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2. PROJECT DESCRIPTION AND PROJECT CONSIDERATION

2.1 Project Objectives

2.1.1 The objectives of the Project are to enhance the flood protection level of the drainage system in Ta Kwu Ling (TKL) and minimise the flooding risk in accordance with DSD's Stormwater Drainage Manual (SDM), accounting for future development and climate change.

2.1.2 The proposed drainage improvement works under the Project would enhance the social connectivity of TKL and its surroundings into an aesthetically pleasing environment. The project also promotes water-friendliness, ecological enhancements, biodiversity and beautification of TKL, taking into consideration of their effects on hydraulic performance.

2.2 Site History and Project Location

2.2.1 The existing watercourses of TKL04 and TKL05 are two of the tributaries of Ping Yuen River which across several villages in Ta Kwu Ling. According to the Drainage Master Plan (DMP) Study for the Northern New Territories (NNTDMP), TKL are within drainage basin "Ta Kwu Ling Basin", covering approximately 5.7 km^2.

2.2.2 The surface runoff from the upstream rural & urban areas of "Ta Kwu Ling Basin" is mainly collected by the existing natural watercourses / engineered open channels and urban drainage systems. Tributaries TKL07, TKL02 and TKL04 in the Ping Che/Ta Kwu Ling (PC/TKL) area drain into TKL05 at the upstream, midstream and downstream sections of TKL05 respectively, before draining into the Lower Ping Yuen River and Shenzhen River. Furthermore, drainage improvement works were carried out at the Ping Yuen River to prevent backwater from Deep Bay to the adjacent low-lying areas.

2.2.3 In view of the flooding occurrences in recent years, there is a genuine need to take forward the Drainage Improvement Works in Ta Kwu Ling (DIWTKL) to relieve the situation. In order to meet the required flood protection standards as stipulated in the SDM, Agreement No. CE 89/2017(DS) "Drainage Improvement Works in Ta Kwu Ling – Investigation, Design and Construction" was developed to improve the existing watercourses of TKL04 and TKL05, drainage system in Ping Che Road and Ping Yeung Village.

2.2.4 The DIWTKL comprises above-ground embankment construction, slope retaining works, road works of public access, greening works, road drainage works, E&M works for associated facilities, formation of public spaces and re-provision of river crossings. Where the above-ground embankment serves to separate the backwater from the low-lying area of Ta Kwu Ling under 1 in 10 years flood protection standard.

2.2.5 The proposed project site falls within both private and government land, and so land resumption is required. This Project does not encroach into the nearby Conservation Areas and Ping Che Egretry.

2.2.6 The current land uses within the proposed project site have been identified and categories in 7 kinds which are Abandoned Agricultural Land (possession of 42%), Development Area (possession of 21%), Agricultural Land)possession of 14%) , Watercourse (possession of 12%), Channel (possession of 5%), Woodland (possession of 5%) and Pond (possession of 1%). The surrounding land uses of the project site are also similar and generally are rural area with farmland and woodland. There are several rural villages nearby the project site and public mainly relied on a main truck road - Ping Che Road for in-and-out of Ta Kwu Ling. Industrial activities are concentrated in the area near mid-stream of TKL05 and farming activities can be found near both watercourse TKL04 and TKL05.

2.3 Benefits of the Project

2.3.1 The implementation of DIWTKL embodies a comprehensive solution in providing adequate drainage performance & flood resilience to Ta Kwu Ling.

2.3.2 The public spaces adjacent to TKL04 and TKL05 will be constructed in form of open space, wetland and woodland. The detail usage will be further reviewed in the detailed design stage to refine the design such as types of leisure facilities, planting species and landscaping details etc. The proposed woodland and wetland can create ecological linkage with nearby habitats, provide extra water storage capacity in the area, enhance biodiversity by improving or re-creating stream habitat to attract faunal species (i.e. birds and fishes), improve the amenity value by incorporating water feature and provide foraging area for fauna, especially water birds, which maybe roosting and nesting at the nearby woodland. Also, the open space is designed for community gathering and leisure in order to enhance the unity in Ta Kwu Ling area.

2.3.3 As there are no proper access to the existing watercourses of TKL04 and TKL05, maintenance works for most areas of the watercourses are very difficult. The safety of the workers carrying out the maintenance works and the services for handling flood complaints were also affected. Upon completion of the Project, proper access will be provided to facilitate the maintenance works. Only environmental friendly materials will be used for the construction of the access, which will be further explored in detailed design stage.

2.3.4 To implement the key concept of Blue-Green Infrastructure by revitalising water bodies by incorporating green and ecoconservation elements into the Project, ideas include planting in river channels and along riverbanks, use of natural river bedding, preserving river ecosystems, enhancing various wildlife growth and introducing landscape designs, which promote greening, biodiversity and environmental beautification while improvement to the drainage system could be

achieved. For the purpose of blue-green infrastructure, this Project can create an environment with lush vegetation and beautiful waterscape for the public to get close to the water bodies and treasure the natural resources.

2.3.5 The Project adopted concept of Blue-Green Infrastructure together with the improvement of the drainage system, and subsequently improved the ecological connectivity among areas in adjacent to Ping Yuen River.

2.3.6 Vegetation and landscaping elements would be introduced to the Project to enhance the watercourses' biodiversity and social connectivity in Ta Kwu Ling.

2.3.7 In additions, the applicability and extent of solar energy will be evaluated during the detailed design stage of the Project. The use of photo-voltaic (PV) module will be adopted for flooding alarm system, street lighting and other E&M devices as far as possible.

2.3.8 The current ability of flood discharge of the existing watercourses is far to meet the latest standards for drainage & flood control performance and this situation would even get worse under the climate change parameters, e.g. wave run-ups and safety margin requirements under DSD's Stormwater Drainage Manual. Hence, upgrading works at the existing watercourses of TKL04 and TKL05 is necessary to ensure adequate protection against extreme weather.

2.4 Without Project Scenario

2.4.1 Without the Project, the flood risk would persist, and extent of flooding would continue to increase in Ta Kwu Ling area under extreme weather events and increasing sea-level due to climate change.

2.4.2 In accordance with the SDM, a vast area in Ta Kwu Ling area would be flooded with maximum flood depths in excess of 1 m. The flood extent maps of "Without Project Scenario" are enclosed in ***Appendix 2.1***. Moreover, the existing watercourses are mainly in natural form, weeds and sediment would further affect the drainage capacity.

2.5 With Project Scenario

2.5.1 With the Project, flooding extent from rainfall & tidal events under 10-year return periods would be significantly reduced in Ta Kwu Ling area with some remaining residual flooding in local low-lying areas. The flood extent maps of "With Project Scenario" are provided in ***Appendix 2.2*** and an increase risk of flooding at Ping Che Road would be relieved.

2.5.2 The proposed drainage improvement works along the existing watercourses TKL04 and TKL05 under the Project would provide an opportunity to implement scenic public spaces for leisure activities and enjoyment and reduces the heat island effect during hot weather and thus promoting the concept of "blue-green

infrastructure". Most of the sections of the watercourses are currently relatively natural and not accessible by the public. The level of access into the watercourse at certain periods throughout the year, such as during the dry season, would be explored during the detailed design stage, particularly for the sections have low water level in dry season, but this would be subject to the findings in the detailed design assessment, establishment of monitoring system and flood warning system, public safety, evacuation system, etc.

2.5.3 In viewing within/adjacent to the site boundary, there are still having many agricultural farms in active. The proposed watercourse and the proposed wetland can supplement the water resources for the agricultural activities. By providing additional waterbodies, it helps fauna such as water birds and fishes roosting and nesting.

2.5.4 The improvement schemes are subject to further development in the Design Stage. Nonetheless, investigation is being conducted to maintain the existing habitat as much as possible. Meanwhile, the setting of new habitats in the proposed woodlands would be explored to enhance the existing ecology.

2.5.5 Given the preliminary design and site investigation works are ongoing at the time of preparation of this report, the final layout of the DIWTKL may subject to slightly adjustment on the river alignment to overcome some site constraints. Within the site boundary, all Chapters in this EIA report has taken into account the most conservative case for assessment.

2.6 Design Consideration

2.6.1 In accordance with *Clause 3.3.3* of the *EIA Study Brief (No. ESB-322/2019)*, this section of the EIA Report considers design and development options as part of the assessment of alternatives for the Project. The section has been divided into a discussion of the following alternatives:

- Alignment;
- Location of stormwater drains and discharge points;
- Design Options;
- Channel bed and embankment lining;
- Dry season weather flow; and
- Construction methods and sequence.

2.7 Design Return Period

2.7.1 The existing watercourses of TKL04 and TKL05 are located at the rural area of Ping Che and these channels are planned to upgrade as village drainage providing 1 in 10 years flood protection standard in accordance with the Stormwater Drainage Manual [(1)]. Moreover, the design is also required to consider measures

(1) DSD (2013) Stormwater Drainage Manual.

for the channels to achieve 1 in 50 years flooding protection standard in order to provide sufficient drainage capacity in the future.

