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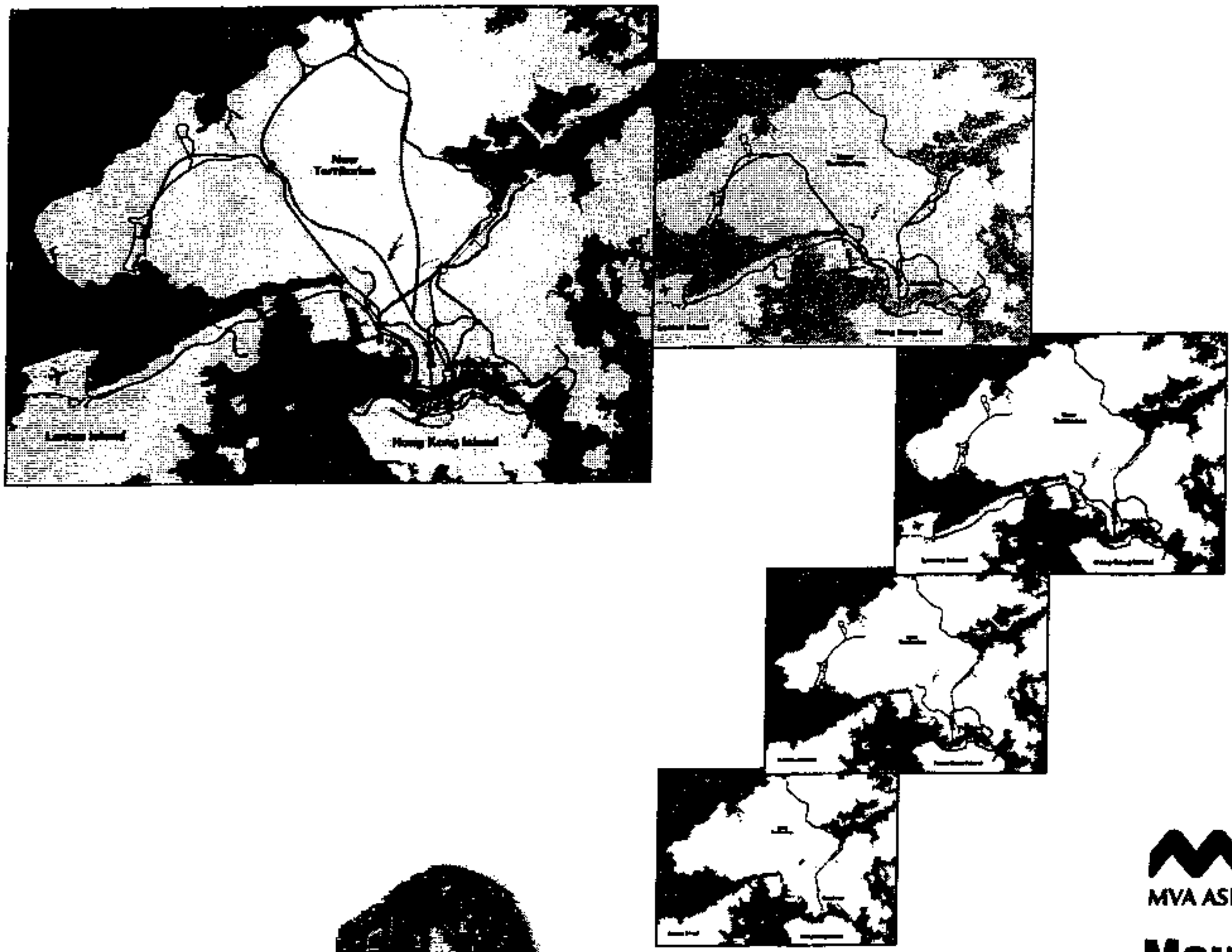
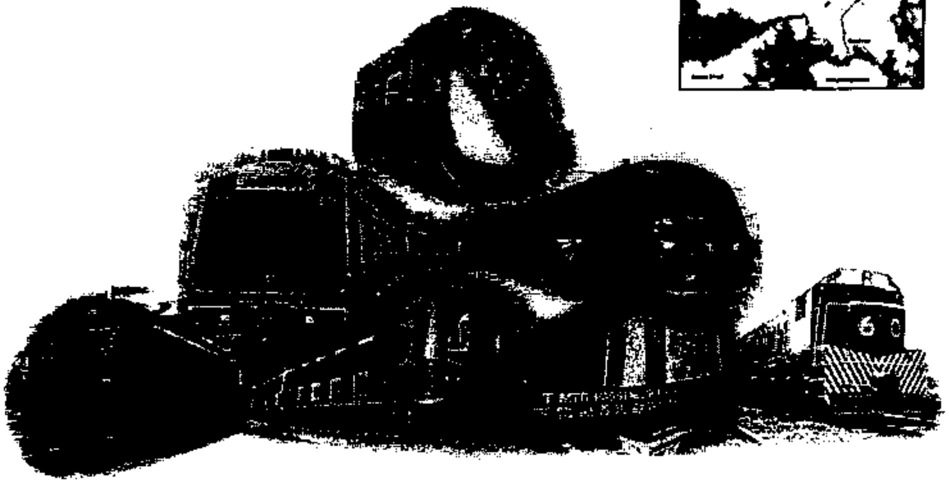
Cumulative Impacts of the Proposed Rail Development Options





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8. CUMULATIVE IMPACTS OF THE PROPOSED RAIL DEVELOPMENT OPTIONS

8.1 Introduction

8.1.1 The preceding chapter has highlighted, in strategic terms, the key environmental impacts that are likely to arise from the implementation of the individual schemes that are included within the proposed rail development options. As a strategic study, it is useful to provide information regarding the cumulative impacts, or benefits, that could be derived from the implementation of the rail development options.

8.1.2 This chapter sets out the cumulative implications of implementing the rail development options. To determine the cumulative impacts, the assessments have been based upon a rail network comprising the Component Schemes and the Stand Alone Schemes. Where appropriate, the Environmental Performance Indicators (EPIs) were used to provide an indication of the cumulative impacts.

8.2 Assessment of the Cumulative Air Quality Implications

8.2.1 An assessment was undertaken to determine the potential cumulative air quality and greenhouse gas 'benefits' that may be accrued from the implementation of the proposed rail development options. This section discusses the approach, findings and conclusions of the assessment.

