2 CONSIDERATION OF ALTERNATIVES

2.1 Consideration of Alternative Site Locations for the PAFF

2.1.1 Background

2.1.1.1 Hong Kong International Airport is strategically extremely important to Hong Kong. It provides air transport connections to more than 140 destinations, employment to 55,000 people, facilitates tourism, and provides a multiplier effect to the economy of Hong Kong. The airport cannot operate without aviation fuel. The throughput demand of the airport is currently 5.8 billion litres per annum. The Aviation Fuel Receiving Facility (AFRF) at Sha Chau has a sustained throughput capacity of 6.1 billion litres per annum, which is the capacity at which the AFRF can supply aviation fuel to the on-airport tank farm not considering typhoons T3 signal and above when no deliveries to the AFRF nor the airport, are possible. In order to cater for typhoons, an allowance of 20% has been factored out of the sustained throughput capacity, thus representing the operational throughput capacity of AFRF which is equal to 5.1 billion litres per annum (i.e. 6.1 billion / 1.2). The projected ultimate throughput capacity of the airport is more than 12 billion litres per annum. The operational throughput capacity of AFRF is even now inadequate.

2.1.1.2 To overcome this, and to mitigate the effect of delay in the construction of the PAFF, the AAHK has upgraded the current aviation fuel emergency connection at the West Quay on the airport which can receive aviation fuel and has a throughput capacity of about 1.1 billion litres per annum. The operational throughput capacity of the AFRF plus the throughput capacity of West Quay, is in total around 6.2 billion litres per annum. However, even with the use of West Quay (which is only a contingency measure), the projected demand of aviation fuel will exceed this combined operational throughput capacity of AFRF and West Quay in 2007. If AFRF is allowed to work above the operational throughput capacity in case there are no typhoons T3 signal and above, the sustained throughput capacity of AFRF plus the throughput capacity of West Quay would be able to support the demand of aviation fuel to around 2009.

2.1.1.3 Under the Gazette Notice 1294 of 13 April 1995, the AFRF at Sha Chau must revert to an emergency back-up as soon as the permanent facility has been expedited. Accordingly, expansion of the AFRF at Sha Chau is ruled out and is, in any case, impracticable on the basis of the shallow water around Sha Chau and its location within the Marine Park. Thus a Permanent Aviation Fuel Facility (PAFF) is essential and will consist of the following:

- a jetty;
- a tank farm; and
- sub-sea pipelines.

2.1.1.4 The PAFF facility will be designed in accordance with the latest technology, standards and statutory requirements as detailed in Section 3 and Appendix A00. In order to provide the projected ultimate throughput capacity, the following requirements must be met:

Fundamental Requirements of the Jetty

(i) two berths are necessary to provide the ultimate discharge capacity, given that:

- the average parcel size would be about 35,000m^3;
- discharge of this parcel size takes about 24 hours;
- berth occupancy must allow for down time, poor visibility, tidal windows, waiting on vessel to arrive, etc; and
- replenishment of stocks is required following drawdown during typhoons.

(ii) a range of vessel sizes must be accommodated because, given the trend towards larger vessel utilization and advice from the industry that a maximum vessel size of 80,000 dwt must be accommodated, the berths must make allowance for a range of vessel sizes from 10,000 to 80,000 dwt. (Currently, 80,000 dwt dedicated vessels provide aviation fuel to some airports in Europe and this trend is expected to grow elsewhere in the world including Asia). This will require a jetty, with two berths end to end, of about 575 metres length.

Fundamental Requirements of the Tank Farm

(i) Quality of the fuel supplied to the airport must be maintained to the highest standards. Settlement, cleaning and drying of the fuel, once discharged from ocean going tankers, must be carried out to international standards. Maintaining a high quality of fuel using these methods has implications on the number of tanks required at the tank farm as follows: -

a) initial phase (2009) - based on the logistics below, it was determined that eight tanks are required:

- two large vessels (say 35,000m^3 parcels each) could be discharged simultaneously to two to three tanks, for quality control;
- previously discharged fuel will occupy at least two to three tanks during quality control, prior to release as hydrant ready fuel
- two tanks are required for pumping to the airport; and
- one tank could be under maintenance;

b) ultimate phase (2040) - based on the logistics below, it was determined that twelve tanks are required.

- two large vessels (say 80,000m3 and 40,000m3 parcels respectively) could be discharged simultaneously to five tanks for quality control;
- previously discharged fuel will occupy at least three to four further tanks during quality control, prior to release as hydrant ready fuel;
- four tanks would be required for pumping to the airport; and
- one tank may be under maintenance.

(ii) In addition, the operation, maintenance, security, safety and routine activities at the PAFF tank farm are catered for by provision of an office with associated facilities (e.g. car park, Emergency Vehicle Access, boundary fence, landscaping etc).

Fundamental Requirements of the Pipeline

(i) To provide the necessary throughput rate and security of supply, twin subsea pipelines of 500mm dia (identical to those from the existing AFRF at Sha Chau to the airport) are required.

2.1.1.5 It is imperative that fuel quality is not compromised as safety of airport operations is of paramount importance. In order to maintain fuel quality and safety, the tank farm must be adjacent to the jetty for the following reasons:

- Industry practice dictates that tank farms should be located adjacent to the jetty. The Airport Authority respects the wisdom of industry practice and does not contemplate adopting inferior practices.

- The longer length of pipeline required when the tank farm and jetty are separated, will, in turn, increase the risk of static electricity build up within the fuel, with an increased risk of ignition upon entry of the fuel to the tanks. To avoid this on longer pipelines, a Static Dissipator Additive (SDA) is dosed into the fuel, but the rate of doping is sensitive (under/over doping are both undesirable). It is thus very difficult to inject the correct dose accurately into a flowing pipeline at the jetty.

- Water is often present in the compartments of ocean going tankers, sometimes in considerable quantities. When this fuel/water interface reaches the equipment, a shock or "water hammer" effect occurs in the system. This affects the filter/water separators with a resulting increased risk of damage and an associated increased potential for fuel spills.

- Despite best efforts to eliminate water from the pipeline by use of filter/water separators, some water will inevitably enter the pipeline. Accordingly, the risk of corrosion (and thus leakage) from the pipeline is greater.

- There is occasionally a need to remove off-spec fuel from the PAFF. A longer pipeline produces a larger quantity of off-spec fuel (through comingling with other batches). Pumping the off-spec fuel back to a tanker at the jetty also produces further off-spec fuel (by subsequent additional comingling) and requires a greater volume of good fuel to purge the off-spec fuel from the pipelines.

2.1.1.6 Thus, the search for a suitable site for the PAFF is based on the following criteria:

- marine access of at least 17m water depth to accommodate vessels at a jetty with two dedicated berths;

- environmental acceptability (to the community, ACE and Green Groups);

- sufficient land adjacent to the jetty to accommodate tanks and related facilities;

- viable route for twin pipelines to the airport; and

- ♦ timely completion.

2.1.1.7 It was determined as early as 1991 that PAFF was a fundamental requirement for delivery of aviation fuel by large vessels to the airport.

2.1.1.8 The search for a PAFF site has taken place over a period of 10 years, during which environmental awareness, environmental concern, the statutory environmental framework and the political back-drop have changed significantly in Hong Kong. The main reasons for this extended period of the site search are identified in the following paragraphs.

2.1.1.9 In 1992, the most realistic and practicable sites within HK SAR waters, following consultation with Government, were identified as:

(i) Airport;
(ii) Bluff Point (BP);
(iii) East of Sokos (EOS);
(iv) Kau Yi Chau (KYC);
(v) Ma Wan Island;
(vi) Penny's Bay;
(vii) Sham Shui Kok (SSK);
(viii) Sham Wat (SW);
(ix) Tsing Yi (TY);
(x) Tuen Mun including Tuen Mun West (TMW) and Tuen Mun Area 38 (TMA 38);
(xi) Mo To Chau (The Brothers);
(xii) Lung Kwu Chau.

2.1.1.10 In 1993, Mo To Chau and Lung Kwu Chau were ruled out from further investigation on the basis of their extreme environmental sensitivity. Other factors against locating the PAFF on Mo To Chau include, difficulties in aligning the jetty satisfactorily along the ebb and flood tides, compromising the efficiency of air navigation and safety systems and being directly under the flight path.

2.1.1.11 The results of more detailed investigations were that (i) Airport, (v) Ma Wan Island, and (vi) Penny's Bay sites were found to be impracticable for the following reasons:

- ♦ Airport

  - extremely shallow water surrounding the airport would necessitate extensive capital and maintenance dredging for a vessel access channel and a turning basin. Such extensive dredging would have associated potential environmental impacts.

  - statutory the airport height restrictions for flight safety which define the maximum height of fixed or transient objects;

  - statutory marine exclusion zones which extend some 2.5km east and west of the airport;

  - contaminated mud pits which lie to the north of the airport; and

  - a jetty located either to the east or west of the airport would be most prone to risks from aircraft incidents either immediately before landing or after take-off.

- ♦ Ma Wan

  - Ma Wan has historically been an important fish mariculture area, lies in an area of very fast tidal currents (which are unsuitable for siting a jetty of the size required) and is now under development as a residential area. Thus, these uses are incompatible with collocation of a PAFF, but also the site is fundamentally impracticable because of the tidal currents.

- ♦ Penny's Bay

  - Penny's Bay was originally intended to be reclaimed for the purpose of a Port/Container Terminal but subsequently has been earmarked, and is now being developed, for Disney. Because of incompatibility with these land uses, the site was ruled out.

2.1.1.12 In addition, sites (ii) Bluff Point and (viii) Sham Wat were also ruled out for environmental reasons, in particular because of their potential impacts on water quality and ecology.

