemini Beach were selected to be representative of the noise at the NSRs.

3 ASSESSMENT OF IMPACTS OF THE SITE ON THE NOISE SENSITIVE RECEIVERS

3.1 Noise Sensitive Receivers (NSRs)

The existing NSRs (1 & 2) are villa type buildings of two to three storeys high. Pink Villa (NSR 1) is approximately 45m to the Northwest of the site boundary. Homi Villa (NSR 2) is approximately 115m to the Northwest of the site boundary (see Figure 1).

The NSRs located further up on Castle Peak Road were considered less affected from the site in comparison with NSR 2. These NSRs are therefore not being considered in this study.

3.2 Measured Noise Levels and Calculated Sound Power Levels of activities

The noise generating activities considered are listed below:

- o Primary conveyor belt system
- o Stockpiling operation
- o Barge loading operation

The operation for loading aggregates onto the barge is similar to the stockpiling but includes some contributions from the impact of the grab with the sides of the barge or lorry. The barge loading operation on Gemini Beach site will be fed by an underground secondary conveyor belt system. As such, dump trucks will not be required for this site.

Based on the measured noise levels at the Lamma Quarry site, the sound power levels are calculated and presented in Appendix 2. A summary of the calculated sound power levels of activities is given in Table 3.1 below.

Activities	Sound Power Level, dB(A) L_{eq}
Aggregates stockpiling	111
Loading aggregates onto the barge	122
Primary conveyor belt (extracted from TM)	90

Table 3.1 : Calculated Sound Power Levels of major activities.

3.3 Predicted Noise Levels of activities at NSR Locations

The predicted noise levels at the two NSR locations are summarised below in Tables 3.2. Calculations are shown in Appendix 3.

	Site Operations					
NSR	Stock-Piling	Barge	Conveyor Belt	Total	Facade correction	CNL
1	53	60	43	63	+3	64
2	48	57	43	58	+3	61

Table 3.2 : Corrected Noise Levels (CNLs) in dB(A) L_{eq} at NSR locations

4 STIPULATED NOISE CRITERIA

The noise limits for residential flats are specified in the "Technical Memorandum on noise from construction work other than percussive piling" published by the Environmental Protection Department. The noise limits apply at the NSR due to the total noise generated by all noise sources. The noise limits do not include any contribution from the pre-existing background noise at the NSR.

The NSRs in the neighbourhood of the Gemini Beach site are located in an rural area which is indirectly affected by traffic noise from Tuen Mun Road. The appropriate Area Sensitivity Rating (ASR) is "B". The Acceptable Noise Limits (ANLs) are summarised below.

Time Period	Acceptable Noise Limit, dB(A)
All day during the evening (1900 to 2300 hours), and general holidays (including Sundays) during the daytime and evening (0700 to 2300 hours)	65
All days during the night-time (2300 to 0700 hours)	50

Table 4.1: Acceptable Noise Limits

5 DISCUSSIONS AND RECOMMENDATIONS

5.1 Predicted noise levels at the Noise Sensitive Receivers without mitigation

The corrected noise levels at the identified NSR 1 and NSR 2 locations are 64dB(A) and 61dB(A) L_{eq} respectively. Comparing with the noise limit for the evening, there will be no noise exceedance and hence, complaints from the residents about the operations at site will be unlikely.

When comparing the corrected noise levels at the identified NSR locations with the night-time noise limit, the exceedance is 11dB(A) and 14dB(A) respectively.

5.2 Restricted Operating Hours

In light of the above predicted noise levels at the NSRs, it is necessary to restrict the operating hours of the proposed site activities to daytime and evening only, ie between 0700 - 2300hrs.

Night-time operations will not be feasible without extensive noise control measures, such as a semi-enclosure for the site.

5.3 Recommended noise mitigation measures

The noise of barge loading is predicted to dominate the noise levels at the NSRs. No practical measures can be adopted to reduce this noise and it is clear that this activity cannot be carried out at night.

The predicted noise levels at the NSR locations, especially at Pink Villa (NSR 1), are within the noise limit by a small margin, it is therefore essential that the following operational parameters should be considered :

a) To ensure that the number of powered mechanical equipment will correspond to the number used in the noise prediction.

b) Operating hours - to restrict the barge loading hours strictly within 0700 - 2300 hours.

c) Noise monitoring - to adopt the recommended noise monitoring programme so as to ensure compliance of noise criterion at the NSR locations.

