Environmental, Health, and Safety Guidelines for Forest Harvesting Operations

Introduction

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP)[1]. When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the **General EHS Guidelines** document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. A complete list of industry-sector guidelines can be found at: www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them.

The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account. The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons.

When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

Applicability

The EHS Guidelines for Forest Harvesting Operations include information relevant to the management of both plantation and natural forests, in temperate, boreal and tropical zones. Guidelines for timber processing industries can be found in the EHS Guidelines for Sawmilling and Manufactured Wood Products and the EHS Guidelines for Board and Particle-based Products. Annex A contains a description of industry sector activities. This document is organized according to the following sections:

Section 1.0 — Industry-Specific Impacts and Management
Section 2.0 — Performance Indicators and Monitoring
Section 3.0 — References and Additional Sources
Annex A — General Description of Industry Activities

[1] Defined as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility.

1.0 Industry-Specific Impacts and Management

The following section provides a summary of EHS issues associated with forestry management which occur during the operational phase, along with recommendations for their management. Recommendations for the management of EHS issues common to most large industrial activities during the construction and decommissioning phases are provided in the **General EHS Guidelines**.

1.1 Environment

The following guidance on environmental impacts from forestry management practices is divided between recommendations applicable to operations in **plantation forests** and those applicable to **managed natural forests**.[2]

Market demands that forest products originate from sustainably-managed natural and plantation forest operations have resulted in the creation of specific forest certification systems to demonstrate that internationally-acceptable standards of forest management are met.[3] These systems generally have formal standards, based on internationally-acceptable principles and criteria for sustainable forest management, and usually include the following:

- compliance with relevant law
- respect for any customary land tenure and use rights of indigenous peoples
- respect for the rights of workers, and compliance with occupational health and safety measures
- measures for community and stakeholder engagement
- conservation of biodiversity and protection of critical habitat
- maintenance of environmentally-sound multiple benefits from the forest
- prevention or minimization of adverse environmental and social impacts
- effective forest management planning
- active monitoring and assessment of relevant forest management areas

Forest sector enterprises may be encouraged or required by regulatory bodies or financial institutions, to obtain such certification as a condition of operation, and such certification is also increasingly being viewed as necessary for access to international or national markets.[4]

Environmental issues in forest harvesting operations primarily include the following:

- Habitat alteration and loss of biodiversity
- Water quality
- Soil productivity
- Hazardous materials management
- Visual impact

Habitat Alteration and Loss of Biodiversity

The establishment of plantation forests and subsequent timber harvesting activities involves the replacement of the existing vegetation cover with native and/or non-native species (see section on Invasive Species below), resulting in the potential

[2] Natural forests, for the purposes of this document, apply to forests where the principal characteristics of natural forests ecosystems (e.g. complexity, structure, and diversity) are present. Plantations are forests where most of these principal characteristics of natural forests ecosystems are not present.

[3] The most widely used sustainable forest management certification systems include the international system developed and implemented by the Forest Stewardship Council (http://www.fsc.org/en/), and the Programme for the Endorsement of Forest Certification (PEFC – http://www.pefc.org/internet/html/), which endorses nationally-based forest management standards as meeting international principles and criteria. Further information is also available from the World Bank Forest Certification Assessment Guide (http://www.worldbank.org/)

[4] The operator will ensure that all natural forests and plantations over which they have management control are independently certified as meeting standards compatible with internationally accepted principles and criteria for sustainable forest management. Where a pre-assessment determines that the operation does not yet meet the requirements of such an independent forest certification system, the operator will develop and adhere to a time-bound, phased action plan for achieving such certification.

loss of habitat diversity and a corresponding loss of wildlife and plant species.

Loss of biodiversity in managed natural forests may be caused by several factors. Certain species of plants and animals may be unable to tolerate the disturbance caused by forest management and harvesting activities, and subsequently leave the area. Other species may not survive habitat modifications caused by forest harvesting practices: for example, canopy dependent species may be unable to cross road openings and become cut off from a resource critical to their survival.

Recommendations to control and prevent loss of biodiversity common to both **plantations and managed natural forests** include the following[5]:

- Leave (reserve) trees or groups of trees in the harvest concession for regeneration purposes, and provide den and nesting sites, food sources, cover, and travel corridors for wildlife, including raptors. Appropriate conservation of understory species, as well as snags, slash, and wood debris on site should also be considered to enhance wildlife habitat;
- Conserve and protect permanent seasonal habitat to ensure their use for migration, spawning, and rearing (see section on 'Water Quality' below);
- Manage riparian zones[6] to preserve water quality and wildlife habitat. Riparian zones should be connected with corridors of natural vegetation across watershed boundaries to allow for the movement of animals and plants;
- Canopy closure should be allowed over roads to maintain habitat continuity;
- Schedule harvesting activities to avoid breeding and nesting seasons for any critically endangered or endangered wildlife species;
- Natural vegetation in the forest management area should be managed to ensure a variety of successional stages;
- Roadside strips should be left vegetated with natural cover;
- Natural vegetation should not be treated with pesticides.

In addition, the following recommendations are specific to **managed natural forests:**

- Biodiversity reserves should be created, managed, and monitored, to protect critical natural habitat, and high conservation value forest as representative samples of existing ecosystems in their natural state;
- Long-term harvest planning should ensure that forestry operations are restricted to as small an area as possible and are not concentrated in one area for long periods of time;
- To minimize damage to the forest ecosystem during harvesting, the following concepts and practices are recommended:
  - Development of a long-term forest management plan[7];
  - Plan choice of logging systems (e.g. harvesting techniques and equipment) taking into consideration specific terrain characteristics, road location and design, soil erosion risk, effects to soil productivity, among other established forest management objectives
  - Pre-harvest resource inventories to map all trees over a specified diameter at breast height (cm DBH) in the stand (depending on the nature of the stand);

[5] Wisconsin Forest Management Guidelines (2003).