2.1.1.13 In 1993, a hazard assessment study of the risk associated with passage of aviation fuel tankers through the Ma Wan Channel resulted in the ruling out of sites in North Lantau Waters. This study considered the long term transit of large aviation fuel vessels through the channel. It was determined, at that time, that the risk was in the ALARP region of the FN curve within HK Risk Guidelines, but could not be mitigated to as low as reasonably practicable. Thus it would not be possible to deliver the required volume of fuel to waters North of Lantau. This meant that search was restricted to sites south of the Ma Wan Channel and ruled out from further consideration a number of potentially viable alternative sites in waters north of Lantau, namely, Sham Shui Kok and Tuen Mun.

2.1.1.14 In 1994, two attractive sites in waters north of Lantau (Tuen Mun Area and Sham Shui Kok) were revisited on the basis of the possible implementation of the Tong Gu Channel. It then transpired that the decision to implement Tong Gu Channel was uncertain. Accordingly, these options were again shelved.

2.1.1.15 Thus by 1994, a suitable permanent site had not been identified, requiring a temporary solution in order to secure an aviation fuel supply for the airport opening. The temporary solution comprised an AFRF just off Sha Chau and twin submarine pipelines connecting to the airport. Following the completion of an EPD and ACE approved EIA on the AFRF and its twin submarine pipelines, the temporary facility was gazetted in April 1995. However, the conditions of the Gazettal required, among other things, that a permanent facility be expedited. The Gazettal also stipulated that once the PAFF became operational, the facility at Sha Chau would only be used as an emergency back-up. Accordingly, the AFRF was developed, became operational in 1998 and currently operates as follows:

- Aviation fuel is transported from overseas refineries by long voyages in ocean-going vessels (about 20,000 to 70,000 dwt), which are normally not dedicated to shipment of aviation fuel. During the voyage there is a tendency for small quantities of seawater to seep into the aviation fuel compartments in these vessels.

- Upon arrival in Hong Kong, the water in the aviation fuel must be allowed to settle in tanks and quality control checks must be carried out before the fuel is ready for use. When fuel has undergone satisfactory settlement and quality control checks, it is loaded into small dedicated vessels (5000 dwt) for transfer to Sha Chau, from where it is pumped direct to the airport.

- Settlement and quality control checks are currently carried out at Tsing Yi. (However, this function will be replaced by the PAFF which will receive aviation fuel tankers direct from overseas and provide for aviation fuel to settle in tanks prior to carrying out quality control checks.).

2.1.1.16 The AFRF has been, and continues to be, operated and managed in a professional and responsible manner and to date has performed extremely well, in full compliance with all environmental commitments. These include:

- a zero-discharge policy for solid and liquid wastes;

- robust and extensive EPD/AFCD approved spill contingency planning;

- spill control and containment equipment is stored on the AFRF ready for use, including 2 dedicated work boats on constant standby;

- AFRF staff are routinely trained in spill response in conjunction with the statutory spill response authorities; and

- fuel delivery vessel crews have been trained in appropriate vessel manoeuvring to minimise vessel impacts on dolphins.

2.1.1.17 As a result of the AFRF development, the designation of the Lung Kwu Chau and Sha Chau Marine Park was expedited and the Park was gazetted in 1996. Thus, the AFRF is located within the boundary of the Marine Park. AAHK funds the management and operation of the Marine Park and has installed an AFCD dolphin look out post on top of the AFRF.

2.1.1.18 The search for the PAFF site in waters south of Lantau continued in parallel with the development of the temporary facility at Sha Chau. Thus, further studies were necessary and in 1998, following consultation with Government, three options were identified south of the Ma Wan Channel, namely East of Soko Islands, Kau Yi Chau and Tsing Yi. However, at a meeting of the Advisory Council on the Environment (ACE) on 28 September 1998 (copy of paper 40/98 and minutes are attached at Appendix A(i)), the Authority demonstrated that none of these options were viable. This was on the basis that these options would exhibit similar but greater environmental problems to those encountered at Sha Chau and, on grounds of their high cost, were commercially unattractive. In addition, East of Soko, which had been identified as the most attractive of these options, has now been identified as a potential Marine Park, and is thus also ruled out on this basis.

2.1.1.19 Tsing Yi was considered in the study of sites south of Lantau to be less favourable than East of Sokos and Kau Yi Chau for the following reasons:

- Restrictions will preclude the construction of a dedicated jetty. Reliance is thus placed upon the willingness of the owners of the existing jetties (five in total) to provide part-time use of their facilities for the airport needs.
- There are tank capacity constraints. The total available capacity cannot match the ultimate needs of the airport.

- The components of PAFF at this site (e.g. jetties and tanks) are widely spread over a distance of around 4km. Gathering lines to collect the fuel from each individual tank farm and deliver it to a transfer point for pumping via twin pipelines to the airport, are thus required. The entire system of jetties, tanks, gathering lines and twin pipelines with the associated controls, management and maintenance would be inherently less efficient than a dedicated compact arrangement.

- The routes for the twin pipelines to the airport have a number of problems which may reduce their durability and thus their ability to provide a secure supply. These problems include the possibility of accelerated corrosion induced by stray currents (such as those produced by passage of trains or presence of high voltage cables) and difficulties of construction through geological fault zones.

- Tsing Yi therefore has uncertain timing, is less efficient and less reliable and does not meet tank and jetty requirements. It was thus ruled out.

2.1.1.20 Meanwhile, the need to identify and develop a permanent site became urgent because it was known that, based on forecast growth, the AFRF at Sha Chau together with West Quay on the airport would reach their capacities by around 2007/2009.

2.1.1.21 In 1998, no site for PAFF had been found, although the AFRF at Sha Chau was by then operational. This dilemma, in which a permanent, realistic option for a PAFF location had yet to be identified, continued until 2000, along with increasing urgency.

2.1.1.22 At this time, a number of significant improvements related to safe passage of vessels through the Ma Wan Channel were being implemented, warranting further study of the then existing constraints to vessel traffic. A study was commissioned by the Airport Authority in 2000 to investigate the changes. This study determined that the use of the Ma Wan Channel for the transport of aviation fuel in ocean going tankers was acceptable, thus by 2001 the way was clear for re-consideration of PAFF sites at Sham Shui Kok, Tuen Mun West and Tuen Mun Area 38. The re-instatement of these three sites was reported to ACE on 18 December 2000 (copy of paper 38/2000 and minutes are attached at Appendix A(ii)). Subsequently, the Authority demonstrated to ACE that Tuen Mun Area 38 was the best available environmental option (copy of paper 50/01 and minutes of 17th December 2001 are attached at Appendix A(iii)).

2.1.1.23 The site search has covered a large number of sites in western waters of Hong Kong. In summary, the considerations set out above have ruled out sites for the PAFF at:

- Sha Chau (AFRF expansion);
- Airport;
- Ma Wan;
- Penny's Bay;
- Mo To Chau (The Brothers); and
- Lung Kwu Chau.

2.1.1.24 In addition, sites at Bluff Point, Sham Wat, Tsing Yi, East of Sokos and Kau Yi Chau have also been ruled out for good reasons. Nevertheless, because these sites still remain theoretically possible, although not preferred, they are taken forward for analysis on a comparative basis, in the next section.

2.1.2 Comparison of Alternative Sites

2.1.2.1 The process, briefly summarised above, of searching for a suitable PAFF site has involved undertaking a number of both preliminary and detailed feasibility studies and investigations. The criteria described in Section 2.1.1.6 have been used as a basis for assessing the feasibility of the various sites considered over this 10-year period. At the time of these feasibility studies, all criteria (including environmental criteria) were considered and discussed with Government, in determining the practicability of each site.

2.1.2.2 Section 2.1.3 below provides, for completeness, a comparison of the eight sites shown in Figure 2.1 and listed below, although a number of these sites have been ruled out as described above.

- Site 1 - Bluff Point (BP);
- Site 2 - East of Sokos (EOS);
- Site 3 - Kau Yi Chau (KYC);
- Site 4 - Sham Shui Kok (SSK);
- Site 5 - Sham Wat (SW);
- Site 6 - Tsing Yi (TY);
- Site 7 - Tuen Mun West (TMW); and
- Site 8 - Tuen Mun Area 38 (TMA 38).

2.1.2.3 Because the feasibility of PAFF sites was not assessed solely on environmental grounds in the historical feasibility studies, a summary considering all criteria is provided below.

2.1.3 Comparative Environmental Assessment

2.1.3.1 The assessment of each site under each criterion is addressed below.

<u>Water Depth</u>

2.1.3.2 A water depth of 17 metres is required for vessel access. This natural water depth is available only at Tuen Mun Area 38 and Tsing Yi but also lies relatively close to Kau

Yi Chau, East of Sokos and Tuen Mun West. However, there is no space available for a jetty to be located at Tsing Yi. Where such depth is not available, capital and maintenance dredging is required (which has potential environmental implications).

Environmental Acceptability

2.1.3.3 A qualitative comparative environmental assessment is given in Appendix A(iv) and the results are given in Tables 2.1a and 2.1b below, for the construction and operational phases, respectively and summarized in Table 2.1c. This assessment of the site alternatives included the consideration of any risk to human life as detailed in the tables.

