2. WATER QUALITY IMPACT ASSESSMENT

2.1 Introduction

2.1.1 This Section presents the water quality impacts associated with the Project with regard to both the construction and operation phases. Construction phase impacts were assessed with regard to potential surface runoff from the works site and wastewater generated from on-site activities while operation phase impacts were primarily focused on those to River Indus and Deep Bay.

2.2 Environmental Legislation, Policies, Standards and Criteria

2.2.1 The following relevant pieces of legislation and associated guidance are applicable to the evaluation of water quality impacts associated with the construction and operation of the Project.

- *Water Pollution Control Ordinance (WPCO);*
- *Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems Inland and Coastal Waters; and*
- *Environmental Impact Assessment Ordinance (Cap. 499. S.16), Technical Memorandum on EIA Process (EIAO TM), Annexes 6 and 14.*

2.2.2 Apart from the above statutory requirements, the Practice Note for Professional Persons, *Construction Site Drainage* (ProPECC PN 1/94), issued by ProPECC in 1994, also provides useful guidelines on the management of construction site drainage and prevention of water pollution associated with construction activities.

<u>Water Pollution Control Ordinance</u>

2.2.3 The *WPCO* is the legislation for the control of water pollution and water quality in Hong Kong. Under the *WPCO*, Hong Kong waters are divided into 10 Water Control Zones (WCZs). Each WCZ has a designated set of statutory Water Quality Objectives (WQOs). The WQOs set limits for different parameters that should be achieved in order to maintain the water quality within the WCZs. The Project is wholly located within the Deep Bay WCZ. The WQOs for the Deep Bay WCZ, which are presented in **Table 2-1**, are applicable as evaluation criteria for assessing compliance of any effects from the construction and operation of the Project.

Table 2-1: Water Quality Objectives for the Deep Bay Water Control Zone

Water Quality Objectives		Part or parts of Zone
A.	AESTHETIC APPEARANCE	
a)	Waste discharges shall cause no objectionable odours or discolouration of the water.	Whole zone
b)	Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole zone
c)	Mineral oil should not be visible on the surface. Surfactants should not give rise to a lasting foam.	Whole zone
d)	There should be no recognizable sewage-derived debris.	Whole zone
e)	Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent.	Whole zone
f)	Waste discharges shall not cause the water to contain substances which settle to form objectionable deposits.	Whole zone
B.	BACTERIA	
a)	The level of Escherichia coli should not exceed 610 per 100 mL, calculated as the geometric mean of all samples collected in one calendar year.	Secondary Contact Recreation Subzone and Mariculture Subzone.
b)	The level of Escherichia coli should be zero per 100 mL, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Yuen Long & Kam Tin (Upper) Subzone, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground Subzones.
c)	The level of Escherichia coli should not exceed 1,000 per 100 mL, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Yuen Long & Kam Tin (Lower) Subzone and other inland waters.
d)	The level of Escherichia coli should not exceed 180 per 100 mL, calculated as the geometric mean of all samples collected from March to October inclusive in one calendar year. Samples should be taken at least 3 times in a calendar month at intervals of between 3 and 14 days.	Yuen Long Bathing Beach Subzone.
C.	COLOUR	
a)	Waste discharges shall not cause the colour of water to exceed 30 Hazen units.	Yuen Long & Kam Tin (Upper) Subzone, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground Subzones.
b)	Waste discharges shall not cause the colour of water to exceed 50 Hazen units.	Yuen Long & Kam Tin (Lower) Subzone and other inland waters.
D.	DISSOLVED OXYGEN	
a)	Waste discharges shall not cause the level of dissolved oxygen to fall below 4 mg per litre for 90% of the sampling occasions during the year; values should be taken at 1 metre below surface.	Inner Marine Subzone excepting Mariculture Subzone.

Water Quality Objectives		Part or parts of Zone
b)	Waste discharges shall not cause the level of dissolved oxygen to fall below 4 mg per litre for 90% of the sampling occasions during the year; values should be calculated as water column average (arithmetic mean of at least 2 measurements at 1 metre below surface and 1 metre above seabed). In addition, the concentration of dissolved oxygen should not be less than 2 mg per litre within 2 metres of the seabed for 90% of the sampling occasions during the year.	Outer Marine Subzone excepting Mariculture Subzone.
c)	The dissolved oxygen level should not be less than 5 mg per litre for 90% of the sampling occasions during the year; values should be taken at 1 metre below surface.	Mariculture Subzone.
d)	Waste discharges shall not cause the level of dissolved oxygen to be less than 4 mg per litre.	Yuen Long & Kam Tin (Upper and Lower) Subzones, Beas Subzone, Indus Subzone, Ganges Subzone, Water Gathering Ground Subzones and other inland waters of the Zone.
E.	pH	
a)	The pH of the water should be within the range of 6.5 – 8.5 units. In addition, waste discharge shall not cause the natural pH range to be extended by more than 0.2 units.	Marine waters excepting Yuen Long Bathing Beach Subzone.
b)	Waste discharges shall not cause the pH of the water to exceed the range of 6.5 – 8.5 units.	Yuen Long & Kam Tin (Upper and Lower) Subzones, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground Subzones.
c)	The pH of the water should be within the range of 6.0 – 9.0 units.	Other inland waters.
d)	The pH of the water should be within the range of 6.0 – 9.0 units for 95% of samples. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.5 units.	Yuen Long Bathing Beach Subzone.
F.	TEMPERATURE	
	Waste discharges shall not cause the natural daily temperature range to change by more than 2.0℃.	Whole zone.
G.	SALINITY	
	Waste discharges shall not cause the natural ambient salinity level to change by more than 10%.	Whole zone.
H.	SUSPENDED SOLIDS	
a)	Waste discharges shall neither cause the natural ambient level to be raised by 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters.
b)	Waste discharges shall not cause the annual median of suspended solids to exceed 20 mg per litre.	Yuen Long & Kam Tin (Upper and Lower) Subzones, Beas Subzone, Indus Subzone, Ganges Subzone, Water Gathering Ground Subzones and other inland waters.

