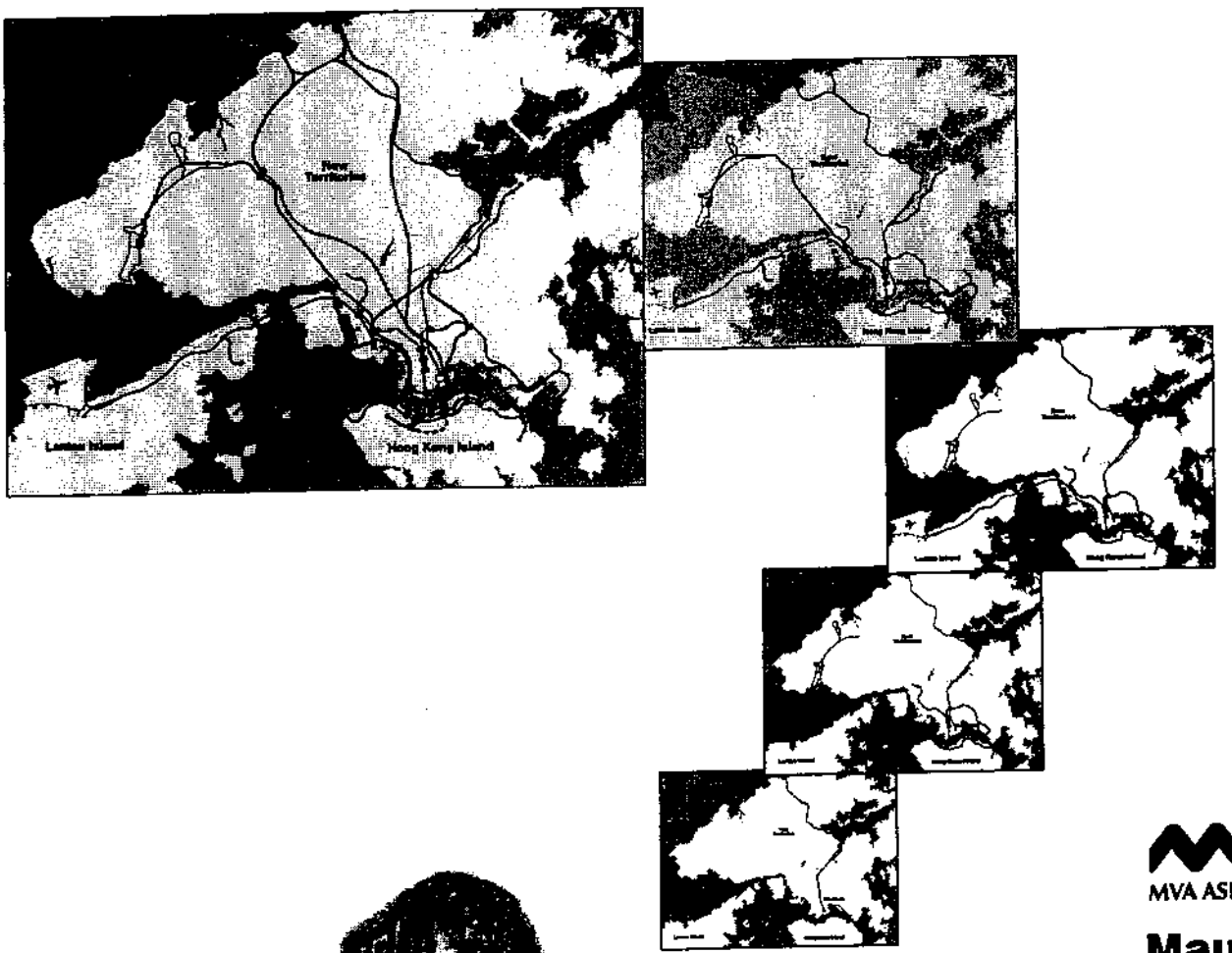
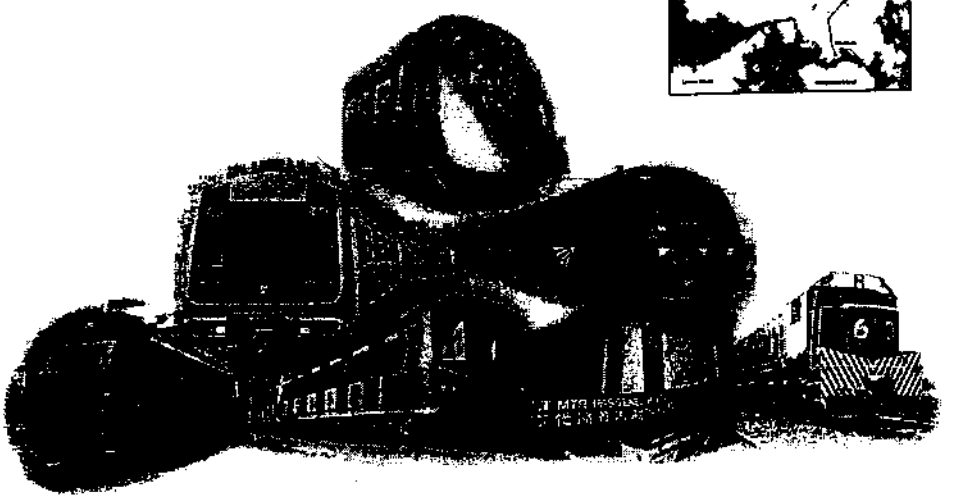
Annexe C

Environmental Performance Indicators Paper





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ANNEXE C ENVIRONMENTAL PERFORMANCE INDICATORS PAPER

1. INTRODUCTION

1.1 Background

1.1.1 MVA/Maunsell, in association with Environmental Resources Management (ERM) and others, have been commissioned on 30 March 1998 to undertake the Second Railway Development Strategy (RDS-2) under Government Agreement No. CE87/97.