Table 2.1c Summary of Environmental Comparison Results: Construction and Operational Phases

Phase	Site 1 - BP	Site 2 – EOS	Site 3 - KYC	Site 4 - SSK	Site 5 - SW	Site 6 – TY	Site 7 - TMA 38	Site 8 - TMW
Ranking for Construction Phase	4	8	3	5	6	2	1	7
Ranking for Operational Phase	6	4	3	5	8	2	1	7

Table 2.1a Construction Phase Environmental Comparison

Criteria		Weighting	Site 1 Bluff Point	Site 2 East of Soko Islands	Site 3 Kau Yi Chau	Site 4 Sham Shui Kok	Site 5 Sham Wat	Site 6 Tsing Yi	Site 7 Tuen Mun Area 38	Site 8 Tuen Mun West
Air Quality Construction Air Quality Impacts	Max Score Score out of 10	**10** 10.00	Low (0.75) **7.50**	Low (0.75) **7.50**	Low (0.75) **7.50**	Medium (0.5) **5.00**	Low (0.75) **7.50**	Very low (1.0) **10.00**	Very low (1.0) **10.00**	Medium (0.5) **5.00**
Noise Above Ground Nose Impacts Underwater Noise Impacts	Max Score Score out of 15	**15** 3.00 12.00	Low (0.75) Low (0.75) **11.25**	Very low (1.0) High (0.25) **6.00**	Very low (1.0) Low (0.75) **12.00**	Medium (0.5) Low (0.75) **10.50**	Low (0.75) Low (0.75) **11.25**	Very low (1.0) Very low (1.0) **15.00**	Very low (1.0) High (0.25) **6.00**	Medium (0.5) High (0.25) **4.50**
Water Quality Water Quality Impacts	Max Score Score out of 20	**20** 20.00	Low (0.75) **15.00**	Medium (0.5) **10.00**	Low (0.75) **15.00**	Low (0.75) **15.00**	Medium (0.5) **10.00**	Very low (1.0) **20.00**	Very low (1.0) **20.00**	Low (0.75) **15.00**
Ecology Marine Faunal Impacts Designated Ecological Receivers	Max Score Score out of 30	**30** 19.50 10.50	High (0.25) Medium (0.5) **10.13**	Very high (0) High (0.25) **2.63**	Medium (0.5) Low (0.75) **17.63**	High (0.25) Low (0.75) **12.75**	Very high (0) Medium (0.5) **5.25**	Low (0.75) Very low (1.0) **25.13**	Low (0.75) Very low (1.0) **25.13**	High (0.25) Low (0.75) **12.75**
Landscape and Visual Landscape Resource Visual Impacts	Max Score Score out of 15	**15** 6.00 9.00	Medium (0.5) High (0.25) **5.25**	Medium (0.5) Medium (0.5) **7.50**	Medium (0.5) Medium (0.5) **7.50**	Medium (0.5) High (0.25) **5.25**	Medium (0.5) High (0.25) **5.25**	Low (0.75) Low (0.75) **11.25**	Low (0.75) Low (0.75) **11.25**	Medium (0.5) Medium (0.5) **7.50**

Criteria		Weighting	Site 1 Bluff Point	Site 2 East of Soko Islands	Site 3 Kau Yi Chau	Site 4 Sham Shui Kok	Site 5 Sham Wat	Site 6 Tsing Yi	Site 7 Tuen Mun Area 38	Site 8 Tuen Mun West
Cultural Heritage	Max Score	**10**								
Terrestrial Cultural heritage		2.00	Very low (1.0)	Very low (1.0)	Very low (1.0)	Very low (1.0)	Very low (1.0)	Very low (1.0)	Very low (1.0)	Very low (1.0)
Marine Archaeology		8.00	High (0.25)	High (0.25)	Medium (0.5)	High (0.25)	High (0.25)	Very low (1.0)	Low (0.75)	High (0.25)
	Score out of 10		**4.00**	**4.00**	**6.00**	**4.00**	**4.00**	**10.00**	**8.00**	**4.00**
Risk	Max Score	**35**								
Construction Stage Risk		35.00	Very low (1.0)	Very low (1.0)	Very low (1.0)	Very low (1.0)	Very low (1.0)	High (0.25)	Very low (1.0)	Very low (1.0)
	Score out of 35		**35.00**	**35.00**	**35.00**	**35.00**	**35.00**	**8.75**	**35.00**	**35.00**
Maximum Score		**135**								
Score (out of 135)			**88.13**	**72.63**	**100.63**	**87.50**	**78.25**	**100.13**	**115.38**	**83.75**
RANKING			**4**	**8**	**2**	**5**	**7**	**3**	**1**	**6**

Table 2.1b Operational Phase Environmental Comparison

Criteria		Weighting	Site 1 Bluff Point	Site 2 East of Soko Islands	Site 3 Kau Yi Chau	Site 4 Sham Shui Kok	Site 5 Sham Wat	Site 6 Tsing Yi	Site 7 Tuen Mun Area 38	Site 8 Tuen Mun West
Air Quality	Max Score	**5**								
Operational Air Quality Impacts		5.00	Very low (1.0)	Very low (1.0)	Very low (1.0)	Low (0.75)	Very low (1.0)	Very low (1.0)	Very low (1.0)	Very low (1.0)
	Score out of 5		**5.00**	**5.00**	**5.00**	**4.00**	**5.00**	**5.00**	**5.00**	**5.00**
Noise	Max Score	**10**								
Above Ground Nose Impacts		2.00	Very low (1.0)	Very low (1.0)	Very low (1.0)	Low (0.75)	Very low (1.0)	Very low (1.0)	Very low (1.0)	Very low (1.0)
Underwater Noise Impacts		8.00	Low (0.75)	Very low (1.0)	Low (0.75)	Low (0.75)	Medium (0.5)	Very low (1.0)	Very low (1.0)	Very low (1.0)
	Score out of 10		**8.00**	**10.00**	**8.00**	**7.50**	**6.00**	**10.00**	**10.00**	**10.00**
Water Quality	Max Score	**15**								
Water Quality Impacts		15.00	Low (0.75)	Low (0.75)	Low (0.75)	Low (0.75)	Medium (0.5)	Very low (1.0)	Very low (1.0)	Low (0.75)
	Score out of 15		**11.25**	**11.25**	**11.25**	**11.25**	**7.50**	**15.00**	**15.00**	**11.25**
Ecology	Max Score	**20**								
Marine Faunal Impacts		20.50	Low (0.75)	Very high (1.0)	Low (0.75)	Low (0.75)	Medium (0.5)	Very low (1.0)	Very low (1.0)	Low (0.75)
	Score out of 20		**15.00**	**20.00**	**15.00**	**15.00**	**10.00**	**20.00**	**20.00**	**15.00**
Risk	Max Score	**35**								
Hazard of Life		19.25	Very low (1.0)	Very low (1.0)	Very low (1.0)	Low (0.75)	Very low (1.0)	High (0.25)	Low (0.75)	Low (0.75)
Environmental Risk		15.75	Medium (0.5)	High (0.25)	Low (0.75)	Low (0.75)	Medium (0.5)	Low (0.75)	Low (0.75)	Low (0.75)
	Score out of 35		**27.13**	**23.19**	**31.06**	**26.25**	**27.13**	**16.63**	**26.25**	**26.25**

Criteria		Weighting	Site 1 Bluff Point	Site 2 East of Soko Islands	Site 3 Kau Yi Chau	Site 4 Sham Shui Kok	Site 5 Sham Wat	Site 6 Tsing Yi	Site 7 Tuen Mun Area 38	Site 8 Tuen Mun West
Landscape and Visual	Max Score	**15**								
Landscape Resource		6.00	High (0.25)	Medium (0.5)	Low (0.75)	Low (0.75)	High (0.25)	Low (0.75)	Very low (1.0)	Low (0.75)
Visual Impacts		9.00	High (0.25)	Medium (0.5)	Low (0.75)	High (0.25)	High (0.25)	Low (0.75)	Low (0.75)	Low (0.75)
	Score out of 15		**3.75**	**7.50**	**11.25**	**6.75**	**3.75**	**11.25**	**12.75**	**11.25**
Maximum Score		**100**								
Score(out of 100)			**70.13**	**76.94**	**81.56**	**70.75**	**59.38**	**77.88**	**89.00**	**78.75**
RANKING			**7**	**5**	**2**	**6**	**8**	**4**	**1**	**3**

2.1.3.4 Throughout the site search, as provided in Appendices A(i), A(ii) and A(iii), AAHK has consulted the ACE to seek guidance.

Land Availability

2.1.3.5 Land is currently only available at Tuen Mun Area 38 and therefore, new reclamation will be required for the other sites. Tsing Yi is a special case (see Section 2.1.1.18). Reclamation has the potential to result in environmental implications, particularly in respect of water quality and marine ecology impacts, with associated potential environmental impacts and is undesirable, particularly when it has to be undertaken close to key environmentally sensitive areas. Given the likelihood that reclamation would be the least environmentally acceptable at Sham Wat, Bluff Point and East of Sokos, these sites would be least favoured.

Pipelines

2.1.3.6 Pipelines from Tsing Yi, Kau Yi Chau and East of Sokos are not viable because for Kau Yi Chau and East of Sokos, the pipeline would need to be in a bored tunnel, and for Tsing Yi, see Section 2.1.1.18. An alternative from East of Sokos is the installation of twin subsea pipelines going around the west of Lantau to the airport. This is undesirable because of its long length and greater potential impact on environmentally sensitive areas (including destruction of pristine seabed and potential impacts on the unspoilt coastline).

2.1.3.7 A bored tunnel must be of sufficient size for maintenance of both pipelines and it is undesirable for the following reasons (which are amplified in Section 2.2.1):

- ♦ There is a risk of delayed completion. Historically long, subsea bored tunnels are prone to serious delay and even in the event of a smooth construction programme, a bored tunnel could not be constructed within the required timeframe.

- ♦ There would be a gradual build up of vapours in the confined space of the tunnel. This poses risks to maintenance crews. To avoid such build up, ventilation shafts (with their own environmental impact) could be constructed. Alternatively, elaborate and time consuming purging procedures could be implemented when tunnel entry is required. Neither option is desirable.

- ♦ Spoil from tunnels is usually contaminated and requires special treatment before disposal.

Timely Completion

2.1.3.8 A completion date as soon as possible is essential because the throughput capacity at Sha Chau and interim facility at West Quay is expected to be exceeded during 2007.

2.1.3.9 In addition, AAHK has made a commitment to ExCo that it will expedite the permanent pipeline and the following complications occur at the following sites:

- at Sham Shui Kok, the reclamation for the tank farm lies over an existing sewage outfall. Relocation of this outfall would be required before reclamation could commence;
- at Tsing Yi, the presence of several third parties (Oil Companies), with whom extensive negotiations would need to be conducted before agreement to undertake the works could be put in place, means that the timing to start of operations is highly uncertain; and
- at Tuen Mun West, an existing sewer outfall would need to be diverted or avoided by the twin subsea pipelines.