Water Quality Objectives		Part or parts of Zone
I.	AMMONIA	
	The un-ionized ammoniacal nitrogen level should not be more than 0.021 mg per litre, calculated as the annual average (arithmetic mean).	Whole zone
J.	NUTRIENTS	
a)	Nutrients shall not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants.	Inner and Outer marine Subzones.
b)	Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.7 mg per litre, expressed as annual mean.	Inner Marine Subzone.
c)	Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.5 mg per litre, expressed as annual water column average (arithmetic mean of at least 2 measurements at 1 metre below surface and 1 metre above seabed).	Outer Marine Subzone.
K.	5-DAY BIOCHEMICAL OXYGEN DEMAND	
a)	Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 3 mg per litre.	Yuen Long & Kam Tin (Upper) Subzone, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground Subzones.
b)	Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 5 mg per litre.	Yuen Long & Kam Tin (Lower) Subzone and other inland waters.
L.	CHEMICAL OXYGEN DEMAND	
a)	Waste discharges shall not cause the chemical oxygen demand to exceed 15 mg per litre.	Yuen Long & Kam Tin (Upper) Subzone, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground Subzones.
b)	Waste discharges shall not cause the 5-day chemical oxygen demand to exceed 30 mg per litre.	Yuen Long and Kam Tin (Lower) Subzone and other inland waters.
M.	TOXINS	
a)	Waste discharges shall not cause the toxins in water to attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other.	Whole zone
b)	Waste discharges shall not cause a risk to any beneficial uses of the aquatic environment.	Whole zone
N.	PHENOLS	
	Phenols shall not be present in such quantities as to produce a specific odour, or in concentration greater than 0.05 mg per litre as C_6H_5OH.	Yuen Long Bathing Beach Subzone.

Water Quality Objectives	Part or parts of Zone
O. TURBIDITY	
Waste discharges shall not reduce light transmission substantially from the normal level.	Yuen Long Bathing Beach Subzone.

Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems Inland and Coastal Waters

2.2.4 All discharges during both the construction and the operational phases of the Project are required to comply with the *Technical Memorandum for Effluents discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* (TM) issued under Section 21 of the *WPCO*. The TM defines discharge limits to different types of receiving waters. Under the TM, effluents discharged into the drainage and sewerage systems, inshore and coastal waters of the WCZs are subject to pollutant concentration standards for particular discharge volumes. Any new discharges within a WCZ are subject to licence conditions and the TM acts as a guideline for setting discharge standards for the licence.

2.2.5 In addition to the provisions of the TM, the 'Deep Bay Zero Discharge Policy' aims to provide protection to the inland and marine water quality of the Deep Bay WCZ. The policy requires that developments within the Deep Bay catchment areas do not result in an increase in pollution loads to the inland and marine waters.

EIAO-TM

2.2.6 *Section 1.4 and 2.1 of Annex 6* of the EIAO-TM provides general guidelines and criteria to be used in assessing water quality issues. In section 1.4 of Annex 6 provides that a water body under stress must be protected against further degradation, using the following criteria: (a) activity must not contribute to, increase or perpetuate stressed conditions; (b) activity must not retard recovery of the water body if pollution from other sources decreases. In section 2.1 of Annex 6 provides that for discharges into sensitive areas, criteria for discharge shall be determined on the basis of the assimilative capacity of the receiving water body and more stringent standards than those stipulated in the *WPCO-TM* may apply.

2.3 Baseline Conditions and Water Quality Sensitive Receivers

2.3.1 In order to characterize the background water quality within the Study Area, reference has been made to data from EPD's routine river water quality monitoring programme. The use of such data follows standard EIA practice and provides sufficient information for the purposes of this Study.

2.3.2 The SWHSTW falls within the catchment of River Indus. Part of the proposed expansion works will be constructed within the existing STW compound while the other in a piece of government land right to the north of the existing STW boundary.

2.3.3 There are two EPD river water quality sampling stations (IN1 and IN2) near the Project site. The river water quality monitoring results at these stations for 2003[(1)] are presented in **Table 2-2**.

Table 2-2: Summary of the EPD Routine River Water Quality Monitoring Data for River Indus in 2003.

Parameter	**Station IN1**	**Station IN2**
Dissolved Oxygen (mg L^{-1})	5.2 (2.5 - 11.8)	7.4 (3.3 – 9.1)
pH	7.2 (6.9 - 7.9)	7.8 (7.0 –9.4)
Suspended Solids (mg L^{-1})	34 (9 –77)	19 (7-150)
5-day Biochemical Oxygen Demand (mg L^{-1})	5 (4 – 20)	4 (1 – 6)
Chemical Oxygen Demand (mg L^{-1})	24 (12 – 44)	13 (8 – 22)
Oil & Grease (mg L^{-1})	0.5 (0.5 – 0.7)	0.5 (0.5 – 0.7)
Faecal Coliforms (cfu 100m L^{-1})	230,000 (27,000 – 6,600,000)	12,000 (860 – 110,000)
E. coli (cfu 100m L^{-1})	78,000 (11,000 – 3,000,000)	1,800 (120 – 16,000)
Ammonia-nitrogen (mg L^{-1})	2.45 (0.41 – 11.00)	0.41 (0.20 – 1.10)
Nitrate-nitrogen (mg L^{-1})	1.65 (0.01 – 3.90)	1.35 (0.87 – 1.90)
Total Kjeldahl Nitrogen, SP (mg L^{-1})	3.95 (2.10 – 13.00)	1.10 (0.54 – 2.10)
Ortho-phosphate (mg L^{-1})	0.83 (0.25 – 1.70)	0.11 (0.03 – 0.20)
Total Phosphorous (mg L^{-1})	1.15 (0.48 – 2.00)	0.29 (0.20 – 0.79)
Sulphide, SP (mg L^{-1})	0.02 (0.02 – 0.03)	0.02 (0.02– 0.05)
Aluminium (μg L^{-1})	225 (80 – 610)	125 (70 – 670)
Cadmium (μg L^{-1})	0.1 (0.1 – 0.9)	0.1 (0.1 – 0.3)
Chromium (μg L^{-1})	1 (1 – 5)	1 (1 – 7)
Copper (μg L^{-1})	6 (2 – 7)	4 (3 – 16)
Lead (μg L^{-1})	3 (1 – 6)	4 (1 – 34)
Zinc (μg L^{-1})	90 (40 – 250)	295 (60 – 2,700)
Flow (Ls^{-1})	NM	NM

Notes :

1. Data presented are annual medians of monthly samples; except those for faecal coliforms and *E. coli* which are annual geometric means.
2. Figures in brackets are annual ranges.
3. NM indicates no measurement taken.
4. cfu – colony forming unit.
5. SP – soluble and particulate fractions (i.e. total value).
6. Equal values for the annual medians and ranges indicate that all data are equal to or below the laboratory reporting limits.