1.1.2 The RDS-2 Study incorporates an integrated Strategic Environmental Assessment (SEA) component in parallel with other study elements that have as their focus the development of conceptual transport corridors and subsequently, preferred network and individual railway alignments to serve the future transport needs in Hong Kong. The future transport needs of Hong Kong are being developed under a two tiered system; a "Top-Down" approach which is addressing a range of possible planning, economic and development scenarios as well as a "Bottom-up" approach which is looking at existing capacity shortfalls and constraints and measures to relieve them. The development of the two approaches in parallel, combined with an integrated SEA component will provide a considered and robust future transport strategy for Hong Kong for the next 20 years.

1.1.3 The primary purpose of the SEA component is to integrate the consideration of environmental factors into the formulation of various railway development options and, through the application of strategic impact assessment, avoid, minimise and mitigate (in order of preference), potential environmental issues associated with the railway proposals and identify those options that are environmentally preferred. As well, the SEA team will providing background information and justification for the preferred railway development proposals and investigating the environmental attributes of railways in a more general sense over comparative transport modes.

1.1.4 The Environmental Performance Indicators (EPI) paper is the second deliverable of Phase II of the RDS-2 Study. The first phase developed a set of conceptual railway corridors under the Top-Down and Bottom-Up approaches. These were coarsely screened with reference to strategic environmental resources with the aim of immediately identifying those which were in conflict with those resources. The results were presented in the Initial Evaluation Report (IER) with a number of alignments being rejected outright on environmental grounds.

1.1.5 The second phase of RDS-2 has as its aim, the selection of a set of preferred railway corridors from the larger, conceptual set developed during the first phase. The preferred corridors will be selected on the basis of the application of detailed computer modelling of ridership under the agreed range of planning and development scenarios. Subsequent to this, the SEA Team will undertake an environmental appraisal of the preferred network options with the aim of identifying those which are preferred on environmental grounds. For other which are considered significantly environmentally difficult, an investigation of potential options and their environmental performance will be undertaken. The outcome of Phase II will be the documentation of a set of preferred network options with environmental justification for their development. These will be taken forward for further detailed assessment of engineering and environmental aspects in Phase III of RDS-2.

1.2 The Environmental Performance Indicators Paper

1.2.1 The Study Brief suggests a series of topics which should form the subject of Key Issues Papers to be submitted during the Study. The Study Brief suggests that one of these Papers addresses "environmental indicators, criteria and methodologies to be used for strategic evaluation and comparison of the development options considered in the Study". The Brief also suggests that, where appropriate, information from other SEA-type studies, such as CTS-3 and SUSDEV21, be harnessed in order to ensure a measure of consistency between SEA projects undertaken in the SAR.

1.2.2 The purpose of this Environmental Performance Indicators (EPI) Key Issues Paper is to develop environmental indicators, criteria and methodologies to be used for the strategic evaluation and comparison of the preferred development options arising from the Network Assessment task of the Main Study. This will be achieved through the application of constraint mapping and other information provided in the Baseline Report to proposed railway development options using the indicators to quantify the perceived level of impact to environmental resources. The EPI paper along with the baseline paper are thus key deliverables of the RDS-2 Study which need to be read in conjunction with each other to understand the manner in which environmental performance is to be measured.

1.2.3 The establishment of EPIs is a complex task given the wide ranging scope of the RDS-2 and it is therefore important that this task is undertaken at an appropriate level of detail. The overriding aim will be to select a set of indicators which represent complex issues using simple and practical means and which can be developed based on readily available data and calculation techniques. The consideration of indicators used in other strategic studies, first and foremost, will serve to ensure that this is achieved as well as ensuring a level of consistency between indicators used in the SAR.

1.2.4 Discussion Paper N1 - Development of an Evaluation Framework documented some early thoughts on how such an evaluation framework could be made up concerning both the environmental and main study evaluation elements. Suggestions in this paper and in the SEA Inception Report included "weighting" indicators to provide a measure of relative importance between environmental disciplines and methods of combining the indicators into a single "score" in order that comparison of alignments could be facilitated. However, in commenting upon the Discussion Paper, the EPD indicated that such an approach to the combination of indicators was not appropriate and that decisions would be taken by the ESMG on the overall evaluation of a particular network option based on the individual discipline specific scores for each option.

1.2.5 Whilst the adoption of an evaluation matrix of individual indicators provides a useful screening mechanism for strategic planning and assessment tasks, it would not be prudent to develop an over-reliance on the quantitative information thus generated. The relevant textural description must be used in parallel in assessing the information provided by the quantitative assessment tools.

1.2.6 Table 2.1 of the IER presents an agreed summary for the introduction of environmental disciplines pertinent to the phasing of the NDS studies. EPIs have been developed based on the baseline information presented as outlined in the table which is relevant to Phase II of the Study. It is also useful to note that the difference between Phases II and III of the Study, in terms of the environmental assessments to be facilitated by EPIs varies only slightly. Typically, those issues introduced in the final phase of works are to be treated at a commentary level and therefore, no indicator will be required with the possible exception of Land Contamination and Greenhouse Gas/Energy considerations. Comments related to these issues are contained within the relevant sections of this Paper.

1.3 Structure of the EPI Paper

1.3.1 An outline of the remainder of the paper is as follows:

- Section 2 of the report presents an overview of the international literature review conducted concerning SEA indicators; and
- Section 3 discusses the proposed objectives and methodology for proposed indicators for each environmental discipline to be used in RDS-2.

2. FINDINGS OF THE INTERNATIONAL LITERATURE REVIEW

2.1 Introduction

2.1.1 Strategic Environmental Assessment (SEA) is a term used to describe the environmental assessment process applicable to assessing the development and implementation of policies, plans and programmes. It is intended to complement the more conventional Environmental Impact Assessment (EIA) process which takes place at a later stage in the planning cycle and tends to focus on a particular project or scheme. At present, SEA is less widely understood and practised than EIA, although SEA studies and applications are increasing in number. The growth of interest in the use of strategic environmental assessment stems mainly from:

- an increasing recognition of the limitations of the traditional environmental impact assessment process when confined to the relatively late stage of the planning process; and
- increasing support for measures to promote sustainable development which require the early and transparent integration of environmental assessment techniques into development planning.