The noise of stockpiling can be reduced by installing the following noise mitigation measures:

a) Provide an acoustic enclosure for stockpile. This would be in the form of a canopy made of acoustic panels which would extend over the whole stockpile, with side walls also made of acoustic panels (see Figure 2).

b) The conveyer shall be fitted with a full enclosure which would run from the stockpile enclosure to Tuen Mun Road (see Figure 2). The acoustic enclosure for both the stockpile and the conveyor should be constructed of 100mm thick steel acoustic panels (see Figure 3).

5.4 Predicted noise levels at Noise Sensitive Receivers with mitigation

The corrected noise levels at NSR1 and NSR2 due to the stockpiling, including the mitigation measures, are 40dB(A) and 37dB(A)Leq respectively. These levels are below the night-time ANL of 50dB(A)Leq and therefore complaints are considered unlikely. It should also be noted that the calculated CNLs are significantly below the measured night-time noise levels at the site which were between 52dB(A) and 61dB(A)Leq.

6 NOISE MONITORING

Noise monitoring will be required at the NSR locations and shall be carried out by the site representative with the following objectives:

- To monitor noise levels during the operational period to ensure that daytime and evening noise limit of 65dB(A) is not exceeded at the NSRs.
- To provide noise measurement records to support that the noise limit has been complied with.
- To provide data to determine additional noise mitigation measures which may be required if changes in the site activities are required.

6.1 Locations of noise monitoring points

The noise monitoring shall be conducted at the identified NSRs, ie locations

NSR 1 and NSR 2 in Figure 1. The assessment point shall be at a position 1m from the exterior of the building facade but may be at other point considered to be appropriate by the Authority.

6.2 Instrumentation

The sound level meters to be used by the measuring person on behalf of the PM shall comply with Type 1 specifications given in International Electrical Commission (IEC) publications 651:1979 and 804:1985. The calibration equipment to be used on site shall comply with IEC 942, Type 1 specifications.

Other measuring and analytical instrumentation used shall be of a comparable professional quality. Microphones giving a free-field response shall be used for noise monitoring. Wherever necessary, the equipment shall be protected against moisture and other weather elements. If long-term monitoring is considered to be necessary, the equipment shall be protected in a weather-proof case and a microphone unit suitable for outdoor use shall be used. The equipment shall be used in accordance with manufacturer's instructions.

The noise monitoring equipment is required to be calibrated annually by an accredited calibration laboratory for compliance with the appropriate parts of IEC publications 651 and 804 (and any other relevant national standard).

On site calibration requires that before and after each set of noise measurements, the accuracy of the sound level meter shall be checked using the calibrator in accordance with the guidelines given by the equipment manufacturer to ensure that no significant drift of greater than 0.5dB in the calibration results.

The noise monitoring shall be carried out with reference to the following TM:

(a) Technical Memorandum on the Assessment of Noise from Construction Work other than Percussive Piling, Hong Kong Government.

6.3 Monitoring Frequency

The time of measurement and monitoring period shall comply with the TM and be appropriate to ensure that the noise measured are truly representative of site activities.

The noise parameter shall be the A-weighted equivalent continuous sound pressure level (L_{Aeq}) with an integrating sound level meter using the "fast" response mode. Noise measurements shall be taken over a 5-minute period.

Noise measurements shall not be made in the presence of mist, fog or rain or with wind at a steady speed exceeding 5m/s, or gusts exceeding 10m/s. Measurements shall not be made outside the conditions as recommended by the equipment manufacturers.

Noise measurements shall not be made when extraneous noise sources (other than Influencing Factors) are apparent at the assessment point. If this cannot be practically avoided, a suitable correction shall be made of such sources in the assessment procedures.