2.3.4 Since the introduction of the Livestock Waste Control Scheme (LWCS) in 1989 and the revised scheme in 1995, there has been a dramatic reduction in the discharge of livestock wastes to the River Indus. However, discharges from unsewered villages and livestock waste still contribute to high levels of *E. coli* in the river. Analysis of the trends in the EPD river water quality monitoring data shows that there have been significant improvements in water quality in the River Indus between 1987 and 2000, with increases in dissolved oxygen and decreases in pollutants (5-day biochemical oxygen demand, chemical oxygen demand, nutrients and bacteria).

(1) EPD (2003). *Op cit.*

2.3.5 For River Indus as a whole, the compliance rate with the WQO for dissolved oxygen in 2003 remained high (89%) and is better than that in 2002 (75%). The overall rate of compliance is still low (67%), although showing some improvements compared to that in 2002 (55%). The Water Quality Index (WQI) for River Indus deteriorated from the category of ‘bad’ in 2002 to ‘fair’ in 2003.

2.3.6 In order to restore the health of River Indus, the Western Trunk Sewer was constructed under the North District Sewerage Master Plan in 2002. In the Stage I plan, two villages in the River Indus catchment will be connected to the sewer by 2005. Improvement to the river water quality is expected with continuous enforcement and gradual provision of public sewer to the unsewered villages.

Deep Bay Catchment

2.3.7 The catchment of River Indus forms part of the Deep Bay catchment in the eastern side. The water quality of Deep Bay is unsatisfactory as reflected by the frequent non-compliance with the statutory Water Quality Objectives. According to the agreement reached under the Hong Kong/Guangdong Environmental Protection Liaison Group, the long-term objective of the Deep Bay water pollution control strategy is to reduce the pollution load to Deep Bay, on a step-by-step basis, so as to work towards meeting the assimilative capacity over a period of time.

2.4 Construction Phase Impact Assessment & Recommended Mitigation Measures

Assessment Methodology

2.4.1 Due to the small scale of the Project, the assessment of the construction phase impacts on water quality was undertaken in a qualitative manner. Consideration has been given to controlling potentially harmful impacts from the site works and given to the use of 'best' practice measures to minimise the potentially harmful discharge of pollutants to nearby River Indus, which is adjacent to the site.

Identification of Potential Sources of Impacts

2.4.2 The key construction activities that may result in water quality impact on River Indus during construction phase of the Project are described in **Table 2-3**. Many of the identified potential impacts may be controlled through the specification of mitigation measures, which are described in Section 2.4.4.

Prediction and Evaluation of Impacts

2.4.3 The potential sources of impacts, described in Section 2.4.2, could be readily controlled by appropriate on-site measures described in Section 2.4.4 to minimise the potential impacts.

Table 2-3: Potential Impacts to Water Quality during the Construction Phase

Construction Works	Activities that result in Water Quality Impact
Construction Runoff and Drainage	This includes runoff and erosion from site surfaces, interception of drainage channels and watercourses, earth working, and stockpiles that may contain increased loads of sediments, other suspended solids (SS) and contaminant. Potential contaminants include: • silt and contaminated runoff from on-site stockpiles and pumped groundwater; • bentonite slurries and other grouting and cement materials; and • fuel, oil and lubricants from construction vehicles and equipment. In addition, the extent of water quality impact could increase during demolition of existing buildings and temporary structures, as this would result in volumes of construction debris. Unless carefully controlled, this construction waste could enter any nearby ponds, streams and rivers and lead to adverse impacts upon water quality. Bentonite, grouting and cement materials may be used during the construction of residential buildings, roads and other infrastructure facilities. They may be delivered to the site by trunks. It is considered that the water pollution will only result if the materials are allowed to enter into water bodies as surface runoff or underground storm water/drainage discharge.
General Construction Activities	On-going site construction activities will have the potential to cause water pollution from rubbish such as food packaging and debris including used construction materials entering the water column, resulting in floating refuse in the vicinity of the site. Spillages of liquids such as oil, diesel and solvents are also likely to affect water quality if they enter surrounding water bodies.
Wastewater from Construction Work Force	Sewage effluents arising from the on-site construction work force and wastewater from any canteen facilities have the potential to cause water pollution. Sewage is characterized by high levels of biochemical oxygen demand (BOD), ammonia, *E. coli* and oil/grease.

Mitigation of Adverse Environmental Impacts

2.4.4 Construction phase mitigation measures, in accordance with *Practice Note for Professional Persons on Construction Site Drainage, Professional Persons Environmental Protection Department, 1994* (ProPECC PN 1/94) include the use of sediment traps, wheel washing facilities for vehicles leaving the site, adequate maintenance of drainage systems to prevent flooding and overflow, sewage collection and treatment, and comprehensive waste management (collection, handling, transportation, disposal) procedures. The requirements of the *Water Pollution Control Ordinance* should also be observed.

Construction Runoff and Drainage

The following measures are recommended for reducing the potential of impacts to the water quality from construction runoff and site drainage:

- At the start of site establishment, perimeter cut-off drains to direct off-site water around the site should be constructed and internal drainage works and erosion and sedimentation control facilities implemented. Channels, earth bunds or sand bag barriers should be provided on site to direct stormwater to silt removal facilities. The design of the temporary on-site drainage system will be undertaken by the contractor prior to the commencement of construction.

- The design of efficient silt removal facilities should be based on the guidelines in Appendix A1 of ProPECC PN 1/94, which states that the retention time for silt/sand traps should be 5 minutes under maximum flow conditions. Sizes may vary depending upon the flow rate, but for a flow rate of $0.1m^3s^{-1}$ a sedimentation basin of $30m^3$ would be required and for a flow rate of $0.5m^3s^{-1}$ the basin would be $150m^3$. The detailed design of the sand/silt traps will be undertaken by the contractor prior to the commencement of construction.

- Ideally, construction works should be programmed to minimize surface excavation works during the rainy season (April to September). All exposed earth areas should be compacted and vegetated as soon as possible after earthworks have been completed, or alternatively, within 14 days of cessation of earthworks where practicable. If excavation of soil cannot be avoided during the rainy season, or at any time of year when rainstorms are likely, exposed slope surfaces should be covered by tarpaulin or other means.