[6] A transitional area between terrestrial and aquatic ecosystems, and adjacent to perennial and intermittent streams, lakes, and estuarine-marine shorelines. A riparian zone is characterized by gradients in biophysical conditions, ecological processes, and biota, through which surface and subsurface hydrology connect waterbodies with their adjacent uplands.

[7] An example of issues covered as part of a forestry management plan is provided in Criteria 7 "Management Plan" of the Forest Stewardship Council Principles and Criteria for Forest Stewardship, available at http://www.fscus.org/images/documents/FSC_Principles_Criteria.pdf

- Identification, mapping, and directional felling prescriptions of all trees selected for harvest (generally practiced only in tropical forests);
- Planning of access roads, skid trails, and log landings based on the distribution of the trees to be harvested in successive rotations. Planned routes and locations of road, skid trail, and landings should minimize impacts to soil and water resources (see sections on Water Quality and Road, Skid Trail, and Landings below). Skid trail routes should be identified on the ground prior to harvest, and felling activities should be conducted to maximize use of planned trails;
- Cutting of vines prior to harvest where vines connect tree crowns (generally practiced only in tropical forests);
- Directional felling by trained crews to minimize canopy damage and distance to skid trails. Cutting stumps low to the ground and optimizing crosscutting of tree stems to maximize yield;
- Avoidance of large canopy holes by limiting proximity of trees to be harvested;
- Use of low impact log hauling and extraction methods, such as cable hauling and log lifting. Ensure that ground skid machines remain on skid trails as much as possible. Minimize damage to trunks of remaining trees by designating a limited number of bumper trees when skidding logs.[8]
- Construction and maintenance of access roads that minimize impact on forest functions (see sections on Roads, Skid Trails, and Landings below);
- Harvesting should be avoided on slopes with gradients in excess of 30 percent. Transport of logs on slopes over 30 percent should be carried out using full or partial lifting cable systems.

In addition to the common points above, the following recommendations are specific to **plantation forests**:

- Diversity in plantation stands should be promoted (e.g. multi-age and multi-species, varying size and spatial distribution of compartments (blocks));[9]
- Before converting land to plantation forest, the project area should be surveyed to identify, categorize, and delineate natural and modified habitat types and ascertain their biodiversity value at the regional or national level;
- Ensure that any natural or modified habitat to be converted to plantation forest does not contain critical habitat , including known habitat of critically endangered or endangered species, or important wildlife breeding, feeding, and staging areas[10];
- Identify the presence of critically endangered or endangered species in areas already used for plantation forest and ensure that their habitat is appropriately managed;
- Set aside any identified critical habitat for biodiversity conservation purposes and for eventual restoration of the natural forest cover.

Exotic Species

Intentional or accidental introduction of alien, or non-native, species of flora and fauna into areas where they are not normally found can be a significant threat to biodiversity, since some alien species can become invasive, spreading rapidly and out-competing native species. Forest operators should not intentionally introduce any new alien species (not currently

[8] Further good practice guidance on extraction techniques for forwarders, ground skidding equipment, winching, cable systems, aerial systems (e.g. helicopters, balloons), and water transport can be found in the Food and Agriculture Organization (FAO), Code of Model Forestry Practices. Available at: http://www.fao.org/docrep/V6530E/V6530E00.htm

[9] An area of land or timber that has been defined for management purposes. One compartment or block may be composed of stands of different species and ages.

[10] Unused roads and skid trails should be closed to reduce their utilization by poachers and bush meat hunters.

established in the country or region of the project) unless this is carried out in accordance with the existing regulatory framework for such introduction, if such framework is present, or is subject to a risk assessment (as part of the Social and Environmental Assessment) to determine the potential for invasive behavior. Operators will not deliberately introduce any alien species with a high risk of invasive behavior or any known invasive species, and will exercise diligence to prevent accidental or unintended introductions. Operators should also take precautions to prevent the spread of existing exotic species as a result of forestry operations. Management techniques include procedures to ensure that equipment (e.g. trucks, skid machines) are power washed prior to moving from an infested area to an un-infested area.

Resource Sustainability for Tropical Forests

Little is known about the growth rates of trees in natural mixed forests, particularly in tropical regions, to inform forest management practices. Resource use in such areas is typically not based on scientific measurements of growth. In many cases, species are over-harvested and may be driven to extinction.

Recommendations to improve resource sustainability include the following:

- To ensure sustainable rates of harvesting, per hectare harvesting practices should be set on the basis of a scientific understanding of the regeneration success, growth rates, and distribution of the species in question;
- Forest managers should use as wide a range of tree species as possible;
- Minimum diameter limits should be set with consideration of the existing density and diameter of target species in the stand;
- Understory clearing should be avoided;
- Felling cycles should be set according to species regeneration studies, depending on local conditions.

Water Quality [11]

Forest operations (e.g. timber harvesting operations and road construction) may negatively impact water quantity and quality of streams, water bodies, and ground water resulting in seasonal hydrologic changes and potential negative impacts on downstream river biota, communities, and fisheries. Impacts to water quality may result from erosion and accumulation of sediment and organic debris in water bodies (e.g. at stream crossings of forest roads and skid trails); chemical contamination (e.g. from use of pesticides, fuels, lubricants, and coolants); increased nutrient loads (e.g. from erosion and use of fertilizers); and changes to temperature levels and stream flows which may affect fish and aquatic biota populations. Impacts to water quantity and timing of flows may occur due to the amount and spatial distribution of vegetation removed in response to the precipitation regime and remaining ecosystem processes. Preventing direct, adverse impacts to water resources and maintaining riparian zones is critical to protect water quality and quantity, in addition to aquatic and terrestrial forest habitats.

