

8 FISHERIES IMPACT ASSESSMENT

8.1 Introduction

This Section presents an assessment of potential impacts to fisheries associated with the construction and operation of Route 10 (NLYLH) (Southern Section). Potential sources of impact associated with the construction have been identified and assessed. Preliminary requirements for mitigation and monitoring are recommended where appropriate. The assessment focuses on an identification and evaluation of impacts to fisheries resources, fishing operations and culture fisheries.

The objectives of the assessment are as follows:

- to establish the importance of the habitats affected by the construction works;
- to identify fisheries sensitive receivers;
- to assess the scale of possible impacts to fisheries from the construction and operation of the works;
- to highlight any insurmountable impacts to fisheries;
- to identify any mitigation measures and residual impacts; and
- to assess the need for a fisheries monitoring and audit programme.

8.2 Government Legislation and Guidelines

The criteria for evaluating fisheries impacts are laid out in the Technical Memorandum on Environmental Impact Assessment Process of the Environmental Impact Assessment Ordinance (Cap 499) (EIAO TM). *Annex 17* sets out the general approach and methodology for assessment of fisheries impacts. *Annex 9* recommends some criteria that can be used for evaluating fisheries impacts. This assessment allows a complete and objective identification, prediction and evaluation of the potential fisheries impacts.

Other legislation that applies to fisheries includes:

- Fisheries Protection Ordinance (Cap 171) 1987 which provides for the conservation of fish and other aquatic life and regulates fishing practices; and
- Marine Fish Culture Ordinance (Cap 353) 1983 which regulates and protects marine fish culture and other related issues.

8.3 Baseline Information

8.3.1 Introduction

In Hong Kong, the commercial marine fishery industry is divided into capture and culture fisheries. To assess the capture fishery within the Study Area, previous fishery reports from AFD were consulted together with results from the AFD Study of Fishing Operations and Fisheries Resources in Hong Kong Waters¹. Mariculture information was obtained from the AFD Annual Report 1996/97.

Although the proposed construction works may not lead to any loss of fishing grounds or nursery areas, the potential impacts to water quality upon the commercial fishing grounds and nursery areas around Ma Wan are discussed.

8.3.2 Capture Fisheries

In 1996, the estimated fisheries production in Hong Kong Waters from both capture and culture fisheries amounted to 192,160 tonnes, valued at HK\$ 2,459 million². Capture fisheries accounted for 96 % by weight of the total production. The remaining 4 % corresponded to the culture sectors of the industry. Within Hong Kong Waters, the highest yields for local fisheries were mainly derived from the eastern and northeastern coasts³.

Fishing Operations

The proposed construction area is within AFD fishery area zones Fa Peng (0001), Tsing Chau Tsai (0024) and Tsing Lung Tau (0038). The waters of these three zones are referred to as the Construction Area. The fishery operations and resources within the adjacent fishery areas (Yam O, 0023; Ma Wan, 0025; Tsing Yi, 0034; Ting Kau, 0036; Sham Tseng, 0037; Tai Lam Chung, 0039) will also be potentially affected and are also discussed. These six zones, combined with the three zones of the Construction Area, make up the Study Area (*Figure 8.1*).

¹ ERM (1998). Fisheries Resources & Fishing Operations in Hong Kong Waters. Final Executive Summary, submitted to AFD.

² AFD (1996). Annual Departmental Report 1995-1996.

³ ERM (1998). *op cit.*

Table 8.1 Total Value (HK\$), Adult Catch (kg) and Fry Catch (tails) Displayed on a Total Production, Production per Hectare and Rank (per Hectare) Basis for the Fishing Zones in the Study Area (All Fishing Vessels)⁴