- The overall slope of the site should be kept to a minimum to reduce the erosive potential of surface water flows, and all trafficked areas and access roads protected by coarse stone ballast. An additional advantage accruing from the use of crushed stone is the positive traction gained during prolonged periods of inclement weather and the reduction of surface sheet flows.

- All drainage facilities and erosion and sediment control structures should be regularly inspected and maintained to ensure proper and efficient operation at all times and particularly following rainstorms. Deposited silt and grit should be removed regularly and disposed of by spreading evenly over stable, vegetated areas.

- Measures should be taken to minimize the ingress of site drainage into excavations. If the excavation of trenches in wet periods is necessary, they should be dug and backfilled in short sections wherever practicable. Water pumped out from trenches or foundation excavations should be discharged into storm drains via silt removal facilities.

- Open stockpiles of construction materials (for example, aggregates, sand and fill material) of more than $50m^3$ should be covered with tarpaulin or similar fabric during rainstorms. Measures should be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system.

- Manholes (including newly constructed ones) should always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris being washed into the drainage system and storm runoff being directed into foul sewers.

- Precautions to be taken at any time of year when rainstorms are likely, actions to be taken when a rainstorm is imminent or forecasted, and actions to be taken during or after rainstorms are summarized in Appendix A2 of ProPECC PN

1/94. Particular attention should be paid to the control of silty surface runoff during storms events, especially for areas located near steep slopes.

- All vehicles and plant should be cleaned before leaving a construction site to ensure no earth, mud, debris and the like is deposited by them on roads. An adequately designed and sited wheel washing bay should be provided at every site exits and wash-water should have sand and silt settled out and removed at least on a weekly basis to ensure the continued efficiency of the process. The section of access road leading to, and exiting from, the wheel-wash bay to the public road should be paved with sufficient backfill toward the wheel-wash bay to prevent vehicle tracking of soil and silty water to public roads and drains.

- On-site drainage system should be equipped with oil interceptors to separate oil/fuel from contaminated storm water.

General Construction Activities

The following measures are recommended for reducing the potential for general construction waste impacts to water quality:

- Construction solid waste, debris and rubbish on site should be collected, handled and disposed of properly to avoid water quality impacts. Requirements for solid waste management are detailed in Annex 3.

- All fuel tanks and storage areas should be provided with locks and sited on sealed areas, within bunds of a capacity equal to 110% of the storage capacity of the largest tank to prevent spilled fuel oils from reaching water sensitive receivers nearly.

Sewage Effluent from Construction Workforce

The following measures are recommended for reducing the potential for impacts to water quality from sewage effluent from construction workforce:

- Sewage from construction workforce should be handled by portable chemical toilets or sewage holding tanks with the sewage regularly collected by a reputable sewage collector for disposal at, for example, SWHSTW. Sewage from on-site toilets should be diverted to and stored within sewage holding tanks for later disposal.

2.5 Operation Phase Impact Assessment & Recommended Mitigation Measures

Assessment Methodology

2.5.1 As the objective of the Project is to provide adequate treatment facilities for treating the sewage generated by nearby unsewered areas in Sheung Shui and Fanling, there will be a reduction of pollution loadings to Deep Bay.

Identification of Potential Sources of Impacts

2.5.2 The potential source of impact during operation phase of the Project is the increased sewage effluent discharge into Deep Bay. Upon commissioning of the Project, the capacity of the SWHSTW will be increased from the present design flow of 80,000m^3/day to 93,000m^3/day. The effluent standards of the SWHSTW are summarized in the **Table 2-4**.

Table 2-4 – Effluent Standards of the Shek Wu Hui Sewage Treatment Works

Parameters	*Standards (95 percentile value)*
5-day Biochemical Oxygen Demand (BOD), mg/L	20
Suspended Solids, SS (mg/l)	30
Ammonia-nitrogen (NH_3N), mg/L	2
Nitrite and Nitrate nitrogen (NO_3N and NO_2N), mg/L	12
E. coli (counts/100mL)	1,500 [100 (Monthly geometric mean)]

Proposed Mitigation Measures

2.5.3 The increase in pollution loads discharging from Shek Wu Hui STW into the water environment will be offset by reduction of pollution loads discharged into the water environment generated by nearby villages in North District as shown on **Figure A2-1** which will be progressively intercepted by village sewers.

2.5.4 In the unsewered villages, on-site treatment facilities namely septic tanks together with soakaway systems are usually used. Due to the high population density, the soakaway system is not effective. Sewage will only be partially treated by the septic tanks. This partially treated sewage is polluting the nearby branches of river upstream of the discharge point of Shek Wu Hui STW such as River Indus and subsequently Deep Bay. **Table 2–5** shows the typical septic tank effluent qualities.

Table 2-5: Typical Septic Tank Effluent Qualities

Pollutants Concentration	*Typical Range*[1]	*Average*
BOD, mg/L	150 - 250	200
SS, mg/L	40 - 140	90
NH_3N, mg/L	30 – 50	40
Total Kjeldahl Nitrogen (TKN), mg/L	50 – 90	70

Notes:
(1) Reference: *"Small and Decentralized Wastewater Management Systems"*, McGraw-Hill, 1998.

2.5.5 Currently, there are 46 numbers of villages within the catchment of Shek Wu Hui STW falling within the village sewerage scheme. Under the village sewerage scheme, communal sewerage will be provided to replace the septic tanks. The sewage generated from these villages will be properly collected and conveyed to Shek Wu Hui STW for treatment before disposal into River Indus. **Table 2-6** below is the names of the committed villages together with populations and the concerned village sewerage construction programme:

Table 2-6: Names of villages where sewage will be intercepted to Shek Wu Hui Sewage Treatment Works for treatment