Approach

8.2.2 As part of the work undertaken for the preparation of Key Issues Paper Number 2, a methodology was developed to undertake an air quality 'emissions comparison' of road and rail (this work was undertaken as part of the justification of rail, and the paper is presented in Annex B of this report). At the time of undertaking the assessment, the methodology was based upon the latest available (1997) information (for electricity usage for railways, fuel mix in electricity power generating power stations, traffic census data and vehicle occupancy rates etc.). However, whilst helpful for illustrating the differences between the two modes of transport, this methodology was not considered appropriate for future projections (and hence calculations to determine the potential air quality implications that may arise from the implementation of the rail development options). The methodology was therefore amended so that it could utilise the transport modelling data generated for the year 2016. This revised methodology is considered to provide a professionally robust approach to determining the future air quality implications of the proposed rail development options.

8.2.3 The introduction of the proposed rail development options will provide passengers who use road based transport with an alternative transport option. Where the new option provides a faster or more direct rail alternative, passengers are likely to make the modal shift to rail.

8.2.4 Reductions in the number of road based vehicle journeys brought about by the implementation of the railway development options will result in consequential reductions in vehicle kilometres travelled. The most significant changes are likely to be related to public transport (i.e. buses and mini-buses). However, changes in the number of car/taxi journeys (and thus kilometres travelled) are also likely to occur. Whilst, in percentage terms, the changes in car/taxi kilometres travelled are likely to be smaller than those related to buses and mini-buses, they are nevertheless predicted to result in a significant reduction in vehicle kilometres because of the far greater numbers of cars/taxis (in comparison to buses) that are predicted to be using the roads in the year 2016 .

8.2.5 The methodology has considered the potential air quality "benefits" arising from the reduction in vehicle kilometres that are forecast to result from the implementation of the rail development options. The approach was based upon determining the likely reduction in bus, mini-bus, car and taxi vehicle kilometres, for the year 2016, and using this data together with emission factors to determine the quantities of the NOx, RSP and CO_2 that would be 'avoided' or 'saved' as a result of the implementation of the rail development options. As this methodology was based on modelled transport data for the year 2016 and robust data on predicted emissions factors, it is considered that this approach provides a reliable estimate of the principal future air quality implications.

8.2.6 NO_X and RSP were chosen as the reference air quality pollutants as they present the greatest concern to roadside air quality in Hong Kong. In addition, both pollutants are emitted by the two sources (i.e. road and rail) and as such, they can be used to make a direct comparison between vehicle and power station emissions. For potential greenhouse gas effects, the emissions of CO_2 from both rail and road transport for the different options was also estimated and compared.

Methodology and Results

8.2.7 The methodology used in the comparison was based upon determining the annual reduction in kilometres travelled for mini-buses, franchised buses (comprising all franchised air conditioned buses), cars and taxis and using established data on quantities of air pollutant emissions produced per vehicle kilometre travelled in order to calculate the projected annual changes in air pollutants.

Emission Factors

8.2.8 The data on quantities of air pollutant emissions produced per vehicle kilometre travelled is detailed in Table 8.1. The data for NOx and RSP (which relates to the year 2011 and assumes, for example, that taxis are using LPG and that all new imported vehicles will be to EURO III standard) was obtained from the EPD's vehicle emission group, whereas the data for CO_2 emissions was derived using vehicle fuel consumption rates based on the general assumption that 2.4 kg of CO_2 emissions arise per litre of fuel consumed by a typical modern family car.

Table 8.1 Quantities of Air Pollutants Generated per Vehicle Kilometre Travelled (grams)

Pollutant	Mini-buses	Buses	Cars	Taxis
NOx	1.54	6.80	0.71	0.73
RSP	0.12	0.69	0.03	0.01
CO_2	449	1,615	299	280

8.2.9 There are many factors that may affect the types and numbers of buses that may be operating in the year 2016. The commercial decisions of the bus operating companies will have a major influence. At a strategic level it is not possible to determine the split of single-decker and double-decker, and air-conditioned and non-air conditioned buses operating in the year 2016. However, as RDS-2 has considered high demand corridors that have the potential for rail expansion, it is considered unlikely that single-decker buses would be used, therefore, it has been assumed that all the buses will be double-decker, air-conditioned buses. The selected emission factors reflect this assumption.

Reductions in Vehicle Kilometres

8.2.10 The transport modelling undertaken by the main study determined the reduction in vehicle kilometres that could be achieved from the Component Schemes of the urban and regional development options, and also from the implementation of the expanded networks.

8.2.11 The expanded networks comprise the Component Schemes and the NOL and WIL schemes. The expanded networks did not include any of the Longer Term Schemes (as the implementation of these schemes will be considered in the next phase of railway planning), nor did it include the REL or the PRL, because, for the REL there are many uncertainties regarding the routing, operator and traffic levels, and because, as the PRL is a freight link, it will have no effect on passenger movements.

8.2.12 Tables 8.2 and 8.3 present the projected reductions in vehicles kilometres in the year 2016 for the Component Schemes and expanded networks respectively. The data was generated with reference to the major network assumptions used in the CTS-3 medium scenario.

Table 8.2 Annual Reduction in Vehicle Kilometres for the Component Schemes (2016 millions)

	Component Schemes					
	Regional (ADM)	Urban - MTR (ADM)	Urban - KCR (ADM)	Regional (VIP)	Urban - MTR (VIP)	Urban - KCR (VIP)
Mini-bus	5.1	6.6	3.9	4.5	7.2	4.3
Bus	56.9	47.1	54.3	61.8	48.4	61.0
Car	69.9	60.5	65.6	74.7	62.7	73.6
Taxi	27.2	23.5	25.5	29.0	24.4	28.6
Total	159.2	137.6	149.4	170.0	142.7	167.5

Table 8.3 Annual Reduction in Vehicle Kilometres for the Expanded Network (2016 millions)

	Expanded Network					
	Regional (ADM)	Urban - MTR (ADM)	Urban - KCR (ADM)	Regional (VIP)	Urban - MTR (VIP)	Urban - KCR (VIP)
Mini-bus	17.4	18.9	16.3	16.8	19.5	16.6
Bus	74.8	64.9	72.2	79.6	66.3	78.9
Car	104.0	94.5	99.7	108.7	96.7	107.6
Taxi	40.4	36.8	38.8	42.3	37.6	41.9
Total	236.7	215.1	226.9	247.5	220.2	245.0

Reductions in Air Pollutants

8.2.13 Using the vehicle kilometres reduction data presented in Tables 8.2 and 8.3 above, the reduction in quantities of air pollutants that could be potentially 'saved' from the implementation of the rail development options were calculated using the data on quantities of air pollutant emissions produced per vehicle kilometre travelled.