2.1.2 SEA is a relatively new tool in its application to Hong Kong. As stated in the SEA Inception Report, it would therefore be useful to look at indicators used in other developed countries as well as Hong Kong in order to harness the work done elsewhere and consider its applicability to the local situation. Section 3.2 provides an overview of the international literature review conducted while Section 2.3 focuses on recent SEA work performed in Hong Kong.

2.2 Trans-European Transport Network

2.2.1 The work undertaken in Europe under this policy directive is considered particularly relevant to RDS-2 because of the close relationship to one of the study aims, that of achieving a sustainable transport strategy.

2.2.2 The policy framework for the development of the Trans-European Transport Network (TETN) consisted of a series of five tiers, each of which was subject to an SEA type review to ensure that the environmental objectives at each level were consistent with the main objective.

2.2.3 A number of guiding principles were developed under this objective in order that indicators could be developed for specific aims. The principles were grouped into the following categories:

- global issues;
- natural resources; and
- community issues

2.2.4 The aims within these principles and the indicators developed are shown in Table 2.1.

Table 2.1 Indicators used for TETN SEA

Principle	Aim	Indicator
Global Issues		
Climate change	minimise emission of GHG	Quantity of CO2 emitted
Acidification	no exceedance of critical acidification loads and levels	Quantity of NOx and SOx emitted
Energy Use	maximise energy efficiency	power consumption in MJ, equivalent tonnes oil or MkWh
Natural Resources		
Nature and Biodiversity	minimise loss of damage to habitats and species	types of habitat effected and associated landtake and number of designated sites effected and associated landtake
Water Quality	minimise pollution of fresh and marine surface waters and groundwater	primarily, the proximity to sensitive receivers, secondly, volume of oxygen demanding waste and number of receivers and areas effected
Community Issues		
Noise	no person should be exposed to noise levels which endanger health and quality of life	population effected within noise contours expressed in LAeq
Air Quality	all people should be protected against recognised health risks from air pollution	quantity of CO, NOx and particulates emitted as well as the number of properties or population within 500m of each potential TETN proposal
Landscape	minimise negative landscape impacts	landtake of designated landscape areas
Built Environment	minimise impacts on the built environment	number of designated buildings and landtake from conservation areas

2.2.5 A further feature of the TETN was consideration of the use of cost-benefit analysis to compare different development options but this was rejected at the time due to the lack of robust monetary values for environmental impacts. It was proposed that the SEA for TETN should use an objective-led Multi-Criteria Analysis to rank projects.

2.3 Sweden

2.3.1 The impact assessment report for The Stomnätsplan (The Trunk Network Plan of Railways) addressed only the potential impacts associated with atmospheric emissions, noise and 'valuable' areas. Indicators used for the assessment of air quality were based on an emissions inventory for CO_2, NO_x, HC and CO. The emissions were presented separately for cars, aircraft, trucks and buses.

2.3.2 The indicator used for noise was the change in the number of people disturbed by noise (including vibration) and was crudely estimated as shown in Table 2.2.

Table 2.2 Noise Indicators

	Per km of Relocated Track	Per km of Improved Track
Settlement with detached houses	Less than 100 disturbed people	Less than 80 disturbed people
Settlement with semi-detached houses or blocks of flats	Less than 500 disturbed people	Less than 400 disturbed people

2.3.3 The indicator for 'valuable area' was similarly crude, identified by whether or not a railway line crossed, touched or was tangent to any 'valuable area'.

2.3.4 The Gothenburg to Jonkoping transport link study involved an environmental impact assessment at a strategic level of transport infrastructure planning and was aimed at developing a preferred transport proposal from seven alternative combinations of road and railway transport links as well as a "do nothing" alternative. An economic analyses for the road safety aspects was also included.

2.3.5 The Study drew upon national and regional environmental objectives as a starting point for developing environmental goals for the transport link. The various transport proposals were then assessed as to the extent to which they achieved or contributed to the fulfilment of these environmental goals.

2.3.6 The environmental goals comprised the following:

- cultural, historical and ecological considerations;
- landscape and the built environment;
- fossil energy dependence; and
- climatic impact.

2.3.7 The Study concluded that whilst none of the alternatives studies could be regarded as being entirely compatible with the set environmental goals, only the "do nothing" option, a railway proposal and a the railway proposal coupled with a minimal upgrading of certain sections of the existing road offered a positive contribution to the environmental goals for the transport link.

2.4 Germany

2.4.1 The Bundesverkehrwegeplan 1992 (BVWP 92) is a multi-modal plan covering road, rail and waterways in Germany. All proposed major development projects relating to transport infrastructure are subject to a uniform assessment according to the following criteria:

- overall economic impact (Cost-Benefit Analysis);
- ecological (environmental) effect;
- town-planning (federal trunk roads only); and
- others.

2.4.2 The emissions of air pollutants are used as indicators of health effects, and of impacts to vegetation and buildings. The total emissions of different pollutants are derived from estimated total fuel consumption and converted into CO-equivalents using toxicity factors. These equivalent emissions are then multiplied by coefficients which express the cost per tonne of damage.

2.4.3 A benefit from a reduction of noise levels is considered if a certain noise threshold value is exceeded in the absence of project implementation and if the difference in noise between the 'with' and 'without' case exceeds 2 dBA. The economic analysis of noise impacts is based upon a consideration of the number of people affected and the level of noise these people are exposed to, taking into account the cost for providing indirect noise mitigation measures.

2.4.4 Ecological risk analysis is carried out in preference to an economic analysis of ecological impacts. Current research does not permit the analysis of the costs or savings that result from ecological impacts.