Village Name (Chinese)	*2005 Population (Projected)*	*2009 Population (Projected)*	*2011 Population (Projected)*	*Construction Programme*
Yin Kong (燕崗), Tai Tau Leng (大頭嶺), Tsung Pak Long (松柏朗), Hang Tau (坑頭)	1879	1879	1879	04/2002 – 06/2005
So Kwun Po (掃管埔)	368	368	368	11/2002 – 11/2005
Kai Leng (雞嶺)	860	860	860	
Ng Uk Tsuen (吳屋村)	193	174	165	
Fan Leng Lau (粉嶺樓)	826	826	826	
Tong Hang (塘坑)	842	929	973	06/2006 – 12/2008
Fan Leng Nam Wai (粉嶺南圍), Fan Leng Pak Wai (粉嶺北圍), Fan Leng Ching Wai (粉嶺正圍)	2723	2723	2723	
Hung Leng Village Expansion Area (孔嶺)	1750	2025	2163	
Kan Lung Tsuen (觀龍村), San Wai (新圍), San Uk Tsuen (新屋村)	1210	1475	1608	
Ko Po (高莆)	90	117	130	
Sun Tong Po (新塘莆)	275	328	354	
Shung Him Tong (崇謙堂)	689	724	741	06/2007 – 06/2010
Lo Wai (老圍), Tsz Tong Tsuen (祠堂村), Tung Kok Wai (東閣圍), Ma Wat Wai (麻笏圍), Wing Ning Wai (永寧圍), Wing Ning Tsuen (永寧村)	4278	5375	5923	
Kwan Tei (軍地)	1068	1384	1542	
Kam Tsin (金錢), Ho Sheung Heung (河上鄉), Tsung Yuen (松園)	2535	2535	2535	
Wo Hop Shek Sun Tsuen (和合石新村)	973	1008	1025	
Sheung Shui Heung Group (上水鄉)	5384	5782	5981	
Ping Kong (丙崗)	792	792	792	
Ling Shan Tsuen (靈山村)	1695	2097	2298	
Fu Tei Pai (虎地排)	648	775	838	
Ma Mei Ha (馬尾下), Kan Tau Tsuen (簡頭村)	420	420	420	
Tan Chuk Hang Lo Wai (丹竹抗老圍), Leng Pei Tsuen (嶺皮村), Ma Mei Ha Leng Tsui (馬尾下嶺咀)	540	540	540	

Tai Hang Group (泰亨), Kau Lung Hang Lo Wai (九龍坑新圍), Tai Wo (大窩), Nam Wa Po (南華莆), Wai Tau Tsuen (圍頭村), Kau Lung Hang San Wai (九龍坑老圍), Yuen Leng (元嶺)	8720	9040	9200	03/2008 – 06/2011
Total Population (sewage flow generated)	38758 (9980m^3/d)	42175 (10860m^3/d)	43884 (11300m^3/d)	-

** The population Projects are made based on information in the "Final Adoptive Review Report" under Agreement No. CE 93/96 prepared by Maunsell Consultants Asia Ltd. in October 1999.*

2.5.6 From **Table 2-4** and **Table 2-5**, we can see that the pollutants concentrations of effluent from septic tanks are much greater than that of STW effluent. Provision of village sewerage to collect the wastewater from these villages to the communal sewerage system for subsequent treatment in Shek Wu Hui STW could greatly reduce the pollutant loads to River Indus. The increase in pollution loads discharged from Shek Wu Hui STW will be offset by the substantial reduction of pollution loads discharged from these villages. The effectiveness of the village sewerage as a mitigation measures is assessed in the following paragraphs.

2.5.7 To give an conservative impact assessment, it is assumed that the pollutants concentrations of the effluent from Shek Wu Hui STW are at the 95 percentile "permissible levels" with 20mg/L BOD, 30mg/L SS, 2mg/L NH_4N, 12mg/L (NO_3N and NO_2N) (i.e. Total Inorganic Nitrogen (TIN) = 2 + 12= 14mg/l) and 15 mg/L Total Nitrogen (which is assumed to be equal to the sum of 2 mg/L NH_4N, 12 mg/L NO_3N and NO_2N and 1 mg/L organic-nitrogen), while the septic tank effluent pollutants concentrations are at the "average levels" with 200mg/L BOD, 90mg/L SS, 40mg/L NH_4N and 70 mg/L Total Nitrogen (which is assumed to be equal to TKN concentration as there is assumed no NO_2 and NO_3).

2.5.8 The Project is designed to cater for the planned development within Fanling/Sheung Shui New Town and the committed village sewerage for design year 2011, therefore this impact assessment is conducted based on the estimated sewage flow and population loads at Year 2011. The effectiveness of the village sewerage as a mitigation measures is tested under the following scenarios:

Year 2011 (Design Year)

Scenario 1A: Without the Project and mitigation measures

Sources	Flow (m^3/d)	BOD (kg/d)	SS (kg/d)	NH_4N (kg/d)	TIN (kg/d)	TN (kg/d)
Shek Wu Hui STW	81700	1634	2451	163	1143	1226
Concerned Unsewered Villages	11300	2260	1017	452	452	791
Total to River Indus	**93000**	**3894**	**3468**	**615**	**1595**	**2017**

Scenario 1B: Design scenario in year 2011 with 100% of village sewerage has been connected to communal sewers.

Sources	Flow (m^3/d)	BOD (kg/d)	SS (kg/d)	NH_4N (kg/d)	TIN (kg/d)	TN (kg/d)
Shek Wu Hui STW	93000	1860	2790	186	1302	1395
Concerned Unsewered Villages	0	0	0	0	0	0
Total to River Indus	93000	1860	2790	186	1302	1395
Changes comparing with Scenario 1A	-	-52.2%	-19.6%	-69.8%	-18.4%	-30.8%

Scenario 1C: Likely scenario in year 2011 – From **Figure A2-2**, 79% of village sewerage will be connected to communal sewers.

Sources	Flow (m^3/d)	BOD (kg/d)	SS (kg/d)	NH_4N (kg/d)	TIN (kg/d)	TN (kg/d)
Shek Wu Hui STW	90627 (*)	1813	2719	181	1269	1359
Concerned Unsewered Villages	2373 (**)	475	214	95	95	166
Total to River Indus	93000	2288	2933	276	1364	1525
Changes comparing with Scenario 1A	-	- 41.2%	-15.4%	-55.1%	-14.5%	-24.4%

(*) : Flow from Shek Wu Hui STW = 81700m^3/d + 79% x 11300m^3/d
(**) : Flow concerned unsewered villages = 21% x 11300m^3/d.

Scenario 1D: Worst scenario in year 2011 with only 35.5% of village sewerage has been connected to communal sewers while the remaining capacity of the STW is being used by other un-planned development. The unplanned flow is equal unsewered villages flow of 7288 m^3/d, which is equivalent to about 30,370 population [(1)].