Cost

2.1.3.10 AAHK operates within prudent commercial principles. Thus, where a cheaper alternative is available, then that site is preferred, subject to no insurmountable environmental impacts.

2.1.4 Preferred Site

2.1.4.1 Comparison of sites based on all criteria is given in Table 2.2. Of the alternative sites considered, it is clear, from the assessment of all criteria that on all counts the site at Tuen Mun Area 38 is preferred. Furthermore it is demonstrated in this EIA that the Tuen Mun Area 38 site is environmentally acceptable for the PAFF.

2.1.4.2 Further details of the site layout at Tuen Mun Area 38 are provided in Section 3 of this EIA.

Table 2.2 Summary of Site Comparison

Site	CRITERIA								
	Acceptable Water Depth?	Sufficient Land Available?	Viable Pipeline Route?	Timely Completion Possible?	Relative Construction Cost?	Environmental Ranking(+)		Acceptable to ACE (and/or) Green Groups	Acceptable Overall?
						Construction	Operation		
1. Bluff Point	No	Currently no land – therefore would need reclamation⦿	Yes	No	1.4C	4	6	No (near sensitive coastline and in an area of pristine seabed)	No
2. East of Sokos	No (but deepwater is relatively close)	Currently no land – therefore would need reclamation⦿	No (Bored Tunnel or alternatively long twin subsea pipelines)	No	3.1C	8	4	No (environmentally sensitive area, cost too high and timing too long/uncertain)	No
3. Kau Yi Chau	No (but deepwater is relatively close)	Currently no land – therefore would need reclamation⦿	No (Bored Tunnel only)	No	2.9C	3	3	No (environmentally sensitive area, cost too high and timing too long/uncertain)	No
4. Sham Shui Kok	No	Currently no land – therefore would need reclamation⦿	Yes (although difficulties would be encountered)	No	1.5C	5	5	No (environmentally inferior to Tuen Mun Area 38)	No
5. Sham Wat	No	Currently no land – therefore would need reclamation⦿	Yes	No	1.8C	6	8	No (near sensitive coastline and in an area of pristine seabed)	No
6. Tsing Yi	Yes	Already reclaimed	No (difficulties would be encountered)	No	2.7C	2	2	(inferior to EOS & KYC)	No
7. Tuen Mun Area 38	Yes	Already reclaimed	Yes (short length across Urmston Road)	Yes	C	1	1	Yes	Yes
8. Tuen Mun West	No (but deepwater is relatively close)	Currently no land – therefore would need reclamation⦿	Yes (but a long length lies in Urmston Road)	No	1.9C	7	7	No (environmentally inferior to Tuen Mun Area 38)	No

*Green Groups +Lower number indicates a better ranking ⦿ Potential impacts resulting from the reclamation have been included under Environmental Ranking
Preliminary Construction Cost of PAFF at Tuen Mun Area 38 is represented by C

2.2 Pipeline Route Selection from Tuen Mun Area 38 to the Airport

2.2.1 Pipeline Route Options

2.2.1.1 Two principal route alignments have been assessed for the pipeline linking the PAFF at Tuen Mun Area 38 site to the airport. The primary option is to capitalise on the existing pipeline that currently runs from the temporary jetty and reception facility at the Airport Fuel Receiving Facility (AFRF) at Sha Chau and thus tie in with this pipeline. An alternative option is to construct a completely new pipeline from the proposed PAFF site direct to the west side of the HKIA. The two routing options are illustrated on Figure 2.2.

2.2.1.2 Other options comprising a connection of the pipeline from Tuen Mun Area 38 to either the north or east of the airport have also been considered. However, as shown in Figure 2.3, the northern pipeline corridor is not viable due to the presence of the Contaminated Mud Pits at East of Sha Chau which dominate the seabed area, north of the airport apron. It is not possible to pass through these pits and as the pits are some 30m deep, it is not viable to pass underneath. In respect of the eastern pipeline corridor, pipelines within this corridor, as shown in Figure 2.3 have also been dismissed for various reasons as summarised below:

- the length of pipeline across Urmston Road will be longer due to the oblique angle of crossing;
- the pipeline will need to either go under or around the sewage outfall from the River Trade Terminal at Pillar Point. The latter brings it close to the Contaminated Mud Pits at East of Sha Chau to the south;
- the pipeline would need to pass under the HV cable with a risk of corrosion induced by stray currents. A further cable is planned by CLP with similar risks;
- there are plans to construct a Lantau / Tuen Mun submerged tunnel in the future and the fuel pipeline would need to allow for this by going deeper;
- the pipeline enters the marine traffic restricted area and more importantly the marine exclusion zone of the southern runway which would result in the runway having to be shut down during the pipeline construction;
- the pipeline passes close to the potential contaminated mud pit to the east of the airport and, thus, the pipeline construction activities may be in close proximity to contaminated mud dumping operations;
- the route on the airport, unless it is in a bored tunnel, passes under or close to already developed areas such as Cathay City, the MTRC and highways. The implementation, engineering and environmental constraints associated with the use of bored tunnels is discussed further below; and
- in passing under the MTRC railway, the pipeline may be subject to stray current and hence induced corrosion.

2.2.1.3 Overall, the constraints on options to the east reduce the pipeline viability and, in addition, the route will be considerably longer than that to Sha Chau but approximately the same as to the airport directly.

2.2.1.4 Thus, the western route corridor constitutes the only practical option, with the two alternatives being a pipeline directly to the airport or one which connects to the existing AFRF at Sha Chau. In order to select the best pipeline option of the two viable alternatives on environmental grounds, a comparative assessment of the relative merits and disadvantages has been undertaken. Details of the comparison are presented below.

2.2.1.5 For the purposes of this assessment it has been assumed that dredging would be needed during the construction of the pipelines. Other possible techniques include the use of a bored tunnel, directional drilling and ploughing but each of these have engineering, programme, environmental and/or cost constraints as detailed in the sections below.

Tunnel Construction

2.2.1.6 Drill and blast tunneling techniques are commonly adopted in the hard rock of Hong Kong. The technique lends itself to larger diameter tunnels such as that which would be required to accommodate the twin subsea pipelines being proposed for the PAFF. The larger bore is required to provide adequate space to muck out the bore and allow maintenance of the pipeline during operations. This technique is regularly adopted for tunnels which will not encounter the poor ground conditions and water ingress which can be anticipated for the sub-marine lengths of pipe being proposed. For these reasons it is considered that drill and blast techniques would not be economic or practical for the proposed tunnels between Tuen Mun Area 38 and the Airport. This is discussed further in the sections below, together with the environmental disadvantages of the technique.

2.2.1.7 The most straight forward and least risk solution to excavate an opening for the sections of underwater pipeline would be to use one or two tunnel boring machines (TBM). TBMs are probably also the most cost-effective way to excavate the tunnel. The smallest practical TBM diameter for the lengths of tunnel envisaged is between 2.5m and 3.5m. The appropriate type of TBM for this type of tunnel is an electric-hydraulic driven machine. Broken rock would be carried away via a screw conveyor from the face of the machine feeding either a long belt conveyor or small gauge railway cars. Small gauge railway cars would be considered most suitable for this project and about 15 to 20 tonnes of broken rock will need to be removed every hour at typical rates of progress.

2.2.1.8 A total of about 210,000m^3 of material would be required to be removed for the diameter tunnels required, including material for the shafts and the reclamation needed at Sha Chau (see Section 2.2.1.9), which is only slightly smaller that the marine mud generated by the dredging for pipeline Option 1 (see Table 2.3) but half the amount for Option 2. However, about 25% of this material is expected to be contaminated with hydraulic oil and must be treated before disposal. This represents a significant environmental drawback. Mucking out of the tunnels and disposal of the spoil would need to be addressed. Whilst there is adequate space at Tuen Mun Area 38 to accommodate a small stockpile, this will have limited capacity, demanding regular clearing to a suitable disposal site.

2.2.1.9 Also of key concern would be the logistics and selection of the size of tunnel access shafts. These will be sunk through reclamation to meet firmer strata at greater depth. Support of the shafts will require substantial diaphragm walling or a steel cofferdam. Sizing and associated cost implications must be balanced against provision of adequate space for access, mucking out and ventilation requirements. The shafts will also require adequate working space around them which will demand additional reclamation work or land to be made available and where these occur in the sea and this will have associated impacts associated with permanent loss of seabed. For the Option 1 pipeline, the shaft at Sha Chau would require the reclamation of a piece of land with a useable area of 50m by 50m and this would need to be built in the Marine Park. The creation of this land would actually result in the disturbance of 40,000m^2 of seabed, require 300,000m^3 of fill and would have to be in an area outside the previous dredged AFRF access channel in order not the disrupt AFRF operations during construction of the PAFF. In comparison, the current dredged pipeline proposal for Option 1 will only affect 12,250m^2 of seabed within the Marine Park and this will be within the area that is already disturbed, with the benthic fauna regenerating once the works have been completed. The timing for the dredging is also significantly shorter and thus so will be the period of disturbance to the marine environment.

2.2.1.10 In respect of the Option 2 pipeline, a reclamation of the same size would also be required in the area just off the airport apron. However, despite the area of affected seabed as noted above, a reclamation to the west of the HKIA would have constraints during the construction period associated with blocking the access for sea rescue, conflicts with the marine exclusion and height restriction zones and potential glare issues affecting the flight path. Based upon these potentially serious operational factors, the option 2 bored tunnel is not considered practicable.