2.7.2 There has been relatively severe flooding reported at the central and southern portions of Ping Yeung Village. Flooding is the result of localised low-lying areas along Ping Yuen Road. Thus, drainage improvement works are planned to carry out to achieve 1 in 10 years flood protection standard.

2.7.3 Due to lack of road drainage system along Ping Che Road, surface water runoff flows along Ping Che Road and discharges into Ping Yuen River and local ponding results during heavy rainstorms. Thus, construction of road drainage system at Ping Che Road are planned to carry out to achieve a 50-year flood protection level.

2.7.4 The Final Drainage Impact Assessment (DIA) Report for the proposed works was submitted on 21 February 2020 [(2)]. According to the prediction of the hydraulic model, it is anticipated that flooding will not occur after the construction of the proposed watercourses TKL04 and 05 during 1 in 10 years flood event. Also, the local flooding at Ping Yeung Village will be relieved after upgrading works.

2.8 Relevant Technical Circulars / Guidelines

2.8.1 Reference has been made to the following Government Technical Circulars / Guidelines in designing the proposed channels.

- ETWB Technical Circular (Works) No. 5/2005 – Protection of Natural Streams / Rivers from Adverse Impacts Arising from Construction Works
- DSD Technical Circular No. 2/2004 – Protection of Natural Rivers and Streams from Adverse Impacts Arising from Construction Works
- DSD Practice Note No. 3/2021 - Guidelines on Design for Revitalisation of River Channel

2.8.2 The first two Technical Circulars provide an administrative framework to better protect all natural streams / rivers from the impacts of construction works, to provide guidelines for the planning and execution of construction works and for the vetting of development proposals that affect natural rivers and streams.

2.8.3 The DSD Practice Note presents the essential environmental and ecological considerations that should be taken into account and incorporated wherever practicable, in the design of river channels. The Practice Note addresses the eco-hydraulics design in implementing flood mitigation works and it would help mainstream biodiversity and sustainable use of biological resources.

2.9 Essential Design Considerations / Principles Adopted

2.9.1 In addition to the Government guidelines, the following essential design considerations / principles were considered in formulating the preferred channel

(2) B&V (2020) Final Drainage Impact Assessment Report.

alignment / lining.

- Adequate flow capacity – the size of the river channels should have adequate capacities to convey design flood flows within bank to achieve the design flood protection standard.
- Public safety – bank stabilisation work is required for unstable banks and where houses and structures are located very close to the existing riverbanks.
- Existing conditions of the riverbanks – some sections of the existing river banks loose surfaces and are prone to erosion and scouring.
- Land constraints – physical features such as road carriageway at one side of the existing river control the widening of the channel at that side.
- Accessibility for maintenance – provision of adequate access for future long-term maintenance of the completed channels is necessary.
- Disturbance to the public – resumption of private domestic houses / any commercial use lands / factories needs to be minimize as much as possible.
- Blue Green Infrastructure design – it is a form of development aiming at improvement of the sustainability and resilience of Hong Kong's drainage system to meet the contemporary public aspirations in respect of the natural environment and protection of the local culture and rural lifestyle.

2.10 Alternative Alignment

2.10.1 The proposed alignment generally follows the alignment of existing watercourses in order to reduce land resumption requirements wherever possible (thus reducing disturbance and inconvenience to the public) and to facilitate interception of incoming watercourses. The alignment is also dictated by physical features constraint such as village areas and existing trees.

2.10.2 The upstream invert of the proposed channel has been designed to match with the level of the existing watercourse, whilst the downstream is governed by the primary channel and the invert levels of side connections.

2.10.3 In general, the bank level of the proposed channel will match with the adjacent ground levels thus allowing free surface runoff by gravity into the proposed channel. Invert levels of the proposed watercourse TKL04 and TKL05 also take due consideration of side connections.

2.10.4 An alternative alignment option has been considered for the Project. The present Project alignment – Option A, and the alternative alignment – Option B are shown in **Figure 2.1**. Both options were assessed in terms of their environmental acceptability.

2.10.5 The works area and the quantity of excavated materials in Option A will be smaller than those of Option B. It is also expected that the number of construction plants required under Option A, and hence the potential dust and noise impacts during construction, will be less than Option B. In addition, as the alignment of Option B

is very close to local village (i.e. Lei Uk and Ping Yeung), the associated dust and noise impact to local village during construction of Option B is anticipated to be greater than Option A.

2.10.6 The alignment of Option B would affect a greater number of trees during the construction. For Option B, more trees would have conflict with the alignment and therefore would need to be removed or transplanted and therefore adopting Option B alignment would lead to greater landscape as well as ecological impacts to the area.

2.10.7 Considering the above environmental factors, Option A is considered as the preferred option and being selected as the Project design.

2.11 Alternative Location of Stormwater Drains and Discharge Points

2.11.1 The proposed stormwater drains for the proposed watercourses TKL04 and TKL05 are all existing crossroad drains to be replaced or upgraded. Other alternative locations were considered to be not practicable, cost effective or preferable in terms of land constraints and hydraulic capacity.

2.11.2 The proposed watercourses TKL04 will discharge to TKL05 and then TKL05 will eventually discharge into the downstream trained section of Ping Yuen River. Alternative discharge point for the proposed channel has not been identified.

2.12 Alternative Design Options for Watercourse TKL04 and TKL05

2.12.1 The design options that have been considered before arriving at the current proposed design are shown in **Table 2.1**. Its corresponding equivalent as promulgated in ETWB TCW No. 5/2005 and as required under the EIA Study Brief (ESB-322/2019) are also presented. The considered drainage options are listed below:

Option 1 – Conforming Design

2.12.2 The two-stage river design concept was adopted basically for the drainage improvement works for the existing watercourses of TKL04 and TKL05. The existing watercourse are designed remaining undisturbed as far as practicable while the area adjacent to the stream was served as floodplain wit embankment provided at the both sides. The relevant plans are enclosed in **Figure 2.2 to 2.3.**

Option 2 – Widening and Deepening Scheme

2.12.3 The major concept of this option is to upgrade the hydraulic performance by widening and deepening the existing watercourses and hence, to increase the flow capacity for catering the required rainfall return period. The relevant plans are enclosed in **Figure 2.4 to 2.8.**

Option 3 – Bypass Box Culvert Scheme

2.12.4 The design concept of this option is to carry the over-flow water from upstream of the watercourses of TKL04&05 to the upstream of Ping Yuen River through the underground box culverts adjacent to the existing watercourses. To minimize the impact to the public and by consideration of the constructability, open cut excavation method would be proposed for construction of box culvert and the associated by-pass pipe. The proposed box culvert is designed for catering 50 years Rainfall Events so that it could minimize the land disturbs or land requirement in the future development. As the existing watercourses is proposed to be retain, the impact to the ecology and natural view of the existing watercourses is considered minimal. For the open space above the proposed box culvert, it is recommended to be opened for public use (e.g. recreation, education, O&M, environmental and walkability enhancement purposes). The relevant plans are enclosed in **Figure 2.9 to 2.10.**

Option 4 – Drainage Tunnel with Pumping Station Scheme

2.12.5 The major concept of this option is to provide a drainage tunnel system along TKL04 and TKL05 for collection of excessive stormwaters from TKL04 and TKL05 and to discharge the collected stormwater to Ping Yuen River directly by a pumping station with estimated flow rate of 90m3/s. The existing watercourses of TKL04 and TKL05 will be maintained except the downstream section of TKL05 between Ping Yuen River and the junction of TKL04 and TKL05. Flood walls will be constructed along this downstream section of TKL05 to avoid backwater effect from Ping Yuen River. The relevant plans are enclosed in **Figure 2.11 to 2.13.**

Option 5 – Deepening Scheme with Pumping Station

2.12.6 The major concept of this option is similar to Option 2 which is to upgrade the hydraulic performance by widening and deepening the existing watercourse and hence, to increase the flow capacity for catering the required rainfall return period. The major difference is the scale of widening in a section of watercourse near Lei Uk Tsuen and the reduction of widening scale is compensated with a pump station. The relevant plans are enclosed in **Figure 2.14 to 2.15.**

Table 2.1 Alternative Design Options Considered for the Proposed Watercourses

Approach*	**Option***	**DSD Practice Note No. 1/2015***	**ETWB TCW No. 5/2005****
Avoidance	1	Two-stage (or multi-stage) channels	N/A
Minimization	2	Enlargement of channel by widening and deepening	iii) enlargement of channel by modifying one bank only; (iv) enlargement of

			channel by modifying/ widening both banks; (v) enlargement of channel by deepening;
Avoidance	3	Relief or by-pass channels	N/A
Avoidance (Modify from Option 3)	4	Relief or by-pass channels (or by-pass tunnel) with pumping system	N/A
Minimization (Modify from Option 2)	5	Enlargement of channel by widening and deepening with pumping system	iii) enlargement of channel by modifying one bank only; (iv) enlargement of channel by modifying/ widening both banks; (v) enlargement of channel by deepening;

Notes:

* Options as promulgated/modified in DSD Practice Note No. 1/2015 – Guidelines on Environmental Considerations for River Channel Design

** Options as promulgated/modified in ETWB TCW No. 5/2005 – Protection of natural streams / rivers from adverse impacts arising from construction works - Appendix C (A)

2.13 Evaluation of Design Options

2.13.1 The channel design options (with reference to the DSD Practice Note No. 1/2015) that have been considered before arriving at the current proposed design are presented in above **Sections 2.12**. The evaluation of the environmental benefits, dis-benefits and other considerations are summarized in **Table 2.2**.