Recommended techniques to prevent and control impacts to water quality and quantity, riparian zones, and wetlands **common to both plantation and managed natural forests** include the following:

- Implementation of a riparian management zone (RMZ) plan. RMZs are typically established on the border of water bodies (e.g. lakes, navigable perennial/intermittent streams, non-navigable streams) to provide a buffer zone to protect water bodies.
    - Locate roads, skid trails, and landings outside RMZs and wetlands

[11] This section on water quality is adapted from guidance available in FAO (1996) and Wisconsin Forest Management Guidelines (2003).

- Where appropriate, slash and debris should be stockpiled above the high water mark to prevent materials from entering lakes, streams, and wetlands
- Avoid soil exposure and compaction to protect ground vegetation and the duff layer by avoiding the operation of wheeled or tracked harvesting equipment in proximity to the ordinary high-water mark for lakes and navigable perennial streams except on roads or at stream crossings.
- Minimize the number and size of stream crossings for vehicle movement within the RMZ. Where crossings are necessary, implement good practices including use of bridges, hardened fords, pipe culverts etc. (see sections on Roads, Skid Trails and Landing below). Stabilize bare soils on beds, banks and approaches to prevent sedimentation

- Prevent or limit disturbance to water resources during the planning phase;
- Maintain functional floodplains to accommodate common overbank flows. For areas at risk of downstream flooding, develop contingency plans to protect people and highly valued resources;
- Restore or rehabilitate disturbed sites to desired ecological conditions prior to completing or decommissioning project operations and facilities. This should include installing water bars on skid trails and restoration of landings (e.g. ripping and seeding to natural vegetation.)

In addition to the above, the following recommendations are specific to **managed natural forests**:

- Minimize vehicular movement over perennial and intermittent streams, and wetland areas. Vehicles should not be allowed to cross or move in unprotected streambeds. Where crossing is necessary, a right angle approach should be used in addition to use of bridges, hardened fords, pipe culverts, and other techniques to minimize impacts to stream banks, flow, and water quality;
- Maximize use of existing skid trails and landings, and ensure that runoff drainage does not empty directly into water bodies without diversions and sediment control (e.g. ditches, berms, and use of straw bales, silt fencing, and sediment traps);
- Minimize equipment use off-trail. Where necessary (e.g. wetlands and lowlands) employ low ground pressure equipment (e.g. wide tire or tracked machines);
- Use slash as a surfacing agent on skid trails. Slash may have to be removed at the end of operations in high fire risk areas (e.g. spread elsewhere, chipped, or piled / burned). Soil rutting generated from equipment use should be filled in and treated with mulch and seed, soil tilth should be restored as practical, and runoff should be diverted to control sedimentation.

In addition to the common points above, the following recommendations are specific to **plantation forests**:

- Hydrological models should be used to estimate the impacts on stream flow and to modify plantation design accordingly;
- Measures should be taken to minimize erosion from bare soil surfaces. Full cultivation should be avoided and ripping, a technique used to break down a hard pan or stone line impediment, if required, should be carried out along the contour.

Soil Erosion [12]

Soil erosion in forests may result from natural causes (e.g. wind and rain), timber harvesting operations, and from construction and use of road infrastructure. Plantations typically operate on a

[12] The sections on roads, skid trails / landings, and stream crossings are based on guidance adapted from FAO (1996) and Wisconsin Forest Management Guidelines (2003).

rotational, clear felling basis, and reduced vegetative cover immediately following the final harvest will expose soil to erosion from rain and wind. Ripping may also lead to water channeling and large-scale erosion. Stacking of brush and slash and use of extraction lanes may also act to funnel water down erodible channels. In natural forests, erosion of topsoil generally results when protective soil cover and anchoring roots have been removed. Further erosion may occur especially where large-leaved species (e.g. teak) funnel water onto bare soil surfaces. Unstable soils may be compromised by some forest management activities, causing mass wasting and debris flows on hillslopes during heavy rain events or under saturated soil conditions.

Timber Harvesting

Recommendations to control and prevent erosion during timber harvesting operations include the following:

- Forest cover should be reestablished as quickly as possible after clear felling. Temporary mulch or slash may be considered to protect erosive soils until desired vegetation has become reestablished.
- Compartment (block) areas should be minimized (as far as economically practical) to reduce the contiguous land area exposed to wind and rain. Compartments should typically not exceed 50 hectares;
- Harvesting operations should be timed to avoid the wet season, and exceptionally wet periods, when soils are saturated;
- Harvesting machinery and use of draught animals should be selected to minimize soil disturbance (e.g. compaction, rutting);
- On slopes exceeding 30 percent, cable extraction systems should be used to avoid use of vehicles on slopes susceptible to erosion;
- Slash and debris should be stacked along the contour.

Roads

Road construction, operation, and maintenance activities may cause significant erosion and adversely affect water quality. Cutting and filling activities during road construction may disrupt subsurface hydrologic flow, and bringing water to the surface in new areas or destabilizing sensitive hill slopes which may cause slope failures. Road surfaces may allow water to flow without restriction, resulting in accelerated surface erosion, channel scouring and transport of sediment loads transport to water bodies.

In most natural forest operations in the tropics, large trees are extracted along single use roads or skid trails. Skid trails often have a much higher impact than roads as their positioning may be poorly planned due to their limited utility. In extreme cases, they may become deeply incised or pass through permanent watercourses. In tropical situations where poor road design restricts drainage, this can lead to permanent flooding of the forest, which typically results in the death of large areas of forest. Roads in natural forests may create similar impacts as in plantation systems, but may also directly inhibit the movement of animals.

