Good Practice Guidelines
Environmental Management of Transport Projects

June 2007
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1. Introduction

1.1 Background

The World Bank (the Bank) supports numerous road projects each year and has prepared a report on transport projects and the environment “Roads and the Environment” Handbook in 1997 (the Handbook). The objective of this Handbook is to provide practical methods that are useful in designing and executing effective environmental assessments / environmental impact assessment (EAs / EIAs) to those who are involved in various aspects of road projects, from planning to construction to maintenance”. Further to this Handbook, The Bank has also identified the need to develop supplemental practical guidelines on good practices for the construction of road transport projects, particularly for locations where environmental monitoring and audit may be limited. The Bank has commissioned Atkins China Ltd to prepare a these supplemental guidelines, which broadly describe typical good working practices and measures that can be implemented during the construction of transport projects to reduce environmental impacts and to help better protect the environment.

1.2 Good practices defined?

The term “good working practices” is a general term and within this report relate specifically to working practices during construction to reduce or avoid environmental impacts. Although some measures are suggested in this report, these are general in nature and need to be considered on a project by project basis considering the scale of the project, location, site and cost constraints and legislative requirements of different client governments. These good working practices are for the management of transport projects specifically during the construction but can also be considered during the planning stage of a project and during the development of the proposed method and approach for construction.

Prior to construction of a road project, an EA or EIA is generally undertaken to identify potential environmental impacts, provide an assessment of their implications and determine if they achieve the acceptable environmental criteria and, if not, to identify what measures need to be undertaken to protect the environment, either as part of the design or as part of the construction plan. In general, good working practices are usually defined in the EA / EIA stage of a project as part of the mitigation measures or main assessment. Following on from the EA / EIA, an Environmental Management Plan (EMP) is then prepared specific to the project. According to the definition provided in the Bank’s Operation Policies and the Handbook, the EMP is one of the most important outputs of the EA /EIA process and this report is the synthesis of all proposed mitigation and monitoring actions, set to a timeline with specific responsibility assigned and follow-up actions defined. Thus, this document in itself defines the requirements for specific working practices that are to be implemented during the project, incorporates the information from the EA / EIA and sets out the framework for the mitigation, monitoring, and institutional measures and actions to be undertaken prior to and during construction and operation of the project. The Annex to this report provides a description of typical activities, key environmental concerns and measures that can be undertaken to reduce environmental impacts.

1.3 Objective and purpose

The objective of this Guideline is to foster ideas, provide suggestions and outline general good working practices to protect the environment during the construction a road project. Certainly the most influential time for managing the environmental implications of a transport project is during the planning and design stage of a project. Although the purpose of this Guideline is to define good working practices during the construction stage, the timing of consideration of these practices should be during the planning stage of a project, then reinforced during construction through the monitoring and management of the site in accordance with the EMP.

These Guidelines are applicable to: (a) Client governments - to make them better able to understand and manage the implementation of the EMP; (b) Consultants - to assist them to ensure that the EMP is properly implemented; (c) Environmental engineers - to assist them to work with the contractors to implement the EMP; (d) Task Managers and other Bank staff who need to supervise road and highway projects.

1.4 Planning and preparation

Before implementation of a project and during the contract specifications stage it is necessary to ensure that all the environmental issues, location of sensitive areas and mitigation measures identified in the project’s EA / EIA are fully documented and are made available to the Client governments, the Task Managers and other Bank staff in relation to the project.

In order to facilitate capturing all the relevant information and mitigation measures, an environmental register (EnvReg) covering all the required environmental mitigation measures and design requirements from the planning, construction to the operational stage of the project should be prepared. This should include the specific area of environmental interest, the measures required for protection, the timing of protection and responsible person for undertaking the measure. The EnvReg should be included as part of the framework of the EMP.

Further, to ensure that good working practices and mitigation measures are incorporated during construction incentives for compliance may be beneficial and can be included in the contract specifications by the Client governments in order to manage / encourage the Contractor’s performance to undertake these practices.
2. Organization & Responsibilities

2.1 Defined roles and responsibilities

A successful project requires active involvement from the Client governments, Engineers Representative (ER), Environmental Engineer Team (ET), the Contractor(s), and the Task Manager / the Bank supervisors. Further, there are significant benefits to the inclusion of an Independent Environmental Checker (IEC) to be included in the team to report impartially on the performance of the Contractor(s). This is particularly important for large projects where there may be multiple contractors with their own Environmental Teams and where cumulative adverse impacts may occur to the environment from concurrent work.

Each of these organizations has an active role to play in the development and implementation of good working practices. The typical roles and responsibilities of these organizations include:

2.1.1 The Task Manager and the Bank’s supervisor(s)

The Task Manager and the Bank’s supervisor(s) are generally responsible for overseeing the project works, carrying out regular audits, review project submissions and the results of audits undertaken by the Consultant, and to ensure that the project is implemented according to the contract specifications and is compliant with the Bank’s policies and procedures. The Task Manager should communicate with the Client governments regarding the identified non-compliance, discrepancies and the required remediation actions.

2.1.2 Client Departments

The Client (governmental or not) generally has the final responsibility for the environmental performance of the project during both construction and operational phases, unless this has been transferred fully to the Contractor. A steering committee can be established by the client agency to ensure responsible person(s) from different divisions of the government departments are represented. The steering committee can oversee the project works and ensure compliance with the environmental requirements.

2.1.3 Engineers Representative (ER)

The ER is responsible for overseeing the construction works of the project and monitors the works undertaken by the Contractor(s) and the organization performing the EMP work (i.e. the Environmental Engineers Team (ET)) in order to ensure compliance with the specifications and contractual requirements. Depending on the project, an Engineers Representative (ER) may be employed to assist with the day-to-day engineering supervision or as a responsible party for checking and certifying the completion of work orders on behalf of the Client. The ER may be required to engage qualified resident site staff with specific knowledge of construction project management to assist them with performing the required duties. The main responsibilities of the ER generally include:

- monitoring the Contractor’s compliance with the contract specifications and, for environmental aspects, may include overseeing the Contractor’s implementation and operation of environmental mitigation measures and other requirements of EMP program;
- monitoring the performance of the ET, verifying monitoring methodologies and results. In case the ER considers that the ET Leader or any member of the ET fails to discharge duties or fails to comply with the contractual requirements, instruct to replace the ET Leader or the member of the ET;
- in case of non-compliance / discrepancies, instructing the Contractor(s) to take actions reducing the impacts and carry out remedial actions within a specified timeframe and / or additional monitoring, if required;
- instructing the Contractor(s) to stop activities which generate adverse impacts, and / or when the Contractor(s) failed to implement the EMP requirements / remedial actions instructed by the ER;
- participating in the regular joint site inspections undertaken by the ET; and
- assisting with complaint investigations and non compliances with environmental pollution control requirements.

2.1.4 The Independent Environmental Checker (IEC)

In order to ensure impartiality, it is beneficial that an Independent Checker (IEC) is appointed to supervise and monitor the construction works and implementation of the EMP throughout the construction phase of the project. The IEC should check, review, verify and validate the overall environmental performance of the project through regular audits, inspections and review of project submissions. This will provide confidence that the reported results are valid and the relevant monitoring program or codes of practice as provided in the project EMP are fully complied with.

In order to ensure independence of the IEC, they should be engaged by and report directly to the Client governments.

The IEC should be a person who can independently and professionally examine records, procedures and processes and may require a small team to assist with checking the site. The IEC should have extensive knowledge and experience in environmental monitoring and auditing to provide independent, objective and professional advice on the environmental performance of the project. The IEC should not be working within the ET team or within the Contractor(s) organization in order to minimize conflict of interest. The IEC should familiarize themselves with the project works through review of the reports, including the project EMP. In particular, the IEC is generally expected to perform the following duties:
• review and audit in an independent, objective and professional manner in all aspects of the EMP;
• validate and confirm the accuracy of monitoring results, monitoring equipment, monitoring locations, monitoring procedures and locations of sensitive receivers;
• carry out random sample check and audit on monitoring data and sampling procedures, etc;
• conduct random site inspections;
• audit the EA recommendations and requirements against the status of implementation of environmental protection measures;
• review the effectiveness of environmental mitigation measures and project environmental performance;
• verify and certify the environmental acceptability of the construction methodology (both temporary and permanent works), relevant design plans and submissions;
• verify the investigation results of any non-compliance of the environmental quality performance and the effectiveness of corrective measures; and
• report on audit results to the Client governments and ER team.

2.1.5 Environmental Engineers Team (ET)

An ET should be established by the Contractor(s). The ET should be led by an ET Leader who should have extensive environmental management, training and monitoring experience in construction projects and familiar with the local environmental legislative requirements. The ET Leader should be supported by qualified staff. Sufficient number of staff should be included in the team in order to carry out the duties specified in the EMP. Generally, it is the Contractor(s) responsibility to ensure adequate resources are available to the ET for the implementation of the EMP throughout the construction and maintenance period. The Contractor(s) often establish the ET within their organization or sub-contract this work to an experienced institution.

The ET Leader and ET are responsible for implementation and management of the EMP program and the required environmental monitoring works. Qualified laboratories should be engaged for analysis of collected samples. The roles and responsibilities of the ET are:

• sampling, analysis and evaluation of monitoring parameters with reference to the EA and the EMP;
• carry out regular environmental reviews and advise the Contractor on their site practices, equipment and work methodologies with respect to pollution control and adequacy of environmental mitigation;
• ensure the success of environmental monitoring and audit program and the implemental take by mitigation measures;
• ensure compliance with environmental protection, pollution prevention and control measures, and contractual requirements;
• prepare reports on the environmental monitoring data and site environmental conditions;
• undertake complaint investigation, evaluation and identification of corrective measures;
• advise the Contractor(s) on environment improvement, awareness, proactive pollution prevention measures;
• follow the procedures in the EMP and recommend the Contractor(s) to undertake suitable mitigation measures in the case of non-compliance / discrepancies and carry out additional monitoring works within the specified timeframe instructed by the ER; and
• liaison with the Contractor(s), ER and the IEC on all environmental performance matters, and timely submission of environmental reports to the ER, the Consultant and the Client governments, if required;

2.1.6 Contractor(s)

The duties of the Contractor(s) generally include the following:

• ensure compliance with relevant environmental legislative requirements;
• work within the scope of contractual requirements and other tender conditions;
• undertaking joint site inspections with the ET, and undertake any corrective actions instructed by the ER and / or the IEC;
• providing updated information to the ET regarding the program and works activities which may be contributable to the generation of adverse environmental impacts;
• in case of non-compliances / discrepancies, carry out investigation, submit proposals along with mitigation measures, and implement remedial measures to reduce the environmental impact;
• stop construction activities which generate adverse impacts upon receiving instructions from the ER / the IEC. Propose and carry out corrective actions and implement alternative construction method, if required, to minimize the environmental impacts;
• adhere to the procedures for carrying out complaint investigation; and
• take responsibility and strictly adhere to the guidelines of the environmental monitoring and audit program and complementary protocols developed by their project staff.

2.2 APPROACH DURING CONSTRUCTION

2.2.1 Project-Specific EMP

As this Guideline only provides a general framework for the implementation of EMP, a project specific EMP will need to be developed for each project prior to awarding contracts. The project EMP should be tailor-made based on the findings and recommendations in the EA. Sufficient information should be included in the project EMP such as register of environmental mitigation measures and figures extracted from the EA to clearly indicate location of sensitive areas, constraint areas, protection targets, proposed project boundary, proposed working areas / disposal sites, access road locations, recommended mitigation measures and monitoring locations.

2.2.2 Contractor's EMP Implementation Plan

Upon awarding of contract and prior to commencement of construction, the Contractor(s) should be required to submit an
EMP Implementation Plan based on the Contractor's actual construction methodologies, work program, type and number of construction plants to be used, for the ER and the Consultant's approval. The Contractor's EMP Implementation Plan should be in line with the project EMP and tailor-made for the project activities.

In general, the EMP should provide the following:

- organization structure, line of reporting and responsibilities of key personnel;
- the project program and work activities;
- methodology, detailed designs and installation locations of access roads and pollution control facilities (e.g. drainage channel, settling tank, temporary noise barrier, etc);
- the Contractor's Waste Management Plan (WMP), and protection plans for Cultural Resources, Ecology, Landscape & Visual and other sensitive aspects of the site and their protection measures; and
- the approach and program for implementing mitigation measures and monitoring.

In relation to the plan, Works Method Statements for construction of the various works including methods of use and construction operations together with all powered mechanical equipment of proposed measures for limiting environmental impacts should also be submitted by the Contractor for ER and IEC approval. Further, the effectiveness and adequacy of mitigation measures should be reviewed and updated regularly during the construction period.
3. Essential Framework

3.1 General Framework

In general, monitoring will need to be carried out at the specified representative sensitive locations in the EA when there are construction activities on site. The monitoring program and monitoring frequency should be designed to show both the overall performance of the project works as well as the short-term adverse impacts that may result during peak construction activities (e.g. ad hoc monitoring during the peak construction time period).

A framework for environmental monitoring and audit requirements and the performance criteria and objectives for general construction projects has been provided in this Guideline. In order to ensure that environmental impacts during construction and operational phases of the project are minimized to an acceptable level, project-specific monitoring and audit requirements, based on the findings of the EA, should be established specific to the project based on its construction requirements and location.

3.2 Impact Monitoring

Impact monitoring during project construction period consists of routine measurements on environmental quality parameters at the designated monitoring locations and the regular site inspections. During the peak construction period, the ET should also carry out additional measurements using hand-held equipment in order to monitor short-term impact. Should non-compliance with environmental quality performance criteria be identified, ad hoc monitoring should be carried out.

The ET should closely monitor the construction activities, the Contractor(s) environmental performance and status of implementation of mitigation measures. ET should carry out daily site walks and visual inspections to identify areas of potential environmental problems and advise the Contractor(s) to take immediately remedial / preventive actions. The area of inspection should cover both the construction areas and the environment outside the site area that could be affected, either directly or indirectly, by the site activities. Regular joint environmental site inspections (e.g. weekly) should be organised by the ET with participation from the Contractor’s construction team supervisors, ER and IEC.

The ET should keep a log-book of circumstances or change of circumstances which may affect the environmental impact assessment and any non-compliance with the recommendations of the EA or the project contract. The log-book should be kept readily available for inspection by all persons assisting in supervision of the implementation of the recommendations of the EA and contract. The ET can make reference to the following information / documentations in conducting the inspection:

- The Contractor's EM&A program, waste reduction plans, hazardous waste management and implementation of the required mitigation measures;
- Compliance with the EMP requirements, contractual specifications and legislation;
- The measures provided for protection of sensitive locations and control mechanism of the restricted areas;
- The Contractor’s construction methodologies and condition of construction plant;
- Individual works methodology proposals (which should include proposal on associated pollution control measures);
- Works progress and programs;
- The adequacy and efficiency of the Contractor’s pollution control measures / treatment facilities for minimizing environmental impacts,
- Landscaping and soil erosion control measures;
- Location, management and pollution control at the waste / material storage areas, borrower pits and access roads; and
- Previous site inspection results.

Generally it is the Contractor’s responsibility to update the ET with all relevant information of the construction contract to facilitate carrying out the site inspections. However, this often needs to be initiated by the ET to ensure that sufficient information is provided to them to undertake their duties. The inspection results and its associated recommendations on improvements to the environmental protection and pollution control works should be submitted in a timely manner to the ER and the Contractors for reference and to ensure immediate action can be undertaken.

3.3 Reporting

Environmental Site Inspection Report Sheets should be completed by the ET after each inspection. In the event of non-compliance / discrepancy and / or exceedance of the environmental quality criteria, corrective actions required for the Contractor(s) should be documented. The Contractor(s) should follow the procedures and time-frame as stipulated in the environmental site inspection and deficiency and action reporting system formulated by the ET Leader to report on any remedial measures subsequent to the site inspections.

Weekly inspection meetings should be organized for the Contractors to report the progress of implementation of remedial actions identified during the previous inspections. Findings identified during the current inspection and the required improvements / remedial actions will be discussed. Minutes of meeting should be prepared and distributed to all participants.