Sources	Flow (m^3/d)	BOD (kg/d)	SS (kg/d)	NH_4N (kg/d)	TIN (kg/d)	TN (kg/d)
Shek Wu Hui STW	93000 (*)	1860	2790	186	1302	1395
Concerned Unsewered Villages	7288 (**)	1458	656	292	292	510
Total to River Indus	100,288	3318	3446	478	1594	1905
Changes comparing with Scenario 1A	+ 7.8%	-14.8%	-0.6%	-22.3%	-0.1%	-5.6%

(*) : Flow from Shek Wu Hui STW = design capacity of the STW
(**) : Flow concerned unsewered villages = 64.5% x 11300m^3/d.

2.5.9 From Section 2.5.8, we can see that even when the pollutant concentrations from Shek Wu Hui STW are at the "permissible levels", only 35.5% of village sewerage has been connected to communal sewers (which less than 50% of the planned 79%) and about 7288m^3/d flow from un-planned development (which is very unlikely), there is still a reduction in pollution loads discharging from Shek Wu Hui STW and nearby villages as compared with the baseline condition. There is a reduction of BOD, SS, NH_4N, TIN

(1) According to Table 2 of Sewerage Manual, Part 1 published by DSD, the global unit flow factor for type R1 private development is 0.24m^3/person/d. Therefore 7288m^3/d is equivalent to about 30,370 population.

and TN in all scenarios. The above assessment is based on a very conservative assumption that the concentration of BOD, SS, NH_4N and NOxN in the effluent of Shek Wu Hui Sewage Treatment Works is all reaching the permissible value. However, according to the past performance data, the actual concentration of BOD, SS, NH_4N and NOxN in the effluent is much lower than the permissible value. Thus, the collection of sewage generated from nearby villages is demonstrated to be an effective and practicable means in mitigating the impact of increase in pollution loads discharge from the Project.

2.5.10 The effectiveness of the mitigation measures is also tested during commissioning stage of the Project in year 2009. For complete assessment purpose, the scenario when Shek Wu Hui STW is fully loaded to 93,000 cubic metres per day in year 2009 i.e. all the capacity has been used up by unexpected development is also tested. However, the chance of occurrence of this scenario is extremely rare according to the latest planning data available.

<u>Year 2009</u>

Scenario 2A: Without the Project and mitigation measures in year 2009.

Sources	Flow (m^3/d)	BOD (kg/d)	SS (kg/d)	NH_4N (kg/d)	TIN (kg/d)	TN (kg/d)
Shek Wu Hui STW	78390	1568	2352	157	1098	1176
Concerned Unsewered Villages	10860	2172	977	434	434	760
Total to River Indus	**89250**	**3740**	**3329**	**591**	**1532**	**1936**

Scenario 2B: Likely scenario at commissioning in year 2009 – From **Figure A2-2**, 27 % of village sewerage will be connected to communal sewers.

Sources	Flow (m^3/d)	BOD (kg/d)	SS (kg/d)	NH_4N (kg/d)	TIN (kg/d)	TN (kg/d)
Shek Wu Hui STW	81322 (*)	1626	2440	163	1139	1220
Concerned Unsewered Villages	7928 (**)	1586	714	317	317	555
Total to River Indus	89250	3212	3154	480	1456	1775
Changes comparing with Scenario 2A	0%	-14.1%	-5.3%	-18.8%	-5.0%	-8.3%

(*) : Flow from Shek Wu Hui STW = 78390m^3/d + 27% x 10860m^3/d
(**) : Flow concerned unsewered villages = (100% - 27%) x 10860m^3/d.

Scenario 2C: Worst scenario at commissioning in year 2009 – With only 9% of village sewerage will be connected to communal sewers.

Sources	Flow (m^3/d)	BOD (kg/d)	SS (kg/d)	NH_4N (kg/d)	TIN (kg/d)	TN (kg/d)
Shek Wu Hui STW	79367 (*)	1587	2381	159	1111	1191
Concerned Unsewered Villages	9883 (**)	1977	889	395	395	692
Total to River Indus	89250	3564	3270	554	1506	1883
Changes comparing with Scenario 2A	0%	-4.7%	-1.8%	-6.3%	-1.7%	-2.7%

(*) : Flow from Shek Wu Hui STW = 78390m^3/d + 9% x 10860m^3/d
(**) : Flow concerned unsewered villages = (100% - 9%) x 10860m^3/d.

Scenario 2D: Extreme scenario at commissioning in year 2009 – With only 9% of village sewerage has been connected to communal sewers while the remaining capacity of the STW is being used by other un-planned development. The un-planned flow of about 11366 m^3/d (=93000m^3/d – 79367 m^3/d), which is equivalent to about 47,000 population.

Sources	Flow (m^3/d)	BOD (kg/d)	SS (kg/d)	NH_4N (kg/d)	TIN (kg/d)	TN (kg/d)
Shek Wu Hui STW	93000 (*)	1860	2790	186	1302	1395
Concerned Unsewered Villages	9883 (**)	1977	889	395	395	692
Total to River Indus	102883	3837	3679	581	1697	2087
Changes comparing with Scenario 2A	+1.53%	+2.6%	+10.5%	-1.7%	10.8%	+7.8%

(*) : Flow from Shek Wu Hui STW = design capacity
(**) : Flow concerned unsewered villages = (100% - 9%) x 10860m^3/d.

2.5.11 From table 2B & 2C, it is noted that there always have a reduction in pollution loads discharging from Shek Wu Hui STW and nearby villages. Thus, the collection of sewage generated from nearby villages is demonstrated to be an effective and practicable means in mitigating the impact of increase in pollution loads discharge from the Project. Even at the extreme case in year 2009 when only 9% of village sewerage has been connected while the remaining capacity of the STW is being used by other un-planned development, there is only minor increase in pollutants concentrations. However, it should be noted that such extreme case is unlikely to happen because a population increase of 41,000 from un-planned developments between year 2005 to year 2009 is nearly impossible to occur taking account of time required for such planning and construction of the developments. Thus, the collection of sewage generated from nearby villages is demonstrated to be an effective and practicable means in mitigating the impact of increase in pollution loads discharge from the Project.