2.2.1.11 Pre-drilling along the tunnel axis will be required in order to identify sections of poor ground. Of particular importance will be the quantity of water inflow expected. Highly fractured rock and open joints are often associated with faults and shears. These promote the ingress of large quantities of water. This exacerbates ground support problems associated with fractured rock and/or fault gouge capable of producing a ground support problem that cannot be practically overcome behind the advancing TBM. Such inflows can be large and halt the works for a considerable period of time. A metre length of 0.4mm wide fissure in rock subjected to 100m of head can produce 500 litres per minute. Grouting of the ground ahead of the advancing tunnel is the most appropriate solution for a bored tunnel, with pre-grouting being more preferable to post-grouting. Only spot or targeted grouting is envisaged as being necessary where pre-drilling has identified particular areas of potential inflow. More comprehensive measures would possibly be required in the areas of the faults, where closely spaced grout holes may be required to displace and wash out gouge in order to allow the grout to penetrate and create an adequate seal. A number of stages may be required in difficult ground. Pre-grout holes are typically 20-25m long and at 2-3m centres for all-round coverage.

2.2.1.12 For the above reasons, the expected rate of progress of shaft sinking and tunnel boring is slow and would add at least an additional year to the overall PAFF programme. Based upon a required operational date of 2009 for the PAFF, it is clear that a tunnel could not be completed in time to meet the forecast date when the facility at Sha Chau reaches its limit of capacity.

2.2.1.13 During operation, maintenance of the pipeline would be required periodically. For this purpose, the air in the tunnel must be fresh for the safety of personnel. This can be achieved either by provision of vent shafts or purging the air with special equipment. In the case of ventilation shafts, this increases the construction phase impacts associated with the use of this technique and in both cases would require long term (for the life of the pipeline), power requirements to provide the fresh air. It should be noted that maintenance in such confined spaces also provides safety issues for personnel.

2.2.1.14 A further factor for consideration during the operational phase, is the control of fuel spill. Tunnelled sections of the line cannot be economically kept drained unless costly lining systems are adopted. It will, therefore, be necessary to allow the tunnelled sections of the alignment to flood once the pipeline installation is complete. In the event of a failure of the line in a flooded tunnel it will be necessary to pump out the tunnel rapidly to effect timely repairs. There will be a significant volume of oil contaminated sea water to be handled in these circumstances. While the impacts can be minimised by suitable surveillance and the provision of a segmentation system in the lines which would minimise the quantity of oil lost in the event of an incident, the requirement to handle, treat and dispose of large quantities of waste water is an environmental disadvantage associated with the use of a tunnel.

2.2.1.15 In summary the main disadvantages of a bored tunnel are as follows:

- ♦ significant environmental issues associated with treatment and disposal of contaminated spoil, temporary loss of seabed for the shafts potentially within the Marine Park, extended scope and period of construction and disposal and treatment of large quantities of contaminated water in the event of a leak;
- ♦ operational constraints associated with shaft reclamation west of airport;
- ♦ the pipeline could not be completed within the required timeframe; and
- ♦ maintenance of the pipeline is difficult and carries safety risks.

<u>Directional Drilling</u>

2.2.1.16 The use of horizontal directional drilling (HDD) for short bores is considered practical only for short lengths of tunnel. Current technology has allowed holes of up to 1500mm diameter to be drilled for lengths of up to 1500 to 1750m. However, the crossing being considered is considerably longer than this and is assumed to be carried out within the rock strata. Bore size is limited by the reamer arrangement although it is possible to pass multiple reaming tools through the pilot hole in order to increment the final bore diameter. At present a bore limitation of about 800 to 1000 mm represents a practical limitation on the technique. Based on the limitation of the distance, it is likely that the technique may only be applicable to the Urmston Road section of the pipeline alignment. However, its use would not negate the need for traditional dredging along the rest of the alignment. Based upon the bore diameter, the amount of spoil generated by this section of the route would be in the region of 2000m^3. This compares to about 80,000m^3 associated with dredging of both pipeline options 1 and 2.

2.2.1.17 However, it should be noted that bentonite will be required where directional drilling techniques are to be adopted and spillage of bentonite where breakthrough of the bores occurs in inevitable. Thus, there is potential for the spoil to be contaminated which will not occur with conventional dredging. Thus, the material to be excavated will require treatment or disposal to contaminated mud pits and will not be suitable for reuse as public fill which respresents an environmental disadvantage.

2.2.1.18 In addition to the above, there are many implementation difficulties associated with this technique which reduce its viability as follows:

- Collapse of the pilot hole or reamed out hole prior to casing installation is a possibility but can be overcome by removing the drill string, grouting up the end of the hole and then drilling through the grouted up section of ground. Jamming of the drill string due to collapsing ground is however a real risk.

- There will be a tendency for the HDD pilot hole to follow pre-existing fractures within the rock-mass. In addition, drills tend to align themselves perpendicular to the fabric or bedding of the rock through which they are drilling. In the area to be drilled for the PAFF project, some wandering of the pilot hole due to fractures and fabrics can be expected. This would require careful monitoring whilst drilling in order to avoid significant deviations.

- The HDD would need to penetrate a variety of geotechnical conditions, such as public fill, rock mound, alluvium, completely decomposed granite before encountering the bed rock described above. It is difficult to overcome this variability, which experience has shown could result in the drill to become stuck causing delays and potentially a new hole would be required to be started. This has both serious economic and programme implications.

- It is necessary to adjust the buoyancy of the final pipeline in order to reduce its effective weight to almost zero while it is being pulled through the flooded reamed directionally drilled hole. This places limitations on the pipe wall thickness to diameter relationship.

- Once installed in the directionally drilled and reamed bore there is no ability for subsequent access. Repairs to the line would necessitate total replacement of the directionally drilled section.

2.2.1.19 In summary, the technique is appropriate for short lengths of tunnel only and would in practice be suitable for the Urmston Road section of the pipeline alignment. However, its use would not negate the need for traditional dredging along the rest of the alignment and has disadvantages associated with its technical implementation, contaminated spoil, programming, costs and future maintenance.

Ploughing

2.2.1.20 ‘Post trenching’ techniques such as ploughing can be used to form a furrow on the seabed into which the pre-laid pipeline falls into. This method dispenses with the need to dredge a trench and there is no requirement to bring spoil to the surface for disposal elsewhere. Soil displaced during ploughing is simply pushed to the side of the pipeline and left to erode. However, with this method it would not be possible to place the required rock armour cover to lie flush with the existing sea floor. Any armour cover would need to be placed as a mound sitting proud of the seabed which would increase the risk of subsequent mechanical damage in the operational phase, from dragged anchors, for example. This represents a major design failing and this option is therefore ruled out.

2.2.1.21 The same limitation would apply to other post trenching methods such as jetting or other such hydraulic means to fluidise the seabed beneath the pipeline. In addition, to the above constraints associated with these techniques, potentially substantial sediment plume that would be generated during fluidisation (ERM 1995).

2.2.1.22 Thus, it is proposed that the pipeline be constructed using dredging techniques, with neither the tunnel, directional drilling nor post trenching techniques providing the preferred method.

2.2.1.23 The pipeline option to the existing AFRF (Option 1) would necessitate the dredging of a trench of approximately 4.8km in length from the PAFF site at Tuen Mun Area 38 to tie in with the existing pipeline at Sha Chau and would optimise the use of the existing pipeline. Approximately 400m of this new trench would have to be dredged within the Marine Park. However, this short section of the trench and pipeline would be formed within the existing dredged AFRF access channel but at greater depth. The pipeline would then be protected with a heavy rock armour to prevent any possible damage during future maintenance dredging works for the access channel and turning basin or other marine activities.

2.2.1.24 The pipeline option connecting directly to the airport (Option 2) would involve laying a completely new pipeline from the PAFF site to the HKIA platform. The pipeline would be approximately 11.2km in length and would be routed to avoid the Marine Park and also to keep clear of the Contaminated Mud Pits East of Sha Chau, as shown in Figure 2.4. Similar rock amour protection would be provided for pipeline Option 2.

2.2.2 Comparative Assessment of Options during the Construction Phase

<u>Key Issues</u>

2.2.2.1 The two pipelines are of significantly different lengths and, with the exception of the first few kilometres which follow similar alignments, traverse different routes. This will affect their respective impacts on water quality and ecology during construction. Similarly, there could be marine archaeological implications in the event that the alignment would pass through an area of seabed artefacts of archaeological interest requiring rescue or other mitigation. The routing will also have a bearing on the operational risk associated with pipeline failure in the operational phase.

2.2.2.2 The shorter pipeline Option 1 would involve construction works in the Lung Kwu Chau and Sha Chau Marine Park. While the alternative option would route the pipeline to avoid the Marine Park, the alignment does run adjacent to the Marine Park boundary for some of its length and, therefore, could also have indirect effects on the Marine Park. However, because the existing AFRF at Sha Chau lies within the Marine Park and would continue to be maintained in a state of operational readiness for emergency backup purposes, there are different operational phase implications that need careful consideration within the comparative assessment of the pipeline options.

2.2.2.3 There are no significant differences in the likely impact to air quality, noise or visual aesthetics associated with the pipelines and therefore these issues are not addressed in the comparative assessment.

Water Quality

2.2.2.4 The assumed lengths and approximate in-situ dredging volumes for the pipelines are presented in Table 2.3. It should be noted that works for the pipeline dredging in the areas other than the Urmston Road will be constrained to 12 hours daytime working as mitigation to protect the Chinese White dolphins in the area. While the total amount of matieral to be dredged for the pipeline as a whole is 340,000m^3, the amount of material to be dredged from the Urmston Road section alone is 247,000m^3. Taking this into account, the worst case construction period for the pipelines, based upon the sole use of a grab dredger with an approximate dredging rate of 7,000m^3 per day would be in the region of 62 days for Option 1 and 195days for the longer Option 2, although the expected use of a trailer suction hopper dredger in the deeper areas of the alignment, with a significantly faster dredging rate of 4,000m^3 per hour, would notably reduce these time periods. For Option 1, if the trailer suction hopper dredger alone was used for the section of pipeline between Urmston Road and the marine park boundary, the dredging would take approximately 6 days, and a further about 9 days for the grab dredger to do the remainder, resulting in a total of about 15 days, 47 days shorter than if the grab was used for the complete length. A similar level of reduction would be expected for Option 2.