3.4 Environmental Performance Evaluation & Remedial Actions

 Immediately after each site walk / inspection and / or environmental measurement, the ET should compare the results with the pre-established environmental quality performance criteria in terms of Action Level (AL) and Limit Level (LL) for each environmental aspect based on the local legislative requirements. The event and action procedures required are
then determined according to an Event and Action Plan. A
generic process of the evaluation and required actions from each
party is provided in Tables 3.1 and 3.2
### Table 3.1 Environmental Performance Action / Limit Levels

<table>
<thead>
<tr>
<th>Event</th>
<th>Action Level</th>
<th>Limit Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental site walks / inspections</td>
<td>• One environmental observation / non-compliance or discrepancy relating; OR&lt;br&gt; • Receipt of one documented complaint.</td>
<td>• Repeated / continuous environmental discrepancy / non-compliance or observation relating for two consecutive events; OR&lt;br&gt; • Receipt of notification of summon or prosecution.</td>
</tr>
<tr>
<td>Environmental monitoring by measurements</td>
<td>• Action Level need to be act on a project by project basis</td>
<td>• Breach of the relevant environmental standard.</td>
</tr>
</tbody>
</table>

### Table 3.2 Event and Action Plan

<table>
<thead>
<tr>
<th>EVENT</th>
<th>ET</th>
<th>IEC</th>
<th>ER</th>
<th>Contractor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breach of the Action Level (AL)</td>
<td>• Identify source, investigate the causes of exceedance / non-compliance and propose remedial measures&lt;br&gt; • Inform the IEC and ER by notification;&lt;br&gt; • Repeat inspection to confirm implementation of remedial action;&lt;br&gt; • Carry out measurement to confirm compliance;&lt;br&gt; • Review effectiveness of Contractor’s remedial action.</td>
<td>• Check monitoring data submitted by ET;&lt;br&gt; • Check Contractor’s working method;&lt;br&gt; • Advise ET on the required remedial actions, if required;&lt;br&gt; • Audit the effectiveness of remedial actions.</td>
<td>• Review monitoring data submitted by ET;&lt;br&gt; • Notify Contractor(s) to take action within a specified time frame;&lt;br&gt; • Supervise the implementation of remedial actions carried out by Contractor(s);&lt;br&gt; • Instruct Contractor(s) to take further actions to remedy remaining impact.</td>
<td>• Propose and rectify any unacceptable practice;&lt;br&gt; • Amend working methods if appropriate;&lt;br&gt; • Timely implementation of remedial actions recommended by ET;&lt;br&gt; • Notify ET, ER and the IEC upon completion of remedial action.</td>
</tr>
<tr>
<td>Breach of the Limit Level (LL)</td>
<td>• Notify ER, the IEC and Contractor(s) by notification;&lt;br&gt; • Identify source, investigate the causes of exceedance / non-compliance and propose remedial measures;&lt;br&gt; • Repeat measurement to confirm findings;&lt;br&gt; • Increase monitoring frequency to daily until cease of exceedance;&lt;br&gt; • Analyze Contractor’s working procedures to determine possible mitigation to be implemented;&lt;br&gt; • Arrange meeting with ER and Contractor(s) to discuss the remedial actions to be taken;&lt;br&gt; • Carry out additional inspections to assess effectiveness of Contractor’s remedial actions and keep the IEC and the ER informed of the results.</td>
<td>• Discuss among ER, ET, and Contractor(s) on the potential remedial actions;&lt;br&gt; • Attend the meeting with the ER, ET and Contractor(s), if appropriate;&lt;br&gt; • Review Contractor’s remedial actions whenever necessary to assure their effectiveness and advise the ER accordingly;&lt;br&gt; • Audit the implementation of remedial measures.</td>
<td>• Confirm receipt of notification of failure in writing;&lt;br&gt; • Notify Contractor(s) to take immediate action;&lt;br&gt; • In consolidation with the IEC, agree with the Contractor(s) on the remedial measures to be implemented;&lt;br&gt; • Ensure remedial measures properly implemented;&lt;br&gt; • If exceedance / non-compliance continues, consider what portion of the work is responsible and instruct the Contractor(s) to stop that portion of work until the exceedance is abated;&lt;br&gt; • Report to the relevant local government authority, if appropriate.</td>
<td>• Take immediate action to avoid further exceedance / non-compliance;&lt;br&gt; • Submit proposals for remedial actions to ER and the IEC within 3 working days of notification;&lt;br&gt; • Implement the agreed proposals;&lt;br&gt; • Resubmit proposals if problem still not under control;&lt;br&gt; • Stop the relevant portion of works as determined by the ER until the exceedance is abated;&lt;br&gt; • Submit written report to the ER and the IEC providing reasons of exceedance / non-compliance, actions taken, and proposal to prevent it from happening again in the future.</td>
</tr>
</tbody>
</table>
4. Management of Environmental Aspects

4.1 Introduction

Construction projects can adversely affect the environment and by providing pollution control guidelines to construction workers on the types of impact that can result from their work and how they can reduce pollution through their working practices, these impacts can be reduced dramatically. The following outlines the type of impacts that are often generated during construction, the implication of these impacts and general good working practices that can be adopted during construction to reduce or minimize impacts.

4.2 Air Quality Management

4.2.1 Typical Emissions

Air pollution generated from road construction projects can include the following:

- Fugitive dust - generated from earthmoving / cutting activities, from soil stockpiles that may be exposed to wind, transport of dusty materials by vehicles on site or on haul roads, batching plants, blasting and other associated activities. Dust can also be generated from offsite activities such as from the mining activities necessary for providing materials for construction, disposal site of surplus fill and borrow areas.

- Gaseous pollutants - are generated during the operation of heavy powered mechanical equipment during construction, particularly those using diesel fuels and from treatment of surfaces and paving activities. The primary pollutants generated during construction from the equipment include nitrogen oxides (NOx), sulfur dioxide (SO2), carbon monoxide (CO) and Photochemical Oxidants (generally measured as ozone (O3)).

4.2.2 Implications of the Emissions

If air pollution emissions are not controlled to within acceptable levels during construction, adverse impacts may result to construction workers as well as neighboring residents in the area. Further, visibility may be impaired from air pollution generated during construction which may result in a greater incident of accidents on site. Dust and other pollutants can also be a nuisance to local residents and can affect vegetation growth and local ecology.

4.2.3 Reference Information

When considering working practices on the site, the documentation that can be referenced may include:

- the Air Pollution Section of the EIA Report - in particular what works may generate potential impacts, who the sensitive receivers are in the area and the mitigation measures that are required to be included to reduce air pollution from project related works.
- the Environmental Management Plan (EMP), which should set out the monitoring and audit of air pollution on the site and the details of the pollutants that will be measured, the frequency of measuring, how this information will be reported and how enforcement of implementation of the required mitigation measures for reducing air pollution will be carried out.
- any specific health and safety requirements for the project, including the type of equipment provided for personal protection from air pollution and environmental pollution control requirements provided in the Contract Documents.

4.2.4 Good Working Practices

Good working practices can considerably reduce air pollution on site. These include basic “low cost” measures such as covering stockpiled materials, spraying water regularly on exposed surface and on access roads, minimizing areas exposed by carrying out construction activities of different segments during different time period, etc.

General good working practices that are relatively easy and cost effective to improvement are highlighted below and a standard checklist of possible measures that may be implemented (depending upon the specific findings and recommendations of the EIA and EMP) are provided in Table 4.1.

- During slope works and earth moving / excavation, the exposed soil surface both in terms of area and duration should be minimized and temporary soil erosion control and slope protection works should be carried out;
- During the transportation of materials by vehicles, the construction of access roads should be properly designed and paved with concrete or laid with small graded rocks prior to use;
- Gaseous emission from batching plant and asphalt plants should be located as far as possible and at down wind location from the sensitive receivers and batching plants should be specified to include efficient dust emission control measures (e.g. enclosing the de-bagging and material mixing process, dust filtration equipment, etc);
- Road surfacing / re-surfacing and the use of asphalt plant should be scheduled during the non-sensitive time periods the day in order to minimize impacts to the air sensitive receivers;
- Construction plant / vehicles that generate serious air pollution and those which are poorly maintained should not be allowed. Terms and conditions for maintenance of construction plant by the Contractor can be included in the contract and enforced by site staff;
- All stockpiled materials and slope surfaces should be covered by impervious sheeting. Spraying water regularly on exposed surface within the construction site will effectively reduce dust emission;
• The load of dusty materials carried by vehicle leaving a construction site should be covered by sheeting to ensure that the dusty materials do not leak from the vehicle. Overflow of material should be avoided and speed limits on access roads should be restricted;
• Prior to any blasting on site, water should be sprayed on the surface of the blast area and surrounding areas to increase its moisture content, wire mesh, gunny sacks and sandbags should be used on top of the blast area at each shot to prevent flying rock and dust. Blasting should not be carried out under adverse weather conditions; and
• Adequate ventilation system and other measures to control concentration of air pollutants within tunnels should be provided.
### Table 4.1 Standard Air Quality Good Practices Checklist

<table>
<thead>
<tr>
<th>Type of Work</th>
<th>Activity / Env. Issue</th>
<th>Timing</th>
<th>Mitigation Measure</th>
<th>Compliance Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Dust from compressor air jet</td>
<td>During Construction (C)</td>
<td>Except for cleaning formwork prior to concreting, or cleaning of slope prior to concreting, a compressed air jet should not be used for cleaning or clearing dust from any vehicle, equipment, other materials or person.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Dust from compressor air jet</td>
<td>During Construction (C)</td>
<td>Use vacuum cleaner instead of air jet for clearing dust as far as practicable.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Dust emission (general)</td>
<td>During Construction (C)</td>
<td>Spray water/dust suppression chemical continuously on the surface where any pneumatic or power-driven drilling, cutting, polishing or other mechanical breaking operation that causes dust emission is carried out, unless the process is accompanied by the operation of an effective dust extraction and filtering device.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Dust emission from debris</td>
<td>During Construction (C)</td>
<td>Cover the debris with impervious sheeting or store them in a debris collection area sheltered on the top and 3 sides.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Dust emission from debris</td>
<td>During Construction (C)</td>
<td>Enclose debris chutes with impervious sheeting or similar materials.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Dust emission from debris</td>
<td>During Construction (C)</td>
<td>Spray the debris with water/dust suppression chemical to keep it wet before it is dumped into a debris chute.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Dust Emission (general)</td>
<td>During Construction (C)</td>
<td>Areas of the site in which dust is likely to be generated should be sprayed with water regularly. Screens, dust sheets, tarpaulins or other methods agreed by the ER should be used to prevent generation of dust. Materials, including earthworks material, from which dust may be generated when being transported to or from the Site should be sprayed with water or covered.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Smoke from open burning</td>
<td>During Construction (C)</td>
<td>Open burning for the purpose of disposal of construction waste / tires, the salvage of metal, or the clearance of site in preparation for construction work should be prohibited.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Black smoke from vehicle emissions</td>
<td>During Construction (C)</td>
<td>Every motor vehicle should be so maintained that: (a) no excessive smoke or visible vapor is emitted there from; (b) so far as is reasonably practicable, the products of combustion, ashes, steam, cinders, petrol, water or oil are not discharged on the road or in such manner as to be likely to cause damage to property or injury or danger or loss of amenity or annoyance to persons.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Black smoke from vehicle emissions</td>
<td>During Construction (C)</td>
<td>The transport should be maintained in a clean and serviceable condition and should be serviced regularly.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Kitchen fume from site canteen</td>
<td>During Construction (C)</td>
<td>The cooking fume control device should be installed should construction site canteen exists. Cooking fume emission should comply with the cooking fume discharge standard.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Kitchen fume from site canteen</td>
<td>During Construction (C)</td>
<td>Use clean fuel (e.g LPG) should be used as far as possible. Use of coal as fuel should be avoided if possible.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Building construction / demolition</td>
<td>During Construction (C)</td>
<td>For any wall of the building to be demolished that abuts or fronts upon a street, service lane or other open area accessible to the public, impervious dust screens or sheeting should be used to enclose the whole wall to a height of at least 1m higher than the highest level of the structure being demolished.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Building construction / demolition</td>
<td>During Construction (C)</td>
<td>When carrying construction of superstructure or renovation on the outer surface of external wall, any skip hoist for material transport should be totally enclosed by impervious sheeting.</td>
<td></td>
</tr>
<tr>
<td>Type of Work</td>
<td>Activity / Env. Issue</td>
<td>Timing</td>
<td>Mitigation Measure</td>
<td>Compliance Status</td>
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<tr>
<td>General</td>
<td>Building construction / demolition</td>
<td>During Construction (C)</td>
<td>Where a scaffolding is erected, effective dust screens, sheeting or netting should be provided to enclose the scaffolding from the ground floor level of the building up to the highest level of the scaffolding where a scaffolding is erected around the perimeter of a building under construction</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Site hoarding</td>
<td>During Construction (C)</td>
<td>Where a site boundary adjoins a road, streets or other area accessible to the public, hoarding of suitable height should be provided along the entire length except for a site entrance or exit.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Pollution Control System / Equipment Management</td>
<td>During Construction (C)</td>
<td>Any air pollution control system, equipment or measure should be operated or implemented. In the case of malfunctioning or breakdown of the system / equipment, the activity concerned should be stopped as soon as practicable until the system / equipment is restored to proper functioning.</td>
<td></td>
</tr>
<tr>
<td>Access Road / Vehicular Transportation</td>
<td>Vehicle Transportation</td>
<td>During Construction (C)</td>
<td>Vehicle speed should be limited to 10 kph except on paved access roads.</td>
<td></td>
</tr>
<tr>
<td>Access Road / Vehicular Transportation</td>
<td>Vehicle Transportation</td>
<td>During Construction (C)</td>
<td>Every vehicle should be washed to remove any dusty materials from its body and wheels before leaving the construction sites.</td>
<td></td>
</tr>
<tr>
<td>Access Road / Vehicular Transportation</td>
<td>Vehicle Transportation</td>
<td>During Construction (C)</td>
<td>The load of dusty materials carried by vehicle leaving a construction site should be covered entirely by clean impervious sheeting to ensure that the dusty materials do not leak from the vehicle.</td>
<td></td>
</tr>
<tr>
<td>Access Road / Vehicular Transportation</td>
<td>Site Entrance</td>
<td>During Construction (C)</td>
<td>The area where vehicle washing takes place and the section of the road between the washing facilities and the exit point should be paved with concrete, bituminous materials or hardcores.</td>
<td></td>
</tr>
<tr>
<td>Access Road / Vehicular Transportation</td>
<td>Dust emission</td>
<td>During Construction (C)</td>
<td>Pave main haul road / access road with hard surface (i.e. concrete, bituminous materials, hardcores or metal plate) and keep clear of dusty materials.</td>
<td></td>
</tr>
<tr>
<td>Access Road / Vehicular Transportation</td>
<td>Dust emission</td>
<td>During Construction (C)</td>
<td>Spray main haul road / access road with water or dust suppression chemical so as to maintain the entire road surface wet.</td>
<td></td>
</tr>
<tr>
<td>Access Road / Vehicular Transportation</td>
<td>Vehicle Transportation</td>
<td>During Construction (C)</td>
<td>Any vehicle with an open load compartment used for transferring dusty materials off Site should have properly fitted side and tail boards. Dusty materials should not be loaded to a higher level than the side and tail boards, and should be covered by a suitable tarpaulin (or any other impervious covering material as approved by the ER) good condition before leaving the site. The term “dusty materials” should include cement, earth, pulverized fuel ash, aggregates, silt, stone, fines, sand, debris, saw dust and wooden chips.</td>
<td></td>
</tr>
<tr>
<td>Batching Plant / Concreting Works</td>
<td>Dust emissions from Cement</td>
<td>During Construction (C)</td>
<td>Every stock of more than 20 bags of cement material should be covered entirely by impervious sheeting or placed in an area sheltered on the top and the 3 sides.</td>
<td></td>
</tr>
<tr>
<td>Batching Plant / Concreting Works</td>
<td>Dust emissions from Cement</td>
<td>During Construction (C)</td>
<td>Loading, unloading, transfer, handling or storage of bulk cement or any cement during or after the de-bagging process should be carried out in an enclosed system or facility (preferably, vent or exhaust should be fitted with an effective fabric or equivalent air pollution control system or equipment), or sheltered on the top and the 3 sides.</td>
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</tr>
<tr>
<td>Batching Plant / Concreting Works</td>
<td>Dust emissions from Cement</td>
<td>During Construction (C)</td>
<td>Cement, or any other dusty materials collected by fabric filters or other air pollution control system or equipment should be disposed of in totally enclosed containers</td>
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<tr>
<td>Type of Work</td>
<td>Activity / Env. Issue</td>
<td>Timing</td>
<td>Mitigation Measure</td>
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<tr>
<td>Batching Plant /</td>
<td>Dust emissions from Cement</td>
<td>During</td>
<td>Cement in bags should be stored in a dry, weatherproof store sheltered on the top and 3 sides with a raised floor. Each delivery should be identified and kept separate and should be used in the order of delivery.</td>
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<tr>
<td>Concreting Works</td>
<td></td>
<td>Construction (C)</td>
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<tr>
<td>Batching Plant /</td>
<td>Dust emissions from Cement</td>
<td>During</td>
<td>Cement delivered in bulk should be stored in a closed silo fitted with an audible high level alarm which is interlocked with the material filling line such that, in the event of the silo approaching an overfilling condition, an audible alarm is triggered and the material filling is stopped.</td>
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<td>Concreting Works</td>
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<td>Construction (C)</td>
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<tr>
<td>Batching Plant /</td>
<td>Dust emissions from cement</td>
<td>During</td>
<td>Cement, gypsum plaster and lime should be delivered in sealed bags or containers bearing the manufacturer's name. The bags and containers should be stored in a dry weatherproof store with a raised floor.</td>
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<td>Concreting Works</td>
<td></td>
<td>Construction (C)</td>
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<tr>
<td>Batching Plant /</td>
<td>Dust emissions from cement</td>
<td>During</td>
<td>For production of concrete or other substances using bagged cement, the de-bagging, batching and mixing processes should be carried out in an area sheltered on the top and the 3 sides.</td>
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<td>Concreting Works</td>
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<td>Construction (C)</td>
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<tr>
<td>Batching Plant /</td>
<td>Dust emissions from cement</td>
<td>During</td>
<td>Use precast concrete units and off-site fabrication yards as much as possible in order to reduce in-situ casting requirements.</td>
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<tr>
<td>Concreting Works</td>
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<td>Construction (C)</td>
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<tr>
<td>Belt Conveyor</td>
<td>Dust emission</td>
<td>During</td>
<td>Every belt conveyor used for the transfer of dusty materials should be enclosed on the top and the 2 sides.</td>
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<td></td>
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<td>Construction (C)</td>
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<tr>
<td>Belt Conveyor</td>
<td>Dust emission</td>
<td>During</td>
<td>Every transfer point between any 2 belt conveyors should be totally enclosed.</td>
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<td>Construction (C)</td>
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<tr>
<td>Belt Conveyor</td>
<td>Dust emission</td>
<td>During</td>
<td>Any effective belt scraper should be installed at the head pulley of every conveyor to dislodge fine particles that may adhere to the belt surface and to reduce carry back of fine particles on the return belt, and the belt scraper should be equipped with bottom plates or other similar means to prevent falling of materials from the return belt.</td>
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<tr>
<td>Belt Conveyor</td>
<td>Dust emission</td>
<td>During</td>
<td>Every stockpiling belt conveyor should be provided with a mechanism to adjust its level such that the vertical distance between the belt conveyor outlet and the material landing point is maintained at not more than 1 m.</td>
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<td>Construction (C)</td>
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<tr>
<td>Belt Conveyor</td>
<td>Dust emission</td>
<td>During</td>
<td>The area for unloading of dusty materials from a belt conveyor outlet to any stockpile, storage bin, truck and barge should be enclosed on the top and the 3 sides.</td>
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<td></td>
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<td>Construction (C)</td>
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<tr>
<td>Blasting</td>
<td>Dust emission</td>
<td>During</td>
<td>The area within 30m from the blasting area should be wetted with water prior to blasting</td>
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<td></td>
<td></td>
<td>Blasting (C)</td>
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<tr>
<td>Blasting</td>
<td>Dust emission</td>
<td>During</td>
<td>Blasting should not be carried out under adverse weather conditions (e.g. strong wind or tropical cyclone warning signal or storms).</td>
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<td>Blasting (C)</td>
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<tr>
<td>Blasting</td>
<td>Dust emission</td>
<td>During</td>
<td>Wire mesh, gunny sacks and sandbags should be used on top of the blast area at each shot to prevent flying rock and dust</td>
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<td></td>
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<td>Blasting (C)</td>
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<tr>
<td>Blasting</td>
<td>Dust emission</td>
<td>During</td>
<td>Water the surface of the blast area to increase its moisture content</td>
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<td></td>
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<td>Blasting (C)</td>
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<tr>
<td>Blasting</td>
<td>Dust emission</td>
<td>During</td>
<td>Dust filters should be fitted to the tunnel construction ventilation systems</td>
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<td></td>
<td></td>
<td>Blasting (C)</td>
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<tr>
<td>Blasting</td>
<td>Dust emission</td>
<td>During</td>
<td>Vents of all silos and weighing scale should be fitted with fabric filtering system</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blasting (C)</td>
<td></td>
<td></td>
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<tr>
<td>Type of Work</td>
<td>Activity / Env. Issue</td>
<td>Timing</td>
<td>Mitigation Measure</td>
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</tr>
<tr>
<td>Blasting</td>
<td>Dust emission</td>
<td>During Blasting (C)</td>
<td>Seating of pressure relief valves of all silos should be checked, and the valves resealed if necessary, before each delivery.</td>
<td></td>
</tr>
<tr>
<td>Blasting</td>
<td>Dust Emission</td>
<td>During Blasting (C)</td>
<td>Blasting to produce finishes should not carried out until the concrete has hardened sufficiently for the cement matrix to be removed without disturbing the coarse aggregate. Adjacent surfaces should be protected from blasting and dust should be controlled by screens and by water-spraying.</td>
<td></td>
</tr>
<tr>
<td>Earthworks</td>
<td>General construction activity</td>
<td>During Construction (C)</td>
<td>Dust suppression efficiency of 50% can be achieved by applying watering twice a day</td>
<td></td>
</tr>
<tr>
<td>Earthworks</td>
<td>Stockpiling</td>
<td>During Construction (C)</td>
<td>Any stockpile of dusty materials should be either: (a) covered entirely by impervious sheeting; (b) placed in an area sheltered on top and the 3 sides; (c) sprayed with water or a dust suppression chemical so as to maintain the entire surface wet</td>
<td></td>
</tr>
<tr>
<td>Earthworks</td>
<td>Stockpiling</td>
<td>During Construction (C)</td>
<td>Any excavated dusty materials or stockpile of dusty materials should be covered entirely by impervious sheeting or sprayed with water so as to maintain the entire surface wet, and recovered or backfilled or reinstated upon completion of works</td>
<td></td>
</tr>
<tr>
<td>Earthworks</td>
<td>Stockpiling</td>
<td>During Construction (C)</td>
<td>Stockpile of dusty materials should not extend beyond the pedestrian barriers, site fencing or traffic cones</td>
<td></td>
</tr>
<tr>
<td>Earthworks</td>
<td>Stockpiling</td>
<td>During Construction (C)</td>
<td>Dusty materials remaining after a stockpile is removed should be wetted with water and cleared from the surface of roads</td>
<td></td>
</tr>
<tr>
<td>Earthworks</td>
<td>Dust emission</td>
<td>During Construction (C)</td>
<td>All dusty materials should be sprayed with water prior to any loading, unloading or transfer operation so as to maintain the dusty material wet</td>
<td></td>
</tr>
<tr>
<td>Earthworks</td>
<td>Excavation</td>
<td>During Construction (C)</td>
<td>The working area of excavation should be sprayed with water immediately before, during and immediately after the operations so as to maintain the entire surface wet</td>
<td></td>
</tr>
<tr>
<td>Earthworks</td>
<td>Excavation</td>
<td>During Construction (C)</td>
<td>The height from which excavated materials are dropped should be controlled to a minimum practical height to limit fugitive dust generation</td>
<td></td>
</tr>
<tr>
<td>Earthworks</td>
<td>Exposed surface</td>
<td>During Construction (C)</td>
<td>Exposed earth should be properly treated by compaction, turfing, hydro seeding, vegetation planting or sealing with latex, vinyl, bitumen, shotcrete or other suitable surface stabilizer upon completion of the last construction activity on the construction site or part of the construction site where the expose earth lies.</td>
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</tr>
<tr>
<td>Earthworks</td>
<td>Exposed surface</td>
<td>During Construction (C)</td>
<td>Earthworks after site clearance, excavation or filling and earthworks material after excavation should be kept free from water and should be protected from damage due to water and from exposure to weather conditions which may affect the earthworks or earthworks material. Measures taken should include the following: (a) The area of exposed surfaces should be kept to a minimum. (b) Temporarily exposed surfaces should be sealed or covered with impermeable sheeting or protected by other methods approved by the ER.</td>
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</tr>
<tr>
<td>Earthworks</td>
<td>Dust emission from site Clearance</td>
<td>During Construction (C)</td>
<td>Spray the working area of any excavation or earth moving operation with water or dust suppression chemical immediately before, during and immediately after the operation so as to maintain the entire surface wet.</td>
<td></td>
</tr>
<tr>
<td>Earthworks</td>
<td>Dust emission from site Clearance</td>
<td>During Construction (C)</td>
<td>The working area for the uprooting of trees, shrubs, or vegetation or for the removal of boulders, poles, pillars or temporary or permanent structures should be sprayed with water or dust suppression chemical immediately before, during and immediately after the operation so as to maintain the entire surface wet.</td>
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<tr>
<td>Type of Work</td>
<td>Activity / Env. Issue</td>
<td>Timing</td>
<td>Mitigation Measure</td>
<td>Compliance Status (Yes = compliant; No = non-compliant)</td>
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<tr>
<td>Earthworks</td>
<td>Dust emission from site Clearance</td>
<td>During Construction (C)</td>
<td>All demolished items (including trees, shrubs, vegetation, boulders, poles, pillars, structures, debris, rubbish and other items arising from site clearance) that may dislodge dust particles should be covered entirely by impervious sheeting or placed in an area sheltered on the top and the 3 sides within a day of demolition.</td>
<td></td>
</tr>
<tr>
<td>Tunneling</td>
<td>Tunnel Construction</td>
<td>During Construction (C)</td>
<td>If dust is generated during the work, measures should be undertaken to reduce dust emissions such as a sprinkler system or other effective dust suppression measures (e.g. spraying with water)</td>
<td></td>
</tr>
<tr>
<td>Tunneling</td>
<td>Tunnel Construction</td>
<td>During Construction (C)</td>
<td>Solid portal doors should be installed which should be closed when undertaken dusty activities and/or during blasting in order to reduce the amount of dust emitted and for safety consideration. Sufficient ventilation should be provided to ensure adequate fresh air in the tunnel.</td>
<td></td>
</tr>
<tr>
<td>Tunneling / Foundation</td>
<td>Spillage of Bentonite</td>
<td>During Construction (C)</td>
<td>Bentonite should be stored in a fully enclosed storage area and debagging will be carried out in a fully enclosed area filled with a filtered extractor ventilation system.</td>
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</tbody>
</table>
4.3 Noise and Vibration