6.4 Reporting

A record shall be kept by the site representative of the measured noise results. In recording the results, the following information relating to the monitoring shall be presented :

- Site name.
- A record of site activities during noise measurements.
- The date and time period over which the monitoring was undertaken.
- Details of the assessment point, including its location, distance from the construction activity being monitored, description of noise screen or intervening topography, height above ground level and distance from any reflecting surface.
- Weather conditions, including wind speed and direction, rain, mist and fog.
- Details of sound level measuring equipment used, including the manufacturer, model/type, serial number and date of last full calibration by an accredited laboratory.
- Equipment settings.
- Calibration levels before and after measurements.
- Presence of Influencing Factors, if any.
- The name of the engineer conducting the noise monitoring.
- Any other information likely to be appropriate (eg presence of extraneous noise sources that are not representative of the site activities during the monitoring period).

7 CONCLUSIONS

A noise survey has been conducted at Lamma Quarry site for the estimation of the potential noise emission in the proposed Gemini Beach site with respect to aggregates stockpiling and barge loading activities.

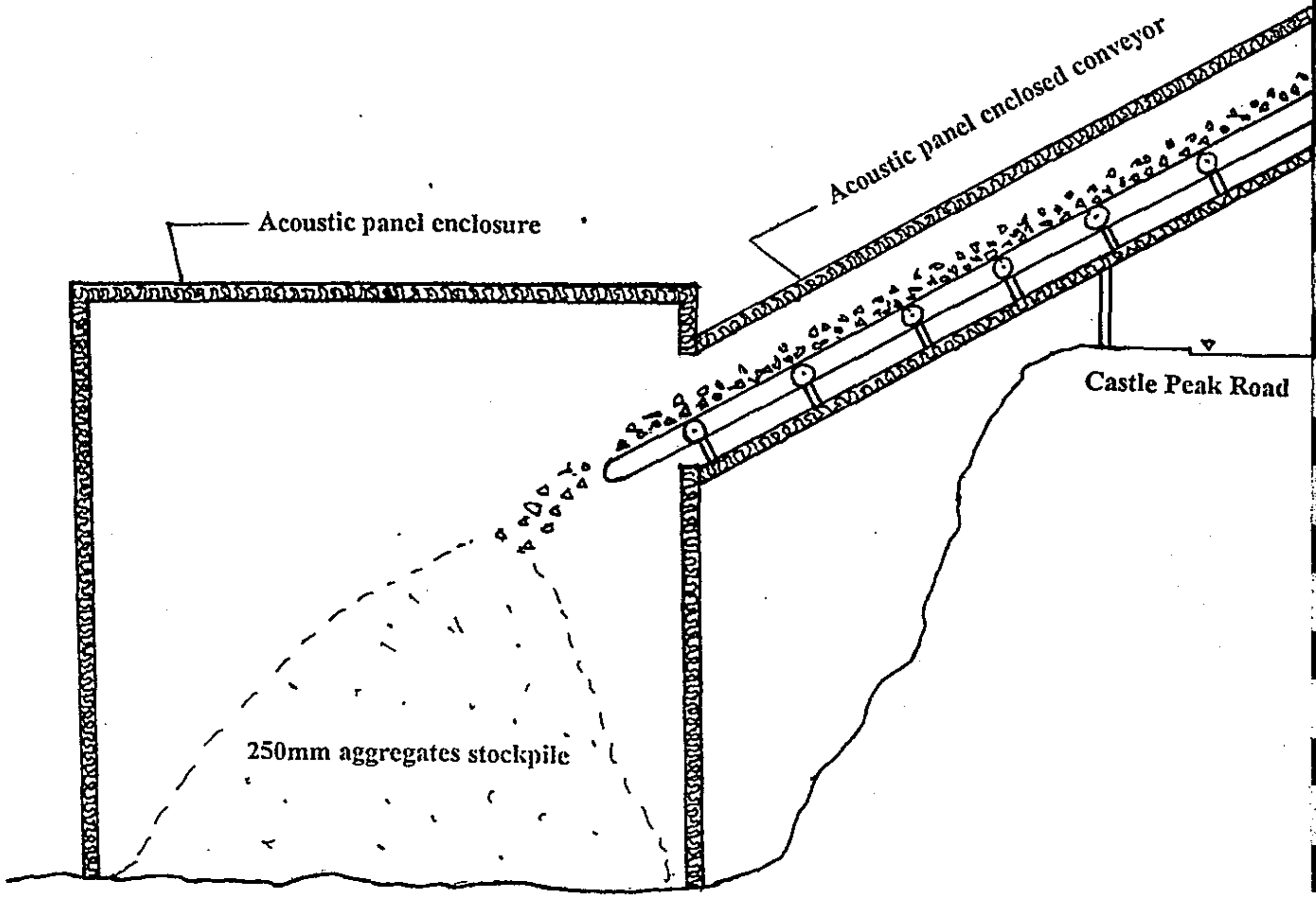
Noise impacts on the existing noise sensitive receivers have been assessed. The predicted noise levels at the building facades of the worst affected NSRs will be within the stipulated noise limit of 65dB(A) for evening (1900 -2300hr) and on Public Holidays (0700 - 2300hr).

