E4296 v1

Pakistan
Sindh Agriculture Growth Project (SAGP)

Environmental and Social Management Framework (ESMF)

Department of Agriculture
Government of Sindh

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Executive Summary

The provincial government of Sindh, Pakistan, through its Department of Agriculture(DoA) and Department of Livestock and Fisheries (DoLF), is planning to undertake **the Sindh Agriculture Growt Project (SAGP)** in various parts of the Province, and seeking the World Bank (WB) assistance for this purpose. In line with the prevailing legislation in the Country, and WB safeguard policies, an environmental and social assessment of the Project has been carried out and the presnet Environmental and Social Management Framework (ESMF) has been prepared.

Project Overview

The Government of Pakistan (GoPak) and Government of Sindh (GoSindh) have both highlighted commercial agriculture and market linkages as priority investments for the sector. GoSindh has also prioritized investments in support of small and medium farmers and in value chains that will positively impact women. The project will improve marketing infrastructure and facilitate reform in local marketing regulations and policies to enhance competitiveness.

The project consists of three components: Component A comprises capacity building of producers, modernization of extension services and agricultural research, and strategic planning for the agricultural sector; Component B comprises horticulture value chains, post-harvest loss management, livestock value chains, and demand driven investment fund; and Component C comprises project management, monitoring and evaluation. Further project details are presented later in the document.

For the SAGP implementation, a Project Management Unit (PMU) will be established in each of the implementing agencies (i.e. DoA and DoLF). In addition, Project Implementation Units (PIUs) will be established at district level.

Regulatory and Policy Overview

The Pakistan Environmental Protection Act, 1997 (the Act) is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The Act is applicable to a broad range of issues and extends to socioeconomic aspects, land acquisition, air, water, soil, marine and noise pollution, as well as the handling of hazardous waste. The discharge or emission of any effluent, waste, air pollutant or noise in an amount, concentration or level in excess of the National Environmental Quality Standards (NEQS) specified by the Pakistan Environmental Protection Agency (Pak-EPA) has been prohibited under the Act, and penalties have been prescribed for those contravening the provisions of the Act. This Act will be applicable to the proposed SAGP.

The World Bank's Operation Policy 4.01 (OP 4.01) requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making. The OP defines the EA process and various types of the EA instruments. Other WB operational policies include OP 4.04 for natural habitat, OP 4.36 for forestry, OP 4.09 for pest management, OP 4.37 for safety of dams, OP 7.50 for projects in international waterways, OP 4.11 for physical cultural property, OP 4.10 for indigenous people, OP 7.60 for projects in disputed areas, OP 4.12 for involuntary resettlement, and policy on

access to information. Of these policies, the OP 4.01, OP 4.09, and policy on access to information will be applicable to the SAGP.

Overview of Environmental and Social Baseline

Location and Geography. The Province of Sindh is located on the western corner of South Asia, bordering the Iranian plateau in the west. Geographically it is the third largest province of Pakistan, stretching about 579 km from north to south and 442 km (extreme) or 281 km (average) from east to west, with an area of 140,915 square kilometers of Pakistani territory. Sindh is bounded by the Thar Desert to the east, the Kirthar Mountains to the west, and the Arabian Sea in the south. In the centre is a fertile plain around the Indus River

Sindh consists of the Lower Indus Plain, which is very flat, generally sloping to the south with an average gradient of about 95 mm per kilometer. The Lower Indus Plain primarily comprises Indus Delta in the south, meander flood plain and cover fold plan. The area can be divided into five micro-relief land forms: active flood plain; meander flood plain; cover flood plain; scalloped interfluves; and Indus Delta.

Topographically, Sindh can be divided into four distinct parts: (a) Kirthar range on the west; (b) a central alluvial plain bisected by the Indus River; (c) a desert belt in the east; and (d) the Indus delta in the South.

Soils. The soil in the plains of Sindh is plastic clay that has been deposited by the Indus. Combined with water it develops into a rich mould and without water it degenerates into a desert. Nearly the entire Indus valley has soil which is extremely friable and easily disintegrated by the flow of water. Resultantly, the water always contains a large amount of suspended silt.

Landuse. Agriculture, followed by forestry, is the main land use in most parts of Sindh. Although more than 50 percent of the total geographical area is cultivable, only 26 percent of it is actually located in the central plain. The land inside the Indus embankments is almost equally employed by agriculture and forestry, while that outside the embankments is more extensively utilized for agriculture in the form of sparsely distributed irrigated plantations.

Water resources. Sindh is entirely dependent on the River Indus for its survival and development. About 95 percent of the farmland in Sindh obtains its water from the irrigation system, while the rest is cultivated with the help of tube wells. The limited groundwater (less than 5 million acre feet or MAF – about 6.17 billion cubic meters or BCM) in the province is available in only 28 percent of the entire area. Rainfall is only in the range of 100 to 200 mm per annum, while the evaporation rate is about 1000 to 2000 mm, depending on climatic conditions. Thus the whole of Sindh is arid, with the River Indus being the primary freshwater source that gives life to the province. With population growth, the average amount of renewable freshwater available to each person has been declining.

Irrigation. The irrigation canals of Sindh were extended and improved by the British in the late 1800s. By 1910, the irrigated area had expanded to 1.4 million hectares (MHa). Sukkur Barrage, completed in 1932, increased the annual cultivated area to 2.37 MHA. The completion of Kotri Barrage (Ghulam Muhammad Barrage, 1955), and Guddu Barrage (1962) brought the rest of Sindh's irrigation system under barrage control. The total command area under the three barrages was 5.1 MHa in 1997-98. There are 13

existing surface drainage systems in Sindh that serve a total area of over 2.5 MHa and have an aggregate length of about 4,800 km. Additional drains are under construction.

Agriculture. About 40 percent of the land in Sindh is arable land and 5 percent of it is rangeland. The total cultivated area in Sindh is 5.88 million hectares and the net area sown is 2.39 million hectares. The total cropped area is 3.10 million hectares, of which 0.71 million hectares are sown more than once1. Sindh grows a variety of field and horticultural crops. Wheat, cotton, rice, and sugarcane are the major field crops, which constitute 68 percent of the total cropped area, while mango, banana and chilies are the major horticultural crops. Among the horticultural crops, Sindh produces 73 percent bananas, 34 percent mangoes, and 88 percent of the chilies. Of the total cropped area of 3.1 million hectares in the year 2000-01, almost 50 percent of the area was under food crops (wheat, rice, maize, sorghum, millet and barley), 25 percent under cash crops (cotton, sugarcane). The remaining area was under fodder (9.1 percent), pulses (4.7 percent), condiments (4.1 percent), oilseeds (3.8 percent), fruits (3.3 percent), and vegetables (1.4 percent).

Demography and administrative division. Sindh has the second highest Human Development Index out of all of Pakistan's provinces at 0.628. The 1998 Census of Pakistan indicated a population of 30.4 million; the current estimates indicate a population of over 35 million in Sindh. Just under half of the population is urban, mainly found in Karachi, Hyderabad, Sukkur, Mirpurkhas, Nawabshah District, Umerkot and Larkana. Sindhi is the sole official language of Sindh since the 19th century. According to the 1998 Population Census of Pakistan, Sindhi-speaking households make up 59.73 percent (92.02 percent in rural and 25.79 percent in urban area) of Sindh; Urdu-speaking households make up 21.05 percent (1.61 percent in rural and 41.48 percent in urban areas); Punjabi 06.99 percent; Pashto 05.01 percent; Balochi 2.11 percent; Saraiki 01.00 percent; and other languages 04.93 percent. Other languages include Gujarati, Memoni, Persian, Kutchi (last one being a dialect of Sindhi), Khowar, Thari, Luri and Brahui. Administratively, Sindh is divided into 23 districts.

Literacy. Literacy is one of the important indicators of education because its improvement is likely to have a longer run impact on other important indicators of national welfare. According to the latest Pakistan Social and Living Standards Measurement (PSLM) Survey 2010-11, the literacy in Sindh for the population (10 years and above) was 59 percent during 2010-11. Literacy remains much higher in urban areas than in rural areas and much higher for men than for women.

Health. The government healthcare facilities in the Province comprise seven Teaching Hospitals, 11 District Headquarter Hospitals, 56 Tehsil Headquarter Hospitals/Civil Hospitals, 130 Rural Health Centers, 774 Basic Health Units, 643 Dispensaries, 90 Mother and Child Health Centers, and 15 Sub-health Centers. In addition, a large number of private healthcare facilities mostly located in cities and towns also exist in the Province. The Infant Mortality Rate in the Province is 81 per 1,000 live births, Under 5 Mortality Rate is 101 per 1,000 live births, Maternal Mortality Ratio is 314 per 100,000 live births, Malnutrition is 22 percent, and Immunization for children under one year is 37 percent.

Stakeholder Consultations

Stakeholder consultations have been carried out while finalizing the project details and during the present ESMP preparation. These consultations have been carried out with institutional as well as grass-root stakeholders. These consultations have revealed that

the proposed SAGP is considered to have a positive social impact by developing selected value chains through supporting farmer mobilization, extension services in enhancing production and productivity, post-harvest processing, value addition, and marketing (consultations summarized below). However, in the agriculture sector, in particular, the stakeholders suggested that project should ensure participation by small landholders, tenants, and women, who play a critical role in production and post-harvest processing.

Impact Assessment and Mitigation

Activities proposed to be financed through SAGP are unlikely to have significant adverse environmental and social impacts. The project would essentially provide extension services to farmers in order to improve productivity and market access for selected crops along a value chain approach. The project would also finance some on-farm activities to directly increase crop production through demonstrations of better farm practices to education farmers about sustainable farming practices including integrated pest and nutrient management.

The potential negative environmental impacts of the project include construction related short-term impacts such as air and water pollution, noise generation, and safety hazards, generation of vegetative solid wastes, increased use of pesticides and other agro-chemicals, drainage and hygiene particularly in livestock markets. Similarly, the potential negative social impacts identified include lack of participation particularly from landless and women farmer groups resulting in differential access to project benefits. While at individual sites, these may be small, cumulative impacts when seen as aggregates could be moderate to high and, therefore, require appropriate mitigation and management measures to contain them.

Environmental and Social Management Framework

Since exact nature, extent, and location of individual investments (subprojects) to be implemented under the SAGP are not known at this stage, a framework approach has been adopted for the present environmental and social assessment. Under this approach, each subproject would be screened for the severity and extent of environmental and social impacts. Small subprojects having negligible environmental and or social impacts would be assessed with the help of a rapid assessment checklist included in this document. Medium to large subprojects having some negative but localized environmental and or social impacts would require an Environmental and Social Management Plan (ESMP) to be prepared. Templates and methodologies of ESMP have been included in the present Framework.

An ESMP for the Artificial Insemination Training Center to be established under the SAGP has been prepared as a sample and annexed to the present document.

Institutional Arrangements for ESMF Implementation. The Project Director of Agriculture PMU and Project Manager of Livestock PMU will be overall responsible for the environmental performance of their respective project components. They will also ensure effective ESMF implementation throughout the project. In each PMU, an appropriate officer will be designated as ESMF Focal Point (EFP) who will be responsible for ESMF implementation for project activities under his/her respective department. Specifically, the EFPs will ensure the preparation and implementation of subproject-specific ESMPs, manage ESMF trainings, carry out environmental monitoring, and prepare monthly and quarterly ESMF reports. The project will also engage an Environment Specialist and a Social Specialist on a short-term contract basis

to assist PMUs in overall ESMF implementation particularly in preparing ESMPs, carrying out monitoring, and conducting trainings.

ESMF Monitoring. ESMF monitoring will be carried out at three levels. At the PMU level, the EFPs with the help of environment and social specialists will carry out ESMF monitoring to ensure that the mitigation plans are being effectively implemented, and will conduct field visits on a regular basis. At the field level, more frequent ESMF monitoring will be carried out by the PIU staff, under the guidance and supervision of EFPs and Environment Specialist. Monitoring checklists will be prepared on the basis of the subproject-specific mitigation plans included in the ESMPs. In addition, the project will engage specialists/firms to conduct external monitoring as third party validation on an annual basis.

ESMF Capacity building. Capacity building of the project staff and project beneficiaries will be carried out for the environmental and social management of the subprojects. The EFPs, Environment Specialist, and Social Specialist will be responsible for this capacity building.

Grievance Redress Mechanism. A grievance redress mechanism (GRM) will be put in place during the project implementation. Under this mechanism, any stakeholder (individual or organization) will be able to submit a grievance to the Project if s/he believes a practice is having a detrimental impact on their community, the environment, or on their quality of life. The PIUs will be tasked to manage the GRM and address the grievances.

Reporting and documentation. Complete documentation will be maintained for the entire ESMF implementation process. This will include environmental and social monitoring checklists filled by the PIUs and EFPs, visit reports with photographs prepared by the environment and social specialists, quarterly reports on overall ESMF implementation of the project, to be prepared by the EFPs, annual third party monitoring reports, and project completion report on overall ESMF implementation during the entire duration of the project – to be prepared by EFPs. The EFPs will be overall responsible for this documentation and reporting.

ESMF disclosure requirements. Once finalized, the ESMF as well as the Urdu and Sindhi translations will be disclosed on the official websites of GoSindh, Agriculture Department, and Livestock Department. These documents will also be maintained in the PMUs and PIUs. In addition, the ESMF will be disclosed on WB InfoShop.

ESMF implementation cost. The total cost of the ESMF implementation has been estimated to be about **Pak Rupees 41 million**. This includes costs of environment and social specialists, capacity building, third party validation, and ESMP preparation for individual subprojects. This cost is included in the overall project cost.

Acronyms

ADB	Asian Development Bank
AITC	Artificial Insemination Training Center
amsl	Above mean sea level
AWB	Area Water Board
BCM	Billion cubic meters
BOD	Biochemical Oxygen Demand
CITES	Convention on International Trade in Endangered Species
DoA	Department of Agricuture
DoLF	Department of Livestock and Fisheries
EA	Environmental Assessment
ECA	Employment of Child Act
EFP	ESMF Focal Point
EHS	Environment, Health, and Environment
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
ESA	Environmental and social assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
FAO	Food and Agriculture Organization
FMU	Field Management Unit
FO	Farmers' Organization
FPA	Foreign Project Assistance
GAPs	Good Agricultural Practices
GDP	Gross Domestic Product
GoSindh	Government of Sindh
GRM	Grievance redress mechanism
IEE	Initial Environmental Examination
IPM	Integrated pest management
IRRI	International Rice Research Institute
IUCN	International Union for Conservation of Nature
KPI	Key performance indicator
KWSB	Karachi Water and Sewerage Board
LAA	Land Acquisition Act
LOS	UN Convention on the Law of Seas
M&E	Monitoring and evaluation
MAF	Million acre feet
MARPOL	Convention for the Prevention of Pollution from Ships
MEA	Multilateral Environmental Agreement

MHa	Million hectares
MIS	Management information system
MSDS	Material Safety Data Sheet
NEQS	National Environmental Quality Standards
NGO	Non-governmental organization
OHS	Occupational health and safety
OP	Operational Policy
Pak-EPA	Pakistan Environmental Protection Agency
PDO	Project Development Objective
PEPA	Pakistan Environmental Protection Act
PEPC	Pakistan Environmental Protection Council
PMU	Project Management Unit
POPs	Persistent Organic Pollutants
PPE	Personal protective equipment
PSC	Project Steering Committee
PSLM	Pakistan Social and Living Standards Measurement
SAGP	Sindh Agriculture Growth Project
SIDA	Sindh Irrigation Development Authority
SS	Suspended solids
SWMO	Sindh Water Management Ordinance
TDS	Total dissolved solids
UNFCCC	UN Framework Convention on Climate Change
WB	World Bank

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1. Introduction

The provincial government of Sindh, Pakistan, through its Department of Agriculture and Department of Livestock and Fisheries, is planning to undertake **the Sindh Agriculture Growt Project (SAGP)** in various parts of the Province, and seeking the World Bank (WB) assistance for this purpose. In line with the prevailing legislation in the Country, and WB safeguard policies, an environmental and social assessment of the Project has been carried out and the presnet Environmental and Social Management Framework (ESMF) has been prepared.

1.1 Background[1]

Starting in the late 1960s, the Green Revolution introduced unprecedented technological and economic transformation and growth in Pakistan's agriculture sector; however, that growth has steadily declined for the past two decades–from 5.4 percent in the 1980s to 3.2 percent in the 2000s. The aggregate numbers hide extreme volatility—e.g., 6.5 percent growth in 2004 compared to only 0.6 percent in 2010. Agriculture in Pakistan has reached a point of diminishing marginal returns from the technologies and resources at its disposal, and insufficient investment in agriculture research and extension has left the sector ill-equipped to cope with climate shocks, reduce rural poverty, or compete in the marketplace.

In recent decades, agriculture's contribution to Pakistan's gross domestic product (GDP) has declined; however, it still accounts for 21.6 percent of value added. Agriculture GDP consists of 32.8 percent major crops, 11.1 percent minor crops, 53.2 percent livestock, 2.9 percent fisheries and forestry.[2] Through its production, agriculture contributes 60 percent to the country's export earnings, and, despite strong urban growth, 64 percent of the population still lives in rural areas and 45 percent of the nation's labor force still work in agriculture. Despite declining productivity growth, Pakistan is among the top 20 global producers in over 48 different agricultural commodities. The country produces over 108 million tonnes of agricultural commodities worth over US$13 billion annually.

In July 2011, the 18th Amendment of Pakistan's Constitution introduced devolution of many government services, including agriculture, to the provinces. With this, many national programs either ended or moved to each province, as did the responsibility for areas like policy development and food security. The provinces now face significant challenges in taking on additional roles that were previously under federal responsibility in addition to the research, extension, and marketing support challenges they already managed.

The top agriculture producing provinces in Pakistan are Punjab and Sindh, which account for 81 percent of agriculture GDP, most of which comes from rice and wheat production. This project will focus on Sindh Province, which contributes 23 percent to agriculture GDP, has a high unmet productive potential, and has received little attention from the World Bank in the past.

[1] Adopted from the WB Project Appraisal Document.

[2] Major crops include cotton, wheat, rice, maize, sugarcane; minor crops include fruits, vegetables, barley, pulses, tobacco, and oil seeds.

Sindh Province has 23.8 percent of Pakistan's population, 18 percent of its land area, and 14 percent of its total cropped area.[3] About 30-35 percent of Sindh's population lives below poverty line, and a majority of the poor are rural. Landholding patterns in Sindh are highly skewed from national norms, with a median farm size of around 11.33 hectares, as compared with 2.83 hectares in Punjab. According to one estimate in 2005, wealthy landlords in Sindh, who held farms in excess of 100 acres and who accounted for less than 1 percent of all farmers in the province, owned 150 percent more land than the combined holdings of 62 percent of small farmers with landholding less than five acres. Large landowners dominate production of the four major crops in Sindh—rice, wheat, sugar cane, and cotton. These crops are heavily regulated and receive extensive government subsidies through price support structures that often favor one segment of the value chain over another.

The SAGP will focus on horticulture—particularly chilies (92 percent of national production), onions (33 percent), and dates (about 50 percent)—and milk production because they have a small farmer focus, have significant involvement of women in production and processing, and, from a national perspective, Sindh enjoys the greatest competitive advantage in these pro-poor production value chains. Horticulture is largely unregulated, includes more private sector actors than the major crops, and has received little donor attention in the past. When donors have invested, they have focused largely on mangos and bananas—the two most profitable horticulture crops, which are often grown by large landowners. Investing in horticulture is seen to offer the best potential for increased small producer incomes, new employment opportunities in production and processing, improved resource productivity, and enhanced micronutrient availability in the market.[4] The one exception to this strategy is the planned intervention in the rice value chain, which will target a cluster of small and medium sized producers to help them reduce the post-harvest damage and loss from poor practices.

The first order constraint identified in the analysis of the targeted value chains is the quality of production and the high level of post-harvest losses, so SAGP will first focus on improving that quality. The interaction between producers and other actors along a value chain varies by commodity. In milk, producers generally produce directly for processors. In horticulture, they may link with either traders or processors. In all of targeted value chains, there are several private sector actors (traders and processors) who are actively seeking high-quality products for domestic and international markets. Despite the presence of many value chain actors, 25 percent of Pakistan's fruits and vegetables produced annually go to waste between the farm and the consumer. Only four percent of Pakistan's total fruit and vegetables are exported and at far lower prices (less than 41% of the world average) due to poor quality and the reliance on traditional low end markets. In milk production, losses climb to about 30 percent in the summer due to lack of infrastructure and equipment. Since milk production declines by 50 percent in the summer, this leads to huge shortages and high prices.

The introduction of good agricultural practices and modest investments in relatively simple technology could substantially increase the quality of production and the potential for increased trade and higher incomes. For example, chili exports from Pakistan are banned by the EU due to unacceptable levels of aflatoxin. In dates, only 20-30 percent of

[3] Sindh's cultivated area is 3.1 million hectares.

[4] Dr. Muhammad Jameel Khan, Advisor for Agriculture Planning, Government of Pakistan Planning Commission. 2011. "Agricultural Growth and Productivity Enhancement". Presentation made at the Roundtable Dialogue on Agriculture and Water in Pakistan.

the production is in high value table dates (khajoor) and only 10 percent of those are Grade A, 60 percent are Grade C. The majority of dates grown are dried dates (chuhara), the majority of which are exported to India to be used in religious ceremonies, where they are thrown into the Ganges. Improved tissue culture, orchard management, and harvesting practices, could increase the production of Grade A table dates, thus increasing income.

1.2 Project Overview

The Government of Pakistan (GoPak) and Government of Sindh (GoSindh) have both highlighted commercial agriculture and market linkages as priority investments for the sector. GoSindh has also prioritized investments in support of small and medium farmers and in value chains that will positively impact women. This project also responds to the Country Partnership Strategy (CPS) (FY2010-13) which states that the Bank will engage in providing technical assistance to help Pakistan in its agricultural policy analysis and design with a view to increasing agricultural competitiveness and expanding rural livelihoods. The project will improve marketing infrastructure and facilitate reform in local marketing regulations and policies to enhance competitiveness.

The project consists of three components: Component A comprises capacity building of producers, modernization of extension services and agricultural research, and strategic planning for the agricultural sector; Component B comprises horticulture value chains, post-harvest loss management, livestock value chains, and demand driven investment fund; and Component C comprises project management, monitoring and evaluation. Further project details are presented later in the document.

1.3 The Study

The various aspects of the present study, including its need and objectives, its scope, the methodology employed while conducting it are described in the following sections.

1.3.1 Need of the Study

The Pakistan Environmental Protection Act, 1997 (PEPA 1997) requires the proponents of every development project in the country to submit either an Initial Environmental Examination (IEE) or "where the project is likely to cause an adverse environmental effect," an Environmental Impact Assessment (EIA) to the concerned environmental protection agency (EPA). The IEE/EIA Regulations 2000 issued under the PEPA 1997 provide separate lists for the projects requiring IEE and EIA (The Act and Regulations are further discussed later in the document).

The World Bank Operational Policy 4.01 (OP 4.01) states that "The Bank requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making"[5].

The present study has been conducted in response to both of the above requirements.

1.3.2 Study Objectives

Since the nature, extent and location of the project activities requiring physical intervention and thus potentially causing environmental degradation are not known at this

[5] Excerpts from OP4.01 – Environmental Assessment. WB, January, 1999.

stage, a 'framework' approach has been adopted during the presnet environmental assessment, and an ESMF has been prepared as the outcome of this study. The specific objectives of the present study are to:

- To assess the existing environmental and socioeconomic conditions of the project area,
- To identify potential impacts of the proposed project on the natural and human environment of the area, to predict and evaluate these impacts, and determine their significance, in light of the technical and regulatory concerns,
- To propose appropriate generic mitigation measures that should be incorporated in the design of the project (and subprojects to be designed and implemented during project implementation) to minimize if not eliminate the potentially adverse impacts,
- To assess the compliance status of the proposed activities with respect to the national environmental legislation and WB's OPs,
- To develop an ESMF providing an environmental and social assessment framework for the subprojects to be implemented under the project.

1.3.3 Study Methodology

The key steps that were followed while conducting the present assessment are briefly described below.

Scoping

During this phase, key information on the project was collected and reviewed. A 'long list' of the potential environmental as well as social issues likely to arise as a result of the project was developed. The stakeholder analysis was also carried out for the consultation to be carried out subsequently.

Stakeholder Consultations

Stakeholder consultations were carried out during the study. Meetings were held with the institutional stakeholders and key environmental and social issues discussed. Extensive consultations with the grass root stakeholders were carried out during visits to the agricultural farms and fields in various parts of the Province.

Data Collection/Compilation

During this phase, data was collected and compiled, in order to develop a baseline of the project area's physical, biological and human environment. For this purpose, primarly review of secondary sources was carried out.

The secondary resources that were consulted included reports of the studies carried out earlier, published books and data, and relevant websites. With the help of these resources a generic profile of the entire project area was developed.

Impact Assessment

During the impact assessment, the environmental, socioeconomic, and project information collected in previous steps was used to determine the potential impacts of the proposed project. Subsequent to this, the potential impacts were characterized in order to determine their significance. Mitigation measures were identified where required to minimize the significant environmental impacts. A management framework was also

developed in the form of an ESMF for the implementation of the mitigation measures identified during the study.

Report Compilation

Report compilation was the last step of the study. The report includes a brief description of the proposed project, a review of environmental legislation and policy framework relevant to the project, a description of baseline environmental and socioeconomic conditions in the project area, and potential project impacts and mitigation measures. (Complete structure of the report is provided in **Section 1.4** below.)

1.4 Document Structure

Chapter 2 discusses the legislative, regulatory, and institutional setup that exists in the Country, as well as the World Bank's safeguard policies relevant to the environmental and social assessment. The Chapter also outlines the international environmental agreements to which the country is a party. **Chapter 3** provides a simplified description of the Project and its components. The environmental and social baseline conditions are presented in **Chapter 4**. The stakeholder consultations have been covered in **Chapter 5**. The assessment of environmental as well as socioeconomic impacts, their mitigation measures are presented in **Chapters 6**. Finally, the Environmental and Social Management Framework is presented in **Chapter 7**.

2. Legislative, Regulatory, and Policy Framework

This Chapter discusses the policy, legal and administrative framework as well as institutional set-up relevant to the environmental and social assessment of the proposed Project. Also included in the Chapter are the environmental and social guidelines from the national agencies as well as international donors and other organizations.

2.1 National Laws and Regulations[6]

Pakistan's statute books contain a number of laws concerned with the regulation and control of the environmental and social aspects. However, the enactment of comprehensive legislation on the environment, in the form of an act of parliament, is a relatively new phenomenon. Most of the existing laws on environmental and social issues have been enforced over an extended period of time, and are context-specific. The laws relevant to the developmental projects are briefly reviewed below.

2.1.1 Pakistan Environmental Protection Act, 1997

The Pakistan Environmental Protection Act, 1997 (the Act) is the basic legislative tool empowering the government to frame regulations for the protection of the environment (*the 'environment' has been defined in the Act as: (a) air, water and land; (b) all layers of the atmosphere; (c) all organic and inorganic matter and living organisms; (d) the ecosystem and ecological relationships; (e) buildings, structures, roads, facilities and works; (f) all social and economic conditions affecting community life; and (g) the inter-relationships between any of the factors specified in sub-clauses 'a' to 'f'*). The Act is applicable to a broad range of issues and extends to socioeconomic aspects, land acquisition, air, water, soil, marine and noise pollution, as well as the handling of hazardous waste. The discharge or emission of any effluent, waste, air pollutant or noise in an amount, concentration or level in excess of the National Environmental Quality Standards (NEQS) specified by the Pakistan Environmental Protection Agency (Pak-EPA) has been prohibited under the Act, and penalties have been prescribed for those contravening the provisions of the Act. The powers of the federal and provincial Environmental Protection Agencies (EPAs), established under the Pakistan Environmental Protection Ordinance 1983,[7] have also been considerably enhanced under this legislation and they have been given the power to conduct inquiries into possible breaches of environmental law either of their own accord, or upon the registration of a complaint.

The requirement for environmental assessment is laid out in Section 12 (1) of the Act. Under this section, no project involving construction activities or any change in the physical environment can be undertaken unless an initial environmental examination (IEE) or an environmental impact assessment (EIA) is conducted, and approval is received from the federal or relevant provincial EPA. Section 12 (6) of the Act states that the provision is applicable only to such categories of projects as may be prescribed. The

[6] In the wake of 18th Amendment in the Constitution of Pakistan, the provinces need to enact their own laws for the subjects devolved to them. Most of the federal laws, most importantly the Pakistan Environmental Protection Act of 1997, will therefore be replaced by corresponding provincial laws.

[7] Superseded by the Pakistan environmental Protection Act, 1997.

categories are defined in the Pakistan Environmental Protection Agency Review of IEE and EIA Regulations, 2000 and are discussed in **Section 2.1.2** below.

The requirement of conducting an environmental assessment of the proposed project emanates from this Act.

2.1.2 Pakistan Environmental Protection Agency Review of IEE and EIA Regulations, 2000

The Pakistan Environmental Protection Agency Review of IEE and EIA Regulations, 2000 (the 'Regulations'), developed by the Pak-EPA under the powers conferred upon it by the Act, provide the necessary details on preparation, submission and review of the initial environmental examination (IEE) and the EIA. Categorization of projects for IEE and EIA is one of the main components of the Regulations. Projects have been classified on the basis of expected degree of adverse environmental impacts. Project types listed in Schedule I are designated as potentially less damaging to the environment, and those listed in Schedule II as having potentially serious adverse effects. Schedule I projects require an IEE to be conducted, provided they are not located in environmentally sensitive areas. For the Schedule II projects, conducting an EIA is necessary.

The proposed project falls under the Schedule II of the Regulations. Hence an EIA has to be conducted for it.[8]

2.1.3 National Environmental Quality Standards

The National Environmental Quality Standards (NEQS), promulgated under the PEPA 1997, specify the following standards:

- Maximum allowable concentration of pollutants in gaseous emissions from industrial sources,
- Maximum allowable concentration of pollutants in municipal and liquid industrial effluents discharged to inland waters, sewage treatment and sea (three separate set of numbers).
- Maximum allowable emissions from motor vehicles.
- Ambient air quality standards.
- Drinking water standards
- Noise standards.

The above NEQS's are presented in **Tables A.1** to **A.6** in **Annex A**. Only a few of these standards will be applicable to the gaseous emissions and liquid effluents discharged to the environment from the activities under the proposed project.

2.1.4 Land Acquisition Act, 1894

The Land Acquisition Act (LAA) of 1894 amended from time to time has been the de-facto policy governing land acquisition and compensation in the country. The LAA is the most commonly used law for acquisition of land and other properties for development projects. It comprises of 55 sections pertaining to area notifications and surveys, acquisition, compensation and apportionment awards and disputes resolution, penalties and exemptions.

[8] The terms ESA and EIA, and ESMF have been used interchangeably in this document. The document has been named as the ESMF, however, it meets all the requirements of an EIA as well.

The subprojects to be implemented under SAGP may require some land. Efforts will be made to acquire such land either on voluntary donation or commercial transaction (willing buyer – willing seller) basis.

2.1.5 Sindh Wildlife Protection Act, 1972

This law was enacted to protect the province's wildlife resources directly and other natural resources indirectly. It classifies wildlife by degree of protection, i.e., animals that may be hunted on a permit or special license, and species that are protected and cannot be hunted under any circumstances. The Act specifies restrictions on hunting and trade in animals, trophies, or meat. The Act also defines various categories of wildlife protected areas, ie, National Parks, Wildlife Sanctuaries, and Game Reserve.

The project activities will have to be carried out in accordance with this Act. In particular, no physical interventions will be carried out inside any protected areas defined under the Act.

2.1.6 Forest Act, 1927

The Act authorizes Provincial Forest Departments to establish forest reserves and protected forests. The Act prohibits any person to set fire in the forest, quarry stone, remove any forest-produce or cause any damage to the forest by cutting trees or clearing up area for cultivation or any other purpose.

The project activities will have to be carried out in accordance with this Act. No activities will be carried out in any protected forests, and no unauthorized tree cutting will be carried out.

2.1.7 Canal and Drainage Act, 1873

The Canal and Drainage Act (1873) prohibits corruption or fouling of water in canals (defined to include channels, tube wells, reservoirs and watercourses), or obstruction of drainage.

This Act will be applicable to the physical works to be carried out during the proposed project.

2.1.8 Sindh Water Management Ordinance, 2002

The Sindh Water Management Ordinance (SWMO) provided a framework for institutional reforms in the water sector by decentralizing the water resources management and irrigation and drainage services. Sindh Irrigation Development Authority (SIDA) has been established under the SWMO at the provincial level for water resources management with a board comprising of stakeholders. Area Water Boards (AWBs) have been established for a similar function at canal command area and Farmers' Organizations (FOs) at distributary and minor level consisting of Water Users Associations at the water course level.

2.1.9 Antiquity Act, 1975

The Antiquities Act of 1975 ensures the protection of cultural resources in Pakistan. The Act is designed to protect 'antiquities' from destruction, theft, negligence, unlawful excavation, trade and export. Antiquities have been defined in the Act as ancient products of human activity, historical sites, or sites of anthropological or cultural interest, and national monuments. The law prohibits new construction in the proximity of a

protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area that may contain articles of archeological significance.

Under this Act, the project proponents are obligated to:

- Ensure that no activity is undertaken in the proximity of a protected antiquity, and
- If during the course of the project an archeological discovery is made, it should be protected and reported to the Department of Archeology, Government of Pakistan, for further action.

This Act will be applicable to the physical interventions such as constructionactivities to be carried out during the proposed project.

2.1.10 Factories Act, 1934

The clauses relevant to the proposed project are those that address the health, safety and welfare of the workers, disposal of solid waste and effluents, and damage to private and public property. The Act also provides regulations for handling and disposing toxic and hazardous substances. The Pakistan Environmental Protection Act of 1997 (discussed above), supersedes parts of this Act pertaining to environment and environmental degradation.

2.1.11 Employment of Child Act, 1991

Article 11(3) of the Constitution of Pakistan prohibits employment of children below the age of 14 years in any factory, mines or any other hazardous employment. In accordance with this Article, the Employment of Child Act (ECA) 1991 disallows the child labor in the country. The ECA defines a child to mean a person who has not completed his/her fourteenth years of age. The ECA states that no child shall be employed or permitted to work in any of the occupation set forth in the ECA (such as transport sector, railways, construction, and ports) or in any workshop wherein any of the processes defined in the Act is carried out. The processes defined in the Act include carpet weaving, biri (kind of a cigarette) making, cement manufacturing, textile, construction and others).

The project proponent, participating farmers and their contractors will be bound by the ECA to disallow any child labor at the project sites.

2.1.12 Pakistan Penal Code, 1860

The Code deals with the offences where public or private property or human lives are affected due to intentional or accidental misconduct of an individual or organization. The Code also addresses control of noise, noxious emissions and disposal of effluents. Most of the environmental aspects of the Code have been superseded by the Pakistan Environmental Protection Act, 1997.

2.2 The World Bank Operational Policies

The WB Operating Policies (OPs) relevant to the proposed project are discussed in the following sections.

2.2.1 Environmental Assessment (OP 4.01)

The World Bank requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to

improve decision making.[9] The OP defines the EA process and various types of the EA instruments.

The proposed project may consist of activities which can potentially have environmental and social consequences, including:

- Changes in land use,
- Damage to crops
- Deterioration of air quality,
- Water contamination and consumption,
- Damage to top soil, land erosion,
- Cutting of trees
- Safety hazard.

Since none of the potential impacts of the project are likely to be large scale, unprecedented and/or irreversible, the project has been classified as Category B, in accordance with OP 4.01. Furthermore, the present assessment is being carried out in accordance with this OP, to identify the extent and consequences of these impacts, and to develop an EMP for their mitigation.

2.2.2 Involuntary Resettlement (OP 4.12)

The WB's experience indicates that involuntary resettlement under development projects, if unmitigated, often gives rise to severe economic, social, and environmental risks: production systems are dismantled; people face impoverishment when their productive assets or income sources are lost; people are relocated to environments where their productive skills may be less applicable and the competition for resources greater; community institutions and social networks are weakened; kin groups are dispersed; and cultural identity, traditional authority, and the potential for mutual help are diminished or lost. This policy includes safeguards to address and mitigate these impoverishment risks.[10]

The overall objectives of the Policy are given below.

- Involuntary resettlement should be avoided where feasible, or minimized, exploring all viable alternative project designs.
- Where it is not feasible to avoid resettlement, resettlement activities should be conceived and executed as sustainable development programs, providing sufficient investment resources to enable the persons displaced by the project to share in project benefits. Displaced persons should be meaningfully consulted and should have opportunities to participate in planning and implementing resettlement programs.
- Displaced persons should be assisted in their efforts to improve their livelihoods and standards of living or at least to restore them, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.

[9] Excerpts from WB OP 4.12.WB Operational Manual. January 1999.

[10] Excerpts from WB OP 4.12.WB Operational Manual. December 2001.

The subprojects to be implemented under SAGP may require some land, as stated earlier as well. Such land will be arranged either on voluntary donation or commercial transaction (willing buyer – willing seller) basis, and it will be ensured that such transactions do not cause any involuntary resettlement. Hence the OP 4.12 is not triggered.

2.2.3 Forestry (OP 4.36)

The objective of this Policy is to assist the WB's borrowers to harness the potential of forests to reduce poverty in a sustainable manner, integrate forests effectively into sustainable economic development, and protect the vital local and global environmental services and values of forests.

None of the project components would be located inside any forested areas. Hence the OP 4.36 is not triggered.

2.2.4 Natural Habitat (OP 4.04)

The conservation of natural habitats, like other measures that protect and enhance the environment, is essential for long-term sustainable development. The Bank therefore supports the protection, maintenance, and rehabilitation of natural habitats and their functions …[11]

All of the proposed project components would be located in areas where the natural habitat has already been significantly modified, as a result of cultivation and associated activities. No subproject would be established inside or in the immediate vicinity of protected area (list provided later in the document). However in view of the presence of a large number of protected areas in the province, the OP 4.04 is triggered for the proposed project (list of the protected areas is presented later in the document).

2.2.5 Pest Management (OP 4.09

Through this OP, the WB supports a strategy that promotes the use of biological or environmental control methods and reduces reliance on synthetic chemical pesticides.

While the project is not financing any direct procurement of pesticides and other agro-chemicals, it is likely that with better marketing opportunities in close proximity, farmers could tend to increase land-based productivity through application of fertilizers, pesticides and other agro-chemicals for increasing crop yields. Therefore, Pest Management is triggered. An Integrated Pest Management Plan (IPMP) will address pesticide usage especially in the chilies crop besides other crops being considered in the project. The plan will also articulate a strategy to incorporate IPM principles in project interventions specifically and in the agriculture sector in Sindh in general.

2.2.6 Safety of Dams (OP 4.37)

The Policy seeks to ensure that appropriate measures are taken and sufficient resources provided for the safety of dams the WB finances. However this OP is not relevant since the proposed project does not involve construction of dams.

2.2.7 Projects on International Waterways (OP 7.50)

This OP defines the procedure to be followed for projects the WB finances that are located on any water body that forms a boundary between, or flows through two or more

[11] Excerpts from WB OP 4.04.WB Operational Manual. June 2001.

states. However, no project components will be located on any such waterways. Hence this OP is not triggered.

2.2.8 Cultural Property (OP 4.11)

The World Bank's general policy regarding cultural properties is to assist in their preservation, and to seek to avoid their elimination. The specific aspects of the Policy are given below. [12]

- The Bank normally declines to finance projects that will significantly damage non-replicable cultural property, and will assist only those projects that are sited or designed so as to prevent such damage.
- The Bank will assist in the protection and enhancement of cultural properties encountered in Bank-financed projects, rather than leaving that protection to chance. In some cases, the project is best relocated in order that sites and structures can be preserved, studied, and restored intact in situ. In other cases, structures can be relocated, preserved, studied, and restored on alternate sites. Often, scientific study, selective salvage, and museum preservation before destruction is all that is necessary. Most such projects should include the training and strengthening of institutions entrusted with safeguarding a nation's cultural patrimony. Such activities should be directly included in the scope of the project, rather than being postponed for some possible future action, and the costs are to be internalized in computing overall project costs.
- Deviations from this policy may be justified only where expected project benefits are great, and the loss of or damage to cultural property is judged by competent authorities to be unavoidable, minor, or otherwise acceptable. Specific details of the justification should be discussed in project documents.
- This policy pertains to any project in which the Bank is involved, irrespective of whether the Bank is itself financing the part of the project that may affect cultural property.

Since the project activities will be carried out in or near the cultivated fields, it is unlikely that any sites of cultural, archeological, historical, or religious significance will be affected. However, in case of discovery of any such sites or artifacts during the project implementation, the work will be stopped at that site and the provisions of this Policy will be followed. Additionally, the provincial and federal archeological departments will be notified immediately, and their advice sought before resumption of the construction activities at such sites.

2.2.9 Indigenous People (OP 4.10)

For purposes of this policy, the term "Indigenous Peoples" is used in a generic sense to refer to a distinct, vulnerable, social and cultural group possessing the following characteristics in varying degrees:[13]

- self-identification as members of a distinct indigenous cultural group and recognition of this identity by others;
- collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories;

[12] Excerpts from the OPN 11.03.WB Operational Manual. September 1986.

[13] Excerpts from the OP 4.10.WB Operational Manual. July 2005.

- customary cultural, economic, social, or political institutions that are separate from those of the dominant society and culture; and
- an indigenous language, often different from the official language of the country or region.

The OP defines the process to be followed if the project affects the indigenous people.

There are no known indigenous groups in the entire Sindh province as identified under Op 4.10. Therefore, this OP is not triggered. The only identified indigenous people are in Kalash valley in the northern Pakistan (Chitral district of Khyber Pakhtunkhwa province).

2.2.10 Projects in Disputed Areas (OP 7.60)

Projects in disputed areas may raise a number of delicate problems affecting relations not only between the Bank and its member countries, but also between the borrowerand one or more neighboring countries. In order not to prejudice the position of either the Bank or the countries concerned, any dispute over an area in which a proposed project is located is dealt with at the earliest possible stage.

The Bank may proceed with a project in a disputed area if the governments concerned agree that, pending the settlement of the dispute, the project proposed for country A should go forward without prejudice to the claims of country B. [14]

This OP is not triggered since no part of the Sindh Province is located in any disputed territory.

2.2.11 Policy on Access to Information

The World Bank recognizes that transparency and accountability are of fundamental importance to the development process and to achieving its mission to alleviate poverty. Transparency is essential to building and maintaining public dialogue and increasing public awareness about the Bank's development role and mission. It is also critical for enhancing good governance, accountability, and development effectiveness. Openness promotes engagement with stakeholders, which, in turn, improves the design and implementation of projects and policies, and strengthens development outcomes. It facilitates public oversight of Bank-supported operations during their preparation and implementation, which not only assists in exposing potential wrongdoing and corruption, but also enhances the possibility that problems will be identified and addressed early on.[15]

In accordance with this Policy, the present ESMF will be disclosed to public.

2.2.12 Applicability of Safeguard Policies

Applicability of the WB safeguard policies – on the basis of the discussion in **Sections 2.2.1** to **2.2.11** above - with respect to the environmental and social issues associated with the proposed project is summarized below.

[14] Excerpts from the OP 7.60.WB Operational Manual. November 1994.

[15] Excerpts from the World Bank Policy on Access to Information. World Bank, July 2010.

Operational Policy	Triggered
Environmental Assessment (OP 4.01)	Yes
Involuntary Resettlement (OP 4.12)	No
Forestry (OP 4.36)	No
Natural Habitat (OP 4.04)	Yes
Pest Management (OP 4.09)	Yes
Safety of Dams (OP 4.37)	No
Projects in International Waters (OP 7.50)	No
Cultural Property (OP 4.11)	No
Indigenous People (OP 4.10)	No
Projects in Disputed Area (7.60)	No
Policy on Access to Information	Yes

2.3 Obligations under International Treaties

Pakistan is signatory of several Multilateral Environmental Agreements (MEAs), including:

- Basel Convention,
- Convention on Biological Diversity, Convention on Wetlands (Ramsar),
- Convention on International Trade in Endangered Species (CITES),
- UN Framework Convention on Climate Change (UNFCCC),
- Kyoto Protocol,
- Montreal Protocol,
- UN Convention to Combat Desertification,
- Convention for the Prevention of Pollution from Ships (MARPOL),
- UN Convention on the Law of Seas (LOS),
- Stockholm Convention on Persistent Organic Pollutants (POPs),
- Cartina Protocol.

These MEAs impose requirements and restrictions of varying degrees upon the member countries, in order to meet the objectives of these agreements. However, the implementation mechanism for most of these MEAs is weak in Pakistan and institutional setup mostly nonexistent.

The MEA most applicable for the Project is the Stockholm Convention on Persistent Organic Pollutants (POPs), under which certain pesticides such as dichloro diphenyl trichloroethane (commonly known as DDT) cannot be used.

2.4 Institutional Setup for Environmental Management

The apex environmental body in the country is the Pakistan Environmental Protection Council (PEPC), which is presided by the Chief Executive of the Country. Other bodies include the Pakistan Environmental Protection Agency (Pak-EPA), provincial EPAs (for four provinces, Azad Jammu and Kashmir and Gilgit-Baltistan), and environmental tribunals.

The EPAs were first established under the 1983 Environmental Protection Ordinance; the PEPA 1997 further strengthened their powers. The EPAs have been empowered to receive and review the environmental assessment reports (IEEs and EIAs) of the proposed projects, and provide their approval (or otherwise).

The proposed project would be located in the Sindh Province. Hence the present report will be sent to the Sindh EPA for review.

2.5 Environmental and Social Guidelines

Two sets of guidelines, the Pak-EPA's guidelines and the World Bank Environmental Guidelines are reviewed here. These guidelines address the environmental as well as social aspects.

2.5.1 Environmental Protection Agency's Environmental and Social Guidelines

The Federal EPA has prepared a set of guidelines for conducting environmental assessments. The guidelines derive from much of the existing work done by international donor agencies and non-governmental organizations (NGOs). The package of regulations, of which the guidelines form a part, includes the PEPA 1997 and the NEQS. These guidelines are listed below.

- Guidelines for the Preparation and Review of Environmental Reports,
- Guidelines for Public Consultation,
- Guidelines for Sensitive and Critical Areas,
- Sectoral Guidelines.

It is stated in the Pakistan Environmental Protection Agency Review of IEE and EIA Regulations, 2000 that the EIA or IEE must be prepared, to the extent practicable, in accordance with the Pakistan Environmental Protection Agency Environmental Guidelines.

2.5.2 World Bank Environmental and Social Guidelines

The principal World Bank publications that contain environmental and social guidelines are listed below.

- Environment, Health, and Environment (EHS) Gudeilines prepared by International Finance Corporation and World Bank in 1997.
- Pollution Prevention and Abatement Handbook 1998: Towards Cleaner Production
- Environmental Assessment Sourcebook, Volume I: Policies, Procedures, and Cross-Sectoral Issues.
- Social Analysis Sourcebook.

3. Project Description[16]

This Chapter describes various aspects of the proposed project including its background, objectives, its components, and activities under each component.

3.1 Project Development Objectives

The proposed Project Development Objective (PDO) is to improve the productivity and market access of small and medium producers in selected commodity value chains. This will be achieved by: (i) investing in knowledge and technology for producers, sub-sectors of crops and livestock; and (ii) strengthening public sector institutions to enhance the enabling environment for sustained sectoral growth.