Emergency Discharge Situation

2.5.12 Based on past plant records, no emergency discharge of untreated effluent had occurred in Shek Wu Hui sewage treatment works since commissioned in early 1980. Despite such, preventive measures including dual power supply from CLP, electricity generators and standby equipment are provided to minimize the risk of any emergency discharge case. The ring main and dual electricity supply will substantially reduce the risk of power failure. Even if there is power failure, the electricity generators on site will provide adequate electricity for the operation of screw pumps before resumption of power from CLP. According to the performance pledge of CLP, they will recover the electricity supply within 4 hours for any reported power outage. Standby equipment will provide further safeguard on proper functioning of all key treatment facilities e.g. standby air blowers to ensure adequate air supply for the biological treatment process and standby pumps to prevent any overflow of sewage due to mechanical failure of pumps. In the remote case that untreated effluent is discharged, an emergency contingency plan has been formulated to minimize the impact of emergency discharges and facilitate subsequent management of emergency. If there is a power failure, the plant manager will start up the emergency generator to provide electricity supplies for the pumps and regularly monitor the quality of effluent discharge.

2.6 Evaluation of Residual Environmental Impacts

Construction Phase

2.6.1 With the implementation of the mitigation measures described in Section 2.4.4, no residual water quality impacts will be predicted to occur due to construction of the Project.

Operation Phase

2.6.2 As the increase in pollution load discharging from Shek Wu Hui STW will be offset by the intercepting sewage from nearby unsewered village, no adverse environmental impact are predicted. In fact, with the commissioning of the Project and proposed mitigation measures, there will be environmental benefits to River Indus and Deep Bay.

2.7 Environmental Monitoring and Audit

Construction Phase

2.7.1 No monitoring of water quality would be required during the construction phase. It is recommended that audit being carried out to confirm that the "best practice" site procedures as defined in Section 2.4.4 are complied with. Full details of the audit requirements will be presented in the EM&A Manual.

Operation Phase

2.7.2 Routine monitoring of the effluent quality from the SWHSTW is currently being carried out by the Drainage Services Department (DSD) in order to satisfy the conditions of the *WPCO* discharge licence. Such monitoring will continue following the expansion of the STW.

2.8 Conclusions

Construction Phase

2.8.1 The construction phase impact assessment has considered the potential impacts to the water quality of River Indus and Deep Bay due to the construction activities of the Project. The potential impacts identified would primarily occur due to surface run-off and wastewater generation within the construction site, including sewage generated by the workforce. The potential impacts may be readily controlled by on-site mitigation measures, which were specified in details in the previous section. No residual impacts to water quality would be predicted during the construction phase of the Project.

Operation Phase

2.8.2 The Project is designed to cater for increasing wastewater flow from the population growth within the catchment area of Fanling/Sheung Shui and committed extension of sewerage to unsewered areas. Upon commissioning of the Project and the mitigation measures of intercepting sewage from nearby unsewered villages to SWHSTW for treatment, the pollution loadings contributed by the unsewered areas and Shek Wu Hui STW would be reduced. The Project will further help to protect the water quality in Deep Bay. The monitoring of effluent quality of SWHSTW is currently undertaken by DSD to ensure compliance with the discharge licence conditions as required by *WPCO* and will be continued upon commissioning of the Project.

2.9 Effluent Re-use

2.9.1 It is noted that there is a plan to reuse SWHSTW effluent. The amount of effluent discharge to Deep Bay will be reduced with the effluent reuse in place. In order to achieve an overall environmental benefit on effluent reuse, the effluent discharge standards at SWHSTW shall be revised such that there will be no net increase of pollution loadings to River Indus when effluent reuse is in place. The revised discharge standards should not be inferior to the year 2005 discharge standards of Shek Wu Hui STW.