4.3.1 Sources of Noise

Noise may be generated from the following activities:

- Operation powered mechanical equipment during construction;
- Vehicles transporting materials within construction site and beyond the construction boundary;
- Loading and unloading of materials;
- Piling activities during construction of foundations / piers;
- Ventilation systems during tunnel construction; and
- Noise due to blasting and vibration during tunnel construction.

4.3.2 Noise Reference Information

Documentation that should be provided to construction workers and the environmental teams should include:

- The Noise Section of the EIA Report - in particular where potential impacts have been identified, who the sensitive receivers are, the noise criteria for each of these receivers in the area and the mitigation measures that should be included as part of their working practices to reduce noise pollution from project related works.
- The Environmental Management Plan (EMP) - which should set out the monitoring and audit of noise on the site and the details of the sound power level to be measured, the frequency of measuring, how this information will be reported and how enforcement of implementation of the required mitigation measures for reducing noise will be carried out.

4.3.3 General Good Working Practices to Review

Adopting good working practices can considerably reduce noise levels on site. These include basic measures such as using quieter plant, locating works far away from the sensitive receivers and using noise barriers during construction.

Some general good working practices that are relatively easy to implement and are effective in reducing noise levels during construction are provided below and a standard checklist is provided in Table 4.2.

- Adopting quiet equipment and limiting the number of equipment to be used at the same time;
- Arranging transport of materials leaving construction site during non-peak hours in order to minimize traffic noise;
- Application of properly designed silencers, mufflers, acoustically dampened panels and acoustic sheds or shields, etc. for construction plant;
- Use of electric-powered equipment where applicable instead of diesel-powered or pneumatic-powered equipment;
- Plant known to emit noise strongly in one direction, should, where possible, be orientated to direct noise away from the Noise Sensitive Receivers (NSRs);
Table 4.2   Standard Noise Good Practices Checklist

<table>
<thead>
<tr>
<th>Type of Work</th>
<th>Activity / Env. Issue</th>
<th>Timing</th>
<th>Mitigation Measure</th>
<th>Compliance Status</th>
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</thead>
<tbody>
<tr>
<td>General</td>
<td>Temporary noise barrier</td>
<td>During Construction (C)</td>
<td>Erecting movable noise enclosures around noisy plants such as site hoarding should not be considered as a noise barrier unless it can meet Leader the required surface density requirements and be effective in screening sound level. The design of the movable noise barrier should be approved by the ET Leader and ER.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Noise from construction</td>
<td>During Construction (C)</td>
<td>Locating noise emitting plants at maximum possible distances from sensitive receivers</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Noise from construction</td>
<td>During Construction (C)</td>
<td>The Contractor’s construction activities / works methods should comply with the contractual clauses for construction works</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Noise from construction</td>
<td>During Construction (C)</td>
<td>Contractor(s) to schedule of noisy operations during daytime. Nighttime works should be avoided as much as possible or approval from the government authority is required.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Quiet equipment / equipment maintenance</td>
<td>During Construction (C)</td>
<td>Regular maintenance of site plant/ equipment.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Noise Emissions from Vehicles</td>
<td>During Construction (C)</td>
<td>Every vehicle propelled by an internal combustion engine should be fitted with a silencer, expansion chamber or other contrivance suitable and sufficient for reducing, as far as may be reasonable, the noise caused by the escape of the exhaust gases from the engine.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Quiet equipment / equipment maintenance</td>
<td>During Construction (C)</td>
<td>Only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction works</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Quiet equipment / equipment maintenance</td>
<td>During Construction (C)</td>
<td>Machines and plant that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Quiet equipment / equipment maintenance</td>
<td>During Construction (C)</td>
<td>Plant known to emit noise strongly in one direction, should, where possible, be orientated to direct noise away from the NSRs</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Quiet equipment / equipment maintenance</td>
<td>During Construction (C)</td>
<td>Mobile plant should be sited as far away from Noise Sensitive Receivers (NSRs) as possible</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Quiet equipment / equipment maintenance</td>
<td>During Construction (C)</td>
<td>Material stockpiles and other structures should be effectively utilised, where practicable, to screen noise from on-site construction activities.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Quiet equipment / equipment maintenance</td>
<td>During Construction (C)</td>
<td>Application of properly designed silencers, mufflers, acoustically dampened panels and acoustic sheds or shields, etc. should be used.</td>
<td></td>
</tr>
<tr>
<td>Type of Work</td>
<td>Activity / Env. Issue</td>
<td>Timing</td>
<td>Mitigation Measure</td>
<td>Compliance Status (Yes = compliant; No = non-compliant)</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------------</td>
<td>--------</td>
<td>--------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>General</td>
<td>Quiet equipment / equipment maintenance</td>
<td>During Construction (C)</td>
<td>Use of electric-powered equipment where applicable instead of diesel-powered or pneumatic-powered equipment</td>
<td></td>
</tr>
<tr>
<td>Blasting</td>
<td>Noise due to blasting events</td>
<td>During Construction (C)</td>
<td>Before blasting is carried out, the Contractor(s) should carry out a detailed survey at the nearby areas / villages and evaluate the degree of impacts due to the blasting activity (e.g. possible damage to structures / utilities due to vibration; affected wild animals; affected local residents) should be determined. Mitigation / protection measures should be implemented to minimize the impacts. Local residents should be informed of the schedule of blasting well in advance.</td>
<td></td>
</tr>
<tr>
<td>Blasting</td>
<td>Noise due to blasting events</td>
<td>During Construction (C)</td>
<td>No blasting should be allowed during nighttime unless prior approval has been granted and the public has been notified.</td>
<td></td>
</tr>
<tr>
<td>Blasting</td>
<td>Blasting in tunnel</td>
<td>During Construction (C)</td>
<td>When blasting is undertaken in tunnels, doors (e.g. metal doors) should be installed at the tunnel portal. Doors should be closed when blasting activities are carried within the tunnel in order to reduce the amount of noise emitted and for safety consideration.</td>
<td></td>
</tr>
</tbody>
</table>
4.4 Water Quality

4.4.1 Sources of Water Quality Impacts

With regard to water quality and wastewater, primary sources of impact during construction include:

- Wastewater generated from construction equipment (e.g. uncontrolled release of bentonite from tunnel drilling machine), oil or lubricant leakage;
- Wastewater from bored piling locations.
- Re-suspension of bottom sediment and mud caused by cut-trench river crossings and construction of bridge foundation within rivers;
- Soil erosion / flush away from uncovered stockpiling locations, uncovered excavation site and unprotected slope surface during adverse weather conditions;
- Uncontrolled surface water run-off carrying sediment laden discharges directly into natural water bodies such as streams, fish ponds, rivers and local irrigation channels; and
- Domestic sewage and canteen waste generated by construction workers.

4.4.2 Reference Information

It is also essential that environmental staff monitoring the works have a full understanding of what they are monitoring, the sensitive receivers and what the criteria is that they should be reviewing their results against. The documentation that should be provided to construction workers and the environmental team should include:

- The Water Pollution Section of the EIA Report - in particular where potential impacts have been identified, who the sensitive receivers are in the area and the mitigation measures that should be included as part of their working practices to reduce water pollution from project related works.
- The Environmental Management Plan (EMP) - which should set out the monitoring and audit of water pollution on the site and the details of the pollutants that will be measured, the frequency of measuring, how this information will be reported and how enforcement of implementation of the required mitigation measures for reducing water pollution will be carried out.
- Drainage Management Plan (DMP) – for the project specific to the site areas. This should include information on topography, drainage, rainfall patterns include requirements of drainage control, drawings of design and locations of proposed drainage channels for the temporary drainage system during the works.

4.4.3 General Good Working Practices to Review

Adopting good working practices can considerably reduce water pollution on site. These include basic measures such as providing appropriate drainage system, using sandbags barriers or retaining walls, minimizing stockpile and concrete paving during different construction period. Some general good working practices include the following measures and further measures are provided in Table 4.3.