Project Beneficiaries

The proposed project would contribute to more inclusive growth by prioritizing support to small and medium sized producers who are trying to compete in horticulture markets. The project would reach to approximately 112,000 farmers covering over 66,000 ha. A substantive number of these farmers would be women involved in the agricultural processes on-farm for pre- and post-harvest practices for the selected commodities. The project will use a value chain approach to provide direct investment support to the farmers and producers groups for: (i) development of more effective and efficient farming systems; (ii) introduction of technology packages for increased productivity and value addition, and; (iii) improved market access. These services will be made available with a defined focus on how they reach the women in agriculture. The project will be provincial in scope but specific activities may be concentrated geographically based on agro-ecological conditions or natural clustering of economic activities. It is expected that beneficiaries will be able to establish effective and efficient production systems and create market linkages.

PDO Level Results Indicators

The key performance indicators for the SAGP (at the outcome results level) will measure changes in:

- Average yields for selected commodities by targeted beneficiaries.
- Percent of high grade produce of selected commodities by targeted beneficiaries.
- Number of beneficiaries disaggregated by gender.

3.2 Project Components

The SAGP would contribute to more inclusive growth by prioritizing support to small producers with commercial potential. The project would be implemented over a period of five years and would have the following components:

Component A: Capacity Building and Institutional Development (US$ 17.1 million): The project will finance capacity building of producers through technology development, technology dissemination, training and exposure. The project would also provide institutional development for the implementing agencies and support strategic planning for Sindh's agricultural sector.

[16] Adopted from the Project Appraisal Document (PAD), prepared by WB.

Sub-component A.1: Capacity Building of Producers (US$ 1.5 million). The project will finance training and capacity building for farmers, which will be based on training needs assessment carried out by the departments and their technical assistance providers. Training topics will include, but not limited to, good agricultural practices, agribusiness management, negotiating in the market, basic accounting, record keeping, etc. This will be done through inter-alia demonstration plots, public information campaigns, face-to-face training, and farmer-to-farmer study tours, and exposure visits. For each value chain, the department will sponsor stakeholder forums to facilitate dialogue with and among value chain actors that will increase the market orientation of departmental activities as well as build capacity of the departments to carry out stakeholder engagement for other crops in the future.

Sub-component A.2: Modernization of Extension Services and Agricultural Research (US$ 13.1 million). This subcomponent will finance: (a) technical assistance to the implementing departments; (b) modernization of extension services and facilities; and (c) competitive fund for adaptive research.

Technical assistance and capacity building. The project will finance the extended presence of a technical assistance consultant/firm who will (a) assist with the planning and management of implementation of investments in Component B, and (b) designing and delivering effective capacity building components. Additional technical assistance and training will be financed through twinning arrangements with international agencies.

Modernization of programs and facilities. Both the Agriculture Department and the Livestock & Fisheries Department have facilities that were affected by the 2010 and 2011 floods, and the project will provide a modest amount of financing to facilitate their rehabilitation. In addition, it will provide support to establish and/or rehabilitate facilities critical to fulfilling the requirements of the project including, the agricultural research centers, artificial insemination training center, and semen production units.

Modernization of extension services by introducing ICT-based technologies. The project will finance ICT-based technologies and services for delivery of agriculture extension and marketing for farmers/producers. These would include information going out to small producers and other stakeholders through the use of mobile phone and other ICT tools including 24/7 call center and interactive websites and other communication tools.

Competitive research fund. The project will finance a program of competitive research grants supporting research on crop agriculture, livestock, and fisheries. The program would be managed Department of Agriculture, in collaboration with Sindh Agriculture University at Tando Jam. The research proposals will be reviewed based on agreed criteria outlined in the Operational Manual.

Sub-component A.3: Strategic Planning for the Agricultural Sector (US$ 2.5 million): The project will finance the: (a) development of Sindh Agricultural Development Strategy; and (b) preparation of feasibility studies for future investments.

Sindh Agricultural Development Strategy ($1.0 million). The project will finance development of the provincial Strategy to set the long-term development and growth vision for Sindh's agricultural sector. To more accurately forecast needs of the sector relative to pricing, climate smart agriculture, competitiveness and consumer demand, etc. The project will finance economic modeling, public expenditure review, private sector development, and sectoral results framework to inform future investment planning as part of preparing background studies. The Strategy development process will be managed by

the office of the Project Coordinator (see Component C) and guided by the Project Steering Committee (PSC).

Preparation of feasibility studies for future investment plans ($1.5 million). The project will finance preparation of studies on additional crop and livestock value chains including, but not limited to, fisheries and aquaculture, meat production and marketing, seed production and food storage, etc. The studies will feed into discussions for future investment project preparation. The approval of topics to study will be accorded by the PSC and the Project Coordinator will manage the implementation and dissemination feasibility studies.

Component B: Investment for Agricultural Growth (US$ 70.6 million): This component finances specific investments in the horticulture and dairy value chains and a targeted investment to reduce post-harvest loss among small-holder rice growers. The component would also finance a demand driven innovation fund to support farmers and producers with technology innovations in the selected value chains. Selection criteria for farmers and producer groups to receive project interventions and detailed procedures for funds transfer and managing contributions are included in the Operational Manual.

Sub-component B.1: Horticulture Value Chains (US$ 36.3 million). The project will finance investments in three (3) horticulture crops – dates, onions and chilies. The key focus will remain on adopting good agricultural practices for production and post-harvest handing of the selected crops.

Dates crop. The project would finance investments for increased productivity through good agricultural practices for improved crop husbandry, tools for pre- and post-harvest processes including, mats for spreading dates in the sun, disease control kits, moisture testing meters, conductivity meters, tree pruner, pollinator guns, harvesting tool, solar dryers, hand carts, plastic crates, tarpaulin sheets, etc. would be provided to small and medium growers on a 30-70 percent cost sharing basis. To support market access, technology would be provided on a 70-30 cost sharing basis with the farmer or farmer group providing their 30 percent of the cost to DoA, which would then notify a supplier in close proximity to the farmer/farmer group to deliver the implement/tool.

Onion crop. The project would provide extension services for increased productivity through correct plant husbandry, both as a pure stand and an intercrop, fertilizer application, spraying techniques, weed and disease control, harvesting, curing and drying. The integrated pest management extension would focus on developing an environmentally sensitive approach to pest management. Under pest and disease management, thrips, damping off, bulb rotting and downy mildew would be of primary concern. The project would also finance technology packages for increase market access which may include, but not limited to, onion diggers, curing and storage facilities to increase shelf life, mechanical dryers, seed threshers, and ancillary equipment, etc. The financing of the tools and equipment will be provided on cost sharing where growers will contribute 30 percent.

Chili crop. The project will focus on increased productivity through improving agricultural practices including introduction of polyester drying mats, along with similar sheets to cover the crop to prevent dew formation on the harvested crop would be provided to famer and grower associations on 30 percent cost sharing bases. The reduction in aflatoxins is directly in response to improving market access by addressing the urgent need of improved food safety of the chili crop for domestic market as well as for facilitating opening of exports to more desirable markets, thus boosting farmer

incomes and foreign exchange earnings. Rehabilitation and up gradation of the Kunri chili research station in district Umerkot would also be financed. The project would facilitate a public-private partnership involving the Chili Growers Association to establish a common facility center in Kunri, which will house equipment and other implements to improve post-harvest handling of chilies. Project financing of the facility will be contingent on an approved business plan and secured cofinancing. Depending on the size of the facility, IFC support would be sought during implementation.

Sub-component B.2: Rice Post-harvest Loss Management (US$ 10.8 million). To increase productivity and stem the loss of 30-40% of the rice crop due to poor processing practices, this subcomponent will finance threshers for farmers and paddy dryers for small mill operators. In addition, the project will provide soil and moisture testing kits, conductivity meters, etc. Financing for the threshers and dryers would be provided on 50 percent cost sharing basis (in accordance with current government practice) to groups of farmers, small mill operators, and individual medium-scale farmers. The remaining smaller technology inputs would be provided on a 70-30 cost sharing basis. To support the market access, the project would also promote knowledge sharing and learning from other rice producing countries for potential market linkage for Sindh's rice.

Sub-component B.3: Dairy Value Chain (US$ 18.5 million): The project will increase productivity of milk commodity through introducing improved animal health and husbandry practices, nutritional services, hygienic milk collection and testing of milk quality, milk quality monitoring and recording, and storage. Approximately 153 milk producers groups (MPGs) will be formed in 8 districts to improve their market access. The project will target small and medium milk-producing households, but since women are involved in at least 80 percent of production management, the project will provide services exclusively targeting women (e.g., extension messages, female extension agents, etc.). The number of MPGs per district will vary according to the animal population and market linkage. Essentially, each MPG would have a production capacity of 1,000 liters each day. Initial targeting will focus on identified "milk pockets" in the 8 districts. Through meetings in these targeted areas, producers will be informed of the project and given the rules for forming an MPG. The mobilization of MPGs will be done by the private sector milk processors and the district level project implementation unit. In addition, arrangements for producers to access markets will vary based on the existence of a competitive field of private sector actors. They could include, direct tie-ups with traders or processors, or community chilling units that allow the MPG to negotiate with different actors on a competitive basis.

Sub-component B.4.: Demand Driven Innovation Fund (US$ 5.0 million). The project would establish a demand driven innovation fund to respond to the needs for small inputs that supplement the project objectives of improved productivity and market access. The identification, planning and selection criteria along with procedures to implement the Fund are included in the Operational Manual.

Component C: Project Management and Monitoring and Evaluation (US$ 12.3 million): This component would finance costs for following:

Sub-component C.1.: Project Management (US$ 8.2 million). Operational costs for Project Management Units (PMUs), Project Coordinator's office and Project Implementation Units (PIUs). This component also includes costs for implementation of Environment and Social Management Framework (ESMF) and Pest Management Plan (PMP) and development of Social Assessment.

Sub-component C.2.: Monitoring and Evaluation and Project Support Costs (US$ 4.1 million). Costs for: (i) development and implementation of communications strategy and awareness campaigns through print and electronic media; (ii) effective grievance redressal mechanism (GRM) include interactive voice response and complaint tracking system; (iii) rigorous impact evaluation rigorous Impact Evaluation will be designed to attribute causality to project interventions; (iv) third party monitoring; and (v) a management information system (MIS).

3.3 Alternatives Considered and Reasons for Rejection

Under agriculture, the emphasis of the proposed initial subproject is on horticulture crops and post-harvest management in rice. However, horticulture, though showing impressive growth in the agricultural sector is a minor contributor to provincial GDP when compared to the four major agricultural crops of wheat, rice, sugarcane and cotton. Alternative design scenarios were considered; these included:

Alternative 1: No investment project. The 'no-project' alternative is not acceptable since in that scenario, no direct investment would strategically promote sectoral growth for agriculture and its subsectors. Additionally, investments in agricultural sector with a focus on reaching to the small and medium farmers have been ad hoc at best. As a result, promotion of horticulture while remains a priority for the GoSindh, few resources are available to address the subsectors many challenges that limit its growth.

Alternative 2: Focus on different horticulture crops. Mangos and bananas are both economically valuable crops in Sindh, and offer a moderate export potential if varietal selection were improved. However, these crops are primarily grown by larger farmers, who are able to access the required investment capital for production units that are economically viable. In addition, both crops have received significant prior support from donors and government and appear to be thriving. Nevertheless, their contribution to the economy of Sindh is lower than that of dates, onions and chilies.

Alternative 3: Focus on the major crops. Wheat, rice, sugarcane and cotton are the backbone of the Sindh agricultural economy. However, to make an impact in these crops would need considerable amounts of investment, and would be beyond the scope of the first phase of this program, which was tasked with showing measurable impact in the first six years. A second consideration is that fact that the major four crops all receive considerable government subsidies in one form or another and operate in distorted market following political rather than economic imperatives.

3.4 Institutional and Implementation Arrangements

The Department of Agriculture and the Department of Livestock and Fisheries will jointly be responsible for implementing the project and for ensuring that the project development objectives are met. The two Departments will be responsible for implementation of their respective components as well as project management. The project would largely be implemented through the existing structures of the two Departments for delivering local agriculture and livestock extension and research services. However, both Departments would be augmented with additional technical and project management capacities to support the implementation.

The implementation arrangements would comprise of three tiers:

- Project oversight and coordination at provincial level;

- Project management at departmental levels; and
- Project implementation at districts level.

Provincial Level Oversight and Coordination

A provincial level the Project Steering Committee (PSC) will guide, monitor, and supervise the implementation of the Bank project. The PSC will be chaired by the Additional Chief Secretary and will provide overall decision making and policy guidance on aspects relating to agricultural sector development and growth for its contribution to the provincial GDP. The PSC would review progress and will meet every quarter or as needed. The PSC members will include:

- Additional Chief Secretary (chair)
- Secretary Finance
- Secretary Agriculture
- Secretary Livestock
- Representatives of Private Sector Stakeholders
- Project Coordinator (member secretary)

The PSC would be supported by a full-time Project Coordinator. The Project Coordinator would be responsible for consolidated monitoring and evaluation of the project. The quarterly reports prepared by the PMUs would be consolidated by the Project Coordinator. In addition, the Project Coordinator would prepare Annual Reports with Project Implementation Plans (PIP). The project monitoring and evaluation (M&E) consultants would report to the Project Coordinator. The Sindh Agricultural Development Strategy will also be managed by the office of the Project Coordinator with under the guidance of the Project Steering Committee (PSC). And the Project Coordinator will be responsible for managing the implementation and dissemination feasibility studies.

Project Management

Project Management Unit: Two Project Management Units (PMUs) would be established in the Department of Agriculture and Department of Livestock respectively headed by Project Directors who are appointed by the Government. The position of a Project Coordinator will be established to ensure that joint monitoring, reporting and coordination takes place with the help of two Departments.

The PMUs would be responsible for overall project management, monitoring and supervision, as well as fiduciary and safeguards implementation and compliance. The PMUs will have project management and implementation staff with adequate qualification and expertise. The PMUs and where needed, would be provided with additional technical support through consultants.

Project Implementation

Project Implementation Units: At the district level, Project Implementation Units (PIUs) will be established to provide support staff, training and equipment to build capacity and strengthen the arrangements already in place, mainly the existing Research and Extension wings of the Department of Agriculture and Department of Livestock. The PIUs would be provided with capacity building so that they can access and use a greater range of information products, decision tools, and manage field demonstrations.

A total of eight (8) PIUs will be established – two each in Hyderabad, Mirpukhas, and Sukkur and one in Larkana and Thatta districts. The PIUs would have adequate staff to ensure all implementation responsibilities are properly resourced. The PIUs will be responsible for the operational management and implementation of the specific sub-components. The PIUs will report to respective PMUs for day-to-day management and implementation of project sub-components and will be supported by implementation as well as fiduciary staff of the PMUs.

Results Monitoring and Evaluation

The PMUs will have overall responsibility for all results monitoring and evaluation. The PMUs will prepare quarterly report that will be consolidated by the Project Coordinator and submitted in an appropriate format to the GoSindh PSC, and the Bank no later than three weeks after the end of each quarter. The quarterly report would cover the progress and implementation status of all project components progress on capacity building and training, activities of the project consultants, progress and results of special studies, other technical, environmental and social, procurement and financial management issues. These reports would be in addition to the quarterly interim financial statements, including: (a) comparison of actual physical and financial outputs with forecasts, and updated six-months project forecasts; (b) project financial statements, including sources and application of funds, expenditures by category statement, and designated account reconciliation statement; and (c) a procurement management report, showing status and contract commitments, overall procurement plan for the next six months. The interim financial statements would be submitted within 45 days after the close of each quarter by each implementing agency.

The Project Coordinator will also prepare Annual Reports with Project Implementation Plans (PIP). The Annual Reports will be consolidated with inputs from the two PMUs and will be prepared by no later than March 31 of each year of project implementation. The Annual Reports will cover: (a) the progress of each component, implementation of key features of the environmental and social management framework, key performance indicators, results framework, operation of project facilities, and financial statements; and (b) the annual Project Implementation Plan (PIP) for the following Fiscal Year with funds required for implementation with breakdown by components/activities, an updated disbursement profile, planned actions for mitigating environmental and social negative effects during implementation, and target indicators for the coming year.

The project would hire M&E consulting firm with a proven track record. The M&E consultants would report to the Project Coordinator and provide support on: (a) monitoring the project results framework including key performance indicators (KPIs); (b) completing a baseline survey for each component; (c) carry out impact evaluation studies for each intervention tier; and (d) establish a Project Management Information System (MIS). The M&E activities would provide continuous feedback to the GoSindh and PSC on the project's performance and its overall impact and of various components, so that corrective actions could be undertaken in a timely manner.

In addition, an impact evaluation would be carried out with the objective of establishing the net contribution of the project to the sustainable livelihoods of the targeted families "before" and" after" the project and/or "with" and "without" the project. This impact evaluation would also feed into preparation of the next phase or follow on of the project. A Mid Term Review (MTR) would be undertaken half way through the project

implementation period and an Implementation Completion Report (ICR) would be submitted to the Bank no later than six months after the closing date of project.

Sustainability

Sustainability under the SAGP has several dimensions. First, is the sustainability of individual investments which includes that in principle, investments under the SAGP are included as part of a broader effort to enhance agriculture sustainability at the farm level. This applies to overall agricultural and in particular horticultural practices initially in the selected crops and scaled up to future investments in other crops. Second is the sustainability of the investments across a given crop cluster which will depend on the quality of the SAGP planning process, the timely execution of activities and the incentives that farmers have in implementing activities. Third, as there are trade-offs between the project support accessed by farmers within different parts of the province, it is expected demonstrative effect will engage additional farmers to participation, in the longer-run, in the sectoral growth programs of the GoSindh and other development partners. In addition, the sustainability of the sector growth agenda will be ensured by the Sindh Agriculture Development Strategy which would address key constraints in promoting extension and marketing issues from small and medium farmers' perspective and hence enable public policy lessons and possible transfer of these towards scaling-up of sectoral investments. All of this will also be linked directly to the quality of the M&E system in capturing results as well as lessons in the SAGP and effectively communicating these to stakeholders including policy and decision makers, development partners and direct and indirect beneficiaries.

4. Environmental and Social Baseline Conditions

This Chapter presents an overall profile of the existing environmental and socioeconomic situation in the Sindh Province as the baseline conditions for project and it's ESMF, since the sites for the interventions included in the proposed project are likely to be spread all over the Province. This baseline has been prepared based upon the secondary literature resources[17].

4.1 Location

Sindh is bounded to the west by Balochistan Province, to the north by Punjab Province, to the east by the Indian states of Gujarat and Rajasthan and to the south by the Arabian Sea. The capital of the province is Karachi, Pakistan's largest city and financial hub (see **Figure 4.1** for the map of the Province and its surroundings).

Figure 4.1: Sindh Province and its Surroundings

[17] Sources include: 1) Atlas of Pakistan; Survey of Pakistan, 1997. 2) Sindh – State of Environment and Development; IUCN, 2004. 3) Wikipedia web page on Sindh accessed on 12 May 2013.

4.2 Geography

The Province of Sindh is located on the western corner of South Asia, bordering the Iranian plateau in the west. Geographically it is the third largest province of Pakistan, stretching about 579 km from north to south and 442 km (extreme) or 281 km (average) from east to west, with an area of 140,915 square kilometers (54,408 square miles) of Pakistani territory. It lies between 23° and 28° North latitudes and 66° and 71° East longitudes. Sindh is bounded by the Thar Desert to the east, the Kirthar Mountains to the west, and the Arabian Sea in the south. In the centre is a fertile plain around the Indus River

Sindh consists of the Lower Indus Plain, which is very flat, generally sloping to the south with an average gradient of about 95 mm per kilometer. The Lower Indus Plain primarily comprises Indus Delta in the south, meander flood plain and cover fold plan. The area can be divided into five micro-relief land forms: active flood plain; meander flood plain; cover flood plain; scalloped interfluves; and Indus Delta.

Topographically, Sindh can be divided into four distinct parts: (a) Kirthar range on the west; (b) a central alluvial plain bisected by the Indus River; (c) a desert belt in the east; and (d) the Indus delta in the South. These are briefly described below.

- **Kirthar Range** consisting of three parallel tiers of ridges which run in north south direction and vary in width from 20 to 50 kilometers. The Kirthar range has little soil and is mostly dry and barren.
- **Central Alluvial Plain** comprising the valley of the Indus River. This plain is about 580 kilometers long and about 51,800 square kilometers in area and gradually slopes downward from north to south. It is a vast plain, around 100 meters high above sea level. According to the past tradition it has been divided into three distinct zones: i) Lar or Southern Sindh comprising the area south of Hyderabad; ii). Wichalo or Central Sindh, the area lying immediately around Hyderabad; and iii) Siro, or Northern Sindh, comprising the area beyond Naushahero Feroze and Sehwan.
- **Eastern Desert Belt** including low dunes and flats in the north, the Achhrro Thar (white and desert) to the south and the Thar Desert in the south-east. There is small hilly tract known as Karunjhar hills. The Aravalli series belongs to Archaen system which constitutes the oldest rocks of the earth's crust.
- **Indus Delta** consisting of the distributaries of the Indus River which starts spreading out near Thatta across the deltaic flood plain in the sea. The even surface is marked by a network of flowing and abandoned channels. A coastal strip, 10 to 40 kilometers wide, is flooded at high tide and contains some mangrove swamps.

Except for a small hilly tract (Nagarparkar), in the southeast corner of the Tharparkar District, western Sindh is the only region which is mountainous and includes the hill ranges of Kirthar, Pab, Laki, and Kohistan. There is no vegetation on these ranges due to scanty rainfall. The highest altitude known as Kutai-ji-Kabar is in the Kirthar Range and is about 2,073 meters high. These ranges run north to south like a crescent turned towards the low lands and extend up to the northern extremity of the province. Kirthar has a simple, anticlinal structure with flanks gently dipping towards west and south. The Laki Range, on the other hand, is mainly composed of tertiary rocks and contains a large number of thermal springs. A large part of Sindh lies in the deltaic plain of the Lower Indus Valley. Most of this region consists of plains overlain by alluvium, trenched with river channels in some places and overridden by raised terraces in others. A few isolated

low limestone hills are the only relieving features in the plains which are otherwise at one level. The plains may be subdivided into three parts: the western valley, the eastern valley, and the deltaic area. The western valley section is distinguished from the eastern valley by the presence of old alluvium and seasonal *nala* flowing from the Kirthar mountain range into the Manchhar Lake. The deltaic area largely consists of mangrove swamps and sandbars. The chief characteristic of the region is the creeks, which serve as the changing outlets of the Indus and as inlets for the sea. The lowland Indus plain merges into this region. The eastern part of Sindh consists of the Thar Desert which continues into Rajasthan (India). The landscape is sandy and rough with sand dunes covering more than 56 percent of the area. The relief in the area varies between near sea level to more than 150 meters above sea level. The sand dunes are mostly longitudinal with a north-east-south-west trend and are stabilized by shrub vegetation and grass.

4.3 Geological Setting

The prevailing geologic conditions in the region are the results of extensive inundation, depositions, coastal movements, and erosions over a long period of time in the geological ages. The geology of the region is closely related to the formation process of Himalayan ranges resulting in intense deformation with complex folding, high angle strike-slip faults and crust thickening expressed in a series of thrust faults. The important tectonic changes which have had so much influence in the region are feebly visible particularly in the Indus Plain, and it is only by considering the geology on a broader regional scale, as well as in site specific detail, that the effects can be appreciated.

Most parts of Sindh are covered either by recent alluvium or wind-borne sand. The principal features of geological significance are to be found in the hilly portions of the province, towards the west of the Indus. Outlying extensions of this hilly tract occur east of the Indus as well, near Sukkur, Hyderabad and Jerruck. The isolated hills of Nagarparkar on the northern border of the Rann of Kutch belong to quite a different system both geographically and geologically.

The geological studies of the proposed site have not been conducted in detail. However, the studies carried out in the vicinity of Port Qasim area which is not far away from the proposed site reveal that Port Qasim and its adjoining areas have been formed in the middle and upper Tertiary and the soil formation found in the area are fresh and slightly weathered with recent and sub-recent shoreline deposits. These formations are derived from Gaj / Manchhar formation of lower Miocene to middle Miocene to Pliocene age. Similar deposits are found all along the coastal belt of Karachi and adjoining areas.

The earthquake hazard in the Indus Delta and the estuaries on the passive continental margin is mainly from intra-plate active faults particularly Rann of Katch Fault also known as the Karachi-Jati-Allah Bund Fault. It has three other segments namely Jhimpir Fault, Pab Fault and Surjani Fault. The main faults between Karachi and Rann of Kutch are generally oriented easterly and slightly concave to the north. Two severe earthquakes occurred in the vicinity of Karachi, one in the year 1050 at Bhambore in which 0.15 million casualties were reported and the other in the year 1668 at Pipri near Steel Mill which is only 60 km away from Karachi, however the details of this are not available.

4.4 Soils

The soil in the plains of Sindh is plastic clay that has been deposited by the Indus. Combined with water it develops into a rich mould and without water it degenerates into

a desert. Nearly the entire Indus valley has soil which is extremely friable and easily disintegrated by the flow of water. Resultantly, the water always contains a large amount of suspended silt.

The Soil Survey of Pakistan has grouped approximately 80 percent Sindh soils into eight land capability classes according to their agriculture potential and the relative suitability for sustained agriculture use (see **Table 4.1**). Soils placed in Class I are generally very responsive to high inputs of water, improved seed, fertilizers, labor and also to improved management techniques, while lower classes have correspondingly decreasing response to inputs and management. Approximately 10 percent of classified land in Sindh falls under Class I and 20 percent under Class II and 15 percent under Class III. Arable area constitutes approximately 50 percent of the classified area in Sindh.

Table 4.1: Extent of Land Capability Classes in the Surveyed Area of Sindh

Class	Sindh ('000 ha)	Pakistan (' 000 ha)	Sindh as Percent of Total	Agricultural Potential
I	1,097.8	5,362.2	20.5	Very high for general agriculture; moderate for rice
II	2,326.9	7,009.1	33.2	High for general agriculture; low to moderate for rice
III	1,496.9	4,888.0	30.6	Moderate for general agriculture
IV	742.5	3,623.8	20.5	Low for general cropping
V	—	171.1	—	High for forestry or range development
VI	8.3	1,270.3	0.7	Moderate for forestry or range development
VII	2,226.3	18,647.4	11.9	Low for forestry or range development
VIII	3,188.7	32,561.1	9.8	No potential for any type of economic agriculture
Unclassified	364.9	1,835.3	19.9	
Total	**11,452.3**	**75,368.3**	**15.2**	

Source: 1. Pakistan's Soil Resources: Pakistan National Conservation Strategy Sector Paper 4, 1993: data updated by Soil Survey of Pakistan in 2000
2. National Fertilizer Development Centre, Islamabad (2002)

Salinity is one of the major soil problems confronting agriculture in Sindh. The problem is generally considered to be the result of the canal irrigation system, but countrywide soil surveys have established that most of the existing saline/saline sodic soils are not related to the present irrigation system, and their formation is the consequence of the gradual redistribution of salts already present in the soil. However, the canal irrigation system has certainly aggravated the situation. This kind of salinity, identified as secondary salinity, is relatively temporary and can be easily eliminated by adopting appropriate measures. Major factors responsible for the development of secondary salinity include lateral seepage of water from the canal system and its evaporation from the surface of adjoining soils, the rising of water table due to excessive percolation from the canal system and over-irrigation practices, inadequate availability of water, and accumulation of salts in low lying areas through runoff from surrounding saline soils.

4.5 Land Use

Agriculture, followed by forestry, is the main land use in most parts of Sindh. Although more than 50 percent of the total geographical area is cultivable, only 26 percent of it is actually located in the central plain. The land inside the Indus embankments is almost equally employed by agriculture and forestry, while that outside the embankments is more extensively utilized for agriculture in the form of sparsely distributed irrigated plantations. The land use in Sindh is given in **Table 4.2**.

Table 4.2: Land Use in Sindh

Land Use	Area (Million Ha)	Percentage
Not Sown	3.022	21.446
Current Fallow	1.439	18.935
Cultivable Waste	2.688	10.212
Total Available for Cultivation	7.149	50.593
Not Available for Cultivation	5.830	41.374
Forest	1.125	7.984
Unreported	0.007	0.049
Total	**14.091**	**100.000**

Source: Sindh State of Environment and Development, International Union for Conservation of Nature (IUCN), 2004.

4.6 Water Resources

Sindh is entirely dependent on the River Indus for its survival and development. About 95 percent of the farmland in Sindh obtains its water from the irrigation system, while the rest is cultivated with the help of tube wells. The limited groundwater (less than 5 million acre feet or MAF – about 6.17 billion cubic meters or BCM) in the province is available in only 28 percent of the entire area. Rainfall is only in the range of 100 to200 mm per annum, while the evaporation rate is about 1000 to 2000 mm, depending on climatic conditions. Thus the whole of Sindh is arid, with the River Indus being the primary freshwater source that gives life to the province. With population growth, the average amount of renewable freshwater available to each person has been declining. A country is considered to be under serious water stress if it falls below 2000 cubic meters. It is classified as water deficient if the per capita water availability falls under 1000cubic meters. In such a situation the socioeconomic and environmental development of the country is seriously hampered.

IndusRiver: The Indus River is the main source of surface water in the project area (and in the country). The Indus rises in Tibet, at an altitude of about 18,000 feet (5,486 m) above mean sea level (amsl), and has a total catchment area of 654,329 km^2. Length of the Indus River in the country is about 2,750 km. Five main rivers that join the Indus from the eastern side are Jhelum, Chenab, Ravi, Beas and Sutlej. Besides these, two minor rivers - Soan and Harrow also drain into the Indus. On the western side, a number of small rivers join Indus, the biggest of which is River Kabul with its main tributaries i.e. Swat, Panjkora and Kunar. Several small streams such as Kurram, Gomal, Kohat, Tai

and Tank, also join the Indus on the right side. **Table 4.3** presents key facts about the river.

The Indus River and its tributaries on an average bring about 154 MAF (189.9 BCM) of water annually. This includes 144.9 MAF (178.7 BCM) from the three western rivers and 9.14 MAF (11.2 BCM) from the eastern rivers. Most of this, about 104.7 MAF (129.1 BCM) is diverted for irrigation, 39.4 MAF (48.6 BCM) flows to the sea and about 9.9 MAF (12.2 BCM) is consumed by the system losses which include evaporation, seepage and spills during floods. The flows of the Indus and its tributaries vary widely from year to year and within the year. As is the case with the water availability there is significant variation in annual flows into sea.

Table 4.3: Key Facts about Indus River [a]

Length of River Indus in Pakistan:	1,708 miles (2,767 km)
Important Engineering Structures on the River:	Tarbela Dam and Ghazi Barotha Hydro Power Project
	Jinnah Barrage (950,000 cusecs),
	Chashma Barrage (1.1 million cusecs),
	Taunsa Barrage (750,000 cusecs),
	Guddu Barrage (1.2 million cusecs),
	Sukkur Barrage (1.5 million cusecs) and
	Kotri Barrage (750,000 cusecs)
Catchment Area:	252,638 miles^2 (663,023km^2)
Annual Average Flow:	48.0 MAF (41.41 Kharif and 6.61 Rabi)

[a] Source: Pakistan Water Gateway.

The Indus Basin Irrigation System

The Indus River system can be divided into western rivers (Indus, Jhelum and Chenab) and eastern rivers (Ravi, Beas and Sutlej). The total flows of the western rivers belong to Pakistan while India has the right to the waters of the eastern rivers. All the rivers of the Indus system are perennial. The irrigation system of Pakistan, fed by the Indus and its tributaries, is the largest integrated irrigation network in the world. The system consists of three major storage reservoirs, 19barrages, 12 inter-river link canals, 43independent irrigation canal commands, and over107,000 watercourses. These are complemented by a surface drainage system. The total length of the canals is 61,000 km whereas watercourses and farm channels measure another 1.6 million km. A watercourse generally commands 80 to320 hectares. The system draws an average of106 MAF (130.7 BCM) of surface water each year for irrigation, supplemented annually by pumped groundwater of some 43 MAF (53 BCM). The overall irrigation efficiency of the IBIS is around 36 percent.

The irrigation canals of Sindh were extended and improved by the British in the late 1800s.By 1910, the irrigated area had expanded to 1.4million hectares (MHa). Sukkur Barrage, completed in 1932,increased the annual cultivated area to 2.37MHA. The

completion of Kotri Barrage (Ghulam Muhammad Barrage, 1955), and Guddu Barrage (1962) brought the rest of Sindh's irrigation system under barrage control. The total command area under the three barrages was 5.1 MHa in 1997-98.

There are 13 existing surface drainage systems in Sindh that serve a total area of over 2.5 MHa and have an aggregate length of about 4,800km. Additional drains are under construction.

During the year 1999-2000, the total irrigated area using all sources in Sindh was of the order of 2.52 MHa. This included 2.39 MHa in the canal commands and 0.13 MHa irrigated by private wells and tube wells. The irrigation system presently comprises of 14canals, 1200 distribution channels and 47,400watercourses. On an average, Sindh has drawn 45 MAF (55.5 BCM) during the period of 1970 to1997.Data from 1980-81 to 1997-98 demonstrates that about 95 percent of the farmland in Sindh gets water from the irrigation system and the rest is cropped with the help of tube wells.

River Water Quality

The water quality of Indus River is generally considered excellent for irrigation purposes. The total dissolved solids (TDS) range from 60 milligrams per liter (mg/l) in the upper reaches to 375 mg/l in the lower reaches of the Indus, which are reasonable levels for irrigated agriculture and also as raw water for domestic use. The disposal of saline drainage from various irrigation projects has been a major factor in the increased TDS in the lower reaches of the rivers in the Indus Plain. There is progressive deterioration downstream and the salinity is at its maximum at the confluence of the Chenab and Ravi rivers, where the TDS ranges from 207 to 907 mg/l. A slight improvement in water quality is noted further downstream at Panjnad due to dilution from the inflow from Sutlej River. The quality of the Indus water at Guddu, however, is within acceptable limits for agriculture; TDS being in the range of 164-270 mg/l.

In the upper reaches of the Indus River, the Dissolved Oxygen (DO) content remains above 8.5 mg/l which is well above the acceptable levels of 4 mg/l. The Biochemical Oxygen Demand (BOD) downstream of Attock has been recorded as 2.9 mg/l. At Kotri, it has a suspended solid (SS) content of 10 to 200 mg/l. Indus River water quality has been studied at the Dadu – Moro Bridge and Kotri Barrage, with nitrate levels at 1.1 and 7.5 mg/l, phosphate at 0.02 and 0.3 mg/l, BOD at 2.4 and 4.1 mg/l, faecal coliforms at 50 and 400 per ml, and aluminum at 1.8 and 0.2 mg/l respectively. Due to industrial waste discharges from Punjab and Sindh, a high content of heavy metals such as nickel, lead, zinc and cadmium have also been found in Indus water.

Groundwater Sources

Regular surveys have not been carried out to assess the availability of groundwater in the province. Various sources estimate that its volume is between 3 to 5 MAF (3.7 to 6.2 BCM) scattered in 28 percent of the geographical area of Sindh. However, some experts suggest it to be less than these estimates. This water is found mainly along the Indus water channels and in the few natural underground streams. In recent years, drought has caused excessive extraction of groundwater to make up for the lack of irrigation water. This, in turn, has resulted in rapid depletion of the groundwater and filling up of the underground freshwater channels and reservoirs with brackish water. There is an urgent need to conduct a survey for assessing the location and potential of ground water in Sindh.

Rain Harvesting. Little effort has been made towards harvesting rainwater in the province. Several projects like the Mol Dam, Kacho Reservoir, the development of lakes, depressions and reservoirs, remain unattended. These water bodies can harvest rain for irrigating crops and can be used for fish farming. However, such projects can cause ecological damage if not well-planned and can also result in the eviction of communities from productive areas they have inhabited for centuries.

4.7 Climate

The climate of Sindh is arid and hot. According to classification made by UNESCO the region has been divided into three zones as under:

(i) Coastal- South of Thatta.

(ii) Southern- from Thatta through Hyderabad to Shaheed Benazirabad (Nawabshah).

(iii) Northern-from Shaheed Benazirabad (Nawabshah) to Jacobabad.

In an average year coastal region receives the maximum rainfall of 175-200mm. The hottest region is Northern where mercury during summer goes upto 53 °C. The wind direction changes from west to southwest in the Coastal zone, to south-southeast in northern zone. The coldest season extends from December to February when dominating influence is the eastern winds. Mean monthly temperature varies from 20 °C near the coast to 14 °C in the north. Daily variation is about 30 °C but temperature above 32or below 2 °C may occasionally be expected. Frosts are very rare in south of Nawabshah. Humidity is in the 40-60 percentage range. Monthly rate of evaporation in the irrigated areas varies from 76mm in the north to 114mm in the south. Rainfall for the three months is less than 25mm. Mean daily temperature rises rapidly from February onwards to its peak in May and June, rather earlier in the south than in the north. Mean maximum temperature reaches about 24 °C in May in the south and as high as 45 °C in June in the north. The severity of the heat varies from year to year, the highest temperature ever recorded on the subcontinent was 53 °C at Jacobabad. Winds are rather variable, being transitional from the northeast to southwest as the season develops. Humidity is at its lowest generally below 40 percent, but increases as the sea breeze become dominant. Evaporation is correspondingly at its highest exceeding 25mm in rocky desert areas. Rainfall is low and generally associated with local thunderstorm. July to mid September is the monsoon season and is characterized comparatively by low day temperature, high humidity (over 60 percent in the south and 50 percent in the north), reduced evaporation (only 15 or 18mm at some stations in August) and a considerable increase in clouds in coastal areas. Occasional depressions from the east result in a 4 or 5 day period of rain and thunderstorm, especially in the south. Heavy rain is generally rare in the north, which receives little influence either from the monsoon current in the south or from those that come up from the Ganges Valley to the northern Indus plains. The rainfall is very variable, instances have been recorded where a single day has considerably exceeded the highest annual average. Mid September to November is the period of sea breeze with occasional north winds. At the start temperature rises slightly, then falls in November. Humidity falls to about 10 to 15 percent, and the evaporation decreases about 100mm in the north, 125mm in the south.

4.8 Agriculture

Agriculture is the foundation of Pakistan's economy. It contributes about 25 percent to the Gross Domestic Product (GDP) of the country. Sindh is a major contributor of staple

crops in the country, producing 35percent of rice, 28 percent of sugarcane, 20 percent of cotton and 12 percent of wheat, respectively. A majority of the people of Sindh depend on agriculture as their main source of livelihood.

About 40 percent of the land in Sindh is arable land and 5 percent of it is rangeland. The total cultivated area in Sindh is 5.88 million hectares and the net area sown is 2.39 million hectares. The total cropped area is 3.10 million hectares, of which 0.71 million hectares are sown more than once1. Sindh grows a variety of field and horticultural crops. Wheat, cotton, rice, and sugarcane are the major field crops, which constitute 68 percent of the total cropped area, while mango, banana and chilies are the major horticultural crops. Among the horticultural crops, Sindh produces 73 percent bananas, 34percent mangoes, and 88 percent of the chilies. Of the total cropped area of 3.1 million hectares in the year 2000-01, almost 50 percent of the area was under food crops (wheat, rice, maize, sorghum, millet and barley), 25 percent under cash crops (cotton, sugarcane). The remaining area was under fodder (9.1 percent), pulses (4.7 percent), condiments (4.1 percent), oilseeds (3.8 percent), fruits (3.3 percent), and vegetables (1.4 percent).

Crop yields in Sindh are generally low and have remained either stagnant or have increased at slow rates. The low availability of quality seed of crop varieties continues to be of major concern for agriculture. The use of crop inputs such as fertilizer and pesticides has increased considerably without a corresponding increase in yield levels. The supply of substandard and adulterated pesticides and fertilizers is also affecting crop yields and the cost of production.

There is increasing degradation of the resource base such as soil, and current farming practices do not adequately address the issue of sustainability of crop production systems. This is in addition to the high cost of inputs and unstable market prices. The farming community is, for the most part, below the poverty line and this is a major constraint to the development of agriculture.

Farm mechanization is limited to the use of tractors and wheat threshers. Laser levelers are a recent introduction with considerable potential for enhancing yield levels and better use of irrigation water. Current water scarcity related problems demand the adoption of efficient water management practices.

Agro-Ecological Zones

The irrigated areas of the province have been divided into three major agro-ecological zones, two of which are further divided into sub-zones, as given below.

Zone A Rice/wheat zone of the right bank of river Indus (upper Sindh) Sub-zone A1 Main area Sub-zone A2 Piedmont soil region

Zone B Cotton/wheat zone of the left bank of river Indus Sub-zone B1 Guddu Barrage command area Sub-zone B2 Sukkur Barrage command area

Zone C Rice/wheat/sugarcane zone of lower Sindh. In addition to the above three zones, there are two more zones in Sindh. Zone D is a desert area in the east of Sindh, and Zone E is the western hilly zone. Main agricultural activity is, therefore, concentrated in the Zones A, Band C. **Table 4.4** shows the main features of the agro-ecological zones including climate, water supply, soil, and cropping pattern.

Zone A: It covers the districts of Shikarpur, Jacobabad, Larkana and the northern taluka of Dadu district. There are six main canals (three from the Guddu Barrage and three from the Sukkur Barrage) feeding zone A, three of which are perennial.

Table 4.4: Main Features of Agro-Ecological Zones including Water Supply, Soil Salinity and Cropping Pattern

Factor	Agro-ecological zones of Sindh				
	A1	A2	B1	B2	C
Climate					
Rainfall mm[a]	75-100	75-100	75-120	120-230	180-250
Rain period[b]	Jul-Aug	Jul-Aug	Jul-Aug	Jun-Sep	Jun-Sep
Evaporation[c]	150-175	150-175	175-200	200-225	150-225
Humidity	Low	Low	Low	Low-High	High
Winter temp^{0}C[d]	8	8	8	12	10
Summer temp^{0}C	44	44	42	40	30
Altitude masl[e]	40-60	40-60	40-60	5-40	0-5
Water Supply					
Perennial percent	55 percent	65 percent	0 percent	100 percent	50 percent
Irrigation area[f]	5,000	2,100	3,100	16,600	3,800
Tube well potential[g]	High	Low	High	High	Low
Soils					
Main types	Calcareous silt loam	Piedmont clays	Calcareous silt loam	Calcareous silt loam	Saline silt/clay
Salinity[h]	10 percent	5 percent	15 percent	15-50 percent	70 percent
Cropping					
Main *Kharif*	Rice	Sorghum	Cotton	Cotton	Rice
Other *Kharif*		Rice Fallow	Rice	High value Sugarcane	Sugarcane Vegetable
Main *Rabi*	Wheat	Wheat	Wheat	Wheat	Sugarcane
Other *Rabi*	Mixed Fodder	Fallow	Fodder	Fodder Vegetable	Fodder Vegetable

Source: Sindh Agriculture Extension and Adaptive Research Report (1994)

a. Mean annual rainfall, millimetres
b. Months experiencing more than 20 mm
c. Annual evaporation, millimetres
d. Winter: Mean minimum monthly temperature, January/December
   Summer: Mean maximum monthly temperature, May/June
e. Altitude, meters above sea level (masl)
f. Thousands of hectares
g. Tube well potential for drainage/Rabi water source
h. Percentage of area with severe upper soil salinity problems
i. High value crops: vegetables, orchards

Zone A1 covers the districts of Shikarpur, Larkana and the northern taluka (Mehar and Khairpur Nathan Shah) of Dadu district. Dadu, Rice and NWC Canals of Sukkur Barrage irrigate the zone. Rice is the major crop of the zone, followed by wheat while Rabi pulses and oilseeds are *dubari* crops. Wheat, sugarcane, oilseeds, Rabi and Kharif vegetables as well as guava and dates are also grown under the command of Dadu and NWC perennial canals.

Zone A2 covers the region of Jacobabad and Larkana districts. Here the soil is richer in clays than the soil of Zone A1, potentially more fertile and less prone to salinity

problems. However, it is slower to drain. The major crop of the zone is rice in Kharif, followed by wheat, Rabi pulses and oilseeds as *dubari* crops.

Zone B: Zone B covers the left bank of river Indus in the districts of Ghotki, Sukkur, Khairpur, Naushero Feroze, Sanghar, Hyderabad, Mirpurkhas and Tharparkar. The entire zone is Indus flood plain. Saline soils are encountered throughout the zone. The problem tends to be more acute in the east of Ghotki and Sukkur Districts (Zone B1) and in eastern Sanghar and Mirpurkhas District (Zone B2). Cotton and sugarcane are the main Kharif crops of Zone B1. Oilseeds like sesame and sunflower are also being cultivated increasingly in the zone due to water scarcity. Wheat, oilseeds and vegetables follow the Kharif crops.

Zone B2 lies in the command area of four perennial canals (Rohri, Khairpur Feeder East and West and Nara) of the Sukkur barrage covering the districts Khairpur, Naushero Feroze, Sanghar, Hyderabad, Mirpurkhas, and Tharparkar. The major Kharif crops of the zone are cotton and sugarcane, followed by sesame, sunflower, and groundnuts. In the Rabi season, wheat is the major crop followed by rapeseed, mustard, sugarcane, Rabi vegetables, and onion. The zone also produces mango, banana, chiku, papaya, citrus, and jujube.

Zone C: Zone C consists of lower Sindh, and is fed from the Kotri Barrage. It includes the Indus Delta and covers the districts of Thatta, Karachi, Badin (except taluka Matli and northern parts of Tando Bago) and taluka Tando Mohammad Khan of District Hyderabad. Zone C is more saline than any other area in Sindh. Salinity and water-logging are most severe in this zone where drainage is difficult due to an absence of a gradient.

The climate of Zone C is mild and humid, and it has the highest rainfall in Sindh (180 to 250 mm per year). However, its agricultural production is low. The main crops are rice and sugarcane in Kharif, which are followed by wheat and vegetables in perennial areas. The main vegetables grown here are onion and tomato and the zone also produces banana, chiku, papaya and coconut. Palm oil plantation has been successfully introduced in this zone.

4.9 Human Environment

Demography and Administrative Division

Sindh has the second highest Human Development Index out of all of Pakistan's provinces at 0.628. The 1998 Census of Pakistan indicated a population of 30.4 million; the current estimates indicate a population of over 35 million in Sindh. Just under half of the population is urban, mainly found in Karachi, Hyderabad, Sukkur, Mirpurkhas, Shaheed Benazirabad District, Umerkot and Larkana. Sindhi is the sole official language of Sindh since the 19th century. According to the 1998 Population Census of Pakistan, Sindhi-speaking households make up 59.73 percent (92.02 percent in rural and 25.79 percent in urban area) of Sindh; Urdu-speaking households make up 21.05 percent (1.61 percent in rural and 41.48 percent in urban areas); Punjabi 06.99 percent; Pashto 05.01 percent; Balochi 2.11 percent; Saraiki 01.00 percent; and other languages 04.93 percent. Other languages include Gujarati, Memoni, Persian, Kutchi (last one being a dialect of Sindhi), Khowar, Thari, Luri and Brahui.

The Sindh is as a whole are composed of original descendants of an ancient population known as Sammaat, various sub-groups related to the Baloch origin are found in interior

Sindh and to a lesser extent Sindhis of Pashtun origins. Sindhis of Balochi origins make up about 30 percent of the total Sindhi population (they however speak Sindhi as their native tongue), while Urdu-speaking Muhajirs make over 20 percent of the total population of the province. Also found in the province are groups of Sindhi tribes claiming descent from early Muslim settlers including Arabs, and Persian.

There are 23 districts in Sindh, listed below and shown in **Figure 4.2**.