*** END ***

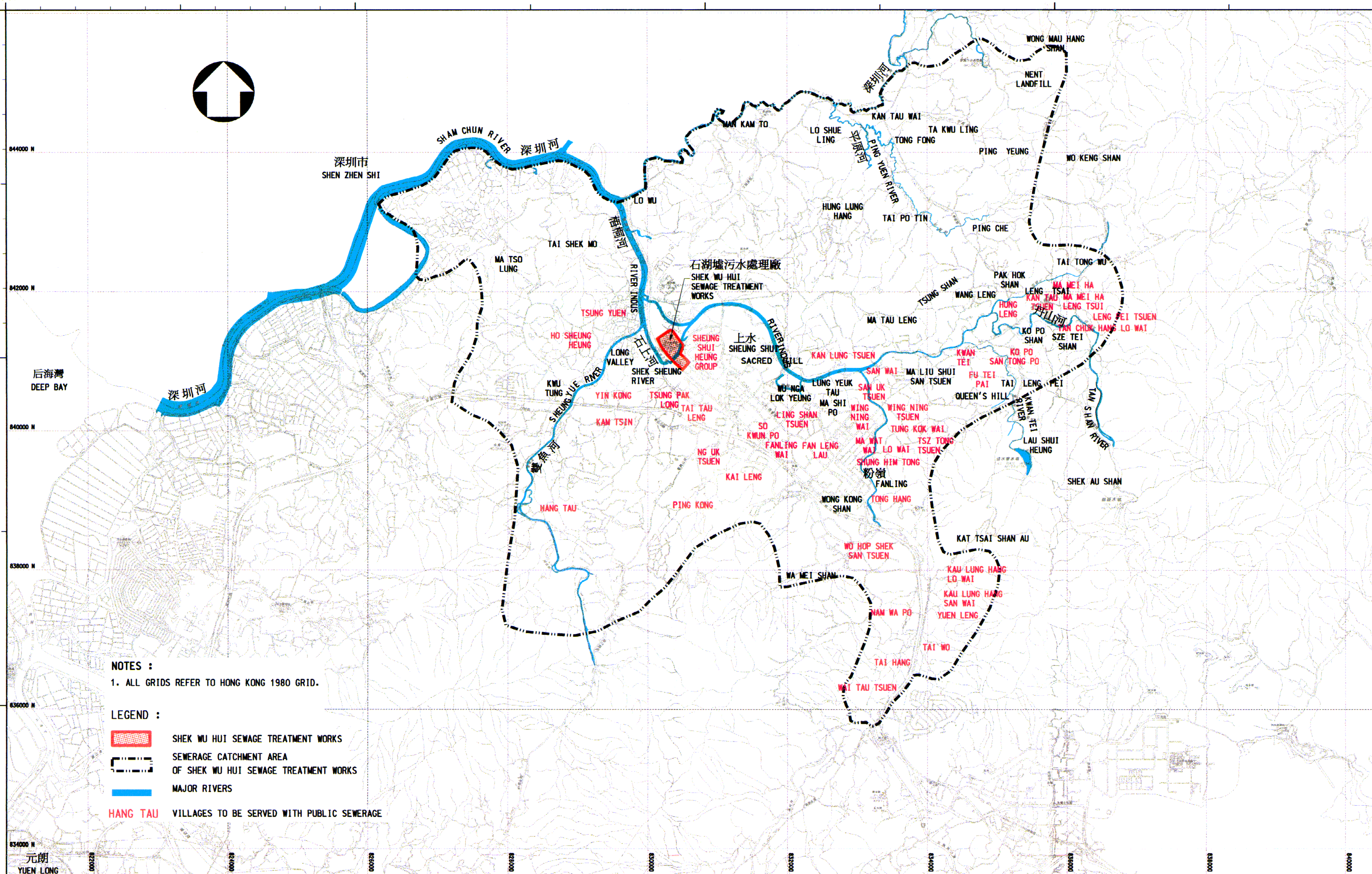

Figure Title

EXPANSION OF SHEK WU HUI SEWAGE TREATMENT WORKS–
MAJOR RIVERS NEARBY SHEK WU HUI SEWAGE TREATMENT WORKS AND VILLAGES TO BE SERVED WITH PUBLIC SEWERAGE

Figure No.	Scale
A2-1	1:50 000

Office SEWERAGE PROJECTS DIVISION

DRAINAGE SERVICES DEPARTMENT
GOVERNMENT OF THE HONG KONG SPECIAL ADMINISTRATIVE REGION

A3 420x297

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Population in Fanling/Sheung Shui New Town(*)	246,300	254,400	266,400	267,500	264,600	262,400	262,900	264,100	264,100	264,100
Population at North District villages	37,904	38,758	39,612	40,467	41,321	42,175	43,030	43,884	43,884	43,884
Flow generated from North District villages	9,760	9,980	10,200	10,420	10,640	10,860	11,080	11,300	11,300	11,300
Population with public sewer	0	0	4,122	4,117	4,112	11,705	11,877	34,684	43,884	43,884
Flow collected from North District Sewerage(#)	0	0	1,061	1,060	1,059	3,014	3,058	8,931	11,300	11,300
Percentage of Flow collected from North District Sewerage	0%	0%	9%	9%	9%	27%	27%	79%	100%	100%

(*) Information Sources: TDD's North District Development Programme 2002/2003 Edition and 2000/2001 Edition.

(#): Estimated based on the construction programme of North District Village Sewerage provided by CM Division, DSD.

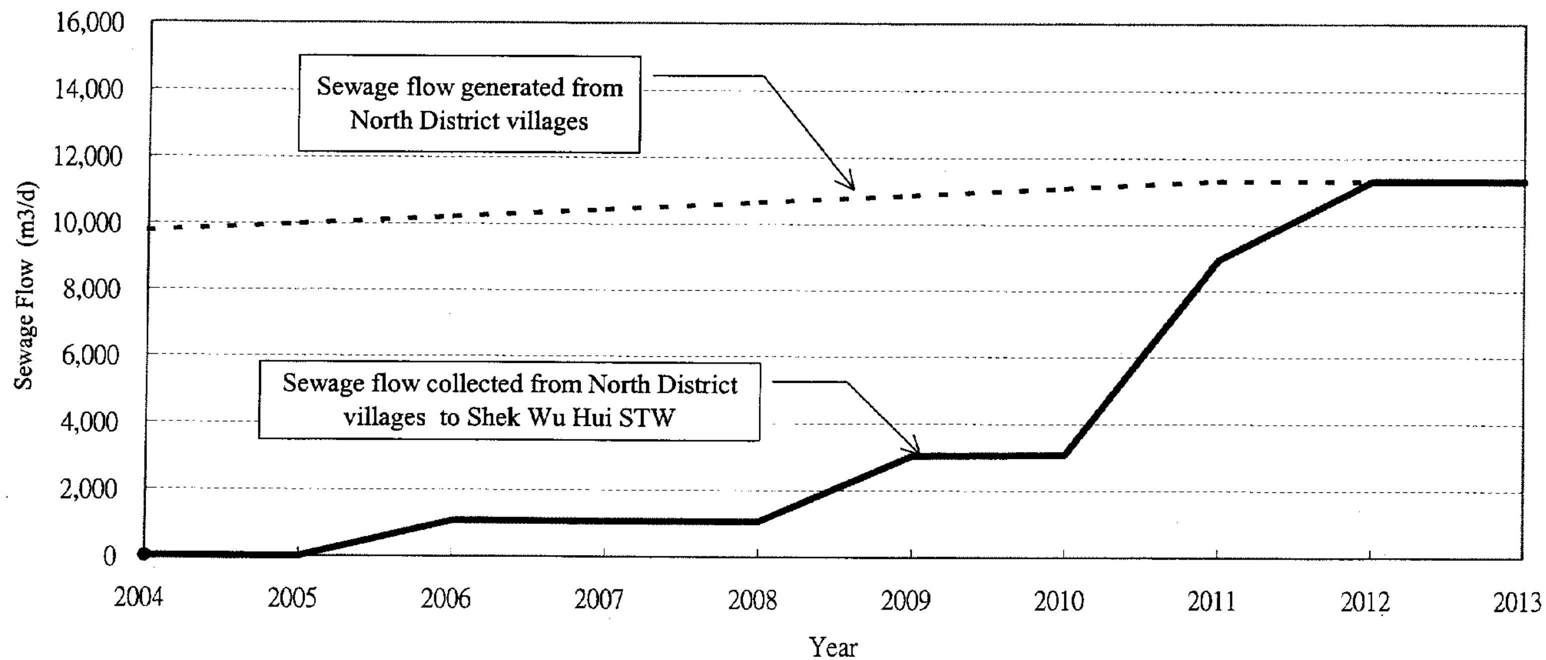

Figure A2-2: Sewage Flow Build-Up from North District Villages to Shek Wu Hui Sewage Treatment Works

[Based on Construction Programme of North District Village Sewerage as in Feb-2005]

File: Water Quality Impact Assessment (9.3.05)_final
Sheet No. : Flow Build-Up
Date: 13/4/2005