8.2.14 The potential 'savings' are presented below in Table 8.4 and 8.5 for the Component Schemes and expanded networks respectively.

Table 8.4 Potential Emissions 'Savings' for the Component Schemes (tonnes per year in 2016)

	Component Schemes					
	Regional (ADM)	Urban - MTR (ADM)	Urban - KCR (ADM)	Regional (VIP)	Urban - MTR (VIP)	Urban - KCR (VIP)
NOx						
Mini-bus	8	10	6	7	11	7
Bus	387	320	369	420	329	415
Car	50	43	47	53	45	52
Taxi	20	17	19	21	18	21
Total	**465**	**390**	**441**	**501**	**403**	**495**
RSP						
Mini-bus	1	1	1	1	1	1
Bus	39	32	37	43	33	42
Car	2	2	2	2	2	2
Taxi	0	0	0	0	0	0
Total	**42**	**35**	**40**	**46**	**36**	**45**
CO_2 ('000)						
Mini-bus	2	3	2	2	3	2
Bus	92	76	88	100	78	99
Car	21	18	20	22	19	22
Taxi	8	7	7	8	7	8
Total	123	104	116	132	107	130

Table 8.5 Potential Emissions 'Savings' for the Expanded Network (tonnes per year in 2016)

	Expanded Network					
	Regional (ADM)	Urban - MTR (ADM)	Urban - KCR (ADM)	Regional (VIP)	Urban - MTR (VIP)	Urban - KCR (VIP)
NOx						
Mini-bus	27	29	25	26	30	26
Bus	509	442	491	542	451	536
Car	74	67	71	77	69	76
Taxi	30	27	28	31	27	31
Total	**639**	**565**	**615**	**676**	**577**	**669**
RSP						
Mini-bus	2	2	2	2	2	2
Bus	52	45	50	55	46	54
Car	3	3	3	3	3	3
Taxi	0	0	0	0	0	0
Total	**57**	**50**	**55**	**61**	**51**	**60**
CO_2 ('000)						
Mini-bus	8	8	7	8	9	7
Bus	121	105	117	129	107	127
Car	31	28	30	33	29	32
Taxi	11	10	11	12	11	12
Total	171	152	165	181	155	179

8.2.15 Due to the greater number of schemes in the expanded network, they offered higher potential emissions savings due to their ability to capture a greater number of passengers and thereby have a greater influence in reducing annual bus vehicle kilometres. For the Component Schemes, the total emissions savings for NOX ranged from 390 tonnes/annum for the urban MTR option via ADM to 501 tonnes/annum for the regional option via Victoria Park, whereas the savings for the expanded networks ranged from 565 to 669 tonnes/annum. For RSP, the Component Schemes offered savings from 35 tonnes/annum for the urban MTR option via ADM to 46 tonnes/annum for the regional option via Victoria Park, whereas for the expanded networks, the savings for the same options ranged from of 50 and 61 tonnes/annum respectively. Total CO_2 emissions savings of between 104,000 and 132,000 tonnes/annum were predicted for the Component Schemes, whereas again, the expanded networks offered higher potential savings of between 152,000 and 181,000 tonnes/annum.

8.2.16 With regard to the expanded networks, the greatest potential NO_X saving is 676 tonnes/annum resulting from implementation of the Regional option via VIP/HKP. To give an impression of this saving, this quantity of NOx is roughly equivalent to that emitted by 1,361 heavy goods lorries idling 24 hours a day for one year. This number of lorries would form a line 24 km long, roughly equivalent to two continuous lanes of lorries along the north shore of Hong Kong Island from Kennedy Town to Shaukeiwan.

8.2.17 The assessment once again reiterates the notion that for new railway proposals, demand-led network developments, which capture high patronage's and thereby encourage a shift from road based transportation and a consequential reduction in bus kilometres, may also result in an environmentally preferred development option.

8.2.18 It should also be noted that the assessment indicates that the environmental (air quality) benefits that could be derived from the Stand Alone Schemes would, in general, be higher than the core schemes. This is mainly because the Stand Alone Schemes tend to serve new areas (where there are no existing railways), and they can therefore capture high patronages. However, the Component Schemes are required partly for relief of other lines in the main urban areas, and without their implementation, the Stand Alone Schemes would overload the rail network and the assessed environmental benefits would not be realised. It should be noted that part of the benefits of the Stand Alone Schemes arise from future developments (e.g. large growth in employment for the WIL and the second tranche of SGAs for the NOL). These factors could affect the timing of the Stand Alone Schemes.

8.2.19 The predicted reductions in road traffic brought about by the Network Options are likely to result in significant reductions in road side emissions of NOx and RSP. These pollutants are generally considered to have "localised" impacts and therefore the savings could have a significant influence on the road side air quality. However, as CO_2 is a "greenhouse" gas, its effects are more "global". If the electricity supply to power the proposed railway network is not generated by 100% nuclear or renewable power, there will be CO_2 emissions attributable to the railway operations. Paragraph 7.5.37 has provided an indication of the relative amounts of CO_2 emissions that are generated from different types of power plant.

8.2.20 As there exist many uncertainties including the future energy requirement of the proposed railway network, and the fuel and plant type that will be used for future power generation, it is difficult to provide an accurate prediction of the CO_2 emissions that would be associated with the provision of the electricity to power the expanded railway network in 2016.

8.2.21 Nevertheless, it is expected that any CO_2 benefits that result from implementing the railways developments could be maximised through the introduction of more 'environmentally friendly' fuel sources and plant types, and by advances in power generation technology.

8.2.22 Furthermore, it is considered that developments in the rail industry (such as more energy efficient rolling stock and stations, and the use of platform edge doors) could help reduce their future electricity requirements thereby leading to lower emissions of CO_2. To ensure that these benefits are maximised, it is recommended that further investigations are undertaken to enhance the energy conservation and efficiency of railways.