- Karachi
- Jamshoro
- Thatta
- Badin
- Tharparkar
- Umerkot
- Mirpur Khas
- Tando Allahyar
- Naushahro Feroze
- Tando Muhammad Khan
- Hyderabad
- Sanghar
- Khairpur
- Shaheed Benazirabad
- Dadu
- Qambar Shahdadkot
- Larkana
- Matiari
- Ghotki
- Shikarpur
- Jacobabad
- Sukkur
- Kashmore

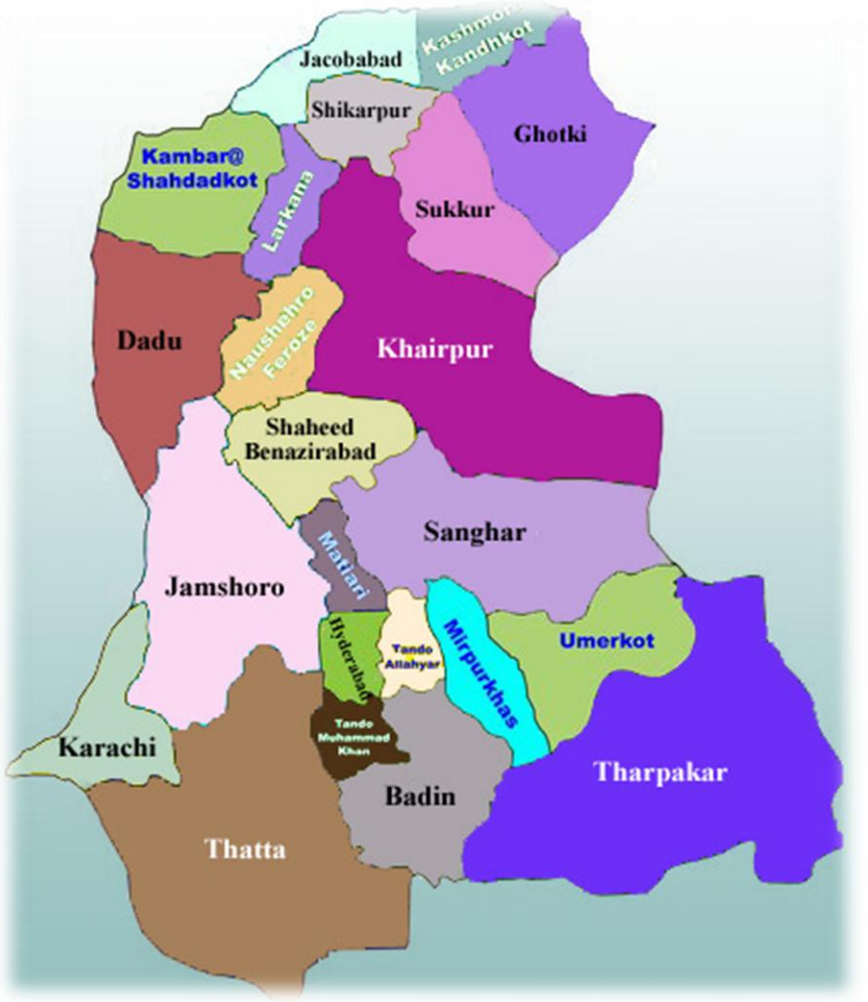


Figure 4.2: Districts in Sindh Province

Economy

Sindh has the second largest economy in Pakistan. Its GDP per capita was $1,400 in 2010 which is 50 per cent more than the rest of the nation or 35 per cent more than the national average. Historically, Sindh's contribution to Pakistan's GDP has been between 30 percent and 32.7 percent. Its share in the service sector has ranged from 21 percent to 27.8 percent and in the agriculture sector from 21.4 percent to 27.7 percent. Performance wise, its best sector is the manufacturing sector, where its share has ranged from 36.7 percent to 46.5 percent. Since 1972, Sindh's GDP has expanded by 3.6 times.

Endowed with coastal access, Sindh is a major centre of economic activity in Pakistan and has a highly diversified economy ranging from heavy industry and finance centered in and around Karachi to a substantial agricultural base along the Indus. Manufacturing includes machine products, cement, plastics, and various other goods.

Sindh is Pakistan's most natural gas producing province. Agriculture is very important in Sindh with cotton, rice, wheat, sugar cane, bananas, and mangoes as the most important crops. Sindh is the richest province in natural resources of gas, petrol, and coal.

Education and Literacy

Literacy is one of the important indicators of education because its improvement is likely to have a longer run impact on other important indicators of national welfare. According to the latest Pakistan Social and Living Standards Measurement (PSLM) Survey 2010-11, the literacy in Sindh for the population (10 years and above) was 59 percent during 2010-11. Literacy remains much higher in urban areas than in rural areas and much higher for men than for women. The details are given in **Table 4.5**.

According to the Annual School Census 2010-11, Sindh has a total of 48,914 schools. These include 44,522 Primary, 2,505 Middle, 1,641 Secondary, and 246 Higher Secondary schools. Of these schools, 12,827 are for boys, 8,458 for girls, and 27,629 are for both boys and girls. In terms of location, 5,765 schools are located in urban areas and 43,149 are located in rural areas. These schools have a total of 144,610 teachers. According to the same survey, the total enrollment in the schools is 4,402,993, which includes 3,291,974 Primary, 237,003, Middle, 620,951 Secondary, and 253,065 Higher Secondary enrollment. [18]

Table 4.5: Literacy in Sindh(10 years and above)

Percentages

	2008-09			2010-11		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**
Rural	61	22	43	60	22	42
Urban	81	65	73	82	68	75
Overall	71	45	59	71	46	59

Source: Pakistan Social and Living Standards Measurement Survey, 2010-11.

[18] Source: Statistical Bulletin – Annual School Census, 2010-11. SEMIS Reforms Support Unit, Department of Education and Literacy, Government of Sindh.

Health

The government healthcare facilities in the Province comprise seven Teaching Hospitals, 11 District Headquarter Hospitals, 56 Tehsil Headquarter Hospitals/Civil Hospitals, 130 Rural Health Centers, 774 Basic Health Units, 643 Dispensaries, 90 Mother and Child Health Centers, and 15 Sub-health Centers. In addition, a large number of private healthcare facilities mostly located in cities and towns also exist in the Province. The Infant Mortality Rate in the Province is 81 per 1,000 live births, Under 5 Mortality Rate is 101 per 1,000 live births, Maternal Mortality Ratio is 314 per 100,000 live births, Malnutrition is 22 percent, and Immunization for children under one year is 37 percent.[19]

Cultural Heritage

Sindh's history dates back to the early Stone Age and fossils of Pleistocene, Paleolithic, Mesolithic and Neolithic periods have been discovered in the mountainous areas. A large quantity of ground stone axes and tools were excavated at the stone age tool factories in upper Sindh at Rohri, Sukkur and Kotdiji areas; Site 101 in Thatta district; as well as at Drigh Road, Korangi and Orangi areas in Karachi. In addition, Sindh has two world heritage sites: Mohenjodaro, located on the right bank of Indus in Larkana district, and Makli, the world's largest necropolis (36 km) in Thatta district.

The province has five different geographical regions with a distinct ethnography, dialect and folklore. They are the mountains of Kohistan, the alluvial plains at the foot of the mountains called Ka'achho, the riverine belt of Indus or Kacho, the Indus Delta, and the desert of Tharparkar. The cultural heritage sites of Sindh range from the Stone Age to the Indus Valley Civilization (third millennium BC) and from Jain and Buddhist to the Hindu and Muslim period spread over all the five regions.

The remnants of Jain sites exist only in Sindh's Nagar Parkar taluka of Thar where ruins of half a dozen major temples depict the past glory of Jain architecture. The most important of these sites is the Gori Temple near Islamkot.

Buddhist sites are located all over the plains and also in the western Kirthar Range. The sites and monuments documented during archaeological surveys undertaken between 1993 and 1996 by the Federal Archaeology Department, listed 26 Buddhist sites in eight districts of upper Sindh. The same survey recorded a dozen Hindu sites, while more than50 Muslim sites are recorded in upper Sindh that include tombs, forts and mosques belonging to the Arghuns, Tarkhans, Kalhora and other Muslim dynasties.

Eighty-four sites in Sindh are protected under the Department of Archaeology, Government of Pakistan, but these sites are badly attended to. These include the Rannikot Fort, believed to be the biggest stone fort in South Asia, its walls stretching over 20 miles. Rannikot Fort is situated 18 miles west of Sann in Dadu district in the Kirthar range and is important for its aesthetic value and military engineering.

4.10 Biological Resources

Flora

Sindh is endowed with a rich diversity of flora. This flora, apart from its aesthetic value, is used as fodder, in rural homes, in industry as well as in the production of medicines. The flora of Sindh can be classified with respect to the ecological zones described below.

[19] Source: Health Facility Assessment – Sindh Provincial Report. TRF/Government of Pakistan. June 2012.

Littoral and mangrove: This zone possesses mangroves that are fairly widespread. In Sindh, these forests are confined to a few areas and represent a genetic stock adapted to local conditions. These areas serve as a dwelling for plant and animal species vital for biodiversity in this ecosystem. Plant species in these regions are Avicenniaalba, Ceriopstagal (C.candol/eana), Halopyrummucronatum and Brugujeraconjugata. In most regions there is a pure stand of only Avicennia. In higher areas, not subject to daily inundation, there is a low scrub of Salsolaimbricata and Suaedafruticosa with scattered bunches of grasses such as Urochondrasetulosa and Halopyrummucronatum.

Riverine: This zone comprises of habitats located in the immediate vicinity of the Indus River and its tributaries up to the base of the foothills in the north. Due to the control of seasonal flooding through irrigation barrages and increased intensity of cultivation adjacent to the main riverbanks, this zone is rapidly disappearing and the riverine forests are drying out. Plant species in these regions are *ClimaxAcacia nilotica (A.arabica),* and in less stable areas, *Tamarixindica, Tamarixaphylia, Populuseuphratica*with grasses such as *Saccharumben galense (Erianthusmunja, Saccharummunja) and Saccharumspontaneum.*

Swamps and the *jheel*: These areas are subject to summer flooding and often become dry by April or May. Typical examples are found around the East Nara and Sanghar, Ghauspur (Jacobabad district) and Manchar (Dadu district).The most commonly found plant species inthese regions are *Taniarixdioica*. Otherdominant shrubs and grasses are *Phragrniteskarka, Typhaangustata, Paspalumpaspaloides, Imperatacylindrica, Arundodonax, Sacdarunispontaneum,* and in water pools Valhsneriaspiralis, Neiunbiumnuciferum and Hydrillaverticillata are present.

Tropical thorn forest: This is a major habitat originally occupying the entire Indus plain from the foothills to the coast, but due to human activity over the course of more than one thousand years, most of this forest has been lost. Its principal edaphic feature is deep soil, where the tropical thorn forests survive in small pockets. A few have recently regenerated in areas such as airfield peripheries (for soil stabilization), around graveyards, and uncultivated areas such as saline flats or the *patt*. In Sindh, they are mostly found on the rightbank of the Indus around Kashmore. Plant species in these forests are *Prosopiscineraria, Capparis decidua, Salvadoraoleoides, Tamarixaphvlla, Ziziphusnummularia, Calotropisprocera, Suaedafruticosa*with grasses such as *Aristidaadscensionis* and *Octhocloacompressa.* Some of these species are scattered shrubby trees which are affectedby lopping. In the waterlogged and saline areasof the south, *Salvadoraoleoides* is replaced by Salvadorapersica and *Tamarixindica* and in the southwest the calcareous rocks are dominated by *Euphorbia caducifolia.*

Sand dune desert: There are five main sand dune deserts in Sindh. They are widely separated from each other. One of these is located between 610 and 1,060 meters (2,000and 3,500 feet) above sea level. The others are less than 152 meters (500 feet) above sea level. Thar is a typical example of the latter type. Plant species in these deserts are *Prosopiscineraria (P. spicigera), Tamarixaphylla, Euphorbia caducifoha, Capparis decidua, Salvadoraoleoides, Commiphorawightii, Ziziphusnummularia, Grewiatenax,Cassia senna, Calligonumpolygonoides and Blepharissindica.*

Dry, sub-tropical, semi-evergreen scrub forest: These are tracts with ridges of sandstone and limestone escarpments, interspersed with low soil deposits in the northern regions of the province. Generally, they are heavily overgrazed by domestic stock and pocked by severe gully erosion. They are found in the hilly areas of Kohistan at an

elevation of 3,000 feet and above. Clumps of cactus-like *Euphorbia* dominate the landscape of Kohistan, which is subject to humid winds during the monsoon season but is hot, dry, and relatively frost-free for the rest of the year. Other species in the region are *Acaciajacquemontii, Maeruacrassifolia, Commiphorawightmukul, Ziziphusnummu/aria, Rhazyastricla, Euphorbia caducifolia, Grewiatenax,* and *Blepharissindica*.

Fauna

Historically, the province of Sindh was known for its diverse range of habitats, ecosystems and several unique species of wildlife. However, the present state of almost all wildlife species in this region is bleak. Most of the wildlife species are found in areas which are not suitable for human habitation and cultivation. **Tables 4.6** and **4.7** respectively present lists of important mammals and reptiles/amphibians of the Province.

Birds. Birds from the South Asian subcontinent, East Africa, Europe and much of Asia are found in the Sindh, which serves as a caravanserai for Eurasian avifauna travelers. Some fly in to stay for the winter, while the rest fly through. For many species the province serves as a breeding ground while others procreate in other areas but have been spotted in this region. There are resident species specific to Sindh, whilst others come from far and wide. **Table 4.8** presents a list of some important birds of the Province.

Table 4.6: Important Mammals of Sindh

S.No.	English Name	Scientific Name	Local Name
1	Sindh Ibex / Persian Wild Goat	*Capra aegagrus blythi*	Sarah, Pahari Bakra
2	Afghan Urial / Asian Wild Sheep	*Ovis vignei blanfordi*	Gad, Pahari Dumba
3	Indian Desert Gazelle / Chinkara	*Gazella bennettii*	Chinkara, Hiran,
4	Black Buck / Indian Savana Antilope	*Antilope cerricapra*	Kala Hiran
5	Hog Deer / Parah Deer	*Axis porcinus*	Phara, Barasingha
6	Blue Bull / Nilgai	*Boselaplus tragocamelus*	Neel Gai, Rojh
7	Indian Wild Ass / Gorkhar / Onagar	*Equus hemionus*	Khur Jungli Gadha, GorkharKhuchhar
8	Striped Hyaena		Hyaena hyaena
9	Indian Desert Wolf	*Cains lupus pallipus*	Bherria, Bagharr
10	Indian Desert Fox	*Vulpes vulpes pusillus*	Lomrri, Lomarr
11	Caracal / Red Lynx	*Felis caracal*	Siah Gosh, Harola
12	Jungle Cat / Swamp Cat	*Felis chaus*	Jungli Billi
13	Fishing Cat	*Prionailurus viverrinus*	Machhi khor billi
14	Small Indian Civet	*Viverricula indica*	Mushk Billi, Rasse
15	Honey Badger / Ratel	*Mellivora capensis*	Bijju, Gor Pat
16	Scaly Anteater / Pangolin	*Manis crassicandata*	Chiunti Khor, Chhalerano
17	Indus Blind Dolphin	*Platanista minor*	Bulhann, Susu Dolphin, Andhy Dolphin
18	Smooth Coated Otter	*Lutrogale perspicillata*	Udh Bilao, Luddharr
19	Flying Fox / Fulvous Fruit Bat	*Rousettus leschenaultii*	Urra Lomrri,Meva Khore Chimgadar,
20	Blue Whale / Sulphur Bottom Whale	*Balaenoptera musculus*	Neeli Whale, Mangrail
21	Mouse-like Hamster	*Calomyscus hotsoni* Hamster	Chooha

Source: www.sindhwildlife.com

Table 4.7: Important Reptiles and Amphibians of Sindh

S.No.	English Name	Scientific Name	Local Name
1	Indian Ocean Green Turtle	*Chelonia mydas*	Samundri Subz Katchhwa
2	Pacific Olive Ridley Turtle	*Lepidochelys olivacea*	Sumundri Zaituni Katchhwa
3	Spotted Pond Turtle	*Geoclemys hamiltoni*	Talabi Katchhwa
4	Indian Sawback River Turtle	*Kachuga tecta*	Daryai Katchhwa
5	Starred Tortoise	*Geochelone elegans*	Sitara Katchhwa
6	Marsh/Snub-Nosed Crocodile	*Crocodylus palustris*	Magar Muchh, Mugger, Wagu
7	Yellow / Striped Monitor - Lizard	*Varanus flavescens*	Goh, Dhari Dar Goh
8	Fat-tailed/Leopard Gecko	*Eubleparis macularius*	Hann Khann, Cheeta Chhupkali
9	Banded Dwarf Gecko	*Tropiocolotes helenac*	Dhari Dar Chhoti Chhupkali
10	Sindh Broad Tailed	*Gecko Teratolepis fasciata*	Sindhi Moti Dum Chhupkali
11	Orange Tailed Sand Skink	*Eumeces schncideri*	Narangi Dum Regmahi, Makh chatti
12	Indian Sand Swimmer	*Ophiomorus tridactgylus*	Regmahi, Makh Chatti
13	Indian Spiny Tailed Lizard	*Uromastix hardwicki*	Sandha, Sandho
14	Indian Chameleon	*Chamaeleo zeylanicus*	Rung Badal Girgit
15	Indian Rock Python	*Molurus*	Azdaha, Arrarh blah
16	Russelle Sand Boa	*Eryx conicus*	Russelle ki do muhi
17	Oxus / Black Cobra	*Naja oxiana*	Kala Naag, Cobra
18	Indian Common Krait	*Bungarus Caeruleus*	Sang choor,Peeun Blah
19	Russelle's Viper	*Vipera russelii*	Ghorriala, Dumbhar Blah
20	Red Spotted Diadem Snake	*Sphalcrosoplis arenarius*	Shahi Naag, Korarr
21	Pakistan Ribbon / Sand Snake	*Psammophis leithi*	Regi Samp, Shehgi
22	Glossy Bellied Racer	*Coluber ventromaculatus*	Paharri Samp, Par Blah
23	Common Rat Snake / Dhaman	*Ptyas mucosus*	Dhamman, Kua mar
24	Sindh River Snake	*Enhydris pakistanicus*	Daryai Samp
25	Beaked Sea Snake	*Enhydrina schistosus*	Chonch dar Samundari Samp
26	Annulated Sea Snake	*Hydrophis cyanocinctus*	Dhari dar, Samundari Samp
27	Slender Blind Snake	*Typhlops porrects*	Andha Samp, sampolia
28	Tiger Bull Frog	*Rana tigerina*	Maindak Dedhar
29	Indus Toad	*Bafo andersori*	Khushki Ka Maindak

Source: www.sindhwildlife.com

Table 4.8: Important Birds of Sindh

S.No.	English Name	Scientific Name	Local Name
1	Great Bustard	*Ardeotis nigricps*	Barri Tiloor, Hukna
2	Houbara/Macqueen's Bustard	*Chlamydotis macqueeni*	Tiloor, Houbara
3	Common/ Blue Peafowl	*Paro cristatus*	Neela More, Mor
4	Black Francolin/ Partridge	*Francolinus francolinus*	Kala Titer, Karo Tittar
5	Grey Francolin/ Partridge	*Francolinus pondicerianus*	Bhura Titer, Achho Tittar
6	Yellow Legged Green Pigeon	*Treron phocnicoptera*	Harrial Kabutar
7	Red Turtle Dove	*Streptopclia tranquebarica*	Surkh Fakhta
8	Dalmatian Pelican	*Pelecanus crispus*	Hawasal, Painn Pakhhi
9	Lesser Flamingo	*Phoenicopterus minor*	Lum Dheeng/ Laakho Jani
10	Oriental Darter/ Anhinga/ Snake Bird	*Anhinga melanogaster*	Jall Kawwa
11	White Stork	*Ciconia ciconia*	Safaid Laqlaq/ Achhhi Toor
12	Painted Stork	*Mycteria leucocephala*	Rangeen Laqlaq, Chit rod toor
13	Greater Painted Snipe	*Rostratula benghalensis*	Rangeen Isnif
14	Sociable Lapwing	*Vanellus gregarius*	Tattihri, Sehkari teeto
15	Pheasant tailed Jacana	*Hydrophasianus*	Peehoo, Peehoorri
16	Spot Billed Duck	*Anas poecilorhyncha*	Hanjar Batakh, Khanjar
17	Marbled Teal	*Marmaronetta angustirostris*	Mar Marin Batakh
18	Mallard	*Anas platyrhynchos*	Neel Sar, Neergi
19	Brahminy/ Ruddy Shelduck	*Tadorna ferruginea*	Surkhab, Lallo Hanj
20	Brown Headed Gull	*Larus brunaicephalus*	Bhori Sar Kina
21	Caspian Tern	*Sterna caspia*	Caspian Dhumrah, Kekrah
22	Indian Skimmer/ Scissors-Bill	*Rynchops albilcullis*	Qainchi Chounch/Pann Cheer
23	Sarus Crane	*Grus antigone*	Sarus Koonj
24	Imperial Eagle	*Aquila heliaca*	Shahi Oqab
25	Pallas's Fish Eagle	*Haliacctus leucorhyplus*	Palasi Oqab, Machh manga
26	Peregrine Falcon	*Falco peregrinus*	Behri/Kala Shaheen
27	Saker Falcon	*Falco cherrug*	Charagh/Saker Baaz
28	Eurasian Eagle Owl/Great-Horned Owl	*Babo bubo*	Oqabi Ullu
29	Lesser Golden-backed Woodpecker	*Dinopium benghalense*	Sunheri Khatkhat
30	Sindh Pied Woodpecker	*Picoides assimilis*	Sindhi Khatkhat
31	Blue Cheeked Bee Eater	*Merops persicus*	Barra Mugs khor/Traklo
32	Golden Oriole	*Oriolus oriolus*	Sunheri Peelak,Peelkio
33	Indian Treepie/ Rufous Treepie	*Dendrocitta vagabunda*	Nabatati Zagh/Katar Khaan
34	Common/ Punjab Raven/ Desert Raven	*Corvus corax subcorax*	Doodh kaag/Paharri Kawwa
35	Pied Crested/Jacobin Cuckoo	*Clamator jacobinus*	Choti Dar Koel/Tarro
36	Rosy Starling/ Rosy Pastor	*Sturnus roseus*	Tillear, Gulabi Myna
37	Jordan's Babbler	*Chrysomma altirostre*	Jorden Ki Ghoghai, Doomni, Pinjhrr
38	Sindh Jungle Sparrow	*Passer pyrrhonotus*	Sindhi Gorria, Jungli Chirria
39	Red Avadavat/ Red Munia	*Amandara formosa*	Surkh Piddi, Garrho Cheeho
40	Baya Weaver	*Ploceus philippinus*	Baya, Borrhi.

Source: Sindh Wildlife Department

Wetlands

Sindh's coastal and estuarine wetlands serve as spawning, rearing, and nursery grounds for the production of shrimp, lobster and fish. They also serve as critical breeding, rearing, staging and wintering grounds for a number of globally important fish and shellfish species. During the migration season, thousands of water birds from 108 species use this habitat. The key wetlands of Sindh are briefly described below.

The Indus Dolphin Reserve is spread over 135 km from the Sukkur upstream to the Guddu Barrage. In 1974, the entire area was declared the home of the endangered Blind Dolphin (IUCN Red Data Book). The major threats it faces include split populations of the dolphins due to dams and barrages on the River Indus, reduction in habitat size during dry season, high turbidity, pollution, and hunting. The number of dolphins at the site has increased from 150 in 1974 to 620 in 2001.

Keenjhar (Kalri) Lake is a large freshwater lake providing drinking water to Karachi. It is located in Thatta district. It was declared a Ramsar site in 1976 and later became a wildlife sanctuary under the Sindh Wildlife Protection Ordinance. An annual Waterfowl Census has been carried out since 1971. Some baseline information indicates 65 species of fauna whose number had increased from 50,000 to 150,000 in the 1970s to 205,000 in 1988. Major threats to the lake include illegal fishing operations, an excessive number of motorized fishing boats and the use of synthetic nets in the lake. The grazing of domestic animals and unchecked recreational activities are other significant threats.

Drigh Lake is a small, slightly brackish lake with extensive marshland. The lake was declared a wildlife sanctuary in 1972, and became a Ramsar site in 1976. Threats include diversion of water; and overgrown Typha and Tamarix resulting in increased grazing pressure. The number of wintering birds visiting the site has decreased over the years from 32,000 in 1973 to 17,400 in 1987-88.

Haleji Lake is a perennial freshwater lake with marshes and a brackish seepage lagoon. Considered a game reserve in 1971, this lake was declared a wildlife sanctuary and in 1976, the lake proceeded to become a Ramsar site. Haleji serves as an important source of water for Karachi besides being a popular recreational destination. Threats to the site include the overlapping of the management of the lake by the Karachi Water and Sewerage Board (KWSB) and the Sindh Wildlife Department; the unauthorized and illegal fishing, hunting and cutting of trees and siltation, as well as eutrophication. The number of birds visiting the site was 60,000 to 100,000 in the 1970s. In 1988, the figure was 103,000.

Jubho Lagoon is a shallow, small brackish water lagoon with mudflats and marshes that support a large concentration of migratory birds including flamingos and endangered Dalmation pelicans, a rare species in the world. This was declared a Ramsar site in 2001 because of the efforts made by IUCN Pakistan.

Nurruri Lagoon is also a brackish, privately owned lagoon with barren mudflats that is visited by large concentrations of migratory water birds. It was also declared a Ramsar site in 2001. Increased salinity, sea intrusion, population pressures, agricultural and industrial pollution are major threats to this site.

Deh Akro is a wildlife sanctuary consisting of four major habitats; desert, wetland, marsh, and agricultural. Located 330km northeast of Karachi, it is a natural inland wetland ecosystem, which supports a variety of rare and endangered wildlife species. This area hosts a considerable number of rare fauna. Many indigenous fish species are

also found here. Water scarcity during a persistent dry spell is adversely affecting this area.

Runn of Kutch is part of the great Thar desert and comprises of stabilized sand dunes, with broad interdunal valleys of alluvial soil, connected across the frontier with India, which includes permanent saline marshes, coastal brackish lagoons, tidal mudflats, and estuarine habitats. The site supports many locally and globally threatened species, including the Great Indian bustard (Choriotisnigriceps), Houbara bustard (Chlamydotisundulata), Sarus crane (Grusantigone), and hyena (Hyeanahyaena) and supports more than 1 percent of the biogeographical population of flamingos.

Indus Delta is the fifth largest delta in the world. The fan-shaped delta consists of creeks, estuaries, mud flats, sand dunes, mangrove habitat, marshes and sea bays. It shelters 82,669 mangroves, mostly Avicenna marina which comprises 97 percent of the total mangrove area in the country and is said to be the largest coastal mangrove forest in the world. A large number of species of birds (including the threatened Dalmatian pelican) of fish and shrimps, and of dolphins (Plumbeous dolphin, Finless porpoise, and Bottlenose dolphin), humpback whale and reptiles are found here. The area is rich in archaeological and religious heritage.

Protected Areas

After 1970, the Sindh government took the initiative of drafting wildlife legislation and promulgated it as the Sindh Wildlife Protection Ordinance, 1973. This legislation has been amended from time to time, keeping in view the requirements of wildlife protection and conservation. Kirthar National Park, covering an area of 1192 square miles, was created in the year 1975 and 35 wildlife sanctuaries and 15game reserves were brought under the wildlife enactment.

There are a number of protected areas in Sindh (see **Table 4.9** and **4.10**).These areas contribute to the protection and maintenance of biodiversity, and of natural and associated cultural resources, managed through legal or other effective means (IUCN, 1994).

A wildlife sanctuary is an area, which is set aside specifically as an undisturbed breeding ground for the protection of wildlife[9]. It is a restricted area, the use of which is denied to the public. No exploitation of the land is allowed except for reducing fire hazards, epidemics, insect attacks or natural calamities. National Parks such as the Kirthar National Park mentioned above, are accessible to the public for and facilities for recreation, education and research are provided, however, the wildlife in these areas must not be harmed within a three miles radius of the park's boundary.

In order to control excessive hunting activity, game reserves were created. Hunting and shooting of animals in these areas are regulated under a special permit. Permits specify the maximum number of animals that may be killed or captured, the area in which it can be done and the hunting period during which these activities can be carried out.

The Indus blind dolphin population was declining at an alarming rate before the WWF International and the Sindh Wildlife Management Board invited Dr Giorgio Pilleri, the Director of the Brain Anatomy Institute and Professor of Neuro anatomy and Comparative Neuropathology at the University of Berne, Switzerland, to study the biological behavior and echolocation of this unique aquatic mammal. On his recommendations, the Government of Sindh created an Indus Dolphin Reserve to ensure the survival of this species in a very disturbed environment. Encouraging results have

been achieved through effective conservation and scientific management which have also been documented.

Table 4.9: Protected Areas of Sindh

S. No.	Name of Protected Area	Area(ha)	District	Habitat
1	Kirthar National Park	308733	Dadu/Karachi	Arid/Semi Arid
	Wildlife Sanctuaries			
2	Bijoro Chach	121	Thatta	Wetland
3	Cut Munarki Chach	405	Thatta	Wetland
4	Deh Akro-II	20243	Nawabshah	Wetland complex
5	Dhoung Block	2098	Shikarpur	Riverine Forest
6	Drigh Lake	164	Larkana	Wetland
7	Ghandak Dhoro	31	Jacobabad	Wetland
8	Gullel Kohri	40	Thatta	Wetland
9	Gulsher Dhund	24	Hyderabad	Wetland
10	Hub Dam	27219	Karachi	Wetland
11	Hudero Lake	1321	Thatta	Wetland
12	Haleji Lake	1704	Thatta	Wetland
13	Hilaya	324	Thatta	Wetland
14	Keti Bunder North	8948	Thatta	Wetland
15	Keti Bunder South	23046	Thatta	Wetland
16	Khadi	81	Thatta	Wetland
17	Khat Dhoro	11	Larkana	Wetland
18	Kinjher Lake	130468	Thatta	Wetland
19	Kot Dinghano	30	Nawabshah	Wetland
20	Lakhat	101	Nawabshah	Wetland
21	Lung Lake	19	Larkana	Wetland
22	Mahal Kohistan	70577	Dadu	Arid/Semi Arid
23	Majiran	24	Thatta	Wetland
24	Marho Kotri	162	Thatta	Wetland
25	Miani Dhand	57	Hyderabad	Wetland
26	Mohabat Dero	16	Nawabshah	Wetland
27	Munarki	12	Thatta	Wetland
28	Nara Desert	223590	Sukkur/Khairpur	Desert
29	Norang	243	Thatta	Wetland
30	Rann of Kutch	320463	Badin/Tharparkar	Desert& Marshy
31	Samno Dhund	23	Hyderbada	Wetland
32	Sadnai	84	Thatta	Wetland
33	Shah Lanko	61	Thatta	Wetland
34	Takkar	43513	Khairpur	Desert/Semi Dese

Source: www. sindhwildlife.com

Table 4.10: Game Reserves of Sindh

S. No.	Game Reserves	Area (ha)	District	Eco-zone
1	Deh Jangisar	314	Thatta	Arid/Semi Ar
2	Deh Khalifa	429	Thatta	Arid/Semi Ar
3	Dosu Forest	2312	Larkana	Riverine Fore
4	Hala	954	Hyderabad	Riverine Fore
5	Indus River Dolphin Game Reserve (From Sukkur to Guddu Barrage)	44200	Jacobabad / Ghotki / Shikarpur & Sukkur	River Indus
6	Khipro Forest	3885	Sanghar	Irrigated Fore
7	Mando Dero	1234	Sukkur	Semi Arid & Culitivated
8	Mirpur Sakro	777	Thatta	Semi Arid
9	Nara	109966	Khairpur	Desert & Wetland
10	Pai Forest	1969	Nawabshah	Riverine Fore
11	Sahib Samo	349	Hyderabad	Riverine Fore
12	Surjan, Sumbak, Eri & Hothiano	406302	Dadu	Arid/Semi Ar
13	Tando Mitho Khan	5343	Sanghar	Desert & Ser Arid

Source: www. sindhwildlife.com

A great impetus was given to wildlife conservation in 1990 when the Wildlife Department was regrouped with the Agriculture Department. A number of new schemes for wildlife management along scientific lines were launched. These included captive breeding of endemic waterfowl species, captive breeding of Nara hog deer, biological studies of ungulates found in Kirthar National Park, establishment of game reserve in Kundah Reserve Forest, breeding of the marsh crocodile and its reintroduction in its original habitat, and multiplication trials of Black buck for introduction into wild habitats in Khairpur and Nawabshah districts. The results achieved overshot the targets that were envisaged in the schemes. Most of the schemes were completed in the first phase but, unfortunately, the second phase of the schemes was not implemented due to financial constraints.

Prominent wildlife conservation interventions include the change in the alignment of the National Highway Authority's Karachi to Peshawar motorway to avoid the bifurcation of

the Mahal Kohistan Wildlife Sanctuary and the Kirthar National Park. The mid-winter waterfowl count initiated by the Sindh Wildlife Management Board in association with the Asian Wetland Bureau and the International Waterfowl Research Bureau has also been initiated. A program for the rehabilitation of the Lung Wetland by the Sindh Wildlife department has been completed. Other conservation interventions include mitigating measures to save the Marbled teal, the hog deer and marsh crocodile, which have become endangered due to the ecological damage being caused by the Chotiari reservoir.

5. Stakeholder Consultations

This Chapter provides the objectives, process and outcome of the stakeholder consultations conducted as part of the present study. The primary objective of consultations at this stage were to incorporate intensive considerations of the local institutional knowledge about the socioeconomic and environmental conditions in the project area and the potential positive and negative environmental and social impacts of the project into project design through the ESMF. The consultations included a meeting of key institutional stakeholders active in the project area and discipline. More than fifteen institutional stakeholders participated in the meeting. A questionnaire was developed for consultations to seek formal responses in addition to the informal discussion that took place and was noted during the consultation meeting. The objectives, process and findings are recounted in this chapter in further detail.

5.1 Objectives

The stakeholder consultation is an integral part of the environmental and social assessment for a project such as SAGP, and aims to provide a two-way communication channel between the stakeholders and the project proponents. In line with this aim, the objectives of the stakeholder consultation conducted as part of the present study were to:

- develop and maintain communication links between the project proponents and stakeholders,
- provide key project information to the stakeholders, and to solicit their views on the project and its potential or perceived impacts, and
- collect and document local institutional knowledge about the socioeconomic and environmental conditions in the project area, how these relate to the project activities and how project activities can be designed to maximize social and environmental benefits and minimize potentially negative impacts, and
- ensure that views and concerns of the stakeholders are incorporated into the project design and implementation with the objectives of reducing or offsetting negative impacts and enhancing benefits of the proposed project.

5.2 Participation Framework

The stakeholder consultation is a continuous process, and should be carried out throughout the life of project. The consultations carried out during the present study and reported in this Chapter are essentially among the initial steps in this process. During the subsequent project phases as well, participation of the project stakeholders need to be ensured.

Table 5.1 charts out the proposed participation framework during different project phases, while **Figure 5.1** provides the conceptual framework employed during the stakeholders consultation carried out as part of the present study. While the different stages identified in the figure are conceptually separate, in actual effect, many of them, (say indidvidual and group consultations) often merge.

5.3 Stakeholder Identification

Stakeholder analysis was carried out to identify relevant stakeholders on the basis of their ability to influence the project or their vulnerability to be negatively impacted from it. This approach ensured that no relevant groups are excluded from the consultation, and appropriate engagement strategies are developed for each stakeholder.

Key stakeholders consulted at various levels include:

- People directly affected by the Project and Project beneficiaries
- Officials from the Agriculture and Livestock Departments
- Environment Protection Agency
- Academia
- The broader interested community
- Donors
- NGOs, international organizations, and other interest groups.

For the purposes of this study, the following institutional stakeholders were consulted;

- Government and affiliated institutions operational in the area and in the field of agriculture
- Regulatory agencies such as Environment Protection Agency
- NGOs, international organizations, and other interest groups.
- Academia and local researchers

5.4 Consultation Process

The consultations with the project stakeholders were carried out while conducting the present study. A participatory and consultative approach was employed for information gathering and data collection.

5.5 Consultations with Institutional Stakeholders

At this stage, a consultation meeting was held with key institutional stakeholders. The meeting was organized by Director General Agriculture Extension Sindh, in Hyderabad on May 16, 2013. Twenty six participants representing more than fifteen institutional members attended the meeting. Key participants included representatives from Sindh Environment Protection Agency, Sindh Irrigation and Drainage Authority, Sindh Agriculture University Tando Jam and a number of local NGOs including DAMAN, Indus Future Foundation and Bhandar Sangat. For a complete list of participants see **Annex B**: List of Institutional Stakeholders. A questionnaire was developed to faciliate the discussion and was circulated among the participants in advanced. Five participants provided written responses to the questionnaire and the questionnaire as well as the written responses are provided in **Annex C**; Institutional Stakeholder Consultations Questionnaire and Some Responses.

The following section summarizes some of the key recommendations which emerged as the lietmotiv from the written and verbal responses during consultations. The findings and suggestions have been summarized and anonymised for the purposes of this section.

5.5.1 Project Design

SAGP should target marginalized populations, in particular, small landholders, women and landless. In the agriculture sector, value chains, such as chili, fruits, and vegetables should be supported, where women and other marginalized populations play substantial roles in production and post-harvest processing. In the livestock sector, the dairy value chain will target women. In facilitating training, the project will enhance female extension workers. The project will also have a gender advisor, who will ensure women's access to training and support their market linkages.

The project should build on existing community-level organizations. SIDA has formed water course associations (WCAs) and farmer organizations (FOs) jointly with the Bank-supported On-farm Water Management (OFWM) project. These are registered organizations under the Sindh Water Management Ordinance (SWWMO) 2002. In mobilizing producer groups, SAGP could engage WCAs and FOs, where they are active.

Cost sharing or in-kind contribution should be considered in providing farming equipment and infrastructure.

5.5.2 Project Environmental Impacts

The project activities would have a positive impact on environment in terms of potential reduction in pesticide usage and safer on-farm practices. The capacity building activities should include trainings on environmental issues.

5.5.3 Project Social Impacts

Social accountability mechanisms should be in place. The project needs to have such mechanisms, in particular, a grievance redressal mechanism that would address complaints related potentially to beneficiary targeting or other issues.

The project should develop a communication strategy to raise awareness on SAGP.

5.6 Consultations with Potential Beneficiaries

Detailed consultations were undertaken with various stakeholders, including produce wholesale dealers (including traders and middlemen), female livestock extension workers, and farmers. The farmers include large, medium and small landholders, landless (tenants), and women.The key observations from the meetings are discussed below; the detailed meeting notes are presented in **Annex D**.

5.6.1 Market Mechanisms

At the produce markets, the wholesale dealers and middlemen facilitate transactions between the producer and the retailer. For this facilitation they charge 7% of each transaction. Part of the facilitation process is the exercise of price determination. There is no standardization in this regard and the dealer determines the price based on a judgemental assessment of a very small sample of the produce. In effect, the price is controlled entirely by the dealer. Unless this process is standardized, increasing produce quality may not benefit the grower and small farmer.

It was also found out that almost all the growers selling produce at the Hyderabad market were indebted to the dealers who gave loans to the farmers in return for promise of share in future produce. This also hinders the ability of the growers and the small farmers specifically to fetch optimal price for their produce.

5.6.2 Targeting Small Farmers and Producers

In Sindh the patterns of land ownership continue to be dominated by a somewhat feudal structure with much of the farming being done by 'tennants', farming small chunks (up to 5 acres) for large land owners who have hundreds if not thousands of such tennants working for them. In return for his labor, the tennant gets half of the produce's value. While small and medium farmers and landowners (owning less than 25 acres) do operate in Sindh, they usually augment their income by taking on labor at other farms. Targeting these small farmers would be a challenge as they are spread out and not organized. Also, making sure that the value chain benefits and modernizes while the small and medium farmers benefit from the project interventions, will be a delicate balance to strike.

Evidence of this can also be seen in the case of women milk producers. Currently they get paid about PKR 50/liter for their milk. This milk is then sold by milkmen in the city for as much as PKR 75/liter. Providing access for these women to chillers where they can sell their milk directly to commercial producers would benefit the value chain by increasing the quantity of milk being sold after UHT and in Tetrapack. However, the women may not be able to obtain a higher price for their milk, as these companies presently buy the milk at PKR 45/liter.

In developing each selected value chain, the project's consultation framework will identiry roles and opportunities for small and medium farmers, tenants, and women. This will ensure that the project benefits reach the intended beneficiaries while improving the value chain in each sector.

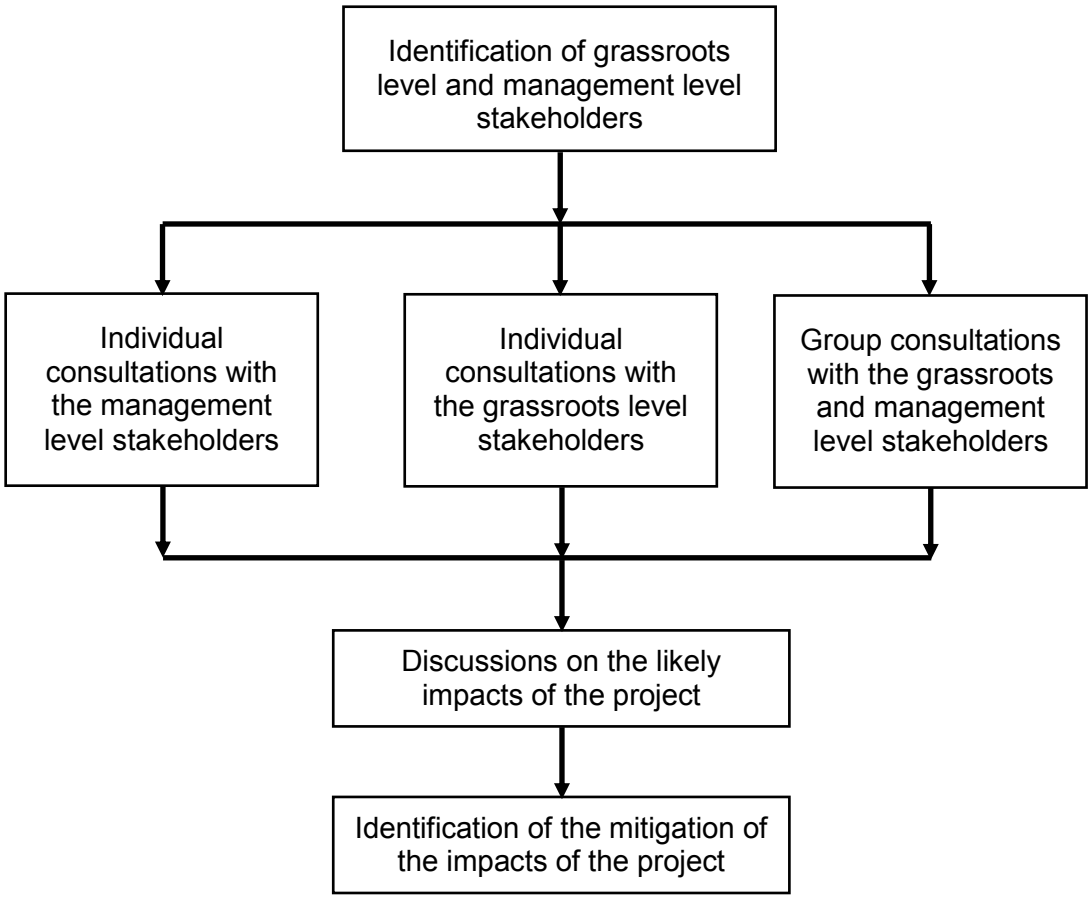
5.7 Summary Findings

Overall, the proposed SAGP is considered to have a positive social impact by developing selected value chains through supporting farmer mobilization, extension services in enhancing production and productivity, post-harvest processing, value addition, and marketing (consultations summarized below). However, in the agriculture sector, in particular, the project should ensure participation by small landholders, tenants, and women, who play a critical role in production and post-harvest processing. The project should strike a right balance between value chain development and social inclusion by developing and implementing (a) a consultation framework to identify roles and opportunities for the marginalized populations and (b) targets in inclusiveness, which should be monitored regularly, such as % of marginal populations in training, % increase in labor, and/or % increase in income among these populations.

Table 5.1: Participation Framework

Project Stage	Proposed Tool	Stakeholders Consulted / to be Consulted	Responsibility
Project Design Phase	Meetings with institutional stakeholders Meetings with grass root stakeholders(carried out during the present study); (See **Annex B** for key stakeholders consulted.)	Institutional stakeholders; Grass root stakeholders, including the communities to be affected/benefitted during the project implementation.	Director General Agriculture Extension, Sindh, Hyderabad
Pre-implementation phase	Consultation framework	Institutional and grassroots stakeholders	Director General Agriculture Extension, Sindh, Hyderabad Director General Livestock
Project implementation Phase	Sharing of the project objectives, project components, major benefits, potential impacts, and mitigation measures with the affected communities (and other stakeholders).	Institutional stakeholders; Grass root stakeholders, including the communities to be affected during the project implementation.	Director General Agriculture Extension, Sindh, Hyderabad Director General Livestock Through the project consultant
	Grievance Redressal Mechanism (discussed in **Section 7.6**).	The communities to be affected/benefitted	AIUs and PMUs
	Consultations with the communities during Environmental and Social Monitoring (discussed in **Section 7.4**).	The communities to be affected/benefitted	AIUs and PMUs
	Consultations with the project affectees / beneficiaries and communities during the external monitoring (discussed in **Section 7.4**).	The communities to be affected/benefitted	External monitoring consultant.
	Consultations with the project affectees / beneficiaries, and communities during the site visits by the WB monitoring mission.	The communities to be affected/benefitted; District government officers	WB monitoring mission.

Figure 5.1: Conceptual Framework for ESMF Stakeholder Consultations



6. Impact Assessment and Mitigation

This Chapter assesses the potential impacts of the proposed project on environment and people. Also provided in the Chapter are the generic mitigation measures to minimize if not eliminate the potentially negative impacts, in order to ensure that the interventions under the proposed project do not cause environmental and/or social impacts beyond the acceptable level.

6.1 Positive Impacts

The key activities under Component A of the project include capacity building of farmers, producers, and relevant government departments as well as preparing Agriculture Strategy. While it is obvious that such activities will not have any negative environmental or social impacts, they do provide environmental enhancement opportunities in the form of integrating environmental awareness aspects in the capacity building initiatives and including environmental protection approaches in the Agriculture Strategy. While the details of these opportunities will be worked out during the project implementation, some suggestions are listed below.

- Health hazards of inappropriately handling pesticides, and guidelines for their proper handling
- Health and environmental hazards for inappropriately and excessively using pesticides and guidelines for their proper application.
- Advantages of integrated pest management.
- Minimizing waste generation in activities such as packaging and processing.
- Proper waste disposal related to agriculture and livestock value chain activities
- Health and hygiene aspects in operations such as handling milk and other dairy products.
- Occupational health and safety aspects related to agriculture and livestock value chain activities such as packaging and processing
- Awareness of environmental degradation caused by intensification of cultivation caused by value chain development, and ways and means to avoid/counter this undesirable consequence.
- Promotion of sustainable and judicious usage of natural resources.
- Awareness, adaptation, and mitigation for climate change and its implications for agriculture sector in the Province.

6.2 Environmental Screening

The Component B of the project will include activities or subprojects for agriculture and livestock value chains and also for post harvest loss management (See **Section 3.2**). These subprojects can potentially cause negative environmental and social impacts. However, exact nature, extent, and location of these subprojects is not known at this stage, as stated in **Chapter 1** also. These potential impacts of generic nature have nonetheless been screened using the Asian Development Bank's (ADB's) Rapid

Environmental Assessment Checklist for agro-industrial projects as given in **Table 6.1** below.