In order to meet the night-time noise limit of 50dB(A) it will be necessary to provide noise mitigation measures. With an acoustic enclosure for the stockpile and a full enclosure of the conveyor upto Tuen Mun Road the night-time noise limit will be met.

Site and NSR locations

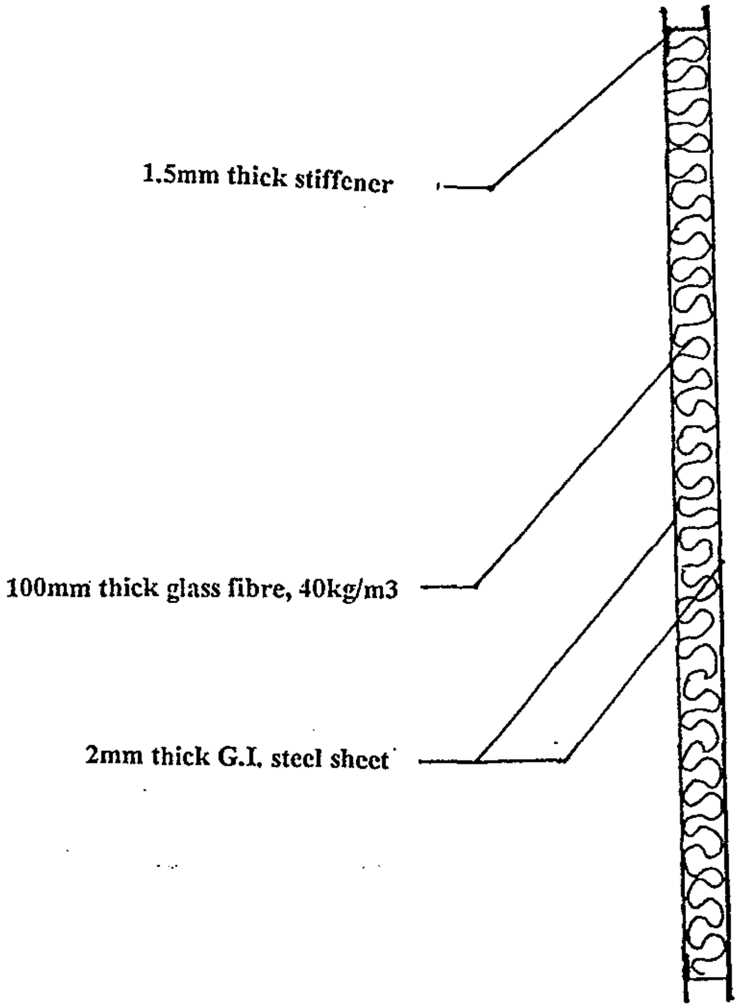
21689

FIGURE 1



Sketch of the Acoustic Enclosure

21689 FIGURE **2**



Details of Acoustic Panels

21689 FIGURE **3**

APPENDIX 1

ACOUSTIC TERMINOLOGY

Appendix 1

Acoustic Terminology

General

Noise is simply the rapid fluctuation of air pressure, usually resulting from the vibration of a noise source. The rate of these fluctuations determines the pitch of the noise and their magnitude determines the volume.

Sound Pressure Level

Sound Pressure Level is a measure of the sound level at a location with a specified distance from a sound source. It is the sound pressure expressed in decibels (dB re 2 x 10^{-5} Pa). It is a quantity directly measurable by a sound level meter. To draw an analogy, sound power is the rated electrical power of an electric heater in a room and sound pressure level is the temperature caused by the heater at a specified location inside the room.

dB(A)

The human ear is not as responsive to low-frequency sound as it is to high-frequency sound. This effect can be simulated electronically and the resulting overall level is called the A-weighted level or the dB(A) level. Research over many years has shown that sound pressure levels expressed in dB(A) give a good guide to the subjective response.