- A Wastewater Treatment Plan should be prepared for the project and should include the design of wastewater treatment;
- Domestic sewage from site office and toilets should either be collected by a licensed waste collector or treated by on-site treatment facilities and discharge of treated wastewater must comply with the discharge limit according to the legislation;
- The design of the proposed road project will need to include measures to trap solid waste to prevent it from flushing into nearby water bodies;
- Emergency spill clean up should be provided in the event of accidents involving leakage of fuel, dangerous goods and toxic materials;
- Wastewater generated from the service areas and car parking areas should either be treated on-site by treatment facility or connect to existing / proposed sewers.
- Wastewater treatment device such as sedimentation tank should be installed or, alternatively, sedimentation ponds can be constructed on-site to settle out excessive Suspended Solids (SS) before discharging;
- Retaining walls and sandbags barriers should be constructed surrounding the bored piling machine in order to trap bentonite and wastewater within the piling location. The collected spent bentonite / wastewater should be pumped for treatment before discharge;
- Prior to rainy season, all the exposed surface and slope surface should be properly covered or landscaping should be provided to minimize run-off of sediment laden. Slope protection can be carried out in sequence to construction and in advance of rainy season; and
- Ground surface at the site office should be concrete paved in order to minimize soil erosion. Site access road should be either concrete paved or laid with small graded rock material. This measure can effectively trap suspended solids within the construction site.
<table>
<thead>
<tr>
<th>Type of Work</th>
<th>Activity / Env. Issue</th>
<th>Timing</th>
<th>Mitigation Measure</th>
<th>Compliance Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Project design</td>
<td>During Design Stage (DS)</td>
<td>The location and extent of watercourses to be affected by the project works should be considered in the design. The design should minimize the numbers of river crossings and to avoid the crossing of sensitive water bodies as far as possible.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Project design</td>
<td>During Design Stage (DS)</td>
<td>Project construction program should be designed to avoid construction activities (especially earthworks / slope works) during rainy season as far as possible. Should construction activities be unavoidable during rainy season, specific control and mitigation measures should be included in the design and in contract.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Provision of facilities</td>
<td>Before Construction (BC)</td>
<td>The Contractor should make all arrangements with and obtain the necessary approvals from the relevant authorities for the facilities such as temporary water, electricity, telephone, sewerage and drainage facilities.</td>
<td></td>
</tr>
<tr>
<td>Drainage System</td>
<td>Drainage system and wastewater treatment</td>
<td>Before Construction (BC)</td>
<td>The Contractors should provide details of the proposed measures in the Contractor's Drainage Management Plan (DMP). The DMP should include temporary and permanent measures to control and management site drainage, and treatment methods of wastewater / domestic sewage both for the construction period and post-construction maintenance period.</td>
<td></td>
</tr>
<tr>
<td>Drainage System</td>
<td>Drainage system and wastewater treatment</td>
<td>Before Construction (BC)</td>
<td>Installation and design of sediment traps should be included in the Contractor's Drainage Management Plan. In general, sediment traps should be installed at outlets concentrates sediment-laden runoff, upstream of any storm drain that may receive sediment-laden runoff.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Stockpiling</td>
<td>During Construction (C)</td>
<td>Stockpiles of fill material, dredged material or excavated material should be away from natural stream courses and fully covered in order to avoid flushing away of material during rainstorm.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Filling material</td>
<td>During Construction (C)</td>
<td>Fill material should not be handled or stored in a manner which will result in segregation, deterioration, erosion or instability of the material.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Impacts to stream courses / nullahs</td>
<td>During Construction (C)</td>
<td>The Contractor should not discharge directly or indirectly (by runoff) or cause or permit to be discharged into any public sewer, storm-water drain, channel, stream-course or sea, any effluent or foul or contaminated water.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Impacts to stream courses / nullahs</td>
<td>During Construction (C)</td>
<td>The Contractor should at all times ensure that all existing stream courses and drains within, and adjacent to the site are kept safe and free from any debris and any excavated materials arising from the works. The Contractor should ensure that chemicals and concrete agitator washings are not deposited in watercourses</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Impacts to stream courses / nullahs</td>
<td>During Construction (C)</td>
<td>All Contractor’s equipment should be designed and maintained to minimize the risk of silt and other contaminants being released into the water column or deposited in other than designated locations.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Impacts to stream courses / nullahs</td>
<td>During Construction (C)</td>
<td>Diversions should be constructed to allow the water flow to discharge without overflow, erosion or washout. The area through which the temporary diversion runs is to be reinstated to its original condition when the temporary diversions is no longer required</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Flushing medium during drilling</td>
<td>During Construction (C)</td>
<td>The flushing medium for drilling should be clean water; other substances or materials should not be introduced into drill holes. The flushing medium for drilling should be passed through a sedimentation basin and should either be reused or be discharged to surface drains or natural stream courses. Measures should be taken to prevent flushing mediums seeping through the ground.</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>Flushing medium during drilling</td>
<td>During Construction (C)</td>
<td>The flushing medium for drilling should not be discharged to stream courses which are used as a supply of drinking water.</td>
<td></td>
</tr>
</tbody>
</table>
| **Type of Work** | **Activity / Env. Issue** | **Timing** | **Mitigation Measure** | **Compliance Status**
Yes = compliant; No = non-compliant |
---|---|---|---|---|
**General** | Discharge of domestic sewage | During Construction (C) | Domestic sewage should be collected and dispose of off-site by a licensed domestic sewage collector. Should treatment of domestic sewage be required, suitable treatment facilities should be installed to treat collected domestic sewage before discharge. The treated sewage should comply with the discharge standard in PRC with a suitable discharge license from the government authority. | |
**General** | Earthworks / Slope works | During Construction (C) | Construction activities, particular earthworks, should avoid to be carried out during rainy season. Should construction be unavoidable, the following measures should be adopted: (a) temporary drainage systems should be constructed in association with the pipeline laying work to control site run off and avoid soil erosion; (b) sand and gravel traps should be provided as necessary and cleaned regularly; (c) measures should be implemented to prevent slope erosion; excavated spoil should be stored only at designated and managed stockpiling areas; (d) temporary drainage systems with sediment traps should be provided around borrow pits and spoil dumps to reduce the release of sediment laden runoff from cut faces. | |
**Drainage System** | Drainage system and wastewater treatment | During Construction (C) | Upon receipt of heavy rainstorm warnings, ensure drainage system is cleared of mud or other obstructions. All pumping systems to be tested, primed, refueled and filters cleared. | |
**Drainage System** | Drainage system and wastewater treatment | During Construction (C) | Provide bunds or other effective barriers to prevent the ingress of excessive water or the overflowing of mud water into the public drain and manholes. | |
**Drainage System** | Drainage system and wastewater treatment | During Construction (C) | Measures should be taken to prevent excavated material, silt or debris from entering drainage systems in watercourses. Entry of water to the gullies should not be obstructed. | |
**Drainage System** | Drainage system and wastewater treatment | During Construction (C) | The Contractor should construct, maintain, remove and reinstate, as necessary, temporary drainage works and take all other precautions necessary for the avoidance of damage by flooding and silt washed down from the works. The Contractor should also provide adequate precautions to ensure that no spoil or debris of any kind is allowed to be pushed, washed down, fall or be deposited on land water bodies adjacent to the site. | |
**Drainage System** | Drainage system and wastewater treatment | During Construction (C) | The Contractor should not permit any sewage, waste water or other effluent containing sand, cement, silt or any other suspended or dissolved material to flow from the site onto any adjoining land or allow any solid waste to be deposited anywhere within the site or onto any adjoining land and should have all such materials removed from the site. | |
**Drainage System** | Drainage system and wastewater treatment | During Construction (C) | The Contractor should be responsible for temporary drainage, diverting or conducting of open streams or drains intercepted by any works and for reinstating these do their original courses on completion of the works | |
**Drainage System** | Drainage system and wastewater treatment | During Construction (C) | Discharge of surface runoff or treated wastewater to watercourses which are used as a supply of drinking water / agriculture irrigation channels, should be avoided as far as possible. If discharge is necessary, prior approval should be obtained from the government authority. | |
**Earthworks** | Slope protection / soil erosion control | During Construction (C) | Carry out protection to open cut slopes and excavations (e.g. grass seeding, slope stabilization measures) to prevent slope slides and soil erosion. Requirements of grass seeding and vegetation should be planned and detailed in the Contractor’s Landscape Implementation Program | |
<table>
<thead>
<tr>
<th>Type of Work</th>
<th>Activity / Env. Issue</th>
<th>Timing</th>
<th>Mitigation Measure</th>
<th>Compliance Status (Yes = compliant; No = non-compliant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthworks</td>
<td>Soil Erosion</td>
<td>During Construction (C)</td>
<td>Earthworks final surfaces and formations should be maintained in a stable condition and should be protected from damage due to water or other causes and from exposure to conditions which may adversely affect the surface.</td>
<td></td>
</tr>
<tr>
<td>Tunneling</td>
<td>Wastewater from tunnel</td>
<td>During Tunneling (C)</td>
<td>All wastewater generated must be treated to the appropriate standard before discharge. Wastewater containing oil (e.g., wastewater generated from construction plant) should also be treated by oil interceptor.</td>
<td></td>
</tr>
<tr>
<td>Tunneling</td>
<td>Wastewater from tunnel</td>
<td>During Tunneling (C)</td>
<td>In the event that conventional sedimentation techniques are inadequate to treat wastewater generated, consideration should be given to the use of alternative techniques such as mobile microfiltration plants or using chemicals (e.g., coagulants).</td>
<td></td>
</tr>
<tr>
<td>Tunneling / Foundation</td>
<td>Prevention of spillage of bentonite</td>
<td>During Construction (C)</td>
<td>Additional controls, including bunding and a separate drainage system will be provided around the bentonite handling area to prevent any spillage of bentonite slurry.</td>
<td></td>
</tr>
</tbody>
</table>
4.5 Waste Management

4.5.1 Types of Waste

Types of waste generated from road construction projects can include the following:

- Construction & Demolition Materials - inert materials consisting of earth, building debris, rock fragments, concrete bricks, tiles, masonry and mortar etc;
- Construction & Demolition Waste (i.e. non-inert materials - such as metals, plastic, paper / cardboards, glass, timber waste, cleared vegetation) and other waste such as general refuse;
- Chemical Waste - such as cleaning fluids, solvents, lubrication oil, fuel and battery;
- Contaminated Soil – soil contaminated with heavy metals, pesticides or other contaminants; and
- Special Handling Wastes – such as asbestos, and other waste materials that require special handling.

4.5.2 Reference Information

The documentation that should be referenced during the construction activities includes:

- The Waste Management Section of the EIA Report - in particular where potential impacts have been identified, who the sensitive receivers are in the area and the mitigation measures that should be included as part of their working practices to manage waste from project related works.
- The Environmental Management Plan (EMP) - which should set out the monitoring and audit of waste management on the site and the details of the issues that will be measured, the frequency of measuring, how this information will be reported and how enforcement of implementation of the required mitigation measures for reducing waste problem will be carried out.

4.5.3 General Good Working Practices

Adopting good working practices can considerably reduce waste problem on site. These include basic measures such as reusing excavated materials, waste separation on site and minimizing waste generation during construction period. These types of basic activities should be incorporated into the training program to provide a better understanding of how construction workers can control impacts and for the environmental team to understand what they can undertake to reduce environmental impact if unacceptable levels are identified.

Some general good working practices are provided as follows. These should be considered with the findings and recommendations in the Project Specific EIA and EMP and a checklist is provided in Table 4.5.

- The amount of surplus excavated material for each road segment should be estimated during the design phase. Excavated material should be re-used on-site or the nearby road segment / other projects as far as possible in order to minimize the quantity of material to be disposed of;
- Recyclable materials such as wooden plates for trench works, steel, scaffolding material, site holding, packaging material, etc should be collected and separated on-site from other waste sources. Collected recyclable material should be re-used for other projects or sold to waste collector for recycling;
- The extent of demolition of existing houses / structures due to the project should be minimized during the design through careful route selection. Major dense populated residential areas should be avoided in order to minimize the demolition;
- Handling of waste generated from on-site treatment facilities (e.g. spent bentonite settled by treatment facility, sediment collected by sedimentation process, etc) should be planned during the design. Collected waste should be disposed of properly through licensed waste collector;
- Hazardous waste (or chemical waste) should be properly stored, handled and disposed of in accordance with the local legislative requirements. Hazardous waste should be stored at designed location and warning sign should be posted;
- Specification on waste management should be included in the contract for contractor(s) to follow. The Contractor(s) should be required to adopt operation measures for all aspects from waste avoidance, reduction, recycling, re-use to waste collection and disposal;
- Good house keeping should be maintained. Domestic waste from site office and canteen should be collected by a licensed waste collector. A designed waste storage area should be provided for the proposed service area. Waste should be cleaned on regular basis.
Table 4.5  Waste Management Good Practice Checklist

<table>
<thead>
<tr>
<th>Activity to Check</th>
<th>Frequency</th>
<th>Corrective Action for Non-compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Permits, Licences &amp; Records</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All necessary waste disposal permits or licences have been obtained.</td>
<td>Prior to commencement of each waste generating activity</td>
<td>Apply for necessary permits/licences prior to disposal of waste. The ET should verify that corrective action has been taken.</td>
</tr>
<tr>
<td>Wastes are disposed of at approved sites.</td>
<td>Regularly</td>
<td>The Contractor(s) should immediately take steps to ensure the wastes are disposed of at approved sites only.</td>
</tr>
<tr>
<td>Only waste hauliers approved by the ER are used for waste collection.</td>
<td>Regularly</td>
<td>The Contractor(s) should use an approved waste hauler with immediate effect.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collection of the concerned waste should be temporarily suspended until an ER-approved waste hauler is used. Corrective action should be taken within 48 hours.</td>
</tr>
<tr>
<td><strong>General Issues</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wastes are removed from site in a timely manner.</td>
<td>Daily</td>
<td>The Contractor(s) should remove waste accordingly.</td>
</tr>
<tr>
<td>Waste storage areas are properly cleaned and do not cause windblown litter or dust nuisance</td>
<td>Daily</td>
<td>The Contractor(s) should clean the storage areas and/or cover waste. ET should verify implementation.</td>
</tr>
<tr>
<td>Different types of waste are segregated in different containers or skips to enhance recycling of material and proper disposal of waste.</td>
<td>As required</td>
<td>The Contractor(s) should provide separate skips/containers and ensure the workers place waste in appropriate containers. The ET should verify implementation.</td>
</tr>
<tr>
<td>The waste management hierarchy is followed as far as possible.</td>
<td>At all times</td>
<td>Contractor(s) to implement.</td>
</tr>
<tr>
<td>Waste handling and management procedures are correctly observed for each type of waste</td>
<td>At all times</td>
<td>Contractor(s) to observe requirements.</td>
</tr>
<tr>
<td>Relevant staff have received appropriate training on waste management procedures and practices</td>
<td>Regularly</td>
<td>Contractor(s) to schedule training sessions as required.</td>
</tr>
<tr>
<td>All works areas are kept free from general litter and refuse.</td>
<td>Regularly</td>
<td>Contractor(s) to assign staff to clear up litter.</td>
</tr>
<tr>
<td>General refuse and litter is stored and removed as required.</td>
<td>Regularly</td>
<td>Contractor(s) to observe requirements.</td>
</tr>
<tr>
<td>Spoil stockpiles are covered to prevent runoff or dust.</td>
<td>As required</td>
<td>Contractor(s) to implement requirements with immediate effect.</td>
</tr>
<tr>
<td><strong>Chemical Wastes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical wastes are disposed of in accordance with corporate and statutory requirements.</td>
<td>As required</td>
<td>The Contractor(s) must implement corrective actions within 24 hours. The ET should verify implementation.</td>
</tr>
<tr>
<td>Records are maintained of chemical wastes disposed of and reused on site</td>
<td>Weekly</td>
<td>Contractor(s) to update records.</td>
</tr>
<tr>
<td>Contaminated material, if any, is stored, handled and disposed of appropriately.</td>
<td>Regularly (when contaminated material is identified).</td>
<td>Contractor(s) should follow the appropriate measures with immediate effect.</td>
</tr>
</tbody>
</table>
4.6 Landscape & Visual

4.6.1 Key Environmental Aspects

Landscape and visual impact from construction projects can be determined by the impact to the following:

- Landscape impact
  - direct impacts upon specific landscape elements;
  - more subtle effects upon the overall pattern of landscape elements that give rise to landscape character, and local and regional distinctiveness;
  - impacts upon acknowledged special interests or values such as areas of high landform with special landscape significance.

- Visual impact
  - visual compatibility with surroundings
  - visual obstruction
  - improvement of visual quality
  - glare from direct or reflected sunlight or man-made light source

4.6.2 Essential Information

The documentation that should be reviewed by construction workers and the environmental team should include:

- The Landscape and Visual Section of the EIA Report - in particular where potential impacts have been identified, who the sensitive receivers are in the area and the mitigation measures that should be included as part of their working practices to reduce landscape and visual impact from project related works.
- The Environmental Management Plan (EMP) - which should set out the monitoring and audit of landscape and visual impact on the site and the details of the impact that will be measured, the frequency of measuring, how this information will be reported and how enforcement of implementation of the required mitigation measures for reducing landscape and visual will be carried out.
- Good Working Practices – general practices to reduce landscape and visual impact from construction sites should be adopted, even if this is not included in the EIA report or detailed in the EMP. These are provided for reference as follows.

4.6.3 General Good Working Practices to Review

Adopting good working practices can considerably reduce landscape and visual impact on site. These include basic measures such as screening off the temporary or permanent structure from sensitive receivers, landscape treatment and prompt reinstatement upon completion of work during construction period.