Table 6.1: Environmental Screening

Screening Questions	Yes	No	Remarks
A. Project Siting Is the Project area adjacent to or within any of the following environmentally sensitive areas?			
• Cultural heritage site	?		Unlikely, however this aspect will be confirmed for each individual sub-project under Component B.
• Protected Area	?	-	Unlikely, however this aspect will be confirmed for each individual subproject under Component B. It will be ensured that no subproject is located inside any protected area.
• Wetland	?		Unlikely, however this aspect will be confirmed for each individual subproject under Component B. It will be ensured that no subproject is located inside any protected wetland.
• Mangrove	?		Unlikely. Most of the cultivation fields are well away from the mangrove forests. However this aspect will be confirmed for each individual subproject under Component B.
• Estuarine	?		Unlikely. Most of the cultivation fields are well away from the estuarine areas. However this aspect will be confirmed for each individual subproject under Component B.
• Buffer zone of protected area	?		Unlikely, however this aspect will be confirmed for each individual subproject under Component B. It will be ensured that no subproject is located inside any protected area.
• Special area for protecting biodiversity	?		Unlikely, however this aspect will be confirmed for each individual subproject under Component B. It will be ensured that no subproject is located inside any protected area.
B. Potential Environmental Impacts Will the Project cause:			
• ecological disturbances arising from the establishment of a plant or facility complex in or near sensitive habitats?	?		Unlikely, however this aspect will be confirmed for each individual subproject under Component B. It will be ensured that no subproject is

Screening Questions	Yes	No	Remarks
			located inside any protected area.
• loss of precious ecological values (e.g. result of encroachment into forests/swamplands or historical/cultural buildings/areas, disruption of hydrology of natural waterways, regional flooding, and drainage hazards)?	?		Unlikely, however this aspect will be confirmed for each individual subproject under Component B. It will be ensured that no subproject is located inside any protected area.
• eventual degradation of water bodies due to discharge of wastes and other effluents from plant or facility complex?	?	-	This aspect will be assessed while designing specific subprojects under Component B. It will be ensured that the subprojects do not cause significant degradation of water bodies.
• serious contamination of soil and groundwater?	?	-	This aspect will be assessed while designing specific subprojects under Component B. It will be ensured that the subprojects do not cause contamination of soil and groundwater.
• aggravation of solid waste problems in the area?	?	-	This aspect will be assessed while designing specific subprojects under Component B. It will be ensured that the subprojects do not aggravate solid waste problems in the area.
• public health risks from discharge of wastes and poor air quality; noise and foul odor from plant emissions?	?	-	These aspects will be assessed while designing specific subprojects under Component B. It will be ensured that the subprojects do not cause public health risks associated with facility construction or operation.
• short-term construction impacts (e.g. soil erosion, deterioration of water and air quality, noise and vibration from construction equipment?	Likely	-	The design of subprojects will include mitigation and management measures to address and minimize construction-related impacts.
• dislocation or involuntary resettlement of people	?		Unlikely, however this aspect will be confirmed for each individual subproject under Component B. It will be ensured that subprojects do not cause any involuntary resettlement of people.
• social conflicts arising from the influx of laborers from other areas?	?		Unlikely, since most of the interventions are expected to be small and thus not necessitating influx of construction laborers from other areas. This aspect will be

Screening Questions	Yes	No	Remarks
			confirmed for each individual subproject under Component B.
• environmental degradation (e.g. erosion, soil and water contamination, loss of soil fertility, disruption of wildlife habitat) from intensification of agricultural land use to supply raw materials for plant operation; and modification of natural species diversity as a result of the transformation to monoculture practices?	?		The project interventions are not likely to cause expansion of cultivated area. Monoculture practices have already been adopted in most the cultivated areas of the province. Awareness raising will be carried out regarding potential environmental degradation caused by intensified cultivation.
• water pollution from discharge of liquid effluents?	?		This aspect will be assessed while designing specific subprojects under Component B. It will be ensured that the subprojects do not cause significant water pollution.
• air pollution from all plant operations?	?		This aspect will be assessed while designing specific subprojects under Component B. It will be ensured that the subprojects do not cause significant air pollution.
• gaseous and odor emissions to the atmosphere from processing operations?	?		This aspect will be assessed while designing specific subprojects under Component B. It will be ensured that the odor and gaseous emissions from subprojects are within acceptable limits.
• accidental release of potentially hazardous solvents, acidic and alkaline materials?	?		This aspect will be assessed while designing specific subprojects under Component B. If applicable, the subproject design will include safeguards against accidental release of potentially hazardous solvents, acidic and alkaline materials.
• uncontrolled in-migration with opening of roads to forest area and overloading of social infrastructure?	?		Unlikely. The project is unlikely to cause any un-controlled in-migration, in view of the small and scattered subprojects. Any potential overloading of local infrastructure will be assessed while designing specific subprojects under Component B.
• occupational health hazards due to fugitive dust, materials handling, noise, or other process operations?	?		This aspect will be assessed while designing specific subprojects under Component B. If applicable, the subproject design will include safeguards against occupational health hazards due to fugitive dust,

Screening Questions	Yes	No	Remarks
			materials handling, noise, or other process operations.
• disruption of transit patterns, creation of noise and congestion, and pedestrian hazards aggravated by heavy trucks?	?		This aspect will be assessed while designing specific subprojects under Component B. If applicable, the subproject design will include mitigation measures to address disruption of transit patterns, creation of noise and congestion, and pedestrian hazards aggravated by heavy trucks.
• disease transmission from inadequate waste disposal?	?		This aspect will be assessed while designing specific subprojects under Component B. If applicable, the subproject design will include safeguards against disease transmission from inadequate waste disposal.
• impediments to movements of people and animals?	?	-	This aspect will be assessed while designing specific subprojects under Component B. Appropriate measures will be included in the design of the subprojects to address these issues.
• disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?	?	-	The project will generally benefit the small land owners and growers, in addition to providing employment opportunities for the local community. This aspect will be assessed while designing specific subprojects under Component B. No indigenous people are known to exist in the Province.
• potential social conflicts arising from land tenure and land use issues?	Unlikely	-	This aspect will be assessed while designing specific subprojects under Component B.
• noise from construction and plant equipment?	?	-	This aspect will be assessed while designing specific subprojects under Component B. It will be ensured that the noise from subprojects' construction and operation remains within acceptable limits.
• soil pollution, polluted farm runoff and groundwater, and public health risks due to excessive application of fertilizers and pesticides?	Possibly	-	The project interventions can potentially increase the usage of pesticides and fertilizers. Appropriate awareness raising and capacity building initiatives will be included in the project design to address the potential impacts.
• risks to community health and	Possibly		This aspect will be assessed while

Screening Questions	Yes	No	Remarks
safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation?			designing specific subprojects under Component B. If applicable, the subproject design will include safeguards against risks to community health and safety.
C. Potential Social Impacts			
• Does the subproject require land acquisition for new construction (e.g., processing center) or installment of new equipment/facility (e.g., milk chiller)? If yes, how is the land obtained?	?		This aspect will be assessed while designing specific subprojects under Component B. Land for subprojects will be arranged either on voluntary donation or commercial transaction (willing buyer – willing seller) basis, and it will be ensured that such transactions do not cause any involuntary resettlement.
• [Private land] Will the construction or installation be done on a private land? If yes, will the cost of construction or installation be shared between the project and landowner?	?		This aspect will be assessed while designing specific subprojects under Component B. Complete documentation will be maintained for land procurement or donation, including the percentage share in investment (between the project and the land owner), number of individuals (tenants, women, etc.) accessing the facility, etc.
• [Purchased by a group of farmers] Will the private land be obtained through land cost paid by the community through willing buyer-willing seller arrangement?	?		This aspect will be assessed while designing specific subprojects under Component B. Complete documentation will be maintained for land procurement, including the percentage share in investment (between the project and the farmers), number of farmers accessing the facility, etc.
• [Private donation to a group of farmers] Will the land be obtained through private voluntary donations, provided the donation will have minimal livelihood impact on the concerned person (less than 10 percent)?	?		This aspect will be assessed while designing specific subprojects under Component B. Complete documentation will be maintained for land donation including the percentage share in investment (between the project and the farmers), number of farmers accessing the facility, etc.

6.3 Assessment of Potential Impacts and Generic Mitigation

The potentially negative impacts identified with the help of environmental screening discussed in **Section 6.2** are assessed in the subsections below. The generic mitigation measures have also been provided here; additional measures may be added as a result of the subproject-specific environmental assessments to be carried out during the Project implementation (subproject-specific environmental assessments are further discussed in the next Chapter).

6.3.1 Subproject Siting (Land Use and Landform)

The subprojects to be implemented under Component B may potentially cause changes in land use and land form, resulting in the following negative impacts:

- disputes over land ownership, blocked access for people of the area,
- encroachment into any sensitive habitat and/or protected areas, and
- encroachment into any sites of archeological, cultural, historical, or religious significance.

Mitigation Measures

The generic mitigation measures to address the potential impacts associated with the subproject siting are given below.

- Community consultations will be carried out before establishing the facility.
- It will be ensured that the local routes are not blocked by such schemes.
- It will be ensured that natural drainage paths are not blocked by the establishment of subprojects.
- If trees are to be cut for any subprojects, the farmer/beneficiary will carry out compensatory plantation of appropriate indigenous tree species. Trees thus planted will be at least five times the number of trees felled for establishing the subproject.
- No schemes should be located inside or in the immediate vicinity of any protected areas listed in **Tables 4.9** and **4.10**.
- The subprojects will not be located in graveyards or shrines.
- The 'chance find'[20] procedures will be included in the scheme agreements.

6.3.2 Land Donation/Purchase

The subprojects to be implemented under Component B may need some land. The following procedures will be followed for obtaining this land:

- The subprojects will be established preferably on the land owned by the beneficiary. It will be ensured that no involuntary resettlement takes place for these subprojects.
- Land for subprojects will be arranged either on voluntary donation or commercial transaction (willing buyer – willing seller) basis, and it will be ensured that such transactions do not cause any involuntary resettlement.

[20] 'Chance find' procedure: In case any artifact or site of archeological, cultural, historical, or religious significance are discovered during activities such as excavation of water ponds, the works will be stopped, and the Archeological Department will be informed.

- Complete documentation will be maintained for land procurement or donation, including the percentage share in investment (between the project and the land owner), and number of individuals (tenants, women, etc.) accessing the facility.
- Community consultations will be carried out before establishing the facility.

6.3.3 Ecological Disturbances and Loss of Precious Ecological Values

The subprojects under Component B if established in or near sensitive habitats such as protected areas listed in **Tables 4.9** and **4.10** can potentially cause ecological disturbances. This could be caused by changes in land form and habitat, habitat fragmentation, blockage of migration paths, water consumption and contamination. Similarly, the subprojects can potentially cause loss of precious ecological assets, if they are inappropriately located and encroach into forests/swamplands or historical/cultural buildings/areas, disrupt hydrology of natural waterways (including natural drainage particularly in southern Sindh where blockage of natural drainage is a serious issue), regional flooding, and drainage hazards.

Mitigation Measures

The generic mitigation measures described in **Section 6.3.1** above will address the potential issues associated with the ecological disturbance and loss of precious ecological values. Training shall be provided to internal and external stakeholders in the specific location and significance of the protected areas and in how it could be ensured to avoid location of project activities in sensitive or critical habitats.

6.3.4 Soil and Water Contamination, and Degradation of Water Bodies caused by Discharge of Wastes

The facilities to be established under the value chain and post-harvest loss management subprojects may generate a wide range of waste effluents. These could include waste water from washing and cleaning operations, oils and oily water generated by machinery maintenance, leaked/spilled fuels and oils, waste effluent discharges from the processing operation, animal wastes, and others. Uncontrolled discharges of these wastes and other effluents can potentially contaminate the soil, pollute the nearby water bodies and degrade their value for communities and ecology. Depending upon their constituents and extent, these discharges can potentially affect the soil fertility, pollute the drinking water sources, contaminate irrigation water thus affecting the crops, and degrade wetlands thus negatively affecting the ecology of the area including natural flora and fauna.

Mitigation Measures

The generic mitigation measures to address the soil and water contamination and degradation of water bodies are listed below.

- The subprojects will be designed employing technologies that are least polluting
- Fuel, oil and other chemicals will be handled and stored at the subproject facilities following the standard operating procedures, avoiding any leakage and spillage, and minimizing contamination of soil and water.
- Appropriate effluent treatment arrangements will be included in the design of the subprojects.
- Settling/retaining tanks will be constructed at the site as appropriate to minimize contaminants leaving the subproject facilities.

- Recycling of waste effluents will be carried out as far as possible and practical.
- It will be ensured that the waste effluents leaving the facility comply with the NEQS (see **Section 2.1.3**).
- It will be ensured that the wastes are not released into any drinking water source, cultivation fields, or critical habitat.
- Waste effluents will be released in irrigation channels only if they do not negatively affect the irrigation water quality.

6.3.5 Aggravation of Solid Waste Problems

The facilities to be established under the value chain and post-harvest loss management subprojects may potentially generate a wide range of solid wastes, including sludge produced by washing and cleaning operations, waste/rotten agriculture produce, animal secreta, wastage from packing operations, workshop wastes, and others. Inappropriate disposal of these wastes can potentially aggravate the solid waste management problems in the area, while also contaminating soil and water.

Mitigation Measures

The generic mitigation measures to address the solid waste management issues are listed below.

- The subprojects will be designed employing technologies that minimize generation of solid wastes
- Use of non-biodegradable substances (e.g. for packaging) will be minimized.
- Recycling of solid waste will be carried out as far as possible and practical.
- Technologies such as biogas will be promoted to gainfully dispose animal dung.
- Composting of biodegradable waste will be considered and adopted if practicable.
- Disposal of solid waste will be carried out in a manner that does not negatively affect the drinking water sources, cultivation fields, irrigation channels, natural drainage paths, wetlands and critical habitat, the existing waste management system in the area, local routes, and general aesthetic value of the area.

6.3.6 Public Health Issues

The facilities to be established under the value chain and post-harvest loss management subprojects may potentially cause public health issues. These issues may be related to waste discharges discussed in **Sections 6.3.4** and **6.3.5** above, and gaseous emissions from the subprojects. These waste discharges and emissions can potentially cause water borne disease, heavy metal poisoning, respiratory disorders, and other similar ailments. In addition, foul odor and noise from these subprojects can potentially cause public nuisance.

Mitigation Measures

The generic mitigation measures to address the public health issues are listed below.

- Mitigation measures listed under **Sections 6.3.4** and **6.3.5** will address the public health issues associated with waste effluents and solid waste from the subproject facilities.

- It will be ensured that the emissions and noise from the subproject facilities comply with NEQS and other relevant standards (e.g. WHO guidelines where NEQS do not prescribe standards).
- Community consultations will be carried out as part of the subproject design activities.
- Grievance redress mechanism will be established in the area to address the public complaints regarding issues such as noise and odor from the subproject facilities.

6.3.7 Construction related Issues

The construction of subproject facilities can potentially cause short-term environmental and social issues such as soil erosion, soil and water contamination, noise and air pollution, and safety hazards for the nearby population. These issues in turn can potentially affect the cultivation fields, soil fertility, human health, ecological degradation, and public nuisance.

Mitigation Measures

The generic mitigation measures to address the construction-related issues are listed below.

- The design of the facility and appropriate construction planning will ensure that construction activities do not cause any soil erosion or degradation. Spoils and excess soil if generated will be disposed appropriately. Borrow areas will be dressed to minimize safety hazards and soil erosion.
- Untreated waste effluents from the construction sites will not be released to drinking water sources, cultivation fields, irrigation channels, and critical habitats. Appropriate effluent treatment arrangements such as settling tanks will be made at the site. It will be ensured that the effluents comply with NEQS.
- Construction machinery, generators, and vehicles will be kept in good working condition, minimizing exhaust emissions. It will be ensured that exhausts from these equipment and vehicles comply with relevant NEQS.
- It will be ensured that noise generated from the construction activities comply with relevant NEQS.
- All safety precautions will be taken to address safety hazards for the nearby community. These precautions may include safety/warning signage, safety barrier around the construction site, and safe driving practices.
- Community consultations will be carried out before commencing the construction activities, informing the nearby population regarding the construction activities and possible impacts such as noise and additional vehicular traffic.
- Grievance redress mechanism (GRM) will be established in the area to address the public complaints regarding issues such as noise from the construction sites.
- WB Group's Environment, Health and Safety (EHS) Guidelines (attached at the end of this document) will be implemented
- The construction contracts will include appropriate clauses to protect environment and public health. The present ESMF will be included in the bidding document.

6.3.8 Environmental Degradation from Intensification of Agricultural Land Use

Development of value chains under Component B of the Project may potentially cause intensification of cultivation, thus increasing the usage of crop inputs including irrigation water, fertilizers, pesticides, and herbicides. This in turn can potentially cause water shortage as well as soil and water contamination, having negative impacts on people, as well as on natural flora and fauna.

Mitigation Measures

The generic mitigation measures to address the environmental degradation associated with agriculture intensification are listed below.

- Judicious use of the irrigation water, chemical inputs and use of alternate techniques (such as integrated pest management, using disease-resistant seeds, and mulching) will be promoted through awareness raising and capacity building initiatives which are included in the Component A of the proposed project.
- Adoption of integrated pest management (IPM) techniques will be promoted through capacity building programs. IPMP has been prepared and shall be implemented.
- Crop rotation practices will be promoted to avoid soil fertility degradation.
- The capacity building program will also include safe handling of hazardous substances such as pesticides.
- High efficiency irrigation technologies (e.g. drip irrigation, tunnel farming) will be promoted to conserve already scarce irrigation water.

6.3.9 Health and Safety Hazards for the Community

Transportation, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation pose health and safety risks for the nearby community. Similarly, accidental release of potentially hazardous substances such as fuels, solvents, acidic and alkaline materials from the subproject facilities may potentially pose health and safety hazards for the nearby population. Such activities/releases may contaminate the drinking water source and other water bodies, damage crops, degrade the soil, contaminate ambient air, and cause explosion and fire thus posing serious risks to life, health, and property of the nearby population.

Mitigation Measures

The generic mitigation measures to address the risks associated with accidental releases from the subproject facilities are listed below.

- The design of the facilities will comply with all relevant and applicable technical standards and safety codes.
- Standard operating procedures will be developed and implemented at each facility.
- Containment arrangements will be made for fuels and oils stored at the facility.
- Material Safety Data Sheet (MSDS) for each hazardous substance will be made available at each facility.
- Emergency response plans will be prepared for each facility as appropriate.

- The facility workers will be appropriately trained to operate the facility and handle emergency situation.
- WB Group's EHS Guidelines will be implemented as appropriate.

6.3.10 Occupational Health and Safety Hazards

Operation and maintenance of the subproject facilities may potentially cause occupational health and safety (OHS) risks for the workers. These risks may be associated with fugitive dust and gaseous emissions, fire and explosion, exposure to noise, electric shock, working on heights, body injuries caused by process equipment, working in confined spaces, and other similar aspects.

Mitigation Measures

The generic mitigation measures to address the OHS risks at the subproject facilities are listed below.

- The design of the facilities will comply with all relevant and applicable technical standards and safety codes to minimize occupational health and safety risks.
- Standard operating procedures will be developed and implemented at each facility. These procedures will address the OHS aspects as well.
- The facility workers will be appropriately trained in OHS aspects.
- Use of appropriate personal protective equipment (PPE) will be mandatory at the facility.
- WB Group's EHS Guidelines will be implemented as appropriate.

6.3.11 Vehicular Traffic

Vehicular traffic during facility construction and operation may potentially cause congestion on the local routes, generate noise, and pose safety hazards for the local population particularly for children and elderly people.

Mitigation Measures

The generic mitigation measures to address the vehicular traffic associated with the subproject facilities are listed below.

- Depending upon the traffic volume and the condition/nature of local routes, a traffic management plan may need to be prepared.
- Community consultations will be carried out before the facility establishment.
- Community liaison will be maintained.
- Safety signage will be erected at appropriate places.
- Safe driving practices will be promoted among the drivers.
- GRM will be put in place.

6.3.12 Impacts on Women, Children, and Vulnerable Groups

The project will generally benefit the small land owners and growers, in addition to providing employment opportunities for the local community. The interventions under Component B are unlikely to negatively affect vulnerable groups such as poor, women and children.

Mitigation Measures

The generic mitigation measures to address the potential impacts on women, children and vulnerable groups are listed below.

- No discrimination with respect to religion, caste, gender, or association with any social group will be practiced during construction and operation of the facilities.
- It will be ensured that the subprojects do not have any negative impacts on women, children and vulnerable groups.

6.3.13 Influx of Workers and Employment

Construction as well as operation and maintenance of the value chain and post-harvest loss reduction facilities will generate employment and contracting/service delivery opportunities. This can potentially cause influx of workers, contractors, and service provides from outside the province resulting into possible conflicts and tension with the local communities.

Mitigation Measures

The generic mitigation measures to address the influx of workers and service providers are listed below.

- Preference will be given to the local contractors, workers, and laborers.
- The capacity building component of the project will include trainings for operation and maintenance of the subproject facilities for supply chains and post-harvest loss control.
- GRM will be put in place to amicably resolve any disputes or conflicts related to employment and service provision.

6.3.14 Impacts from Projects Emerging from Feasibility Studies

Under component A3 the project will finance the preparation of studies on additional crop and livestock value chains, in addition to sub-sectors included in the current project including, but not limited to, fisheries and aquaculture, meat production and marketing, seed production and food storage, etc. The studies will feed into discussions for future project preparation. The approval of topics to study will be accorded by the Project Steering Committee will as per pre-determined criteria with which to appraise study proposals. The Office of the Project Coordinator will manage the implementation and dissemination feasibility studies.

These studies could lead to activities and projects which, though not funded by the project may have additional environmental or social impacts.

Mitigation Measures

- All projects emerging from the feasibility studies conducted under this project shall have to comply with World Bank safeguards policies and this will be reflected in the development of TORs for the feasibility studies for the projects.

6.4 Cumulative Impacts

The environmental and or social impacts of individual subprojects may be quite insignificant, however cumulative impacts of a cluster of small subprojects may be quite

significant. This aspect will be considered while assessing the impacts of an individual subproject.

7. Environmental and Social Management Framework

This Chapter presents the Environmental and Social Management Framework (ESMF) for the proposed project.

7.1 Subproject Screening

As described in **Section 1.3.2**, exact nature, extent and location of the subprojects for value chains and post-harvest loss control under Component B of the Project are not known at this stage. As a consequence, a site- and subproject-specific environmental and social assessment has not been carried out during the present study, and a framework approach has been adopted instead. In line with this approach, a generic environmental and social assessment, discussed in **Chapter 6**, has been carried out.

During the project implementation, when the exact nature, type, size, and location of individual subprojects are known, a site-specific environmental and social screening will need to be carried out for each subproject to be considered under the SAGP. The project will not finance subprojects with potentially significant negative environmental and or social impacts (eg. inside any environmentally and or social critical areas or protected areas; involving large quantities of waste disposal; large scale or linear infrastructural works; substantial health and safety risks; potential impacts likely to extend beyond the immediate vicinity of the site). On the basis of this screening, the nature and extent of the subproject-specific environmental and social assessment will be determined; see **Table 7.1** below for the screening criteria.

Table 7.1: Screening Criteria

Subproject Types	Assessment Needs
Simple subprojects with minimal environmental and or social impacts (typically without involving any construction and waste disposal; subprojects such as Herd Disease Reporting System).	Environmental Assessment with the help of checklist provided in **Annex E**
Subprojects with some potentially negative environmental and or social impacts (outside any environmentally and or social critical areas or protected areas; involving some construction and waste disposal activities; impacts likely to be confined to the immediate vicinity; subprojects such as Herd Health Screening; Efficient Utilization of Excess Animals; Processing and Packaging Facility).	Environmental Assessment with the help of suggested methodology provided in **Annex F** and preparation of an ESMP

The above described checklists and ESMPs will be sent to WB for review and clearance. No site work of any subproject will be initiated unless its filled checklist or ESMP has been cleared by the Bank.

ESMP for Artificial Insemination Training Center

An ESMP has been prepared for the proposed Artificial Insemination Training Center to be established in the Agriculture University at Tando Jam (see **Annex G**). This ESMP, though having some gaps thus needing to be completed during the project implementation, will be used as a sample and template for such Plans to be prepared for various interventions under Component B.

7.2 Institutional Arrangements

The Project Director of Agriculture PMU and Project Manager of Livestock PMU will be overall responsible for the environmental performance of their respective project components. They will also ensure effective ESMF implementation throughout the project.

In each PMU, an appropriate officer will be designated as ESMF Focal Point (EFP) who will be responsible for ESMF implementation for project activities under his/her respective department. Specifically, the EFPs will ensure the preparation and implementation of subproject-specific ESMPs, manage ESMF trainings, carry out environmental monitoring, and prepare monthly and quarterly ESMF reports.

The project will also engage an Environment Specialist and a Social Specialist on a short-term contract basis to assist PMUs in overall ESMF implementation particularly in preparing ESMPs, carrying out monitoring, and conducting trainings.

7.3 Mitigation Plans

The generic mitigation plan prepared on the basis of impact assessment discussed in the previous Chapter is presented in **Table 7.2**. In addition, mitigation plans for the types of subprojects known at this stage are presented in **Tables 7.3** to **7.9**. The subproject-specific mitigation plans will be implemented in combination with the generic mitigation plan. These mitigation plans will be expanded if needed and finalized once the subproject location is known. These plans will also be included in the subproject ESMPs.

The relevant mitigation plans and also the site-specific ESMP will be included in the design of each subproject, and included in the bidding documents in case contracting is involved.

Appropriate environmental and social aspects will also be incorporated in the feasibility studies to be conducted under project component A3 (see **Section 3.2**).

Table 7.2: Generic Mitigation Plan

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
1	Subproject Siting (Land Use, Landform, and Land Take); Ecological Disturbances and Loss of Precious Ecological Values	■ The subprojects will be established on the land owned by the beneficiary. It will be ensured that no involuntary resettlement takes place for these subprojects. Checklist and agreement deed format in **Annex H** and **Annex I** will be used for this purpose. ■ Community consultations will be carried out before establishing the facility. ■ It will be ensured that the local routes are not blocked by such schemes. ■ It will be ensured that natural drainage paths are not blocked by the establishment of subprojects. ■ If trees are to be cut for any subprojects, the farmer/beneficiary will carry out compensatory plantation of appropriate indigenous tree species. Trees thus planted will be at least five times the number of trees felled for establishing the subproject. ■ No schemes will be located inside or in immediate vicinity of any protected areas listed in **Tables 4.9** and **4.10**. ■ The subprojects will not be located in graveyards or shrines. ■ The 'chance find'[21] procedures will be included in the scheme agreements. ■ Use checkilist in **Annex J** for scheme location.	PIU and subproject design team	EFPs	During design stage of subproject
2	Soil and Water Contamination, and Degradation of Water Bodies caused by	■ The subprojects will be designed employing technologies that are least polluting ■ Fuel, oil and other chemicals will be handled and stored at the subproject facilities following the standard operating procedures, avoiding any leakage	PIU and subproject design team	EFPs	During design and O&M stages of subproject

[21] 'Chance find' procedure: In case any artifact or site of archeological, cultural, historical, or religious significance are discovered during activities such as excavation of water ponds, the works will be stopped, and the Archeological Department will be informed.

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
	Discharge of Wastes	and spillage, and minimizing contamination of soil and water. ■ Appropriate effluent treatment arrangements will be included in the design of the subprojects. ■ Settling/retaining tanks will be constructed at the site as appropriate to minimize contaminants leaving the subproject facilities. ■ Recycling of waste effluents will be carried out as far as possible and practical. ■ It will be ensured that the waste effluents leaving the facility comply with the NEQS (see Section 2.1.3). ■ It will be ensured that the wastes are not released into any drinking water source, cultivation fields, or critical habitat. ■ Waste effluents will be released in irrigation channels only if they do not negatively affect the irrigation water quality.			
3	Aggravation of Solid Waste Problems	■ The subprojects will be designed employing technologies that minimize generation of solid wastes ■ Use of non-biodegradable substances (e.g. for packaging) will be minimized. ■ Recycling of solid waste will be carried out as far as possible and practical. ■ Technologies such as biogas will be promoted to gainfully dispose animal dung. ■ Composting of biodegradable waste will be considered and adopted if practicable. ■ Disposal of solid waste will be carried out in a manner that does not negatively affect the drinking water sources, cultivation fields, irrigation channels, natural drainage paths, wetlands and critical habitat, the existing	PIU and subproject design team; Sub-project owners	EFPs	During design and O&M stages of subproject

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
		waste management system in the area, local routes, and general aesthetic value of the area.			
4	Public Health Issues	■ It will be ensured that the emissions and noise from the subproject facilities comply with NEQS and other relevant standards (e.g. WHO guidelines where NEQS do not prescribe standards). ■ Community consultations will be carried out as part of the subproject design activities. ■ Grievance redress mechanism will be established in the area to address the public complaints regarding issues such as noise and odor from the subproject facilities.	Sub-project design team; Sub-project owners	EFPs	During design and O&M stages of subproject
5	Construction related Issues	■ The design of the facility and appropriate construction planning will ensure that construction activities do not cause any soil erosion or degradation. ■ Spoils and excess soil if generated will be disposed appropriately. ■ Borrow areas will be dressed to minimize safety hazards and soil erosion. ■ Untreated waste effluents from the construction sites will not be released to drinking water sources, cultivation fields, irrigation channels, and critical habitats. Appropriate effluent treatment arrangements such as settling tanks will be made at the site. It will be ensured that the effluents comply with NEQS. ■ Construction machinery, generators, and vehicles will be kept in good working condition, minimizing exhaust emissions. It will be ensured that exhausts from these equipment and vehicles comply with relevant NEQS. ■ It will be ensured that noise generated from the construction activities comply with relevant NEQS. ■ All safety precautions will be taken to address safety hazards for the nearby	Contractor	PIUs and EFPs	Construction phase

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
		community. These precautions may include safety/warning signage, safety barrier around the construction site, and safe driving practices. ■ Community consultations will be carried out before commencing the construction activities, informing the nearby population regarding the construction activities and possible impacts such as noise and additional vehicular traffic. ■ Grievance redress mechanism (GRM) will be established in the area to address the public complaints regarding issues such as noise from the construction sites. ■ WB Group's Environment, Health and Safety (EHS) Guidelines (attached at the end of this document) will be implemented ■ The construction contracts will include appropriate clauses to protect environment and public health. The present ESMF will be included in the bidding document. ■ The generic safeguards requirements for construction works are presented in **Annex K**.			
6	Environmental Degradation from Intensification of Agricultural Land Use	■ Judicious use of the irrigation water, chemical inputs and use of alternate techniques (such as integrated pest management, using disease-resistant seeds, and mulching) will be promoted through awareness raising and capacity building initiatives which are included in the Component A of the proposed project. ■ Adoption of IPM techniques will be promoted through capacity building programs. ■ Crop rotation practices will be promoted to avoid soil fertility degradation. ■ The capacity building program will also include safe handling of hazardous	Sub-project owners	PIUs and EFPs	O&M phase

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
		substances such as pesticides. ■ High efficiency irrigation technologies (eg, drip irrigation, tunnel farming) will be promoted to conserve already scarce irrigation water.			
7	Health and Safety Hazards for the Community	■ The design of the facilities will comply with all relevant and applicable technical standards and safety codes. ■ Standard operating procedures will be developed and implemented at each facility. ■ Containment arrangements will be made for fuels and oils stored at the facility. ■ Material Safety Data Sheet (MSDS) for each hazardous substance will be made available at each facility. ■ Emergency response plans will be prepared for each facility as appropriate. ■ The facility workers will be appropriately trained to operate the facility and handle emergency situation. ■ WB Group's EHS Guidelines will be implemented as appropriate.	Sub-project design team; Sub-project owners	EFPs	During design and O&M stages of subproject
8	Occupational Health and Safety Hazards	■ The design of the facilities will comply with all relevant and applicable technical standards and safety codes to minimize occupational health and safety risks. ■ Standard operating procedures will be developed and implemented at each facility. These procedures will address the OHS aspects as well. ■ Fire alarm and fire fighting arrangements will be provided, as appropriate ■ The facility workers will be appropriately trained in OHS aspects. ■ Use of appropriate personal protective equipment (PPE) will be mandatory at the facility.	Sub-project design team; Sub-project owners	EFPs	During design and O&M stages of subproject

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
		■ WB Group's EHS Guidelines will be implemented as appropriate.			
9	Vehicular Traffic	■ Depending upon the traffic volume and the condition/nature of local routes, a traffic management plan may need to be prepared. ■ Community consultations will be carried out before the facility establishment. ■ Community liaison will be maintained. ■ Safety signage will be erected at appropriate places. ■ Safe driving practices will be promoted among the drivers. ■ GRM will be put in place.	Contractor Sub-project owners	EFPs	During construction and O&M stages of subproject
10	Impacts on Women, Children, and Vulnerable Groups	■ No discrimination with respect to religion, caste, gender, or association with any social group will be practiced during construction and operation of the facilities. ■ It will be ensured that the subprojects do not have any negative impacts on women, children and vulnerable groups.	Contractor Sub-project owners	EFPs	During construction and O&M stages of subproject
11	Influx of Workers and Employment	■ Preference will be given to the local contractors, workers, and laborers. ■ The capacity building component of the project will include trainings for operation and maintenance of the subproject facilities for supply chains and post-harvest loss control. ■ GRM will be put in place to amicably resolve any disputes or conflicts related to employment and service provision.	Contractor Sub-project owners	EFPs	During construction and O&M stages of subproject

Table 7.3: Mitigation Plan for Water Tanks and Ponds

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
1	Land requirement	Land if required for the subproject will be donated by the community on voluntary basis. Checklist and agreement deed format in **Annex H** and **Annex I** will be used for this purpose.	PIU and subproject design team	EFPs	During design stage of subproject
2	Water quality and availability	Carrying out laboratory analysis to ensure that that water complies with the NEQS for drinking water – if the water is to be used for drinking purposes.	PIU, subproject design team and contractor	EFPs	During design and construction stages of subproject
		Protecting the water tanks and ponds from contaminants			
		Protective fencing for tanks and ponds to minimize safety hazards			
3	Location and design of the subproject	Ensuring no blocked access, avoiding damage to crops, cultivation fields, graveyards and cultural heritage sites	PIU, subproject design team and contractor	EFPs	During design and construction stages of subproject
		Ensuring no effect on the water rights of others			
		Use checkilist in **Annex J** for subproject location			
		Ensuring equitable distribution of subproject benefits through community participation			
		Avoiding blockage of natural drainage. Provide alternates as appropriate after carrying out consultation with the beneficiary community			
		Carrying out consultation with the beneficiary community, including women - ensuring that the subproject is socially acceptable/suitable to women.			
		Minimizing tree felling requirements to the extent possible. If unavoidable, maintain documentary and photographic record of each tree felled, and carry out compensatory tree plantation (five plants for every tree felled).			
		No subproject will be located inside or in immediate vicinity of any protected areas listed in **Tables 4.9** and **4.10**.			
4	Construction phase	Employing good engineering/construction practices and due diligence during construction activities to avoid/minimize: soil erosion and contamination; release of polluted water/effluents; excessive noise generation near the communities; damage to crops and cultivated fields; tree cutting, damage to	Contractor	EFPs	During construction stage of

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
		public infrastructure (damaged infrastructure to be restored/repaired); damage to graveyards and other cultural heritage sites; and safety/health hazards for the community. The site will be restored and cleared of all debris/scrap/left over construction material after completion of construction works. The generic safeguards requirements for construction works are presented in **Annex K**.			subproject
		Appropriately disposing the surplus soil and left-over construction materials, in consultation with community (e.g., in existing ditches/depressions, proper contouring)			
5	O&M phase	Taking appropriate steps against mosquito breeding and educating the communities in preventive & curative measures against malaria/dengue.	Subproject owner / community	EFPs	During O&M stage of subproject
		Educating the community regarding the importance and methods of cleaning the ponds and tanks.			
		Educating farmers on modern irrigation (e.g., sprinkler system) and cultivation (e.g., bed and furrow) practices, water conservation, safe use of farm inputs, integrated pest management, disease control, and other related aspects.			

Table 7.4: Mitigation Plan for Land Development and Leveling Schemes

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
1	Land requirement	Land if required for the subproject will be donated by the community on voluntary basis. Checklist and agreement deed format in **Annex H** and **Annex I** will be used for this purpose.	PIU and subproject design team	EFPs	During design stage of subproject
2	Location and design of the subproject	Ensuring no blocked access, avoiding damage to crops, cultivation fields, graveyards and cultural heritage sites	PIU, subproject	EFPs	During design and
		Minimize the possibility of soil erosion by employing appropriate techniques			

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
		such as check-dams, embankments, and turfing.	design team and contractor		construction stages of subproject
		Use checkilist in **Annex J** for scheme location			
		Ensuring equitable distribution of subproject benefits through community participation			
		Avoiding blockage of natural drainage. Provide alternates as appropriate			
		After carrying out consultation with the beneficiary community, including women - ensuring that the scheme is socially acceptable and suitable to women.			
		Ensuring no damage to cultural heritage sites and graveyards.			
		Minimizing tree felling requirements to the extent possible. If unavoidable, maintain documentary and photographic record of each tree felled, and carry out compensatory tree plantation (five plants for every tree felled).			
		Avoid damage to public infrastructure. Repair/restore damaged caused by the scheme.			
		Minimize noise generation near the communities.			
		No subproject will be located inside or in immediate vicinity of any protected areas listed in **Tables 4.9** and **4.10**.			
3	O&M phase	Educating farmers on modern irrigation (e.g., sprinkler system) and cultivation (e.g., bed and furrow) practices, water conservation, safe use of farm inputs, integrated pest management, disease control, and other related aspects.	Subproject owner / community	EFPs	During O&M phase

Table 7.5: Mitigation Plan for Storage, and Packing/Processing Facilities

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
1	Land requirement	Land if required for the subproject will be donated by the community on voluntary basis. Checklist and agreement deed format in **Annex H** and **Annex I** will be used for this purpose.	PIU and subproject design team	EFPs	During design stage of subproject
2	Location and design of the subproject	Ensuring no blocked access, avoiding damage to crops, cultivation fields, graveyards and cultural heritage sites	PIU and Design team; contractor	EFPs	During design and construction stages of subproject
		Minimize the possibility of soil erosion by employing appropriate techniques such as check-dams, embankments, and turfing.			
		Use checkilist in **Annex J** for scheme location			
		Ensuring equitable distribution of subproject benefits through community participation			
		Avoiding blockage of natural drainage. Provide alternates as appropriate			
		After carrying out consultation with the beneficiary community, including women - ensuring that the scheme is socially acceptable and suitable to women.			
		Ensuring no damage to cultural heritage sites and graveyards.			
		Minimizing tree felling requirements to the extent possible. If unavoidable, maintain documentary and photographic record of each tree felled, and carry out compensatory tree plantation (five plants for every tree felled).			
		Avoid damage to public infrastructure. Repair/restore damaged caused by the scheme.			
		Minimize noise generation near the communities.			
		No subproject will be located inside or in immediate vicinity of any protected areas listed in **Tables 4.9** and **4.10**.			
3	Construction phase	Employing good engineering/construction practices and due diligence during construction activities to avoid/minimize: soil erosion and contamination; release of polluted water/effluents; excessive noise generation near the communities; damage to crops and cultivated fields; tree cutting, damage to public infrastructure (damaged infrastructure to be restored/repaired); damage	Contractor	EFPs	During construction stage of subproject

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
		to graveyards and other cultural heritage sites; and safety/health hazards for the community. The site will be restored and cleared of all debris/scrap/left over construction material after completion of construction works. The generic safeguards requirements for construction works are presented in **Annex K**. Appropriately disposing the surplus soil and left-over construction materials, in consultation with community (e.g., in existing ditches/depressions, proper contouring)			
		Appropriately disposing the surplus soil, in consultation with community (e.g., in existing ditches/depressions, proper contouring)			
4	O&M Phase	Educating the subproject owners about safe waste management and disposal.	subproject owners / managers	EFPs	During O&M phase
		Educating the subproject owners about safe and efficient operation of the facility			
		Educating the subproject owners about standard HSE procedures and precautions.			

Table 7.6: Mitigation Plan for Rural Roads, Culverts and Bridges

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
1	Land requirement	Land if required for the subproject will be donated by the community on voluntary basis. Checklist and agreement deed format in **Annex H** and **Annex I** will be used for this purpose.	PIU and subproject design team	EFPs	During design stage of subproject
2	Road alignment	Ensuring no blocked access, avoiding damage to crops, cultivation fields, cultivation fields, graveyards and cultural heritage sites	PIU and Design team;	EFPs	During design and construction stages of
		Use checkilist in **Annex J** for scheme location			
		Ensuring equitable distribution of scheme benefits through community			

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
		participation	contractor		subproject
		Avoiding blockage of natural drainage. Provide alternates as appropriate			
		After carrying out consultation with the beneficiary community, including women - ensuring that the scheme is socially acceptable and suitable for women.			
		Minimizing tree felling requirements to the extent possible. If unavoidable, maintain documentary and photographic record of each tree felled, and carry out compensatory tree plantation (five plants for every tree felled).			
		No subproject will be located inside or in immediate vicinity of any protected areas listed in **Tables 4.9** and **4.10**.			
3	Construction phase	Employing good engineering/construction practices and due diligence during construction activities to avoid/minimize: soil erosion and contamination; release of polluted water/effluents; excessive noise generation near the communities; damage to crops and cultivated fields; tree cutting, damage to public infrastructure (damaged infrastructure to be restored/repaired); damage to graveyards and other cultural heritage sites; and safety/health hazards for the community. The site will be restored and cleared of all debris/scrap/left over construction material after completion of construction works. The generic safeguards requirements for construction works are presented in **Annex K**. Appropriately disposing the surplus soil and left-over construction materials, in consultation with community (e.g., in existing ditches/depressions, proper contouring)	Contractor	EFPs	During construction stage of subproject
4	O&M Phase	Installing warning signs along the road.	subproject owners / community	EFPs	During O&M phase
		Educating the community for appropriate precautionary measures against safety hazards associated with vehicular traffic.			

Table 7.7: Mitigation Plan for Livestock Schemes

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
1	Land requirement	Land if required for the subproject will be donated by the community on voluntary basis. Checklist and agreement deed format in **Annex H** and **Annex I** will be used for this purpose.	PIU and subproject design team	EFPs	During design stage of subproject
2	Location of subproject	Ensuring no blocked access, avoiding damage to crops, cultivation fields, cultivation fields, graveyards and cultural heritage sites	PIU and Design team; contractor	EFPs	During design and construction stages of subproject
		Use checklist in **Annex J** for scheme location			
		Ensuring equitable distribution of scheme benefits through community participation			
		Avoiding blockage of natural drainage. Provide alternates as appropriate			
		After carrying out consultation with the beneficiary community, including women - ensuring that the scheme is socially acceptable and suitable for women.			
		Minimizing tree felling requirements to the extent possible. If unavoidable, maintain documentary and photographic record of each tree felled, and carry out compensatory tree plantation (five plants for every tree felled).			
		No subproject will be located inside or in immediate vicinity of any protected areas listed in **Tables 4.9** and **4.10**.			
3	Construction phase	Employing good engineering/construction practices and due diligence during construction activities to avoid/minimize: soil erosion and contamination; release of polluted water/effluents; excessive noise generation near the communities; damage to crops and cultivated fields; tree cutting, damage to public infrastructure (damaged infrastructure to be restored/repaired); damage to graveyards and other cultural heritage sites; and safety/health hazards for the community. The site will be restored and cleared of all debris/scrap/left over construction material after completion of construction works. The generic safeguards requirements for construction works are presented in **Annex K**. Appropriately disposing the surplus soil and left-over construction materials, in	Contractor	EFPs	During construction stage of subproject

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
		consultation with community (e.g., in existing ditches/depressions, proper contouring)			
4	O&M Phase	Educating the subproject owner/community for proper O&M of the facility, safe hygiene practices, and safe waste disposal.	subproject owners / managers	EFPs	During O&M phase
		Educating the farm workers on bio-security issues and safe vaccination practices.			

Table 7.8: Mitigation Plan for Establishing Training Centers

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
1	Land requirement	Land if required for the subproject will be donated by the community on voluntary basis. Checklist and agreement deed format in **Annex H** and **Annex I** will be used for this purpose.	PIU and subproject design team	EFPs	During design stage of subproject
2	Location of subproject	Ensuring no blocked access, avoiding damage to crops, cultivation fields, cultivation fields, graveyards and cultural heritage sites	PIU and Design team; contractor	EFPs	During design and construction stages of subproject
		Use checkilist in **Annex J** for scheme location			
		Ensuring equitable distribution of scheme benefits through community participation			
		Avoiding blockage of natural drainage. Provide alternates as appropriate			
		After carrying out consultation with the beneficiary community, including women - ensuring that the scheme is socially acceptable and suitable for women.			
		Minimizing tree felling requirements to the extent possible. If unavoidable, maintain documentary and photographic record of each tree felled, and carry out compensatory tree plantation (five plants for every tree felled).			

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
		No subproject will be located inside or in immediate vicinity of any protected areas listed in **Tables 4.9** and **4.10**.			
3	Construction phase	Employing good engineering/construction practices and due diligence during construction activities to avoid/minimize: soil erosion and contamination; release of polluted water/effluents; excessive noise generation near the communities; damage to crops and cultivated fields; tree cutting, damage to public infrastructure (damaged infrastructure to be restored/repaired); damage to graveyards and other cultural heritage sites; and safety/health hazards for the community. The site will be restored and cleared of all debris/scrap/left over construction material after completion of construction works. The generic safeguards requirements for construction works are presented in **Annex K**. Appropriately disposing the surplus soil and left-over construction materials , in consultation with community (e.g., in existing ditches/depressions, proper contouring)	Contractor	EFPs	During construction stage of subproject
4	O&M Phase	Provision of toilets with appropriate sewage disposal (such as septic tank and soaking pit); Provision of safe drinking water	Facility owners / managers	EFPs	During O&M phase
		Awareness raising for environmental care, personal hygiene and cleanliness.			

Table 7.9: Mitigation Plan for Facility Rehabilitation

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
1	Rehabilitation works	Employing good engineering/construction practices and due diligence during construction/rehabilitation activities to avoid/minimize: soil erosion and contamination; release of polluted water/effluents; excessive noise generation near the communities; damage to crops and cultivated fields; tree cutting, damage to public infrastructure (damaged infrastructure to be restored/repaired); damage to graveyards and other cultural heritage sites; and safety/health hazards for the community. The site will be restored and cleared of all debris/scrap/left over construction material after completion of construction works. The generic safeguards requirements for construction works are presented in **Annex K**. Appropriately disposing the surplus soil and debris, in consultation with community (e.g., in existing ditches/depressions, proper contouring)	Contractor	EFPs	During rehabilitation phase
2	O&M Phase	Provision of toilets with appropriate sewage disposal (such as septic tank and soaking pit); Provision of safe drinking water Awareness raising for environmental care, personal hygiene and cleanliness.	Facility owners / managers	EFPs	During O&M phase

7.4 Monitoring

ESMF monitoring is carried out to ensure that the mitigation plans are regularly and effectively implemented. It will be carried out at three levels. At the PMU level, the EFPs with the help of environment and social specialists will carry out ESMF monitoring to ensure that the mitigation plans are being effectively implemented, and will conduct field visits on a regular basis. At the field level, more frequent ESMF monitoring will be carried out by the PIU staff, under the guidance and supervision of EFPs and Environment Specialist. Monitoring checklists will be prepared on the basis of the mitigation plans (**Tables 7.2** to **7.9**) and the subproject-specific mitigation plans included in the ESMPs. Finally, the project will engage specialists/firms to conduct external monitoring as third party validation on an annual basis.