Equivalent Continuous Noise Level, L_{eq}

The Equivalent Continuous Noise Level, or L_{eq}, is used to describe a varying noise level. It is defined as the level of constant noise that contains the same acoustic energy as the non-constant noise, and is thus an energy average. This unit is becoming increasingly used to describe a broad range of noise sources.

APPENDIX 2

MEASURED NOISE LEVELS & CALCULATED SOUND POWER LEVELS

Project: Route 3 Country Park Section
Title: Estimation of SWL of site activities
Date: 3 March, 1995

Activities: Aggregates Stockpiling
Barge loading

Plant Items	Leq (dB(A))	Dist. (m)	Corr. (dB(A))	Lw (dB(A))	Remark
Stockpiling	86	7	25	111	
Barge loading	102	4	20	122	
Conveyor belt	-	-	-	*90	CNP 041

*Noise level of the conveyor belt system at Lamma Quarry site is below background noise
the sound power level of the conveyor belt system is extracted from the TM

APPENDIX 3

PREDICTED FACADE NOISE LEVELS AT NSRs

Project: Route 3 Country Park Section
Title: Prediction of Stockpiling Noise at NSRs
Date: 3 March, 1995

NSR1: Pink Villa at Northwest of the Stockpiling Point (see Figure 1)

Noise Sources: Operational
1 container barge at Gemini Beach
1 conveyor system forwarding aggregates to the stockpiling point
1 underground conveyor system forwarding the aggregates onto the container barge

Scenario: Daytime and Evening (0700hr - 2300hr) - All noise sources in operation
(with noise mitgation measures)

Plant Items	Lw (dB(A))	Dist. (m)	Corr. (dB(A))	No. off	Screen Loss	Enclosure Loss	Facade Correction	Lp (dB(A))
Barge loading	122	153	-52	1	-10	0	3	63
Stockpiling Point	111	95	-48	1	-10	-20	3	56
Conveyor System (segment 1)	87	90	-47	1	0	-10	3	43
Conveyor System (segment 2)	87	240	-56	1	0	0	3	34

Total Leq 64 dB(A)

Project: Route 3 Country Park Section
Title: Prediction of Stockpiling Noise at NSRs
Date: 3 March, 1995

NSR1: Pink Villa at Northwest of the Stockpiling Point (see Figure 1)

Noise Sources: Operational
1 container barge at Gemini Beach
1 conveyor system forwarding aggregates to the stockpiling point
1 underground conveyor system forwarding the aggregates onto the container barge

Scenario: Daytime and Evening (0700hr - 2300hr) - All noise sources in operation
(without noise mitgation measures)

Plant Items	Lw (dB(A))	Dist. (m)	Corr. (dB(A))	No. off	Screen Loss	Facade Correction	Lp (dB(A))
Barge loading	122	153	-52	1	-10	3	63
Stockpiling Point	111	95	-48	1	-10	3	56
Conveyor System	90	90	-47	1	0	3	46

Total Leq 64 dB(A)

Project: Route 3 Country Park Section
Title: Prediction of Stockpiling Noise at NSRs
Date: 3 March, 1995

NSR1: Pink Villa at Northwest of the Stockpiling Point (see Figure 1)

Noise Sources: Operational
1 conveyor system forwarding aggregates to the stockpiling point

Scenario: Night-time (2300hr - 0700hr) - All noise sources in operation
(with noise mitigation measures)

Plant Items	Lw (dB(A))	Dist. (m)	Corr. (dB(A))	No. off	Screen Loss	Enclosure Loss	Facade Correction	Lp (dB(A))
Stockpiling Point	111	95	-48	1	-10	-20	3	36
Conveyor System (segment 1)	87	90	-47	1	0	-10	3	33
Conveyor System (segement 2)	87	240	-56	1	0	0	3	34

Total Leq 40 dB(A)

Project: Route 3 Country Park Section
Title: Prediction of Stockpiling Noise at NSRs
Date: 3 March, 1995

NSR2: Homi Villa at Northeast of the Stockpiling Point (see Figure 1)