Table 2.2 Evaluation of the Proposed Options

	Option 1 – Conforming Design	**Option 2 – Widening and Deepening Scheme**	**Option 3 – Bypass Box Culvert Scheme**	**Option 4- Drainage Tunnel with Pump Station Scheme**	**Option 5- Widening and Deepening Scheme with Pump Station**
Land Matters	• Affected land lots area about **55,000m²**	• Affected land lots area about **26,000 m²**	• Affected land lots area about **33,000m²**	• Affected land lots area about **43,000 m²**	• Affected land lots area about **17,000 m²**
Operation and Maintenance Concerns	• Routine maintenance of the proposed watercourses and detention ponds is required. • Frequency of maintenance are anticipated to be low.	• Routine maintenance of the proposed watercourses and detention ponds is required. • Frequency of maintenance are anticipated to be low.	• Routine maintenance for by-pass box culvert, proposed watercourses and detention ponds is required. • Frequency of maintenance are anticipated to be medium.	• Routine maintenance of the existing watercourses. • Routine maintenance of tunnel system and bypass facilities. • Routine operation and maintenance of the pump station and the associated equipment. • Maintain stable power supply • Frequency of maintenance are anticipated to be high.	• Routine maintenance of the proposed watercourses and detention ponds is required. • Routine operation and maintenance of the pump station and the associated equipment. • Maintain stable power supply • Frequency of maintenance are anticipated to be high.
Public Concerns	• Land resumption extent • Nuisance during construction • Watercourses become wider and deeper	• Land resumption extent • Nuisance during construction • Watercourses become wider and deeper	• Land resumption extent • Nuisance during construction • Existing watercourses generally maintained	• Land resumption extent • Nuisance during construction • Existing watercourses generally maintained • Nuisance from pump station	• Land resumption extent • Nuisance during construction • Watercourses become wider and deeper • Nuisance from pump station
Major Environmental Considerations					

	Option 1 – Conforming Design	Option 2 – Widening and Deepening Scheme	Option 3 – Bypass Box Culvert Scheme	Option 4- Drainage Tunnel with Pump Station Scheme	Option 5- Widening and Deepening Scheme with Pump Station
Air	• No additional emission of dust and odour	• No additional emission of dust and odour	• No additional emission of dust and odour	• May slightly emit dust and odour during plant operation	• May slightly emit dust and odour during plant operation
Noise	• No additional noise source created	• No additional noise source created	• No additional noise source created	• Additional noise source from PME in plant	• Additional noise source from PME in plant
Water Quality	• No generation of new pollution loads	• No generation of new pollution loads	• No generation of new pollution loads	• May generate new pollution loads due to accidentally leakage of chemicals from plant	• May generate new pollution loads due to accidentally leakage of chemicals from plant
Waste	• silt material and debris in maintenance • Generate C&D materials from excavation of widening the watercourse	• silt material and debris in maintenance • Generate C&D materials mainly from excavation of widening and deepening the watercourse	• silt material and debris in maintenance • Generate C&D materials mainly from excavation of construction of underground box culvert	• silt material and debris in maintenance • Small amount of screenings and chemical waste in maintenance • Generate C&D materials mainly from tunneling and construction of foundation for pump station	• silt material and debris in maintenance • Small amount of screenings and chemical waste in maintenance • Generate C&D materials mainly from excavation of widening and deepening of watercourses and construction of foundation for pump station
Ecology	• Slightly change of ecological habitat due to relatively large	• Enhance ecological value due to provision of	• Maintain existing ecological habitat	• Slightly change of ecological habitat due to impact from pump	• Slightly change of ecological habitat due to impact from pump

	Option 1 – Conforming Design	Option 2 – Widening and Deepening Scheme	Option 3 – Bypass Box Culvert Scheme	Option 4- Drainage Tunnel with Pump Station Scheme	Option 5- Widening and Deepening Scheme with Pump Station
	footprint	woodland and wetland as well as the large planting scale		station • Tunneling works may slightly affect the underground habitat	station
Visual and landscape	• Minor visual and landscape impact due to construction of aboveground embankments	• No adverse visual impact • Relatively minor landscape impact due to construction of embankments below existing ground level	• No adverse visual impact • Relatively minor landscape impact due to construction of embankments and underground box culvert	• Visual and landscape impact due to construction of pump station	• Visual and landscape impact due to construction of pump station
Environmental Benefits	• No excavation of the existing stream will be required, and hence permanent loss of the natural stream bed habitat will be avoided. • Different flood regimes and water tables result in the development of different types of habitat. • Depending on the design, excavated rocks and soils could be reuse as channel	• Enhance environmental value by proposed wetland and woodland and reformation of natural river • Excavation volume will be minimized as the improvement works will be carried out along the existing watercourse. • Less construction plant is required for this option due to the lower excavation volume and hence the	• Only small-scale changes to the condition of existing watercourses, ease to preserve ecological habitat • No excavation of the existing stream will be required. • The existing stream will be left untouched and hence the stream and riparian habitats will be preserved with aquatic life left undisturbed.	• Only small-scale changes to the condition of existing watercourses, ease to preserve ecological habitat • No excavation of the existing stream will be required. • The existing stream will be left untouched and hence the stream and riparian habitats will be preserved with aquatic life left undisturbed.	• The least excavation materials will be generated • Excavation volume can further be minimized by comparing to Option 2 where the hydraulic needs is replaced by a pump station. • Generally similar to Option 2

	Option 1 – Conforming Design	Option 2 – Widening and Deepening Scheme	Option 3 – Bypass Box Culvert Scheme	Option 4- Drainage Tunnel with Pump Station Scheme	Option 5- Widening and Deepening Scheme with Pump Station
		potential air quality and noise impacts will be less significant. • The environmental condition of the proposed drainage channel can be improved with suitable design on lining and bedding to enhance the ecological value. • As the improvement works will be carried out along existing streams, it can minimize major resumption of land and reduce environmental impacts imposed to other areas away from the existing stream			
Environmental Disbenefits	• There may be potential loss of stream banks and riparian habitats	• Construction nuisances including dust and noise will affect all sensitive	• Construction nuisances including dust and noise will affect all sensitive	• Longer period of environmental disturbance • Operation nuisances	• Operation nuisances from pump station including waste and noise will affect all

	Option 1 – Conforming Design	Option 2 – Widening and Deepening Scheme	Option 3 – Bypass Box Culvert Scheme	Option 4- Drainage Tunnel with Pump Station Scheme	Option 5- Widening and Deepening Scheme with Pump Station
	depending on design adopted.	receivers along entire works alignment. • Impacts on the existing stream are unavoidable. The hydrology of the whole river changed	receivers along entire works alignment • Construction of by-pass channels on existing land will involve larger excavation volume.	from pump station including waste and noise will affect all sensitive receivers • Construction of by-pass channels on existing land will involve larger excavation volume.	sensitive receivers • Generally similar to Option 2
Construction Method	• Excavation by open cut method	• Excavation by open cut method	• Excavation by open cut method	• Tunneling works • Piling works for pumping station • Civil, structural and E&M works for pumping station • Excavation by open cut method	• Piling works for pumping station • Civil, structural and E&M works for pumping station • Excavation by open cut method
Construction Sequence	• Flow diversion • Excavation in dry season • Backfill and landscaping works	• Flow diversion • Excavation in dry season • Backfill and landscaping works	• Excavation for construction of box culvert • Installation of water collection system at dry season • Connection to existing watercourses at dry season	• Excavation for launching and receiving pit • Tunneling works • Installation of water collection system at dry season • Connection to existing watercourses at dry season • Foundation works of pumping station	• Flow diversion • Excavation in dry season • Backfill and landscaping works • Foundation works of pumping station • Construction of plant and connection to the watercourse TKL05