7.5 Capacity Building

The objectives of the environmental and social trainings include providing basic knowledge and information on the key environmental and social issues associated with the proposed interventions to the key project personnel including the EFPs, other PMU staff, PIUs, and project beneficiaries.

The training plan is presented in **Table 7.10**. The EFPs will be responsible for the implementation of this plan, while the trainings will be conducted by the environment specialist and social specialist. At the subproject sites, the contractors will be responsible to provide such trainings to their construction staff and workers.

Table 7.10: Environmental and Social Training Plan

Description	Aspects to be Covered	Participants	Responsibility	Frequency
Environmental and social trainings	Environmental and social awareness; Key environmental and social issues associated with the project and subprojects ESMF findings; Subproject-specific ESMPs and their components; ESMP implementation.	PMU staff, EFPs, PIU staff	EFPs with the assistance of Environment Specialist and Social Specialist	At the start of the project; Afterwards as required
	ESMP implementation, OHS aspects	Contractor staff and workers	Contractors	On-going
Awareness raising	Judicious use of fertilizers, pesticides and herbicides; Use of alternate techniques (such as IPM, using better seeds) to reduce the application of chemical inputs; Safe handling and	Subproject beneficiaries	EFPs, PIUs	On-going

Description	Aspects to be Covered	Participants	Responsibility	Frequency
	application of pesticides and herbicides and use of protective gear; Waste disposal; Community mobilization			

7.6 Grievance Redressal Mechanism [22]

Any stakeholder (individual or organization) will be able to submit a grievance to the Project if s/he believes a practice is having a detrimental impact on their community, the environment, or on their quality of life. They may also submit comments and suggestions. Grievances could include:

- Negative impacts on a person or a community (e.g. financial loss, physical harm, nuisance);
- Project participation and inclusiveness (consultation process, beneficiary targeting, etc.);
- Dangers to health and safety or the environment;
- Failure of the contractors and their workers or drivers to comply with standards or legal obligations;
- Harassment of any nature;
- Criminal activity;
- Improper conduct or unethical behavior;
- Financial malpractice or impropriety or fraud; and
- Attempts to conceal any of the above.

Each PIU at district level will be required to have a formal logging system, which is linked to a relevant PMU at provincial level.[23] The PIUs will log grievances that are received directly. A standard form will be developed by the PMUs to record complaints that are received from individuals or organizations by any means including site visits, telephone calls or written correspondence. In addition to the contact information and complaint details, the logging system needs to track the action taken by the Project staff to investigate the cause of the complaint and bring about corrective action if justified, as well as the date of reply to the complainant, with a file reference to any correspondence.

The PIUs will log the receipt of a comment, formally acknowledge it, track progress on its investigation and resolution, and respond in writing with feedback to the aggrieved party. A response time of 10 working days, unless there are exceptional circumstances, would be the aim.

[22] Adopted from Environmental and Social Assessment (prepared by Independent Consultants), Tarbela 4th Extension Hydropower Project, Water and Power Development Authority, December 2011.

[23] There will be two PMUs at provincial level: one at the Department of Agriculture and another at the Department of Livestock.

The PIUs will identify an appropriate investigation officer/team with the correct skills to review the issue raised and to decide whether it is Project related or whether it is more appropriately addressed by a relevant authority outside the Project.

The PIUs will explain in writing (or where literacy is an issue, orally) the manner in which the review was carried out, the results of the review, any changes to activities that will be undertaken to address the grievance or how the issue is being managed to meet appropriate environmental and social management systems and requirements. The PIUs will report to relevant PMU on, at least quarterly basis.

The PIUs and PMUs will summarize grievances in project performance reports, at least quarterly during implementation.

7.7 Reporting and Documentation

Complete documentation will be maintained for the entire ESMF implementation process. This will include the following:

- environmental and social monitoring checklists filled by the PIUs and EFPs,
- visit reports with photographs prepared by the Environment Specialist,
- training reports to be prepared by EFPs and Environment Specialist and Social Specialist,
- quarterly reports on overall ESMF implementation of the project, to be prepared by the EFPs,
- annual third party monitoring reports,
- project completion report on overall ESMF implementation during the entire duration of the project – to be prepared by EFPs.

The EFPs will be overall responsible for the above documentation and reporting.

7.8 ESMF Disclosure Requirements

Once finalized, the ESMF as well the Urdu and Sindhi translations will be disclosed on the official websites of GoSindh, Agriculture Department, and Livestock Department. These documents will also be maintained in the PMUs and PIUs. In addition, the ESMF will be disclosed on WB InfoShop.

7.9 ESMF Implementation Budget

The cost estimates to implement ESMF is provided in **Table 7.11** below. This cost is included in the overall project cost. Additional costs could be included in the sub-project specific ESMPs.

Table 7.11: ESMF Implementation Budget

Description	Cost (million PKR)	Notes/basis
Environment Specialist	2.88	Two weeks per month for first year and then one week per month for the remaining project duration; PKR 40,000 per week; 72 weeks

Description	Cost (million PKR)	Notes/basis
Social Specialist	2.88	Two weeks per month for first year and then one week per month for the remaining project duration; PKR 40,000 per week; 72 weeks
Third party validation	7.50	1.5 m per year × 5 years
Capacity Building	14.4	Two trainings per month for first year and then one training per month for the remaining project duration; PKR 200,000 per training; 72 trainings
ESMP Preparation	2.5	Expected ten @ PKR 500,000 each
Development of HSE Protocols and training	5.0	1.0 m per crop
Miscellaneous expenses	6.00	PKR 1.2 m per year × 5 years
Total (for 5 years)	**41.16**	**(about USD 400,000)**

Annex A. National Environmental Quality Standards

The National Environmental Quality Standards (NEQS), promulgated under the PEPA 1997, specify the following standards:

- Maximum allowable concentration of pollutants in gaseous emissions from industrial sources,
- Maximum allowable concentration of pollutants in municipal and liquid industrial effluents discharged to inland waters, sewage treatment and sea (three separate set of numbers).
- Maximum allowable emissions from motor vehicles.
- Ambient air quality standards.
- Drinking water standards
- Noise standards.

The above NEQS's are presented in **Tables A.1** to **A.6** below. Only a few of these standards will be applicable to the gaseous emissions and liquid effluents discharged to the environment from the activities under the proposed project.

Table A.1: Selected NEQS for Waste Effluents

Parameter	Unit	Standards (maximum allowable limit)
Temperature increase	°C	< 3
pH value (acidity/basicity)	pH	6-9
5-day biochemical oxygen demand (BOD) at 20 °C	mg/l	80
Chemical oxygen demand (COD)	mg/l	150
Total suspended solids	mg/l	200
Total dissolved solids	mg/l	3,500
Grease and oil	mg/l	10
Phenolic compounds (as phenol)	mg/l	0.1
Chloride (as Cl)	mg/l	1,000
Fluoride (as F)	mg/l	10
Sulfate (SO_4)	mg/l	600
Sulfide (S)	mg/l	1.0
Ammonia (NH_3)	mg/l	40
Cadmium	mg/l	0.1
Chromium (trivalent and hexavalent)	mg/l	1.0
Copper	mg/l	1.0
Lead	mg/l	0.5
Mercury	mg/l	0.01
Selenium	mg/l	0.5
Nickel	mg/l	1.0
Silver	mg/l	1.0
Total toxic metals	mg/l	2.0
Zinc	mg/l	5
Arsenic	mg/l	1.0
Barium	mg/l	1.5
Iron	mg/l	8.0
Manganese	mg/l	1.5
Boron	mg/l	6.0
Chlorine	mg/l	1.0

Notes:

1. The standard assumes that dilution of 1:10 on discharge is available. That is, for each cubic meter of treated effluent, the recipient water body should have 10 m^3 of water for dilution of this effluent.
2. Toxic metals include cadmium, chromium, copper, lead, mercury, selenium, nickel and silver. The effluent should meet the individual standards for these metals as well as the standard for total toxic metal concentration.

Source: Government of Pakistan (2000) (SRO 549 (I)/2000).

Table A.2: NEQS for Industrial Gaseous Emissions

mg/Nm^3 unless otherwise stated

Parameter	Source of Emission	Standards (maximum allowable limit)
Smoke	Smoke opacity not to exceed	40% or 2 Ringlemann Scale or equivalent smoke number
Particulate matter [1]	(a) Boilers and furnaces: i. Oil fired ii. Coal fired iii. Cement Kilns	 300 500 300
	(b) Grinding, crushing, clinker coolers and related processes, metallurgical processes, converters, blast furnaces and cupolas	500
Hydrogen Chloride	Any	400
Chlorine	Any	150
Hydrogen fluoride	Any	150
Hydrogen sulphide	Any	10
Sulphur Oxides [2, 3]	Sulfuric acid/Sulphonic acid plants	5,000
	Other Plants except power Plants operating on oil and coal	1,700
Carbon Monoxide	Any	800
Lead	Any	50
Mercury	Any	10
Cadmium	Any	20
Arsenic	Any	20
Copper	Any	50
Antimony	Any	20
Zinc	Any	200
Oxides of Nitrogen [3]	Nitric acid manufacturing unit	3,000
	Other plants except power plants operating on oil or coal: i. Gas fired ii. Oil fired iii. Coal fired	 400 600 1,200

Explanations:

1. Based on the assumption that the size of the particulate is 10 micron or more.
2. Based on 1% sulphur content in fuel oil. Higher content of sulphur will cause standards to be pro-rated.
3. In respect of emissions of sulphur dioxide and nitrogen oxides, the power plants operating on oil and coal as fuel shall in addition to NEQS specified above, comply with the standards provided separately.

Source: Government of Pakistan (2000) (SRO 549 (I)/2000).

Table A.3: National Environmental Quality Standards for Ambient Air [24]

Pollutants	Time-weighted Average	Concentration in Ambient Air		Method of Measurement
		Effective from 1st July 2010	Effective from 1st January 2013	
Sulfur Dioxide (SO_2)	Annual Average*	80 µg/m^3	80 µg/m^3	Ultraviolet Fluorescence
	24 hours**	120 µg/m^3	120 µg/m^3	
Oxides of Nitrogen as (NO)	Annual Average*	40 µg/m^3	40 µg/m^3	Gas Phase Chemiluminescence
	24 hours**	40 µg/m^3	40 µg/m^3	
Oxides of Nitrogen as (NO_2)	Annual Average*	40 µg/m^3	40 µg/m^3	Gas Phase Chemiluminescence
	24 hours**	80 µg/m^3	80 µg/m^3	
Ozone (O_3)	1 hour	180 µg/m^3	130 µg/m^3	Non dispersive UV absorption
Suspended Particulate Matter (SPM)	Annual Average*	400 µg/m^3	360 µg/m^3	High Volume Sampling, (Average flow rate not less than1.1 m^3/minute).
	24 hours**	550 µg/m^3	500 µg/m^3	
Respirable Particulate Matter. PM_{10}	Annual Average*	200 µg/m^3	120 µg/m^3	β Ray absorption
	24 hours**	250 µg/m^3	150 µg/m^3	
Respirable Particulate Matter. $PM_{2.5}$	Annual Average*	25 µg/m^3	15 µg/m^3	β Ray absorption
	24 hours**	40 µg/m^3	35 µg/m^3	
	1 hour	25 µg/m^3	15 µg/m^3	
Lead (Pb)	Annual Average*	1.5 µg/m^3	1.0 µg/m^3	ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	2.0 µg/m^3	1.5 µg/m^3	
Carbon Monoxide (CO)	8 hours**	5 mg/m^3	5 mg/m^3	Non Dispersive Infra Red (NDIR)
	1 hour	10 mg/m^3	10 mg/m^3	

*Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

** 24 hourly /8 hourly values should be met 98% of the in a year. 2% of the time, it may exceed but not on two consecutive days.

Source: Government of Pakistan (2010) (SRO 1062 (I)/2010).

[24] Full text of the *Standards* is available at the Pak-EPA website: (http://www.environment.gov.pk/info.htm).

Table A.4: NEQS for Motor Vehicles Exhaust and Noise [25]

(i) For In-use Vehicles

	Parameter	Standard (Maximum Permissible Limit)	Measuring Method	Applicability
1	Smoke	40% or 2 on the Ringlemann Scale during engine acceleration mode.	To be compared with Ringlemann Chart at a distance 6 or more. r	Immediate effect
2	Carbon Monoxide	6%	Under idling conditions: Non-dispersive infrared detection through gas analyzer.	
3	Noise	85 db (A).	Sound meter at 7.5 meters from the source.	

(ii) For new Vehicles

Emission Standards for Diesel Vehicles

(a) For Passenger Cars and Light Commercial Vehicles (g/Km)

Type of Vehicle	Category/Class	Tiers	CO	HC+ NOx	PM	Measuring Method	Applicability
Passenger Cars	M 1: with reference mass (RW) upto 2500 kg. Cars with RW over 2500 kg to meet NI category standards.	Pak-II IDI	1.00	0.70	0.08	NEDC (ECE 15+ EUDCL)	i. All imported and local manufactured diesel vehicles with effect from 01-07-2012
		Pak-II DI	1.00	0.90	0.10		
Light Commercial Vehicles	NI-I (RW<1250 kg)	Pak-II IDI	1.00	0.70	0.08		
		Pak-II DI	1.00	0.90	0.10		
	NI-II (1250 kg< RW <1700 kg0	Pak-II IDI	1.25	1.00	0.12		
		Pak-II DI	1.25	1.30	0.14		
	NI-III (RW>1700 kg)	Pak-II IDI	1.50	1.20	0.17		
		Pak-II DI	1.50	1.60	0.20		

Parameter	Standard (maximum permissible limit)	Measuring Method
Noise	85 db (A)	Sound meter at 7.5 meters from the source.

[25] Full text of the NEQS is available at the Pak-EPA website: (http://www.environment.gov.pk/info.htm).

(b) For Heavy Duty Diesel Engines and Large Goods Vehicles (g/Kwh)

Type of Vehicle	Category / Class	Tiers	CO	HC	NOx	PM	Measuring Method	Applicability
Heavy Duty Diesel Engines	Trucks and Buses	Pak-II	4.0	1.1	7.0	0.15	ECE-R-49	All Imported and local manufactured diesel vehicles with the effect 1-7-2012
Large goods Vehicles	N2 (2000 and up	Pak-II	4.0	7.0	1.10	0.15	EDC	

Parameter	Standard (maximum permissible limit)	Measuring Method
Noise	85 db (A)	Sound meter at 7.5 meters from the source.

Emission Standards for Petrol Vehicles (g/km)

Type of Vehicle	Category / Class	Tiers	CO	HC+ NOx	Measuring Method	Applicability
Passenger	M 1: With reference mass (RW) upto 2500 kg. Cars with RW over 2500 kg. to meet N1 category standards	Pak-II	2.20	0.50	NEDC (ECE 15 + EUDCL)	All imported and new models* locally manufactured petrol vehicles with effect from 1st July, 2009**
Light Commercial Vehicles	N1-I (RW<1250 kg)	Pak-II	2.20	0.50		
	N1-II (1250 kg>RW <1700 kg)	Pak-II	4.00	0.65		
	N1-III (RW>1700 kg)	Pak-II	5.00	0.80		
Motor Rickshaws & motor Cycles	2.4 strokes <150 cc	Pak-II	5.50	1.50	ECER 40	
	2.4 strokes>150 cc	Pak-II	5.50	1.30		

Parameters	Standard (maximum permissible limit)	Measuring Method
Noise	85 db (A)	Sound meter at 7.5 meters from the source

Explanations:	
DI:	Direct Injection
IDI:	Indirect Injection
EUDCL:	Extra Urban Driving Cycle
NEDC:	New Urban Driving Cycle
M:	Vehicles designed and constructed for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat
N:	Motorvehicles with at least four wheels designed and constructed for the carriage of goods.
*	New model means both model and engine type change
**	The existing models of petrol driven vehicles locally manufacturedwill immediately switch ever to Pak-II emission standards but not later than 30th June, 2012

Source: Government of Pakistan (2009) (SRO 72 (KE)/2009).

Table A.5: National Standards for Drinking Water Quality[26]

Properties/Parameters	Standard Values for Pakistan
Bacterial	
All water intended for drinking (e.Coli or Thermotolerant Coliform bacteria)	Must not be detectable in any 100 ml samples
Treated water entering the distribution system (E.Coli orthermotolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml samples
Treated water in the distribution system (E.Coli orthermo tolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml samples In case of large supplies, where sufficient samples are examined, must not be present in 95% of the samples taken throughout any 12- month period.
Physical	
Color	≤15 TCU
Taste	Non objectionable/Accept able
Odor	Non objectionable/Accept able
Turbidity	< 5 NTU
Total hardness as $CaCO_3$	< 500 mg/l
TDS	< 1000
pH	6.5 – 8.5
Chemical	
Essential Inorganic	***mg/Litre***
Aluminum (Al)	≤0.2
Antimony (Sb)	≤0.005 (P)
Arsenic (As)	≤ 0.05 (P)
Barium (Ba)	0.7
Boron (B)	0.3
Cadmium (Cd)	0.01
Chloride (Cl)	<250
Chromium (Cr)	≤0.05
Copper (Cu)	2
Toxic Inorganic	***mg/Litre***
Cyanide (Cn)	≤0.05
Fluoride (F)*	≤1.5
Lead (Pb)	≤0.05
Manganese (Mn)	≤ 0.5
Mercury (Hg)	≤0.001
Nickel (Ni)	≤0.02

[26] Full text of the Standards is available at the Pak-EPA website: (http://www.environment.gov.pk/info.htm).

Properties/Parameters	Standard Values for Pakistan
Nitrate (NO_3)*	≤50
Nitrite (NO_2)*	≤3 (P)
Selenium (Se)	0.01 (P)
Residual chlorine	0.2-0.5 at consumer end; 0.5-1.5 at source
Zinc (Zn)	5.0
Organic	
Pesticides mg/l	PSQCA No. 4639-2004, Page No. 4 Table No. 3 Serial No. 20- 58 may be consulted.**
Phenolic compound (as phenols) mg/l	WHO standards: ≤ 0.002
Polynuclear Aromatic hydrocarbon (as PAH) g/L	WHO standards: ≤ 0.01v(by GC/MS method)
Radioactive	
Alpha Emitters bq/L or pCi	0.1
Beta Emitters	1

* indicates priority health related inorganic constituents which need regular monitoring.

** PSQCA: Pakistan Standards Quality Control Authority.

Source: Government of Pakistan (2010) (SRO 1063(I)/2010).

Table A.6: National Environmental Quality Standards for Noise [27]

Limit in dB(A) Leq *

Category of Area/Zone	Effective from 1st July 2010		Effective from 1st July 2012	
	Day time	Night time	Day time	Night time
Residential area	65	50	55	45
Commercial area	70	60	65	55
Industrial area	80	75	75	65
Silence zone	55	45	50	45

Notes:

1. Day time hours: 6:00 a.m. to 10:00 p.m.
2. Night time hours: 10:00 p.m. to 6:00 a.m.
3. Silence zone::Zones that are declared as such by the competent authority. An area comprising not less than 100 m around the hospitals, educational institutions, and courts.
4. Mixed categories of areas may be declared as one of the four above-listed categories by the competent authority.

* dB(A) Leq: Time weighted average of the level of sound in decibels on Scale A which is relatable to human hearing.

Source: Government of Pakistan (2010) (SRO 1064(I)/2010).

[27] Full text of the Standards is available at the Pak-EPA website: (http://www.environment.gov.pk/info.htm).

Annex B. List of Institutional Stakeholders Consulted

	Name	Designation	Organization
1.	Mr. Hidayatullah Chhajaro (In Chair)	Director General Agri. Ext.	Agriculture Extension
2.	Mr. Bashir Ahmed Kerio	Director Plant Protection	Agriculture Extension
3.	Mr. Nazir Ahmed Irsani	General Manager Transition	Sindh Irrigation & Drainage Authority (SIDA)
4.	Mr. Ismail Kumbhar	Assistant Professor	Sindh Agriculture University Tando Jam
5.	Dr. Abdul Sattar Buriro	Consultant, Productivity Enhancement	World Bank Assisted SOFWM Project
6.	Mr. Ali Asghar Mahesar	Deputy Director Environment Management Unit (EMU)	Sindh Irrigation & Drainage Authority (SIDA)
7.	Mr. Mir Hajan Talpur	Technical Officer D.G. Ext.	Agriculture Extension
8.	Mr. Masroor Ahmed Shahwani	Institutional Specialist	Sindh Irrigation & Drainage Authority (SIDA)
9.	Mr. Lal Chand	Agriculture Officer / Focal Person IPM	Agriculture Extension
10.	Mr. Nadeem Ahmed Korai	Agriculture Officer	Agriculture Extension
11.	Mr. Waheed Jamali	Coordinator	SAFWCO
12.	Mr. Zahoor Ahmed	Micro Biologist	Environment Protection Agency Sindh Hyd.
13.	Mr. A.Rauf Qureshi	Assistant Director	Environment Protection Agency Sindh Hyd.
14.	Mr. Shahjahan Hashmi	Project Manager	SAFWCO
15.	Dr. Noor Ahmed	Disease Investigation Officer	Livestock Department
16.	Mr. Zulfiqar Haleopoto	PPC	SDF
17.	Mr. Maqbool Dal	Executive Director	VCDO
18.	Mr. Abass Khoso	Executive Director	IRADO
19.	Mr. Jabbar Bhatti	Executive Director	Institute for Social Change
20.	Mr. Ghulam Mustafa Baloch	Regional Head	SPO
21.	Mr. Jai Kolhi	Executive Member	Development Awareness & Management of Natural Resources (DAMAN)
22.	Ms. Umbreen Rafia	Managing Director	Indus Future Foundation
23.	Mr. Farhan Ali Abbasi	Project Coordinator	Sindh Hari Porhiat Council
24.	Mr. Shams u ddin	RCM	NRSP
25.	Mr. Azam Solangi	Deputy Director	Agriculture Research Sindh
26.	Mr. Taj Marri	-	Bhandhar Sangat

Annex C. Questionnaire for Stakeholder Consultation

Questionnaire

Project Design

1. What are your observations about the stated project objectives?
2. What further objectives can be added to increase project utility?
3. What objectives have parallels to any activities going on under your purview? Are there any redundancies?
4. Are there any areas where project activities can be used to support ongoing work under your purview?
5. Do you think the interventions identified are adequate to address the project objectives? Which interventions can be added to the list? Which are redundant and should be removed?

Project Environmental Impacts

6. Of the project interventions identified, do you see any potential environmental impacts emerging which need to be identified?
7. Are there any potential adverse impacts on the project area flora?
8. Are there any potential adverse impacts on the project area fauna?
9. Are there any potential adverse impacts on the project area water resources?
10. Are there any potential physiographical impacts or impacts to soils, especially in cultivated areas?
11. Are there any health/safety hazards associated with the project activities?
12. What mitigation measures should be taken to ensure that project activities in general do not lead to adverse environmental impacts including impacts on flora, fauna, water resources, soil and air?
13. Any environmental enhancement measures that could be added to the project?
14. Any other suggestions?

Project Social Impacts

15. In terms of land ownership patterns in the province, do you have any suggestions to ensure the projects benefits are inclusive?
16. Does the project adequately target all social groups?
17. Are there any marginalized social groups that need to be especially targeted? How can project objectives be amended to include such groups in the impact area?
18. Do the project benefits adequate reach women and children and what actions can be taken to ensure that?
19. What would be the appropriate range of beneficiary contributions (percentage) for the project? Is 30% beneficiary contribution a realistic expectation?
20. Are there any potential social accountability issues? How can these be addressed?
21. What are the best possible mechanisms for grievance redressal and participatory monitoring on the project? Do you have a mechanism in place which can be adopted for project usage?

22. What are the key areas where capacity building would be needed in the province? What should capacity building for beneficiaries focus on? What should capacity building for stakeholders and implementing agencies focus on?

Annex D. Summary and Written Responses

Please see the following pages.

16/5/2013

SIDA Office Hyderabad

Consultative Meeting Regarding Proposed World Bank Assisted

"Sindh Agriculture Growth Program Project (SAGPP)

General comments:

This is a wonderful project and we need to welcome and appreciate the World Bank Support wholeheartedly for their contribution towards enhancing Agriculture growth in the province. No doubt it would bring several benefits to the farmers' community at large.

The Project involves a multidimensional approach through integrating good practices, farmers' education, technology, new agriculture techniques and research. It also involves facilitation to farmers through providing them with knowledge, equipment and land which is really commendable. Therefore, it is really a dynamic developmental project.

However, it would need to define its target group /beneficiaries such as: Ultra-poor communities may be landless peasants both (men & women), small landowners (upto 16 acres of land) and tail-reach framers.

Also there isn't any mention of the Project background such how the need was identified for such project, was there any baseline survey etc, conducted before designing the Project?

Why some specific crops are focused? Can we also include some more vegetable crops and introduce the concept of (integrated vegetable farming)?

Detail comments/suggestions/Answers

Project design (questions 1-5):

i. Further, looking at Project Objectives one concludes that those are number of interventions as those do not reflect on the results/outputs to be produced or the outcomes to be achieved as a result of those. Our suggestion is that Objectives need to be defined in strategic manner such as; short, medium and long-term basis.

ii. Presently (SIDA) is already practicing reforms in the Irrigation sector through introduction of Participatory Irrigation Management (PIM) The PIM is also supported by World Bank under various projects including NDP, SOFWMP and

1

ongoing Water Sector Improvement Project (WSIP). SIDA jointly with OFWM, have organized grassroots level communities and have constituted Water Course Associations (WCAs) and Farmer Organizations (FOs). Those are registered bodies under Sindh Govt's legal framework named as Sindh Water Management Ordinance (SWWMO) 2002.

iii. Therefore, it is self-explanatory that the Irrigation water user communities (WCAs & FOs) need water for their Agriculture lands and crops, for the reason they are knitted close together. Additionally, it is the vision of SIDA and also the WSIP Objectives are aimed at enhancing agriculture productivity for improving the living standard of farming communities so that they could educate their children, have access to livelihood opportunities, basic facilities of clean drinking water and health.

iv. Therefore, based on above argument we strongly recommend that SAGPP may be integrated with FOs. SIDA will contribute to SAGPP through providing them a registered network of WCAs & FOs and another technical support required therein.

v. SIDA interventions aimed at capacity building of WCAs & FOs needs to be added for creating innovative and integrated approach for more vibrant farming communities.

vi. The concept of irrigation extension may be introduced and small interventions related with irrigated agriculture may be introduced at farming community groups including WCAs and FOs and small farmers association. Drip and sprinkler irrigation may be promoted.

vii. The concept of farmer field school (FFS) is very well thought. Model FOs with good irrigation management and farming practices/performance could be allied with FFS. SIDA has recently supported through WB, to install various community infrastructures including FO offices, bridges on channels to link the farmers with market.

viii. Efforts may be made to develop farmer enterprises groups especially for small landholders or FOs may be supported to build these groups within their area.

ix. On market linkages, support in export certifications (like global GAP, HACP, BRC, Hilal) and farmer enterprises may be supported from farmers to producers.

2

x. Special market access program may be introduced and farmers may be given opportunity to participate and meet with international farmer/producer groups in global events like food logistca

xi. Support to FOs/farmers groups like chilli, dates, onion growers associations in introducing new technologies at onfarm and off farm level. This may include: solor dryer for chillies/dates. Similarly cold chains may be developed from farm field to export houses.

xii. Concept of tunnel farming may be introduced and FOs can be a good platform to introduce on pilot basis in their region/area.

xiii. For crop varieties with high productivity, tissue culture labs, screen houses may be added in the program

xiv. Agribusiness and value chain and backward/demand based linkages/approaches may be considered in this project.

xv. Concept of Business development service providers (BDSPs) may be introduced and farmers should be turned into entrepreneurs.

Project Environmental Impacts (questions 6-14)

Refer Annex-A

Project Social Impacts (questions 15-22)

15. For Landownership patterns we would need to take into account the studies already conducted on account of the reason that this SAGPP Project has identified diverse geographical cluster in terms of socio-political, cultural and economical, etc such as: Badin &Dadu both are located in the tail of irrigation system, Badin has a coastal climate and floods are frequent there.

Further, in Dadu some of the locations are semi-arid, flood and drought prone. Whereas; Umerkot is also located in the tail-reaches of irrigation system and is poverty-ridden. Qamber& Shahdadkot are also flood prone. Jacobabadad, Kashmore @ Kandhkot are socio-economically deprived and poverty-ridden and very diverse socio-culturally, politically and economically. Larkana and Sihkarpur are also different socio-culturally, politically and economically.

Furthermore, we would also need to take into account the socio-cultural norms and taboos in order to understand dynamics and factors needed to influence change into the

mindsets of communities and where it could be comparatively easier to initiate the Project and get expected /desired results from the Project?

16. The project may consider priority to field farmers groups including chilly and fruits and vegetable where comparatively small, women and landless work.

17. Project should particularly target the marginalized farming communities such as; small landowners, landless peasants (men & women) and tail reach farmers.

18. Gender mainstreaming would require and women and children needed to be included in the direct beneficiaries' group such as malnourished children girls& boys, also malnourished women & men, pregnant mothers, etc.

19. Need consensus by all. Contribution in kind is suggested and contribution should be considered on the nature of individual intervention.

20. Potential Social Accountability issues might emerge as a result of different interventions such as; while identifying the target groups criterion may not be appropriate and not followed accordingly and as a result the target group population might face neglected. Delays might also may occur in services and supplies delivery, other constraints could be belief systems of the particular socio-cultural community set up due to diverse geographical areas, social pressures within particular cast-cultural setups, etc

21. Although there are number of Grievance Redressal Mechanisms suited to different nature of interventions on the basis of socio-cultural settings. Out of those one way of strengthening grievance redressal mechanism is through developing appropriate "Communication Plan" for general public awareness-raising compliant management which could be easily accessible to general public. SIDA is already implementing that system through formation of grievance redressal committee having membership from within the Organization.

22. The key areas where capacity building of beneficiaries' would be needed in the province are as follows:

i. Sustainable Land use management
ii. Crop diversification
iii. Integrated farming
iv. Agriculture farming on scientific basis involving introduction to new technology and innovative techniques such as; soil-testing, laser land leveling methods and techniques, selection of seed variety, irrigation techniques, crop sowing methods and learning to manage post-harvesting phase, price-fixing, etc

v. linkages development with Govt and Line Deptts:
vi. Marketing

Areas where capacity building of stakeholders should be focused as follows:

i. Sustainable livelihoods
ii. Micro-financing
iii. Cooperative farming
iv. Marketing
v. Climate Change Adaptation
vi. Food security
vii. agribusiness and enterprise development
viii. value chain
ix. good agriculture practices
x. export and compliance certifications (for groups/producres)
xi. Awareness raising on DRR/DRM and creating resilience among the farming communities, etc

5

WORKING PAPER BY SIDA "SIND AGRICULTURE GROWTH PROGRAM PROJECT (SAGPP)"

PROJECT ENVIRONMENTAL IMPACTS

The niain objective of the project is to improve the Agriculture Practice in Date Crop Onion crop. chillies and Rice crops. These crops have direct and indirect linkage between environments. The application of excess/inappropriate insecticides and herbicides are used for common practice for agricultural crops and horticulture which is main cause of negative impacts on atmosphere (air, water. sediment soil and food). Many users are not given proper information about short and long term risks. and necessary measures/precautions for correct application of toxic chemical. Pesticides pollute/contaminate the soil and water when are sprayed aerially. run off field and escaped water from agricultural field and inappropriate discard bottles. These activities are main reasons of generation environmental negative impact which issue death warrant to not only human being as well as flora and fauna. It has been mentioned in the last objective "Creation awareness among the farming community about Integrated Pest Management (IPM) and Plant Nutrient Managment". This objective will be helpful for reducing the negative environmental impact some extent but not overall adverse environmental impacts. These pesticides (alderin, chlordrine, DDT. endrine and etc) have chronic effects permanently. Excess application of inorganic fertilizers also generates the adverse environmental effects. These activities contaminate the agricultural cropped land. Therefore. the polluted water of agricultural land is disposed off into safer places for avoiding further degradation of fresh environment.

Are there any potential adverse impacts on the project area flora and fauna?
Nitro fixation which is required for growth of flora which is hindered by pesticides in soils and on other hand pesticides has negative effects on root hair development and reduces plant growth. The excess application of pesticides caused several deaths of birds, animal and aquatic life. The inappropriate application pesticides create many diseases among humans but especially major ailment is cancer.

Are there any potential adverse impacts on the project area water resources and potential impact to soils?

The pesticides are major cause of contamination of fresh water resource such as rivers, canals and wetlands. The pesticides in the project area will develop environmental negative impact on groundwater and surface water during rainfall run off and degrading the fertile soil in the project area.

Are there any health/safety hazards associated with the project activities?
The personal Protective Equipments (PPEs) should be provided to the Workers during spray of pesticides.

What mitigation measures should be taken to ensure that activities in general do not lead to adverse environmental impacts including impacts on flora, fauna, water resources, soil and air?
The organic and botanic pesticides should be used such Nictone, Pyrathrum, Neam and etc which develop less environmental negative impacts. The Integrated Pest Management (IPM) should be adopted.

Agricultural Research
In this Research component brief was provided about dates, Onion and Chillies but not about Paddy (rice crops). It is worthwhile to mention that excess use of irrigation for rice crops which causes waterlogging and salinity. The waterlogging salinity is major cause of adverse environmental impact. Therefore, there is need of research for seedling of such species which receive less quantity of water in comparison which are growing recently.

Suggestion
Agricultural Extension has provided authority by Government to control sub-standard pesticides which are used frequently in the field without any objection which is major cause of degradation of environment. There is basic need of development Data Base Information System about quality and standard of pesticides production. Hence every stakeholder can approach easily.

Submitted by: **DEVELOPMENT AWARENESS & MANAGEMENT OF NATURAL RESOURCES (DAMAN)**

Meeting Date:
16.05.2013

Meeting Location:

Office of Directorate General Agriculture Extension Sindh Hyderabad

Meeting Participants:

DEVELOPMENT AWARENESS & MANAGEMENT OF NATURAL RESOURCES (DAMAN)

-Provide a brief explanation of the project background, objectives and details of potential interventions.

-Explain that the meeting is being conducted to get the stakeholder's feedback on the project and relevant suggestions will be considered in project design.

- Seek answers to the following questions (divided in three categories);

Project Design

1. What are your observations about the stated project objectives?
    - Agriculture Sector is the backbone of the Economy of Country so need to strengthen Agriculture Sector. No observation regarding the project.
2. What further objectives can be added to increase project utility?
    - The role of sharecroppers (tenants) is not clear in the concept paper. It is suggested that tenants may also be included in the beneficiaries.
3. What objectives have parallels to any activities going on under your purview? Are there any redundancies?
    ---
4. Are there any areas where project activities can be used to support ongoing work under your purview?
    - Mirpurkhas is the main Agriculture district which is not included in the Concept paper. Since it is located in the tail in irrigation system so project activities like Agriculture Extension Services, Water Management Services, Marketing Services are required in this area.
5. Do you think the interventions identified are adequate to address the project objectives? Which interventions can be added to the list? Which are redundant and should be removed?
    Following Interventions are suggested to be included in the project:
    - Inclusion of more high value crops along with Onion, Chilies, Dates and Rice.
    - Since Cotton is the major Cash Crop of Sindh no any activity on Cotton crop in the project. So it may be included in the project.

- Wheat is also a major food secure crop. Therefore it may also be added in the project to combat food insecurity issue in Sindh province.

Project Environmental Impacts

6. Of the project interventions identified, do you see any potential environmental impacts emerging which need to be identified?
   - Due to natural disasters in last couple of years the condition of the soil is already damaged due to erosion, waterloging and salinity. The project activities may result excessive crop cultivation which may threat more soil problems.
7. Are there any potential adverse impacts on the project area flora?
   - The over use of synthetic fertilizers and pesticides may result negative impact over flora.
8. Are there any potential adverse impacts on the project area fauna?
   - The use of pesticides in Agriculture fields will harm natural fauna.
9. Are there any potential adverse impacts on the project area water resources?
   - The water requirement may increase so the problem of shortage of irrigation water may be raised.
10. Are there any potential physiographical impacts or impacts to soils, especially in cultivated areas?
    - Already answered.
11. Are there any health/safety hazards associated with the project activities?
    - Pesticide residues and natural hazardous such as aflatoxin in rice and chilies may cause health problem.
12. What mitigation measures should be taken to ensure that project activities in general do not lead to adverse environmental impacts including impacts on flora, fauna, water resources, soil and air?
    - Proper Integrated Pest Management (IPM) may be implemented in the project and excessive use of synthetic fertilizers and pesticides may be discouraged in the project.
13. Any environmental enhancement measures that could be added to the project?
    ---
14. Any other suggestions?

Project Social Impacts

15. In terms of land ownership patterns in the province, do you have any suggestions to ensure the projects benefits are inclusive?
    - The Sindh Tenancy Act is not properly implemented by Revenue Department. There is no proper tenancy system exists so, there are several issues due to which the relation between tenants and land owners are sometimes not said to be better for better agriculture.
16. Does the project adequately target all social groups?

- No any benefit is seen for share holder/ tenant. Therefore it must be cleared in the project proposal.

17. Are there any marginalized social groups that need to be especially targeted? How can project objectives be amended to include such groups in the impact area?
    - Tenants may also be directly mentioned as beneficiaries.
18. Do the project benefits adequate reach women and children and what actions can be taken to ensure that?
    - No role of women is mentioned in the project.
19. What would be the appropriate range of beneficiary contributions (percentage) for the project? Is 30% beneficiary contribution a realistic expectation?

    ---
20. Are there any potential social accountability issues? How can these be addressed?

    ---
21. What are the best possible mechanisms for grievance redressal and participatory monitoring on the project? Do you have a mechanism in place which can be adopted for project usage?
    - Grievances redressal committees may be established at local and central level. Third party monitoring system is also suggested.
22. What are the key areas where capacity building would be needed in the province? What should capacity building for beneficiaries focus on? What should capacity building for stakeholders and implementing agencies focus on?
    - It is worth mentioning here that lack of knowledge is a big issue of Sindh. So proper capacity building of farmers from soil selection to marketing of the crop may be included in the project. More the farmers will trained more production and quality production will be outcome.

SINDH AGRICULTURE AND FORESTRY WORKERS COORDINATING ORGANISATION

SAFWCO Recommendations with reference to the Proposed World Bank Assisted

"SINDH AGRICULTURE GROWTH PROGRAM PROJECT (SAGPP)"

Dear Sir

Reference to the meeting held today, given below are the a few suggestions. SAFWCO would be glad to offer any support as required by your department:

1. **Providence of Mats for Chillies drying**

   SAFWCO implementing such a proposal along with training and development with the help of ASF

   SAFWCO has developed a concept note and process of providing farmers Geo Textile sheets

   Progress made so far:

- SAFWCO has already formed 100 FEGs (Farmer Enterprise Group) in Kunri area.
- Each FEG is consisted of 15 members out of these 3 are office bearers
- In total 1500 small farmer holding 1 to 12 acres chilli cultivation
- All the 1500 growers will be provided Geo textile sheets and some other material
- SAFWCO will conduct technical training program one every week each covering 30 growers. The training will be focused on IPM covering insect pest control, cultural practices, reducing post harvest loses etc.
- SAFWCO has developed an Office for farmers support equipped with required equipments and material.

2. **Activation of Aflatoxins Laboratory Kunri**

   Excellent machinery all the equipments are there in excellent condition.

Staff hiring from same area

- Staff training
- Certificate issuance from the lab for lots
- Propagation of facility availability through Print, Radio and other BTL activities
- Charges for providing testing facility

3. **Rice Combine Harvesters**

Along with thresher Rice Combine Harvesters shall be provided on subsidized basis. Certified used and new can be imported from EU. This can harvest one acre of rice in 20-30 minutes. Speed of the machine depending upon

The model of combine harvester is used?

Moisture in the soil

Crop is standing or lodging

The harvested paddy is directly poured into the open top trolley and directly transported to the rice mill.

Benefits:

About 10% less grain breakage hence higher milling yield. High price for rice, high price for paddy

Better quality of paddy, lesser dust, lesser other foreign material therefore, higher paddy quality, higher paddy price.

Time saving, therefore wheat sowing is done early

Higher yield of Rabi crop as early sowing of Rabi crop provides higher yield

In areas like Larkana, Jacobabad, Kashomre, Qamber Shehdadkot, Dadu rice moisture will be utilised to sow Rabi crop on the rice moisture

Cost saving it costs about 2500 per acres whereas manually cost includes labor harvesting, hand threshing, bagging, cost of bags, shifting of paddy from field to threshing yards etc

4. Establishment of Centre of Excellence FFS

Centre of excellence shall be developed where trainers are trained who then further replicate their learning's in the field

Development of Centre of Excellence shall be operated by an internationally reputed established institute i.e. IBA etc. The centre shall be developed in Hyderabad or Karachi and foreign experts shall also be invited

A minimum 6 months Certification program shall provided completed by passing the exam and certificate ward

5. Development of new varieties

It is suggested that instead of importing foreign varieties focus shall be made on developing and improving local varieties.

Importing foreign varieties can cause many issues like:

Ownership rights by the variety inventing company

Issues like GMOs which may cause harmful effect like nobody knows harmful effects of Badillus thuringiensis inserted into Cotton seed BT variety.

Annex E. Rapid Assessment Checklist

Screening Questions	Yes	No	Remarks
A. Project Siting Is the Project area adjacent to or within any of the following environmentally sensitive areas?			
• Cultural heritage site			
• Protected Area			
• Wetland			
• Mangrove			
• Estuarine			
• Buffer zone of protected area			
• Special area for protecting biodiversity			
B. Potential Environmental Impacts Will the Project cause:			
• ecological disturbances arising from the establishment of a plant or facility complex in or near sensitive habitats?			
• loss of precious ecological values (e.g. result of encroachment into forests/swamplands or historical/cultural buildings/areas, disruption of hydrology of natural waterways, regional flooding, and drainage hazards)?			
• eventual degradation of water bodies due to discharge of wastes and other effluents from plant or facility complex?			
• serious contamination of soil and groundwater?			
• aggravation of solid waste problems in the area?			
• public health risks from discharge of wastes and poor air			

Screening Questions	Yes	No	Remarks
quality; noise and foul odor from plant emissions?			
• short-term construction impacts (e.g. soil erosion, deterioration of water and air quality, noise and vibration from construction equipment?			
• dislocation or involuntary resettlement of people			
• social conflicts arising from the influx of laborers from other areas?			
• environmental degradation (e.g. erosion, soil and water contamination, loss of soil fertility, disruption of wildlife habitat) from intensification of agricultural land use to supply raw materials for plant operation; and modification of natural species diversity as a result of the transformation to monoculture practices?			
• water pollution from discharge of liquid effluents?			
• air pollution from all plant operations?			
• gaseous and odor emissions to the atmosphere from processing operations?			
• accidental release of potentially hazardous solvents, acidic and alkaline materials?			
• uncontrolled in-migration with opening of roads to forest area and overloading of social infrastructure?			
• occupational health hazards due to fugitive dust, materials handling, noise, or other process operations?			
• disruption of transit patterns, creation of noise and congestion, and pedestrian hazards aggravated by heavy trucks?			
• disease transmission from inadequate waste disposal?			
• impediments to movements of			

Screening Questions	Yes	No	Remarks
people and animals?			
• disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?			
• potential social conflicts arising from land tenure and land use issues?			
• noise from construction and plant equipment?			
• soil pollution, polluted farm runoff and groundwater, and public health risks due to excessive application of fertilizers and pesticides?			
• risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation?			
C. Potential Social Impacts			
• Does the subproject require land?			
• If yes, will the subproject cost be shared between the project and landowner? (Complete documentation will be maintained for land procurement or donation.)			
• Will the private land be obtained through land cost paid by the community through willing buyer-willing seller arrangement? (Complete documentation will be maintained for land procurement).			
• Will the land be obtained through private voluntary donations, provided the donation will have minimal livelihood impact on the concerned person (less than 10 percent)? (Complete documentation will be maintained for land donation.)			

Annex F. Methodology and Structure of Environmental and Social Management Plans

Suggested Methodology

The subproject-specific ESMPs will be prepared using the standard methodology, as briefly listed below (ADB's Rapid Environmental Assessment Checklist given in **Annex E** and FAO's Environmental Guidelines given in **Annex L** will also be used for ESMP preparation).

- Scoping – studying the subproject details and preparing long list of potential issues and concerns
- Site survey and data collection – recording the key environmental and social aspects of the area, identifying any environmental/social hot spots or key concerns, carrying out consultations with the community.
- Screening – on the basis of the above, short listing the key concerns and potential impacts of the subproject on environment and people.
- impact assessment – assessing the significance of each potential impact and identifying appropriate mitigation measures. Assessment of cumulative impacts of a cluster of subprojects.
- ESMP compilation – documenting the process and outcome of the study. The ESMP structure is discussed below.

Suggested ESMP Structure

The ESMP will follow the standard structure as given below.

- Introduction, including background, a brief description of the SAGP, an overview of the relevant legal and policy framework
- A simplified description of the subproject, including its layout and location, resource requirements, wastes to be generated, manpower requirement, a brief description of construction activities, and a brief description of operation and maintenance activities.
- Baseline description, primarily describing the proposed site and its **immediate** surrounding aided with maps, photographs and schematics, key environmental and social aspects/resources of the surroundings such as land form and land use, land ownership, water resources, settlements, any critical habitat or protected area, any cultural heritage sites or graveyards, any sensitive receptor such as schools and hospitals, access routes, and other relevant details.
- Stakeholder consultations, recording the key concerns and suggestions of the community regarding the subproject and its potential impacts, and a description of the way these concerns will be addressed.
- Mitigation plans, listing all the impacts, their mitigation measures, assigning responsibility of implementing these measures, and also assigning responsibility for monitoring. Also identifying cumulative impacts if applicable.
- Monitoring plan, describing the monitoring requirements, frequency, and responsibility of conducting the monitoring.

- Training plan, describing the training requirements, contents, frequency, training recipients, and responsibility of conducting these trainings.
- Documentation and reporting, describing the requirement, frequency, and responsibility of documentation and reporting.
- ESMP implementation budget, providing the cost estimate of its implementation.

Annex G. ESMP for Artificial Insemination Training Center (Sample Only – To be Completed during SAGP Implementation)

Introduction

The Department of Livestock and Fisheries plans to establish the Artificial Insemination Training Center (AITC) within the premises of the Agriculture University Tando Jam, under the World Bank financed Sindh Agriculture Growth Project (SAGP). The present Environmental and Social Management Plan (ESMP) has been prepared to address the potentially adverse environmental and or social impact of this facility, in accordance with the requirements laid down in Environmental and Social Management Framework (ESMF) that has been prepared for the SAGP.

SAGP Overview

The Government of Pakistan (GoPak) and Government of Sindh (GoSindh) have both highlighted commercial agriculture and market linkages as priority investments for the sector. GoSindh has also prioritized investments in support of small and medium farmers and in value chains that will positively impact women. This project also responds to the Country Partnership Strategy (CPS) (FY2010-13) which states that the Bank will engage in providing technical assistance to help Pakistan in its agricultural policy analysis and design with a view to increasing agricultural competitiveness and expanding rural livelihoods. The project will improve marketing infrastructure and facilitate reform in local marketing regulations and policies to enhance competitiveness.

The project consists of three components: Component A comprises capacity building of producers, modernization of extension services and agricultural research, and strategic planning for the agricultural sector; Component B comprises horticulture value chains, post-harvest loss management, livestock value chains, and demand driven investment fund; and Component C comprises project management, monitoring and evaluation. Further project details are presented later in the document.