Fishing Area and AFD Code	Total Production			Production (ha ⁻¹)			Rank (Production ha ⁻¹)		
	Adult Fish (kg)	Value (HK\$)	Fry (tails)	Adult Fish (kg)	Value (HK\$)	Fry (tails)	Adult Fish (kg)	Value (HK\$)	Fry (tails)
Construction Area									
0001 Fa Peng	12,384	492,411	-	42	1,661	-	131	118	-
0024 Tsing Chau Tsai	38,943	1,825,481	7,661	229	10,718	45	39	15	46
0038 Tsing Lung Tau	35,179	1,801,583	7,661	161	8,235	35	62	25	58
Other Fishing Areas									
0023 Yam O	63,009	1,699,973	-	119	3,208	-	82	85	-
0025 Ma Wan	81,988	4,496,689	7,661	196	10,672	18	48	16	68
0034 Tsing Yi	47,426	1,888,784	-	36	1,424	-	139	127	-
0036 Ting Tau	36,042	1,408,040	-	161	6,279	-	63	36	-
0037 Shum Tseng	1,251	7,661	-	15	89	-	157	172	-
0039 Tai Lam Chung	7,908	270,130	-	21	729	-	148	153	-

On the basis of their ranking (see *Table 8.1*), the fishing zones of the Study Area are of varied importance (from low to medium-high) to the Hong Kong fishing industry. The fishing zones of low ranking include Fa Peng (0001), Tsing Yi (0034), Shum Tseng (0037) and Tai Lam Chung (0039), whereas the fishing zones of medium-high ranking include Tsing Chau Tsai (0024), Yam O (0023), Ma Wan (0025), Ting Tau (0036) and Tsing Lung Tau (0038).

The proposed dredging/reclamation works will affect two fishing zones: Tsing Lung Tau (0038) and Fa Peng (0001). Tsing Lung Tau is ranked medium-high to the Hong Kong fishing industry. However, the small reclaimed area will cover only 2.6 hectares which constitutes 1% of the total area (218.77 ha) and provides a production value of only HK\$ 21,411. As Fa Peng is of low ranking, the small dredged/reclaimed area of 5.5 hectares (2% of the total area of 296.5 ha and a production value of HK\$ 9,136) is predicted to exert minimal impact to the Hong Kong fishing industry.

⁴ AFD (1998). Port Survey 96/97, Capture Fisheries Division, Agriculture & Fisheries Department, August 1998.

The most abundant organisms in the catch from five out of the nine fishery zones were classified under the mixed fish species category (Table 8.2). The mixed fish species mainly comprise juveniles of scad (*Caranx kalla*), rabbit fish (*Siganus canaliculatus*), sardine (*Sardinella sp*), pony fish, (*Leiognathus brevirostris*) and gizzard shad (*Clupanodon punctatus*). The mixed species are of very low commercial value (HK\$ 1.6 kg⁻¹) and are sold as fish feed for the mariculture industry. From the species list presented in Table 8.2, the yellow croaker (*Pseudosciaena crocea*) and the silver shrimp (*Acetes sp*) are high value species (>HK\$ 15 kg⁻¹) while croaker (*Argyrosomus sp*) is medium value species (HK\$ 10-15 kg⁻¹). The remainder of the catch are of low value at <HK\$ 10 kg⁻¹.

Table 8.2 Five Most Abundant Fisheries Resources Caught within the Study Area. High and Medium Value Species are Underlined.

AFD Fishery Area	AFD Fishery Area Code	Most Abundant Organisms in decreasing order	Common name
Fa Peng	0001	<i>Muraenosox cinereus</i> Mixed fish species* <i>Sebasticus marmoratus</i> <i>Platycephalus indicus</i> <i>Oratosquilla</i> species	Conger pike eel Rockfish Flathead Mantis shrimp
Yam O	0023	Mixed fish species* <i>Sebasticus marmoratus</i> <i>Clupanodon punctatus</i> <i>Mugil affinis</i> <i>Sparidae</i> species	Rockfish Gizzard shad Mullet Sea bream
Tsing Chau Tsai	0024	Mixed fish species* <i>Sebasticus marmoratus</i> <i>Argyrosomus</i> species <i>Muraenosox cinereus</i> <i>Sparidae</i> species	Rockfish Croaker Conger pike eel Sea breams
Ma Wan	0025	<i>Siganus oramin</i> <i>Sebasticus marmoratus</i> Mixed fish species* <i>Argyrosomus</i> species <i>Sparidae</i> species	Rabbit fish Rockfish Croaker Sea breams
Tsing Yi	0034	Mixed fish species* <i>Argyrosomus</i> species <i>Siganus oramin</i> <i>Acetes</i> species <i>Muraenosox cinereus</i>	Croaker Rabbit fish Silver shrimp Conger pike eel