Recommendations to control and prevent impacts to water quality and habitat from the construction, operation, and maintenance of roads include the following:

- Planning and design phase issues prior to road construction, include:
  - Maximize use of existing roads networks
  - Consider future road uses at the design stage. This may include adjusting design considerations if roads are intended for longer term use beyond forestry applications

- Design (e.g. width, surfacing) and construct roads for the type and intensity of anticipated traffic over the long term
- Maximize use of temporary roads
- Minimize number of stream crossings, and site road crossings in suitable locations (e.g. at stream locations with rocky beds and low banks)
- Site roads on soil with good drainage capability, emphasizing high ridge routes and avoiding low valleys when possible
- Locate roads outside RMZs and wetlands
- Design road networks in advance to minimize road length and road density. Road widths should be minimized taking into consideration safety and transport requirements
- Roads should be designed and sited so as not to act as dams allowing water to accumulate behind embankments
- Allow canopy closure over roads to maintain habitat continuity

- Minimize cut and fill construction by following natural landscape route contours;
- Roads should not exceed a gradient of 10 percent, where possible, with 5 percent being the optimum gradient.
- Road drainage (e.g. water bars, dips, ditches and cross drains) should be constructed at appropriate intervals to drain water away from the road surface;
- Road surfaces should be shaped (e.g. convexinsloped, outsloped, or crowned) to ensure water runoff into appropriate drainage channels and vegetation and to eliminate channeling in ruts;
- Road-side drains should be diverted (e.g. through use of berms, ditches, or culverts) away from the road into vegetation at regular intervals. Outflow drainage areas may benefit from use of mulch, seed, dry wells, rock aprons and other soil stabilization measures. Drains should not empty directly into watercourses, and should be capable of handling local rainfall and runoff conditions. Drains should be maintained as needed to accommodate expected flows;
- Gravel or other surfacing should be considered on steep road slopes and tight corners;
- Burying of debris in the road base should be avoided, as it may result in uneven surfaces and holes leading to erosion. Roads should be compacted prior to use.

Where construction of roads is unavoidable, recommended techniques to prevent and control impacts for roads include:

- Roads should be designed and constructed (e.g. placement of fill) to prevent or limit disruption to aquatic and terrestrial habitat and wildlife (e.g. nesting and breeding areas) in wetlands and riparian areas;
- Road approaches to the wetland should be constructed at an upward angle to minimize drainage of road runoff into the wetland;
- Landing areas should not be constructed in wetlands;
- Cross drainage (e.g. culverts, bridges, permeable road materials etc.) should be installed to minimize disruption to natural water flow through the wetland area;
- Vehicle activities should remain on firm ground, if possible, to avoid rutting. Use of low pressure equipment (e.g. machines with wide tires and/or tracks) and mats/corduroy on skid trails is preferable, and activities should be halted if rutting becomes excessive.

During road maintenance, the following recommended prevention and control measures should be considered:

- Establish a regular maintenance inspection schedule
- Clear debris from ditches and other drainage structures
- Grade road surfaces to maintain drainage contour, and fill holes promptly

- If dust control measures are applied, ensure that runoff will not adversely impact water quality in surrounding water bodies and groundwater

Techniques to prevent and control impacts during road closure include the following:

- Dirt roads should be tilled and re-vegetated with an appropriate short cover, preferably with native species, if likely to remain unused for some time; Periodic road drainage may need to be added to adequately prevent concentrated flow from eroding the road surface or fill slopes in areas where surface topography is not completely restored.
- Temporary drainage and stream crossings structures should be removed;
- Grading and other techniques should be employed to ensure long term drainage from road surface;
- Install water bars and drainage diversion structures as necessary;
- Access to closed roads should be prevented to discourage use by general public, and to impede uncontrolled timber harvest and poachers.

Skid Trails and Landings

Recommended techniques to prevent and control impacts from landings and skid trails include the following:

- Locate skid trails and landings outside RMZs and wetlands. Skid trail routes should be established prior to the harvest and felling activities should be conducted to maximize use of planned trails;
- Landings should be located in areas with good drainage, and should be sloped slightly to direct runoff to diversion channels emptying into shrub vegetation or other runoff filtering mechanisms;
- Landings may require periodic dust control (e.g. use of water), and should be tilled and revegetated (and ripped, if necessary due to compaction) after use;
- Skid trails should be as straight as possible, curving only to climb elevations in excess of approximately 30 degrees of slope;
- A designated set of skid trails should be reused to the maximum extent possible. Skidding should be halted in very wet conditions to prevent erosion;
- Use of the skidder blade to construct skid trails should be minimized. Trail brush should be laid on the skid trail, and stumps should be cut to ground level.

Stream Crossings

For stream crossings, the following recommended prevention and control measures should be considered:

- Minimize vehicular movement over perennial and intermittent streams, and wetland areas. Where crossing is necessary, a right angle approach should be used in addition to use of bridges, fords, pipe culverts, and other techniques to minimize impacts to stream banks, flow, water quality.
- Crossing structures (e.g. bridges, culverts, fords) should be designed to withstand peak flows of high intensity storms, and ensure that movement of aquatic species is not impaired;
- Vehicle movement over unprotected streambeds should be prevented. Skid trails should not cross streams or gullies. If crossing is necessary, a hard rock stream bottom is preferable;
- Road drainage should be diverted to vegetation and not into the stream;
- Approaches to crossing should be stabilized with aggregate to avoid increased sediment entering the

stream. Stabilize soil at stream banks of crossing though use of mulch and seed, silt fences, and straw bales.