	Option 1 – Conforming Design	Option 2 – Widening and Deepening Scheme	Option 3 – Bypass Box Culvert Scheme	Option 4- Drainage Tunnel with Pump Station Scheme	Option 5- Widening and Deepening Scheme with Pump Station
				• Construction of plant and connection to tunnel	
Programme	• About 54 months for construction works	• About 54 months for construction works	• About 54 months for construction of box culvert works	• About 60 months for the pumping station, drainage tunnel system	• About 54 months for the pumping station, river improvement works
Costs	Medium: • Large scale of exaction works for widening river and construction of flood wall	Low: • Exaction works for widening and deepening of river	Medium: • Construct underground box culvert and associated piping system	High: • Construct pumping station, drainage tunnel system	Medium: • Construct pumping station, small scale of excavation for widening and deepening of river
Sustainability	• Construction of detention pond with area about **63,400m²**	• Construction of detention pond with area about **10,000 m²**	• Construction of detention pond with area about **20,500 m²**	• Installation of additional pump sets	• Installation of additional pump sets
Reliability	• High – the capacity of the existing watercourses is improved by hydraulic means (i.e. by widening and deepening)	• High – the capacity of the existing watercourses is improved by hydraulic means (i.e. by widening and deepening)	• High – the capacity of the existing watercourses is improved by hydraulic means (i.e. by widening and deepening)	• Low – the capacity of the existing watercourses is improved by pumping	• Medium – the capacity of the existing watercourses is improved by semi-hydraulic means (i.e. by widening and deepening with pumping)
Recommendation	• Not recommended, as a large amount of private lots are required to be resumed.	• Recommended, as widening and deepening can substantially increase the flow capacity.	• Not recommended, as a large amount of private lots are required to be resumed	• Not recommended, as construction of pump station may bring up long term and costly environmental impact	• Not recommended, although the land resumption of private land lot reduced, construction of pump

	Option 1 – Conforming Design	**Option 2 – Widening and Deepening Scheme**	**Option 3 – Bypass Box Culvert Scheme**	**Option 4- Drainage Tunnel with Pump Station Scheme**	**Option 5- Widening and Deepening Scheme with Pump Station**
	• More than 30% of existing watercourse has been channelised and is thus not suitable to adopt this option.	• Meanders can be recreated	• Large area to be resumed for drainage channel will limit the potential for future development of the area into other uses.		station may bring up long term and costly environmental impact

2.14 Recommended Drainage Options

2.14.1 In view of the environmental benefits and dis-benefits as well as engineering considerations presented above, the Option 2 - "Widening and Deepening Scheme" would be developed.

2.15 Alternative Channel Bed Lining / Embankment Lining Options

2.15.1 Common channel bed and embankment lining options are listed below:

- Natural / unlined;
- Rip-rap lining;
- Gabion / mattress lining;
- Rubbles / stones embedded in concrete / mortar;
- Geotextile reinforced grass lining;
- Grassed cellular concrete paving;
- Concrete lining; and
- Eco-bag lining.

2.15.2 **Figure 2.16 and 2.17** shows photos of the above lining options.

2.15.3 Channel lining is required to maintain the structural integrity of the channel for performing its functions in intercepting and conveyance.

2.15.4 The choice of channel lining is a compromise solution between various factors including hydraulic characteristics, cost, operation and maintenance issues, environmental and ecological considerations, visual and aesthetic impacts, availability of materials etc.

2.15.5 Options for channel lining in banks and bed include natural bed (gravel or mud), gabions, eco-bag, concrete or grasscrete. While the hydraulic performance of concrete and grasscrete lined channels are considered the best for smooth flow and easy maintenance, the ecological value of these featureless habitats is generally not high. Also, the rate of transport of sediments downstream will also increase and hence lead to increased levels of suspended solids and biochemical oxygen demand in water. Frequent and Regular maintenance of watercourses is required.

2.15.6 Gabions and natural stream beds offer surfaces/habitats of greater complexity that will sustain aquatic assemblages and are better for retaining sediments and establishment of vegetation on banks. This would also reduce the rate of sediment loss from the catchment. However, they have general hydraulic performance requiring larger land intake to provide adequate hydraulic capacity. Also, they are more expensive to maintain as they are often displaced or damaged after heavy storms. Regular trimming of bank side vegetation and

removal of excess sediments will be required to ensure sufficient hydraulic capacity is retained. Natural banks are especially prone to erosion and subject to scour.

2.15.7 To provide environmental-friendly and engineering feasible design in the project, it is considered to adopt combined lining type for the proposed watercourses TKL04 and TKL05. In view of engineering needs, stones embedded in concrete lining will be the main lining option to ensure the structural stability and provide natural texture to maintain living style of fauna species in the river. Gabion mattress and eco-bag will be applied in the riverbed slope to provide a better ecological value for surrounding habitat. Eco-bag will be inserted into gabion mattress where the hydraulic performance is acceptable. Rip-rap and natural lining will formed by reinstatement of existing natural substrate into the riverbed to create a water habitat similar to the natural river.

2.15.8 The evaluation of the environmental benefits, dis-benefits, as well as other considerations for choosing the lining of the proposed watercourses TKL04 and TKL05 is summarized in **Table 2.3**.

Table 2.3 Summary of the Evaluation of Alternative Channel Bed / Embankment Lining Options

Option	Environmental Benefits	Environmental Dis-benefits	Other Considerations / Recommendation
Natural /unlined	• Disturbance to natural stream habitats can be minimized or avoided. • Better for retaining sediments and establishment of vegetation on banks. • Very minimum impact during construction. • Visually acceptable.	• Prone to scouring during flood flows. • Erosion of banks	• Not favorable to hydraulic performance and high roughness. • Suitable only at where the flow velocity is low • Recommend adopting for riverbed design to reduce the disturbance to natural stream habitats.
Rip-rap lining	• Provides surfaces/ habitats with greater complexity for aquatic communities. • Minimum impact during construction. • Better for retaining sediments and establishment of vegetation on banks. • Visually acceptable	• Prone to little scouring during flood flows.	• Not favorable to hydraulic performance and high roughness. • Recommend adopting for riverbed design subject to the flow velocity, suitable for dry weather flow

Gabion / mattress lining	• Provides surfaces /habitats with greater complexity for aquatic communities. • Better for retaining sediments and establishment of vegetation on banks. • Visually acceptable	• Prone to damage if poorly designed.	• Better hydraulic performance • High maintenance efforts and costs in replacement • Susceptible to corrosion • Recommend for formation of riverbed slope
Rubbles / Stones embedded in concrete / mortar	• Slightly better aesthetic appearance than concrete.	• Offer featureless habitat with low ecological value	• Better hydraulic performance • Little maintenance required. • Generally applied in watercourses' sections
Geotextile reinforced grass lining	• Good aesthetic appearance.	• Offer habitat with low ecological value	• High maintenance cost • Not recommended.
Grassed cellular concrete paving lining	• Slightly better appearance than concrete.	• Offer habitat • with low • ecological value	• Fast conveyance of flood flows. • Better structural integrity. • Little maintenance • Applied to maintenance access only.
Concrete lining	• Environmental-friendly construction material	• Poor aesthetic appearance. • Offer featureless habitat with low ecological value. • Fast conveyance of flood flows may lead to increase in suspended solid level and biochemical oxygen demand downstream	• Good hydraulic performance • Fast conveyance of flood flows • Little maintenance • Applied to box culvert and river crossings
Eco-bag lining	• Provides surfaces for vegetation. • Better for retaining sediments and establishment of vegetation on banks. • Visually acceptable	• Prone to scouring if poorly designed. • Erosion of banks	• Not favorable to performance and high roughness. • Suitable only at where the flow velocity is relatively low. • Recommend to

			combine using with gabion mattress to form the riverbed slop

2.15.9 Taking into account the environmental benefits and dis-benefits as well as engineering considerations presented above, the general configuration for the proposed watercourses TKL04 and TKL05 is summarised in **Table 2.4**.

Table 2.4 Configuration of Proposed Watercourses TKL04 and TKL05

Watercourse	Approx. Length (m)	Approx. Chainage	Structure Form	Lining Type	Base Widths (m)	Average Depth (m)
TKL04	230	1200 – 1400	Channel	Combined*	6.2	3
TKL04	1178	0 – 1200	Channel	Combined*	3	3.5
TKL05	119	1800 – 2100	Retaining Wall	Combined*	17.5	3.5
TKL05	700	1100 – 1800	Retaining Wall	Combined*	10.5	3.5
TKL05	1100	0 – 1100	Retaining Wall	Combined*	6.5	3.5

Notes: * the slope of watercourse lined with concrete in form of channel/retaining wall and the riverbed lined with gabion with eco-bag as well as rip-rap with natural substrate.