AFD Fishery Area	AFD Fishery Area Code	Most Abundant Organisms in decreasing order	Common name
Ting Kau	0036	Mixed fish species* <i>Acetes</i> species <i>Muraenosox cinereus</i> <i>Argyrosomus</i> species <i>Siganus oramin</i>	Silver shrimp Conger pike eel Croaker Rabbit fish
Shum Tseng	0037	Mixed crab species <i>Sillago sihama</i> <i>Siganus oramin</i> <i>Pseudosciaena crocea</i> <i>Leiognathus brevirostris</i>	Sand borer Rabbit fish Yellow Croaker Pony fish
Tsing Lung Tau	0038	Mixed fish species* <i>Sebasticus marmoratus</i> <i>Argyrosomus</i> species <i>Siganus oramin</i> <i>Acetes</i> species	Rockfish Croaker Rabbit fish Silver shrimp
Tai Lam Chung	0039	<i>Acetes</i> species <i>Muraenosox cinereus</i> Mixed fish species* <i>Sebasticus marmoratus</i> <i>Argyrosomus</i> species	Silver shrimp Conger pike eel Rockfish Croaker

* Mixed fish species composed of juveniles of *Caranx kalla*, *Siganus canaliculatus*, *Sardinella* sp, *Leiognathus brevirostris* and *Clupanodon punctatus*

Fisheries Resources

Recent construction works for the Airport Core Programme projects are likely to have caused disturbance to previously existing fisheries habitat in the area. These disturbances may have led to a reduction in the importance of the North Lantau coastline as a nursery area. The main commercial fisheries in the vicinity of North Lantau are shrimping and purse seining for migratory croaker⁵. Fish species can move away from temporarily affected areas. Shrimp are very prolific, and have remained in the area despite disturbance from recent marine construction works.

All fish and macroinvertebrate species recorded in a trawl survey undertaken in the South Tsing Yi area as part of the EIA for Backfilling of South Tsing Yi and North Lantau⁶ were commonly found in the coastal waters of Hong Kong. Their numbers and abundances were low. Key fisheries resources consist of rocky substrate around Ma Wan which provides important fisheries habitat and potential fish fry nursery areas along the east Lantau coast.

⁵ ERM-Hong Kong Ltd (1995) *op cit.*

⁶ *ibid.*

8.3.3 Culture Fisheries

Only one Fish Culture Zone (FCZ), Ma Wan, is identified in the Study Area. Information from the AFD Annual Report for 1997 indicates that the FCZ at Ma Wan consists of 138 licensed rafts with a total licensed area of 14,557 m² (total gazetted area = 46,300 m²). There are no figures available for individual production at this FCZ, although Hong Kong production in 1996 totalled 3,000 tonnes valued at \$173 million. The main species cultured were the spotted grouper (*Epinephelus chlorostigma*), goldlined seabream (*Rhabdosargus sarba*), mangrove snapper (*Lutjanus argentimaculatus*) and the pompano (*Trachinotus blochii*).

In April 1998 widespread toxic red tide algal blooms caused fish kills at many of the FCZs in Hong Kong. The Ma Wan FCZ, due to the fast currents in the vicinity, was the least affected of the FCZs and only minimal fish kills occurred (AFD pers comm).

8.4 Sensitive Receivers

Based on the preceding review of the available information on the baseline fisheries resources of the waters in the Study Area, the only sensitive receiver which may be affected by the project has been identified as Ma Wan FCZ.

New *ex gratia* arrangements for mariculturists affected by dredging and dumping projects were approved in July 1993. If, at any one time, the suspended solids concentration exceeds 50 mg L⁻¹ or exceeds by 100% the highest level recorded at the fish culture zone during the five years before commencement of works, mariculturists are eligible for *ex gratia* allowance payments. When such criteria are exceeded, appropriate mitigation measures, including stopping work if necessary, should be adopted to keep the impact within acceptable levels. Should *ex gratia* payments be triggered the eligible mariculturists may then opt to:

- continue mariculture in the same place at their own risk, in which case they would be eligible for an *ex gratia* allowance equivalent to 50 % of the normal two-year fish culture cycle; or,
- suspend mariculture operations for two years, in which case they would be eligible for an *ex gratia* equivalent to the notional loss of income for a normal two-year fish cycle; or
- cease mariculture operations permanently, in which case they would receive the existing *ex gratia* allowance payable for extinguishment, which contains elements for the notional loss of income for two years and the loss of capital investment in rafts and cages.