Soil Productivity

Soil productivity is integral to the sustainability of timber harvesting and the overall health of forest ecosystems and wildlife. Forest harvest operations and road construction may result in physical impacts to soil including compaction, rutting, displacement, and erosion impacts (see sections on Soil Erosion and Roads, Skid Trails, and Landings above). Impacts to the chemical properties of soil may include changes to the pH level and nutrient balance. Impacts to the biological properties of soil may include changes to microflora and microfauna populations that are critical to soil formulation, decomposition services, and nutrient cycling to promote tree growth (e.g. mycorrizhae).

In addition to the above management recommendations for soil erosion, measures to manage soil productivity include the following:

- Time forestry operations to avoid periods when ground is saturated (e.g. in early spring and immediately after heavy rainfalls);
- Minimize land use for landings, roads, skid trails and consider use of low ground pressure equipment and use of slash cover on skid trails;
- Incorporate soil productivity and nutrient cycles as part of harvest planning and management considerations;
- Rutting on roads and skid trails should be repaired on an ongoing basis to prevent formation of gullies;
- Avoid excessive mechanical site preparation prior to replanting / seeding that removes excessive amounts of soil moisture and the protective duff layer;
- Slash should be scattered on the site to provide shelter and organic matter for seedlings;
- Consider addition of nutrients to soil as indicated by integrated nutrient management strategies (INM). Nutrients may be added to forest plantations at the time of replanting, if necessary to address nutrient depletion. INM should aim to optimize yield while maintaining and improving the soil nutrient status, and avoiding contamination of groundwater resources and eutrophication of surface water resources from runoff and leaching of excess nutrients.

Hazardous Materials Management

Use of Fuels and Lubricants

Forestry operations and road construction involves the use of machinery, vehicles, and related fuels, lubricants, and other materials which may cause negative impacts if accidentally spilled. Logging equipment should not be washed near streams to prevent entry of hazardous materials into water bodies. Replacement of oil / hydraulic fluids should not be undertaken in sensitive areas, and used fluids should be managed properly. Recommendations to control and prevent fuel and chemical contamination, including guidance on storage and disposal of wastes, are provided in the **General EHS Guidelines**.

Use of Pesticides

Pests and their management are an integral part of forest management. Decisions about pesticide use should be made in the context of pest and forest management objectives and goals. Pesticides may be needed to protect the establishment and growth, or maintenance, of desired species or conditions in the forest. Pesticide use may be extensive to deter wood boring insects from damaging stockpiled wood prior to removal from the forest concession. Because forest pests are part of the forest ecosystem, any attempt to suppress pest with extensive pesticide use will undoubtedly influence the other components of the ecosystem. The use of pesticide may be justified for

plantation forest operations, whereas their use in *managed natural forests* is primarily limited to localized uses.

The primary aim of pest management should not be to eradicate all organisms or species, but to manage pests and diseases that may negatively affect desired forest species so that they remain at a level that is under an economically and environmentally damaging threshold. Pesticides should be managed to avoid their migration into off-site land or water environments by establishing their use as part of an Integrated Pest Management (IPM) strategy and a documented Pest Management Plan (PMP). The following stages should be considered when designing and implementing an IPM strategy, giving preference to alternative pest management practices, with the use of synthetic chemical pesticides as a last option.

Alternatives to Pesticide Application

Where feasible, the following alternatives to pesticides should be considered:

- Provide those responsible for deciding on pesticides application with training in pest identification, weed identification, and field scouting;
- Use pest-resistant tree varieties;
- Use mechanical weed control and / or thermal weeding;
- Protect natural enemies of pests by providing a favorable habitat, such as bushes for nesting sites and other original vegetation that can house pest predators;
- Support and use beneficial organisms, such as insects, birds, mites, and microbial agents, to perform biological control of pests;
- Use mechanical controls such as traps, barriers, and light, to kill, relocate, or repel pests.

Pesticide Application

If pesticide application is warranted, users should take the following precautions to reduce the likelihood of environmental impacts:

- Train personnel to apply pesticides and ensure that personnel have received applicable certifications or equivalent training where such certifications are not required; [13]
- Use pesticide according to the label provided by the manufacturer. The label provides the necessary information on recommended dosage and safe use of the pesticide;
- Apply pesticides based on criteria such as field observations of the target pest, weather data, time of treatment, and dosage, and maintain a pesticide logbook to record such information;
- Avoid the use of pesticides that fall under the World Health Organization Recommended Classification of Pesticides by Hazard Classes 1a and 1b;
- Avoid the use of pesticides that fall under the World Health Organization Recommended Classification of Pesticides by Hazard Class if the project host country lacks restrictions on distribution and use of these chemicals, or if they are likely to be accessible to personnel without proper training, equipment, and facilities to handle, store, apply, and dispose of these products properly;
- Avoid the use of pesticides listed in Annexes A and B of the Stockholm Convention, except under the conditions noted in the convention;[14]

[13] Examples of certification schemes are provided by the United States (US) Environmental Protection Agency (EPA) (2006), which classifies pesticides as either "unclassified" or "restricted" and requires workers that apply unclassified pesticides to be trained according to the Worker Protection Standard (40 CFR Part 170) for Agricultural Pesticides. It further requires restricted pesticides to be applied by or in the presence of a certified pesticide applicator.

[14] The Stockholm Convention on Persistent Organic Pollutants (2001).