Noise Sources: Operational
1 container barge at Gemini Beach
1 conveyor system forwarding aggregates to the stockpiling point
1 underground conveyor system forwarding the aggregates onto the container barge

Scenario: Daytime and Evening (0700hr - 2300hr) - All noise sources in operation
(without noise mitigation measures)

Plant Items	Lw (dB(A))	Dist. (m)	Corr. (dB(A))	No. off	Screen Loss	Facade Correction	Lp (dB(A))
Barge loading	122	214	-55	1	-10	3	60
Stockpiling Point	111	182	-53	1	-10	3	51
Conveyor System	90	135	-51	1	0	3	42

Total Leq 61 dB(A)

Project: Route 3 Country Park Section
Title: Prediction of Stockpiling Noise at NSRs
Date: 3 March, 1995

NSR2: Homi Villa at Northeast of the Stockpiling Point (see Figure 1)

Noise Sources: Operational
1 container barge at Gemini Beach
1 conveyor system forwarding aggregates to the stockpiling point
1 underground conveyor system forwarding the aggregates onto the container barge

Scenario: Daytime and Evening (0700hr - 2300hr) - All noise sources in operation
(with noise mitigation measures)

Plant Items	Lw (dB(A))	Dist. (m)	Corr. (dB(A))	No. off	Screen Loss	Enclosure Loss	Facade Correction	Lp (dB(A))
Barge loading	122	214	-55	1	-10	0	3	60
Stockpiling Point	111	182	-53	1	-10	-20	3	51
Conveyor System (segment 1)	87	135	-51	1	0	-10	3	39
Conveyor System (segment 2)	87	240	-56	1	0	0	3	34

Total Leq 61 dB(A)

Project: Route 3 Country Park Section
Title: Prediction of Stockpiling Noise at NSRs
Date: 3 March, 1995

NSR2: Homi Villa at Northeast of the Stockpiling Point (see Figure 1)

Noise Sources: Operational
1 conveyor system forwarding aggregates to the stockpiling point

Scenario: Night-time (2300hr - 0700hr) - All noise sources in operation
(with noise mitigation measures)

Plant Items	Lw (dB(A))	Dist. (m)	Corr. (dB(A))	No. off	Screen Loss	Enclosure Loss	Facade Correction	Lp (dB(A))
Stockpiling Point	111	182	-53	1	-10	-20	3	31
Conveyor System (segment 1)	87	135	-51	1	0	-10	3	29
Conveyor System (segment 2)	87	240	-56	1	0	0	3	34

Total Leq 37 dB(A)

APPENDIX 4

PHOTOGRAPHS

Plate 1 : The site (Gemini Beach)

Plate 2 : NSR 1 - Pink Villa

Plate 3 : NSR 2 - Homi Villa

Plate 4 : West view from site (towards NSR 1 - Pink Villa)

Plate 5 : East view from site (towards NSR 2 - Homi Villa)