Ex gratia allowance payments have been administered at the Ma Wan FCZ to mariculturists affected by previous works in the vicinity.

8.5 Potential Impacts from Construction and Operation

8.5.1 Construction Impacts

Direct Impacts

Direct impacts to fishing operations and resources due to dredging/reclamation works may occur through killing fisheries resources by underwater blasting together with the total loss of 8.1 hectares of seabed area that supports fisheries resources at Tsing Lung Tau, Tso Wan and Fa Peng. Underwater blasting¹³ will only be carried out at Tsing Lung Tau and will probably be conducted for a period of 8 weeks (only one blast per day for a maximum of 60 days) and impacts are predicted to be intermittent. The losses in seabed area only constitute a loss of 1% of the Tsing Lung Tau Fishing Zone and 2% of the Fa Peng Fishing Zone. It should be noted that the direct/indirect impacts due to pier construction for Yi Chuen viaduct are likely to be negligible and will not be addressed further in this EIA, for only three slender piers are proposed to be bore-piled into the seabed.

Potential Impacts of Underwater Blasting to Ma Wan Fish Culture Zone

The construction of the Tsing Lung Bridge North Tower will involve the use of blasting into the bedrock for the foundations of the bridge tower (*Figure 7.16*). The Toll Plaza will, however, be constructed without the use of blasting or percussive piling into the bedrock.

The size of the lethal zone of an underwater blast depends upon numerous factors¹⁴, including:

- the type of explosives;
- the magnitude of the explosion;
- the dimensions of the body of water, that is, its area and depth;
- the nature of the seabed;
- the depth at which the charge is set off; and
- the nature and sensitivity of potentially impacted organisms.

Shock Waves: Explosive impacts can cause the swim bladder of fish species to be readily ruptured by an underwater explosion. A study¹⁵ showed that under similar blast conditions (about 16m from 4kg charge of dynamite), all species without swim bladders survived unhurt, whereas four of the five species with swim bladders were killed. Therefore, fish are more susceptible to underwater blasting as they usually possess a swim bladder. However, direct, and possibly fatal, impacts could potentially affect other species, if the organisms were located in close proximity to an underwater explosive charge.

¹³ Information on the type and amount of explosives will be provided during the detailed design stage. The preliminary setting is that the maximum charge per day will be 1kg for the east foundation and 5kg for the west foundation. Only one charge will be carried out at either the east or the west foundation on a single day

¹⁴ Westing A H (1978), *Military Impact on Ocean Ecology*, from *Military Activities*, The University of Chicago, pp 337-466.

¹⁵ Aplin J A (1947). *Effect of Explosives on Marine Life*. *California Fish and Game* 33: 23-30.

Noises: Fisheries resources mainly contain animals that do not rely on acoustic information to communicate and to explore their environment. Therefore, noise impacts to the Ma Wan FCZ are expected to be minimal.

Implementation of an air-bubble curtain (*Figure 7.16*) as an effective mitigation measure for underwater blasting (see Section 8.7) is proposed to prevent any unacceptable impacts to the Ma Wan FCZ. The size of impact due to underwater blasting is predicted to cover a maximal area of 1km radius from the blast site. As the blast site at Tsing Lung Tau is far from the Ma Wan FCZ (approximately 2 km), shock waves and noises generated from the blast will be further attenuated over such a long distance. Therefore, it is anticipated that impacts due to underwater blasting will be negligible.

Indirect Impacts

Indirect impacts to fisheries resources during construction include sediment release associated with the above construction works. Potential impacts to water quality from sediment release are as follows:

- increased concentrations of suspended solids (SS);
- a resulting decrease in dissolved oxygen (DO) concentrations; and
- an increase in nutrient concentrations in the water column.