2.16 Alternative Dry Weather Flow Channel

2.16.1 DSD Stormwater Drainage Manual specifies that dry weather flow channel is desirable for non-tidal sections of channel to reduce siltation during low flow conditions. As the proposed watercourses TKL04 and TKL05 are not subjected to the tidal effect, so a low flow channel is required for minimising the siltation. Dry Weather Flow Channel is proposed along whole proposed watercourses TKL04 and TKL05. Under conventional design, a small concrete channel will be laid under the channel base.

2.16.2 The proposed dry weather flow channel is designed by natural substrate with a slightly "U" shape which provides conditions conducive to sustaining riparian species.

2.17 Project Scope

2.17.1 The location and alignment of the Project components are shown in **Figure 2.19**. The scope of the Project comprises:

(i) the improvement of two sections of Ping Yuen River, namely TKL04 (about 1.4km long) and TKL05 (about 2.1km long), in Ta Kwu Ling;

(ii) the drainage improvement works at Ping Yeung Village, Ta Kwu Ling (about 1050m long in total); and

(iii) the construction of road drainage system at part of Ping Che Road, Ta Kwu Ling (about 1150m long in total).

2.17.2 Pedestrian and vehicular crossings will be re-provided along the proposed upgraded channel.

2.18 Project Design

Watercourse TKL04 and TKL05

2.18.1 The watercourse TKL05 is designed as trapezoidal channel according to the site conditions. The average depth of proposed watercourse is about 3.5 m. and its length is approximately 2.1 km long with the base width is ranging from 6.5m to 17.5m.

2.18.2 The watercourse TKL04 is designed as trapezoidal channel according to the site conditions. The average depth of proposed watercourse is about 3 m. and its length is approximately 1.4 km long with the base width is ranging from 3m to 6.2m.

2.18.3 Configuration of the existing and proposed watercourse are summarized in ***Table 2.6***. Details of proposed and existing watercourse are also shown in **Figures 2.19 (a to h)** and **Figures 2.20 (a to s)** respectively.

Table 2.6 Configuration of Existing and Proposed Watercourse TKL04 and TKL05

Approx. Length (m)	Approx. Chainage	Existing Lining Type	Proposed Lining Type	Existing Average Width (m)	Proposed Average Width (m)	Existing Average Depth (m)	Proposed Average Depth (m)
TKL04							
300	0-300	Natural	Natural Bedding Material*	7.0	5.0	1.6	3
700	300-1000	Natural	Natural Bedding Material*	4.7	5.0	0.9	3
200	1000-1200	Concrete	Natural Bedding Material*	1.6	5.0	1.5	3
200	1200 – 1400	Concrete	Natural Bedding Material*	6.2	9.0	1.7	3.5
TKL05							
300	0-300	Natural	Natural Bedding Material*	7.3	10.0	1.6	3
600	300-900	Natural	Natural Bedding	11.0	10.0	1.7	3

Approx. Length (m)	Approx. Chainage	Existing Lining Type	Proposed Lining Type	Existing Average Width (m)	Proposed Average Width (m)	Existing Average Depth (m)	Proposed Average Depth (m)
			Material*				
500	900-1400	Natural	Natural Bedding Material*	10.7	14.0	1.9	3.5
400	1400-1800	Natural & Concrete	Natural Bedding Material*	7.9	14.0	1.89	3.5
300	1800-2100	Natural	Natural Bedding Material*	14.3	21.0	1.6	3.5

Notes: * the slope of watercourse lined with concrete in form of channel/retaining wall and the riverbed lined with gabion with eco-bag as well as rip-rap with natural substrate.

2.18.4 Works for widening, deepening and re-alignment as well as embankment construction will be undertaken mainly along the existing watercourses of TKL04 and TKL05.

2.18.5 The improvement works of TKL05 will be undertaken within the section of the existing watercourse between the Ping Che Road at the upstream boundary and ending at Ping Yuen River at the downstream.

2.18.6 The improvement works of TKL04 will be undertaken within the section of the existing watercourse between the Ping Yeung Village at the upstream boundary and ending at Ping Che Road near rural road to Lei Uk at the downstream.

2.18.7 The design principle of the works is to protect the livelihood of residents along the proposed watercourse by achieving a flood protection standard of 1 in 10 years with an environmental-friendly design. As indicated in **Figure 2.19**, the design alignment will follow the existing watercourse as far as possible to reduce alternation to the existing river profile and meandering nature, reduce land resumption and avoid massive excavation and filling.

2.18.8 For TKL05, retaining wall design will be used for all sections of the proposed watercourse. The bottom width will be in a range of 6.5 to 17.5 m. The top width of the river sections will be in a range of 10m to 21m and the slope of sidewalls will be in average of 80 degree. The area at the riverbank will be used as maintenance access and public access with 3m width in each side. Vehicular maintenance access of 3.5m width will also be constructed on the channel bed.

2.18.9 For TKL04, trapezoidal channel design will be used for all sections of the proposed watercourse. The bottom width will be in a range of 3 to 6.2 m. The top width of the river sections will be in a range of 5m to 9m and the slope of sidewalls will be in average of 80 degree. The area at riverbank will be used as maintenance access and public access with 3m width in each side. Non-vehicular maintenance access of 1.2m width will also be constructed on the channel bed.

Proposed Gabion Mattress for Riverbed

2.18.10 It is proposed to adopt 300 mm thick gabion mattress as channel bed lining, which is graded stone contained in a wire cage. Gabion mattress is applied all along the riverbed. The stone is graded in a manner which to allow some sedimentation and eventually re-colonization of the channel bed by benthic organisms. The mattress also has the effect of holding the stone in place and limiting migration of bed material during flood flows.

2.18.11 Although limited migration of bed material is preferred to mimic the natural stream environment, large scale migration of large quantities of bed material during a major flood in channel could have catastrophic consequences. The structural integrity of the channel itself could be affected if the banks are buffeted by large quantities of bed material.

2.18.12 Channel banks are designed to be constructed by concrete retaining wall where the form will be wider at the base stepping back to a thinner structure closer to the natural ground level. The extent to which the size of the retaining structure varies will need to be determined during the detailed design stage. Besides, stone facing of retaining wall would be provided for aesthetics reason.

2.18.13 Pre-seeded soil or eco-bag are considered to insert into the gabion mattress and native species of floating plant, emergent plant and submerged plant would be adopted as far as possible. Emergent plants and floating plants will provide perching sites, shelter and breeding habitats for adult dragonflies and emergence sites for dragonfly nymphs. Submerged plants provide hiding places for dragonfly nymphs and tadpoles and egg-laying sites for adult dragonflies. Test species will in turn attract higher order faunal species such as fishes and birds thereby increasing the biodiversity of the completed river.

2.18.14 During detailed design the draw-down effect on the local water table will be reviewed. If necessary, an appropriate geotextile will be recommended to line the base of the retaining walls and channel in order to control water ingress and egress from the channel. It is more likely that in these areas a geotextile separation layer will be employed.

Proposed Natural Substrate for Riverbed

2.18.15 For all section of TKL04 and TKL05, natural substrate bedding with eco-bag inserted gabion mattress are adopted. The natural substrate will be extracted from the original riverbed and restore after construction. Also, imported natural substrates may be required in which it shall be similar to the existing riverbed material, which allows faster habitats recovery after construction works.

2.18.16 River slopes are designed to be constructed by concrete lining with stone-facing. The sloping surface is about 80^{o} to the horizontal to facilitate the growth of creepers and provision of exit for trapped animals. The form and extent of the stone-facing sloping surface will need to be further studied during the detailed design stage.

2.18.17 It is also possible to fill up the eco-bag with pre-seeded topsoil before

installation in order to speed up the greening after construction. Strong native species can be selected in the planting proposal to suppress the growth of invasive non-native species within the completed channel. When selecting native species, potential impacts to local landscape and ecology will be considered. Generally, native species that are observed to be naturally occur along the existing watercourse of TKL04 and TKL05, except for local weed species, will be selected to reduce potential impacts to local landscape and ecology.

2.18.18 Dry weather flow channel formed by natural substrate is adopted to covey the drains in dry season. The design of dry weather flow channel will consider existing stream condition and the flow depth in dry weather to make sure sufficient water depth for aquatic life in dry weather.

Channels and Drains at Ping Yeung Village and Ping Che Road

2.18.19 For the drainage improvement works at Ping Yeung Village, Ta Kwu Ling, it is proposed to provide 850m of u-channel and 200m of stormwater drains of diameters ranging from 825mm to 1200mm along Ping Yuen Road. For the construction of road drainage system at part of Ping Che Road, Ta Kwu Ling it is proposed to provide 550m of u-channel and 600m of stormwater drains of diameters ranging from 750mm to 1200mm along Ping Che Road. The works generally include temporary traffic arrangement, shoring works, excavation, stormwater pipe laying and backfilling works. The proposed drainage pipes and channels are summarized in **Table 2.7** below.