Regulatory and Policy Overview

The Pakistan Environmental Protection Act, 1997 (the Act) is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The Act is applicable to a broad range of issues and extends to socioeconomic aspects, land acquisition, air, water, soil, marine and noise pollution, as well as the handling of hazardous waste. The discharge or emission of any effluent, waste, air pollutant or noise in an amount, concentration or level in excess of the National Environmental Quality Standards (NEQS) specified by the Pakistan Environmental Protection Agency (Pak-EPA) has been prohibited under the Act, and penalties have been prescribed for those contravening the provisions of the Act. The powers of the federal and provincial Environmental Protection Agencies (EPAs), established under the Pakistan Environmental Protection Ordinance 1983,have also been considerably enhanced under this legislation and they have been given the power to conduct inquiries into possible breaches of environmental law either of their own accord, or upon the registration of a complaint. This Act will be applicable to the proposed AITC to be established under the SAGP.

The World Bank's Operation Policy 4.01 (OP 4.01) requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are

environmentally sound and sustainable, and thus to improve decision making. The OP defines the EA process and various types of the EA instruments. Other WB operational policies include OP 4.04 for natural habitat, OP 4.36 for forestry, OP 4.09 for pest management, OP 4.37 for safety of dams, OP 7.50 for projects in international waterways, OP 4.11 for physical cultural property, OP 4.10 for indigenous people, OP 7.60 for projects in disputed areas, OP 4.12 for involuntary resettlement, and policy on access to information. Of these policies, the OP 4.01, OP 4.09 and policy on access to information will be applicable to the AITC subproject.

Subproject Description (to be completed during SAGP implementation)

The AITC will be established within the premises of the Agriculture University at Tando Jam. The University is located on the highway connecting Hyderabad and Mirpurkhas (see **Figure 1**).

The land proposed for this facility belongs to the University and is currently lying vacant as can be seen in the **Figure 1**.

The facility is likely to provide training facility and will also house about ten animals.

(To be included here: facility description; facility layout (map); construction details; facility utilization; activities during facility operation; water requirements; requirement of any other materials; any toxic material to be used or disposed; waste generation and disposal; …….)

Baseline Conditions

The generic baseline conditions of the entire project area for SAGP (ie, entire province of Sindh) have been described in the ESMF of the SAGP, the specific site-specific baseline description for the AITC subproject is presented below.

The proposed site is a flat tract of land as shown in the **photographs** provided at the end of this ESMP. The land is owned by the Agriculture University, as mentioned earlier, and some occasional cultivation is carried out here by the University employees. Some trees also exist here. There are no water bodies in the immediate vicinity of the site, nor do any settlements exist in the vicinity except the University buildings and facilities as can be seen in **Figure 1**. No wildlife protected area or site of cultural, archeological, religious or historical importance exist in the vicinity. No sensitive receptors exist in the area except the University facilities and buildings.

Stakeholder Consultations

(To be added by the Project.)

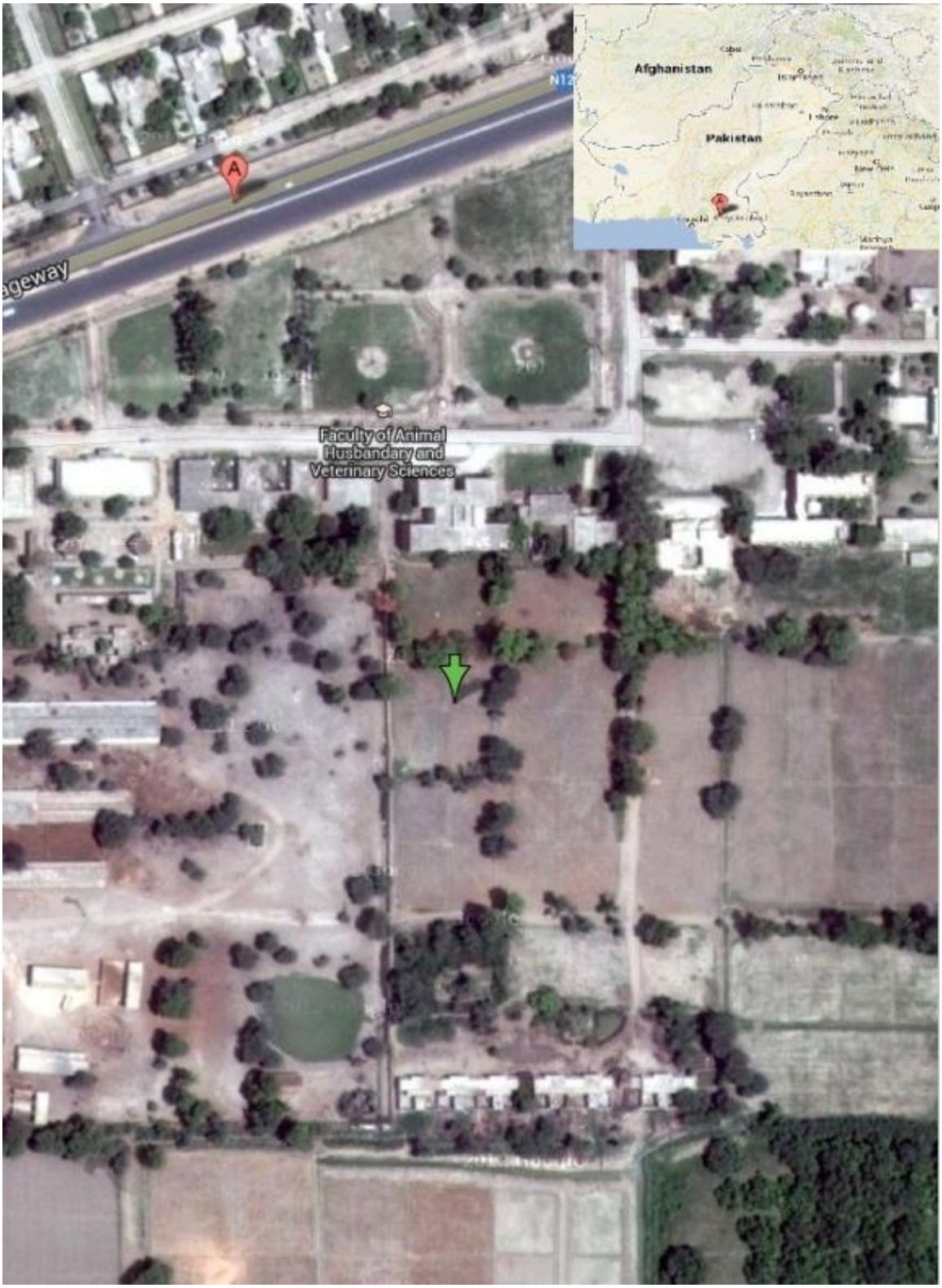


Figure 1: Location of the Proposed AITC[28]

[28] Source: Google Maps accessed on 4 June 2013.

Screening and Assessment

The potential environmental and social impact of the AITC subproject have been screened and assessed below (this will be reviewed once more information on AITC design and operation is available).

Screening Questions	Yes	No	Remarks
A. Project Siting Is the Project area adjacent to or within any of the following environmentally sensitive areas?			
• Cultural heritage site		✓	
• Protected Area		✓	
• Wetland		✓	
• Mangrove		✓	
• Estuarine		✓	
• Buffer zone of protected area		✓	
• Special area for protecting biodiversity		✓	
B. Potential Environmental Impacts Will the Project cause:			
• ecological disturbances arising from the establishment of a plant or facility complex in or near sensitive habitats?		✓	No sensitive habitat exists in the vicinity of the proposed site.
• loss of precious ecological values (e.g. result of encroachment into forests/swamplands or historical/cultural buildings/areas, disruption of hydrology of natural waterways, regional flooding, and drainage hazards)?		✓	The immediate surroundings of the proposed site do not have any precious ecological value. The area has already been modified to establish the Agriculture Universities decades ago. Also, the establishment of the proposed facility will not alter the ecological stetting of the area in general.
• eventual degradation of water bodies due to discharge of wastes and other effluents from plant or facility complex?		✓	No untreated wastes will be released to the environment. Sewage from the facility will be treated in a septic tank and soaking pit. The animal wastes will mostly be used as fertilizer in the cultivation fields within the University. During construction phase, good housekeeping practice will be

Screening Questions	Yes	No	Remarks
			implemented to forestall any release of untreated effluents to the environment.
• serious contamination of soil and groundwater?		✓	Same as above.
• aggravation of solid waste problems in the area?		✓	During the construction phase, the contractor will be required to responsibly dispose solid waste generated by the construction activities. During the facility operation, domestic solid waste will be disposed along with other such waste being generated in the University. The animal waste (cow dung) will be used as fertilizer in the cultivation fields within the University, as described earlier.
• public health risks from discharge of wastes and poor air quality; noise and foul odor from plant emissions?	Possibly		During the facility operation, foul odor from the animal screeta may be a cause of concern. The facility design will ensure that the animal shed is constructed away from any sensitive receptor (eg, residences and class rooms). Regular removal of animal screeta will be ensured during facility operation.
• short-term construction impacts (e.g. soil erosion, deterioration of water and air quality, noise and vibration from construction equipment?	Possibly		No soil erosion is likely in view of the flat nature of the site. Deterioration of air and water quality is likely to take place if appropriate measures are not implemented. Similarly, construction activities are likely to cause some localized noise. The contractor will be required to implement appropriate mitigation measures to reduce the above impacts and follow the applicable standards (such as NEQS) for noise, air quality and other impacts. The contractor will also be required to maintain liaison with the relevant University officials.
• dislocation or involuntary resettlement of people		✓	The site is lying vacant.
• social conflicts arising from the influx of laborers from other areas?		✓	Local contractors are likely to be engaged for the construction works. They are likely to engage local construction workers.

Screening Questions	Yes	No	Remarks
• environmental degradation (e.g. erosion, soil and water contamination, loss of soil fertility, disruption of wildlife habitat) from intensification of agricultural land use to supply raw materials for plant operation; and modification of natural species diversity as a result of the transformation to monoculture practices?		✓	Not applicable.
• water pollution from discharge of liquid effluents?		✓	As described above, no untreated effluents will be released to environment.
• air pollution from all plant operations?		✓	No plant or machinery operation is involved. The facility may have a diesel generator, which will cause some localized air pollution.
• gaseous and odor emissions to the atmosphere from processing operations?	Possibly		Foul odor from animal screeta may be a cause of concern as described earlier also. The facility design will ensure that the animal shed is constructed away from any sensitive receptor (eg, residences and class rooms). Regular removal of animal screeta will be ensured during facility operation.
• accidental release of potentially hazardous solvents, acidic and alkaline materials?	?	?	To be assessed once more information is available about facility operation.
• uncontrolled in-migration with opening of roads to forest area and overloading of social infrastructure?		✓	Not applicable. The area is already significantly modified to establish the University decades ago.
• occupational health hazards due to fugitive dust, materials handling, noise, or other process operations?	Possibly		Construction Phase: Occupational health hazards are likely to exist during construction phase and will be addressed with the help of appropriate OHS practices (eg, use of PPEs, safety protocols, fire fighting, first aide, and others). Operation phase may pose bio-safety hazards. Implementation of appropriate bio-safety and bio-security protocols will forestall these risks. (to be expanded once more subproject information is available)
• disruption of transit patterns, creation of noise and congestion, and pedestrian hazards		✓	Not applicable since no intensive heavy vehicular movement is envisaged for the subproject.

Screening Questions	Yes	No	Remarks
aggravated by heavy trucks?			
• disease transmission from inadequate waste disposal?	Possibly		Appropriate waste disposal arrangements will have to be implemented to forestall any disease transmission. Similarly, bio-safety protocols will need to be implemented to avoid any disease transmission from (and among) the animals.
• impediments to movements of people and animals?		✓	Unlikely since the site is not used for animal or people movement.
• disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?		✓	The subproject is unlikely to cause any impact on poor, women or children since it is located away from communities and the facility will have no interaction with these vulnerable groups. No Indigenous People (as defined under the OP 4.10) are known to exist in the Province.
• potential social conflicts arising from land tenure and land use issues?		✓	The land is owned by the University and currently lying mostly vacant (except for some cultivation by University employees).
• noise from construction and plant equipment?	Possibly		Some noise is expected from construction operation. The contractor will be required to implement appropriate mitigation measures.
• soil pollution, polluted farm runoff and groundwater, and public health risks due to excessive application of fertilizers and pesticides?		✓	Not applicable since the subproject does not involve usage of fertilizers or pesticides.
• risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation?		✓	No hazardous materials will be used at the site (to be confirmed). Bio-safety protocols will be implemented at the facility.
C. Potential Social Impacts			
• Does the subproject require land?	✓		
• If yes, will the subproject cost be shared between the project and landowner? (Complete documentation will be maintained for land procurement or donation.)			Not applicable, since the land is already owned by the University (ie, Government owned land).

Screening Questions	Yes	No	Remarks
• Will the private land be obtained through land cost paid by the community through willing buyer-willing seller arrangement? (Complete documentation will be maintained for land procurement).		✓	
• Will the land be obtained through private voluntary donations, provided the donation will have minimal livelihood impact on the concerned person (less than 10 percent)? (Complete documentation will be maintained for land donation.)		✓	

Mitigation Plan

The mitigation plan is presented in **Table 1**. This will be reviewed and updated as needed once more information on the AITC is available during SAGP implementation.

Monitoring Plan

During the construction phase, ESMP monitoring will be carried out at three levels. At the PMU level, the EFPs with the help of environment and social specialists will carry out ESMP monitoring to ensure that the mitigation plan is being effectively implemented, and will conduct field visits on a regular basis. At the field level, more frequent ESMP monitoring will be carried out by the PIU staff, under the guidance and supervision of EFPs and Environment Specialist. Monitoring checklists will be prepared on the basis of the mitigation plan (**Table 1**). Finally, the SAGP will engage specialists/firms to conduct external monitoring as third party validation on an annual basis.

During the operation phase, the environmental management and monitoring will be carried out the AITC staff themselves, under the leadership of the AITC In-charge.

Documentation and Reporting

Complete documentation will be maintained for the entire ESMP implementation process. This will include the following:

- environmental and social monitoring checklists filled by the PIUs and EFPs,
- visit reports with photographs prepared by the Environment Specialist,
- quarterly reports on overall ESMP implementation of the project, to be prepared by the EFPs,
- annual third party monitoring reports,
- subproject completion report on overall ESMP implementation – to be prepared by EFPs.

The EFPs will be overall responsible for the above documentation and reporting.

Table 1: Mitigation Plan (this will be reviewed once more information on AITC design and operation is available)

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
1	Subproject Siting (Land Use, Landform, and Land Take); Ecological Disturbances and Loss of Precious Ecological Values	■ A memo of understanding will be signed between the SAGP and University authorities regarding the establishment of the facility and its ownership. ■ Consultations will be carried out before establishing the AITC facility. ■ It will be ensured that the local routes are not blocked by AITC facility. ■ It will be ensured that natural drainage paths are not blocked by the establishment of AITC facility. ■ Trees may need to be felled to construct the facility (see photographs at the end of this ESMP). Compensatory tree plantation will be carried out to mitigate this impact. Trees thus planted will be at least five times the number of trees felled for establishing the AITC facility. ■ The 'chance find'[29] procedures will be included in the construction contract document.	PIU and AITC design team	EFPs	During design stage of AITC
2	Soil and Water Contamination, and Degradation of Water Bodies caused by Discharge of Wastes	■ The AITC will be designed employing technologies that are least polluting ■ Fuel, oil and other chemicals will be handled and stored at the AITC facilities following the standard operating procedures, avoiding any leakage and spillage, and minimizing contamination of soil and water. ■ Appropriate effluent treatment arrangements will be included in the design of the AITC. This will include septic tank and soaking pit for sewage treatment. ■ Settling/retaining tanks will be constructed at the site as appropriate to minimize contaminants leaving the AITC.	PIU and AITC design team; In-charge of AITC	EFPs	During design and O&M stages of AITC

[29] 'Chance find' procedure: In case any artifact or site of archeological, cultural, historical, or religious significance are discovered during activities such as excavation of water ponds, the works will be stopped, and the Archeological Department will be informed.

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
		■ The animal wastes will mostly be used as fertilizer in the cultivation fields within the University. ■ During construction phase, good housekeeping practice will be implemented to forestall any release of untreated effluents to the environment. ■ Recycling of waste effluents will be carried out as far as possible and practical. ■ It will be ensured that the waste effluents leaving the facility comply with the NEQS. ■ Any other waste?? (to be assessed once more information is available)			
3	Aggravation of Solid Waste Problems	■ During the construction phase, the contractor will be required to responsibly dispose solid waste generated by the construction activities. Domestic solid waste will be disposed along with similar waste generated in the University; scrap and excess construction material will be removed from site; reusable and recycle-able waste will be sold. ■ During the facility operation, domestic solid waste will be disposed along with other such waste being generated in the University. The animal waste (cow dung) will be used as fertilizer in the cultivation fields within the University, as described earlier. ■ Any other waste?? (to be assessed once more information is available)	PIU and AITC design team; In-charge of AITC	EFPs	During design and O&M stages of AITC
4	Public Health Issues	■ During the facility operation, foul odor from the animal screeta may be a cause of concern. The facility design will ensure that the animal shed is constructed away from any sensitive receptor (eg, residences and class rooms). ■ Regular removal of animal screeta will be ensured during facility	AITC design team; In-charge of AITC	EFPs	During design and O&M stages of AITC

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
		operation. ■ It will be ensured that the emissions and noise from the AITC comply with NEQS and other relevant standards (eg, WHO guidelines where NEQS do not prescribe standards). ■ Consultations will be carried out as part of the AITC design activities. ■ Grievance redress mechanism will be established in the area to address the public complaints regarding issues such as noise and odor from the subproject facilities. ■ Any other issue?? (to be assessed once more information is available)			
5	Construction related Issues	■ Spoils and excess soil if generated will be disposed appropriately. ■ Untreated waste effluents from the AITC construction site will not be released to environment. Appropriate effluent treatment arrangements such as settling tanks will be made at the site. It will be ensured that the effluents comply with NEQS. ■ Construction machinery, generators, and vehicles will be kept in good working condition, minimizing exhaust emissions. It will be ensured that exhausts from these equipment and vehicles comply with relevant NEQS. ■ It will be ensured that noise generated from the construction activities comply with relevant NEQS. ■ All safety precautions will be taken to address safety hazards for the nearby community/offices/classrooms. These precautions may include safety/warning signage, safety barrier around the construction site, and safe driving practices. ■ Consultations will be carried out before commencing the construction activities, informing the nearby population regarding the construction	Contractor	PIUs and EFPs	Construction phase

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
		activities and possible impacts such as noise and additional vehicular traffic. ■ Grievance redress mechanism (GRM) will be established in the area to address the public complaints regarding issues such as noise from the construction sites. ■ WB Group's Environment, Health and Safety (EHS) Guidelines (attached at the end of this document) will be implemented ■ The construction contracts will include appropriate clauses to protect environment and public health. The present ESMP will be included in the bidding document.			
8	Occupational Health and Safety Hazards	■ Occupational health hazards during construction phase will be addressed with the help of appropriate OHS practices (eg, use of PPEs, safety protocols, fire fighting, first aide, and others). ■ Operation phase of AITC may pose bio-safety hazards. Implementation of appropriate bio-safety and bio-security protocols will forestall these risks. (to be expanded once more subproject information is available) ■ The design of the facilities will comply with all relevant and applicable technical standards and safety codes to minimize occupational health and safety risks. ■ Standard operating procedures will be developed and implemented at the AITC facility. These procedures will address the OHS aspects as well. ■ Fire alarm and fire fighting arrangements will be provided, as appropriate ■ The facility workers will be appropriately trained in OHS aspects. ■ Use of appropriate personal protective equipment (PPE) will be mandatory	AITCdesign team; In-charge of AITC	EFPs	During design and O&M stages of AITC

	Environmental /Social Impact/Issue	Mitigation Actions	Responsibility		Timing
			Execution	Monitoring	
		at the facility. ■ WB Group's EHS Guidelines will be implemented as appropriate.			
9	Vehicular Traffic	■ The contractor will be asked to use the routes designated by the University officials ■ Consultations will be carried out before the AITC establishment. ■ Safety signage will be erected at appropriate places. ■ Safe driving practices will be promoted among the drivers. ■ GRM will be put in place.	Contractor In-charge of AITC	EFPs	During construction and O&M stages of AITC
10	Influx of Workers and Employment	■ Preference will be given to the local contractors, workers, and laborers. ■ GRM will be put in place to amicably resolve any disputes or conflicts related to employment and service provision.	Contractor In-charge of AITC	EFPs	During construction and O&M stages of AITC

ESMP Implementation Budget

The ESMP implementation budget is provided below. It will be reviewed once more information is available on the AITC subproject and the present ESMP is finalized.

Table 2: ESMP Implementation Budget

Description	Cost (million PKR)	Notes/basis
Environment Specialist	-	Included in the overall SAGP budget
Social Specialist	-	Included in the overall SAGP budget
Third party validation	-	Included in the overall SAGP budget
Capacity Building	-	Included in the overall SAGP budget
ESMP Preparation	0.5	This may be needed to revise and finalize the present ESMP
Development of HSE Protocols and training	-	Included in the overall SAGP budget
Miscellaneous expenses	0.5	
Total	**1.0**	

Site Photographs

Annex H. Involuntary Resettlement Screening Checklist

Name of Enumerator:_____ Date: _____
Province:_____ District:_____ Project:_____ Sector:_____
Project Categorization: A B C

SECTION 1	Yes	No	Expected	Remarks
Does the project require land acquisition? Yes/No				
If yes, then describe the type of land being acquired from the categories below:				
Land (Quantify and describe types of land being acquired in "remarks column".				
Government or state owned land free of occupation (agriculture or settlement)				
Private land				
• Residential				
• Commercial				
• Agricultural				
• Communal				
• Others (specify in "remarks").				
• Name of owner/owners and type of ownership document if available.				
If land is being acquired, describe any structures constructed on it				
Land-based assets:				
• Residential structures				
• Commercial structures (specify in "remarks")				
• Community structures (specify in "remarks")				
• Agriculture structures (specify in "remarks")				
• Public utilities (specify in "remarks")				
• Others (specify in "remarks")				
If agricultural land is being acquired, specify the following:				
Agriculture related impacts				
• Crops and vegetables (specify types and cropping area in "remarks).				
• Trees (specify number and types in "remarks").				
• Others (specify in "remarks").				
Affected Persons (DPs)				
Will any people be displaced from the land when acquired? Yes/No				
• Number of DPs				
• Males				
• Females				
• Titled land owners				
• Tenants and sharecroppers				
• Leaseholders				
• Agriculture wage laborers				
• Encroachers and squatters (specify in remarks column)				

• Vulnerable DPs (e.g. women headed households, minors and aged, orphans, disabled persons and those below the poverty line). Specify the number and vulnerability in “remarks”.				
• Others (specify in “remarks”)				
• How will people be affected?				
Section 2				
Will land be donated voluntarily? Yes/No				
If yes, does the owner been made aware of VLD nature and procedure?				
Has the landowner agreed to sign the VLD documents?				
Can the owner produce land title deeds/documents of ownership?				
Are there any tenants on the land?				
If yes, describe number of tenants, gender and type of tenancy and length of residence.				
If yes, are tenants willing to move?				
Will there be adverse impacts on tenants? Describe in remarks column				
Are there people using the land for livelihoods, cultural activities? Yes/No				
If yes, how many people? Gender? Type of activity?				
How will voluntary land donation effect people using the land?				

Annex I. Format to Document Contribution of Assets

The following agreement has been made on..... day of.....…… between.....resident of ....(the Owner) and …….(the Recipient).

1. That the Owner holds the transferable right of .....……hectares of land/structure/asset in.....……
2. That the Owner testifies that the land/structure is free of squatters or encroachers and not subject to other claims.
3. That, to the best of his knowledge, there are no other lawful claimants to the property
4. That he/she does not have tenants on the property.
5. That the Owner hereby grants to the Recipient this asset for the construction and development of .....for the benefit of the villagers and the public at large.

(Either, in case of donation):

6. That the Owner will not claim any compensation against the grant of this asset.

(Or, in case of compensation):

7. That the Recipient shall construct and develop the……..……and take all possible precautions to avoid damage to adjacent land/structure/other assets.
8. That both the parties agree that the……so constructed/developed shall be public premises.
9. That the provisions of this agreement will come into force from the date of signing of this deed.
10. That the owner gives up all claims to the land donated and the title to the land will be transferred to the recipient through notary public.

_____ _____
Signature of the Owner Signature of the Recipient

Witnesses:

1. _____Village or Tribal Head_____
2. _____Government Employee_____
3. ----------Adjacent land owner _____
   (Signature, name and address)

Annex J. Checklist for Scheme Siting

Sr.#	Issues	Yes	No	Don't Know	Mitigation Measures
1	Does the subproject require land acquisition? [Note: Fill in the land acquisition form if YES]				
2	Will the subproject negatively impact livelihoods [Note: Describe separately if YES]				
3	Is the subproject located on land with contested ownership?				
4	Does the owner know that the land will be donated voluntarily?				
5	Are there people currently living on this land?				
6	Is the subproject located on land reclaimed from floods (the ownership here may be contested)				
7	Is the subproject located in an area with designated natural reserves?				
8	Is the subproject located in an area with unique natural features?				
9	Is the subproject located in an area with endangered or conservation-worthy ecosystems, fauna or flora?				
10	Is the subproject located in an area falling within 500 meters of national forests, protected areas, wilderness areas, wetlands, biodiversity, critical habitats, or sites of historical or cultural importance?				
11	Is the subproject located in an area which would create a barrier for the movement of conservation-worthy wildlife or livestock?				
12	Is the subproject located close to groundwater sources, surface water bodies, water courses or wetlands?				
13	Is the subproject located in an area with designated cultural properties such as archaeological, historical and/or religious sites?				
14	Is the subproject in an area with religious monuments, structures and/or cemeteries?				
15	Is the subproject located in an area from where people have been displaced?				
16	Is the subproject located in an area where IDPs are temporarily settled?				

Sr.#	Issues	Yes	No	Don't Know	Mitigation Measures
17	Is the subproject located in a politically sensitive area?				
18	Is the subproject located in a polluted or contaminated area?				
19	Is the subproject located in an area of high visual and landscape quality?				
20	Is the subproject located in an area susceptible to landslides or erosion?				
21	Is the subproject located in an area of seismic faults?				
22	Is the subproject located in a densely populated area?				
23	Is the subproject located on a prime agricultural land?				
24	Is the subproject located in an area of tourist importance?				
25	Is the subproject located near a waste dump?				
26	Does the subproject have access to potable water?				
27	Is the subproject located far (1-2 km) from accessible roads?				
28	Is the subproject located in an area with a wastewater network?				
29	Is the subproject located in the urban plan of the city?				
30	Is the subproject located outside the land use plan?				

Checklist filled by (Name, designation, and signature): _____Date:_____

Checklist reviewed by (Name, designation, and signature):_____Date:_____

Annex K. Safeguards Procedures for Inclusion in the Technical Specifications of Contracts

I. **General**

1. The Contractor and his employees shall adhere to the mitigation measures set down and take all other measures required by the Engineer to prevent harm, and to minimize the impact of his operations on the environment.

2. The Contractor shall not be permitted to unnecessarily strip clear the right of way. The Contractor shall only clear the minimum width for construction and diversion roads should not be constructed alongside the existing road.

3. Remedial actions which cannot be effectively carried out during construction should be carried out on completion of each Section of the road (earthworks, pavement and drainage) and before issuance of the Taking Over Certificate:

   (a) these sections should be landscaped and any necessary remedial works should be undertaken without delay, including grassing and reforestation;
   (b) water courses should be cleared of debris and drains and culverts checked for clear flow paths; and
   (c) borrow pits should be dressed as fish ponds, or drained and made safe, as agreed with the land owner.

4. The Contractor shall limit construction works to between 6 am and 7 pm if it is to be carried out in or near residential areas.

5. The Contractor shall avoid the use of heavy or noisy equipment in specified areas at night, or in sensitive areas such as near a hospital.

6. To prevent dust pollution during dry periods, the Contractor shall carry out regular watering of earth and gravel haul roads and shall cover material haulage trucks with tarpaulins to prevent spillage.

II. **Transport**

7. The Contractor shall use selected routes to the project site, as agreed with the Engineer, and appropriately sized vehicles suitable to the class of road, and shall restrict loads to prevent damage to roads and bridges used for transportation purposes. The Contractor shall be held responsible for any damage caused to the roads and bridges due to the transportation of excessive loads, and shall be required to repair such damage to the approval of the Engineer.

8. The Contractor shall not use any vehicles, either on or off road with grossly excessive, exhaust or noise emissions. In any built up areas, noise mufflers shall be installed and maintained in good condition on all motorized equipment under the control of the Contractor.

9. Adequate traffic control measures shall be maintained by the Contractor throughout the duration of the Contract and such measures shall be subject to prior approval of the Engineer.

III. **Workforce**

10. The Contractor should whenever possible locally recruit the majority of the workforce and shall provide appropriate training as necessary.

11. The Contractor shall install and maintain a temporary septic tank system for any residential labor camp and without causing pollution of nearby watercourses.

12. The Contractor shall establish a method and system for storing and disposing of all solid wastes generated by the labor camp and/or base camp.
13. The Contractor shall not allow the use of fuel wood for cooking or heating in any labor camp or base camp and provide alternate facilities using other fuels.

14. The Contractor shall ensure that site offices, depots, asphalt plants and workshops are located in appropriate areas as approved by the Engineer and not within 500 meters of existing residential settlements and not within 1,000 meters for asphalt plants.

15. The Contractor shall ensure that site offices, depots and particularly storage areas for diesel fuel and bitumen and asphalt plants are not located within 500 meters of watercourses, and are operated so that no pollutants enter watercourses, either overland or through groundwater seepage, especially during periods of rain. This will require lubricants to be recycled and a ditch to be constructed around the area with an approved settling pond/oil trap at the outlet.

16. The contractor shall not use fuel wood as a means of heating during the processing or preparation of any materials forming part of the Works.

IV. **Quarries and Borrow Pits**

17. Operations of a new borrow area, on land, in a river, or in an existing area, shall be subject to prior approval of the Engineer, and the operation shall cease if so instructed by the Engineer. Borrow pits shall be prohibited where they might interfere with the natural or designed drainage patterns. River locations shall be prohibited if they might undermine or damage the river banks, or carry too much fine material downstream.

18. The Contractor shall ensure that all borrow pits used are left in a trim and tidy condition with stable side slopes, and are drained ensuring that no stagnant water bodies are created which could breed mosquitoes.

19. Rock or gravel taken from a river shall be far enough removed to limit the depth of material removed to one-tenth of the width of the river at any one location, and not to disrupt the river flow, or damage or undermine the river banks.

20. The location of crushing plants shall be subject to the approval of the Engineer, and not be close to environmentally sensitive areas or to existing residential settlements, and shall be operated with approved fitted dust control devices.

V. **Earthworks**

21. Earthworks shall be properly controlled, especially during the rainy season.

22. The Contractor shall maintain stable cut and fill slopes at all times and cause the least possible disturbance to areas outside the prescribed limits of the work.

23. The Contractor shall complete cut and fill operations to final cross-sections at any one location as soon as possible and preferably in one continuous operation to avoid partially completed earthworks, especially during the rainy season.

24. In order to protect any cut or fill slopes from erosion, in accordance with the drawings, cut off drains and toe-drains shall be provided at the top and bottom of slopes and be planted with grass or other plant cover. Cut off drains should be provided above high cuts to minimize water runoff and slope erosion.

25. Any excavated cut or unsuitable material shall be disposed of in designated tipping areas as agreed to by the Engineer.

26. Tips should not be located where they can cause future slides, interfere with agricultural land or any other properties, or cause soil from the dump to be washed into any watercourse. Drains may need to be dug within and around the tips, as directed by the Engineer.

VII. **Disposal of Construction and Vehicle Waste**

27. Debris generated due to the dismantling of the existing structures shall be suitably reused, to the extent feasible, in the proposed construction (e.g. as fill material for embankments). The disposal of remaining debris shall be carried out only at sites identified and approved by the project engineer. The contractor should ensure that these sites (a) are not located within designated forest areas; (b) do not impact natural drainage courses; and (c) do not impact endangered/rare flora. Under no circumstances shall the contractor dispose of any material in environmentally sensitive areas.

28. In the event any debris or silt from the sites is deposited on adjacent land, the Contractor shall immediately remove such, debris or silt and restore the affected area to its original state to the satisfaction of the Supervisor/Engineer.

29. Bentonite slurry or similar debris generated from pile driving or other construction activities shall be disposed off to avoid overflow into the surface water bodies or form mud puddles in the area.

30. All arrangements for transportation during construction including provision, maintenance, dismantling and clearing debris, where necessary, will be considered incidental to the work and should be planned and implemented by the contractor as approved and directed by the Engineer.

31. Vehicle/machinery and equipment operations, maintenance and refueling shall be carried out to avoid spillage of fuels and lubricants and ground contamination. An 'oil interceptor" will be provided for wash down and refueling areas. Fuel storage shall be located in proper banded areas.

32. All spills and collected petroleum products shall be disposed off in accordance with standard environmental procedures/guidelines. Fuel storage and refilling areas shall be located at least 300m from all cross drainage structures and important water bodies or as directed by the Engineer.

VIII. **HIV/AIDS Education**

33. The Contractor shall ensure that detection screening of sexually transmitted diseases, especially with regard to HIV/AIDS, amongst laborers is actually carried out and will submit a certificate of compliance.

Annex L. Environmental Guidelines[30]

Agriculture

The project is likely to:

- Be formulated with a good understanding of the local biophysical and socio-economical and socio-cultural environment.
- Use sustainable agricultural practices/approaches/technologies.
- Promote the sustainable management and use of biological processes (as agricultural inputs).
- Follow the ecosystem approach for sustainable agriculture production and management.
- Contribute to protection or conservation of significant areas of land.
- Conserve genetic resources/diversity, especially agricultural genetic resources/diversity.
- Promote a balanced production system between crops and livestock.
- Reduce top-soil losses from erosion and the reduction in soil fertility/soil life.
- Induce conservation and efficient use of water.
- Reduce misuse of agrochemicals, contributing to a reduction of toxic substances in soil and water.
- Introduce techniques for plant nutrition (e.g. IPNS) and plant protection (e.g. IPM).
- Induce low energy consumption technologies or promote bioenergy sources.
- Involve use of purchased inputs for greater productivity.
- Benefit or involve targeted groups (landless farmers, women's groups, indigenous peoples), taking into consideration farmers' rights, as appropriate.
- Consider the free, prior and informed consent of local stakeholders.
- Increase agro-processing capacity.
- Protect critical ecosystems or reduce pressure on protected areas.
- Secure conservation, sound husbandry of land resources.
- Maintain current land management practices.
- Promote awareness on the need for mitigation of greenhouse gases and adaptation to climate change.
- Recognize climate change trends together with opportunities for mitigation and adaptation.
- Be formulated within the framework of national or local sustainable development plans.

[30] Source: Environmental Impact Assessment – Guidelines for FAO Field Projects. Food and Agriculture Organization of the United Nations, Rome, 2011.

- Be compatible with principles and obligations of international agricultural conventions (e.g. IT-PGRFA, IPPC).
- Avoid changes in water quality and supply downstream of the project area.

Links: http://www.fao.org/ag/ca

Livestock and animal husbandry

The project is likely to:

- Maintain forested areas and protect wild-life (particularly for tsetse fly eradication).
- Avoid competing land uses or affect prevailing land rights.
- Preserve local environment, in particular, as regards disease prevention and habitat impacts.
- Avoid stocking rates exceeding the livestock carrying capacity of land and rangeland degradation.
- Avoid the dissociation of animal husbandry from mixed farming.
- Preserve the loss of traditional practices that conform with sustainable management practices.
- Avoid the introduction of new livestock types that do not fit with local farming systems.
- Avoid losses of animal genetic resources.
- Take into account rotational grazing systems or combined animal husbandry.
- Preserve hilly areas or limit soil erosion and compaction problems, such as near waterways.
- Avoid untested strains of forage plants.
- Avoid unsustainable manure management practices that can result in soil and water contamination.
- Avoid risk of disease transmission to other animal species, wildlife and to humans.
- Avoid greenhouse gas emissions from the animal food chain.
- Avoid risk of disease transmission through poor quarantine and trans-boundary movements.
- Be compatible with principles and obligations of international agricultural conventions (e.g. CBD, UN-CCD, Global Plan of Action for Animal Genetic Resources)

Links: http://www.fao.org/ag/againfo/resources/en/publications.html

http://www.fao.org/ag/againfo/programmes/en/A5.html

http://www.fao.org/ag/againfo/themes/en/Environment.html

Fertilizers

The project is likely to:

- Encourage integrated plant nutrition systems by combining mineral fertilizers with organic inputs such as farmyard or green manure.
- Increase the efficiency of fertilizer use while limiting environmental pollution.
- Limit fertilizer applications to maximum effective rates taking into account the predominant cropping system, soil conditions, and other intensification factors.
- Protect areas or critical aquifers or water bodies (aquifers, sources of freshwater for urban centers).
- Promote use of biological nitrogen fixation or other processes that might reduce fertilizer requirements.
- Be planned with prior consultation with farmers, indigenous peoples or other local populations.
- Create planned environmental benefits as a result of its cumulative effects with other projects.
- Encourage crop rotations that recycle nutrients in crop by-products (e.g, straw, haulms), particularly from legumes.
- Avoid a shift in cropping pattern as a result of fertilizer introduction.
- Avoid the accumulation of excess nutrients in soils, causing the leaching of nutrients into groundwater, and excessive nutrient loading of water surface bodies and wetlands.
- Avoid significant changes in land use and water extraction patterns.

Links: http://www.fao.org/ag/agl/agll/ipnis/index.asp

http://www.fao.org/agriculture/crops/core-themes/theme/spi/plantnutrition/en

Pesticides

The project is likely to:

- Be within provisions of the Rotterdam Convention and national or trans-boundary pest control strategies.
- Apply integrated pest management (IPM) techniques and best practices, including use of biological methods, timing of crop sowing, use of pest-resistant varieties etc.
- Apply best practice guidelines and standards for safe use and disposal of used pesticides containers and outdated stocks[8].
- Protect surface and ground water quality, livestock, human health, fish stock, aquatic habitat and wildlife, in particular where run-off is likely to occur.
- Promote natural enemies of pests and avoid an increase in pest incidence or creation of new pests.
- Take into account beneficial soil micro-organisms and enhance micro-zoo genetic populations.
- Ensure conditions by which the application of pesticides is well targeted.
- Limit the intense application of systemic chemical pesticides.
- Limit handling of chemicals by inexperienced farmers.

- Require involvement or strengthening of extension services consultation of affected farmers.
- Be designed with prior consultation and participation of affected populations.
- Decrease reliance on non-renewable sources of energy.
- Create planned environmental benefits as a result of its cumulative effects with other projects.
- Require disposal of obsolete pesticides.

Links: http://www.fao.org/agriculture/crops/core-themes/theme/pests/pm/en

http://www.fao.org/waicent/faoinfo/agricult/agp/agpp/pesticid/disposal/en/103194/index.html

http://www.fao.org/docrep/006/ad487e/ad487e00.htm

http://www.fao.org/docrep/006/Y2765E/Y2765E00.HTM

http://www.fao.org/docrep/006/Y2753E/Y2753E00.HTM

http://www.fao.org/docrep/006/Y2757E/Y2757E00.HTM

http://www.fao.org/docrep/007/y5774e/y5774e00.htm

http://www.fao.org/docrep/006/Y2752E/Y2752E00.HTM

http://www.fao.org/docrep/006/Y2751E/Y2751E00.HTM

http://www.fao.org/docrep/006/Y2683E/Y2683E00.HTM

http://www.fao.org/docrep/006/Y2685E/Y2685E00.HTM

http://www.fao.org/docrep/006/Y2686E/Y2686E00.HTM

http://www.fao.org/docrep/006/Y2767E/Y2767E00.HTM

http://www.fao.org/docrep/006/Y2766E/Y2766E00.HTM

Socio-economic dimensions

The project is likely to:

- Contribute to alleviating poverty for a significant portion of the rural poor population.
- Create stable employment or generate new income in agriculture, forestry or fisheries.
- Create opportunities for payments for environmental services such as carbon storage.
- Facilitate participation, including women, in decision-making that directly or indirectly affects them.
- Enhance food security in terms of self-reliance and self-sufficiency.
- Ensure rural equity, gender equity, and inter-generational equity.
- Be designed and implemented with prior consultation, consent and participation of affected populations.
- Introduce new and/or adapted technologies that are environmentally, economically and socially sound.
- Introduce preventive measures that reduce degradation of natural resources, protect natural ecosystems and biodiversity, and reduce human risk.

- Not establish new institutional mechanisms (policy, legislation, regulations, and institutions).
- Increase local and national understanding and knowledge of sustainable development processes.
- Develop new models of sustainable management.
- Improve local management and technical capabilities.
- Catalyze formation of self-reliant local groups.
- Build upon experience of settlers in particular ecosystems, farming activities or technologies.
- Provide for training, extension and economic incentives to aid settlers in new environments and economic settings.
- Consider land rights schemes and existing systems of land use rights.

Gender considerations

The project is likely to:

- Create opportunities for the empowerment of women.
- Promote women's participation in decision-making and ensure that women benefit from the project along with men.
- Safeguard the rights and needs of vulnerable or marginalized populations, including women, youth, the elderly or disabled.
- Contribute to the equal distribution of resources (land, labour, fertilizer, credit, technology, extension, markets) between men and women.
- Draw on the distinct knowledge and skills of men and women.
- Take into account the different vulnerabilities of men and women, due to differences in access to resources and different constraints.
- Target both men's and women's roles and tasks (such as in what animals they rear or which crops they grow)so that both men and women are included.
- Identify any gender biases in institutions regarding who should receive technology, information and extension services and ensure that both men and women are supported.
- Account for the differential impacts of migration on men and women.

Links: http://www.fao.org/sd/Seaga/downloads/En/projecten.pdf

ftp://ftp.fao.org/docrep/fao/012/i1240e/i1240e00.pdf

http://www.fao.org/sd/2001/PE0602a_en.htm

http://worldbank.org/genderinag

ftp://ftp.fao.org/docrep/fao/012/i1243e/i1243e00.pdf

Annex M. EHS Guidelines

The World Bank Group's EHS Guidelines are presented in the following pages.

Environmental, Health, and Safety General Guidelines

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 **General EHS Guidelines** are designed to be used together with the relevant **Industry Sector EHS Guidelines** which provide guidance to users on EHS issues in specific 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[2] 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.

The **General EHS Guidelines** are organized as follows:

[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.

[2] For IFC, such assessment is carried out consistent with Performance Standard 1, and for the World Bank, with Operational Policy 4.01.

General Approach to the Management of EHS Issues at the Facility or Project Level

Effective management of environmental, health, and safety (EHS) issues entails the inclusion of EHS considerations into corporate- and facility-level business processes in an organized, hierarchical approach that includes the following steps:

- Identifying EHS project hazards[3] and associated risks[4] as early as possible in the facility development or project cycle, including the incorporation of EHS considerations into the site selection process, product design process, engineering planning process for capital requests, engineering work orders, facility modification authorizations, or layout and process change plans.
- Involving EHS professionals, who have the experience, competence, and training necessary to assess and manage EHS impacts and risks, and carry out specialized environmental management functions including the preparation of project or activity-specific plans and procedures that incorporate the technical recommendations presented in this document that are relevant to the project.
- Understanding the likelihood and magnitude of EHS risks, based on:
    - The nature of the project activities, such as whether the project will generate significant quantities of emissions or effluents, or involve hazardous materials or processes;
    - The potential consequences to workers, communities, or the environment if hazards are not adequately managed, which may depend on the proximity of project activities to people or to the environmental resources on which they depend.
- Prioritizing risk management strategies with the objective of achieving an overall reduction of risk to human health and the environment, focusing on the prevention of irreversible and / or significant impacts.
- Favoring strategies that eliminate the cause of the hazard at its source, for example, by selecting less hazardous materials or processes that avoid the need for EHS controls.
- When impact avoidance is not feasible, incorporating engineering and management controls to reduce or minimize the possibility and magnitude of undesired consequences, for example, with the application of pollution controls to reduce the levels of emitted contaminants to workers or environments.
- Preparing workers and nearby communities to respond to accidents, including providing technical and financial resources to effectively and safely control such events, and restoring workplace and community environments to a safe and healthy condition.
- Improving EHS performance through a combination of ongoing monitoring of facility performance and effective accountability.

[3] Defined as "threats to humans and what they value" (Kates, et al., 1985).

[4] Defined as "quantitative measures of hazard consequences, usually expressed as conditional probabilities of experiencing harm" (Kates, et. al., 1985)

1.0 Environmental

1.1 Air Emissions and Ambient Air Quality

Applicability and Approach

This guideline applies to facilities or projects that generate emissions to air at any stage of the project life-cycle. It complements the industry-specific emissions guidance presented in the Industry Sector Environmental, Health, and Safety (EHS) Guidelines by providing information about common techniques for emissions management that may be applied to a range of industry sectors. This guideline provides an approach to the management of significant sources of emissions, including specific guidance for assessment and monitoring of impacts. It is also intended to provide additional information on approaches to emissions management in projects located in areas of poor air quality, where it may be necessary to establish project-specific emissions standards.

Emissions of air pollutants can occur from a wide variety of activities during the construction, operation, and decommissioning phases of a project. These activities can be categorized based on the spatial characteristic of the source including point sources, fugitive sources, and mobile sources and, further, by process, such as combustion, materials storage, or other industry sector-specific processes.

Where possible, facilities and projects should avoid, minimize, and control adverse impacts to human health, safety, and the environment from emissions to air. Where this is not possible, the generation and release of emissions of any type should be managed through a combination of:

- Energy use efficiency
- Process modification
- Selection of fuels or other materials, the processing of which may result in less polluting emissions
- Application of emissions control techniques

The selected prevention and control techniques may include one or more methods of treatment depending on:

- Regulatory requirements
- Significance of the source
- Location of the emitting facility relative to other sources
- Location of sensitive receptors
- Existing ambient air quality, and potential for degradation of the airshed from a proposed project
- Technical feasibility and cost effectiveness of the available options for prevention, control, and release of emissions

Ambient Air Quality

General Approach

Projects with significant[5,6] sources of air emissions, and potential for significant impacts to ambient air quality, should prevent or minimize impacts by ensuring that:

- Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards[9] by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines[10] (see Table 1.1.1), or other internationally recognized sources[11];
- Emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, this Guideline suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed.[12]

At facility level, impacts should be estimated through qualitative or quantitative assessments by the use of baseline air quality assessments and atmospheric dispersion models to assess potential ground level concentrations. Local atmospheric, climatic, and air quality data should be applied when modeling dispersion, protection against atmospheric downwash, wakes, or eddy effects of the source, nearby[13] structures, and terrain features. The dispersion model applied should be internationally recognized, or comparable. Examples of acceptable emission estimation and dispersion modeling approaches for point and fugitive sources are

Table 1.1.1: WHO Ambient Air Quality Guidelines[7],[8]

	Averaging Period	Guideline value in µg/m³
Sulfur dioxide (SO_2)	24-hour 10 minute	125 (Interim target-1) 50 (Interim target-2) 20 (guideline) 500 (guideline)
Nitrogen dioxide (NO_2)	1-year 1-hour	40 (guideline) 200 (guideline)
Particulate Matter PM_{10}	1-year 24-hour	70 (Interim target-1) 50 (Interim target-2) 30 (Interim target-3) 20 (guideline) 150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (guideline)
Particulate Matter $PM_{2.5}$	1-year 24-hour	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline) 75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 25 (guideline)
Ozone	8-hour daily maximum	160 (Interim target-1) 100 (guideline)

[5] Significant sources of point and fugitive emissions are considered to be general sources which, for example, can contribute a net emissions increase of one or more of the following pollutants within a given airshed: PM10: 50 tons per year (tpy); NOx: 500 tpy; SO2: 500 tpy; or as established through national legislation; and combustion sources with an equivalent heat input of 50 MWth or greater. The significance of emissions of inorganic and organic pollutants should be established on a project-specific basis taking into account toxic and other properties of the pollutant.