Table 2.3 Pipeline Options 1 and 2 Pipeline Lengths and Dredge Volumes

Option	Route	Length (km)	(1) Dredge Volume (m^3)
1	Tuen Mun Area 38 to AFRF at Sha Chau	4.8	340,000
2	Tuen Mun Area 38 to HKIA	11.2	563,000

Note (1) : Based upon indicative trench cross sections detailed in Section 3.

2.2.2.5 It can be seen that the Option 2 pipeline route is more than double the length of the Option 1 route and would involve dredging of more than twice the volume of sea bed sediment. For the purposes of this assessment it is assumed that very similar construction methods would be adopted for either route and thus, the instantaneous levels of suspended sediment observed during construction emanating form the work point are likely to be similar for any given activity. However, the period of construction for the longer Option 2 will be approximately twice as long. Thus Option 1 is significantly advantageous from this perspective.

2.2.2.6 Option 1 requires dredging in the Marine Park during construction within the existing access channel to the AFRF at Sha Chau. However, this channel must be maintained in the long term for either route to facilitate emergency access and as the dredging for the pipeline will be scheduled to coincide with the future maintenance dredging for this access channel, no additional water quality impacts on the Marine Park will occur.

2.2.2.7 The water quality modelling results discussed in Section 6 of this report indicate that no identified sensitive receivers would be adversely affected by disturbances to water quality during the construction period for Option 1, including the Marine Park. There are no sensitive receivers unique to the Option 2 as opposed to Option 1 and therefore, both options are not expected to result in adverse water quality impacts.

2.2.2.8 Thus, both options are similar in that no significant impacts are expected to any sensitive receiver from sediment plumes caused by the construction works. However, Option 1, notwithstanding the fact that it enters the Marine Park, is preferred on the basis that degree of disturbance to water quality generally will be minimised.

Waste Management

2.2.2.9 Seabed sediments dredged to form the pipeline trench will require transport off-site and suitable disposal at a marine fill area. As indicated in Table 2.3, the total quantity of spoil arising for Option 2 amounts to an estimated 563,000 m^3 compared to 340,000m^3 for the shorter Option 1. An option which generates the least amount of waste is preferable and thus, Option 1 is recommended from a waste management perspective.

Ecology

2.2.2.10 As the pipeline options are in relative close proximity, only the ecological receivers that are known to differ in their distribution along the options have been assessed in the comparative assessment. A comparative ecological assessment of the two pipeline options is provided below.

Benthic Habitat

2.2.2.11 The benthic habitat characteristic of both pipeline corridor options comprises of a soft-bottom material composed of silts and clay as a homogenous layer or in loosely packed mud clasts bound in a puzzle fabric (Binnie Consultants, 1995; ERM, 1999). Based on grab samples taken at various locations in the Northwestern waters, the macro-invertebrate assemblages present are likely to be similar along both pipeline routes (Greiner-Maunsell, 1991; ERM, 1997; Mouchel, 2001a) and are characteristic of soft-bottom benthic communities throughout Hong Kong (Shin and Thompson, 1982).

2.2.2.12 The benthos distributed along the two pipeline options are generally comprised of filter-feeding and deposit-feeding representatives including polychaetes, molluscs, crustaceans and echinoderms and these most common representatives typically account for 95% of the benthic assemblage (ERM, 1997) and are characteristic of soft-bottom benthic communities throughout Hong Kong (Shin and Thompson, 1982). The infauna are key components of marine systems as they are involved in the biotic cycling of matter and nutrients, bioturbation of sediments and also significant prey organisms for demersal species including fish. Temporary impacts during the construction phase attributable to laying of the pipeline could, therefore, reduce the potential prey of fish and higher trophic levels such as the dolphin.

2.2.2.13 Temporary losses of benthos attributable to each pipeline option have been assessed in terms of dislodgement of macro-infauna (interpreted in terms of losses from the system/ study area and calculated using biomass) and hence possible reduction in food prey items to fish and higher trophic levels, including dolphins. The potential losses to each pipeline of macroinfaunal biomass are presented below in Table 2.4.

Table 2.4 Predicted Temporary loss of Macro-infauna Biomass Attributed to Each Pipeline Option

Pipeline Option	Seabed lost (m^2)	Estimated loss of biomass (kg)[1]
Option 1	124,975	3,642
Option 2	269,525	7,854

[1]Calculation is based on the macro-infauna collected at various stations in the Northwestern waters in May 2001 which showed an approximate (wet weight) biomass of 29.14g m^{-2} in surficial sediment (Mouchel, 2001a).

2.2.2.14 Results from the assessment of both submarine pipeline options on potential temporary loss of food sources to marine biota, such as fisheries and dolphins, indicated that the lowest source of biomass loss was, as expected, associated with the shorter fuel pipeline that links directly to the AFRF. The loss of macro-infaunal prey items (calculated as biomass) to higher trophic levels, however, is not considered to represent a significant impact, given the homogenous distribution of these food items in the Northwestern waters and the likelihood that dislodged prey items would not necessarily be lost from the system. However, Pipeline Option 1 was calculated to lose approximately 3,642 kg of biomass over the entire length; whereas the longer pipeline Option 2 located to the south of the Marine Park would lead to the loss of 7,854 kg of biomass.

2.2.2.15 The temporary losses of macro-infauna calculated for both options are considered to be an overestimate of the losses as not all infauna would be lost from the system and with respect to the marine benthic communities, the impacts from either of the pipeline options are, therefore, judged to be similar and insignificant from a conservation perspective.

2.2.2.16 However, it can be seen that the degree of disturbance to the benthic habitat and its loss of function is in proportion to the length of the pipeline. While both options have to pass through the dredged channel for the Castle Peak Power Station (CPPS), as shown in Figure 2.4, the alignment of Option 1 will also pass through the existing disturbed area of the AFRF access channel for approximately half of its length, with 400m within the Marine Park. Maintenance dredging of this channel is undertaken every 3 to 4 years and while some recolonisation will occur during this time, the abundance and diversity of benthic fauna is expected to be less than in undisturbed areas. This is also the case for the CPPS access channel. From this perspective, Option 1, to connect the PAFF to the existing AFRF at Sha Chau represents the preferred option, rather than Option 2 which is more than twice as long, affects more areas of undisturbed seabed and would result in approximately double the amount of benthic biomass loss.

Corals

2.2.2.17 There are few coral communities present of note in the vicinity of either pipeline route with predominantly wide-spread (mostly soft-coral) species recorded. Soft corals (sea pens such as *Pteroides esperi*) are widespread throughout the seabed (e.g., Greiner-Maunsell, 1991; Mouchel, 2001a; 2001b) of both pipeline options (as well as elsewhere in Hong Kong). Both options pass through seabed known to contain soft corals although greater losses are predicted for the longer Option 2 as it will require more seabed dredging. There are records of protected stony corals (faviids) from southwest Sha Chau and also the gorgonian coral *Ellisella gracilis* which is of some ecological interest from northeast of Sha Chau (ERM, 1995; 1996). Although no significant impacts are envisaged to either hard or soft corals for either option, Option 1 is in closer proximity to an area (i.e., northeast of Sha Chau) known to be colonised by gorgonian coral and both options are approximately the same distance from the faviids present to the southwest of Sha Chau. It should, however, be noted that owing to the prevailing estuarine conditions in Northwestern waters that inhibit the establishment of hard coral communities, only isolated hard corals have been recorded and these are distributed at other localities in the broader study area (including those considered to suffer from pollution impacts; Mouchel, 2001b) and it is likely that hard corals will be present wherever ecophysiological parameters such as depth and light penetration permit and a hard substrate is present.

2.2.2.18 The water quality modelling (based on suspensions of sediment attributable to worst-case trailer suction hopper dredging; see Section 6) for pipeline laying in the study area predicted that the elevations in suspended solids would be highly localised and mostly confined to the bed layer and well within the range of natural variability for Northwestern waters. Suspended solids released through dredging activity do not, therefore, represent any concern to either the hard or soft corals present in the study area.

2.2.2.19 Although the potential for impacts to corals from suspended solids during construction phase activity is insignificant, as the dredging is longer for Option 2 which will lead to a greater loss of seabed (and hence soft-bottom seabed containing soft corals), the shorter Option 1 is preferred. There is, however, no clear preference for either pipeline option based on the few protected hard corals present in the study area. The potential for greater disturbance impacts (loss of seabed) are, therefore, higher for the longer Option 2.

Horseshoe Crab

2.2.2.20 There are three species of horseshoe crab reported to regularly occur in Hong Kong coastal waters. There is some evidence to suggest that the population of horseshoe crabs in Hong Kong has declined (Chiu and Morton, 1999) and it is notable that only infrequent sightings of the occasional individual are now reported. These findings would imply that the local surviving populations are small and it is, therefore, important to protect these species of conservation interest together with their nursery grounds. The area likely to be disturbed due to PAFF construction is, however, small (see Table 2.4) compared with the total area of subtidal seabed present in Northwestern waters. Horseshoe crabs have been accidentally trawled at various locations in the Northwestern waters although there are no nursery areas present in the vicinity of either pipeline option. Impacts to the horseshoe crab are, therefore, insignificant for both pipeline options. The shorter Option 1 is slightly preferred over Option 2.

Indo-Pacific Humpback Dolphin

2.2.2.21 Neither route would be expected to result in any significant impact to the dolphin population when the PAFF is operational. Impacts on the dolphin may arise from temporary disturbance during the construction phase. In particular, cetaceans are known to be sound-sensitive and generally avoid areas subjected to high noise disturbance (Wursig *et al.*, 2000). Anecdotal evidence suggests that the dolphins avoided the area around The Brothers during the airport construction (although this was a considerably larger project than the PAFF) however they returned on cessation of construction activities suggesting that disturbance impacts are transient and only present during the construction phase. Further evidence for noise-induced avoidance was observed immediately after the AFRF construction. Immediately following construction of the AFRF, dolphin numbers declined in the area (recorded during the period of Spring 1997) although further surveys (Summer and Autumn 1997; and more recent survey work) revealed that there was an influx of individuals back into the area (Jefferson, 2000a; 2000b) indicating that temporary avoidance of areas due to noise does not have a long-term detrimental effect on the population.