8.2.23 It should be noted that the assessment of the cumulative air quality impacts is based on a number of assumptions, consequently, the findings are only intended to provide a 'strategic level' indication of the potential air quality implications.

8.3 Cumulative Ecological Impacts

8.3.1 The great majority of the schemes within the proposed rail development options are to be constructed underground within an urban environment. The potential for ecological impacts from the majority of the lines is therefore relatively low. Impacts may however occur from the implementation of above ground schemes (or above ground sections of the schemes).

8.3.2 To provide an indication of the potential cumulative ecological impacts that may result from the implementation of the proposed rail development schemes, the SEA Team has drawn upon the approach defined in the EPI paper.

8.3.3 The key ecological impacts that are likely to result from the implementation of the proposed rail schemes include potential losses or impacts to areas designated for conservation purposes, or areas which comprise sensitive ecological habitats or resources known to support rare, protected or endemic species (such as native woodland, marshland or egretries).

8.3.4 The construction phase would give rise to the greatest potential for ecological impacts due to direct loss of habitat resulting from (both temporary and permanent) landtake requirements.

8.3.5 Following advice from the Engineering Team, it has been assumed that, to enable construction, the landtake requirements along the above ground sections of alignment will comprise a corridor 40 m wide, whilst for stations, the width of the landtake will be 100 m.

8.3.6 In accordance with the EPIs, the above ground sections of the assumed rail alignments were assessed to identify the extent of any ecological impacts that may result from the currently assumed landtake requirements. Where impacts were predicted, reference was made to the 'importance' of the affected habitats as well as the extent of any landtake affecting natural habitat areas. The following factors were taken into account:

- any direct physical impact to recognised conservation areas;
- any direct physical impact to areas of ecological interest; and
- the total landtake of natural habitat areas.

8.3.7 To undertake the assessment, and to provide an indication of the total areas of landtake, reference was made to the World Wide Fund for Nature (WWF) Hong Kong vegetation map.

8.3.8 The NOL and the freight link connecting the NOL to the existing East Rail are both currently proposed to be above ground schemes. Whilst the ERX and WRE are both predominantly underground schemes, the currently envisaged alignments include above ground sections. However, it should be reiterated that these schemes, especially the ERX and WRE are at an early stage of development and the details of the horizontal and vertical alignment are still subject to possible change, although such changes are likely to increase rather than decrease the below ground proportion of the routes.

8.3.9 Discussion regarding the ecological impacts that are likely to occur from the implementation of each of the currently assumed Component Schemes are presented within the discussion of the individual schemes. However, a summary of the cumulative ecological impacts is presented in Table 8.6.

Table 8.6 Cumulative Ecological Impacts

Habitat Type	Scheme	Area of Habitat Affected (Ha)	Percentage of Area Affected in Terms of Overall Habitat in Hong Kong
Natural woodland	NOL	4.2	0.04%
	WRE	0.22	0.002%
	ERX	0.15	0.002%
	Total	4.42*	0.042%*
Plantation woodland	ERX	1.18	0.01%
	Total	1.18	0.01%
Other wetland, (including marsh areas)	NOL	1.1	0.32%
	WRE	1.6	0.49%
	Total	2.7	0.81%
Inland water (including fishponds, streams/rivers, nullahs, reservoirs, ponds etc)	NOL	8.0	0.16%
	NOL (Freight Connection)	5.3	0.1%
	WRE	8.0	0.16%
	ERX	3.7	0.08%
	Total	21.3*	0.42%*
Low shrub	NOL	0.7	0.01%
	ERX	1.65	0.02%
	Total	2.35	0.03%
Tall shrub	ERX	0.17	0.002%
	Total	0.17	0.002%
Grassland	NOL	2.0	0.01%
	ERX	1.8	0.01%
	Total	3.8	0.02%
Cultivation	NOL	5.5	0.39%
	NOL (Freight Connection)	0.3	0.02%
	WRE	9.2	0.65%
	ERX	0.34	0.34%
	Total	15.0*	1.06*
Abandoned cultivation	NOL	9.4	0.30%
	NOL (Freight Connection)	2.1	0.07%
	WRE	2.2	0.07%
	Total	13.7	0.44%

* With regard to the WRE and ERX it has been assumed that only one of these schemes will be implemented (i.e. if WRE is implemented ERX will not; and vice versa). Therefore, where ecological impacts to the same habitat type may be attributed to both schemes, only the scheme with the highest potential impact has been considered in the calculation.

8.3.10 It should be noted that each of the alignments are currently considered to be indicative, and thus they may be subject to change as the development process is undertaken similarly, the width of the assumed 'construction corridor' may alter as the construction methodology is developed. Therefore, the data presented below should be considered within the context of a "strategic" assessment since it is only intended to provide an indication of the potential ecological impacts. It should also be noted that this assessment was undertaken after the re-alignment of the NOL freight connection to avoid Long Valley.

8.3.11 Whilst the above table presents information on the potential for cumulative ecological impacts, the significance of the impacts to each of the habitat types needs to be related to the relative importance of the affected area (eg the specifies diversity or rarity of the species contained within the affected area). Consequently, the above information must be used with caution.

8.3.12 The ecological assessment work has provided an indication of the extent of the potential ecological impacts that may result from the currently assumed indicative alignments. In line with best practice, the information should be used during the development process to minimise the impacts to ecological resources (possibly by altering the alignment). The aim should be to avoid or minimise impacts to ecological resources.

8.3.13 However, it may not be possible to avoid all ecological impacts. In such circumstances, following established mitigation practice in Hong Kong, the loss of certain habitats (including natural woodland, wetlands, and fishponds) will need to be compensated. The extent and location of such compensatory areas will need to be commensurate with the significance and exact area of the affected habitats. The determination of compensation requirements will need to be evaluated fully at the EIA stage when the alignments are finalised and the area and importance of the affected habitats can be more clearly defined.

8.3.14 It should be noted that there are limitations to providing habitat compensation as a mitigation measure, for example, the proposed areas may not prove adequate in the long term for providing 'like-for-like' compensation. Additionally, the policy of not permitting the resumption of private land for off-site habitat compensation can limit the scope of any mitigation proposals, especially since there is often limited scope for habitat compensation within the project boundary. Consequently, all practicable efforts should be taken to avoid or minimise the impacts to important ecological areas, thereby avoiding the need to consider providing compensatory areas.