- Use only pesticides that are manufactured under license and registered and approved by the appropriate authority and in accordance with the Food and Agriculture Organization (FAO) International Code of Conduct on the Distribution and Use of Pesticides[15];
- Use only pesticides that are labeled in accordance with international standards and norms, such as the FAO Revised Guidelines for Good Labeling Practice for Pesticides[16];
- Select application technologies and practices designed to reduce unintentional drift or runoff only, and under controlled conditions;
- Maintain and calibrate pesticide application equipment in accordance with manufacturer's recommendations;
- Establish untreated buffer zones or strips along water sources, rivers, streams, ponds, lakes, and ditches to help protect water resources.

Pesticide Handling and Storage

To prevent, reduce, or control the potential contamination of soils, groundwater, or surface water resources, which may result from accidental spills during transfer, mixing, and storage, pesticides should be stored and handled in accordance with the recommendations for hazardous materials management in the **General EHS Guidelines**. Additional recommendations include the following:

- Store pesticides in their original packaging, in a dedicated, dry, cool, frost-free, and well aerated location that can be locked and properly identified with signs, with access limited to authorized people[17]. No human or animal food may be stored in this location. The store room should also be designed with spill containment measures and sited in consideration of potential for contamination of soil and water resources;
- Mixing and transfer of pesticides should be undertaken by trained personnel in ventilated and well lit areas, using containers designed and dedicated for this purpose.
- Containers should not be used for any other purpose (e.g. drinking water). Contaminated containers should be handled as hazardous waste, and should be treated accordingly. Disposal of containers contaminated with pesticides should be done in a manner consistent with FAO guidelines and with manufacturer's directions;[18]
- Purchase and store no more pesticide than needed and rotate stock using a "first-in, first-out" principle so that pesticides do not become obsolete.[19] Additionally, the use of obsolete pesticides should be avoided under all circumstances;[20] A management plan that includes measures for the containment, storage and ultimate destruction of all obsolete stocks should be prepared in accordance to guidelines by FAO and consistent with country commitments under the Stockholm, Rotterdam and Basel Conventions.
- Collect rinse water from equipment cleaning for reuse (such as for the dilution of identical pesticides to concentrations used for application);
- Ensure that protective clothing worn during pesticide application is either cleaned or disposed of in an environmentally responsible manner
- Implement groundwater supply wellhead setbacks for pesticide application and storage
- Maintain records of pesticide use and effectiveness.

[15] FAO (2002c)
[16] FAO (2002c)
[17] FAO (2002c)
[18] See FAO Guidelines for the Disposal of Waste Pesticides and Pesticide Containers.
[19] See FAO (1996).
[20] See the FAO publication on pesticide storage and stock control manual. FAO Pesticide Disposal Series No. 3 (1996).

Visual Impacts

Forestry operations and road systems may result in negative visual impacts to resources associated with other uses of the forest (e.g. recreation, tourism).

Forest management recommendations to prevent and minimize negative visual impacts include the following:

- Identify potential visual impacts at the pre-harvest stage and incorporate strategies to prevent and/or mitigate into the forest management plan, including:
  - Identify natural landscape features (e.g. topography) and avoid artificial harvest patterns where possible. Use GIS mapping and shaping techniques to ameliorate viewing duration and intensity when designing harvest boundaries in areas of visual sensitivity (e.g. provide a buffer of trees along the border between harvested areas and roads; break down and clear slash debris piles near roadways).
- Design road systems to meet the needs of visual quality as well as timber management, including:
  - Minimize the number of exits onto sensitive roadways (e.g. travel or recreation routes);
  - Locate roads and gravel pits to minimize visibility from scenic outlooks or water bodies;
  - Use road curving to minimize straight visual site lines into the forest.

1.2 Occupational Health and Safety

Occupational health and safety hazards in forestry projects primarily include the following:

- Physical hazards
- Noise and vibrations
- Fire
- Chemical hazards

Physical Hazards

Forest operations involve a number of activities that may result in severe physical injury to workers. Injury may result from improper use of chainsaws and axes or machetes during felling, crosscutting and debranching activities. Use of cables to extract logs may expose workers to injury from cable breakage under tension or the sudden release of loads. Falling trees and loose branches are a significant cause of injury, particularly when workers are engaged in clearing windthrow damage and other tree entanglements/hang-ups.

Cutting Equipment

Recommendations to prevent and control injuries from cutting equipment include the following:

- Workers should be properly trained in the safe use of cutting equipment, including work group coordination and safety measures;
- Equipment should be properly maintained and include all necessary safety devices (e.g. blade guards on saws);
- Workers should be provided with, and required to use, all necessary personal protective equipment (e.g. gloves, footwear, protective clothing, helmets);
- On-site first aid equipment and trained personnel should be available, as well as procedures for emergency evacuation.

Falling Trees and Cable Use for Log Extraction

Recommendations to control and prevent injury related to falling trees and cable use include the following:

- No worker other than the chainsaw operator and an assistant should be within two tree lengths when trees are felled;
- Workers should be trained in clearance of windthrow before entering an affected area;

- Hard hats should be worn at all times by workers when working under a forest canopy with a risk of falling branches;
- Where cables under tension are used for extraction of trees, no worker should be within two cable lengths of the closest secured point.

Machinery and Vehicles

Accidents may occur in connection with the use of machines and vehicles, including tractors and harvesting machinery, and during the transport of workers along poorly maintained roads. Occupational safety and health impacts and controls relating to equipment and vehicle operation and repair are discussed in the **General EHS Guidelines**.

Lone and Isolated Workers

Forestry operations may necessitate that workers are isolated and out of verbal and line of sight communication with a supervisor, other workers, or other persons capable of providing aid and assistance, for continuous periods exceeding one hour. The worker is therefore at increased risk should an accident or injury occur. Recommendations to manage situations where workers are isolated are discussed in the **General EHS Guidelines**.