Table 2.7 Summary of the proposed drainage pipes and u-channels at Ping Che Road and Ping Yeung Village

Ping Yeung Village		
U-Channel/ Drainage Pipe	**Size (mm)**	**Gradient**
U-channel	1050	200
U-channel	2x1200	150
U-channel	1050	150
U-channel	1200	200
Drainage Pipe	1200	250
U-channel	825	150
Ping Che Road		
U-Channel/ Drainage Pipe	**Size (mm)**	**Gradient**
U-channel	750	150
U-channel	1050	150
U-channel	900	150

Drainage Pipe	1200	150

2.18.20 In addition to the above channels and pipes, gullies are provided along Ping Che Road. The proposed gullies will be installed in according to the standards and guideline. The proposed gullies are summarized in **Table 2.8** below.

Table 2.8 Summary of the proposed gullies in Ping Che Road

Ping Che Road	
Type of gully	Standard double triangular grating (type GA1 - 450)
Design gully spacing	7 m

2.19 Ancillary Infrastructure

Maintenance Access Road

2.19.1 Stormwater Drainage Manual [3] recommends providing a 3.5 m wide maintenance access road for maintenance works by DSD. In due consideration of optimization of land resumption and maintaining the natural environment of the river, the width of maintenance access road provided for TKL04 and TKL05 have considered the balancing of natural riverbed section and the hard-paved area. The proposed width of maintenance access road at the verge of riverbed are 1.2m and 3.5m for TKL04 and TKL05 respectively. They are proposed to be constructed by grasscrete in order to enhance the greening at riverbed. For TKL05, maintenance access road will be provided all along the verge of riverbed and it allows vehicles to carry out desilting and repair works. In similar case, maintenance access road of TKL04 will be provided all along the verge of riverbed, but it allows only man-entry with a trolley to carry out the desilting and repair works. Apart from maintenance access road at verge of riverbed, a 3m wide public access is being provided on the banks of channels of TKL04 and TKL05 for regular inspection. The detailed arrangement for maintenance access roads and ramps will be explored further during detailed design.

2.19.2 The maintenance staircases will be provided at suitable intervals along the proposed watercourses in both sides. Gates with locks will be provided at the entrance of these staircases to prevent any trespassing. The staircases will also function as an animal corridor to provide escape route for the trapped animals or passage for animal to reach the river.

Crossings

2.19.3 Existing pedestrian and vehicular crossings affected by the proposed watercourses will be re-provided as appropriate. These crossings and bridges will be re-provisioned to Highways Department's standard. Liaison will be undertaken to ensure that the design of the works can meet the maintenance authority's

([3]) DSD (2018) Stormwater Drainage Manual.

satisfaction. Also, the re-provisioned crossings and bridges will have soffit above the estimated water level with adequate freeboard to allow design flow to pass without obstruction.

2.19.4 For TKL04, the pedestrian and vehicular crossings will be designed in form of box culvert with adequate paving on top. The For TKL05, the pedestrian and vehicular crossings will be designed in form of slab-beam bridge with adequate paving on top. The locations and width of the re-provided crossings have been preliminarily discussed with the relevant stakeholders and government department. The detailed arrangement for crossing design will be confirmed during detailed design. In general, the re-provided crossings will provide a width of 3m for pedestrian crossings and a width ranging 5m to 15m for vehicular crossings subject to the number of lanes. The length of the re-provided crossings are ranging from 5m to 10m at TKL04 and from 10m to 45m at TKL05. The height of the re-provided crossings are ranging from 3m to 3.5m subject to the average depth of the channel as stated in **Table 2.6**.

2.20 Landscaping Works

2.20.1 Gabion mattress lining at the channel bed can allow the natural vegetation to grow. In addition, trees will be planted along the verge of public access in order to provide potential habitats for birds and enhance the amenity value.

2.20.2 Grasscrete will be adopted to construct the maintenance access road. Grasscrete would be either casted in-situ on site or prefabricated in industry for onward transportation to site for installation.

2.20.3 Granite stone facing would be provided in all channel sections to beautify the environment and to facilitate the growth of creeper. Detailed landscape design for the Project will be submitted to the relevant authority for approval during the detailed design stage.

2.21 Construction Method

General Descriptions

2.21.1 Construction of the proposed Project comprises the following key activities:

- Temporary River Diversion;
- Excavation Works;
- Construction of Embankment;
- Construction of Channel Lining;
- Construction of Maintenance Access;
- Re-provision of Existing Pedestrian and Vehicular Accesses/Crossings;
- Landscaping Works; and
- Construction of Site Access.

2.21.2 The above key construction activities of the Project are described below.

Temporary River Diversion

2.21.3 Prior to construction, a Temporary Drainage Management Plan (TDMP) will be submitted to the DSD for approval before the construction of the proposed watercourses of TKL04 and TKL05. In the TDMP, the run-off will be calculated and compared against the diversion scheme so that the designed river course can maintain the original performance.

2.21.4 Some of the construction works will not cut across the existing watercourse and therefore no water diversion is needed. For example, when building the channel of TKL05 from Chainage 1450 to 1650, the existing water flow will remain and water from upstream can flow through the existing watercourse. As these sections of the proposed alignment do not follow the existing watercourse, the construction works at this section will not involve any temporary river diversion.

2.21.5 A typical water diversion scheme is shown in **Figures 2.21 to 2.23**. Water will be diverted before the commencement of the soil excavation and construction works within the existing watercourse. Excavation and construction of the embankment foundation will first take place on dry land and will be stopped near the river and form an earth bund in order to retain the existing watercourse. When the excavation and construction are carried out on one side, the river course on the other side will be used as diversion channel.

2.21.6 When the construction on one side is completed, the earth bund will be removed, and a stack of precast concrete blocks will be placed in position. The precast concrete blocks and the constructed channel embankment will form a temporary channel for flow diversion. The excavation and construction are then carried out on the other side and water will flow through diversion channel.

Excavation Works

2.21.7 With the implementation of water diversion scheme, excavation will be carried out in dry condition. The riverbank will be excavated by backhoes of 2 m^3 capacity. The riverbed material will be excavated by backhoes of 1 m^3 capacity or long boom backhoe of 0.55 m^3 capacity. Once the excavation of riverbed is completed, the concrete blocks will be removed using the backhoes or long boom backhoe.

2.21.8 The excavated spoils will be transported by dump trucks and temporarily stored at the stockpiling area within the Project Site.

Embankment Construction

2.21.9 Concrete retaining structures on both sides of the river course will be constructed by conventional method including excavation, erection of formwork, steel fixing, concreting and backfilling.

2.21.10 The slope embankments on both sides of the river course will be built with the reused soil from the excavation works. The thickness of each filling layer will be between 300 to 500 mm and compaction will be carried out by roller or hand-

held compactor.

Construction of Channel Lining

2.21.11 Retaining wall will be constructed to form the watercourse. First, excavate to the required base level and form a flat ground surface by 50 to 100mm of concrete blinding layer. Second, place formwork for the raft foundation of retaining wall and lay the reinforcement and fix the starter bars with adequate spacing. Third, pour concrete into the formwork. Forth, form the stem of retaining wall by placing formwork, laying reinforcement and pouring concrete. Finally, backfill and compact the excavated soil up to required level.

2.21.12 Gabion mattress lining will be installed along the verge of riverbed and the void between non-cohesive stones or granular inside the cage will be filled with eco-bag or pre-seeded soil. An interlocking system will be formed among the gabion cages by driving the anchor into the soil and connector located between eco-bags.

2.21.13 Granite stone are installed for aesthetic purpose on the façades of retaining wall and it also facilitates the growth of creepers and passage of fauna. These stone facing will be embedded in cement mortar and will be installed by hand.

Construction of Maintenance Access Ramps

2.21.14 Two numbers of maintenance access ramps with gradient of 1:12 will be constructed along the channel TKL05 at Ch 0 and Ch 1600 and one existing maintenance access ramp at Ping Yuen River near Ch 2119 of TKL05 will also be made use of an entrance to TKL05 for maintenance. In TKL04, two numbers of maintenance access ramps with gradient of 1:12 will be constructed along the channel TKL05 at Ch 0 and Ch 1150. These vehicular access ramps will be constructed by conventional method which involves excavation, installation of temporary support, erection of formwork, steel fixing, concreting and backfilling.

Re-provision of Existing Pedestrian and Vehicular Accesses/Crossings

2.21.15 As some of the existing pedestrian and vehicular accesses / crossings will be affected by the proposed works, they will be demolished and re-provided to minimize the impact to residents. These pedestrian and vehicular crossings will be constructed with box culvert structural form in TKL04 and beam-slab form in TKL05.

2.21.16 These accesses and crossings will be constructed by typical cast in-situ construction method, including excavation, installation of temporary support, erection of formwork, steel fixing, concreting and backfilling.