2.5 France

2.5.1 The study "Intermodal proposals for the A7-A9 route in the year 2010" appraised measures to alleviate congestion on the A7-A9 route. Three types of measures were evaluated: road construction, measures other than road construction (coach and rail transport, combined transport and rail motorway) and traffic operation measures.

2.5.2 The SEA was subsequently applied to the following three transport scenarios, and analysed their effects on water protection, air pollution and safety:

- a comparison between a motorway and a rail motorway;
- new motorway links; and
- a comparison of road, rail and waterway options.

2.5.3 The SEA considered impacts on geology, meteorology, flooding, water catchments, national parks, nature reserves, biotopes, listed sites, state forests, urban and industrial areas and agriculture. Indicators used were the cost of water protection, safety provision and air pollution associated with the various modal options. Constraint mapping in relation to impacts was also used.

2.6 Finland

2.6.1 An example of SEA conducted in Finland is the Valtatieverkon kehittämissuunnitelma 2010 (Main Road Network Development Plan, hereafter VKS 2010) which included assessment of the following:

- impacts on transport mode selection;
- economic and regional effects;
- impacts on noise zones;
- fuel use and air pollution; and
- impacts on nature.

2.6.2 Indicators used to describe impacts on air pollution were emissions of CO, HC and NO_x, and fuel consumption. Changes of concentrations of air pollutants were not estimated in the study.

2.6.3 The noise impact assessment for VKS 2010 used the A-weighted day-time equivalent sound level as the basis for the analysis. The primary indicator used was the total area in which the noise level exceeded a threshold value.

2.7 The Netherlands

2.7.1 The purpose of the Second Transport Structure Plan (STSP) and its SEA was to organise transport in the Netherlands in a way which minimises energy consumption, landtake and impacts on air quality. Specific indicators which were developed in the STSP are:

- percentage change in emissions of HCs, NO_x and CO_2;
- change in facade noise, in terms of dB(A);
- percentage change in road accident fatalities and injuries;
- change in fragmentation of countryside relative to 1990; and
- change in relation to objective of zero reduction in safety for transport of hazardous material relative to 1990.

2.8 Denmark

2.8.1 The main purpose of Traffic 2005 is to provide an overview of the effects of transport policy and to stimulate debate. The policies proposed under Traffic 2005 were evaluated in terms of the extent to which they:

- influenced the volume and distribution of traffic;
- promoted alternatives to car transport; and
- curbed environmental problems.

2.8.2 The plan also entails specific targets against which the performance of particular policies can be evaluated. The indicators used were:

- total emissions of CO_2, NO_x, HC and particulates;
- percentage reduction in road accidents;
- percentage of the population exposed to noise over 65 dB(A); and
- land-take of areas of nature or landscape interest.

2.9 United Kingdom

2.9.1 The South Pennines Transport Needs Study SEA (the Pennines are a mountain range in the northern-midlands of England of recognised scenic and visual quality) was undertaken to compare the potential environmental effects of five transport strategy options which included road and rail options based on desktop study. The effects of traffic on the community were considered through the potential impacts on people arising from deterioration or improvement in visual amenity, noise vibration impacts and air quality. The environmental assessment also established six key categories or elements on which the existing or improved road and rail infrastructure and associated traffic could have an effect. These were:

- land use and vegetation of significant value;
- landscape quality and character including statutory designations;
- visual factors e.g. landscape of special scenic quality, landscape features of particular significance, etc.
- the built environment;
- cultural heritage; and
- sites of nature conservation interest based on a hierarchy of statutory designations.

2.9.2 The assessment of effects considered direct physical effects on identified features within the landscape such as new structures, indirect effects of traffic on visual amenity, landscape quality and character and the general landscape setting particularly in relation to cultural heritage sites and the effects of traffic on air quality, vibration and noise levels on communities and people.

2.10 Hong Kong Experience

2.10.1 SEA is new to Hong Kong and the number and scope of studies to which it has been applied are limited and diverse. Examples of previous SEAs which may be relevant to RDS-2 are:

- Territorial Strategy Development Review (TDSR);
- Sustainable Development for the 21st Century (SUSDEV 21); and
- The Third Comprehensive Transport Strategy (CTS-3).

2.10.2 A fourth recently released study, "Heading Towards Sustainability?, Practical Indicators of Environmental Sustainability for Hong Kong" is also reviewed.

2.10.3 The CTS-3 study was commissioned in August 1997. The primary purpose of the Study is to assess future transport needs and to provide the broad parameters for the development of our transport infrastructure and policies for the next 20 years. As part of the Study, the projects and policies of CTS-3 will be subject to a Strategic Environmental Assessment which includes air quality and noise assessments as well as ecological appraisal.

2.10.4 The SUSDEV 21 study commissioned by Planning Department is undoubtedly the most detailed and all-encompassing of the SEA listed, however, the aims of the Study and hence its focus, are considered too wide ranging and diverse to be of direct benefit to the RDS team. As an example, the SUSDEV indicators span a range of principles including:

- economy;
- health;
- natural resources;
- environmental quality (including GHG);
- society and social infrastructure; and
- leisure and cultural vibrancy.

2.10.5 Economic issues for SUSDEV 21 focused on aspects such as the expected impacts on the prosperity of the economy, the impact on intra-generational equity, the sustainability of any improvements in prosperity and the efficiency of economic resource use and the impact on incentives. Indicators used to measure performance were cost-benefit analysis (CBA), percentage change in income less income tax for the upper quartile household, gross domestic fixed capital formation and expenditure on education respectively. For leisure and cultural vibrancy, indicators were based on such items as:

- number of recorded archaeology sites;
- number of recorded cultural and historical sites;
- percentage of population living within districts with a shortfall of open space/recreational facilities; and
- annual urbtix sales

2.10.6 Those principles that appear most relevant to RDS-2 from the above include natural resources and environmental quality, however, even within these there is a wide range of indicators proposed. For example, the indicators for natural resources include:

- consumption of energy per unit of output ($ GDP);
- quantity of municipal solid waste and construction waste requiring final disposal per capita;
- the total remaining landfill capacity;
- volume of freshwater supplied per capita;
- percentage of demand met by locally derived freshwater sources; and
- area of countryside.