Noise and Vibrations

Chainsaws, vehicles, and other mechanical forestry equipment emit noise at excessive levels. Some logging machinery can subject workers to unsafe levels of vibration leading to work-related injury to internal organs or hands. Use of vibration limitation devices on chainsaws and in seating designs on harvesting machinery should be implemented. However, as most of noise sources in forestry operations cannot be prevented, control measures should include the use of personal hearing protection by exposed personnel and implementation of work rotation programs to reduce cumulative exposure to vibration. Additional recommendations on the management of occupational noise are provided in the **General EHS Guidelines.**

Fire

Wildfires caused by natural events (e.g. lightening strikes) or human error are one of the most significant risks to the profitability and sustainability of forest resources. In natural forests, the opening of the forest canopy by selective logging usually leads to a proliferation of ground level vegetation. This is often accompanied by an increased ignition hazard due to the presence of forestry workers or members of the public who use forestry roads for access.

Prescribed burns may be used as a land management technique to reduce the presence of excessive wood fuel (e.g slash) and decrease wildfire risk; to prepare the land for replanting / seeding; and to provide natural forest regeneration cycles for certain species, in addition to other uses.

Recommended measures to prevent and control risk of forest fire include:

- Development of a fire risk monitoring system;
- Preparation of a formal fire management and response plan supported by the necessary resources and training, including training for workers in the use fire suppression equipment and evacuation. Procedures may include coordination activities with local authorities. Further recommendations for emergency preparedness and response are addressed in the **General EHS Guidelines**;
- Forestry operations should be equipped with fire suppression equipment appropriate for the size of operations and that meets internationally recognized technical specifications (e.g. fire beaters and knapsack sprayers, small portable water pumps and tanks, water tankers and fire fighting aircraft);

- Undertake regular removal of high-hazard fuel accumulations (e.g. through thinning and prescribed burns). Time thinning and prescribed burns to avoid forest fire seasons. Prescribed burns[21] should adhere to applicable burning regulations, fire suppression equipment requirements, and typically must be monitored by a fire watcher;
- Establishment and maintenance of a network of fuel breaks of less flammable materials or cleared land to slow progress of fires and allow fire-fighting access.

Chemical Hazards

Exposure to Pesticides

Occupational health and safety impacts associated with pesticides are similar to those for other hazardous substances, and their prevention and control are discussed in the **General EHS Guidelines**. Potential exposures to pesticides include dermal contact and inhalation during their preparation and application. The effect of such impacts may be increased by climatic conditions, such as wind, which may increase the chance of unintended drift, or high temperatures, which may be a deterrent to the use of personal protective equipment (PPE) by the operator. Recommendations specific to plantation crop production include the following:

- Train personnel to apply pesticides and ensure that personnel have received the necessary certifications,[22] or equivalent training where such certifications are not required
- Use pesticides according to the specific label
- Respect post-treatment intervals to avoid operator exposure during reentry to areas with residues of pesticides
- Ensure hygiene practices are followed (in accordance to FAO and PMP) to avoid exposure of family members to pesticides residues.

1.3 Community Health and Safety

Community health and safety hazards in forestry projects primarily include the following:

- Water resources
- Fire
- Transportation
- Pesticide exposure

Water Resources

Communities may be dependent on the surface and ground water resources from forests. Reduction in water quality or quantity caused by forestry operations may affect water supplies needed for drinking, hygiene, and other ecosystem services (e.g. fisheries). Forestry operators should protect water resources by implementing the recommended guidance contained in the Water Quality section of this document. Further guidance on community health and safety related to water resources is provided in the **General EHS Guidelines**.

Fire

Fires originating in forests may endanger nearby communities. Fire response and management plans should be prepared with the participation of local authorities and potentially affected communities.

Transportation

Large vehicles carrying heavy forest product loads on major and minor roads that pass through local communities may expose

[21] Prescribed burning should only be performed after considering potential impacts to air quality and according to the local air quality management requirements.
[22] The US EPA classifies pesticides as either "unclassified" or "restricted." All workers that apply unclassified pesticides must be trained according to the Worker Protection Standard (40 CFR Part 170) for Agricultural Pesticides. Restricted pesticides must be applied by or in the presence of a certified pesticide applicator. For more information, see http://www.epa.gov/pesticides/health/worker.htm

the public to significant risks. Road transport may also lead to other impacts on communities such as unacceptable levels of dust and noise disturbance. Recommendations to prevent and control transportation hazards, including traffic safety, dust suppression, noise mitigation, and transport of dangerous goods, are discussed in the **General EHS Guidelines**.

Pesticide Exposure

Where pesticides are used on a large-scale, accidental spraying of local property may expose the public to unacceptable pesticide concentrations. Pesticides may affect community health in the same ways that they affect individual operators (see Occupational Health and Safety), through dermal contact or through inhalation of such chemicals as a result of application. The potential for community exposure to pesticides in the environment may be considerably influenced by climatic conditions, such as wind velocity, while the potential for exposure to residual levels in post-harvest products may depend on adherence to pesticide use instructions. There may also be a risk to the community caused by dermal contact with residues in containers, packaging, etc. Improper disposal of containers used for transporting and storing pesticides is an additional risk when communities may reuse them, for example, for drinking water.

Recommendations to control and prevent pesticide exposure include the following:

- Avoid the aerial application of pesticides, whenever feasible;
- Use biological or safe products, whenever feasible;
- Implement a system to warn neighboring communities of the application of pesticides in the forest;
- Pesticides should not be applied close to watercourses;
- Clean (e.g., a triple rinse or pressure technique) and dispose of (e.g., through crushing, shredding, or return to suppliers) pesticide packaging and containers to ensure that they are not subsequently used as containers for food or drinking water.