2.21.17 Temporary access will be provided during the construction stage to facilitate passage and minimize the disturbance to the public. Temporary fencing and lighting will be provided at the temporary access for safety purpose.

Landscaping Works

2.21.18 Landscaping works involves planting of trees along the verge of public access and construction of maintenance access along verge of riverbed with grasscrete.

2.21.19 Tree planting works will be carried out after the completion of embankment construction and slope formation works. The works will be carried out at suitable seasons under the supervision of qualified landscape professionals [(4)].

2.21.20 Grasscrete will be either constructed using cast in-situ method or precast method.

Site Access

2.21.21 The proposed watercourses can be readily accessed through existing roads. Temporary run-in will be provided for the construction vehicles to enable them to merge and diverge from the normal traffic as smoothly as possible.

2.22 Consideration of Alternative Construction Methods

Channels

2.22.1 Potential alternative construction method includes offsite precast structures for the retaining wall and pre-filled gabion cages. The benefit of offsite precast structures is that there will be less environmental nuisance to nearby sensitive receivers during construction. However, for the excavation and construction of the open channel, there are no other suitable or practicable alternative construction methods.

([4]) A professional member of relevant landscape institute.

2.22.2 In order to match with existing topography, off-site precast structures are considered not practical or cost effective. Although on-site construction could pose environmental impacts to air quality, noise and water quality, the duration and magnitude of the impacts are generally temporary and localised given the short section to be constructed. The improvement works will be conducted in segments of about 50m, at most 3 work fronts will be conducted at the same time for each section. The construction works at Ping Che Road and Ping Yeung Village shall carry out at only one work front in each divided section. It is anticipated that the environmental impacts can be mitigated by appropriate measures.

2.22.3 Pre-filled gabion blocks are not practicable as heavy lifting appliances will be required to lift the blocks. The lifting process will be dangerous and also restrict the potential reuse of excavated rocks within the site. Therefore, conventional construction method of in-situ construction of channels as well as assembly and filling of gabions are considered more suitable and practical. Natural materials will be reused in forming the gabion lining as far as practicable.

Crossings / Bridges

2.22.4 In consideration of existing topography, lifting operation and access in the project site, off-site precast structures are not practical and cost effective. Although on-site construction could pose environmental nuisance such as constructional noise, dust and water quality impacts, it is expected that the duration and magnitude of the impacts are temporary and localized given the short section and small size of the crossings/bridges to be constructed. It is anticipated that the potential environmental impacts can be alleviated by proper implementation of appropriate mitigation measures. Therefore, conventional construction method of in-situ construction of crossing/bridge structure is considered more suitable and practical and will be adopted.

Drainage Pipe

2.22.5 The proposed works for underground drainage pipes would be implemented by open cut method as far as practicable, due to its cost effectiveness in the improvement in proposed drainage works. The proposed work at respective workfronts would be carried out on a section-by-section basis to minimize period of nuisance to the nearby sensitive receivers during construction.

2.22.6 The proposed drainage pipes and u-channels will be located along a section of Ping Che Road and Ping Yuen Road in Ta Kwu Ling. In order to minimise traffic impact and conflict with the congested underground utilities, trenchless method is proposed for pipe installation, while open trench method will be adopted for construction of u-channel. **Table 2.5** provides the comparisons on environmental benefits and dis-benefits of open-cut and trenchless method.

Table 2.5 Environmental Benefits and Dis-Benefits of Alternative Construction Methods

Options	Environmental Benefits	Environmental Dis-Benefits
Open-Cut Method	• Faster construction progress and hence the period of environmental disturbance is reduced.	• Construction nuisances including dust and noise will affect all sensitive receivers along entire works alignment.
Trenchless Method	• Excavation is only required at launching and receiving pit locations. Hence localized construction nuisances are limited to the sensitive receivers near the working pits only. • Comparatively less excavated materials will be generated.	• Longer period of environmental disturbance due to slow construction progress.

2.22.7 For both open-cut method and trenchless method, necessary temporary traffic management will be carried out on a section-by-section basis to minimize period of nuisance to the traffic. Upon the completion of utility survey and inspection pits to ensure no existing utilities would clash with the proposed works, ground excavation will take place between the time periods 7am and 7pm. No construction noise permit would be required. For excavation deeper than 1.2m, sheet piles shall be installed as temporary support for the trench. Underground pipes would be laid after the completion of pipe bedding and then backfilled with soil.

2.23 Consideration of Alternative Construction Sequence

2.23.1 The proposed construction works will be divided into 3 main sections for TKL04, 4 main sections for TKL05, 2 main sections each for Ping Che and Ping Yuen Road. Details can refer to **Figure 2.18**. Construction of channel and road drains will be carried out in parallel. This approach will strike a balance between the need to control the magnitude of environmental impact at the same time while not hindering the overall programme of the Project. The proposed work at respective workfronts would be carried out along the channels on a section-by-section basis to minimize the period of nuisance to the nearby sensitive receivers and the need for temporary drainage diversion.

2.23.2 It will be necessary to carry out careful phasing of the works to re-connect the proposed drainage channel with existing incoming watercourses to ensure satisfactory diversion of flows without the risk of flooding to adjacent areas especially during wet seasons. It is thus recommended that the connection with existing watercourses should be carried out during dry season to minimize flooding risks.

2.23.3 With regard to river excavation, instead of directly excavating the riverbed which will generate sediment plumes in river water and lead to water quality impacts, the excavation of riverbed for this Project will be carried out within an

enclosed area surrounded by hessian bags. By adopting this method, sediments generated from the excavation works will be confined within the enclosed area, thus minimising the potential water quality impacts due to dispersal of suspended sediments. Temporary river diversion works will be carried out before the commencement of excavation works within the existing watercourse. Therefore, excavation works will be undertaken in dry condition which will further reduce the potential water quality impacts.

2.24 Scope of Works during Operational Phase

2.24.1 Maintenance would be necessary regularly in 6-month basis for the proposed watercourses to remove excessive silts, vegetation, debris and obstructions in order to maintain its hydraulic performance and structural integrity. Siltation will generally be allowed to accumulate, and removal of excess silt would be carried out at locations only if it would impede water flow. Such small-scale maintenance would require only light mechanical equipment such as a small loader and/or a small crane truck. Hand-held equipment will be used for vegetation removal.

2.25 Construction Programme

2.25.1 The construction programme for the proposed works is tentatively expected to start in 2024 for completion by 2028. Detailed construction programme is not available at this current stage. The tentative key milestone dates are tabulated in **Table 2.9** below.

Table 2.9 Tentative Key Milestone Dates

Key Milestones	Date (season/year)
Completion of Design Phase	Q4/ 2022
Commencement of Tender Phase	Q3/ 2023
Commencement of Works Contract	Q1/ 2024
Substantial Completion of Works Contract	Q3/ 2028

2.26 Concurrent Projects

2.26.1 The following projects which will be undertaken concurrently in the vicinity of the Project Site. Details of extent is shown in **Table 2.10** and **Figure 2.24**.

Table 2.10 Summary of Concurrent Project

Government Department / Enterprise	Project Name	Construction Programme
Water Supplies Department (WSD)	Implementation of Water Intelligent Network (WIN), Remaining District Metering Areas and Pressure Management Areas in Yuen	October 2020 to Q2/2024.

Government Department / Enterprise	Project Name	Construction Programme
	Long and Sheung Shui & Fanling Major Supply Zones – Investigation, Design and Construction	
Highway Department (HyD)	Widening of the Western Section and Eastern Section of Lin Ma Hang Road (Ping Yuen River to Ping Che Road / Tsung Yuen Ha to Lin Ma Hang)	February 2020 to Q4/2023
Planning Department (PlanD) and Civil Engineering and Development Department (CEDD)	Preliminary Feasibility Study on Developing the New Territories North (NTN)	NA
Drainage Services Department (DSD)	Upgrading of existing sewage and leachate pumping stations and the associated trunk sewerage at North East New Territories (NENT)	Q4/2021 to Q2/2027
Drainage Services Department (DSD)	4165CD - Drainage Improvement Works at North District	2021 to 2027

Implementation of Water Intelligent Network (WIN), Remaining District Metering Areas and Pressure Management Areas in Yuen Long and Sheung Shui & Fanling Major Supply Zones – Investigation, Design and Construction – WSD

2.26.2 Through the installation of high-technology monitoring and sensing equipment in discrete District Metering Areas (DMAs) and associated Pressure Management Areas (PMAs), flow and pressure data as well as other associated network data will be collected.

2.26.3 Implementation of WIN will enable problematic DMAs and PMAs to be prioritized for follow-up actions according to their degree of water loss and the determination of the most suitable network management measures.

2.26.4 The construction works had been commenced since October 2020 and target to be completed in Q2 of 2024. According to the programme in **Table 2.6**, it is anticipated that there will be a short period of overlapping.