2.10.7 Hence, while the SUSDEV Study has developed a detailed and considered approach to indicators, the broad ranging nature of the Study and its aims prevent the indicators proposed from being directly applicable to RDS-2.

2.10.8 Objectives, criteria and performance measures were developed under TDSR (Planning Department) in two streams for the initial and hybrid development options under consideration. The primary difference between the two was the degree of detail in the indicator calculation which, presumably also, was made possible by the level of available information on each option.

2.10.9 For example for air quality, the measurement of performance under the initial options was addressed under 5 broad indicators whereas under the Hybrid options evaluation, it was further split into 13 indicators. This is in fact similar to the approach adopted in the SEA Initial Evaluation Report where a coarse screening was applied to strategic environmental resources. In the evaluation performed at that stage, indicators produced either a "hit" or "miss" result which reflected the physical conflict or otherwise with these resources.

2.10.10 TSDR indicators were developed to address the issues of air quality, noise, water quality, ecology, potentially hazardous installations (risk) and waste. Table 2.3 shows the TDSR indicators which are considered most relevant to the RDS-2 Study.

Table 2.3 Indicators used in TDSR with Potential Applicability to RDS-2

Objective	Criteria	Measurement
Noise Pollution		
To minimise or reduce noise impacts from major transport corridors and industrial sources	To minimise the impact of freight rail traffic	Direct interface with residential areas
		Estimated volume of rolling stock
	Reduce noise impact of major road links	Direct interface with residential areas
		Interface with other sensitive receptors
		Estimated noise levels (dB(A))
Hazardous Installations		
To minimise the risk to the population at large from hazardous installations	To ensure protection of the population in the vicinity of PHIs	Hectares of new development within the PHI consultation zone
		Kilometres of new road passing through PHI Consultation Zones
Ecology		
To maximise the opportunity for conservation of ecologically important areas	The extent of distinct plant and animal communities that may be adversely affected by proposed developments	Length of interface with ecologically significant sites (statutory and non-statutory protection)
		Extent of wetland depletion
		Extent of coastal landform modification
		Volumes of dredged contaminated spoil requiring off-site disposal

2.10.11 A recently released study from the University of Hong Kong entitled "Heading Towards Sustainability? Practical Indicators of Environmental Sustainability for Hong Kong" is also considered beneficial to review. The primary difference between this study and SUSDEV21 is that for the latter, the indicators are being developed to assist existing policy and appraisal tools and are focused on providing institutional responses to sustainability concerns.

2.10.12 The indicators used by the University of Hong Kong team are shown in Table 2.4 below.

Table 2.4 Indicators for Environmental Sustainability*

Air Quality Average annual concentration of RSP for urban area as a ratio of the AQO for RSP Average annual concentration of NO_2 for urban areas as a ratio of the AQO for NO_2 Average of the four highest 1-hr maximum annual concentrations of Ozone for urban areas as a ratio of the AQO for O_3 Total annual emissions of CO_2 as a ratio of 1990 total CO_2 emissions
Marine Waters Quality Average annual concentration of E.Coli at all bathing beaches as a ratio to the WQO Average annual concentration of total inorganic nitrogen in the marine water as a ratio to the minimal threshold level for eutrophication
Solid Waste Annual non-hazardous municipal, construction and demolition waste arisings as a ratio to the total remaining capacity of available disposal facilities

* Heading Towards Sustainability - Practical Indicators of Environmental Sustainability for Hong Kong, HKU, January 1999.

2.11 Conclusion

2.11.1 The studies reviewed internationally and locally show a wide variety in the scope and content of the indicators used, typically reflecting a focus on particular environmental issues which are appropriate to the SEA application. For example, it is clear from the European examples that air quality in relation to transport infrastructure proposals is considered a key issue. Road and rail traffic noise and particularly, its effect on resident population, is also a key issue although, methods of adjudging performance in this category vary.

2.11.2 In Hong Kong, where there has been a limited number of SEA projects undertaken, there is also diversity in the indicators which have been used which again, reflects a different goal or purpose for which the indicators have been developed.

2.11.3 SUSDEV21's indicators are intended to be predictive and are wide ranging to account for the wide variety of projects to which they may need to be applied. Applications might include the development of a new residential, commercial or industrial facility, a transport link, a new airport, a reclamation, a new theme park, power station, etc. Those of the HKU Study differ from the others as they were primarily designed to "track" the environmental effects addressed.

2.11.4 In principle, TDSR and CTS-3 indicators are broadly considered most applicable to the SEA Study as these are applied at a SAR territory-wide level scale and yet provide for the specific application to the new developments. Similar to RDS-2, these studies and the indicators developed were geographical in nature, although neither either in part or in combination provide the coverage of environmental disciplines to be addressed by RDS-2.

2.11.5 In developing suitable indicators for use in RDS-2, the overriding principle being adhered to is to generate information which is appropriate to the level of decision making being undertaken. Specifically, the indicators aim to identify potential risks and opportunities which can either be addressed at the strategic level or be the subject of more detailed assessment at a later stage in the environmental process.

2.11.6 In developing appropriate indicators for RDS-2, use has been made of previous studies undertaken in Hong Kong with emphasis added to the issues of most relevance to railway development as well as those issues which have been identified as particular concerns resulting from discussions and comments from the ESMC and on previous reports.

2.11.7 It is considered that the application of the methodology and component indicators set out in this report will enable judgements to be made as to which of the rail proposals performs best in environmental terms and to enable potential areas of risk and opportunity to be identified.

3. DEVELOPMENT OF ENVIRONMENTAL PERFORMANCE INDICES

3.1 Introduction

3.1.1 This section draws on the information presented in Section 2 of the report to develops a set of objectives and environmental performance indicators for the environmental issues provided in Table 2.1 of the IER. Where relevant, preference has been given to the use of indicators developed for application in previous studies; where this is not appropriate, indicators have been developed for specific application within the SEA of RDS-2.