8.4 Cumulative Cultural and Heritage Impacts

8.4.1 The greatest potential for impacts to occur to cultural and heritage resources is likely to be during the execution of above-ground construction works associated with any at-grade or elevated alignments, cut and cover sections or station/depot structures.

8.4.2 The potential construction phase impacts that may occur to sites of cultural and heritage importance include noise, dust, visual and vibration impacts. Whilst there is also the potential for the direct loss of the cultural heritage resource due to the construction works, this scenario would not be permitted since the resources are statutorily protected and have been identified at an early stage of the development process in order to prevent such an unacceptable impact.

8.4.3 During the operational phase there is the potential for both above and below ground alignments to give rise to noise and/or vibration impacts. Visual impacts may also potentially occur from above ground alignments and structures. The magnitude of these impacts (both related to the construction and operational phases) are likely to be related predominantly to the proximity of the rail scheme or station to the identified resource.

8.4.4 However, as the majority of the alignments proposed within the Study are to be constructed underground the potential for cultural and heritage impacts is generally considered to be low.

8.4.5 In order to provide an indication of the potential cumulative cultural heritage impacts that may result from the implementation of the proposed rail development schemes, the SEA Team has drawn upon the approach defined in the EPI paper.

8.4.6 Using this approach, the above and below ground sections of the assumed rail alignments were assessed to determine the proximity to any cultural and heritage resources that have been identified and recorded by AMO. The following factors were taken into account:

- the number of sites of cultural heritage within the assumed landtake; and
- closest proximity of the railway alignment and stations to the cultural and heritage resource (m).

8.4.7 The results of the assessment are presented in Table 8.7. It can be seen that 10 cultural and heritage resources have been identified within 50 m of the currently assumed alignments. Consequently, there is the potential for impacts to these resources.

8.4.8 The alignments of each of the rail schemes that come within 50 m of the identified cultural and heritage resources are all assumed to be underground. Whilst this will significantly reduce the potential for impacts, concerns have been expressed by the Antiquities and Monuments Office (AMO) regarding the proximity of the alignments and the potential for impacts to Victoria Prison, the Central Police Station Compound and Former Central Magistracy, Government House and Duddell Street Steps and Gas Lamps. AMO are also concerned that the currently assumed KSL may damage the tunnel networks located below the Former Marine Police Headquarters. As such, it is suggested by AMO that the details of the proposed schemes are examined during the planning stage with a view to maximising the separation distance between the proposed rail schemes and the historic and cultural resources.

8.4.9 Because of the importance and fragility of the identified historic and cultural resources, (and line with AMO's suggestion), the information presented in the above table should be considered when further developing the proposed rail schemes and construction methodologies so that potential impacts can be avoided. Full consideration will also need to be given to cultural and heritage implications during the EIA stage when details related to the construction methodology, route alignments and station layouts have been finalised.

Table 8.7 Cumulative Heritage Impacts

Scheme	Heritage Site (Deemed or Declared Monument)	Horizontal Distance to Nearest Station (m)	Horizontal Distance from alignment (m)
NIL	The Exterior of the Old Supreme Court Central	380 m (HOK)	230 m (underground alignment)
FHC	Tin Hau Temple, Causeway Bay	220 m (VIP)	200 m (underground alignment)
(CEW via VIP/ LEH)	The Exterior of the Main Building, the Helena May, Garden Road, Central	70 m (HKP)	70 m (underground alignment)
	St. John's Cathedral, Garden Road	50 m (HKP)	50 m (underground alignment)
	Former French Mission Building, Battery Path, Central	100 m (HKP)	100 m (underground alignment)
	Government House, Upper Albert Rd	100 m (HKP)	20 m (underground alignment)
	Duddell Street Step and Gas Lamps	240 m (HKP)	40 m (underground alignment)
	Victoria Prison, Central Police Station Compound & Former Central Magistracy	20 m (CEW)	20 m (underground alignment)
	Old Wanchai Post Office	150 m (WCS)	80 m (underground alignment)
	Old Pathological Institute, Caine Lane, Sheung Wan	340 m (CEW)	40 m (underground alignment)
FHC	Flagstaff House, Cotton Tree Drive, Central	350 m (ADM)	90 m (underground alignment)
(CEW via EXH/ ADM)	The Exterior of the Main Building, the Helena May, Garden Road, Central	-	50 m (underground alignment)
	Government House, Upper Albert Rd	-	100 m (underground alignment)
	Duddell Street Step and Gas Lamps	-	150 m (underground alignment)
	St. John's Cathedral, Garden Road	-	160 m (underground alignment)
	Victoria Prison, Central Police Station Compound & Former Central Magistracy.	30 m (CEW)	30 m (underground alignment)
WIL	Western Market, Sheung Wan	10 m (SHW)	10 m (underground alignment)
(via SHW to KEN)	The Exterior of Hung Hing Ying Building, the University of Hong Kong	260 m (DVR)	260 m (underground alignment)
	The Exterior of Tang Chi Ngong Building, University of Hong Kong	280 m (DVR)	280 m (underground alignment)

Scheme	Heritage Site (Deemed or Declared Monument)	Horizontal Distance to Nearest Station (m)	Horizontal Distance from alignment (m)
WIL	Main Building of St. Stephen's Girls College	-	5 m (underground alignment)
(via FHC from CEW to KEN)	Old Pathological Institute, Caine Lane, Sheung Wan	100 m (CEW)	60 m (underground alignment)
	The Exterior of Tang Chi Ngong Building, University of Hong Kong	-	80 m (underground alignment)
	The Exterior of the Main Building, University Hong Kong	-	160 m (underground alignment)
	The Exterior of Hung Hing Ying Building, the University of Hong Kong	-	260 m (underground alignment)
REL - East Rail	King Law Ka Shuk Ancestral Hall	-	700 m (underground alignment)
	Enclosed wall and corner watch tower of Kun Lung Wai and Lung Gate Tower	400 m (FAE)	400 m (above ground alignment)
	Entrance Tower and Enclosing Wall of Lo Wai	-	440 m (above ground alignment)
	Entrance Tower of Ma Wat Wai	-	620 m (above ground alignment)
	Tang Chung Ling Ancestral Hall	-	300 m (above ground alignment)
	Liu Man Shek Ancestral Hall	-	800 m (above ground alignment)
	Historic Buildings, Structures and Archaeological Sites		
	San UK Tsuen & Sin Shut Study Hall	500 m (FAE)	500 m (above ground alignment)
	Wing Ling Wai	-	600 m (above ground alignment)
	Tung Kok Wai	-	250 m (above ground alignment)
	Two Stone Tablets of Chung Hin Bridge	-	960 m (above ground alignment)
	Sheung Shui Wah Shan Archaeological Site		580 m (underground alignment)
	Man Ming Temple	-	340 m (underground alignment)