2.26.5 Close liaison with WSD and their consultant is required to gather the latest information and examine the potential interfacing components during construction and operation phase of the Project.

Widening of the Western Section and Eastern Section of Lin Ma Hang Road (Ping Yuen River to Ping Che Road / Tsung Yuen Ha to Lin Ma Hang) – HyD

2.26.6 The Western Section between Ping Yuen River and Ping Che Road is about 0.75km long. The existing 3.5m wide single track access road will be widened to a standard 7.3m wide single two-lane carriageway with 2m wide footpath on both sides of the carriageway. The works will include construction of the proposed

road and bridge, road drainage, pedestrian and traffic ancillary facilities, environmental mitigation measures and greening, etc.

2.26.7 The Eastern Section between Tsung Yuen Ha and Lin Ma Hang of the Lin Ma Hang Road Widening Works is a Designated Project under the Environmental Impact Assessment (EIA) Ordinance. A series of surveys and investigations were completed. Considering factors such as environmental impacts, land issues, traffic flow, and other engineering elements, preliminary design scheme for the project was formulated. The preliminary design scheme for the Eastern Section proposes to widen the existing 3.5m wide singe track access road to a standard 6.75m wide single two-lane carriageway with 2m wide footpath on one side of the carriageway. Refinement of the design of the road and associated facilities is carried out by consideration of public views.

2.26.8 The construction works is tentatively scheduled to complete in 2023. As the construction stage of drainage improvement works in Ta Kwu Ling is tentatively scheduled to commence in 2023, project interface is considered minimal. The construction works is tentatively scheduled to complete in 2023. As the construction stage of drainage improvement works in Ta Kwu Ling is tentatively scheduled to commence in 2023, project interface is considered minimal.

2.26.9 The construction works had been commenced since February 2020 and target to be completed in Q4 of 2023. According to the programme in **Table 2.6**, it is anticipated that there will be a short period of overlapping.

2.26.10 Close liaison with HyD and their consultant is required to gather the latest information and examine the potential interfacing components during construction and operation phase of the Project.

Preliminary Feasibility Study on Developing the New Territories North (NTN)– PlanD & CEDD

2.26.11 The study would focus on the development potential of the New Territories North, strategic infrastructure provisions required for the development and the development of a modern new town.

2.26.12 The project is under planning and engineering study, so the construction programme is not available at the current stage.

2.26.13 Close liaison with PlanD, CEDD and consultant is required to gather the latest information and examine the potential interfacing components during construction and operation phase of the Project.

Upgrading of existing sewage and leachate pumping stations and the associated trunk sewerage at North East New Territories (NENT)

2.26.14 The project is to ensure the sewerage of NENT would cope with the future developments and sewer connection works in the area.

2.26.15 The construction of the Project will tentatively commence in 2021 Q4 for completion in 2027 Q2.

2.26.16 Close liaison with DSD and consultant is required to gather the latest information and examine the potential interfacing components during construction and operation phase of the Project.

Drainage improvement works at North District

2.26.17 The project aims at alleviating the flooding problems at various locations at North District including Sha Tau Kok Town, Shek Kiu Tau, Hang Tau, Ha Wan Tsuen, San Tin Eastern Main Channel, Lower Ping Yuen River, Lok Ma Chau Tsuen, Kai Fong Yuen, Nam Wa Po, Yuen Leng, Kwu Tung Road, Ying Pun, Tin Ping Shan Tsuen, Ta Shek Wu, Ko Hang Ha, Ping Kong and Upper Ng Tung River.

2.26.18 The project comprises the construction of village flood protection schemes, drainage channels, box culverts, drains, and other ancillary works.

2.26.19 The construction of the Project will tentatively commence in 2021 for completion in 2027.

2.26.20 Close liaison with DSD and consultant is required to gather the latest information and examine the potential interfacing components during construction and operation phase of the Project.

2.27 Cumulative Environmental Impact

2.27.1 As the concurrent projects discussed in *Section 2.26* above, will have construction works undertaken concurrently in close proximity to Project Site, there is a potential for cumulative construction phase impacts, including dust, noise, water quality, waste, ecology, cultural heritage and landscape and visual, which need to be assessed in this EIA. Since only small-scale maintenance works to remove excessive silts, vegetation, debris and obstructions from the proposed watercourse TKL05 will be undertaken during the operation phase, no cumulative operation phase impacts are anticipated.

2.27.2 The schedules and programs of those Frontier Closed Area (FCA) Study proposals should be subject to private initiatives and market-driven factors. Hence, it is not possible to assess the cumulative impact at this stage. For government projects proposed under the FCA Study, it is noted that development proposal/infrastructure works in the short-term programme will be completed between 2011 and 2017 and works related to the long-term programme will be completed between 2023 and 2030. EIA Studies on these works are not yet available and they are thus not included in the cumulative impact assessment with the current Project.

2.28 Sustainability Considerations

2.28.1 Blue-green drainage infrastructure is a form of development aiming to improve the sustainability and resilience of the drainage system. It facilitates the infiltration of rainfall and the process of natural filtering to reduce the quantity and improve the quality of stormwater runoff.

2.28.2 The concept of blue-green infrastructure is advocated to be incorporated in the future development, maximising amenity and biodiversity opportunities while minimising the impacts from climate change.

2.28.3 Various ecological features would be introduced in the proposed drainage improvement works to provide habitats for aquatic life, thus promoting conservation of biodiversity and sustainable use of biological resources. Blue-green components, embracing Sustainable Drainage Systems (SuDS) such as vertical greening, solar panels, porous pavements and rainwater harvesting ponds, would be subjected to further feasibility study in detailed design. Hence, achieving a value-adding design to the proposed drainage improvement works in TKL.

2.29 Continuous Public Involvement (CPI)

Public Activities to Date

2.29.1 The process of CPI for the proposed Project through meetings and public consultation area summarized below in **Table 2.11**.

Table 2.11 Summary of Continuous Public Involvement

Date/Period	Activities	Concerned Parties
5 October 2018	Liaison Meeting	Green Groups
2 October 2019 to 14 October 2019	Preliminary Dialogues	Local Farmers, Schools & Local Associations, Agricultural Expert & Historians
24 October 2020 to 9 May 2020	In-depth Interviews	Residents, Local Farmers, Community Activists, Schools & Local Associations, Green Groups, North District Council Members, Agricultural Expert & Historians, Engineering Professionals
19 December 2019 to 29 May 2020	Field Visits	Resident, Community Activists, Green Groups, Engineering Professionals

21 January 2020 to 30 June 2020	Focus Group Meeting	Residents, Local Farmers, Community Activists, Schools & Local Associations, Green Groups
10 December 2019 to 16 June 2020	Community Briefings	Residents, Community Activists,
19 March 2020	Rural Committee Meeting	Rural Committee Members

Public Comments in CPI Activities

2.29.2 The public comments collected from the CPI activities are categorized and the analysis are summarized below in **Table 2.12**.

Table 2.12 Summary of Public Concerns and Analysis

Major Comment/Concern	Design Consideration
Alleviate flooding issue/ Effectiveness of flood prevention	According to the flood protection standard formulated by the Government, the design standard of this project is classified as village drainage for 1 in 10 years return period. The size of drainage channels is designed mainly based on the above criteria.
Impact on water source for irrigation/ sustainable water supply for farming activities	Water-well will be re-provided at identified locations and the proposed wetland can also support the local farming activities apart from environmental value.
Disturbance/ change of residence rural lifestyle	The proposed alignment of the drainage improvement works will follow the existing watercourses as far as practicable in order to reduce disturbance of surrounding.
Integration between the watercourses and surrounding environment/ preservation of natural environment	Formation of natural riverbed and enhancement of greening cover at river slope and river blank by a planning scheme will be introduced. Also, Woodland and wetland are proposed to keep the existing environmental connection.
Maintaining water quality	Regular inspection and maintenance of the watercourses will be carried out. If there is any illegal discharge observed, cases will be reported and transferred to relevant law enforcement parties.

Promotion of cultural heritage in Ta Kwu Ling	Selective information of cultural heritage will be displayed in form of signage, showcase and display board etc. to promote local characteristic.
Avoid introduction of exotic and/or invasive species	The planting scheme will include this consideration in the detail design stage.
Management of abandoned meander (including ecological and hydrological functions etc.)	Under the current design scheme, all the abandoned meander will be filled up or recharged by water to become part of the proposed open space and wetland.
Suggest using natural bottom lining, provision of shallow ponds and aquatic planting bays at the base of the channels to compensate or enhance riparian ecology.	A planting scheme will be implemented in the proposed river channel design to enhance the riparian ecology. The scheme will cover the riverbank, river slope and riverbed. Details of the scheme will be developed in detail design.

END OF TEXT