3.1.2 In the development of environmental performance indices, the following environmental resources, media and topics have been addressed:

- operational noise;
- ecology;
- hazard; and
- heritage and cultural.

3.1.3 Each of these is discussed separately below.

3.1.4 For the remaining disciplines e.g. air quality, landscape and visual, greenhouse gas/energy, land contamination, etc. explanation is given as to how these issues are being dealt with within the context of RDS-2.

3.2 Air Quality

3.2.1 The IER makes clear the rationale upon which construction air quality issues have been ruled out of being strategically relevant to the development of new railways. Indeed, the experience presented in Section 2 of the report also bears this point out.

3.2.2 Railway EIA assessments undertaken in Hong Kong have traditionally concluded that operational air quality emissions in terms of pollutants within the remit of the Hong Kong Air Quality Objectives are not a significant issue.

3.2.3 Within RDS-2 however, air quality emissions from railways are being considered in a much wider context. The prime objective of the work being conducted is to allow the comparison of railway network proposals to be conceptually compared against those which would be generated by road vehicles assuming the same number of passengers were to be transported. This separate study will focus on NOx and RSP emissions arising from the rail and road sources as a means of justification of the new network proposals. The results of this study will be contained within the Network Options Evaluation Paper of the SEA.

3.2.4 Another area of interest for decision makers is the comparative performance of railways (against other forms of transportation) in terms of greenhouse gas/energy considerations. Development of objectives, criteria and indicators for operational air quality will therefore be considered within the discussion presented in Section 3.10 on GHG/energy issues.

3.3 Operational Noise

3.3.1 General

3.3.2 The primary noise performance indicators used in both the international and local studies are:

- Numbers of population affected by a threshold noise level;
- Linear length of railway/sensitive receiver interface; and
- Estimated noise levels.

3.3.3 Environment 1997 (EPD, 1997) states that some 120,000 persons were estimated to be affected by operational railway noise. However, following studies to find effective and practical methods of reducing operational railway noise, both MTRC and KCRC have embarked on programmes to bring about relief to the effected population. KCRC are somewhat more effected as a result of the majority of their infrastructure being built at grade and, under a programme commenced in 1993, are committed to providing enclosures at 27 locations within ten years which will bring relief to approximately 100,000 people. Combined with MTRC's own efforts, this is expected to provide relief to the vast majority of the population currently effected by railway noise.

3.3.4 Consideration of the NCO in Hong Kong as it applies to railways indicates that the NCO adequately controls the generation of operational noise in exactly the manner in which performance is typically measured. Under the NCO, railways are subject to a stringent, absolute limit on operating noise. The predicted noise levels from proposed railways must therefore be mitigated to meet this standard, else the development cannot proceed. This absolute noise threshold therefore also forms a proxy for a deemed level of 'acceptable' noise; thus, as long as a railway meets the NCO noise criterion, there are not considered to be noise impacts on nearby population.

3.3.5 It has been discussed above, that for a strategic assessment, the use of traditional indicators to measure performance for operational railway noise is inappropriate because of the level and method of control provided by governing Ordinances. A related issue, however, arising from discussions at the Second Environmental Study Management Group (ESMG) meeting, is the investigation of the marginal cost of providing an alignment underground as a maximum form of noise mitigation in comparison to the benefit of making available the above ground area which the alignment would have occupied for residential developments. The examination and quantification of this issue is understood to be the focus of the RDS work.

3.3.6 The provisions of the NCO set out noise threshold limits based on an Area Sensitivity Rating (ASR) which reflects, among other things, the type of environment through which the new railway will pass and broadly takes account of the likely level of ambient noise. A new railway development is required to meet the noise criterion which is applicable to the existing noise condition (taking into account committed future developments), although, in under developed areas, this may in ten years or so time, leave areas 'sterilised' by levels of noise in excess of the noise criterion which has changed as a result of additional development. In a worst case situation, a greenfield site interfacing with the boundary of a new railway may be replaced in 20 years by a tall, high density development which overlooks the railway alignment. Unless this situation could be

preconceived at the time of the railway design, this may place the operator in an untenable situation whereby areas of land required for the necessary mitigation are unobtainable.

3.3.7 Among the issues to be considered are the "fairness" of the retroactively application of the NCO in this regard and the need of the operator to take such changes into account at an early stage.

3.3.8 The SEA Team propose a proactive approach to these challenging questions whereby the predicted noise level information resulting from the railway proposals will be presented in the form of indicative noise contours and overlaid onto the baseline maps which indicate assumed development scenarios for future years. In comparing the baseline information (absolute noise threshold derived from ASR rating) with the predicted noise levels, it will be possible to determine the extent and cost of noise mitigation to meet this criteria and also, the marginal cost of providing the ultimate operational noise solution in the context of the land which would thus be made available for development. This information could then be used to advance discussions amongst the ESMG on the tradeoffs between the community benefits and financial implications of the full spectrum of noise mitigation scenarios.

3.3.9 It should be noted that the predicted noise contour information will depend upon guidance as to the expected rolling stock type, grade, speed profile, etc. being available - this implies a level of advancement of the engineering aspect of the Main Study which may be inconsistent with the Network Options Evaluation phase of RDS. However, it is believed that the issue at the core of these discussions is not one which will affect the selection of preferred options (vertical elevation is an alignment issue which will be progressed during Phase III of RDS) and therefore, the later submission and discussion of these aspects is not considered to be a hindrance to the overall progression of the Study.

Objective: To investigate and present information on the tradeoff between potential benefits (in terms of land availability) and financial costs arising from a range of operational noise mitigation scenarios and whether strategic intervention into the issue is justified.

Indicator: Predicted noise contours will be prepared (based on the timely arising of engineering information) to indicate the compatibility between available noise mitigation solutions and available land area for development adjacent to the railway alignment (ha). Cost estimates would be prepared as necessary to demonstrate the magnitude of the differences involved.