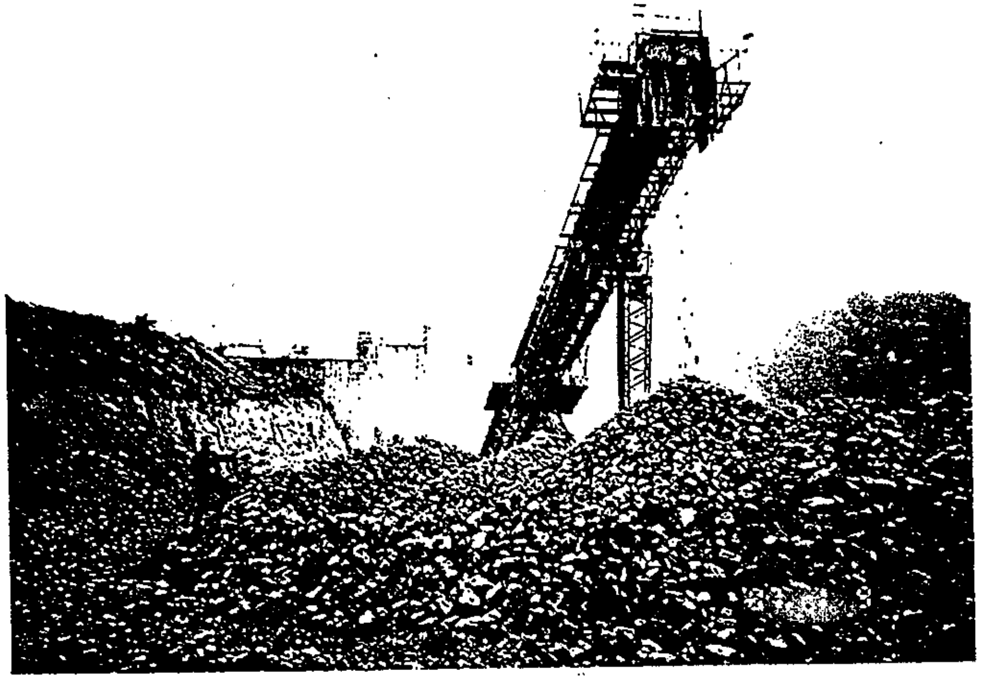


Plate 6 : Conveyer belt system at Lamma Quarry site

Plate 7 : Noise measurement at stockpiling point

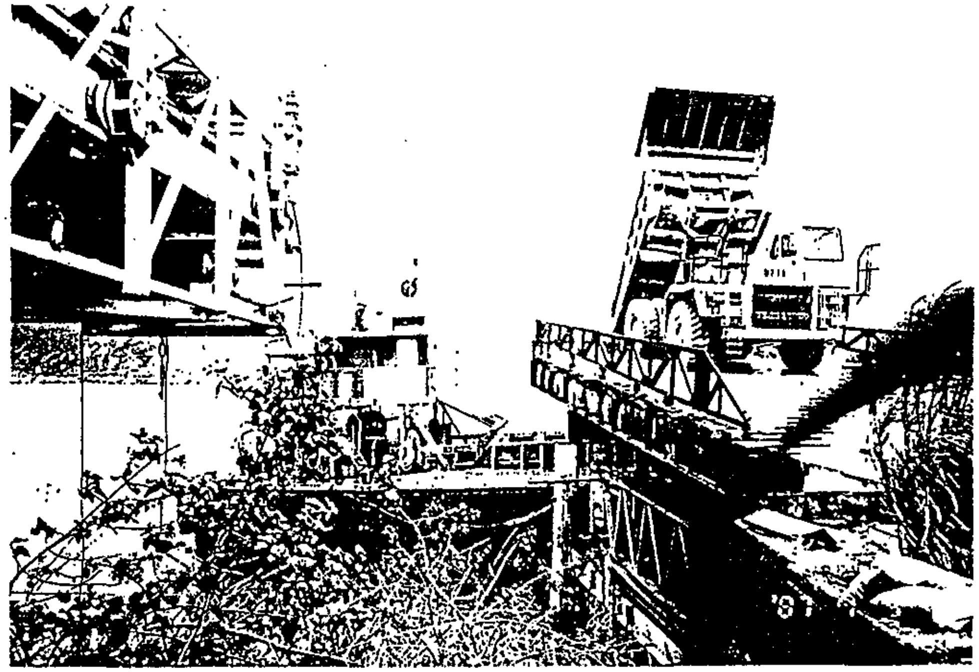


Plate 8 : Loading of container barge at Lamma Quarry site

APPENDIX D
PRELIMINARY REPORTS FOR STREAM *E. COLI* TESTING

MateriaLab

W

Lab. No. :

Report No. : 951445WA50036

REPORT ON ANALYSIS OF WATER

Client : Woodward-Clyde International

Project : Gemini - Beach - Route 3

Sample description : One sample of water

Sample identification : Sample #1

Tests required : E-coli count

PRELIMINARY TEST RESULT

This result is released for information only and is not a formal report. Please note that the contents of this report may be revised.

Released by:

MATERIALAB LIMITED

Date received : 20/07/95

Date completed : 22/07/95

Methods used : millipore ~~pre~~ we filtration method using membrane lauryl sulphate broth, incubated at 44.5°C for 18-22 hrs and confirmed by urease test.

Result :

Testing item	Result
E-coli count, cfu/100ml	1.4×10^2

Prepared ~~Tested~~ by : Monica Cho Certified by :

Checked by : Date :