Suspended sediment fluxes occur naturally in the marine environment. Consequently, fish have evolved behavioural adaptations to tolerate increased SS loads. These include clearing their gills by flushing water over them. When SS levels become excessive fish can move to clearer waters. Susceptibility generally decreases with age, with eggs the most vulnerable and adults the least sensitive to effects from sediments. The rate, season and duration of SS elevations will influence the type and extent of impact upon fish. Sediment sampled at the Toll Plaza were found to be uncontaminated (refer to Section 5). Therefore, the release of contaminants from sediments into the receiving waters will not be of concern and no further investigation was undertaken. As SS release due to the construction works will be minimal, impacts derived from elevations of SS & nutrients and DO depletion are likely to be negligible and therefore acceptable to fisheries resources in the Study Area.

Sediment testing results showed that sediments to be dredged from the Toll Plaza were uncontaminated (see Section 5). Average Tributyltin (TBT) concentrations in sediments at Tsing Lung Tau and Toll Plaza were 8 and 39 $\mu\text{gSn kg}^{-1}$ respectively. As there is no evaluative criterion for TBT concentration in sediment, the average values were compared with data previously gathered in a study by EVS²⁰. In the EVS study, TBT concentrations in sediments from 26 samples from the Rambler Channel varied greatly from 0.15 to 720 $\mu\text{gSn kg}^{-1}$. When compared to the Rambler Channel, although the areas at Tsing Lung Tau and Toll Plaza are in close proximity to some of the busiest shipping lanes in Hong Kong, average TBT concentrations (8 and 39 $\mu\text{gSn kg}^{-1}$) are relatively small and thus likely to exert minimal impacts on marine ecology. As inorganic and TBT contaminants are in low concentrations and a minimal amount of suspended sediment will be released from dredging/reclamation, the desorption of heavy metals and TBT from sediments into the surrounding waters is predicted to be negligible.

Mitigation measures such as using closed grab and silt curtain would reduce SS loss to the water column. However, as SS released due to the construction works is predicted to be minimal, the need to implement such mitigation measures will be determined during the Detailed Design stage.

8.5.2 Operational Impacts

During the operational phase, toxic chemicals from the spilled oil of vehicles can enter the marine waters via the drainage system and may impact fisheries resources. However, the design of the highway and its safety management are expected to prevent such spillage of gasoline oil from vehicles. It should also be noted that an oil trap is likely to be implemented at locations of potential contamination from oil (eg parking area at Toll Plaza Administration Building Complex) as a preventive measure. As spillage of gasoline oil from vehicles into marine waters is unlikely to occur, its impacts on fisheries ecology will not be addressed further in this EIA.

8.6 Impact Evaluation

The severity of impact on fisheries associated with the construction works is considered low. An evaluation of the impact in accordance with the TMEIA *Annex 9* is presented as follows:

- **Nature of Impact:** A permanent loss of a seabed area (approximately 8.1 hectares) which supports fisheries resources will occur due to dredging/reclamation works at Tsing Lung Tau, Tso Wan and Fa Peng. Underwater blasting will probably be conducted for a period of 8 weeks (only one charge per day) and the direct and indirect impacts are predicted to be intermittent. Underwater blasting will kill fisheries resources and the loss is dependent on the number present within the lethal zone¹⁰. In addition, there will be temporary impacts to pelagic and demersal fisheries resources as a result of minor perturbations to water quality. Providing the Water Quality Objectives are not exceeded, these impacts will be negligible.
- **Size of Affected Area:** During construction operations direct impacts to fishing operations and resources are predicted to occur only within the Construction Area. Small amounts of sediment release and deposition are predicted outside of the Construction Area but are considered to cover a small area.
- **Size of fisheries resources/production:** Directly impacted areas at Tsing Lung Tau and Fa Peng are respectively ranked medium-high and low in comparison to other areas in Hong Kong in terms of catch weight and value. Indirectly impacted areas in the Study Area are ranked from low to medium-high to the Hong Kong fishing industry. However, as the construction impacts are predicted to be transient and localised, their influence on fisheries resources/production should be minimal and therefore insignificant.

¹⁰ Aplin J A (1947). Effect of Explosives on Marine Life. *California Fish and Game* 33: 23-30.