3.4 Water Quality

3.4.1 Water quality considerations will only be pertinent in relation to the specific implications arising from reclamation necessary to accommodate new railway developments. No reclamation proposals have been identified to date so it is proposed to keep this indicator in reserve until specific information becomes available. Volume of dredged contaminated material requiring off-site disposal is being addressed under ecology.

Objective: Not applicable

Indicator: None required at this stage; however this will be kept under review by the SEA Team as specific information on proposals becomes available.

3.5 Ecology

3.5.1 General

In developing suitable indicators for ecological impacts, the SEA assessment conducted for TDSR in 1992 acknowledged that there remained many aspects of the terrestrial and marine ecology of Hong Kong which were poorly understood and therefore, the opportunity for the formulation of appropriate objectives and indicators which adequately described the complex chain of biological and ecological relationships was limited. TDSR concluded that the only realistic performance measures were those that enabled the extent and proximity of a development to sensitive receivers to be quantified and those which permitted a direct measure of habitat loss.

Those promulgated in the TDSR assessment of hybrid options were:

- The length of interface with ecologically sensitive sites;
- Extent of wetland depletion;
- Extent of coastal landform modification; and
- Volume of dredged material requiring off-site disposal.

One of the primary measures of judging the ecological impact of new railway proposals will be the permanent area lost to new railways. Given that railways are constrained in a vertical sense by their ability to negotiate grade conditions, potential new alignments would generally be located in flatter areas such as flood plains, foothills and valley floors, although tunnelling may be an acceptable solution and often with less environmental impact. In ecological terms, this generally translates into potential impacts upon flora and fauna which occupy these areas which may include mangrove stands, mud flat, agricultural land, wetlands, fishponds and similar habitat. Indicators are therefore proposed which provide a quantitative measure of the total area which will be lost to the new proposals, stated both as an absolute amount which will be used to "cost" any ecological compensatory proposals as well as in a "loss ratio" figure which will indicate the percentage loss based on existing baseline conditions. The World Wide Fund for Nature (WWF) SAR vegetation map (amended as necessary during application through field surveys) will be used as the most up to date reference (1992) of the existing baseline conditions.

The dredging and disposal of marine muds is also considered an important issue which may potentially impact upon marine ecological resources. Whilst there are only a limited number of immersed tube crossings proposed under RDS-2, the proposed locations suggests that contaminated muds will be an issue and therefore important to be included within the evaluation process. The indicators proposed for ecology are outlined below.

Objectives: To maximise the opportunity for conservation of ecologically important areas through minimising their loss and to identify onsite opportunities to reprovide for that element which is considered most vulnerable or sensitive to loss.

To estimate for information purposes, the likely quantity of contaminated muds arising as a result of dredging for immersed tube proposals.

Indicators:

- Areal extent of permanently lost habitat (disaggregated for individual habitat types) resulting from development proposal (ha);
- Areal extent of permanent lost habitat (i.e. wetland, fishponds, floodplain, etc. categories as defined by WWF) as a percentage of remaining resource in Hong Kong;
- Linear extent of permanently lost natural coastline;
- Identified area of compensatory habitat within railway scheme (ha); and
- Estimated volume of dredged mud for immersed tube proposals.

3.6 Hazards

3.6.1 The primary issue of concern from a risk perspective is the development of stations and alignments in the vicinity of Potentially Hazardous Installations (PHIs) or other potential sources of hazard such as Dangerous Goods (DG) road transport routes and high pressure gas pipelines. For PHIs, a Consultation Zone (CZ) is defined and this will be used as the basis for assessing encroachment impacts. For other sources of hazard the proxy guidance provided in the Baseline Paper will be applied.

3.6.2 The indicators proposed to be used in RDS-2 are therefore as follows:

Objective: Minimise the risk to population from potential sources of hazard

Indicators:

- Number of stations within the CZ of PHIs (or proxy guidance for other sources of hazard) (No.); and
- Length of above-ground track within the CZ of PHIs (or proxy guidance for other sources of hazard) (m).

3.6.3 It is noted that the development of railways (as opposed to roads) offers generally improved levels of safety for the travelling public. There may also be safety benefits in terms of DG transport by rail (as opposed to road) and reduced risk from external sources of hazard such as PHIs. These wider issues will be examined in greater detail in Key Issues Report No 2.

3.7 Landscape and Visual

3.7.1 Indicators for areas considered to be of landscape and visual value are inherently difficult given the subjective nature of the medium and the limited existing information. For the SUSDEV study and following lengthy discussion and deliberation, it was agreed that an assessment commentary on these aspects was sufficient to ensure that potential issues were highlighted for future consideration and action.

3.7.2 Areas of landscape and visual value have already been identified to some extent by the SEA where these correspond with existing ecological resources e.g. country parks, SSSIs, etc. A limited amount of additional information on areas considered of "high" landscape and visual value has also been obtained from the ongoing NENT Planning Study and the Sheung Shui to Lok Ma Chau Feasibility Study.

3.7.3 Given the subjective nature of the subject and the limited existing information, it is considered prudent that an approach similar to SUSDEV is adopted with the focus of commentary on those issues identified as primary causes of impacts combined with, where possible, estimation of losses to areas considered of high value from existing information. Those features which are considered to constitute visual impacts in the context of railways are the structural elements which carry the railway e.g. viaducts, embankments, cuttings, etc. their inherent slope features and station and related structures.

Objective: To provide an assessment of potential impacts to landscape and visual resources focusing on the built environment which will parallel other elements of the assessment process

Indicator: Textural commentary will be provided with, where possible, estimates of loss of areas considered of high landscape and visual value from existing information caused by railway development.

3.8 Heritage and Cultural

3.8.1 As of August 1998, there were 67 sites which have been designated as declared monuments by the Antiquities and Monuments Office (AMO). These sites are statutorily protected, and in the context of strategic value, will be considered absolute constraints to the development of future railways. Deemed monuments are other sites of recognised cultural value which have the potential to be upgraded to statutory status.