Scheme	Heritage Site (Deemed or Declared Monument)	Horizontal Distance to Nearest Station (m)	Horizontal Distance from alignment (m)
	Shung Him Church,	-	800 m (above ground alignment)
	Tin Hau Temple,	-	400 m (above ground alignment)
NOL	Yi Tai Study Hall, Kam Tin,	-	500 m (above ground alignment)
	Man Lun-Fung Ancestral Hall	-	400 m (above ground alignment)
	Tai Fu Tai	-	400 m (above ground alignment)
	Hau Kui Shek Ancestral Hall*	-	90 m (above ground alignment)
	Tang Kwong U Ancestral Hall*	-	420 m (above ground alignment)
	Cheung Chun Yuen*	-	500 m (above ground alignment)
	<u>Historic Buildings, Structures and Archaeological Sites</u>		
	Hung Shing Temple and Pai Fung Temple	-	60 m (above ground alignment)
	Sin Wai Nunnery	-	60 m (above ground alignment)
	Lady Ho Tong (Dispensary)	560 m (KTU)	560 m (above ground alignment)
	The Manor House	600 m (KTU)	600 m (above ground alignment)
	Bok Man School	-	1200 m (above ground alignment)
	Hakka Wai	-	1260 m (above ground alignment)

Scheme	Heritage Site (Deemed or Declared Monument)	Horizontal Distance to Nearest Station (m)	Horizontal Distance from alignment (m)
KSL	Former Marine Police Headquarters	-	0 m (underground alignment)
	Former Kowloon-Canton Railway, Clock Tower	-	200m (underground alignment)

* Deemed Monuments

8.5 Cumulative Landtake Impacts

8.5.1 In relation to landtake issues, an indication of the potential cumulative impacts that would result from the implementation of the proposed rail development options can be gained by making reference to the total lengths of new railways that are currently proposed, and more precisely, the proposed length of above ground track. Whilst the provision of stations and depots will also require additional land requirements these have not been included in the assessment because the schemes are still under development.

8.5.2 Table 8.8 provides a summary of the total length of new railways proposed for each of the Component Schemes.

Table 8.8 Lengths of Proposed Railway Schemes

Scheme	Length (km)
North Island Line	3.8
East Kowloon Line (via HMT)	5.1
Fourth Harbour Crossing (EKL - CEW to HUH)	6.0
Fourth Harbour Crossing (ER - CEW to MKK)	8.3
Fourth Harbour Crossing (EKL - CEW to HUH)	7.3
Fourth Harbour Crossing (ER - CEW to MKK)	9.5
Tai Wai to Diamond Hill Link (through running with MOS)	5.6
Tai Wai to Diamond Hill Link (3-way interchange at TAW)	6.3
Kowloon Southern Link (NAC to HUH)	5.7
Northern Links	12.8
East Rail Express (HUH to LOW)	28.2
West Rail Express (HUH to KSR)	22.5
Port Rail Line	8.3

8.5.3 The total length of new railway will be dependant upon which option is implemented (eg in relation to the FHC or the TDL). To give an indication of the maximum landtake that may be required for the implementation of the rail development options, it has been assumed, for the purposes of this calculation, that the alignment options with the greatest length will be implemented. With this assumption, the maximum length of new railways that would be constructed (both above and below ground) as a result of the implementation of the rail development option would be 75.9 km (this assumes that if the ERX is implemented, the WRE will not).

8.5.4 However, of more relevance to landtake is the total length of new railway that are proposed to be located above ground (either at grade or on viaduct). In total, six of the potential schemes were found to include possible sections of above ground track. Table 8.9 presents the lengths of above ground track.

Table 8.9 Lengths of Above Ground Track

Scheme	Length (m)
Tai Wai to Diamond Hill Link (through running with MOS)	900
Northern Links	11,750
East Rail Express (Hung Hom to Lo Wu)	5,700
West Rail Express	5,700
Port Rail Line	1,400
Total	19,800

8.5.5 It can be seem from the above that the 'worst case' total length of track that is proposed to be above ground is 19.8 km.

8.5.6 A relatively large component of this above ground length would made up from the ERX and WRE both of which are schemes which are at an early stage of development. Consequently, the actual lengths of above ground track may differ significantly as the alignments are refined. Additionally, it is likely, certainly in the immediate future, that the implementation of a regional express service would be through the implementation of either the ERX or the WRE. It is not envisaged that both options would be implemented; therefore the permanent landtake impacts will be proportionally less than implied above.

8.5.7 Section 5 of Annex B presents information regarding the comparative landtake and landuse implications of roads in comparison to rail. The above data on lengths of above ground railways can be related to this discussion.

8.6 Cumulative Hazard Impacts

8.6.1 The EPIs were used to assess the potential cumulative hazard implications.

8.6.2 Five of the currently proposed routes have sections of alignment that pass within the Consultation Zones of PHIs. For each of these routes where the alignment entered the Consultation Zone (CZ), Table 8.13 summarises the PHI in question, together with details of the number of stations (if any) and the length of track within the CZ.

8.6.3 The EPIs suggest that the length of above ground alignment that is within the CZ is reported. Whilst it is noted that the scope for potential hazard related implications both to and from the operation of the railway is likely to be significantly lower for underground sections of alignment, Table 8.10 also provides details of the length of underground alignment that is with a CZ.