- Destruction and disturbance of nursery and spawning grounds: Key fisheries resources in the area consist of rocky substrate around Ma Wan which provides important fisheries habitat. If compliance with the Water Quality Objectives is achieved at this sensitive receiver, the potential impacts through SS elevations and DO depletion are expected to be negligible.
- Impact on Fishing Activity: Based on the existing limited fishing activity, due to busy marine traffic in the Study Area, the impact on fishing activity is expected to be negligible.
- Impact on Aquaculture Activity: As SS elevations are predicted to be in compliance with the Water Quality Objective at the Ma Wan FCZ, impacts to this sensitive receiver are expected to be negligible. It is expected that shock waves and noises due to underwater blasting will be effectively mitigated through the use of the air-bubble curtain implemented at Tsing Lung Tau. Effects will be further attenuated in the water body (approximately 2km from Ma Wan FCZ). The residual impacts are likely to be minimal and therefore insignificant.

8.7 Mitigation Measures

As impacts are predicted to be confined to within the dredging/reclamation areas, they will not cause any adverse impacts to fisheries resources. The installation of an air-bubble curtain created by production of bubbles from a perforated compressed air hose placed on the seabed in the vicinity of the blasting area will mitigate the shock waves¹¹ and noise¹² generated from the blast. The efficiency of the air curtain has been tested during blasting and an approximately ten-fold reduction in shock wave pressures was recorded¹³. To ensure the effectiveness of the air-bubble curtain, requirements of pre-blast bubbling and air pressure adjustment will be specified during the Detailed Design stage. It is therefore likely that the impacts due to underwater blasting will be mitigated to acceptable levels. In addition, the mitigation measures which were recommended to control water quality impacts to within acceptable levels, are also expected to control impacts to fisheries resources. Hence, no mitigation measures are required to specifically protect fishery resources.

8.8 Environmental Monitoring & Audit

The monitoring and audit activities, designed to detect and mitigate any unacceptable impacts on water quality and marine ecology, will also serve to protect against unacceptable impacts on fisheries resources. The EM&A programme will provide management actions and supplemental mitigation measures to be employed should impacts arise, thereby ensuring the environmental acceptability of the project. As insignificant impacts to the fishery are expected to occur, the development and implementation of a monitoring and audit programme specifically designed to assess the effects on commercial fisheries resources is not necessary.

¹¹ Graves M (1968). Air-bubble Curtain in Sub-aqueous Blasting at Muddy Run. Civil Engineering - ASCE, July 1968, pp 59-61.

¹² Würsig B, C R Greene Jr, T A Jefferson (1999). Development of An Air Bubble Curtain to Reduce Underwater Noise of Percussive Piling. Environmental Research 48: 1-15.

¹³ Graves M (1968) *op cit*.

8.9 Conclusions

A review of existing information indicates that the Study Area supports both capture and culture fisheries resources. Directly impacted areas at Tsing Lung Tau and Fa Peng are ranked medium-high and low respectively in comparison to other areas in Hong Kong in terms of catch weight and value. Indirectly impacted areas in the Study Area are ranked from low to medium-high to the Hong Kong fishing industry.

Direct Impacts

Direct impacts to fishing operations and resources will occur through killing fisheries resources by underwater blasting and the loss of a seabed area (approximately 8.1 hectares) which supports fisheries resources due to dredging/reclamation works at Tsing Lung Tau, Tso Wan and Fa Peng. As direct impacts are predicted to occur only within the Construction Area during construction operations, the loss in fisheries production is expected to be insignificant.

Indirect Impacts

Indirect impacts during the construction phase include an increase in suspended sediment concentrations and decrease in dissolved oxygen in the water column. SS fluxes occur naturally in the marine environment, consequently fish have evolved behavioural adaptations to tolerate increased SS loads. These include clearing their gills by flushing water over them. When SS levels become excessive fish can move to clearer waters. Susceptibility generally decreases with age, with eggs the most vulnerable and adults the least sensitive to effects from sediments. The rate, season and duration of SS elevations will influence the type and extent of impact upon fish. However, these indirect impacts are anticipated to be localized and transient. In addition, any constraints on construction operations recommended to reduce impacts to water quality and marine ecology to acceptable levels are expected to also mitigate for effects on fisheries resources. Therefore, no special mitigation measures are recommended for the fisheries sensitive receivers. Those mitigation measures on marine ecology, which are related to the protection of fisheries resources, are summarised in the Implementation Schedule.