3.8.2 In addition to cultural heritage resources which have been designated, a wide range of sites of cultural heritage have been identified and recorded by the AMO. Consideration of cross-media issues such as heritage/visual impacts and heritage/ecological impacts may also be significant in the context of these resources although this can only be appropriately addressed through textural commentary.

Objective: To maximise the potential for conservation of sites of heritage and cultural importance and to consider, as appropriate, other related cross-media issues.

Indicator:

- Number of sites of cultural heritage within landtake required for the railway (No) ; and
- Closest proximity of railway to the resource (m)

3.9 Waste

3.9.1 Issues regarding the management of solid waste are generally not considered significant nor of strategic importance to the development of new railways. Therefore, an indicator is not proposed. The disposal of dredged contaminated mud is being addressed under the heading of marine ecology.

Objective: Not applicable

Indicator: None proposed

3.10 Greenhouse Gas

3.10.1 Climate change is being considered by many countries as one of the guiding principles of SEA as evidenced from the literature review contained in Section 2. The Hong Kong Government has been compiling its GHG annual inventory since 1992. Hong Kong is similar to other developed countries where emissions of CO_2 arising directly from the combustion of fossil fuels constitutes approximately 90% of the national inventory. As with the other countries reviewed in Section 2, therefore, it is considered appropriate to limit the determination of GHG emissions for railways to that of CO_2.

3.10.2 The investigation of the contribution of railways is being considered in RDS-2 to provide information to decision makers on the environmental performance of railways over competing modes as a means of environmental justification as required in the Brief. Additionally, GHG considerations will be included among indicators of performance, in order that any disparity in the performance of network options can be identified.

3.10.3 Assuming that similar rolling stock will be used and that alignment options are likely to be of the same length, there are two fundamental influences on the GHG emission calculations:

- differences in vertical alignment between the two options e.g. at grade vs below grade; and
- differences in numbers of stations between two points.

3.10.4 Where alignment options do not involve differences in these essential elements, it is assumed that within the accuracy of the estimates being provided, the performance of the options will be similar.

3.10.5 To perform the GHG emission calculations, vehicle-kilometres travelled (VKT) data will be obtained from the RDS-2 traffic model. Emission factors will be calculated (where not already available) from fuel consumption figures on the basis of fuel content and other simplifying assumptions on the vehicle fleet mix.

3.10.6 As RDS-2 is assessing a particular subsection of the economy that may contribute to climate change e.g. railway under the transport sector instead of Territory-wide GHG emissions, an indicator expressed in the form of total CO2 emissions (tonnes per year) is considered appropriate. This is also consistent with the SUSDEV Study.

Objective: To provide information to indicate the likely GHG (CO_2) emissions arising from the development of preferred transport corridors and alternatives to these where these are likely to differ.

Indicator: CO2 emissions (tonnes/year) for each preferred transport corridor.

3.11 Fisheries

3.11.1 Fish culture zones were mapped and an initial environmental screening of new railway proposals was conducted for the Initial Evaluation Report (IER). As fish culture zones are considered absolute constraints to new railway developments, their avoidance was crucial to the initial acceptance of railway proposals for further evaluation and investigation. The IER revealed no potential impacts to identified fish culture zones and therefore it is no longer considered necessary to develop an indicator for them.

Objective: Not applicable

Indicator: None proposed

3.12 Land Contamination

3.12.1 Contaminated land issues are primarily linked to the specific nature of the historical landuse of a particular site and railways, in common with other means of transport infrastructure, by virtue of their long, linear nature have a high likelihood of contacting some of these areas. Under the EIAO TM, potential land contamination impacts can result from a range of historical site activities and use of hazardous substances including wrecking yards, open or container storage, oil depots, etc. Potential impacts are highest during the construction phase where construction workers may come into direct contact with contaminated material, although during operation, there is generally a low likelihood of impact given the separation of receivers from the contamination source.

3.12.2 Apart from a few notable and obvious examples such as the Kai Tak Airport Apron, former landfills, etc., there is a paucity of information available regarding the location and extent of potentially contaminated areas in Hong Kong. The information is also very difficult to compile as there are a number of Government Departments with responsibility for the issue including EPD, PlanD, FSD and LDC for example.

3.12.3 It should also be clear from the above discussion that the vast majority of potentially contaminated sites are extremely localised in nature and include areas of registered chemicals storage, petrol stations, other flammable or hazardous substances storage facilities, etc. In a strategic sense, therefore, apart from the more notable examples, these are not considered a significant constraint on the development of a new railway.

3.12.4 The proposed indicator for land contamination is therefore very simple to identify and that proposed for use in RDS-2, where possible, is presented below.

Objective: To identify major areas of potential with respect to major land contamination concerns in order to minimise impacts to workers, other sensitive receivers and to the disposal and management facilities available to accommodate contaminated material.

Indicator: None proposed; commentary will provided with respect to major areas of known contaminated land within the landtake proposed for a railway development (ha).

4. CONCLUSIONS

4.1 This Environmental Performance Indicators Key Issues Paper has reviewed available international experience in the formation and development of indicators pertinent to environmental issues. In addition, other Hong Kong Strategic Studies have been considered in order that relevant local experience is utilised where appropriate.

4.2 The development of indicators for RDS-2 draws on discussions and approaches presented in the Initial Evaluation Report and the information provided in the Baseline Paper of the SEA. It is therefore essential that this document is read in conjunction with these others in order that the background to these proposals is fully understood.

4.3 Whilst the indicators presented in this paper have been developed for the primary purpose of evaluating the performance of discrete railway proposals, it is also acknowledged that they may be used to compare alternatives to these proposals where these are subsequently identified. In this instance, mathematical techniques to "streamline" the indicator results may be necessary in order that the comparison of impacts to particular resources may be clearly understood.