Typical measures that can be covered include:

- Locating facilities / structures according to the terrain / geographical features of the project site;
- Landscape treatment of structures such as foundations of viaduct segment, site offices, buildings and tunnel portals can also minimize visual impacts;
- Existing trees / plants within the construction boundary should be tagged to indicate whether the trees are to be retaining, transplanted or removed. Transplantation of existing trees affected by the project works should be carried out prior to commencement of construction;
- Excavations should avoid damage to the root systems. Mitigation measures are also required to prevent damage to trunks and branches of trees;
- Temporary hoarding barriers should be of a recessive visual appearance in both colour and form;
- Upon completion of the construction, the affected areas should be immediately restored to their original condition, including the re-creation of natural and rocky shoreline, footpath and re-establishment of disturbed vegetation.
<table>
<thead>
<tr>
<th>Type of Work</th>
<th>Activity / Env. Issue</th>
<th>Timing</th>
<th>Mitigation Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Master Landscape Plan</td>
<td>During Design Stage (DS)</td>
<td>A Master Landscape Plan should be prepared during the design stage which should include preliminary designs on the temporary and permanent landscaping plan during both the construction and post-construction maintenance period. The landscape plan should cover all project works which may affect vegetation and natural landform (e.g. borrow pits, disposal sites, slopes and temporary stockpiling areas). Sensitive locations and areas where landscaping works are required both during construction and after the construction should be identified and incorporated into the design.</td>
</tr>
<tr>
<td>General</td>
<td>Construction area and programme</td>
<td>During Design Stage (DS)</td>
<td>The construction programme for the Project should be reduced to the shortest possible period and should be executed in phases, particularly in those locations where severe or high landscape and visual impacts are expected. Additionally, the extent and periphery of the works areas should be managed so that they are as small as possible and do not appear cluttered, untidy and unattractive, particularly to pedestrians and people undertaking recreation activities.</td>
</tr>
<tr>
<td>General</td>
<td>Site hoarding</td>
<td>During Design Stage (DS)</td>
<td>Temporary hoarding barriers should be of a recessive visual appearance in both colour and form.</td>
</tr>
<tr>
<td>General</td>
<td>Contractor's Landscape Implementation Programme and Compensatory Planting Plan</td>
<td>Before Construction (BC)</td>
<td>Contractor's Landscape Implementation Programme and Compensatory Plan should be prepared. This document will need to include project-specific details about when, where and how landscaping works / soil erosion will be carried out during both the construction and post-construction period. It should also include temporary measures to protect exposed surfaces / slopes during rainy periods (e.g. advance grass seeding and fully coverage of exposed slopes).</td>
</tr>
<tr>
<td>General</td>
<td>Visual intrusion</td>
<td>During Construction (C)</td>
<td>Hoardings, fences, gates and signs on the Site should be maintained in a clean, stable and secure condition.</td>
</tr>
<tr>
<td>General</td>
<td>Visual intrusion</td>
<td>During Construction (C)</td>
<td>The permission of the ER should be obtained before hoardings, fences, gates or signs are removed. Hoardings, fences, gates and signs which are to be left in position after completion of the Works should be repaired and repainted as instructed by the ER.</td>
</tr>
<tr>
<td>General</td>
<td>Visual intrusion</td>
<td>During Construction (C)</td>
<td>The ends of fences, walls, structures, utilities and other items should be made good in such a manner that the affected parts will not corrode or deteriorate, and will remain stable.</td>
</tr>
<tr>
<td>General</td>
<td>Storage of material on site</td>
<td>During Construction (C)</td>
<td>Measures should be implemented during construction to store materials in areas with the least obstruction to residents, pedestrians and traffic and cover all material stockpiles with impermeable material and sandbagging diversions around exposed soil.</td>
</tr>
<tr>
<td>Type of Work</td>
<td>Activity / Env. Issue</td>
<td>Timing</td>
<td>Mitigation Measure</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------------------------------------------</td>
<td>-----------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>General</td>
<td>Contractor(s) Landscape Programme / Plan</td>
<td>During Construction (C)</td>
<td>In compensation for the disturbance, a Landscape Implementation Programme and Compensatory Planting Plan should be prepared by the Contractor(s) before commencement of construction and implemented during construction and maintenance period.</td>
</tr>
<tr>
<td>General</td>
<td>Damage to trees / vegetation</td>
<td>During Construction (C)</td>
<td>Excavations should avoid damage to the root systems. Mitigation measures are also required to prevent damage to trunks and branches of trees.</td>
</tr>
<tr>
<td>General</td>
<td>Surface run-off control</td>
<td>During Construction (C)</td>
<td>Surface water run-off must be controlled to avoid contaminated run-off affecting trees and other vegetation.</td>
</tr>
<tr>
<td>Earthworks</td>
<td>Soil Erosion</td>
<td>During Construction (C)</td>
<td>Earthworks material should not be handled or stored in a manner which will result in segregation, deterioration, erosion or instability of the material.</td>
</tr>
<tr>
<td>Earthworks</td>
<td>Filling material</td>
<td>During Construction (C)</td>
<td>Fill material should not contain any of the following: (a) peat, vegetation, timber, organic, soluble or perishable material; dangerous or toxic material or material susceptible to combustion.</td>
</tr>
<tr>
<td>Landscaping</td>
<td>Transplanting of trees and compensatory planting</td>
<td>During Construction (C)</td>
<td>Where possible, the transplantation of existing trees affected by the proposed works and new compensatory planting works should be carried out as early as possible in the construction period instead of at the end. This will allow the maximum time for maintenance, resulting in a higher success rate for the survival of transplanted trees and the early establishment of new screen trees and compensatory planting.</td>
</tr>
<tr>
<td>General</td>
<td>Restoration of affected areas</td>
<td>Post Construction (PF)</td>
<td>Upon completion of the construction works, the affected areas should be restored to their original condition, including the recreation of natural and rocky shoreline, footpath and re-establishment of disturbed vegetation. Where mature trees are felled that are considered high in environmental amenity, a replacement semi-mature tree should be planted. Existing trees cleared by construction activity should be replaced so that there is a net gain in tree numbers after the project is completed. Native species should be selected during restoration.</td>
</tr>
<tr>
<td>General</td>
<td>Restoration of affected areas</td>
<td>Post Construction (PF)</td>
<td>The revegetation schemes should be designed to require minimal maintenance. Therefore, selection of appropriate native species of good quality will be of particular importance. There should be adequate care during planting and adequate initial watering and fertilization.</td>
</tr>
</tbody>
</table>
4.7 Ecology

4.7.1 Key Aspects

Ecological impact refers to the effect on a habitat or species due to direct or indirect changes in the environment brought about by a project. Besides magnitude and scale, the significance of an ecological impact is also related to the habitat or species to be affected. In general, the impact on an important habitat or species will be more significant in comparison to other less important one.

4.7.2 Ecological Reference Information

The documentation that should be reviewed by construction workers and the environmental team should include:

- The Ecology Section of the EIA Report - in particular where potential impacts have been identified, who the sensitive receivers are in the area and the mitigation measures that should be included as part of their working practices to reduce ecological impact from project related works.
- The Environmental Management Plan (EMP) - which should set out the monitoring and audit of ecological impact on the site and the details of the pollutants that will be monitored, the frequency of monitoring, how this information will be reported and how enforcement of implementation of the required mitigation measures for reducing ecological impact will be carried out.

4.7.3 General Good Working Practices to Review

Adopting good working practices can considerably reduce ecological impact on site. These include basic measures such as minimizing the physical extent of the site, erecting fences to protect species and prompt reinstatement upon completion of work during construction period.

Some general good working practices are provided as follows to control ecological impacts. These should be considered with the findings and recommendations in the Project Specific EIA and EMP.

- The extent of site clearance, formation and removal of vegetation during the beginning of the project should be controlled through careful design and route selection to minimize the amount of plants / animals affected by the project. Protected areas, key sensitive locations and areas for rare / endangered species should be avoided;
- Prior to commencement of construction and site clearance additional ecological survey should be carried out by the project ecologist to confirm the findings of the EA and to carry out detailed ecological assessment for the proposed construction area / access roads. Mitigation measures should be proposed by the project ecologist for protection of rare species identified in the survey;
- Erect fences along the boundary of construction sites before the commencement of works to prevent tipping, vehicle movements, and encroachment of personnel into adjacent areas, particularly streams, forest and other ecologically sensitive location;
- The area of land occupation required should be controlled to a minimal level. Occupation of agricultural lands / farmlands should be avoided;
- Sufficient trainings on ecological protection and mitigation measures should be provided to construction workers and site management staff;
- An evaluation programme should be established to assess and evaluate the proposed mitigation measures and to propose new mitigation measures should inadequacy be identified;
- Protection of sensitive areas which are inaccessible prior to the project should be maintained through careful design and proper route selection process.
- Topsoil should be retained on-site during excavation and restored after works;
- Work site boundaries should be regularly checked to ensure that they are not exceeded and that no damage occurs to surrounding areas;
- Treat any damage that may occur to individual major trees in the adjacent area with surgery;
- Prohibit and prevent open fires during construction and provide temporary fire fighting equipment in the work areas, particularly close to forest areas;
- The roots of trees and shrubs which have been cut down should be mulched. Branches should not be removed from trees which are to be retained. The cut surfaces should be treated with a wound sealant;
- Restoration and re-vegetation should be carried out timely for the exposed slopes / soils and finished areas should be reinstated in order to achieve the stability of slopes and maintain soil integrity; and
- Local native species should be selected for the compensatory planting and restoration of the natural landform.

Table 4.7 provides a checklist for good practices.
<table>
<thead>
<tr>
<th>Type of Work</th>
<th>Activity / Env. Issue</th>
<th>Timing</th>
<th>Mitigation Measure</th>
<th>Compliance Status (Yes = compliant; No = non-compliant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological Protection</td>
<td>Incorporation in Design</td>
<td>During Design Stage (DS)</td>
<td>Areas of ecologically value identified in the EIA should be incorporated into the design. Disturbance to these areas should be avoided and control measures should be incorporated into the design.</td>
<td></td>
</tr>
<tr>
<td>Ecological Protection</td>
<td>Design of Facilities</td>
<td>During Design Stage (DS)</td>
<td>Key facilities should be sited during the design process to ensure that no important ecological resources will be adversely affected.</td>
<td></td>
</tr>
<tr>
<td>Ecological Protection</td>
<td>Incorporation in Design</td>
<td>During Design Stage (DS)</td>
<td>The physical extent of construction works should be minimized as far as is practicable and should not beyond the RoW. Excavations should be minimized by careful route alignment at the design stage.</td>
<td></td>
</tr>
<tr>
<td>Ecological Protection</td>
<td>Establishment of work site boundaries</td>
<td>Before Construction (BC)</td>
<td>Erect fences along the boundary of construction sites before the commencement of works to prevent tipping, vehicle movements, and encroachment of personnel into adjacent areas, particularly streams, forest and other ecologically sensitive locations.</td>
<td></td>
</tr>
<tr>
<td>Ecological Protection</td>
<td>Establishment of work site boundaries</td>
<td>During Construction (C)</td>
<td>Regularly check the work site boundaries to ensure that they are not exceeded and that no damage occurs to surrounding areas.</td>
<td></td>
</tr>
<tr>
<td>Ecological Protection</td>
<td>Damage/removal of trees</td>
<td>During Construction (C)</td>
<td>Treat any damage that may occur to individual major trees in the adjacent area with surgery.</td>
<td></td>
</tr>
<tr>
<td>Ecological Protection</td>
<td>Reinstatement of disturbed areas</td>
<td>During Construction (C)</td>
<td>Reinstate temporary work sites/disturbed areas immediately after completion of the construction by on-site tree/shrub planting. Tree/shrub species used should take reference from those in the surrounding area.</td>
<td></td>
</tr>
<tr>
<td>Ecological Protection</td>
<td>Prohibition of open fires</td>
<td>During Construction (C)</td>
<td>Prohibit and prevent open fires during construction and provide temporary fire fighting equipment in the work areas, particularly close to forest areas.</td>
<td></td>
</tr>
<tr>
<td>Ecological Protection</td>
<td>Damage/removal of trees</td>
<td>During Construction (C)</td>
<td>Trees should not be felled without prior approval from the ER and / or the authority.</td>
<td></td>
</tr>
<tr>
<td>Ecological Protection</td>
<td>Damage/removal of trees</td>
<td>During Construction (C)</td>
<td>Trees which are to be retained or which are not required to be removed in order to carry out the Works, should be protected from damage at all times by methods agreed by the ER. Materials, including excavated materials, should not be banked around such trees ad they should not be trimmed or cut without the approval of the ER.</td>
<td></td>
</tr>
<tr>
<td>Ecological Protection</td>
<td>Damage/removal of trees</td>
<td>During Construction (C)</td>
<td>The roots of trees and shrubs which have been cut down should be grubbed up. Branches should not be removed from trees which are to be retained unless permitted by the ER; if permitted, the cut surfaces should be treated with a wound sealant approved by the ER.</td>
<td></td>
</tr>
<tr>
<td>Ecological Protection</td>
<td>Damage to natural resources / utilities</td>
<td>During Construction (C)</td>
<td>Work should be carried out in such a manner that, as far as practicable, there is no damage to or interference with the following, other than such damage as is required to enable the execution of the works: (a) watercourses or drainage systems; (b) utilities; (c) structures, roads including street furniture, or other property; and (d) trees, graves or burial urns.</td>
<td></td>
</tr>
<tr>
<td>Tunneling</td>
<td>Prevention of stream sedimentation</td>
<td>During Construction (C)</td>
<td>Prevent stream sedimentation during construction, particularly tunnel construction, by erection of sediment barriers and operation of stilling ponds in streams which could be potentially affected.</td>
<td></td>
</tr>
<tr>
<td>Restoration</td>
<td>Restoration of natural landform</td>
<td>Post Construction (PF)</td>
<td>Local native species should be selected for the compensatory planting and restoration of the natural landform. Soil integrity should be maintained.</td>
<td></td>
</tr>
</tbody>
</table>
4.8 Cultural Aspects

4.8.1 Key Environmental Aspects

Potential impacts to cultural sites and heritage relics may include:

- Loss of cultural sites due to the project;
- Potential damage of the structure / stability of the cultural site during construction of the project;
- Damage to the cultural site due to vibration during operation of the project.

4.8.2 Reference Information

The documentation that should be reviewed by construction workers and the environmental team should include:

- The Cultural Aspects Section of the EIA Report - in particular where potential impacts have been identified, who the sensitive receivers are in the area and the mitigation measures that should be included as part of their working practices to reduce impact to cultural aspects from project related works; and
- The Environmental Management Plan (EMP) - which should set out the monitoring and audit of impact to cultural aspects on the site and the details of the impacts that will be measured, the frequency of measuring, how this information will be reported and how enforcement of implementation of the required mitigation measures for reducing impact to cultural aspects will be carried out.

4.8.3 General Good Working Practices to Review

Adopting good working practices can considerably reduce impact to cultural aspects on site. These include basic measures such as conducting cultural resources study, incorporating mitigation measures into design and undertaking continuous monitoring by qualified staff during construction period.

Some general good working practices are provided in the following to control impact to cultural aspects. These should be considered with the findings and recommendations in the Project Specific EIA and EMP.

- A study on cultural resources / heritage relics should be undertaken at the early stage of the project design in order to collect background information regarding the number, location and importance of cultural resources within the project boundary;
- Should impact be resulted due to the project, mitigation measures and rescue measures should be proposed which should be incorporated into the design. The project alignment should then be reviewed and adjusted so that the impact can be minimized or avoided. General speaking, the project should avoid passing through the cultural areas directly;
- Should impact due to the project be unavoidable, suitable mitigation measures and monitoring process should be fully considered in the design and included in the project contract;
- Should the cultural site be an archaeological site, archaeological investigation should be undertaken prior to the project and construction should not be commenced until the investigation's completed;
- Qualified professional staff should undertake continuous monitoring of the impact on cultural areas during both the construction and operational phases of the project. Further mitigation measures should be taken should adverse impact be identified.
5. Environmental Records

5.1 EMP Equipment

The equipment and test methods to be adopted for the monitoring works should comply with the requirements stipulated in the relevant local legislative environmental quality standards. The monitoring equipment should be calibrated regularly and re-calibrated prior to each in-site measurement. All the calibration records should be properly documented by the ET for future reference and audit by the concerned parties such as the ER and the Consultant.

An accredited laboratory should be used for the laboratory analysis should. Test methods and equipment requirements should comply with the local legislative requirements.

5.2 EM&A Records

All the monitoring results should be properly documented by the ET for future reference and audited by the concerned parties such as the ER and the Consultant. Template of field measurement record is provided in Appendix C. ET should keep copies of all site records, reports, approvals, statutory documents, certificates, licenses or permits in relation to environmental matters for recording purposes.

Any changes to the monitoring equipment and monitoring methodology should be approved by the ER and verified by the Consultant as necessary. Based on the nature of project works, prior approval, licenses or permits may be required for certain activities and/or restricted time periods, all these records must be kept on site by the ET and made available for audit. Table 5.1 sets out the general list of records that should be maintained by the ET in each respective activity site office.