2.2.2.22 For the purposes of this comparative assessment, it has been judged that the degree of disturbance is related to the pipeline length and the intensity with which the dolphins currently frequent the areas traversed by the pipeline. To examine the distribution of the dolphin along each option, data on dolphin sightings (Ocean Park Conservation Fund study funded by AFCD; Jefferson, 1998; 2000a) over the period November 1995 to October 2001 were used to calculate an impact index (I). This provides the basis for a quantitative assessment of habitat utilisation and predicted impacts based on the best available scientific data.

2.2.2.23 The Impact Index (I) was calculated as follows:

$$I = \sum_{i-1}^{n} (D\ l)$$

where n = number of 1 km^2 blocks the pipeline route passes through,
D = dolphin density in block i, and
l = length of pipeline route in block i.

2.2.2.24 The higher the impact index, the higher the predicted impact on the dolphin population, based on the assumption that human activity in a higher density area for dolphins would have a greater impact than the same activity in a lower density area.

2.2.2.25 Information on dolphin density in the North Lantau area was obtained based upon the Ocean Park Conservation Foundation Indo-Pacific Hump-backed dolphin sighting database, which covers vessel surveys conducted between November 1995 to October 2001 (see Jefferson and Leatherwood 1997; Jefferson 2000a) from a long-term research project in the area (Jefferson and Leatherwood, 1997; Jefferson, 2000a). The dolphin densities obtained from this research per 1 km^2 grid is shown in Figure 2.5. It should be noted that the dolphin numbers within each grid do not represent the 'true' density but the relative density, for example, it should not be assumed that between 22 and 23 dolphins are actually recorded in the km^2 grid blocks off Tuen Mun. The calculation of the densities is relative to survey effort and based on the number of sightings of dolphin groups per sea area in each block during line transect surveys over the past seven years. The research was designed to survey the entire North Lantau area evenly, and as such these densities are considered to be an accurate reflection of the actual dolphin use of those blocks.

2.2.2.26 The length of pipeline was calculated by overlaying a map showing the pipeline route over a 1 km^2 grid of the study area.

2.2.2.27 For Option 1 connecting to the existing AFRF at Sha Chau, the pipeline route passes through only seven 1km^2 grid blocks and has an overall Impact Index of 64.43. By means of comparison, Option 2, which connects directly to the airport, passes through sixteen 1km^2 grid blocks and has an Impact Index of 86.99. The Impact Index for the Option 1 is only 74.1% of the index calculated for the longer direct route to the airport. This indicates that the Option 1 pipeline is likely to have a notably lower impact on the dolphin population than Option 2 and thus, is preferred from this perspective.

Cultural Heritage

2.2.2.28 As discussed in the cultural heritage impact assessment in Section 9, the area of the north western waters in Tuen Mun and Sha Chau crossed by pipeline Option 1 has high archaeological potential based upon historic marine use of the area in the form of trading routes and battles. The marine archaeological value in Tuen Mun is also relevant to Option 2 but after that the pipeline takes an alternative alignment towards the east side of the airport. Thus, a baseline review of the approaches to the current airport and around Chek Lap Kok has been undertaken in order to provide a comparison of the two pipeline routes from a marine archaeological perspective.

Historical Background of Chek Lap Kok

2.2.2.29 The island of Chek Lap Kok first appears in late Ming historical documents under the name ‘Chek Lap Chau’. The name apparently derives from a fish formerly ‘chek lap’ (now known as ‘lap yue’) that was abundant in the waters around the island. The first reference to the island in western sources is a brief mention (referred to as the island of ‘Shatlapko’) in a British naval reconnaissance report by Lt. H.W. Parrish in 1794. There is no mention of any inhabitants of the island or the type of land use.

2.2.2.30 The first detailed evidence of human occupation on the island from written sources is the land use survey carried out in 1904-5 by British Army Indian surveyors, as part of the general registration of land ownership in the New Territories. This record reveals an elaborate and complicated web of ownership and land use.

2.2.2.31 In 1809, the area became a battlefield for pirates and the Ching navy. The book ‘History of the Pirates who infested the China Seas from 1807 to 1810’ gives a very detailed record of that incident:

> *“ … In consequence of this determination all commanders and officers of the different vessels were ordered to meet on the seventeenth at Chek Lap Kok, to blockade the pirates in Ta Yu Shan, and to cut off all supplies of provisions that might be sent to them. To annoy them yet more, the officers were ordered to prepare the materials for the fire-vessels. These fire-vessels were filled with gunpowder, nitrate and other combustibles; after being filled, they were set on fire by a match from the stern, and were instantly all in a blaze. The Major of Heang Shan, Pang Noo, asked permission to bring soldiers with him, in order that they might go ashore and make an attack under the sound of martial music, during the time the mariners made their preparation. On the twentieth it began to blow very fresh from the north, and the*

commander ordered twenty fire-vessels to be sent off, when they took driven by the wind, an easterly direction; but the pirates' entrenchments being protected by a mountain, the wind ceased, and they could not move father on in that direction; they turned about and set on fire two men of war. The pirates know our design were well prepared for it; they had bars with very long pincers, by which they took hold of the fire-vessels and kept them off, they that they could not come near. Our commander, however, would not leave the place; and being very eager to fight, he ordered that an attack should be made, and it is presumed that about three hundred pirates were killed. Pao (i.e.Cheung Pao Tsai) now began to be afraid, and asked the Spirit of the Three Po, or old Mothers to give a prognostic. The Puh, or lot for fighting was disastrous; the Puh, or lot to remain in the easterly entrenchment, was to be happy. The Puh, or lot for knowing if he might force the blockade or not on leaving his station tomorrow, was also happy, three times one after another.

There arose with the daylight on the twenty-second a light southerly breeze; all the squadrons began to move, and the pirates prepared themselves to joyfully leave their station. About noon, there was a strong southerly wind, and a very rough sea on. As soon as it became dark the pirates made sail, with a good deal of noise, and broke through the blockade, favoured by the southerly wind. About a hundred vessels were upset, when the pirates left Ta Yu Shan. But our commander being unaware that the pirates would leave their entrenchments, was not prepared to withstand them. The foreign vessels fired their guns and surrounded about ten leaky vessels, but could not hurt the pirates themselves; the pirates left the leaky vessels behind and ran away"

2.2.2.32 During the dredging of the seabed between Chek Lap Kok and Tung Chung for the new airport in 1993, part of a cannon was discovered and reported to the Provisional Airport Authority. An inscription on the cannon reveals that it was manufactured around 1808 in China (Meacham, 1994). There is no way of knowing its origin but it is the only evidence that has been found for the above battle.

2.2.2.33 With the surrender of the pirates in 1810, the inhabitants of the island were able to live in peace and continue their intensive farming and quarrying. The large amount of granite produced on the island favoured the development of granite quarrying. The products were used to build roads and houses in the developing city of Hong Kong. Some fishermen made use of the coastal area for repairing their boats and for drying their fishing nets. Thus on the north coast of the island there was a Tin Hau temple built in 1823. The temple was built of granite with money donated by some quarry companies. After World War II, the quarrying activity declined and many people moved to the city for better employment. By the 1950s, only about two hundred people lived on the island.

2.2.2.34 The historical data presented above gives the seabed approaches to Chek Lap Kok very high archaeological potential, akin to the potential found in Tuen Mun and Sha Chau. However, disturbance to large portions of the seabed, as shown in Figure 2.4, will have reduced the archaeological potential of the study area as a whole.

2.2.2.35 In respect of the two pipeline options, any marine archaeological impacts close to the Tuen Mun Area 38 shoreline and across the Urmston Road will be the same. After this point, Option 1 enters the existing AFRF dredged access channel which is considered to have lower archaeological potential than undisturbed areas of seabed. Option 2 is much longer in length and, due to the need to avoid existing development such as the Contaminated Mud Pits at East of Sha Chau, passes through areas of seabed which are not believed to have been disturbed. Thus, the potential for impacts on marine archaeological reserves is notably greater for Option 2 and based upon this, pipeline Option 1 would be preferred.

2.2.3 *Comparative Assessment of Options during the Operational Phase*

2.2.3.1 The main difference in the operational phase between the two pipelines is associated with the need to maintain the existing receiving AFRF at Sha Chau in a state of immediate operational readiness for the purpose of providing an emergency back-up system should the PAFF and associated pipeline become inoperable. This requires that the existing pipeline from the jetty at Sha Chau running southwards to the airport must be kept 'live' and has to be regularly flushed through with fuel to avoid stagnation of the sitting pipe volume.

2.2.3.2 For Option 1, this situation would not arise as the existing pipeline would be in continuous use. For Option 2, however, the existing pipeline would cease to be used routinely and fuel would be pumped to the airport through the completely new fuel link direct to the airport. The fuel sitting in the existing pipeline would therefore have to be periodically flushed. This would be done by flushing a clean load of aviation fuel through from the existing receiving jetty at Sha Chau at a frequency of approximately once every 6 weeks. This fuel would be transported to the jetty by barge exactly in accordance with current practice. Based upon this, it can be seen that Option 2 has the disadvantage of requiring on-going disturbance within the Marine Park throughout the operational life of the facilities as full barges continue to enter and berth at the jetty. Option 1 is thus the preferred from this operational perspective.

<u>Hazard to Life and Marine Environment</u>

2.2.3.3 As discussed in Section 10, Section 2.2.3.1 and summarized in Table 11.2, the statistically predicted frequency of a spillage varies for the tank farm, pipeline leak, loading arm rupture at the jetty and for a vessel collision. It can be seen from these figures that not only is the risk very low in all cases, the highest risks are associated with marine transport and the jetty, with the risks from a pipeline route being not very significant. Notwithstanding, as the risk is recorded per km per year, the length of the pipeline will influence the risk factor. The longest pipeline option, Option 2, is more than twice the length of Option 1 (see Table 2.4) which will increase the frequency of failure for this route.