2.0 Performance Indicators and Monitoring

2.1 Environment

Emissions and Effluent Guidelines

The forestry sector does not typically give rise to significant point source air emissions or effluents. Where dust or potentially contaminated water runoff exists, site operations should comply with principles and guidelines described in the **General EHS Guidelines** to meet ambient air and surface water quality guidelines.

Environmental Monitoring

Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators applicable to the particular project. Potential monitoring indicators include yield of forest products harvested and growth / regeneration rates of the forest, invasive species incursions, and, in addition, total suspended solids and turbidity for off-site runoff.

Monitoring frequency should be sufficient to provide representative data for the parameter being monitored. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Additional guidance on applicable

sampling and analytical methods for emissions and effluents is provided in the **General EHS Guidelines**.

2.2 Occupational Health and Safety

Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, of which examples include the Threshold Limit Value (TLV®) occupational exposure guidelines and Biological Exposure Indices (BEIs®) published by American Conference of Governmental Industrial Hygienists (ACGIH),[23] the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),[24] Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),[25] Indicative Occupational Exposure Limit Values published by European Union member states,[26] or other similar sources.

Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources (e.g. US Bureau of Labor Statistics and UK Health and Safety Executive)[27].

Occupational Health and Safety Monitoring

The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals[28] as part of an occupational health and safety monitoring program. Facilities should also maintain a record of occupational accidents and diseases and dangerous occurrences and accidents. Additional guidance on occupational health and safety monitoring programs is provided in the **General EHS Guidelines**.

[23] Available at: http://www.acgih.org/TLV/ and http://www.acgih.org/store/
[24] Available at: http://www.cdc.gov/niosh/npg/
[25] Available at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992
[26] Available at: http://europe.osha.eu.int/good_practice/risks/ds/oel/
[27] Available at: http://www.bls.gov/iif/ and http://www.hse.gov.uk/statistics/index.htm

[28] Accredited professionals may include Certified Industrial Hygienists, Registered Occupational Hygienists, or Certified Safety Professionals or their equivalent.

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Annex A: General Description of Industry Activities

The forest management sector is dedicated to the production of roundwood timber primarily for inputs into industrial processes. The forestry sector can be divided broadly into two segments, plantation and natural forests. Plantation forests replace the native vegetation, often with exotic species. Plantation forests are managed and generally produce round timber at rates of between 5 and 30 cubic meters per hectare per year (m^3/ha/yr). Natural forests are typically harvested selectively and produce timber at rates between 0.01 and 5 m^3/ha/yr.

Forests provide a number of ecosystem services including fresh water, food, timber, fuel, fiber, biodiversity regulation, nutrient cycling, air quality and climate regulation, recreational opportunities, tourism resources, among others.

Investments in forest management are likely to be associated with specific processing plants with a high demand for raw material. Therefore, forest management may cover large areas. Typically, the area under management is increased year by year as the project progresses. However, impact identification and mitigation should consider the final area under management necessary to supply the industry demand.

In almost all cases, final harvest requires the use of heavy machinery to extract the trees. In plantation systems, individual stems usually weigh less than one ton but in natural forest stems of in excess of 20 tons are handled occasionally.

Forests have a variety of ancillary activities necessary to their operation but which often happen off-site. These include areas for vehicle maintenance and other workshops and nurseries for the propagation of seedlings for replanting. These sites are often characterized by heavier uses of chemicals, oils, and fuels.

Forest management is an outdoor activity which requires people to work out of doors in all weathers and climates in difficult terrain and using dangerous equipment.

Plantation Forest Management

Plantation forests are typically characterized by even aged stands of a single species. These stands are typically in the range of 10-100ha, however large stands of up to 3000ha are possible. Forest estates vary in size from a few thousand hectares up to tens of thousands of hectares. Forest estates often have multiple stands of different species in order to maximize the productivity of the sites and to provide a mix of products to the market. Stands on the estate have a mixture of ages in order to provide for a constant flow of roundwood to the market. Plantations are characterized by intensive silvicultural[29] operations throughout the life of the stand and stands are generally clear felled at the end of rotation. Silvicultural operations may include all or some of the following activities:

- Site cultivation
- Fertilization
- Chemical or manual weed suppression
- Thinning
- Pruning
- Intermediate harvesting
- Final felling
- Since the system is based on even aged stands, large areas may be left without forest cover for some years during the regeneration phase.

[29] Care and cultivation of forest trees

Natural Forest Management

Natural forest management is more variable and complex than plantation management. It is characterized by a wide range of possible practices ranging from the selective extraction of a few trees per hectare to clear felling of large areas at periods ranging from 50 to 100 years. Occasionally, stands are regenerated by planting seedlings on a large scale, but typically natural regeneration from seed is practiced. In some cases, intermediate silviculture in the form of density thinning may be used to increase growth and to reduce competition around valuable species.

Non-Timber Forest Products

Non-timber forest products (NTFP) are an important resource both for commercial and subsistence use. Commercially important non-timber forest products include bushmeats, honey, fungi, rattans, foliage plants, flowers, medicinal plants, fruits, and vegetables which can be sold on local and international markets in either processed or unprocessed form. NTFP are rarely cultured on a commercial scale although some have been successfully domesticated such as the fern *Ruhmora adiantifolia*. In most cases, NTFP are collected from the wild and, in many cases, this has led to a depletion of the resource by subsistence users. NTFP are of great importance to forest people since they often provide resources at times of agricultural shortages. Commercial demand for some species has led to a serious decline in the resource, for example, rattans in many areas. Charcoal is the most important NTFP on a global scale and the local consumption of charcoal (in towns and cities) has led to widespread deforestation in developing countries. There are small but increasing international markets for high-quality charcoal for barbecuing.