<table>
<thead>
<tr>
<th>Category</th>
<th>Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Environmental training records (e.g. attendance records for environmental awareness training, topics covered)</td>
</tr>
<tr>
<td></td>
<td>Environmental permits / licences</td>
</tr>
<tr>
<td></td>
<td>Site diary and site inspection records</td>
</tr>
<tr>
<td></td>
<td>Environmental log-book, complaint log-book and environmental quality limits exceedances notification forms;</td>
</tr>
<tr>
<td></td>
<td>Construction programme</td>
</tr>
<tr>
<td></td>
<td>Equipment maintenance / repair records</td>
</tr>
<tr>
<td></td>
<td>Correspondence with concerned parties and other parties in relation to environmental matters</td>
</tr>
<tr>
<td></td>
<td>Meeting minutes</td>
</tr>
<tr>
<td>Noise Control</td>
<td>Updated list of Powered Mechanical Equipment currently on-site</td>
</tr>
<tr>
<td></td>
<td>Details of examination periods if any local schools may be affected</td>
</tr>
<tr>
<td>Water Pollution Control</td>
<td>Plans of construction site drainage</td>
</tr>
<tr>
<td></td>
<td>Records of quantities of collected spent bentonite slurries and/or drilling muds for reuse, reconditioning and disposal</td>
</tr>
<tr>
<td></td>
<td>Records of maintenance and cleaning schedules for sediment and oil/grease traps</td>
</tr>
<tr>
<td></td>
<td>Records of toilet sewage disposal (where connection to existing foul sewer main is not undertaken)</td>
</tr>
<tr>
<td>Waste Management</td>
<td>Copies of relevant valid licences as provided by the employed waste hauliers and waste collectors</td>
</tr>
<tr>
<td></td>
<td>Records of quantities of reused and recycled waste</td>
</tr>
<tr>
<td></td>
<td>Records of quantities of inert waste transferred to other Project activity sites for fill purposes (if any)</td>
</tr>
<tr>
<td></td>
<td>Waste disposal records</td>
</tr>
<tr>
<td>Land Contamination</td>
<td>Preliminary analysis results of materials suspected to be contaminated (if any)</td>
</tr>
<tr>
<td>Ecological Resources</td>
<td>Records of sensitive ecological resources locations and associated protection plan</td>
</tr>
</tbody>
</table>
5.3 Contractor’s Project Document Submissions

The Contractor(s) should be required to provide details of their procedures, program and plans. These submissions should be checked by the ET and approved by the ER and the Consultant as conforming to the environmental requirements in EA and EMP, and audited / updated throughout the construction phase. The document submission required by the Contractor(s) includes but not limited to:

- EMP Implementation Plan (including works method statements);
- Waste Management Plan;
- Landscape Implementation Program and Compensatory Planting Plan;
- Site Drainage Management Plan; and
- Other Works Method Standards

5.4 Environmental Monitoring And Audit (EM&A) Reports

5.4.1 EM&A Reports

The results and findings of all EM&A works required for the project should be recorded in the monthly EM&A reports prepared by the ET Leader. The EM&A report should be endorsed by IEC and ER and submitted within two weeks after the end of each reporting month, with the first report due the month after construction commences.

Before submission of the first EM&A report, the ET Leader should liaise with the parties on the exact number of copies and format of the monthly reports in both hard copy and electronic medium requirement.

The ET Leader should review the number and location of monitoring stations and parameters to monitor quarterly or on an as needed basis in order to cater for the changes in surrounding environment and nature of works in progress.

The Monthly EM&A Report should include at least the following:

(a) 1-2 pages executive summary;
- Breaches of environmental compliance levels
- Complaints Log
- Notifications of any summons and successful prosecutions
- Reporting Changes
- Future key issues

(b) Basic Project Information
- Project organisations including key personnel contact names and telephone numbers
- Construction programme
- Management structure
- Works undertaken during the month

(c) Environmental Status
- Work undertaken during the month with illustrations (such as location of works and activities)
- Drawing showing the project area, any environmental sensitive receivers and the locations of the monitoring stations

(d) Summary of EM&A requirements
- All monitoring parameters
- Environmental compliance levels
- Event-Action Plans
- Environmental mitigation measures, as recommended in the project EIA Report
- Environmental requirements in contract documents

(e) Implementation Status
- Advice on the implementation status of environmental protection and pollution control/mitigation measures, as recommended in the project EIA Report, summarised in the implementation schedule.

(f) Monitoring Results
To provide monitoring results together with the following information:
- Monitoring methodology
- Name of laboratory and types of equipment used and calibration details
- Parameters monitored
- Monitoring locations (and depth)
- Monitoring date, time, frequency, and duration.
- Weather conditions during the period.
- Any other factors which might affect the monitoring results.
- QA/QC results and detection limits

(g) Report on Non-compliance, Complaints, Notifications of Summons and Successful Prosecutions
- Record of all noncompliance (exceedances) of the environmental quality performance limits (AL / LL Levels).
• Record of all complaints received (written or verbal) for each media, including locations and nature of complaints investigation, liaison and consultation undertaken, actions and follow-up procedures taken, results and summary.

• Record of all notifications of summons and successful prosecutions for breaches of the current environmental protection/pollution control legislations, including locations and nature of the breaches, investigation, follow-up actions taken, results and summary.

• Review of the reasons for and the implications of non-compliance, complaints, summons and prosecutions including review of pollution sources and working procedures.

• Description of the actions taken in the event of noncompliance and deficiency reporting and any follow-up procedures related to earlier noncompliance.

(h) Others

• An account of the future key issues as reviewed from the works programme and works method statements.

• Advice on the solid and liquid waste management status.

5.4.2 Data Keeping

The site document such as the raw monitoring field records, laboratory analysis records, etc. are generally not required to be included in the monthly EM&A reports for submission. However, the document should be well kept by the ET and be ready for inspection upon request. All relevant information should be clearly and systematically recorded in the document.

The monitoring data should also be recorded electronically if possible, and the software copy can be available upon request. All the documents and data should be kept throughout the project construction and maintenance periods, and should be made available to the Project Proponent upon request within one year after the completion of the project.

The results and findings of all EM&A works should be reported in the monthly EM&A reports prepared by the ET. The EM&A report should be endorsed by the IEC and ER.

The ET should review the number and location of monitoring stations and parameters to monitor quarterly or on an as needed basis in order to cater for the changes in surrounding environment and nature of works in progress.
6. Environmental Training and Awareness

The Contractors should ensure that all concerned staff are aware of the relevant environmental requirements as stipulated in local environmental legislation and the Contract specifications. To achieve this, they should distribute to the key staff, including newly joined key staff members, which should include but not be limited to the following:

- Contractor's Environmental Policy;
- Copies of the relevant extracts from the environmental documents

The Contractor should provide appropriate training to all staff. This should be tailored to suit their level of responsibility for environmental matters. The Contractor should also ensure that all site staff members are aware of the emergency response procedures. All staff should receive environmental induction training and managerial staff should receive additional training. The training materials should be reviewed by the ET and submitted to the ER for approval. Additional refresher training may be provided and this should be scheduled following periodic internal review of requirements for the Project activity concerned. Records should be maintained for staff environmental training and submitted to the ER upon request.

Records should be kept on site where possible for each project activity for easy access during site audits or enquiries. Environmental training records (e.g. attendance records for environmental awareness training, topics covered) should be kept.
7. Complaint and Public Relation Procedures

7.1 Public Relationship

A good public relationship should be maintained through the project. Communication channel between the Contractor(s), ER and the public can be enhanced through setting up hotline and regular meetings with local residents and communities. Understanding the needs, tradition and behaviors of local communities and the timing response for queries can effectively reduce number of complaints resulted from the project and the potential conflicts that may lead to.

7.2 Complaint Investigation

- Complaints should be referred to the ET for carrying out complaint investigation procedures. The ET should undertake the following procedures upon receipt of complaint.
  - log complaint and date of receipt onto the complaint database and inform the ER and / or the IEC immediately;
  - investigate the complaint to determine its validity, and to assess whether the source of the problem is due to works activities;
  - if a complaint is valid and due to works, identify mitigation measures;
  - if mitigation measures are required, advise the Contractor(s) accordingly;
  - review the Contractor's response on the identified mitigation measures, and the updated situation;
  - if the complaint is transferred from the local government authority, submit interim report to local government authority on status of the complaint investigation and follow-up action within the time frame assigned by local government authority;
  - undertake additional monitoring and audit to verify the situation if necessary, and review that any valid reason for complaint does not recur;
  - report the investigation results and the subsequent actions to the source of complaint for responding to complainant (If the source of complaint is local government authority), the results should be reported within the time frame assigned by local government authority); and
  - record the complaint, investigation, the subsequent actions and the results in the monthly EM&A reports.

During the complaint investigation work, the Contractor and ER should cooperate with the ET in providing all the necessary information and assistance for completion of the investigation. If mitigation measures are identified in the investigation, the Contractor(s) should promptly carry out the mitigation. The ER should ensure that the measures have been carried out by the Contractor(s).
Annexes
A.1 Site Formation (Excavation, Earth Moving, Filling, Slope Cutting)

DESCRIPTION

Site formation including excavation, earth moving, filling and slope cutting can result in excessive noise, fugitive dust, and impacts to sensitive areas. Good Working practices can help to minimize these types of adverse impacts to environment.

KEY ASPECTS OF CONCERN

Noise

☑ During excavation noise can be caused by powered mechanical equipment, drilling, blasting and scraping and cutting works.

Air Quality

☑ Dust emissions are common during earth moving activities for site formation, in particular in dry weather and from stockpile materials.

Water Quality / Ecology

☑ Soil excavation and grading operations loosen large amounts of soil that can flow or accumulate in storm drains. Once this material enters the watercourse, water quality and ecology can be adversely affected.

Waste / Land Contamination

☑ Spoil and excavated materials are often generated during site formation. Balancing this material on site and / reuse for access road base or other fill material is preferred.

Landscape and Visual

☑ Tree felling and slope cutting can significantly affect the overall landscape characteristics and the aesthetics of an area and can cause further erosion and instability to soil.

Objectives

Site formation activities can result in adverse impacts to the environment. The objective of this Annex is to describe the environmental issues associated with the site formation activities and to review practices that can help reduce environmental impacts.

Environmental Aspects

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td>☑</td>
</tr>
<tr>
<td>Air quality</td>
<td>☑</td>
</tr>
<tr>
<td>Water quality</td>
<td>☑</td>
</tr>
<tr>
<td>Ecology</td>
<td>☑</td>
</tr>
<tr>
<td>Waste</td>
<td>☑</td>
</tr>
<tr>
<td>Land contamination</td>
<td>☑</td>
</tr>
<tr>
<td>Landscape &amp; Visual</td>
<td>☑</td>
</tr>
</tbody>
</table>

Timing of Consideration

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CONTROL ACTIVITIES

Noise
- Movable noise enclosures can be placed around noisy plant.
- Locating noise emitting plants far from sensitive receivers.
- Scheduling noisy operations during daytime and avoiding nighttime works.
- Regular maintenance of site plant/ equipment.
- Shut down machines and plant in intermittent use between work periods.
- Utilizing material stockpiles and other structures to screen noise.
- Application of properly designed silencers, mufflers, acoustically dampened panels and acoustic sheds or shields, etc.
- Preferred use of electric-powered equipment over diesel-powered or pneumatic-powered equipment.
- Good relationship with local community.

Air Quality
- Watering twice a day.
- Covering or wetting stockpiled material.
- Watering materials prior to loading, unloading or transfer.
- Watering during and after any excavation or earth moving operation.
- Controlling and reducing the height from which excavated materials are dropped.
- Compaction, turfing, hydroseeding, vegetation planting or sealing with latex, vinyl, bitumen, shotcrete or other suitable surface stabilizer on exposed earth.
- Reducing exposed surfaces to a minimum.
- Covering demolished items such as shrubs, pillars that may dislodge dust particles.

Water Quality
- Treating open cut slopes and excavations (e.g. grass seeding, slope stabilization measures) to prevent slope slides and soil erosion.
- Stabilizing earthworks final surfaces and formations from damage.
- Protecting down slope drainage courses, streams, and storm drains with temporary drainage, silt fences, berms or storm drain inlet filters.
- Using check dams or ditches to divert runoff around excavations and graded areas.

Waste
- Balancing cut and fit and maximizing the opportunity for re-use of materials.
- Converting unsuitable excavated materials for use in other purpose (e.g. upgrading of subsoil to topsoil by mixing with compost).
- Segregation of excavated topsoil from roots and re-use for the landscaping works to minimize the volume of waste requiring off-site disposal.
- Developing special handling and disposal procedures if contaminated materials are to be excavated.
- Ensuring care during refueling of plant and storing necessary lubricants properly in sealed contains on panel surfaces and avoiding spillage during their use.

Landscape and Visual
- Removal of existing vegetation only as necessary.
- Seed or plant temporary vegetation for erosion control on slopes or where construction is not immediately planned.
- Avoid unnecessary damage to trees and root structures fence off important areas as required.
- Development of landscape plan and inclusion of native species.

Erosion and Sediment Control
- Install permanent erosion and sediment control structures at the beginning of construction.
- Apply permanent or temporary soil stabilization practices to cleared areas within a defined period.
- Coordinate temporary erosion and sediment control structures with permanent practices.
- Remove all temporary erosion and sediment controls structures after site stabilization.
- Wash all vehicles prior to leaving the construction site.
- Minimize the area that is cleared for construction.
- Consider the length and steepness of slopes, soil types, upslope drainage areas and ground-water conditions in cut-and-fill slopes.
- Minimize runoff entering and leaving the site through perimeter and onsite sediment controls.
- Divert and convey offsite runoff around disturbed soils and steep slopes to stable areas.
- Protect all storm drain inlets that are made operable from sediment-laden water.

REFERENCES
**A.2 Establishment of Work Site Areas and Construction Camp Activities**

**DESCRIPTION**

Establishment of work site areas and construction camp activities can result in short and long term environmental impacts. Works site areas can act as storage sites for materials and equipment and construction camps may include temporary housing and offices for construction workers. Site selection should be subject to environmental assessment and establishment of facilities and activities at these sites should follow good working practices to avoid adverse environmental impacts.

**KEY ASPECTS OF CONCERN**

**Noise and Air Quality**
- During site establishment and operations, noise can be generated from workers and movement of heavy machinery and vehicle transport of good and materials to site. Air quality can also be affected if site and haul roads are unpaved.

**Water Quality**
- Activities at work sites and construction camps can generate large amounts of wastewater which require treatment prior to discharge and appropriate drainage should be established to reduce sediment laden runoff.

**Ecology**
- Consideration of the local ecology should be provided prior to selection of the sites and water courses and other environmental sensitive areas such as forests and wetlands should be avoided to minimize impacts to ecology.

**Waste**
- Improper or insufficient waste management facilities and policies can lead to waste problems such as stockpiling of waste, illegal dumping and disposed of recyclable materials to landfill.

**Land Contamination**
- Spillage and leakage from storage of oil or chemical / hazardous substances can potentially contaminate the ground and water bodies.

**Landscape & Visual**
- Visual impacts can result if these areas are located in sensitive areas and are not properly shielded or if good housekeeping is not maintained.

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**Objectives**

The establishment of work site areas and construction camps can result in adverse impacts to the environment. The objective of this Annex is to identify the environmental issues with the establishment of work site areas and to identify practices that can help reduce adverse environmental impacts.

**Environmental Aspects**

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CONTROL ACTIVITIES

Construction Camp Facilities

- Avoidance of extensive site clearance involving the removal of walls, hedges, ditches, and trees, other vegetation during their establishment.
- Provision of the following facilities:
  - A perimeter security fence.
  - Facilities for washing clothes, latrines and urinals, and separate bathing facilities for male and female workers.
  - Provision of suitable potable water.
- Provision bunded areas with compacted / impervious floor for the storage of fuel or lubricants and for a maintenance workshop.
- Provision treatment for wastewater discharges from toilets, wash rooms and showers.
- Provision storm water drainage system to avoid water egress on the site and to discharge all surface run off from the camp to a silt retention pond.
- Provision waste disposal facilities including septic tanks for the disposal of sanitary wastes and excreta, soak pits for kitchen wastes, and kitchen sump for wastewater.
- Reuse of solid wastes and development of a waste management plan to dispose waste frame the site dispose to land fill.
- Paving access roads to the sites and transport connection with the site area.
- Ensure fire breaks and effective fire prevention policy is in place.
- Proper containment of oil and grease and avoidance of discharge to water bodies.
- Restricting the following activities on and around the site:
  - Use of rivers streams for washing of clothes.
  - Use of welding equipment, oxy-acetylene torches and other bare flames.
  - Indiscriminate disposal of rubbish or construction wastes.
  - Spillage of potential pollutants, such as petroleum products.
  - Collection of firewood.
  - Poaching of any description.
  - Latrining outside of the designated facilities.
  - Burning of wastes and/or cleared vegetation.
- Dismantle and remove all construction camp facilities from the site and reinstate the site at the completion of the construction work to a similar or better state.

Work Site Areas

- Protection measures for soil and water bodies should be established such as:
  - Preventing discharge of silty water into watercourses.
  - Having all materials to be used during construction and operation shall be identified and their hazard potential evaluated.
- Maintenance of vehicles and equipment involving activities with potential for leakage and spillage only to be undertaken with the areas appropriately equipped to control these discharges.
- Any construction plant which causes pollution to catchwaters or water bodies due to leakage of oil or fuel should not be used.
- Suitable containers should be used to hold the chemical wastes to avoid leakage or spillage during storage, handling and transport.
- Large and heavy containers shall be stored at ground level.
- Chemical waste containers shall be stored below eye level.
- Incompatible chemicals should be stored separately.
- All workers should be made aware of emergency contact numbers and the location of all relevant pollution control equipment.
- A Waste Management Plan (WMP) for the works site areas should be prepared prior to operation.
- Temporary refuse collection facilities should be set-up by the contractor and wastes should be stored in appropriate containers prior to collection and disposal.
- Domestic effluent generated by the workforce should be directed to chemical toilets if public facilities are not available.
- Effective dust screens, sheeting or netting should be provided around the work site.
- Dump truck loads with material should be covered by sheeting.
- Dusty materials or stockpiles should be covered by sheeting or sprayed with water so as to maintain the entire surface wet.