[6] United States Environmental Protection Agency, Prevention of Significant Deterioration of Air Quality, 40 CFR Ch. 1 Part 52.21. Other references for establishing significant emissions include the European Commission. 2000. "Guidance Document for EPER implementation." http://ec.europa.eu/environment/ippc/eper/index.htm ; and Australian Government. 2004. "National Pollutant Inventory Guide." http://www.npi.gov.au/handbooks/pubs/npiguide.pdf

[7] World Health Organization (WHO). Air Quality Guidelines Global Update, 2005. PM 24-hour value is the 99th percentile.

[8] Interim targets are provided in recognition of the need for a staged approach to achieving the recommended guidelines.

[9] Ambient air quality standards are ambient air quality levels established and published through national legislative and regulatory processes, and ambient quality guidelines refer to ambient quality levels primarily developed through clinical, toxicological, and epidemiological evidence (such as those published by the World Health Organization).

[10] Available at World Health Organization (WHO). http://www.who.int/en

[11] For example the United States National Ambient Air Quality Standards (NAAQS) (http://www.epa.gov/air/criteria.html) and the relevant European Council Directives (Council Directive 1999/30/EC of 22 April 1999 / Council Directive 2002/3/EC of February 12 2002).

[12] US EPA Prevention of Significant Deterioration Increments Limits applicable to non-degraded airsheds.

included in Annex 1.1.1. These approaches include screening models for single source evaluations (SCREEN3 or AIRSCREEN), as well as more complex and refined models (AERMOD OR ADMS). Model selection is dependent on the complexity and geo-morphology of the project site (e.g. mountainous terrain, urban or rural area).

Projects Located in Degraded Airsheds or Ecologically Sensitive Areas

Facilities or projects located within poor quality airsheds[14], and within or next to areas established as ecologically sensitive (e.g. national parks), should ensure that any increase in pollution levels is as small as feasible, and amounts to a fraction of the applicable short-term and annual average air quality guidelines or standards as established in the project-specific environmental assessment. Suitable mitigation measures may also include the relocation of significant sources of emissions outside the airshed in question, use of cleaner fuels or technologies, application of comprehensive pollution control measures, offset activities at installations controlled by the project sponsor or other facilities within the same airshed, and buy-down of emissions within the same airshed.

Specific provisions for minimizing emissions and their impacts in poor air quality or ecologically sensitive airsheds should be established on a project-by-project or industry-specific basis. Offset provisions outside the immediate control of the project sponsor or buy-downs should be monitored and enforced by the local agency responsible for granting and monitoring emission permits. Such provisions should be in place prior to final commissioning of the facility / project.

Point Sources

Point sources are discrete, stationary, identifiable sources of emissions that release pollutants to the atmosphere. They are typically located in manufacturing or production plants. Within a given point source, there may be several individual 'emission points' that comprise the point source.[15]

Point sources are characterized by the release of air pollutants typically associated with the combustion of fossil fuels, such as nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), and particulate matter (PM), as well as other air pollutants including certain volatile organic compounds (VOCs) and metals that may also be associated with a wide range of industrial activities.

Emissions from point sources should be avoided and controlled according to good international industry practice (GIIP) applicable to the relevant industry sector, depending on ambient conditions, through the combined application of process modifications and emissions controls, examples of which are provided in Annex 1.1.2. Additional recommendations regarding stack height and emissions from small combustion facilities are provided below.

Stack Height

The stack height for all point sources of emissions, whether 'significant' or not, should be designed according to GIIP (see Annex 1.1.3) to avoid excessive ground level concentrations due to downwash, wakes, and eddy effects, and to ensure reasonable diffusion to minimize impacts. For projects where there are multiple sources of emissions, stack heights should be established with due consideration to emissions from all other project sources, both point and fugitive. Non-significant sources of emissions,

[13] "Nearby" generally considers an area within a radius of up to 20 times the stack height.

[14] An airshed should be considered as having poor air quality if nationally legislated air quality standards or WHO Air Quality Guidelines are exceeded significantly.

[15] Emission points refer to a specific stack, vent, or other discrete point of pollution release. This term should not be confused with point source, which is a regulatory distinction from area and mobile sources. The characterization of point sources into multiple emissions points is useful for allowing more detailed reporting of emissions information.

including small combustion sources,[16] should also use GIIP in stack design.

Small Combustion Facilities Emissions Guidelines

Small combustion processes are systems designed to deliver electrical or mechanical power, steam, heat, or any combination of these, regardless of the fuel type, with a total, rated heat input capacity of between three Megawatt thermal (MWth) and 50 MWth.

The emissions guidelines in Table 1.1.2 are applicable to small combustion process installations operating more than 500 hours per year, and those with an annual capacity utilization of more than 30 percent. Plants firing a mixture of fuels should compare emissions performance with these guidelines based on the sum of the relative contribution of each applied fuel[17]. Lower emission values may apply if the proposed facility is located in an ecologically sensitive airshed, or airshed with poor air quality, in order to address potential cumulative impacts from the installation of more than one small combustion plant as part of a distributed generation project.

[16] Small combustion sources are those with a total rated heat input capacity of 50MWth or less.

[17] The contribution of a fuel is the percentage of heat input (LHV) provided by this fuel multiplied by its limit value.

Table 1.1.2 - Small Combustion Facilities Emissions Guidelines (3MWth – 50MWth) – (in mg/Nm^3 or as indicated)				
Combustion Technology / Fuel	**Particulate Matter (PM)**	**Sulfur Dioxide (SO_2)**	**Nitrogen Oxides (NOx)**	**Dry Gas, Excess O_2 Content (%)**
Engine				
Gas	N/A	N/A	200 (Spark Ignition) 400 (Dual Fuel) 1,600 (Compression Ignition)	15
Liquid	50 or up to 100 if justified by project specific considerations (e.g. Economic feasibility of using lower ash content fuel, or adding secondary treatment to meet 50, and available environmental capacity of the site)	1.5 percent Sulfur or up to 3.0 percent Sulfur if justified by project specific considerations (e.g. Economic feasibility of using lower S content fuel, or adding secondary treatment to meet levels of using 1.5 percent Sulfur, and available environmental capacity of the site)	If bore size diameter [mm] < 400: 1460 (or up to 1,600 if justified to maintain high energy efficiency.) If bore size diameter [mm] > or = 400: 1,850	15
Turbine				
Natural Gas =3MWth to < 15MWth	N/A	N/A	42 ppm (Electric generation) 100 ppm (Mechanical drive)	15
Natural Gas =15MWth to < 50MWth	N/A	N/A	25 ppm	15
Fuels other than Natural Gas =3MWth to < 15MWth	N/A	0.5 percent Sulfur or lower percent Sulfur (e.g. 0.2 percent Sulfur) if commercially available without significant excess fuel cost	96 ppm (Electric generation) 150 ppm (Mechanical drive)	15
Fuels other than Natural Gas =15MWth to < 50MWth	N/A	0.5% S or lower % S (0.2%S) if commercially available without significant excess fuel cost	74 ppm	15
Boiler				
Gas	N/A	N/A	320	3
Liquid	50 or up to 150 if justified by environmental assessment	2000	460	3
Solid	50 or up to 150 if justified by environmental assessment	2000	650	6

Notes: -N/A/ - no emissions guideline; Higher performance levels than these in the Table should be applicable to facilities located in urban / industrial areas with degraded airsheds or close to ecologically sensitive areas where more stringent emissions controls may be needed.; MWth is heat input on HHV basis; Solid fuels include biomass; Nm^3 is at one atmosphere pressure, 0°C.; MWth category is to apply to the entire facility consisting of multiple units that are reasonably considered to be emitted from a common stack except for NOx and PM limits for turbines and boilers. Guidelines values apply to facilities operating more than 500 hours per year with an annual capacity utilization factor of more than 30 percent.

Fugitive Sources

Fugitive source air emissions refer to emissions that are distributed spatially over a wide area and not confined to a specific discharge point. They originate in operations where exhausts are not captured and passed through a stack. Fugitive emissions have the potential for much greater ground-level impacts per unit than stationary source emissions, since they are discharged and dispersed close to the ground. The two main types of fugitive emissions are Volatile Organic Compounds (VOCs) and particulate matter (PM). Other contaminants (NO_x, SO_2 and CO) are mainly associated with combustion processes, as described above. Projects with potentially significant fugitive sources of emissions should establish the need for ambient quality assessment and monitoring practices.

Open burning of solid wastes, whether hazardous or non-hazardous, is not considered good practice and should be avoided, as the generation of polluting emissions from this type of source cannot be controlled effectively.

Volatile Organic Compounds (VOCs)

The most common sources of fugitive VOC emissions are associated with industrial activities that produce, store, and use VOC-containing liquids or gases where the material is under pressure, exposed to a lower vapor pressure, or displaced from an enclosed space. Typical sources include equipment leaks, open vats and mixing tanks, storage tanks, unit operations in wastewater treatment systems, and accidental releases. Equipment leaks include valves, fittings, and elbows which are subject to leaks under pressure. The recommended prevention and control techniques for VOC emissions associated with equipment leaks include:

- Equipment modifications, examples of which are presented in Annex 1.1.4;
- Implementing a leak detection and repair (LDAR) program that controls fugitive emissions by regularly monitoring to detect leaks, and implementing repairs within a predefined time period.[18]

For VOC emissions associated with handling of chemicals in open vats and mixing processes, the recommended prevention and control techniques include:

- Substitution of less volatile substances, such as aqueous solvents;
- Collection of vapors through air extractors and subsequent treatment of gas stream by removing VOCs with control devices such as condensers or activated carbon absorption;
- Collection of vapors through air extractors and subsequent treatment with destructive control devices such as:
  - Catalytic Incinerators: Used to reduce VOCs from process exhaust gases exiting paint spray booths, ovens, and other process operations
  - Thermal Incinerators: Used to control VOC levels in a gas stream by passing the stream through a combustion chamber where the VOCs are burned in air at temperatures between 700º C to 1,300º C
  - Enclosed Oxidizing Flares: Used to convert VOCs into CO_2 and H_2O by way of direct combustion
- Use of floating roofs on storage tanks to reduce the opportunity for volatilization by eliminating the headspace present in conventional storage tanks.

Particulate Matter (PM)

The most common pollutant involved in fugitive emissions is dust or particulate matter (PM). This is released during certain operations, such as transport and open storage of solid materials, and from exposed soil surfaces, including unpaved roads.

[18] For more information, see Leak Detection and Repair Program (LDAR), at: http://www.ldar.net

Recommended prevention and control of these emissions sources include:

- Use of dust control methods, such as covers, water suppression, or increased moisture content for open materials storage piles, or controls, including air extraction and treatment through a baghouse or cyclone for material handling sources, such as conveyors and bins;
- Use of water suppression for control of loose materials on paved or unpaved road surfaces. Oil and oil by-products is not a recommended method to control road dust. Examples of additional control options for unpaved roads include those summarized in Annex 1.1.5.

Ozone Depleting Substances (ODS)

Several chemicals are classified as ozone depleting substances (ODSs) and are scheduled for phase-out under the Montreal Protocol on Substances that Deplete the Ozone Layer.[19] No new systems or processes should be installed using CFCs, halons, 1,1,1-trichloroethane, carbon tetrachloride, methyl bromide or HBFCs. HCFCs should only be considered as interim / bridging alternatives as determined by the host country commitments and regulations.[20]

Mobile Sources – Land-based

Similar to other combustion processes, emissions from vehicles include CO, NO_x, SO_2, PM and VOCs. Emissions from on-road and off-road vehicles should comply with national or regional programs. In the absence of these, the following approach should be considered:

- Regardless of the size or type of vehicle, fleet owners / operators should implement the manufacturer recommended engine maintenance programs;
- Drivers should be instructed on the benefits of driving practices that reduce both the risk of accidents and fuel consumption, including measured acceleration and driving within safe speed limits;
- Operators with fleets of 120 or more units of heavy duty vehicles (buses and trucks), or 540 or more light duty vehicles[21] (cars and light trucks) within an airshed should consider additional ways to reduce potential impacts including:
  - Replacing older vehicles with newer, more fuel efficient alternatives
  - Converting high-use vehicles to cleaner fuels, where feasible
  - Installing and maintaining emissions control devices, such as catalytic converters
  - Implementing a regular vehicle maintenance and repair program

Greenhouse Gases (GHGs)

Sectors that may have potentially significant emissions of greenhouse gases (GHGs)[22] include energy, transport, heavy industry (e.g. cement production, iron / steel manufacturing, aluminum smelting, petrochemical industries, petroleum refining, fertilizer manufacturing), agriculture, forestry and waste management. GHGs may be generated from direct emissions

[19] Examples include: chlorofluorocarbons (CFCs); halons; 1,1,1-trichloroethane (methyl chloroform); carbon tetrachloride; hydrochlorofluorocarbons (HCFCs); hydrobromofluorocarbons (HBFCs); and methyl bromide. They are currently used in a variety of applications including: domestic, commercial, and process refrigeration (CFCs and HCFCs); domestic, commercial, and motor vehicle air conditioning (CFCs and HCFCs); for manufacturing foam products (CFCs); for solvent cleaning applications (CFCs, HCFCs, methyl chloroform, and carbon tetrachloride); as aerosol propellants (CFCs); in fire protection systems (halons and HBFCs); and as crop fumigants (methyl bromide).

[20] Additional information is available through the Montreal Protocol Secretariat web site available at: http://ozone.unep.org/

[21] The selected fleet size thresholds are assumed to represent potentially significant sources of emissions based on individual vehicles traveling 100,000 km / yr using average emission factors.

[22] The six greenhouse gases that form part of the Kyoto Protocol to the United Nations Framework Convention on Climate Change include carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulfur hexafluoride (SF_6).

from facilities within the physical project boundary and indirect emissions associated with the off-site production of power used by the project.

Recommendations for reduction and control of greenhouse gases include:

- Carbon financing;[23]
- Enhancement of energy efficiency (see section on 'Energy Conservation');
- Protection and enhancement of sinks and reservoirs of greenhouse gases;
- Promotion of sustainable forms of agriculture and forestry;
- Promotion, development and increased use of renewable forms of energy;
- Carbon capture and storage technologies;[24]
- Limitation and / or reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy (coal, oil, and gas).

Monitoring

Emissions and air quality monitoring programs provide information that can be used to assess the effectiveness of emissions management strategies. A systematic planning process is recommended to ensure that the data collected are adequate for their intended purposes (and to avoid collecting unnecessary data). This process, sometimes referred to as a data quality objectives process, defines the purpose of collecting the data, the decisions to be made based on the data and the consequences of making an incorrect decision, the time and geographic boundaries, and the quality of data needed to make a correct decision.[25] The air quality monitoring program should consider the following elements:

- *Monitoring parameters*: The monitoring parameters selected should reflect the pollutants of concern associated with project processes. For combustion processes, indicator parameters typically include the quality of inputs, such as the sulfur content of fuel.
- *Baseline calculations*: Before a project is developed, baseline air quality monitoring at and in the vicinity of the site should be undertaken to assess background levels of key pollutants, in order to differentiate between existing ambient conditions and project-related impacts.
- *Monitoring type and frequency*: Data on emissions and ambient air quality generated through the monitoring program should be representative of the emissions discharged by the project over time. Examples of time-dependent variations in the manufacturing process include batch process manufacturing and seasonal process variations. Emissions from highly variable processes may need to be sampled more frequently or through composite methods. Emissions monitoring frequency and duration may also range from continuous for some combustion process operating parameters or inputs (e.g. the quality of fuel) to less frequent, monthly, quarterly or yearly stack tests.
- *Monitoring locations*: Ambient air quality monitoring may consists of off-site or fence line monitoring either by the project sponsor, the competent government agency, or by collaboration between both. The location of ambient air

[23] Carbon financing as a carbon emissions reduction strategy may include the host government-endorsed Clean Development Mechanism or Joint Implementation of the United Nations Framework Convention on Climate Change.

[24] Carbon dioxide capture and storage (CCS) is a process consisting of the separation of CO_2 from industrial and energy-related sources; transport to a storage location; and long-term isolation from the atmosphere, for example in geological formations, in the ocean, or in mineral carbonates (reaction of CO_2 with metal oxides in silicate minerals to produce stable carbonates). It is the object of intensive research worldwide (Intergovernmental Panel on Climate Change (IPCC), Special Report, Carbon Dioxide Capture and Storage (2006).

[25] See, for example, United States Environmental Protection Agency, Guidance on Systematic Planning Using the Data Quality Objectives Process EPA QA/G-4, EPA/240/B-06/001 February 2006.

quality monitoring stations should be established based on the results of scientific methods and mathematical models to estimate potential impact to the receiving airshed from an emissions source taking into consideration such aspects as the location of potentially affected communities and prevailing wind directions.

- *Sampling and analysis methods*: Monitoring programs should apply national or international methods for sample collection and analysis, such as those published by the International Organization for Standardization,[26] the European Committee for Standardization,[27] or the U.S. Environmental Protection Agency.[28] Sampling should be conducted by, or under, the supervision of trained individuals. Analysis should be conducted by entities permitted or certified for this purpose. Sampling and analysis Quality Assurance / Quality Control (QA/QC) plans should be applied and documented to ensure that data quality is adequate for the intended data use (e.g., method detection limits are below levels of concern). Monitoring reports should include QA/QC documentation.

Monitoring of Small Combustion Plants Emissions

- Additional recommended monitoring approaches for **boilers**:

  Boilers with capacities between =3 MWth and < 20 MWth:

  - Annual Stack Emission Testing: SO_2, NO_x and PM. For gaseous fuel-fired boilers, only NO_x. SO_2 can be calculated based on fuel quality certification if no SO_2 control equipment is used.
  - If Annual Stack Emission Testing demonstrates results consistently and significantly better than the required levels, frequency of Annual Stack Emission Testing can be reduced from annual to every two or three years.
  - Emission Monitoring: None

  Boilers with capacities between =20 MWth and < 50 MWth

  - Annual Stack Emission Testing: SO_2, NO_x and PM. For gaseous fuel-fired boilers, only NO_x. SO_2 can be calculated based on fuel quality certification (if no SO_2 control equipment is used)
  - Emission Monitoring: SO_2. Plants with SO_2 control equipment: Continuous. NO_x: Continuous monitoring of either NO_x emissions or indicative NO_x emissions using combustion parameters. PM: Continuous monitoring of either PM emissions, opacity, or indicative PM emissions using combustion parameters / visual monitoring.

- Additional recommended monitoring approaches for **turbines**:
  - Annual Stack Emission Testing: NO_x and SO_2 (NO_x only for gaseous fuel-fired turbines).
  - If Annual Stack Emission Testing results show constantly (3 consecutive years) and significantly (e.g. less than 75 percent) better than the required levels, frequency of Annual Stack Emission Testing can be reduced from annual to every two or three years.
  - Emission Monitoring: NO_x: Continuous monitoring of either NO_x emissions or indicative NO_x emissions using combustion parameters.SO_2: Continuous monitoring if SO_2 control equipment is used.

- Additional recommended monitoring approaches for **engines**:
  - Annual Stack Emission Testing: NO_x ,SO_2 and PM (NO_x only for gaseous fuel-fired diesel engines).

[26] An on-line catalogue of ISO standards relating to the environment, health protection, and safety is available at: http://www.iso.org/iso/en/CatalogueListPage.CatalogueList?ICS1=13&ICS2=&ICS3=&scopelist=

[27] An on-line catalogue of European Standards is available at: http://www.cen.eu/catweb/cwen.htm .

[28] The National Environmental Methods Index provides a searchable clearinghouse of U.S. methods and procedures for both regulatory and non-regulatory monitoring purposes for water, sediment, air and tissues, and is available at http://www.nemi.gov/.

- If Annual Stack Emission Testing results show constantly (3 consecutive years) and significantly (e.g. less than 75 percent) better than the required levels, frequency of Annual Stack Emission Testing can be reduced from annual to every two or three years.
- Emission Monitoring: NO_x: Continuous monitoring of either NO_x emissions or indicative NO_x emissions using combustion parameters. SO_2: Continuous monitoring if SO_2 control equipment is used. PM: Continuous monitoring of either PM emissions or indicative PM emissions using operating parameters.

Annex 1.1.1 – Air Emissions Estimation and Dispersion Modeling Methods

The following is a partial list of documents to aid in the estimation of air emissions from various processes and air dispersion models:

Australian Emission Estimation Technique Manuals
http://www.npi.gov.au/handbooks/

Atmospheric Emission Inventory Guidebook, UN / ECE / EMEP and the European Environment Agency
http://www.aeat.co.uk/netcen/airqual/TFEI/unece.htm

Emission factors and emission estimation methods, US EPA Office of Air Quality Planning & Standards
http://www.epa.gov/ttn/chief

Guidelines on Air Quality Models (Revised), US Environmental Protection Agency (EPA), 2005
http://www.epa.gov/scram001/guidance/guide/appw_05.pdf

Frequently Asked Questions, Air Quality Modeling and Assessment Unit (AQMAU), UK Environment Agency
http://www.environment-agency.gov.uk/subjects/airquality/236092/?version=1&lang=_e

OECD Database on Use and Release of Industrial Chemicals
http://www.olis.oecd.org/ehs/urchem.nsf/

Annex 1.1.2 – Illustrative Point Source Air Emissions Prevention and Control Technologies

Principal Sources and Issues	General Prevention / Process Modification Approach	Control Options	Reduction Efficiency (%)	Gas Condition	Comments
Particulate Matter (PM)					
Main sources are the combustion of fossil fuels and numerous manufacturing processes that collect PM through air extraction and ventilation systems. Volcanoes, ocean spray, forest fires and blowing dust (most prevalent in dry and semiarid climates) contribute to background levels.	Fuel switching (e.g. selection of lower sulfur fuels) or reducing the amount of fine particulates added to a process.	Fabric Filters	99 - 99.7%	Dry gas, temp <400F	Applicability depends on flue gas properties including temperature, chemical properties, abrasion and load. Typical air to cloth ratio range of 2.0 to 3.5 cfm/ft^2 Achievable outlet concentrations of 23 mg/Nm^3
		Electrostatic Precipitator (ESP)	97 – 99%	Varies depending of particle type	Precondition gas to remove large particles. Efficiency dependent on resistivity of particle. Achievable outlet concentration of 23 mg/Nm^3
		Cyclone	74 – 95%	None	Most efficient for large particles. Achievable outlet concentrations of 30 - 40 mg/Nm^3
		Wet Scrubber	93 – 95%	None	Wet sludge may be a disposal problem depending on local infrastructure. Achievable outlet concentrations of 30 - 40 mg/Nm3
Sulfur Dioxide (SO_2)					
Mainly produced by the combustion of fuels such as oil and coal and as a by-product from some chemical production or wastewater treatment processes.	Control system selection is heavily dependent on the inlet concentration. For SO2 concentrations in excess of 10%, the stream is passed through an acid plant not only to lower the SO2 emissions but also to generate high grade sulfur for sale. Levels below 10% are not rich enough for this process and should therefore utilize absorption or 'scrubbing,' where SO2 molecules are captured into a liquid phase or adsorption, where SO2 molecules are captured on the surface of a solid adsorbent.	Fuel Switching	>90%		Alternate fuels may include low sulfur coal, light diesel or natural gas with consequent reduction in particulate emissions related to sulfur in the fuel. Fuel cleaning or beneficiation of fuels prior to combustion is another viable option but may have economic consequences.
		Sorbent Injection	30% - 70%		Calcium or lime is injected into the flue gas and the SO_2 is adsorbed onto the sorbent
		Dry Flue Gas Desulfurization	70%-90%		Can be regenerable or throwaway.
		Wet Flue Gas Desulfurization	>90%		Produces gypsum as a by-product

Annex 1.1.2: Illustrative Point Source Air Emissions Prevention and Control Technologies (continued)

Oxides of Nitrogen (NOx)		Percent Reduction by Fuel Type			Comments
Associated with combustion of fuel. May occur in several forms of nitrogen oxide; namely nitric oxide (NO), nitrogen dioxide (NO_2) and nitrous oxide (N_2O), which is also a greenhouse gas. The term NOx serves as a composite between NO and NO_2 and emissions are usually reported as NOx. Here the NO is multiplied by the ratio of molecular weights of NO_2 to NO and added to the NO_2 emissions. Means of reducing NOx emissions are based on the modification of operating conditions such as minimizing the resident time at peak temperatures, reducing the peak temperatures by increasing heat transfer rates or minimizing the availability of oxygen.	**Combustion modification** (Illustrative of boilers)	**Coal**	**Oil**	**Gas**	These modifications are capable of reducing NOx emissions by 50 to 95%. The method of combustion control used depends on the type of boiler and the method of firing fuel.
	Low-excess-air firing	10–30	10–30	10–30	
	Staged Combustion	20–50	20–50	20–50	
	Flue Gas Recirculation	N/A	20–50	20–50	
	Water/Steam Injection	N/A	10–50	N/A.	
	Low-NOx Burners	30–40	30–40	30–40	
	Flue Gas Treatment	**Coal**	**Oil**	**Gas**	Flue gas treatment is more effective in reducing NOx emissions than are combustion controls. Techniques can be classified as SCR, SNCR, and adsorption. SCR involves the injection of ammonia as a reducing agent to convert NOx to nitrogen in the presence of a catalyst in a converter upstream of the air heater. Generally, some ammonia slips through and is part of the emissions. SNCR also involves the injection of ammonia or urea based products without the presence of a catalyst.
	Selective Catalytic Reduction (SCR)	60–90	60–90	60–90	
	Selective Non-Catalytic Reduction (SNCR)	N/A	30–70	30–70	

Note: Compiled by IFC based on inputs from technical experts.

Annex 1.1.3 - Good International Industry Practice (GIIP) Stack Height

(Based on United States 40 CFR, part 51.100 (ii)).

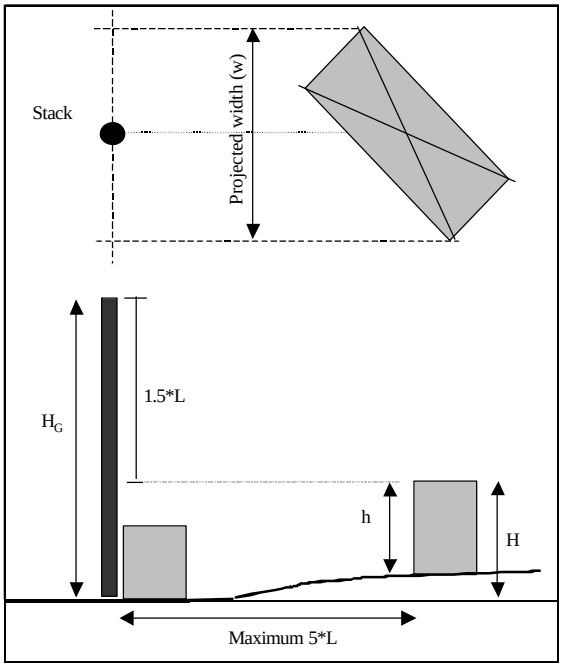
$H_G = H + 1.5L$; where

H_G = GEP stack height measured from the ground level elevation at the base of the stack

H = Height of nearby structure(s) above the base of the stack.

L = Lesser dimension, height (h) or width (w), of nearby structures

"Nearby structures" = Structures within/touching a radius of 5L but less than 800 m.



Annex 1.1.4 - Examples of VOC Emissions Controls

Equipment Type	Modification	Approximate Control Efficiency (%)
Pumps	Seal-less design	100[29]
	Closed-vent system	90[30]
	Dual mechanical seal with barrier fluid maintained at a higher pressure than the pumped fluid	100
Compressors	Closed-vent system	90
	Dual mechanical seal with barrier fluid maintained at a higher pressure than the compressed gas	100
Pressure Relief Devices	Closed-vent system	Variable[31]
	Rupture disk assembly	100
Valves	Seal-less design	100
Connectors	Weld together	100
Open-ended Lines	Blind, cap, plug, or second valve	100
Sampling Connections	Closed-loop sampling	100
Note: Examples of technologies are provided for illustrative purposes. The availability and applicability of any particular technology will vary depending on manufacturer specifications.		

29 Seal-less equipment can be a large source of emissions in the event of equipment failure.
30 Actual efficiency of a closed-vent system depends on percentage of vapors collected and efficiency of control device to which the vapors are routed.
31 Control efficiency of closed vent-systems installed on a pressure relief device may be lower than other closed-vent systems.

Annex 1.1.5 - Fugitive PM Emissions Controls

Control Type	Control Efficiency
Chemical Stabilization	0% - 98%
Hygroscopic salts Bitumens/adhesives	60% - 96%
Surfactants	0% - 68%
Wet Suppression – Watering	12% - 98%
Speed Reduction	0% - 80%
Traffic Reduction	Not quantified
Paving (Asphalt / Concrete)	85% - 99%
Covering with Gravel, Slag, or "Road Carpet"	30% - 50%
Vacuum Sweeping	0% - 58%
Water Flushing/Broom Sweeping	0% - 96%

1.2 Energy Conservation

Applicability and Approach

This guideline applies to facilities or projects that consume energy in process heating and cooling; process and auxiliary systems, such as motors, pumps, and fans; compressed air systems and heating, ventilation and air conditioning systems (HVAC); and lighting systems. It complements the industry-specific emissions guidance presented in the Industry Sector Environmental, Health, and Safety (EHS) Guidelines by providing information about common techniques for energy conservation that may be applied to a range of industry sectors.

Energy management at the facility level should be viewed in the context of overall consumption patterns, including those associated with production processes and supporting utilities, as well as overall impacts associated with emissions from power sources. The following section provides guidance on energy management with a focus on common utility systems often representing technical and financially feasible opportunities for improvement in energy conservation. However, operations should also evaluate energy conservation opportunities arising from manufacturing process modifications.

Energy Management Programs

Energy management programs should include the following elements:

- Identification, and regular measurement and reporting of principal energy flows within a facility at unit process level
- Preparation of mass and energy balance;
- Definition and regular review of energy performance targets, which are adjusted to account for changes in major influencing factors on energy use
- Regular comparison and monitoring of energy flows with performance targets to identify where action should be taken to reduce energy use
- Regular review of targets, which may include comparison with benchmark data, to confirm that targets are set at appropriate levels

Energy Efficiency

For any energy-using system, a systematic analysis of energy efficiency improvements and cost reduction opportunities should include a hierarchical examination of opportunities to**:**

- Demand/Load Side Management by reducing loads on the energy system
- Supply Side Management by:
  - Reduce losses in energy distribution
  - Improve energy conversion efficiency
  - Exploit energy purchasing opportunities
  - Use lower-carbon fuels

Common opportunities in each of these areas are summarized below.[32]

Process Heating

Process heating is vital to many manufacturing processes, including heating for fluids, calcining, drying, heat treating, metal heating, melting, melting agglomeration, curing, and forming[33].

In process heating systems, a system heat and mass balance will show how much of the system's energy input provides true process heating, and quantify fuel used to satisfy energy losses caused by excessive parasitic loads, distribution, or conversion losses. Examination of savings opportunities should be directed by the results of the heat and mass balance, though the following techniques are often valuable and cost-effective.

Heating Load Reduction

- Ensure adequate insulation to reduce heat losses through furnace/oven etc. structure
- Recover heat from hot process or exhaust streams to reduce system loads
- In intermittently-heated systems, consider use of low thermal mass insulation to reduce energy required to heat the system structure to operating temperature
- Control process temperature and other parameters accurately to avoid, for example, overheating or overdrying
- Examine opportunities to use low weight and/or low thermal mass product carriers, such as heated shapers, kiln cars etc.
- Review opportunities to schedule work flow to limit the need for process reheating between stages
- Operate furnaces/ovens at slight positive pressure, and maintain air seals to reduce air in-leakage into the heated system, thereby reducing the energy required to heat unnecessary air to system operating temperature
- Reduce radiant heat losses by sealing structural openings and keep viewing ports closed when not in use
- Where possible, use the system for long runs close to or at operating capacity
- Consider use of high emissivity coatings of high temperature insulation, and consequent reduction in process temperature
- Near net weight and shape heat designs
- Robust Quality assurance on input material
- Robust Scheduled maintenance programs

Heat Distribution Systems

Heat distribution in process heating applications typically takes place through steam, hot water, or thermal fluid systems. Losses can be reduced through the following actions:

- Promptly repair distribution system leaks
- Avoid steam leaks despite a perceived need to get steam through the turbine. Electricity purchase is usually cheaper overall, especially when the cost to treat turbine-quality boiler feed water is included. If the heat-power ratio of the distribution process is less than that of power systems, opportunities should be considered to increase the ratio; for example, by using low-pressure steam to drive absorption cooling systems rather than using electrically-driven vapor-compression systems.
- Regularly verify correct operation of steam traps in steam systems, and ensure that traps are not bypassed. Since

[32] Additional guidance on energy efficiency is available from sources such as Natural Resources Canada (NRCAN http://oee.nrcan.gc.ca/commercial/financial-assistance/new-buildings/mnecb.cfm?attr=20); the European Union (EUROPA. http://europa.eu.int/scadplus/leg/en/s15004.htm), and United States Department of Energy (US DOE, http://www.eere.energy.gov/consumer/industry/process.html).

[33] US DOE. http://www.eere.energy.gov/consumer/industry/process.html

steam traps typically last approximately 5 years, 20% should be replaced or repaired annually

- Insulate distribution system vessels, such as hot wells and de-aerators, in steam systems and thermal fluid or hot water storage tanks
- Insulate all steam, condensate, hot water and thermal fluid distribution pipework, down to and including 1" (25 mm) diameter pipe, in addition to insulating all hot valves and flanges
- In steam systems, return condensate to the boiler house for re-use, since condensate is expensive boiler-quality water and valuable beyond its heat content alone
- Use flash steam recovery systems to reduce losses due to evaporation of high-pressure condensate
- Consider steam expansion through a back-pressure turbine rather than reducing valve stations
- Eliminate distribution system losses by adopting point-of-use heating systems

Energy Conversion System Efficiency Improvements

The following efficiency opportunities should be examined for process furnaces or ovens, and utility systems, such as boilers and fluid heaters:

- Regularly monitor CO, oxygen or CO2 content of flue gases to verify that combustion systems are using the minimum practical excess air volumes
- Consider combustion automation using oxygen-trim controls
- Minimize the number of boilers or heaters used to meet loads. It is typically more efficient to run one boiler at 90% of capacity than two at 45%. Minimize the number of boilers kept at hot–standby
- Use flue dampers to eliminate ventilation losses from hot boilers held at standby
- Maintain clean heat transfer surfaces; in steam boilers, flue gases should be no more than 20 K above steam temperature)
- In steam boiler systems, use economizers to recover heat from flue gases to pre-heat boiler feed water or combustion air
- Consider reverse osmosis or electrodialysis feed water treatment to minimize the requirement for boiler blowdown
- Adopt automatic (continuous) boiler blowdown
- Recover heat from blowdown systems through flash steam recovery or feed-water preheat
- Do not supply excessive quantities of steam to the de-aerator
- With fired heaters, consider opportunities to recover heat to combustion air through the use of recuperative or regenerative burner systems
- For systems operating for extended periods (> 6000 hours/year), cogeneration of electrical power, heat and /or cooling can be cost effective
- Oxy Fuel burners
- Oxygen enrichment/injection
- Use of turbolators in boilers
- Sizing design and use of multiple boilers for different load configurations
- Fuel quality control/fuel blending

Process Cooling

The general methodology outlined above should be applied to process cooling systems. Commonly used and cost-effective measures to improve process cooling efficiency are described below.

Load Reduction

- Ensure adequate insulation to reduce heat gains through cooling system structure and to below-ambient temperature refrigerant pipes and vessels
- Control process temperature accurately to avoid overcooling
- Operate cooling tunnels at slight positive pressure and maintain air seals to reduce air in-leakage into the cooled system, thus reducing the energy required to cool this unnecessary air to system operating temperature
- Examine opportunities to pre-cool using heat recovery to a process stream requiring heating, or by using a higher temperature cooling utility
- In cold and chill stores, minimize heat gains to the cooled space by use of air curtains, entrance vestibules, or rapidly opening/closing doors. Where conveyors carry products into chilled areas, minimize the area of transfer openings, for example, by using strip curtains
- Quantify and minimize "incidental" cooling loads, for example, those due to evaporator fans, other machinery, defrost systems and lighting in cooled spaces, circulation fans in cooling tunnels, or secondary refrigerant pumps (e.g. chilled water, brines, glycols)
- Do not use refrigeration for auxiliary cooling duties, such as compressor cylinder head or oil cooling
- While not a thermal load, ensure there is no gas bypass of the expansion valve since this imposes compressor load while providing little effective cooling
- In the case of air conditioning applications, energy efficiency techniques include:
  - Placing air intakes and air-conditioning units in cool, shaded locations
  - Improving building insulation including seals, vents, windows, and doors
  - Planting trees as thermal shields around buildings
  - Installing timers and/or thermostats and/or enthalpy-based control systems
  - Installing ventilation heat recovery systems[34]

Energy Conversion

The efficiency of refrigeration service provision is normally discussed in terms of Coefficient of Performance ("COP"), which is the ratio of cooling duty divided by input power. COP is maximized by effective refrigeration system design and increased refrigerant compression efficiency, as well as minimization of the temperature difference through which the system works and of auxiliary loads (i.e. those in addition to compressor power demand) used to operate the refrigeration system.

System Design

- If process temperatures are above ambient for all, or part, of the year, use of ambient cooling systems, such as provided by cooling towers or dry air coolers, may be appropriate, perhaps supplemented by refrigeration in summer conditions.
- Most refrigeration systems are electric-motor driven vapor compression systems using positive displacement or centrifugal compressors. The remainder of this guideline relates primarily to vapor-compression systems. However, when a cheap or free heat source is available (e.g. waste heat from an engine-driven generator—low-pressure steam

[34] More information on HVAC energy efficiency can be found at the British Columbia Building Corporation (Woolliams, 2002. http://www.greenbuildingsbc.com/new_buildings/pdf_files/greenbuild_strategies_guide.pdf), NRCAN's EnerGuide (http://oee.nrcan.gc.ca/equipment/english/index.cfm?PrintView=N&Text=N) and NRCAN's Energy Star Programs (http://oee.nrcan.gc.ca/energystar/english/consumers/heating.cfm?text=N&printview=N#AC), and the US Energy Star Program (http://www.energystar.gov/index.cfm?c=guidelines.download_guidelines).

that has passed through a back-pressure turbine), absorption refrigeration may be appropriate.

- Exploit high cooling temperature range: precooling by ambient and/or 'high temperature' refrigeration before final cooling can reduce refrigeration capital and running costs. High cooling temperature range also provides an opportunity for countercurrent (cascade) cooling, which reduces refrigerant flow needs.
- Keep 'hot' and 'cold' fluids separate, for example, do not mix water leaving the chiller with water returning from cooling circuits.
- In low-temperature systems where high temperature differences are inevitable, consider two-stage or compound compression, or economized screw compressors, rather than single-stage compression.

Minimizing Temperature Differences

A vapor-compression refrigeration system raises the temperature of the refrigerant from somewhat below the lowest process temperature (the evaporating temperature) to provide process cooling, to a higher temperature (the condensing temperature), somewhat above ambient, to facilitate heat rejection to the air or cooling water systems. Increasing evaporating temperature typically increases compressor cooling capacity without greatly affecting power consumption. Reducing condensing temperature increases evaporator cooling capacity and substantially reduces compressor power consumption.

Elevating Evaporating Temperature

- Select a large evaporator to permit relatively low temperature differences between process and evaporating temperatures. Ensure that energy use of auxiliaries (e.g. evaporator fans) does not outweigh compression savings. In air-cooling applications, a design temperature difference of 6-10 K between leaving air temperature and evaporating temperature is indicative of an appropriately sized evaporator. When cooling liquids, 2K between leaving liquid and evaporating temperatures can be achieved, though a 4K difference is generally indicative of a generously-sized evaporator.
- Keep the evaporator clean. When cooling air, ensure correct defrost operation. In liquid cooling, monitor refrigerant/process temperature differences and compare with design expectations to be alert to heat exchanger contamination by scale or oil.
- Ensure oil is regularly removed from the evaporator, and that oil additions and removals balance.
- Avoid the use of back-pressure valves.
- Adjust expansion valves to minimize suction superheat consistent with avoidance of liquid carry-over to compressors.
- Ensure that an appropriate refrigerant charge volume is present.

Reducing Condensing Temperature

- Consider whether to use air-cooled or evaporation-based cooling (e.g. evaporative or water cooled condensers and cooling towers). Air-cooled evaporators usually have higher condensing temperatures, hence higher compressor energy use, and auxiliary power consumption, especially in low humidity climates. If a wet system is used, ensure adequate treatment to prevent growth of *legionella* bacteria.
- Whichever basic system is chosen, select a relatively large condenser to minimize differences between condensing and the heat sink temperatures. Condensing temperatures with air cooled or evaporative condensers should not be more than 10K above design ambient condition, and a 4K approach in a liquid-cooled condenser is possible.

- Avoid accumulation of non-condensable gases in the condenser system. Consider the installation of refrigerated non-condensable purgers, particularly for systems operating below atmospheric pressure.
- Keep condensers clean and free from scale. Monitor refrigerant/ambient temperature differences and compare with design expectations to be alert to heat exchanger contamination.
- Avoid liquid backup, which restricts heat transfer area in condensers. This can be caused by installation errors such as concentric reducers in horizontal liquid refrigerant pipes, or "up and over" liquid lines leading from condensers.
- In multiple condenser applications, refrigerant liquid lines should be connected via drop-leg traps to the main liquid refrigerant line to ensure that hot gases flow to all condensers.
- Avoid head pressure control to the extent possible. Head pressure control maintains condensing temperature at, or near, design levels. It therefore prevents reduction in compressor power consumption, which accompanies reduced condensing temperature, by restricting condenser capacity (usually by switching off the condenser, or cooling tower fans, or restricting cooling water flow) under conditions of less severe than design load or ambient temperature conditions. Head pressure is often kept higher than necessary to facilitate hot gas defrost or adequate liquid refrigerant circulation. Use of electronic rather than thermostatic expansion valves, and liquid refrigerant pumps can permit effective refrigerant circulation at much reduced condensing temperatures.
- Site condensers and cooling towers with adequate spacing so as to prevent recirculation of hot air into the tower.

Refrigerant Compression Efficiency

- Some refrigerant compressors and chillers are more efficient than others offered for the same duty. Before purchase, identify the operating conditions under which the compressor or chiller is likely to operate for substantial parts of its annual cycle. Check operating efficiency under these conditions, and ask for estimates of annual running cost. Note that refrigeration and HVAC systems rarely run for extended periods at design conditions, which are deliberately extreme. Operational efficiency under the most commonly occurring off-design conditions is likely to be most important.
- Compressors lose efficiency when unloaded. Avoid operation of multiple compressors at part-load conditions. Note that package chillers can gain coefficient of performance (COP) when slightly unloaded, as loss of compressor efficiency can be outweighed by the benefits of reduced condensing and elevated evaporating temperature. However, it is unlikely to be energy efficient to operate a single compressor-chiller at less than 50% of capacity.
- Consider turndown efficiency when specifying chillers. Variable speed control or multiple compressor chillers can be highly efficient at part loads.
- Use of thermal storage systems (e.g., ice storage) can avoid the need for close load-tracking and, hence, can avoid part-loaded compressor operation.

Refrigeration System Auxiliaries

Many refrigeration system auxiliaries (e.g. evaporator fans and chilled water pumps) contribute to refrigeration system load, so reductions in their energy use have a double benefit. General energy saving techniques for pumps and fans, listed in the next section of these guidelines, should be applied to refrigeration auxiliaries.

Additionally, auxiliary use can be reduced by avoidance of part-load operation and in plant selection (e.g. axial fan evaporative condensers generally use less energy than equivalent centrifugal fan towers).

Under extreme off-design conditions, reduction in duty of cooling system fans and pumps can be worthwhile, usually when the lowest possible condensing pressure has been achieved.

Compressed Air Systems

Compressed air is the most commonly found utility service in industry, yet in many compressed air systems, the energy contained in compressed air delivered to the user is often 10% or less of energy used in air compression. Savings are often possible through the following techniques:

Load reduction

- Examine each true user of compressed air to identify the air volume needed and the pressure at which this should be delivered.
- Do not mix high volume low pressure and low volume high pressure loads. Decentralize low volume high-pressure applications or provide dedicated low-pressure utilities, for example, by using fans rather than compressed air.
- Review air use reduction opportunities, for example:
    - Use air amplifier nozzles rather than simple open-pipe compressed air jets
    - Consider whether compressed air is needed at all
    - Where air jets are required intermittently (e.g. to propel product), consider operating the jet via a process-related solenoid valve, which opens only when air is required
    - Use manual or automatically operated valves to isolate air supply to individual machines or zones that are not in continuous use
    - Implement systems for systematic identification and repair of leaks
    - All condensate drain points should be trapped. Do not leave drain valves continuously 'cracked open'
    - Train workers never to direct compressed air against their bodies or clothing to dust or cool themselves down.

Distribution

- Monitor pressure losses in filters and replace as appropriate
- Use adequately sized distribution pipework designed to minimize pressure losses

1.3 Wastewater and Ambient Water Quality

Applicability and Approach

This guideline applies to projects that have either direct or indirect discharge of process wastewater, wastewater from utility operations or stormwater to the environment. These guidelines are also applicable to industrial discharges to sanitary sewers that discharge to the environment without any treatment. Process wastewater may include contaminated wastewater from utility operations, stormwater, and sanitary sewage. It provides information on common techniques for wastewater management, water conservation, and reuse that can be applied to a wide range of industry sectors. This guideline is meant to be complemented by the industry-specific effluent guidelines presented in the Industry Sector Environmental, Health, and Safety (EHS) Guidelines. Projects with the potential to generate process wastewater, sanitary (domestic) sewage, or stormwater should incorporate the necessary precautions to avoid, minimize, and control adverse impacts to human health, safety, or the environment.

In the context of their overall ESHS management system, facilities should:

- Understand the quality, quantity, frequency and sources of liquid effluents in its installations. This includes knowledge about the locations, routes and integrity of internal drainage systems and discharge points
- Plan and implement the segregation of liquid effluents principally along industrial, utility, sanitary, and stormwater categories, in order to limit the volume of water requiring specialized treatment. Characteristics of individual streams may also be used for source segregation.
- Identify opportunities to prevent or reduce wastewater pollution through such measures as recycle/reuse within their facility, input substitution, or process modification (e.g. change of technology or operating conditions/modes).
- Assess compliance of their wastewater discharges with the applicable: (i) discharge standard (if the wastewater is discharged to a surface water or sewer), and (ii) water quality standard for a specific reuse (e.g. if the wastewater is reused for irrigation).