Table 8.10 Hazard Impacts

Scheme	PHI	Size of CZ	Number of stations within the CZ	Length of track within the CZ
EKL	(K1) HK & China Gas facility at Ma Tau Kok	300m	1 (TKW station - underground)	720m (below ground)
TDL (Option 1)	(N13) Shatin Water Treatment Works	1,000m	0	900m (320 above and 580 below ground)
TDL (Option 2)	(N13) Shatin Water Treatment Works	1,000m	0	600m (below ground)
PRL	(N13) Shatin Water Treatment Works	1,000m	0	100m (below ground)
PRL	(N37) Shek Lei Pui Water Treatment Works	1,000m	0	120m (below ground)
ERX (via Lok Fu)	(N13) Shatin Water Treatment Works	1,000m	0	350m (below ground)
ERX	(N14) Tai Po Tau Water Treatment Works	1,000m	0	1,300m (below ground)
ERX (extension to Lo Wu)	(N18) Sheung Shui Water Treatment Works	1,000m	0	2,200m (above ground)
NOL	(N22) Au Tau Water Treatment Works	1,000m	1 (KSR station - above ground)	1,220m (above ground)
NOL	(N18) Sheung Shui Water Treatment Works	1,000m	0	1,680m (above ground)

8.6.4 From Table 8.13 it is possible to gain a overall indication (using the criteria in the EPIs) of the cumulative hazard related implications from implementing the rail development options. The actual scope and magnitude of the hazard implications will, if required, need to be determined at a later date (once the alignments are further developed) as part of a hazard assessment.

8.6.5 The overall extent of the hazard implications will be dependant upon which routes and route options that are implemented. For the purposes of this assessment, it has been assumed that the strategic implications of underground sections of alignment will be significantly lower than above ground sections. Therefore, the quantification of cumulative hazard implications has been assessed by determining the sum total of above ground rail track that runs within the CZs. Where route options exist, the option with the greatest length of track within the CZ have been used to provide a 'worst case' indication of the cumulative hazard implications.

Table 8.11 "Worst-case" Cumulative Hazard Implications

Scheme	Number of Above Ground Stations within CZ (m)	Length of Above Ground Track within CZ (m)
TDL (Option 1)	0	320
ERX (Extension to Lo Wu)	0	2,200
NOL	1	1,220
NOL	0	1,680
Total	1	5,420

8.6.6 Overall, the worst case cumulative impacts are 5,420 m of above ground track and one above ground station within the CZs. In comparison to the total length of proposed new railway (comprising 75.9 km of both above and below ground sections) the 'worst case' length of potential above ground track within the CZs is relatively small. It is also noted that 3,000 m of the track is within the CZs of two PHIs (i.e. the Sheung Shui Water Treatment Works and the Shatin Water Treatment Works) both of which currently have significant lengths (i.e. 2,900 m) of above ground railway within their CZs.

8.6.7 Whilst the predicted lengths of track within the CZs are not predicted to present any insurmountable impacts, as is standard practice, hazard assessments will be required to assess the actual hazard implications, and, where applicable, to develop and specify suitable mitigation measures.

8.7 Cumulative Noise Impacts

8.7.1 Railway noise is controlled by absolute performance limits defined within the Noise Control Ordinance (NCO). Direct (at source) mitigation measures must therefore be developed to meet the required noise standard. Unlike road traffic noise, the use of in-direct noise mitigation measures such as acoustic glazing is not permitted. As a consequence of the statutory requirements, the implementation of the proposed rail development options will not result in any properties being exposed to railway noise in excess of the require noise criteria. Consequently, there should be no cumulative impacts.

8.7.2 The majority of the rail routes proposed within the rail development options are to be located underground. This will be major mitigating factor for rail noise. For those sections of the proposed rail routes that are at grade, proven at-source mitigation measures exist for controlling the noise to within an acceptable level. The implementation of these measures will ensure that existing and planned sensitive receivers are not exposed to unreasonable levels of railway noise, and that the potential for land 'sterilisation' (due to the exposure of elevated noise levels) is, as far as possible, avoided.

8.7.3 A detailed assessment of the actual noise levels that local sensitive receivers will be exposed to through the implementation of the proposed rail development options is outside the scope of this strategic study. Assessments to this level of detail will be undertaken at later stages of the rail development process (eg the Project Feasibility or EIA stage). However, the following sections provide a brief overview of the types of direct mitigation measures that could be used to control railway noise.

Purpose-built Noise Barriers

8.7.4 Purpose built structures can be used to provide noise mitigation. These structures which can comprise barriers, in the form of earth berms or solid fences which can be built adjacent to the railway. If required, full noise enclosures can also be constructed over the railway. These options can be effective in reducing noise wherever they prevent line-of-sight between the source and the receiver.

8.7.5 The height of noise barriers required for mitigation purposes will depend on many factors including the roadway geometry, the height and location of the noise sensitive receivers and the topography of intervening terrain. In general, the higher the noise receiver, the taller the barrier will need to be to provide mitigation.

Timetabling

8.7.6 In contrast to roads, railway noise can also be controlled through changing operational and timetabling factors such as reducing the speed and frequency of the trains. However, these measures are not always practicable since they decrease the operational efficiency and profitability of the railway.

Undergrounding

8.7.7 Although the majority of the proposed rail schemes are proposed to be underground, there may be situations where an above ground route passes through a densely populated area (such as an SGA). In such situations, there could be a case for placing the railway underground (as outlined above). However, since it is envisaged that the noise criteria could, in most cases, be met through the use of direct mitigation methods, it is likely that 'undergrounding' may not be considered an optimum overall solution because of the additional expense that would be incurred compared to the additional environmental benefits to be gained.

Integrated Building - Railway Design

8.7.8 The provision of public transportation into the densely populated areas has the potential to result in noise conflicts. An effective way to overcome these potential nose conflicts, especially during the planning stages of a development area (such as an SGA) is to integrate the rail noise source into the development. For example, train stations can be located within planned developments (either underground or beneath a podium) thereby providing an effective means of noise mitigation.

Advances in Railway Noise Mitigation

8.7.9 In recent years there have been advances made in the design of railway mitigation measures to ensure that the required noise criteria are met by direct means.

8.7.10 An example of this, and a measure that is currently being incorporated into the design and construction of West Rail, is the use of an innovative noise attenuation system, the 'Multi-plenum System'. This system controls both airborne and, where viaduct is used, structure borne sources (i.e. train-induced vibration in any viaduct structure which radiates as audible noise). The Multi-plenum System achieves this through the integrated design of trackform and elevated structures within airborne noise containment systems. In essence, the system utilises undercar skirts, made of acoustic absorptive material, which form part of a cascading system of acoustic plena, each of which provides direct and reverberant noise attenuation. The resultant airborne noise emissions are attenuated by restricting the gap between the side plena and the train. Acoustic modelling has demonstrated that the 'Multi-plenum System' can provide significant noise attenuation when used in combination with low height parapets.