Noise

- Movable noise enclosures can be placed around noisy plant.
- Locating noise emitting plants far from sensitive receivers.
- Scheduling noisy operations during daytime and avoiding nighttime works.
- Regular maintenance of site plant/ equipment.

REFERENCES

1. Construction Camps, Anil H. Somani
http://www7.caret.cam.ac.uk/guide_roads_in_dev_countries.htm
A.3 Borrow Areas and Quarries

DESCRIPTION

Borrow area and quarries can result in significant environmental impacts such as noise and dust to neighboring residents disturbance to the existing habitats, local pollution to river, landscape and visual impacts. Careful considerations in the operations of borrow areas and quarries can help to reduce the environmental impacts.

KEY ASPECTS OF CONCERN

Noise

☑ Operations at quarries and excavating borrow areas have the potential to produce noise from heavy equipment, sizing, loading and transport of materials.

Air Quality

☑ The primary air emissions associated with borrow areas and quarries operations are dust which can affect workers and neighboring residents and can be affect ambient air quality.

Water Quality

☑ Sediment laden runoff can be a source of pollution from these operations.

Landscape and Visual / Ecology

☑ Excavation and mining can have a significant impact on landform and can result in visual impacts and if care is not taken during the selection of their location, ecological impacts can result.

Objectives

The operation of borrow areas and quarries can result in adverse impacts to the environment. The objective of this Annex is to identify the environmental issues associated with the operation of borrow areas and quarries and to identify practices that can help reduce environmental impacts.

Environmental Aspects

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CONTROL ACTIVITIES

Operating Borrow

- Inspect borrow pits and record all earthwork operations (i.e. areas excavated, depth of cut, and adequacy of the equipment) performed in the borrow pit.
- Treat borrow areas through stockpiling topsoil when first opening the borrow pit. After all usable borrow has been removed, spread back the previously stockpiled topsoil over the borrow area and grade it to a smooth, uniform surface, sloped to drain.
- Fertilize and seed the entire area as a final step.

Operating Quarries

- Conduct operations in discrete stages with all valuable material fully extracted so that progressive rehabilitation can be carried out.
- Deposits should be worked in a systematic manner, generally across or down the slope, so that worked out sections can be rehabilitated and left to re-vegetate without further disturbance.
- Where substantial volumes of waste rock or overburden will be produced by the operation of the quarry, this material should be placed in properly designed dumps, which are located and shaped to blend in with the surrounding landscape.
- Minimize the total disturbed area through boundary markers, such as stakes and flagging tape, to indicate to machinery operators the extent of areas to be cleared.
- Avoid blasting in overcast and other adverse weather conditions. Where blasting times are not specified in the Permit, a regular blasting time should be adhered to.
- Quarrying should be carried out in a series of working benches if the material is stable.
- Wherever possible, place stripped topsoil directly onto an area being rehabilitated to avoid stockpiling and double handling. Topsoil is usually the darker, upper soil layers.
- Topsoil will deteriorate in quality while stockpiled and the soil quality can be maintained through:
  - keep it separate from overburden, gravel and other materials;
  - if possible, windrows of topsoil should not exceed one meter in height to reduce ‘souring’;
  - protect topsoil stockpiles from erosion;
  - growing vegetation on the stockpiles (shrubs or grasses) reduces erosion and will maintain biological activity in the soil;
  - excessive handling of topsoil should be avoided.
- Collect all run-off from working areas, which contains sediment in settling ponds before being discharged from the premises.

Noise

- Confine operations to reasonable operating hours.
- Enclosures may be required around crushing and screening plants. Solid barriers, such as bund walls and topographical features, provide the most effective ‘in line’ reduction of sound levels.
- Hydraulic rock breakers produce less noise than secondary blasting with explosives.

Air Quality

- Plant trees for windbreaks or topography and utilize embankments to shield stockpiles and working areas from prevailing winds.
- As conveyors and transfer points can be major sources of dust, enclosures, mist sprays, or approved dust extraction equipment may be required.
- Restrict the speed of vehicles on site especially along unsealed roads in the vicinity of residents.
- Regular watering can suppress dust.
- Restrict the loading height to the minimum amount necessary.

Landscape and Visual

- Keep clearing to the minimum amount necessary for efficient operations.
- Quarry faces should be screened from frequently used roads and commonly visited vantage points.
- Existing topographic features may be utilized as effective screens.
- Where practical, working faces should be oriented away from vantage points and neighbors and uppermost benches should be rehabilitated as soon as possible.

REFERENCES

1. Borrow Areas, Anil H. Somani
A.4 Concrete Batching / Rock Crushing Plant

DESCRIPTION

Environmental concerns with concreting operations relate to the emission of particulates to air and noise, discharge of sediment-laden and sometimes high COD run-off from the plant site that can contaminate surface and groundwater and disposal of wasted concrete. If chilled water is used for concrete batching, the chilling water plant can also release SOx and NOx from the combustion as well as oil and grease from spills. Environmental best practices are thus required to address the environmental concerns.

KEY ASPECTS OF CONCERN

Noise

- The unloading of aggregate, their transfer and mixing and indiscriminate movement of aggregate to stockpiles using front-end loaders and dumpers can cause high levels of noise.

Air Quality

- Movement of vehicles on unpaved haul roads, spillage of sand and blowing of dust from gravel if they are transported uncovered, stockpiles and overhead storage bins or silos by wind action and preparation of concrete can generate dust nuisances.

Water Quality

- Inadequate drainage of the site may lead to creation of stagnant pools of water and attendant problems while mixing of admixtures from drums can have negative impact on water quality.

Objectives

The concrete operation can result in adverse impacts to the environment. The objective of this Annex is to identify the environmental issues associated with concrete operation and to identify practices that can help reduce environmental impacts.

Environmental Aspects

- Noise ✓
- Air quality ✓
- Water quality ✓
- Waste ✓
- Land contamination ✓
- Landscape & Visual ✓
- Ecology ✓

Timing of Consideration

- Planning ✓
- Design ✓
- Construction ✓
- Reinstatement ✓
CONTROL ACTIVITIES

Haulage of raw material to plant site

- The principal impacts during haulage arise from particulate emissions caused due to movement of vehicles on unpaved haul roads, spillage of sand and blowing of dust from gravel if they are transported uncovered. Mitigation measures for haulage of raw material can include a combination of material loss reduction measures and mitigation. These include:
  - Fill up the truck 150mm below the level of top of the shutters to reduce material being blown away by wind.
  - Cover carriage compartments of all trucks / dumpers carrying sand and gravel.
  - Compact or wet the material during loading to ensure that little flies out during transport.
  - Compact haul roads by providing a layer of coarse aggregate on top.
  - Sprinkle water on the haul roads at regular interval and maintain a log-book of this water sprinkling.
  - Prepare contingency plans for spills along haul roads, carry out emergency drills and provide appropriate personal protection equipment.

Storage of material on-site

- If cement, dust or sand is carried by run-off, increased sediment loads may also be observed in receiving streams which can be detrimental to the aquatic ecosystem. Mixing of admixtures from drums can show up as high COD in water due to its large oxygen demand. Mitigation measures include:
  - Pave the plant site with lean concrete to deal with non-point particulate emissions.
  - Sprinkle, do not hose, water over the stockpiles to prevent drying out of the aggregate and water quantity should be regulated such that there is no run-off.
  - Provide temporary wind-shields using sheets and poles, especially for sand stockpiles if permanent storage is not available.
  - Install an automatic shut-down switch to stop the flow of cement to the silo within 60 seconds of the high level alarm activation.
  - Lock the silo delivery pipe at all times except when a delivery is in progress and fit the infill pipe with a fail-safe valve, which is made of wear-resistant materials and able to withstand high velocity product delivery.
  - Overhead bins must be completely covered or all bins must be filled to a maximum level of 1m below the top of the containers to prevent blowing away of material by wind.
  - Cover all conveyors and chutes or have water spraying facilities to reduce emissions of particulates when material is being transported to the bins.
  - Fully enclose conveyor transfer points and hopper discharge areas, and use double rubber curtain seals for transfer point outlets.
  - Fit conveyor belts with belt cleaners on the return side of the conveyors and have regular replacement.
  - Install spill trays under conveyors, especially close to drop points.
  - Cover the admixture drums storage area with temporary or permanent roof.
  - Prevent excessive discharge to rush into areas that may generate high concentrations of sediment such as sand stockpiles or close to the cement silo by bunds made of concrete or other impervious material.
  - Provide adequately sized drains and all such drains should collect the run-off in a collection tank with a sloped bottom (1V: 8H) to easily separate out the sediment carried by the run-off.
  - If the run-off is contaminated with oil & grease, the film may be removed using a boom or other appropriate device before discharge.

Preparation of concrete and transfer to agitator trucks

- Cover the weighing hoppers from 3 sides to prevent release of sand, aggregate or cement to air.
  - Provide a dust collector system on the mixer.
  - Enclose loading bay with drain below the truck area leading to the sump draining into the collection tank.
  - Check the integrity of the admixture dosing system to prevent spillage.
  - Provide ear-plugs to the workers on the mixer plant.
  - Use only prescribed fuel for the boiler. If the emissions of SO\textsubscript{x} and NO\textsubscript{x} from the boiler used for chilled water and any other power requirement are expected to be higher than standards, provide a wet scrubber for the flue gases.
  - Check all truck-mounted agitators for integrity of the structure and proper running of the machinery.
• Have spill prevention and control plan for concrete as well as for fuel used for boilers used in the plant, and conduct periodical drills.

**Vehicle Parking, Washing, and Repairs**

• Instruct operators to allow vehicle parking, washing and repairs only in designated areas.
• Provide an adequately sized sedimentation tank – cum – oil & grease separator for vehicle washing and repair areas before draining water to the collection tank.
• Provide a smaller oil & grease trap in the vehicle parking areas.
• Provide pH correction dosing system before the entry to these traps if acidic chemicals are used in washing agitator trucks.
• Prepare spill prevention and management plans for oil and lubricants as well as for cleaning solutions and conduct drills.
• Provide equipment such as booms, pads, vacuum cleaners, etc. to contain and collect spilled material and personal protective equipment.
• Identify and isolate place for storage of wasted concrete and this area should also be drained into collection tank. A stand-by system for pH correction may be required to reduce the pH before it enters the collection tank.

**REFERENCES**

Concrete Batch Plants, Anil H. Somani

Pollution Solutions Concrete Batching, Operator
Environmental Guide for Environmentally Relevant Activities
62, Brisbane City, April 2000.
A.5 Development of Access Road

DESCRIPTION

The development of access roads to construction works sites particularly for more remote sites can result in removal of natural vegetation, slope cutting, river crossing and other associated works that can impact the environment. Access roads can result in both direct and indirect impacts to the environment and careful planning is required for their design and specific measures need to be undertaken during design and construction and for reinstatement after construction works.

KEY ASPECTS OF CONCERN

Noise
✓ Construction noise impacts can occur if access roads are close to sensitive receivers, e.g. hospitals, schools, residential buildings.

Air Quality
✓ Dust nuisances generated from transport on access roads as well as dust from their construction can affect ambient air quality and sensitive receivers.

Water Quality
✓ Surface run-off from exposed surfaces can cause water pollution to local streams and other water bodies. This can affect drinking water supply, fishing and damage ecology living with the stream cause.

Waste
✓ Construction and demolition waste are generated from the construction of access roads and often these is a significant amount of rock, soil and mitigation that requires disposed.

Ecology / Landscape and Visual
✓ Clearance of natural vegetation and slopes cutting can alter the existing topography and habitats resulting in fragmentation of areas and can have negative impact on the aesthetics of an area.

Objectives

The construction of access roads for construction purposes can result in adverse impacts to the environment. The objective of this Annex is to describe the environmental issues associated with access road construction and to highlight practices that can help reduce environmental impacts.

Environmental Aspects

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CONTROL ACTIVITIES

Construction
- Clearing should be kept to a minimum.
- Clearing should be undertaken in dry months to minimize soil erosion.
- Vegetation removal should be undertaken carefully to avoid soil erosion and damage the ecology.
- Temporary drainage should be constructed along the access roads.
- Natural vegetation near water crossings should be retained as long as possible to minimize soil exposure and erosion.
- Waste material disposal should be carefully considered and should not block the flow of water.
- Earth fills and cuts should be as shallow as possible.
- Construct fills in shallow, full-width layers with stable side slopes.
- The works should be completed in manageable sections.
- Roads should be paved to avoid runoff and dust.

Road Maintenance
- Maintain drainage by carrying out regular inspections, cleaning out of blocked ditches and culverts, etc.
- Grading the road as necessary to remove ruts and maintain crown to shed water.
- Returning loose gravel to the center of the road.
- Removing or trimming back road side vegetation to restore visibility and promote road drying.
- Checking and maintain check dams and sediment traps.
- Reinstatement may be necessary for access roads. Careful consideration of stabilization and planting should be undertaken.

REFERENCES
Access Road, Anil H. Somani
A.6 Tunneling Works

DESCRIPTION

Tunnel excavation undertaken by traditional drill and blast, chemical treatment or tunnel boring machines can have an adverse effect on the environment and appropriate planning and precautionary measures should be undertaken during construction to greatly minimize these environmental impacts.

KEY ASPECTS OF CONCERN

Noise

☑ Blasting and tunnel boring/drilling operations may cause excessive noise and vibration impacts on the community.

Air Quality

☑ Dust nuisances are often generated from the tunneling works, especially during blasting and from vehicles moving on unpaved work sites.

Water Quality

☑ Waste water generated from the tunnel works can be sediment laden and difficult to manage and generally require treatment before discharge.

Waste

☑ Large amounts of spoil can be generated from tunnel works and proper disposed of this material and balancing on site, as much as possible, is important to reduce the quantity of waste material.

Land Contamination

☑ Lubricants and fuels can result in land contamination if improperly used, stored or disposed of.

Landscape & Visual

☑ Changes to landform often occur at tunnel ventilation shafts and areas used for disposal of surplus fill can be visually adverse and change the characteristics of these areas.

Ecology

☑ Runoff of tunnel waste materials and improper disposal of surplus fill and spoil can have an impact on ecology depending on the location of these works.

Objectives

Tunneling work can result in adverse noise, dust and water quality impacts. The objective of this Annex to describe the relevant environmental issues associated with tunneling and to explain practices that can help reduce these impacts.

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CONTROL ACTIVITIES

Noise
- Good site practice and noise management can significantly reduce the impact of tunnelling activities on nearby noise sensitive receivers (NSR) and good community awareness and an understanding of the NSRs is essential.
- Only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction works.
- Material stockpiles and other structures should be effectively utilized, where practicable, to screen noise from activities.
- The timing of blasting should be established to suit the situation and firing blasts when neighbors are busy with their daily tasks (and at a regular time such as lunch time) and outside school exam periods.
- When blasting is undertaken in tunnels, doors (e.g. metal doors) can be installed at the tunnel portal and kept closed during blasting to reduce noise.

Dust
- Measures to reduce dust emissions should be used, such as a sprinkler system or other effective dust suppression measures within the tunnel.
- Solid portal doors can be installed and closed or dust screens, sheeting or netting can be provided to enclose the tunnel portals during dust generating activities and blasting.
- Excavated dusty materials or stockpile of dusty materials should be covered by impervious sheeting or sprayed with water so as to maintain the entire surface wet.
- Main haul road should be used and kept clear of dusty materials or sprayed with water so as to maintain the entire road surface wet.
- Vehicles should be washed to remove any dusty materials from its body and wheels before leaving the construction sites.
- Dusty materials carried by vehicle leaving a construction site should be covered by clean impervious sheeting.
- The working area of excavation should be sprayed with water immediately before, during and immediately after the operations so as to maintain the entire surface wet.
- The area within 30m from the blasting works can be wetted to help reduce dust and wire mesh and sandbags can be used on top of the blast area at each spot to prevent flying rock and dust.
- Dust filters can also be used and fitted to the tunnel construction ventilation system to reduce dust levels.
- Blasting to produce finishes should not be carried out until the concrete has hardened sufficiently for the cement matrix to be removed without disturbing coarse aggregate.

Water Quality
- Sandbags or other measures to provide bunds around the perimeter can help to effectively reduce water egress from the site.
- Appropriate drainage planning and temporary drainage construction is essential around the tunnel portals and works areas.
- Control of discharge of wastewater with suspended materials is important and the provision of sufficiently sized sedimentation tanks is necessary to ensure discharge is controlled.
- Interceptor structures are often used to ensure avoidance of direct works within the stream courses. Identification of strategic location for stockpiles is necessary for avoiding potential impact such as runoff that can be exacerbated during rainstorms.
- All wastewater generated during tunneling should be treated to the appropriate standard before discharge. Wastewater containing oil should also be treated by oil interceptor.

Waste / Land Contamination
- A waste management plan which describes how tunnel waste is managed and ultimately disposed of should be prepared.
- Waste haulers should be advised not to undertake illegal disposal of waste materials.
- Lubricants and fuels need to be stored and used properly to avoid contamination to land and water with sufficient measures for control and clean up in the event of spillage.

Landscape/Visual
- During construction, attractive site hoardings shall be installed around the sites.
- The works areas shall be kept tidy and construction waste shall be properly managed to reduce the visual impact of the construction sites to a minimum.
- The works areas all the portal sites should be kept to a minimum and where possible, the site boundary should maintain a vegetated buffer.
- The site should be reinstated after work has been completed and replanted with native species.

Ecology
- The works should avoid ecologically sensitive areas and the portal works area should be defined to avoid exceeding land encroachment.