2.2.3.4 However, the location of the pipeline must also be taken into consideration with a pipeline in an area subject to significant vessel movement being at greater risk irrespective of its length. The key risk from marine traffic to the pipeline is rupture by the vessels' anchors. In respect of both the pipeline alternatives, Urmston Road will need to be crossed. Vessels will not anchor in this area because it is a major shipping route and the currents are too strong. However, vessels could anchor to the side of the channel and there have been reports of accidental damage to unprotected outfall pipes as a result of dragging anchors in the Wan Chai and Chai Wan areas. The longer length of the pipeline Option 2 will increase the probability of such an incident occurring. Notwithstanding, the risks for both pipelines are expected to be low, given the rock armour protection on the pipeline.

2.2.3.5 The key hazard to life concern involving the handling, storage and transport of fuel materials is fire. In respect of the pipelines, fires may occur on the sea due to loss of containment of the pipeline. However, in respect of aviation fuel, due to the entrainment of water in the fuel droplets after a pipeline spill or leak, the amount of fuel that can vaporise to form a flammable mixture just above the fuel pool on the sea surface will be very limited. In addition, while the aviation fuel that is not entrained would float on water and it is combustible when exposed to heat or flame, the fuel itself is not explosive. For the normal range of ambient temperatures in Hong Kong, the vapour pressure of aviation fuel is too low for it to form a flammable vapour cloud, with its flash point being above the ambient temperature. Thus, there is a very low probability of ignition of a spill on the sea and a low probability of the onshore population or marine traffic being affected. This would be the case for both pipeline options.

2.2.3.6 In terms of environmental risk, a spill would have the most damaging effects on low energy shorelines characterised by mangroves and seagrasses, with the majority of mobile species, including fish and dolphins, predicted to avoid the spill. The more sessile benthic species would be largely unaffected because the fuel floats to the surface.

2.2.3.7 The closest important mangal stands are located at San Tau and Tai Ho Wan on the Northwest coast of Lantau (Tam and Wong, 2000). These two important mangrove stands are about 8 km away from the alignment of pipeline Option 1. However, the southern end of pipeline Option 2, which connects to the western side of the airport, will be within 4km from the San Tau SSSI mangroves and seagrasses in Tung Chung Bay. Option 1 is thus marginally preferred.

2.2.4 Environmental Performance of the Existing Pipeline

2.2.4.1 Option 1 includes retaining the existing pipeline from the AFRF to the airport. This section of the report provides a review of the environmental assessment and performance of this pipeline.

2.2.4.2 The EIA Report of the AFRF predicted no operational impacts on the marine ecology from the operation of subsea pipeline. The existing pipeline has performed very well since airport opening. There have been no fuel leakages and it is anticipated that the pipeline will perform in the same way for over 50 years.

2.2.4.3 In order to monitor the performance of the pipeline, a thorough internal inspection of the pipeline is conducted every five years using an intelligent pig, which surveys and keeps records of the entire pipeline including an ultra sound survey. The first intelligent pigging, after the commencement of the operation of the pipeline, was undertaken in early 2001 and this demonstrated that the pipeline was performing to its design standards.

2.2.4.4 Surveys to assess the abundance and trends in numbers of Indo-Pacific Humback dolphins north of Lantau Island have been conducted since November 1995. Although these were primarily intended to assess potential impacts during construction, they also cover the operational period.

2.2.4.5 North Lantau dolphin abundance estimates showed an apparent decreasing trend until winter/spring of 1997/1998, perhaps due to the construction activities in the vicinity of the new airport during this period. Dolphins may have avoided this area due to the noise associated with the piling work (even with a noise attenuating bubble curtain in place during the piling activity), although impacts were assessed as not statistically significant.

2.2.4.6 There appears to have been an influx of dolphins back into the area as found during operational monitoring of the AFRF. Dolphin abundance appears to have stabilised, indicating that the day to day operation of the AFRF, including the pipeline, has had no adverse impact on dolphin abundance. More recent dolphin monitoring further supports this.

2.2.4.7 The surveys of dolphin abundance in the North Lantau area for the operational phase study period give results which are similar to those from time periods preceding the construction phase, and there is now no evidence of any impact on dolphin abundance arising as a result of day to day AFRF and pipeline operations. Abundance of dolphins in the North Lantau area continues to be stable.

2.2.4.8 As shown later in this Report (Chapter 10), the likelihood of damage to the pipeline in extremely low. Nevertheless, in case of any incident, the Airport Authority has prepared a contingency response plan. This contingency response plan is very comprehensive and part of it covers events relating to the pipeline damage. Although extremely unlikely, depending on the event, the fuel spill size could vary depending upon the event. These events cover: spills from a hole in the subsea pipeline, a fracture in the subsea pipeline wall, and third party damage to the pipeline, e.g. a dragging anchor. The contingency response plan includes the following and further details are provided in Section 11 of this report:

- identification of the location of a spill;
- assessing the size/volume of a spill;
- advice on the planned action to be followed to contain any liquid or fuel lost to the marine waters;
- action to be taken pending Marine Department personnel arriving at the site;
- diver inspections for any underwater pipe leak;
- treatment of recovered fuel; and
- investigation of cause of the spill, preparation of a report and instigation of actions to avoid a recurrence.

2.2.4.9 It is thus concluded that the environmental performance of the existing pipeline is satisfactory.

2.2.5 Conclusions

2.2.5.1 Pipeline routing Option 2 has the advantage of completely avoiding the Marine Park, where there is a presumption against development and marine works. However, it is concluded from this comparative assessment, that Option 1, which involves constructing the fuel pipeline to tie in with the existing AFRF jetty and existing pipeline to the airport, is overwhelmingly the more environmentally attractive option, principally because it is significantly shorter and it makes use of the existing AFRF access channel thereby minimising further impacts to undisturbed seabed. The amount of dredging is more than halved for Option 1 compared to Option 2, as is the construction time and thus the period of disturbance. For each of the key environmental issues assessed, the longer routing is predicted to be more environmentally disruptive than the shorter route.

2.2.5.2 Option 1 would necessitate dredging for a pipeline trench within the boundaries of the Marine Park. However, this particular stretch of seabed will in any case require regular maintenance dredging every 3-4 years or so to facilitate marine access to the existing jetty. The additional works activities to construct the trench would only take in the region of 1 week to complete and could be timed to coincide with this activity and would be relatively minor in comparison.

2.2.5.3 Option 2 would require tankers to continue to access the existing AFRF jetty within the Marine Park routinely, albeit at a greatly reduced frequency than is presently experienced. Option 1, therefore, reduces disturbance to the Marine Park in the operational phase compared to Option 2.

2.2.5.4 Possibly the biggest environmental concern in this area relates to the degree of disturbance to the dolphins that inhabit this area. Although the Sha Chau and Lung Kwu Chau Marine Park was designated primarily to protect important habitat for dolphins, areas outside of the marine park boundaries are frequently used by dolphins as well. It has been shown quantitatively, using best available scientific data, that Option 1 is preferred in this respect.

2.2.5.5 Pipeline Option 1 which involves constructing a new pipeline between the PAFF site at Tuen Mun Area 38 to connect with the existing AFRF at Sha Chau is therefore identified as the preferred pipeline routing. Furthermore it is demonstrated in this EIA that the Option 1 pipeline is environmentally acceptable.

2.2.6 Environmental Conditions in the Absence of the Project

2.2.6.1 The PAFF will be located on an area of reclaimed land within Tuen Mun Area 38. This land is zoned for industry and is surrounded by other industrial uses including the Shiu Wing Steel Mill, Castle Peak Power station and the River Trade Terminal. The area as a whole is subject to noise, both from the surrounding industry, and marine traffic in the busy Urmston Road shipping channel.

2.2.6.2 In respect of the ecology of the area, the land has no ecology value, having been created using public fill. The proposed pipeline passes underneath north western waters, which, while known to be a habitat for the important Chinese White Dolphins and fisheries, is an area already subject to considerable disturbance because of other development projects and existing uses. The area is not known to give rise to notable benthos of significant abundance and diversity. The selected pipeline alignment is proposed to connect to the existing AFRF at Sha Chau and as such a small portion must be located within the Sha Chau and Lung Kwu Chau Marine Park. However, it should be noted that the alignment in the Marine Park will follow the existing AFRF access channel which will continue to be dredged on a periodic basis. No significant environmental effects on the Marine Park itself or the Chinese White Dolphins are expected from the installation or operation of the pipeline.

2.2.6.3 Reducing the potential for impacts and maintaining the existing environmental conditions as far a possible has been a major objective of the assessment and in the selection of the preferred PAFF site and pipeline route.

2.2.6.4 The existing AFRF is a temporary facility only and does not have sufficient capacity to meet the fuel demands of the HKIA beyond 2009 (together with West Quay). As such, if the PAFF at Tuen Mun Area 38 did not proceed, this facility would continue to operate in the short term with 5,000 dwt vessels continuing to deliver fuel to the AFRF in the Marine Park on a daily basis. This is considered to present a greater risk of spill and present more disturbance to the Marine Park and the Chinese White Dolphins than the delivery of fuel through a pipeline, as would be the case with the proposed PAFF. In addition, the site at Tuen Mun Area 38 would anyway be allocated to an alternative industrial use, in fitting with the existing and future land use planning of the area.

2.2.6.5 A PAFF is vital to replace the AFRF and to meet the fuel needs of the HKIA. Based upon the more than 10 years of search for a suitable site, it is considered that the site at Tuen Mun Area 38 and selected pipeline alignment present the most preferable options environmentally as well as in terms of programme and operational aspects. Subsequent sections of this report demonstrate that the Tuen Mun Area 38 site is an environmentally acceptable option for the PAFF.

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