8.7.11 Structure borne noise is also controlled through the use of floating slab trackform with soft baseplates, in combination with a highly impedant viaduct cross-section in order to control low frequency "rumble" noise.

8.7.12 Advances in direct means of railway noise attenuation, such as the 'Multi-plenum System', have made it possible for above ground railways (such as West Rail and the Ma On Shan Line) to achieve the stringent railway noise criteria whilst passing through and serving densely populated urban areas of Hong Kong. The use of the 'Multi-plenum System' avoids the need to use extensive lengths of noise barriers or enclosures that can present an adverse visual impacts to local sensitive receivers.

8.7.13 It is considered that, in the that future, further developments and advances in noise attenuation technology could assist in further reducing the operational noise emissions from the planned railways.

8.8 Housing Developments

8.8.1 To provide efficient and 'user-friendly' rail services that capture high patronages (thereby helping to ensure their viability), it is inevitable that the proposed components of the rail development options will be located in close proximity to residential areas and public housing estates. During the course of the SEA Study, concerns were raised regarding the potential environmental impacts to existing and planned housing developments. Of particular concern were the potential noise and air quality impacts. As highlighted elsewhere and discussed above, the majority of the proposed rail components are underground and this will very greatly reduce the potential for operational noise and air quality impacts. For those sections of alignment that are above ground, proven at-source mitigation measures exist for controlling noise to within the statutory criteria. As such, at a strategic level, it is not envisaged that there will be any insurmountable impacts to planned or existing housing developments from the implementation of the rail development options. Nevertheless, the detailed consideration of the impacts to housing developments will need to be undertaken by the project proponent at the EIA stage once the alignments are finalised. To ensure, as far as practicable, that the impacts to housing developments are avoided, it is considered prudent to maintain close communications with the Housing Department and to make regular reference to the Control List for Public Housing Site. It is therefore recommended that this objective is carried forward into the rail development process as part of the strategic EM&A system outlined in Chapter 9.

8.9 Strategic Bench-marking

8.9.1 The assessments of the cumulative impacts provides a strategic bench-mark for the sum of potential impacts from the currently assumed schemes; the information contained within the SEA should be used in the further development of the rail proposals and the actual impacts from each scheme assessed in more detail at the EIA stage once the alignments are finalised, with the aim of meeting, and preferably falling below this benchmark.

8.10 Environmental Performance Indicators

8.10.1 Environmental Performance Indicators (EPIs) were developed during the SEA study with the intention that they would be used as an evaluation technique during the later phases of the SEA study to assist in the selection of preferred rail schemes. However, this did not prove possible to the extent originally envisaged for the following reasons:

- the study did not develop any sufficiently different "alignment" options (eg different links serving the same locations or purpose) where it was considered that the EPIs could be used to differentiate between options;
- the networks being compared during phases 2 and 3 were predominantly underground and therefore were largely neutral in terms of their impact on noise, landscape, ecology, etc. The evaluation of relevant environmental impacts undertaken at the time indicated little discernible difference qualitatively or quantitatively in their environmental performance. Similarly, due to the better environmental performance of the proposed rail links in comparison to equitable road alternatives, all the proposed alignments were, from an environmental viewpoint, considered worthy of retention in the development options; and
- during stage 3 of the study, all the schemes were proposed to be taken forward and there was no need to identify schemes which should be retained, in particular, based on environmental considerations.

8.10.2 Nevertheless, as detailed in the preceding sections, the EPIs were used, where appropriate, to assist in the assessment of cumulative environmental impacts.

8.10.3 It is considered that the work done in developing the EPIs provides useful information and a mechanism that could be used in future rail related SEA projects. It is therefore recommended that the work undertaken in this area is retained with a view to developing and using it during future strategic studies.

8.10.4 The working paper on the EPIs is presented in Annex C of this Report.

8.11 Identification of an Environmentally Preferred Scheme

8.11.1 An objective of the SEA Study was to identify the environmentally preferred rail development option. This Section provides a brief summary of the environmental assessment work that has been undertaken and presented in the preceding chapters, and discusses whether an environmentally preferred rail development option can be identified.

8.11.2 Environmental assessments have been undertaken for each of the individual Component Schemes and Stand-alone schemes which make up the current urban and regional rail development options. The cumulative impacts of implementing the rail development options have also been addressed; including an evaluation of the potential air quality "benefits" that may be obtained from the implementation of the railway development options.

8.11.3 The component schemes within each of the railway development options are, with the exception of the FHC, virtually identical and there is therefore, in general, little to distinguish between the two rail development options. The majority of the component schemes in each of the railway development options are currently proposed to be constructed and operated predominantly underground. This factor very greatly reduces the potential environmental impact of each of the component schemes since the potentially affected environmental resources are largely located on the surface. The predicted impacts from the component schemes were therefore reduced substantially from similar above ground alternatives.

8.11.4 At this strategic study level, the purpose of the assessment was to identify whether there were any potential 'strategic' environmental implications that would make the scheme under consideration 'unattractive' from an environmental perspective or that would require particular attention if the scheme progressed.

8.11.5 In strategic terms, the assessments of the Component Schemes and Stand-alone schemes did not identify any impacts that were considered to have an insurmountable environmental impacts i.e. although potential environmental impacts were identified for each component scheme, it was considered that with appropriate attention during the design and development stages, the magnitude of such impacts could, in many cases be reduced, and that, particularly during the EIA stage, appropriate mitigation measures could be developed to ensure that the impacts were controlled to within the required statutory criteria. Further discussion regarding the means of carrying forward the required actions to address the identified impacts is contained within Chapter 9.

8.11.6 Due to the similarity between the rail development options and the predicted patronage forecasts, the review of the air quality benefits that may be accrued from implementing the schemes did not provide a clear means of distinguishing between the development options in terms of environmental performance. However, the review demonstrated that potentially greater air quality benefits could be gained from those development options which attracted the highest patronages.

8.11.7 As a result of proactive consideration of environmental aspects during the initial development of the options, neither the environmental assessment of the component schemes nor the investigation into the cumulative air quality benefits yielded a clear distinction between the rail development options. Consequently, each of the rail development options may be considered, in strategic terms, to be "environmentally sound" rather than one being 'environmentally preferred'.