REFERENCES
A.7 Surplus Waste Management

DESCRIPTION

Construction of a new road may generate excess waste materials in localities where the quantity of the material is over and above what can be utilized. Good planning and management of surplus waste is essential for reducing the number of disposed sites and the extent of environmental impacts from projects.

KEY ASPECTS OF CONCERN

Air Quality

✔ Dust nuisances can result from stockpiled waste and during transport of waste to other sites or disposal areas. Surplus waste that is improperly disposed and not seeded or landscaped may generate dust.

Water Quality

✔ Improper Storage and disposal or surplus waste can result in water quality impacts from runoff of solids into watercourse and may affect the local ecology.

Waste

✔ Surplus waste can result in burden to landfills and if it is not planned and managed properly can result in impacts to the environment.

Landscape & Visual / Ecology

✔ Waste stockpiles can be intrusive and visually unappealing and disposal sites may significantly change the characteristics of an area and affect local ecology.

Objectives

Surplus waste storage and disposal can result in adverse impacts to the environment. The objective of this Annex is to identify the environmental issues associated with surplus waste materials and to identify good management practices that can help reduce environmental impacts.

Environmental Aspects

| Air quality | ✔ |
| Water quality | ✔ |
| Waste | ✔ |
| Landscape & visual | ✔ |
| Ecology | ✔ |

Timing of Consideration

| Planning | ✔ |
| Design | ✔ |
| Construction | ✔ |
| Reinstatement | ✔ |
CONTROL ACTIVITIES

General Measures for Management

• Surplus materials should be categorized and waste management practices should be adopted based on the following:

Minimization

• Reduce the amount of waste that will be produced within the constraints of the project specification.
• A well run construction site will minimize waste by ensuring the correct amount of construction materials are ordered and by minimizing and/or recycling packaging where possible.

Re-use

• Measures can be undertaken to ensure re-use much as of excavated material as practicable within the project area where it will be generated.
• Surplus material can often be used effectively in widening embankments or in providing parking areas.
• Re-use of excavated materials and waste for beneficial use on other sites / projects.
• Suitable projects or other opportunities for offsite disposed of excavated material should be identified if available.

Disposal

• Disposal sites should be selected on the basis of their proximity to worksites and ease of transport methods available for the delivery of material to the site.
• All wastes should be disposed of at a approved designated site.

Specific Measures

• Quantities of material requiring disposal need to be established in advance.
• Re-use of material to the maximize extent possible such as for fill section, embankment slope, village approach road etc.
• Track disposal companies and use Chain Custody form to ensure waste materials are disposed properly.
• Prepare a plan including detailed layout plan and cross-section for disposal of surplus waste.
• Avoid disposal of spoil material in areas having a high or very high landscape or visual quality.
• All spoil areas shall be covered with topsoil (removed from the demarcated spoil area) and re-vegetated.
• Where possible, spoil sites should be identified and approved during the design phase.
• Disposal areas should not negatively affect surface drainage, and nor shall they alter the topography to the extent that they become visually intrusive. These areas should be re-vegetated and rehabilitated on completion of the works.
• The locations of disposal areas should be agreed by the relevant parties. All dumping operations shall be controlled to ensure the optimum utilization of each area.
• Segregate different types of waste as they are generated using different skips where possible (given the space available).

REFERENCES

   http://bilddocuments.crossrail.co.uk/80256FA10055060F/Pages/(includingdraftconstructioncode)/$FILE/annex+4+-excavated+materials+and+waste+management+strategy+-+revision+3.0.pdf
2. Guidance on Construction Site Waste Management, ClacksWeb
   http://www.clacksweb.org.uk/environment/constructionsite/wastemanagement/
A.8 Concreting and Paving

DESCRIPTION

Concreting and paving include the activities of equipment wash-down on a building site, hardstand construction, concrete, tile and brick cutting, washing exposed aggregate, concrete delivery and concrete pumping. Significant environmental impacts can be associated with these activities and environmental best practices shall be implemented to avoid them.

KEY ASPECTS OF CONCERN

Noise

☑ Concreting will likely be the noisiest activities during construction.

Air Quality

☑ Loading, unloading, transfer, handling or storage of bulk cement or any cement during or after the de-bagging process can generate dust.

Water Quality

☑ Road paving happen right in the street, where there are numerous opportunities for asphalt, saw-cut slurry, or excavated material to illegally enter storm drains.

Ecology

☑ Fresh concrete and cement-related mortars that wash into lakes, streams, or estuaries are toxic to fish and the aquatic environment. Disposing of these materials to the storm drains or creeks can block storm drains, causes serious problems.

Objectives

The Concreting and Paving can result in adverse impacts to the environment. The objective of this Annex is to identify the environmental issues associated with concreting and paving and to identify practices that can help reduce environmental impacts.

Environmental Aspects

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Timing of Consideration

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CONTROL ACTIVITIES

Concrete Wash-down area

- Establishing and maintaining a designated wash-down area on a construction site allows the equipment washed down properly without contaminating the local stormwater system, it applies to:
  - storing wet and dry concrete and cement mortar materials and equipment;
  - on-site preparation and use of concrete and cement mortar equipment;
  - equipment wash-down only (not for disposal of excess concrete).
- Locate the wash-down area with appropriate sediment controls, inspect and maintain regularly and be repaired or replaced as necessary.
- Scrape excess concrete off the equipment before it is washed to minimize the amount of wash-down water generated.
- Place excess concrete into a site receptacle designated for concrete and masonry, and allows to set.
- A high pressure, low volume water spray nozzle conserves water and reduces maintenance of sediment controls.
- Wash-down water is best managed by draining it into a container (such as a 200L drum), allowing the water to stand until the solid particles settle at the bottom. After adjusting the pH of the water to neutral, it can then be siphoned off and reused, and the residue in the bottom can be allowed to set, then recycled with other excess concrete and masonry material.
- No wash-down water may be disposed of to the sewerage system without prior agreement of the local water authority.
- The wash-down area should drain to a low point where water is allowed to percolate through geotextile fabric into the soil. The settled and hardened concrete residue on the ground must be allowed to set and must be placed in a designated concrete/masonry recycling bin on-site.
- Do not allow equipment wash-down water to flow directly into a stormwater drain or system.
- Ensure that all staff are aware that a wash-down area is available on-site with clear signpost.
- Monitor on-site concrete wash-down and excess concrete handling and recycling areas at least on a daily basis.

Hardstand construction management

- Hardstand construction management is applicable to the:
  - application of concrete and/or seal coat during paving, footpath, driveway, curb and guttering surfacing and resurfacing;
  - storage of paving equipment;
  - concrete cleaning (including exposing aggregate, rinsing and sweeping).
- If existing concrete needs to be replaced, ensure that it is separated for recycling and do not dispose of concrete to landfill.
- Apply concrete and/or sealing coats during dry weather to prevent contaminated runoff entering the street gutters or stormwater drains.
- Avoid mixing excess amounts of fresh concrete or cement mortar on-site.
- Where possible, divert all contaminated runoff away from street gutters, stormwater drains and local waterways.
- Ensure appropriate sediment controls are in place around stormwater drains and street gutters before starting work.
- Contain all concrete slurry and runoff in a pooled area (for example, portable booms, sandbags), and allow for the fine suspended material to settle, if time permits.
- Consider all reuse opportunities and disposal options. For example, on solid surfaces such as roads and gutters, a wet industrial vacuum or suction pump can collect and filter runoff water into a container (such as a 200L drum) for reuse in another concrete mix process.
- Alternatively, treat the water (filter solids such as grit and pebbles and adjust the pH), then dispose of it to either the sewer or an approved liquid waste treatment facility.
- For small volumes of water and as a final resort where containment is not possible, allow water to flow across grassed areas (not bushland) and percolate into the soil.
- Always park machinery over drip trays or absorbent materials to prevent oil leaking into the stormwater system.
- Cover materials and stockpiles with plastic or tarpaulins to reduce dust and erosion problems.
- Always erect a sediment fence on the downward side of the stockpile to filter suspended solids.
- Inspect and maintain machinery regularly to minimize leaks and drips.
• Inspect pollution controls regularly or after every storm event.
• Maintain pollution controls in a manner that does not impede traffic flow before or during rain events.

Making concrete, brick and tile cuts
• Ensure appropriate sediment controls are in place around stormwater drains and street gutters before starting sawcutting works, e.g. diversion channels or bunds
• Place a series of absorbent material inlays in the gutter (such as foam) to soak up the concrete runoff. Once the cutting is finished, the absorbed water can be squeezed into a container for re-use or treatment before appropriate disposal.
• Whether you divert or soak up runoff, use a coagulating agent in the water supply for the blade cooling system. This will cause the concrete particles in the runoff to congeal into a solid that can be separated from the water more easily. (Note: the water will still have an elevated pH level and will still require management).
• Use only the minimum amount of water to adequately cool the cutting blade and suppress dust.
• Consider all opportunities for reuse and recycling of waste or treat all collected water.
• Allow any concrete slurry or residue to dry and is swept up or scrapped after the job is complete. Never hose residue or slurry into stormwater drains or gutters.
• Set up cutting equipment away from stormwater drains. The set-up area should be sufficiently large to contain water runoff, residues and any waste material.

Waste water and slurry management
• On solid surfaces a wet industrial vacuum or suction pump can collect and filter contained runoff water into a container (such as a 200L drum).
• Treat the water (filter solids such as grit and pebbles and adjust the pH) then dispose of it to either the sewer or an approved liquid waste treatment facility.
• Small volumes of concrete slurry can be disposed of by pouring it into geotextile-lined ditches in the wash-down area. Water should be allowed to evaporate or soak into the ground. Allow the slurry to dry before disposing of it in the recycling bin.
• Immediately after you complete the job, shovel, sweep, or vacuum any residue left in street gutters. Under no circumstances should any residue be hosed down the stormwater system

Washing down exposed aggregate concrete
• If washing exposed aggregate concrete is still an option, contaminated runoff must be prevented from reaching stormwater drains. This can be achieved by diverting the water to a bermed or level area.
• Never allow contaminated runoff water to enter a stormwater drain or watercourse.
• Collect and return sweepings from exposed aggregate concrete to the stockpile or recycling bin.
• Where possible, expose aggregate during hot, dry conditions so the water can evaporate more easily, and avoid exposing aggregate over prolonged rainy periods.

Concrete delivery
• Where possible, ensure the delivery of concrete occurs on the site, where the risk of spillage contaminating the stormwater system is minimized.
• If site access is restricted and the delivery of concrete must occur on the street, appropriate sediment controls will need to be in place before pouring begins.
• Sweep up any spillage that has occurred during the delivery procedure before removing the sediment controls. Do not hose concrete spillage into any stormwater drain or gutter.
• Vehicles should return to their depot with excess concrete and for thorough wash-down.
• Excess concrete could be placed in the site designated concrete / masonry recycling receptacle.
• Rinse chutes, barrels, wheelbarrows and other equipment in the site wash-down area. Remove excess concrete before rinsing and place in the designated concrete/masonry recycling receptacle.
• Mud, soil and stones carried off-site are regarded as pollutants. All tires and undercarriages must be clean before vehicles leave the construction site.

Concrete pumping
• Vehicles and machinery must be regularly serviced and maintained to minimize noise and exhaust emissions and oil and fuel drips.
• Where possible, concrete pumping equipment should be set up on the construction site. This reduces the potential of leakages from
hoppers, hoses and fittings that could contaminate the stormwater system.

- Exhaust emissions can be reduced by fitting pollution control equipment. For example, a catalytic converter can be fitted to the exhaust system of each petrol-driven internal combustion engine.

- Ensure adequate protective screens are erected around the pump area to prevent concrete splashing into street gutters or stormwater drains.

- Ensure the pumping of concrete occurs at a location on the site where any spillage will not contaminate the stormwater system.

- Where a concrete pump is located on a roadway or footpath where excess material could enter the stormwater system, install appropriate bunding to trap spilled material. Place portable concrete collection units (plastic or metal trays or receptacles) under pumping equipment to collect any spilled material during works.

- Wash hoses, hoppers, wheelbarrows and other equipment in the site wash-down area after all excess material has been removed by hand.

- Excess and residue concrete from the hopper and line should either be collected and sent back with the delivery truck or placed in the site designated concrete/masonry recycling receptacle.

- Scrape excess concrete residue from the hopper before washing to minimize the amount of wash-down water generated. Do not wash out the hopper directly into the street gutter.

- Wash-down water from the hopper must not contaminate the stormwater system. The wash-down area should be used only for small volumes of wash-down water and is not to be used as a disposal point.

- Inspect and maintain the machinery regularly to minimise leaks and drips.

REFERENCES

Environmental Best Management Practice Guideline for Concreting Contractors, Department of Environment and Conservation (NSW), November 2004


Fresh Concrete and Mortar Applications
http://www.sanjoseca.gov/esd/water-pollution-prevention/PDFs/SCConcrete.PDF
A.9 Drainage (Road and Slope)

DESCRIPTION

Proper drainage extends the life of roads and reduces potential environmental impacts. Runoff controls are essential to preventing polluted runoff from roads, slopes from reaching surface waters.

KEY ASPECTS OF CONCERN

Water quality

☑ Erosion during and after construction of roads, and highways can contribute large amounts of sediment and silt to runoff water, which can deteriorate water quality.

☑ Heavy metals, oils, other toxic substances, and debris from construction traffic and spillage can be absorbed by soil at construction sites and carried with runoff water to lakes, rivers and bays.

Ecology

☑ The deterioration of water quality can lead to fish kills and other ecology problems.
CONTROL ACTIVITIES

- Apply perimeter control practices to protect the disturbed area from offsite runoff and to prevent sedimentation damage to areas below the construction site.
- A sediment and runoff barrier surrounding the disturbed area prevents construction site runoff from moving offsite and fouling surface waters downstream.
- Keep runoff velocities low and retain runoff on the site. The erosive power of runoff increases dramatically as distance and slope increase.
- Stabilize disturbed areas immediately after final grade has been attained since any exposed soil is subject to erosion from rainfall, wind, and vehicles.
- Temporary stabilization practices include seeding, mulching, and erosion control blankets or mats.
- Develop a schedule and implement a comprehensive inspection and maintenance program.
- Straw bale barriers should be bound, entrenched, and securely anchored to prevent deterioration. A row of straw bales slow runoff flow and creates a pond behind the barrier where sediment can settle out. Straw bale barriers are most effective for filtering low to moderate storm flows, where structural strength is not required.
- Filter fabrics are engineering fabrics designed to retain sediment particles larger than a certain size and allow water to pass through. Filter fabrics can be used in silt fences or erosion control mats. Erosion control mats protect soil and seed from erosion and can be designed to allow vegetation to grow through the material.
- Silt fences are vertical fences of filter fabric that are stretched across and attached to support poles. The fabric retains sediment on the construction site and allows relatively sediment-free water to pass through. Silt fences are placed to protect streams and surrounding property from sediment-laden runoff.
- Sediment basins are ponds created by excavation or the construction of a dam or barrier. Sediment basins primarily serve to retain or detain runoff to allow excessive sediment to settle out during construction. Sediment basins can be converted into permanent detention ponds or wetlands after construction.
- Stabilized entrances reduce the amount of sediment carried off a construction site by vehicles when pressure-washed on-site. These entrances are designed to include stabilized pads of aggregate underlain with a filter fabric. Stabilized construction site entrances should be located at any point in the construction zone where vehicles enter and leave. Wheels and undercarriages of vehicles should be washed before leaving the site.
- When refueling or when vehicle / equipment maintenance must be done on site, designate a location away from storm drains.
- Do not use diesel oil to lubricate equipment parts or clean equipment.
- Recycle used oil, concrete, broken asphalt, etc. whenever possible, or dispose of properly.
- Avoid paving and seal coating in wet asphalt or when rain is forecast, to prevent fresh materials from contacting stormwater runoff.
- Cover and seal catch basins and manholes when applying seal coat, slurry seal, fog seal, or similar materials.
- Protect drainage ways by using earth dikes, sand bags, or other controls to divert or trap and filter runoff.
- Never wash excess material from exposed-aggregate concrete or similar treatments into a street or storm drain. Collect and recycle, or dispose to dirt area.
- Cover stockpiles (asphalt, sand, etc.) and other construction materials with plastic tarps. Protect from rainfall and prevent runoff with temporary roofs or plastic sheets and berms.
- Park paving machines over drip pans or absorbent material (cloth, rags, etc.) to catch drips when not in use.
- Clean up all spills and leaks using "dry" methods (with absorbent materials and/or rags), or dig up, remove, and properly dispose of contaminated soil.
- Collect and recycle or appropriately dispose of excess abrasive gravel or sand.
- Avoid over-application by water trucks for dust control.
- Avoid creating excess dust when breaking asphalt or concrete.
- After breaking up old pavement, be sure to remove all chunks and pieces. Make sure
broken pavement does not come in contact with rainfall or runoff.

- When making saw cuts, use as little water as possible. Shovel or vacuum saw-cut slurry and remove from the site. Cover or protect storm drain inlets during saw-cutting. Sweep up, and properly dispose of, all residues.
- Sweep, never hose down streets to clean up tracked dirt. Use a street sweeper or vacuum truck. Do not dump vacuumed liquor in storm drains.

REFERENCES

Erosion, sediment and Runoff control for Roads and Highways, U.S. Environmental Protection Agency
http://www.epa.gov/nps/education/runoff.html


Storm Drain Pollution from Roadwork
http://www.sanjoseca.gov/esd/water-pollution-prevention/PDFs/SCRoadwork.PDF
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