Additionally, the generation and discharge of wastewater of any type should be managed through a combination of:

- Water use efficiency to reduce the amount of wastewater generation
- Process modification, including waste minimization, and reducing the use of hazardous materials to reduce the load of pollutants requiring treatment
- If needed, application of wastewater treatment techniques to further reduce the load of contaminants prior to discharge, taking into consideration potential impacts of cross-media transfer of contaminants during treatment (e.g., from water to air or land)

When wastewater treatment is required prior to discharge, the level of treatment should be based on:

- Whether wastewater is being discharged to a sanitary sewer system, or to surface waters
- National and local standards as reflected in permit requirements and sewer system capacity to convey and treat wastewater if discharge is to sanitary sewer
- Assimilative capacity of the receiving water for the load of contaminant being discharged wastewater if discharge is to surface water
- Intended use of the receiving water body (e.g. as a source of drinking water, recreation, irrigation, navigation, or other)
- Presence of sensitive receptors (e.g., endangered species) or habitats
- Good International Industry Practice (GIIP) for the relevant industry sector

General Liquid Effluent Quality

Discharge to Surface Water

Discharges of process wastewater, sanitary wastewater, wastewater from utility operations or stormwater to surface water should not result in contaminant concentrations in excess of local ambient water quality criteria or, in the absence of local criteria, other sources of ambient water quality.[35] Receiving water use[36] and assimilative capacity[37], taking other sources of discharges to the receiving water into consideration, should also influence the acceptable pollution loadings and effluent discharge quality. Additional considerations that should be included in the setting of project-specific performance levels for wastewater effluents include:

- Process wastewater treatment standards consistent with applicable Industry Sector EHS Guidelines. Projects for which there are no industry-specific guidelines should reference the effluent quality guidelines of an industry sector with suitably analogous processes and effluents;
- Compliance with national or local standards for sanitary wastewater discharges or, in their absence, the indicative guideline values applicable to sanitary wastewater discharges shown in Table 1.3.1 below;
- Temperature of wastewater prior to discharge does not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use and assimilative capacity among other considerations.

Discharge to Sanitary Sewer Systems

Discharges of industrial wastewater, sanitary wastewater, wastewater from utility operations or stormwater into public or private wastewater treatment systems should:

- Meet the pretreatment and monitoring requirements of the sewer treatment system into which it discharges.
- Not interfere, directly or indirectly, with the operation and maintenance of the collection and treatment systems, or pose a risk to worker health and safety, or adversely impact

[35] An example is the US EPA National Recommended Water Quality Criteria http://www.epa.gov/waterscience/criteria/wqcriteria.html

[36] Examples of receiving water uses as may be designated by local authorities include: drinking water (with some level of treatment), recreation, aquaculture, irrigation, general aquatic life, ornamental, and navigation. Examples of health-based guideline values for receiving waters include World Health Organization (WHO) guidelines for recreational use (http://www.who.int/water_sanitation_health/dwq/guidelines/en/index.html)

[37] The assimilative capacity of the receiving water body depends on numerous factors including, but not limited to, the total volume of water, flow rate, flushing rate of the water body and the loading of pollutants from other effluent sources in the area or region. A seasonally representative baseline assessment of ambient water quality may be required for use with established scientific methods and mathematical models to estimate potential impact to the receiving water from an effluent source.

characteristics of residuals from wastewater treatment operations.

- Be discharged into municipal or centralized wastewater treatment systems that have adequate capacity to meet local regulatory requirements for treatment of wastewater generated from the project. Pretreatment of wastewater to meet regulatory requirements before discharge from the project site is required if the municipal or centralized wastewater treatment system receiving wastewater from the project does not have adequate capacity to maintain regulatory compliance.

Land Application of Treated Effluent

The quality of treated process wastewater, wastewater from utility operations or stormwater discharged on land, including wetlands, should be established based on local regulatory requirements. . Where land is used as part of the treatment system and the ultimate receptor is surface water, water quality guidelines for surface water discharges specific to the industry sector process should apply.[38] Potential impact on soil, groundwater, and surface water, in the context of protection, conservation and long term sustainability of water and land resources should be assessed when land is used as part of any wastewater treatment system.

Septic Systems

Septic systems are commonly used for treatment and disposal of domestic sanitary sewage in areas with no sewerage collection networks, Septic systems should only be used for treatment of sanitary sewage, and unsuitable for industrial wastewater treatment. When septic systems are the selected form of wastewater disposal and treatment, they should be:

- Properly designed and installed in accordance with local regulations and guidance to prevent any hazard to public health or contamination of land, surface or groundwater.
- Well maintained to allow effective operation.
- Installed in areas with sufficient soil percolation for the design wastewater loading rate.
- Installed in areas of stable soils that are nearly level, well drained, and permeable, with enough separation between the drain field and the groundwater table or other receiving waters.

Wastewater Management

Wastewater management includes water conservation, wastewater treatment, stormwater management, and wastewater and water quality monitoring.

Industrial Wastewater

Industrial wastewater generated from industrial operations includes process wastewater, wastewater from utility operations,, runoff from process and materials staging areas, and miscellaneous activities including wastewater from laboratories, equipment maintenance shops, etc.. The pollutants in an industrial wastewater may include acids or bases (exhibited as low or high pH), soluble organic chemicals causing depletion of dissolved oxygen, suspended solids, nutrients (phosphorus, nitrogen), heavy metals (e.g. cadmium, chromium, copper, lead, mercury, nickel, zinc), cyanide, toxic organic chemicals, oily materials, and volatile materials. , as well as from thermal characteristics of the discharge (e.g., elevated temperature). Transfer of pollutants to another phase, such as air, soil, or the sub-surface, should be minimized through process and engineering controls.

Process Wastewater – – Examples of treatment approaches typically used in the treatment of industrial wastewater are summarized in Annex 1.3.1. While the choice of treatment

[38] Additional guidance on water quality considerations for land application is available in the WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater. Volume 2: Wastewater Use in Agriculture http://www.who.int/water_sanitation_health/wastewater/gsuweg2/en/index.html

technology is driven by wastewater characteristics, the actual performance of this technology depends largely on the adequacy of its design, equipment selection, as well as operation and maintenance of its installed facilities. Adequate resources are required for proper operation and maintenance of a treatment facility, and performance is strongly dependent on the technical ability and training of its operational staff. One or more treatment technologies may be used to achieve the desired discharge quality and to maintain consistent compliance with regulatory requirements. The design and operation of the selected wastewater treatment technologies should avoid uncontrolled air emissions of volatile chemicals from wastewaters. Residuals from industrial wastewater treatment operations should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.

Wastewater from Utilities Operations - Utility operations such as cooling towers and demineralization systems may result in high rates of water consumption, as well as the potential release of high temperature water containing high dissolved solids, residues of biocides, residues of other cooling system anti-fouling agents, etc. Recommended water management strategies for utility operations include:

- Adoption of water conservation opportunities for facility cooling systems as provided in the Water Conservation section below;
- Use of heat recovery methods (also energy efficiency improvements) or other cooling methods to reduce the temperature of heated water prior to discharge to ensure the discharge water temperature does not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity among other considerations;
- Minimizing use of antifouling and corrosion inhibiting chemicals by ensuring appropriate depth of water intake and use of screens. Least hazardous alternatives should be used with regards to toxicity, biodegradability, bioavailability, and bioaccumulation potential. Dose applied should accord with local regulatory requirements and manufacturer recommendations;
- Testing for residual biocides and other pollutants of concern should be conducted to determine the need for dose adjustments or treatment of cooling water prior to discharge.

Stormwater Management - Stormwater includes any surface runoff and flows resulting from precipitation, drainage or other sources. Typically stormwater runoff contains suspended sediments, metals, petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs), coliform, etc. Rapid runoff, even of uncontaminated stormwater, also degrades the quality of the receiving water by eroding stream beds and banks. In order to reduce the need for stormwater treatment, the following principles should be applied:

- Stormwater should be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge
- Surface runoff from process areas or potential sources of contamination should be prevented
- Where this approach is not practical, runoff from process and storage areas should be segregated from potentially less contaminated runoff
- Runoff from areas without potential sources of contamination should be minimized (e.g. by minimizing the area of impermeable surfaces) and the peak discharge rate should

be reduced (e.g. by using vegetated swales and retention ponds);

- Where stormwater treatment is deemed necessary to protect the quality of receiving water bodies, priority should be given to managing and treating the first flush of stormwater runoff where the majority of potential contaminants tend to be present;
- When water quality criteria allow, stormwater should be managed as a resource, either for groundwater recharge or for meeting water needs at the facility;
- Oil water separators and grease traps should be installed and maintained as appropriate at refueling facilities, workshops, parking areas, fuel storage and containment areas.
- Sludge from stormwater catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.

Sanitary Wastewater

Sanitary wastewater from industrial facilities may include effluents from domestic sewage, food service, and laundry facilities serving site employees. Miscellaneous wastewater from laboratories, medical infirmaries, water softening etc. may also be discharged to the sanitary wastewater treatment system. Recommended sanitary wastewater management strategies include:

- Segregation of wastewater streams to ensure compatibility with selected treatment option (e.g. septic system which can only accept domestic sewage);
- Segregation and pretreatment of oil and grease containing effluents (e.g. use of a grease trap) prior to discharge into sewer systems;
- If sewage from the industrial facility is to be discharged to surface water, treatment to meet national or local standards for sanitary wastewater discharges or, in their absence, the indicative guideline values applicable to sanitary wastewater discharges shown in Table 1.3.1;
- If sewage from the industrial facility is to be discharged to either a septic system, or where land is used as part of the treatment system, treatment to meet applicable national or local standards for sanitary wastewater discharges is required.
- Sludge from sanitary wastewater treatment systems should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.

Table 1.3.1 Indicative Values for Treated Sanitary Sewage Discharges[a]

Pollutants	Units	Guideline Value
pH	pH	6 – 9
BOD	mg/l	30
COD	mg/l	125
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN[b] / 100 ml	400[a]

Notes:
[a] Not applicable to centralized, municipal, wastewater treatment systems which are included in EHS Guidelines for Water and Sanitation.
[b] MPN = Most Probable Number

Emissions from Wastewater Treatment Operations

Air emissions from wastewater treatment operations may include hydrogen sulfide, methane, ozone (in the case of ozone disinfection), volatile organic compounds (e.g., chloroform generated from chlorination activities and other volatile organic compounds (VOCs) from industrial wastewater), gaseous or volatile chemicals used for disinfection processes (e.g., chlorine and ammonia), and bioaerosols. Odors from treatment facilities can also be a nuisance to workers and the surrounding community. Recommendations for the management of emissions are presented in the Air Emissions and Ambient Air Quality section of this document and in the EHS Guidelines for Water and Sanitation.

Residuals from Wastewater Treatment Operations

Sludge from a waste treatment plant needs to be evaluated on a case-by-case basis to establish whether it constitutes a hazardous or a non-hazardous waste and managed accordingly as described in the Waste Management section of this document.

Occupational Health and Safety Issues in Wastewater Treatment Operations

Wastewater treatment facility operators may be exposed to physical, chemical, and biological hazards depending on the design of the facilities and the types of wastewater effluents managed. Examples of these hazards include the potential for trips and falls into tanks, confined space entries for maintenance operations, and inhalation of VOCs, bioaerosols, and methane, contact with pathogens and vectors, and use of potentially hazardous chemicals, including chlorine, sodium and calcium hypochlorite, and ammonia. Detailed recommendations for the management of occupational health and safety issues are presented in the relevant section of this document. Additional guidance specifically applicable to wastewater treatment systems is provided in the EHS Guidelines for Water and Sanitation.

Monitoring

A wastewater and water quality monitoring program with adequate resources and management oversight should be developed and implemented to meet the objective(s) of the monitoring program. The wastewater and water quality monitoring program should consider the following elements:

- *Monitoring parameters*: The parameters selected for monitoring should be indicative of the pollutants of concern from the process, and should include parameters that are regulated under compliance requirements;

- *Monitoring type and frequency*: Wastewater monitoring should take into consideration the discharge characteristics from the process over time. Monitoring of discharges from processes with batch manufacturing or seasonal process variations should take into consideration of time-dependent

variations in discharges and, therefore, is more complex than monitoring of continuous discharges. Effluents from highly variable processes may need to be sampled more frequently or through composite methods. Grab samples or, if automated equipment permits, composite samples may offer more insight on average concentrations of pollutants over a 24-hour period. Composite samplers may not be appropriate where analytes of concern are short-lived (e.g., quickly degraded or volatile).

- *Monitoring locations*: The monitoring location should be selected with the objective of providing representative monitoring data. Effluent sampling stations may be located at the final discharge, as well as at strategic upstream points prior to merging of different discharges. Process discharges should not be diluted prior or after treatment with the objective of meeting the discharge or ambient water quality standards.

- *Data quality*: Monitoring programs should apply internationally approved methods for sample collection, preservation and analysis. Sampling should be conducted by or under the supervision of trained individuals. Analysis should be conducted by entities permitted or certified for this purpose. Sampling and Analysis Quality Assurance/Quality Control (QA/QC) plans should be prepared and, implemented. QA/QC documentation should be included in monitoring reports.

Annex 1.3.1 - Examples of Industrial Wastewater Treatment Approaches

Pollutant/Parameter	Control Options / Principle	Common End of Pipe Control Technology
pH	Chemical, Equalization	Acid/Base addition, Flow equalization
Oil and Grease / TPH	Phase separation	Dissolved Air Floatation, oil water separator, grease trap
TSS - Settleable	Settling, Size Exclusion	Sedimentation basin, clarifier, centrifuge, screens
TSS - Non-Settleable	Floatation, Filtration - traditional and tangential	Dissolved air floatation, Multimedia filter, sand filter, fabric filter, ultrafiltration, microfiltration
Hi - BOD (> 2 Kg/m^3)	Biological - Anaerobic	Suspended growth, attached growth, hybrid
Lo - BOD (< 2 Kg/m^3)	Biological - Aerobic, Facultative	Suspended growth, attached growth, hybrid
COD - Non-Biodegradable	Oxidation, Adsorption, Size Exclusion	Chemical oxidation, Thermal oxidation, Activated Carbon, Membranes
Metals - Particulate and Soluble	Coagulation, flocculation, precipitation, size exclusion	Flash mix with settling, filtration - traditional and tangential
Inorganics / Non-metals	Coagulation, flocculation, precipitation, size exclusion, Oxidation, Adsorption	Flash mix with settling, filtration - traditional and tangential, Chemical oxidation, Thermal oxidation, Activated Carbon, Reverse Osmosis, Evaporation
Organics - VOCs and SVOCs	Biological - Aerobic, Anaerobic, Facultative; Adsorption, Oxidation	Biological : Suspended growth, attached growth, hybrid; Chemical oxidation, Thermal oxidation, Activated Carbon
Emissions – Odors and VOCs	Capture – Active or Passive; Biological; Adsorption, Oxidation	Biological : Attached growth; Chemical oxidation, Thermal oxidation, Activated Carbon
Nutrients	Biological Nutrient Removal, Chemical, Physical, Adsorption	Aerobic/Anoxic biological treatment, chemical hydrolysis and air stripping, chlorination, ion exchange
Color	Biological - Aerobic, Anaerobic, Facultative; Adsorption, Oxidation	Biological Aerobic, Chemical oxidation, Activated Carbon
Temperature	Evaporative Cooling	Surface Aerators, Flow Equalization
TDS	Concentration, Size Exclusion	Evaporation, crystallization, Reverse Osmosis
Active Ingredients/Emerging Contaminants	Adsorption, Oxidation, Size Exclusion, Concentration	Chemical oxidation, Thermal oxidation, Activated Carbon, Ion Exchange, Reverse Osmosis, Evaporation, Crystallization
Radionuclides	Adsorption,Size Exclusion, Concentration	Ion Exchange, Reverse Osmosis, Evaporation, Crystallization
Pathogens	Disinfection, Sterilization	Chlorine, Ozone, Peroxide, UV, Thermal
Toxicity	Adsorption, Oxidation, Size Exclusion, Concentration	Chemical oxidation, Thermal oxidation, Activated Carbon, Evaporation, crystallization, Reverse Osmosis

1.4 Water Conservation

Applicability and Approach

Water conservation programs should be implemented commensurate with the magnitude and cost of water use. These programs should promote the continuous reduction in water consumption and achieve savings in the water pumping, treatment and disposal costs. Water conservation measures may include water monitoring/management techniques; process and cooling/heating water recycling, reuse, and other techniques; and sanitary water conservation techniques.

General recommendations include:

- Storm/Rainwater harvesting and use
- Zero discharge design/Use of treated waste water to be included in project design processes
- Use of localized recirculation systems in plant/facility/shops (as opposed to centralized recirculation system), with provision only for makeup water
- Use of dry process technologies e.g. dry quenching
- Process water system pressure management
- Project design to have measures for adequate water collection, spill control and leakage control system

Water Monitoring and Management

The essential elements of a water management program involve:

- Identification, regular measurement, and recording of principal flows within a facility;
- Definition and regular review of performance targets, which are adjusted to account for changes in major factors affecting water use (e.g. industrial production rate);
- Regular comparison of water flows with performance targets to identify where action should be taken to reduce water use.

Water measurement (metering) should emphasize areas of greatest water use. Based on review of metering data, 'unaccounted' use–indicating major leaks at industrial facilities–could be identified.

Process Water Reuse and Recycling

Opportunities for water savings in industrial processes are highly industry-specific. However, the following techniques have all been used successfully, and should be considered in conjunction with the development of the metering system described above.

- *Washing Machines:* Many washing machines use large quantities of hot water. Use can increase as nozzles become enlarged due to repeated cleaning and /or wear. Monitor machine water use, compare with specification, and replace nozzles when water and heat use reaches levels warranting such work.
- *Water reuse:* Common water reuse applications include countercurrent rinsing, for example in multi-stage washing

and rinsing processes, or reusing waste water from one process for another with less exacting water requirements. For example, using bleaching rinse water for textile washing, or bottle-washer rinse water for bottle crate washing, or even washing the floor. More sophisticated reuse projects requiring treatment of water before reuse are also sometimes practical.

- *Water jets/sprays:* If processes use water jets or sprays (e.g. to keep conveyors clean or to cool product) review the accuracy of the spray pattern to prevent unnecessary water loss.
- *Flow control optimization:* Industrial processes sometimes require the use of tanks, which are refilled to control losses. It is often possible to reduce the rate of water supply to such tanks, and sometimes to reduce tank levels to reduce spillage. If the process uses water cooling sprays, it may be possible to reduce flow while maintaining cooling performance. Testing can determine the optimum balance.
    - If hoses are used in cleaning, use flow controls to restrict wasteful water flow
    - Consider the use of high pressure, low volume cleaning systems rather than using large volumes of water sprayed from hosepipes
    - Using flow timers and limit switches to control water use
    - Using 'clean-up' practices rather than hosing down

Building Facility Operations

Consumption of building and sanitary water is typically less than that used in industrial processes. However, savings can readily be identified, as outlined below:

- Compare daily water use per employee to existing benchmarks taking into consideration the primary use at the facility, whether sanitary or including other activities such as showering or catering
- Regularly maintain plumbing, and identify and repair leaks
- Shut off water to unused areas
- Install self-closing taps, automatic shut-off valves, spray nozzles, pressure reducing valves, and water conserving fixtures (e.g. low flow shower heads, faucets, toilets, urinals; and spring loaded or sensored faucets)
- Operate dishwashers and laundries on full loads, and only when needed
- Install water-saving equipment in lavatories, such as low-flow toilets

Cooling Systems

Water conservation opportunities in cooling systems include:

- Use of closed circuit cooling systems with cooling towers rather than once-through cooling systems
- Limiting condenser or cooling tower blowdown to the minimum required to prevent unacceptable accumulation of dissolved solids
- Use of air cooling rather than evaporative cooling, although this may increase electricity use in the cooling system
- Use of treated waste water for cooling towers
- Reusing/recycling cooling tower blowdown

Heating Systems

Heating systems based on the circulation of low or medium pressure hot water (which do not consume water) should be closed. If they do consume water, regular maintenance should be conducted to check for leaks. However, large quantities of water may be used by steam systems, and this can be reduced by the following measures:

- Repair of steam and condensate leaks, and repair of all failed steam traps
- Return of condensate to the boilerhouse, and use of heat exchangers (with condensate return) rather than direct steam injection where process permits
- Flash steam recovery
- Minimizing boiler blowdown consistent with maintaining acceptably low dissolved solids in boiler water. Use of reverse osmosis boiler feed water treatment substantially reduces the need for boiler blowdown
- Minimizing deaerator heating

1.5 Hazardous Materials Management

Applicability and Approach

These guidelines apply to projects that use, store, or handle any quantity of hazardous materials (Hazmats), defined as materials that represent a risk to human health, property, or the environment due to their physical or chemical characteristics. Hazmats can be classified according to the hazard as explosives; compressed gases, including toxic or flammable gases; flammable liquids; flammable solids; oxidizing substances; toxic materials; radioactive material; and corrosive substances. Guidance on the transport of hazardous materials is covered in Section 3 of this document.

When a hazardous material is no longer usable for its original purpose and is intended for disposal, but still has hazardous properties, it is considered a *hazardous waste* (see Section 1.4).

This guidance is intended to be applied in conjunction with traditional occupational health and safety and emergency preparedness programs which are included in Section 2.0 on Occupational Health and Safety Management, and Section 3.7 on Emergency Preparedness and Response. Guidance on the Transport of Hazardous Materials is provided in Section 3.5.

This section is divided into two main subsections:

General Hazardous Materials Management: Guidance applicable to all projects or facilities that handle or store any quantity of hazardous materials.

Management of Major Hazards: Additional guidance for projects or facilities that store or handle hazardous materials at, or above, threshold quantities[39], and thus require special treatment to prevent accidents such as fire, explosions, leaks or spills, and to prepare and respond to emergencies.

The overall objective of hazardous materials management is to avoid or, when avoidance is not feasible, minimize uncontrolled releases of hazardous materials or accidents (including explosion and fire) during their production, handling, storage and use. This objective can be achieved by:

[39] For examples, threshold quantities should be those established for emergency planning purposes such as provided in the US Environmental Protection Agency. *Protection of Environment* (Title Threshold quantities are provided in the US Environmental Protection Agency. *Protection of Environment* (Title 40 CFR Parts 68, 112, and 355).

- Establishing hazardous materials management priorities based on hazard analysis of risky operations identified through Social and Environmental Assessment;
- Where practicable, avoiding or minimizing the use of hazardous materials. For example, non-hazardous materials have been found to substitute asbestos in building materials, PCBs in electrical equipment, persistent organic pollutants (POPs) in pesticides formulations, and ozone depleting substances in refrigeration systems;
- Preventing uncontrolled releases of hazardous materials to the environment or uncontrolled reactions that might result in fire or explosion;
- Using engineering controls (containment, automatic alarms, and shut-off systems) commensurate with the nature of hazard;
- Implementing management controls (procedures, inspections, communications, training, and drills) to address residual risks that have not been prevented or controlled through engineering measures.

General Hazardous Materials Management

Projects which manufacture, handle, use, or store hazardous materials should establish management programs that are commensurate with the potential risks present. The main objectives of projects involving hazardous materials should be the protection of the workforce and the prevention and control of releases and accidents. These objectives should be addressed by integrating prevention and control measures, management actions, and procedures into day-to-day business activities. Potentially applicable elements of a management program include the following:

Hazard Assessment

The level of risk should be established through an on-going assessment process based on:

- The types and amounts of hazardous materials present in the project. This information should be recorded and should include a summary table with the following information:
  - Name and description (e.g. composition of a mixture) of the Hazmat
  - Classification (e.g. code, class or division) of the Hazmat
  - Internationally accepted regulatory reporting threshold quantity or national equivalent[40] of the Hazmat
  - Quantity of Hazmat used per month
  - Characteristic(s) that make(s) the Hazmat hazardous (e.g. flammability, toxicity)
- Analysis of potential spill and release scenarios using available industry statistics on spills and accidents where available
- Analysis of the potential for uncontrolled reactions such as fire and explosions
- Analysis of potential consequences based on the physical-geographical characteristics of the project site, including aspects such as its distance to settlements, water resources, and other environmentally sensitive areas

Hazard assessment should be performed by specialized professionals using internationally-accepted methodologies such as Hazardous Operations Analysis (HAZOP), Failure Mode and Effects Analysis (FMEA), and Hazard Identification (HAZID).

Management Actions

The management actions to be included in a Hazardous Materials Management Plan should be commensurate with the level of

[40] Threshold quantities are provided in the US Environmental Protection Agency. *Protection of Environment* (Title 40 CFR Parts 68, 112, and 355).

potential risks associated with the production, handling, storage, and use of hazardous materials.

Release Prevention and Control Planning

Where there is risk of a spill of uncontrolled hazardous materials, facilities should prepare a spill control, prevention, and countermeasure plan as a specific component of their Emergency Preparedness and Response Plan (described in more detail in Section 3.7). The plan should be tailored to the hazards associated with the project, and include:

- Training of operators on release prevention, including drills specific to hazardous materials as part of emergency preparedness response training
- Implementation of inspection programs to maintain the mechanical integrity and operability of pressure vessels, tanks, piping systems, relief and vent valve systems, containment infrastructure, emergency shutdown systems, controls and pumps, and associated process equipment
- Preparation of written Standard Operating Procedures (SOPs) for filling USTs, ASTs or other containers or equipment as well as for transfer operations by personnel trained in the safe transfer and filling of the hazardous material, and in spill prevention and response
- SOPs for the management of secondary containment structures, specifically the removal of any accumulated fluid, such as rainfall, to ensure that the intent of the system is not accidentally or willfully defeated
- Identification of locations of hazardous materials and associated activities on an emergency plan site map
- Documentation of availability of specific personal protective equipment and training needed to respond to an emergency
- Documentation of availability of spill response equipment sufficient to handle at least initial stages of a spill and a list of external resources for equipment and personnel, if necessary, to supplement internal resources
- Description of response activities in the event of a spill, release, or other chemical emergency including:
  - Internal and external notification procedures
  - Specific responsibilities of individuals or groups
  - Decision process for assessing severity of the release, and determining appropriate actions
  - Facility evacuation routes
  - Post-event activities such as clean-up and disposal, incident investigation, employee re-entry, and restoration of spill response equipment.

Occupational Health and Safety

The Hazardous Materials Management Plan should address applicable, essential elements of occupational health and safety management as described in Section 2.0 on Occupational Health and Safety, including:

- Job safety analysis to identify specific potential occupational hazards and industrial hygiene surveys, as appropriate, to monitor and verify chemical exposure levels, and compare with applicable occupational exposure standards[41]
- Hazard communication and training programs to prepare workers to recognize and respond to workplace chemical hazards. Programs should include aspects of hazard identification, safe operating and materials handling procedures, safe work practices, basic emergency procedures, and special hazards unique to their jobs.

[41] Including: Threshold Limit Value (TLV®) occupational exposure guidelines and Biological Exposure Indices (BEIs®), American Conference of Governmental Industrial Hygienists (ACGIH), http://www.acgih.org/TLV/; U.S. National Institute for Occupational Health and Safety (NIOSH), http://www.cdc.gov/niosh/npg/; Permissible Exposure Limits (PELs), U.S. Occupational Safety and Health Administration (OSHA), http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992; Indicative Occupational Exposure Limit Values, European Union, http://europe.osha.eu.int/good_practice/risks/ds/oel/; and other similar sources.

Training should incorporate information from Material Safety Data Sheets[42] (MSDSs) for hazardous materials being handled. MSDSs should be readily accessible to employees in their local language.

- Definition and implementation of permitted maintenance activities, such as hot work or confined space entries
- Provision of suitable personal protection equipment (PPE) (footwear, masks, protective clothing and goggles in appropriate areas), emergency eyewash and shower stations, ventilation systems, and sanitary facilities
- Monitoring and record-keeping activities, including audit procedures designed to verify and record the effectiveness of prevention and control of exposure to occupational hazards, and maintaining accident and incident investigation reports on file for a period of at least five years

Process Knowledge and Documentation

The Hazardous Materials Management Plan should be incorporated into, and consistent with, the other elements of the facility ES/OHS MS and include:

- Written process safety parameters (i.e., hazards of the chemical substances, safety equipment specifications, safe operation ranges for temperature, pressure, and other applicable parameters, evaluation of the consequences of deviations, etc.)
- Written operating procedures
- Compliance audit procedures

[42] MSDSs are produced by the manufacturer, but might not be prepared for chemical intermediates that are not distributed in commerce. In these cases, employers still need to provide workers with equivalent information.

Preventive Measures

Hazardous Materials Transfer

Uncontrolled releases of hazardous materials may result from small cumulative events, or from more significant equipment failure associated with events such as manual or mechanical transfer between storage systems or process equipment. Recommended practices to prevent hazardous material releases from processes include:

- Use of dedicated fittings, pipes, and hoses specific to materials in tanks (e.g., all acids use one type of connection, all caustics use another), and maintaining procedures to prevent addition of hazardous materials to incorrect tanks
- Use of transfer equipment that is compatible and suitable for the characteristics of the materials transferred and designed to ensure safe transfer
- Regular inspection, maintenance and repair of fittings, pipes and hoses
- Provision of secondary containment, drip trays or other overflow and drip containment measures, for hazardous materials containers at connection points or other possible overflow points.

Overfill Protection

Overfills of vessels and tanks should be prevented as they are among the most common causes of spills resulting in soil and water contamination, and among the easiest to prevent. Recommended overfill protection measures include:

- Prepare written procedures for transfer operations that includes a checklist of measures to follow during filling operations and the use of filling operators trained in these procedures
- Installation of gauges on tanks to measure volume inside
- Use of dripless hose connections for vehicle tank and fixed connections with storage tanks

- Provision of automatic fill shutoff valves on storage tanks to prevent overfilling
- Use of a catch basin around the fill pipe to collect spills
- Use of piping connections with automatic overfill protection (float valve)
- Pumping less volume than available capacity into the tank or vessel by ordering less material than its available capacity
- Provision of overfill or over pressure vents that allow controlled release to a capture point

Reaction, Fire, and Explosion Prevention

Reactive, flammable, and explosive materials should also be managed to avoid uncontrolled reactions or conditions resulting in fire or explosion. Recommended prevention practices include:

- Storage of incompatible materials (acids, bases, flammables, oxidizers, reactive chemicals) in separate areas, and with containment facilities separating material storage areas
- Provision of material-specific storage for extremely hazardous or reactive materials
- Use of flame arresting devices on vents from flammable storage containers
- Provision of grounding and lightning protection for tank farms, transfer stations, and other equipment that handles flammable materials
- Selection of materials of construction compatible with products stored for all parts of storage and delivery systems, and avoiding reuse of tanks for different products without checking material compatibility
- Storage of hazardous materials in an area of the facility separated from the main production works. Where proximity is unavoidable, physical separation should be provided using structures designed to prevent fire, explosion, spill, and other emergency situations from affecting facility operations
- Prohibition of all sources of ignition from areas near flammable storage tanks

Control Measures

Secondary Containment (Liquids)

A critical aspect for controlling accidental releases of liquid hazardous materials during storage and transfer is the provision of secondary containment. It is not necessary for secondary containment methods to meet long term material compatibility as with primary storage and piping, but their design and construction should hold released materials effectively until they can be detected and safely recovered. Appropriate secondary containment structures consist of berms, dikes, or walls capable of containing the larger of 110 percent of the largest tank or 25% percent of the combined tank volumes in areas with above-ground tanks with a total storage volume equal or greater than 1,000 liters and will be made of impervious, chemically resistant material. Secondary containment design should also consider means to prevent contact between incompatible materials in the event of a release.

Other secondary containment measures that should be applied depending on site-specific conditions include:

- Transfer of hazardous materials from vehicle tanks to storage in areas with surfaces sufficiently impervious to avoid loss to the environment and sloped to a collection or a containment structure not connected to municipal wastewater/stormwater collection system
- Where it is not practical to provide permanent, dedicated containment structures for transfer operations, one or more alternative forms of spill containment should be provided, such as portable drain covers (which can be deployed for the duration of the operations), automatic shut-off valves on storm water basins, or shut off valves in drainage or sewer facilities, combined with oil-water separators

- Storage of drummed hazardous materials with a total volume equal or greater than 1,000 liters in areas with impervious surfaces that are sloped or bermed to contain a minimum of 25 percent of the total storage volume
- Provision of secondary containment for components (tanks, pipes) of the hazardous material storage system, to the extent feasible
- Conducting periodic (e.g. daily or weekly) reconciliation of tank contents, and inspection of visible portions of tanks and piping for leaks;
- Use of double-walled, composite, or specially coated storage and piping systems particularly in the use of underground storage tanks (USTs) and underground piping. If double-walled systems are used, they should provide a means of detecting leaks between the two walls.

Storage Tank and Piping Leak Detection

Leak detection may be used in conjunction with secondary containment, particularly in high-risk locations[43]. Leak detection is especially important in situations where secondary containment is not feasible or practicable, such as in long pipe runs. Acceptable leak detection methods include:

- Use of automatic pressure loss detectors on pressurized or long distance piping
- Use of approved or certified integrity testing methods on piping or tank systems, at regular intervals
- Considering the use of SCADA[44] if financially feasible

[43] High-risk locations are places where the release of product from the storage system could result in the contamination of drinking water source or those located in water resource protection areas as designated by local authorities.

[44] Supervisory Control and Data Acquisition

Underground Storage Tanks (USTs)[45]

Although there are many environmental and safety advantages of underground storage of hazardous materials, including reduced risk of fire or explosion, and lower vapor losses into the atmosphere, leaks of hazardous materials can go undetected for long periods of time with potential for soil and groundwater contamination. Examples of techniques to manage these risks include:

- Avoiding use of USTs for storage of highly soluble organic materials
- Assessing local soil corrosion potential, and installing and maintaining cathodic protection (or equivalent rust protection) for steel tanks
- For new installations, installing impermeable liners or structures (e.g., concrete vaults) under and around tanks and lines that direct any leaked product to monitoring ports at the lowest point of the liner or structure
- Monitoring the surface above any tank for indications of soil movement
- Reconciling tank contents by measuring the volume in store with the expected volume, given the stored quantity at last stocking, and deliveries to and withdrawals from the store
- Testing integrity by volumetric, vacuum, acoustic, tracers, or other means on all tanks at regular intervals
- Considering the monitoring groundwater of quality down gradient of locations where multiple USTs are in use
- Evaluating the risk of existing UST in newly acquired facilities to determine if upgrades are required for USTs that will be continued to be used, including replacement with new systems or permanent closure of abandoned USTs. Ensuring that new USTs are sited away from wells,

[45] Additional details on the management of USTs is provided in the EHS Guidelines for Retail Petroleum Stations.

reservoirs and other source water protection areas and floodplains, and maintained so as to prevent corrosion.

Management of Major Hazards

In addition to the application of the above-referenced guidance on prevention and control of releases of hazardous materials, projects involving production, handling, and storage of hazardous materials *at or above threshold limits*[46] should prepare a Hazardous Materials Risk Management Plan, in the context of its overall ES/OHS MS, containing all of the elements presented below.[47] The objective of this guidance is the prevention and control of catastrophic releases of toxic, reactive, flammable, or explosive chemicals that may result in toxic, fire, or explosion hazards.[48]

Management Actions

- *Management of Change:* These procedures should address:
  - The technical basis for changes in processes and operations
  - The impact of changes on health and safety
  - Modification to operating procedures
  - Authorization requirements
  - Employees affected
  - Training needs
- *Compliance Audit*: A compliance audit is a way to evaluate compliance with the prevention program requirements for each process. A compliance audit covering each element of the prevention measures (see below) should be conducted at least every three years and should include:
  - Preparation of a report of the findings
  - Determination and documentation of the appropriate response to each finding
  - Documentation that any deficiency has been corrected
- *Incident Investigation:* Incidents can provide valuable information about site hazards and the steps needed to prevent accidental releases. An incident investigation mechanism should include procedures for:
  - Initiation of the investigation promptly
  - Summarizing the investigation in a report
  - Addressing the report findings and recommendations
  - A review of the report with staff and contractors
- *Employee Participation:* A written plan of action should describe an active employee participation program for the prevention of accidents.
- *Contractors:* There should be a mechanism for contractor control which should include a requirement for them to develop hazard materials management procedures that meet the requirements of the hazardous materials management plan. Their procedures should be consistent with those of the contracting company and the contractor workforce should undergo the same training. Additionally, procedures should require that contractors are:
  - Provided with safety performance procedures and safety and hazard information
  - Observe safety practices
  - Act responsibly
  - Have access to appropriate training for their employees
  - Ensure that their employees know process hazards and applicable emergency actions

[46] Threshold quantities should be those established for emergency planning purposes such as provided in the US Environmental Protection Agency. *Protection of Environment* (Title 40 CFR Parts 300-399 and 700 to 789).

[47] For further information and guidance, please refer to International Finance Corporation (IFC) Hazardous Materials Risk Management Manual. Washington, D.C. December 2000.

[48] The approach to the management of major hazards is largely based on an approach to Process Safety Management developed by the American Institute of Chemical Engineers.

- Prepare and submit training records for their employees to the contracting company
- Inform their employees about the hazards presented by their work
- Assess trends of repeated similar incidents
- Develop and implement procedures to manage repeated similar incidents

- *Training*: Project employees should be provided training on Hazmat management. The training program should include:
  - A list of employees to be trained
  - Specific training objectives
  - Mechanisms to achieve the objectives (i.e., hands-on workshops, videos, etc.)
  - The means to determine whether the training program is effective
  - Training procedures for new hires and refresher courses for existing employees

Preventive Measures

The purpose of preventive measures is to ensure that safety-related aspects of the process and equipment are considered, limits to be placed on the operations are well known, and accepted standards and codes are adopted, where they apply.

- *Process Safety Information:* Procedures should be prepared for each hazardous materials and include:
  - Compilation of Material Safety Data Sheets (MSDS)
  - Identification of maximum intended inventories and safe upper/lower parameters
  - Documentation of equipment specifications and of codes and standards used to design, build and operate the process

- *Operating Procedures:* SOPs should be prepared for each step of all processes or operations within the project (e.g. initial startup, normal operations, temporary operations, emergency shutdown, emergency operations, normal shutdown, and start-up following a normal or emergency shutdown or major change). These SOPs should include special considerations for Mazmats used in the process or operations (e.g. temperature control to prevent emissions of a volatile hazardous chemical; diversion of gaseous discharges of hazardous pollutants from the process to a temporary storage tank in case of emergency).

Other procedures to be developed include impacts of deviations, steps to avoid deviations, prevention of chemical exposure, exposure control measures, and equipment inspections.

Mechanical Integrity of process equipment, piping and instrumentation: Inspection and maintenance procedures should be developed and documented to ensure mechanical integrity of equipment, piping, and instrumentation and prevent uncontrolled releases of hazardous materials from the project. These procedures should be included as part of the project SOPs. The specific process components of major interest include pressure vessels and storage tanks, piping systems, relief and vent systems and devices, emergency shutdown systems, controls, and pumps. Recommended aspects of the inspection and maintenance program include:

- Developing inspection and maintenance procedures
- Establishing a quality assurance plan for equipment, maintenance materials, and spare parts
- Conducting employee training on the inspection and maintenance procedures
- Conducting equipment, piping, and instrumentation inspections and maintenance
- Identifying and correcting identified deficiencies

- Evaluating the inspection and maintenance results and, if necessary, updating the inspection and maintenance procedures
- Reporting the results to management.

- *Hot Work Permit:* Hot work operations – such as brazing, torch-cutting, grinding, soldering, and welding – are associated with potential health, safety, and property hazards resulting from the fumes, gases, sparks, and hot metal and radiant energy produced during hot work. Hot work permit is required for any operation involving open flames or producing heat and/or sparks. The section of SOPs on hot work should include the responsibility for hot work permitting, personal protection equipment (PPE), hot work procedures, personnel training, and recordkeeping.
- *Pre-Start Review:* Procedures should be prepared to carry out pre-start reviews when a modification is significant enough to require a change in safety information under the management of change procedure. The procedures should:
  - Confirm that the new or modified construction and/or equipment meet design specifications
  - Ensure that procedures for safety, operation, maintenance, and emergency are adequate
  - Include a process hazard assessment, and resolve or implement recommendations for new process
  - Ensure that training for all affected employees is being conducted

Emergency Preparedness and Response

When handling hazardous materials, procedures and practices should be developed allowing for quick and efficient responses to accidents that could result in human injury or damage to the environment. An Emergency Preparedness and Response Plan, incorporated into and consistent with, the facility's overall ES/OHS MS, should be prepared to cover the following:[49]

- *Planning Coordination:* Procedures should be prepared for:
  - Informing the public and emergency response agencies
  - Documenting first aid and emergency medical treatment
  - Taking emergency response actions
  - Reviewing and updating the emergency response plan to reflect changes, and ensuring that employees are informed of such changes
- *Emergency Equipment:* Procedures should be prepared for using, inspecting, testing, and maintaining the emergency response equipment.
- *Training:* Employees and contractors should be trained on emergency response procedures.

Community Involvement and Awareness

When hazardous materials are in use above threshold quantities, the management plan should include a system for community awareness, notification and involvement that should be commensurate with the potential risks identified for the project during the hazard assessment studies. This should include mechanisms for sharing the results of hazard and risk assessment studies in a timely, understandable and culturally sensitive manner with potentially affected communities that provides a means for public feedback. Community involvement activities should include:

- Availability of general information to the potentially affected community on the nature and extent of project operations, and the prevention and control measures in place to ensure no effects to human health

[49] For a comprehensive treatment of the development of emergency response plans in conjunction with communities refer to the Awareness and Preparedness for Emergencies at Local Level (APELL) Guidelines available at: http://www.uneptie.org/pc/apell/publications/handbooks.html

- The potential for off-site effects to human health or the environment following an accident at planned or existing hazardous installations
- Specific and timely information on appropriate behavior and safety measures to be adopted in the event of an accident including practice drills in locations with higher risks
- Access to information necessary to understand the nature of the possible effect of an accident and an opportunity to contribute effectively, as appropriate, to decisions concerning hazardous installations and the development of community emergency preparedness plans.

1.6 Waste Management

Applicability and Approach

These guidelines apply to projects that generate, store, or handle any quantity of waste across a range of industry sectors. It is not intended to apply to projects or facilities where the primary business is the collection, transportation, treatment, or disposal of wastes. Specific guidance for these types of facilities is presented in the Environmental Health and Safety (EHS) Guidelines for Waste Management Facilities.

A *waste* is any solid, liquid, or contained gaseous material that is being discarded by disposal, recycling, burning or incineration. It can be byproduct of a manufacturing process or an obsolete commercial product that can no longer be used for intended purpose and requires disposal.

Solid (non-hazardous) wastes generally include any garbage, refuse. Examples of such waste include domestic trash and garbage; inert construction / demolition materials; refuse, such as metal scrap and empty containers (except those previously used to contain hazardous materials which should, in principle, be managed as a hazardous waste); and residual waste from industrial operations, such as boiler slag, clinker, and fly ash.

Hazardous waste shares the properties of a hazardous material (e.g. ignitability, corrosivity, reactivity, or toxicity), or other physical, chemical, or biological characteristics that may pose a potential risk to human health or the environment if improperly managed. Wastes may also be defined as "hazardous" by local regulations or international conventions, based on the origin of the waste and its inclusion on hazardous waste lists, or based on its characteristics.

Sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility, and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial operations needs to be evaluated on a case-by-case basis to establish whether it constitutes a hazardous or a non-hazardous waste.

Facilities that generate and store wastes should practice the following:

- Establishing waste management priorities at the outset of activities based on an understanding of potential Environmental, Health, and Safety (EHS) risks and impacts and considering waste generation and its consequences
- Establishing a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes.
- Avoiding or minimizing the generation waste materials, as far as practicable
- Where waste generation cannot be avoided but has been minimized, recovering and reusing waste

- Where waste can not be recovered or reused, treating, destroying, and disposing of it in an environmentally sound manner

General Waste Management

The following guidance applies to the management of non-hazardous and hazardous waste. Additional guidance specifically applicable to hazardous wastes is presented below. Waste management should be addressed through a Waste management system that addresses issues linked to waste minimization, generation, transport, disposal, and monitoring.

Waste Management Planning

Facilities that generate waste should characterize their waste according to composition, source, types of wastes produced, generation rates, or according to local regulatory requirements. Effective planning and implementation of waste management strategies should include:

- Review of new waste sources during planning, siting, and design activities, including during equipment modifications and process alterations, to identify expected waste generation, pollution prevention opportunities, and necessary treatment, storage, and disposal infrastructure
- Collection of data and information about the process and waste streams in existing facilities, including characterization of waste streams by type, quantities, and potential use/disposition
- Establishment of priorities based on a risk analysis that takes into account the potential EHS risks during the waste cycle and the availability of infrastructure to manage the waste in an environmentally sound manner
- Definition of opportunities for source reduction, as well as reuse and recycling
- Definition of procedures and operational controls for on-site storage
- Definition of options / procedures / operational controls for treatment and final disposal

Waste Prevention

Processes should be designed and operated to prevent, or minimize, the quantities of wastes generated and hazards associated with the wastes generated in accordance with the following strategy:

- Substituting raw materials or inputs with less hazardous or toxic materials, or with those where processing generates lower waste volumes
- Applying manufacturing process that convert materials efficiently, providing higher product output yields, including modification of design of the production process, operating conditions, and process controls[50]
- Instituting good housekeeping and operating practices, including inventory control to reduce the amount of waste resulting from materials that are out-of-date, off-specification, contaminated, damaged, or excess to plant needs
- Instituting procurement measures that recognize opportunities to return usable materials such as containers and which prevents the over ordering of materials
- Minimizing hazardous waste generation by implementing stringent waste segregation to prevent the commingling of non-hazardous and hazardous waste to be managed

[50] Examples of waste prevention strategies include the concept of Lean Manufacturing found at http://www.epa.gov/epaoswer/hazwaste/minimize/lean.htm

Recycling and Reuse

In addition to the implementation of waste prevention strategies, the total amount of waste may be significantly reduced through the implementation of recycling plans, which should consider the following elements:

- Evaluation of waste production processes and identification of potentially recyclable materials
- Identification and recycling of products that can be reintroduced into the manufacturing process or industry activity at the site
- Investigation of external markets for recycling by other industrial processing operations located in the neighborhood or region of the facility (e.g., waste exchange)
- Establishing recycling objectives and formal tracking of waste generation and recycling rates
- Providing training and incentives to employees in order to meet objectives

Treatment and Disposal

If waste materials are still generated after the implementation of feasible waste prevention, reduction, reuse, recovery and recycling measures, waste materials should be treated and disposed of and all measures should be taken to avoid potential impacts to human health and the environment. Selected management approaches should be consistent with the characteristics of the waste and local regulations, and may include one or more of the following:

- On-site or off-site biological, chemical, or physical treatment of the waste material to render it non-hazardous prior to final disposal
- Treatment or disposal at permitted facilities specially designed to receive the waste. Examples include: composting operations for organic non-hazardous wastes; properly designed, permitted and operated landfills or incinerators designed for the respective type of waste; or other methods known to be effective in the safe, final disposal of waste materials such as bioremediation.

Hazardous Waste Management

Hazardous wastes should always be segregated from non-hazardous wastes. If generation of hazardous waste can not be prevented through the implementation of the above general waste management practices, its management should focus on the prevention of harm to health, safety, and the environment, according to the following additional principles:

- Understanding potential impacts and risks associated with the management of any generated hazardous waste during its complete life cycle
- Ensuring that contractors handling, treating, and disposing of hazardous waste are reputable and legitimate enterprises, licensed by the relevant regulatory agencies and following good international industry practice for the waste being handled
- Ensuring compliance with applicable local and international regulations[51]

Waste Storage

Hazardous waste should be stored so as to prevent or control accidental releases to air, soil, and water resources in area location where:

[51] International requirements may include host-country commitments under the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their disposal (http://www.basel.int/) and Rotterdam Convention on the prior Inform Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (http://www.pic.int/)

- Waste is stored in a manner that prevents the commingling or contact between incompatible wastes, and allows for inspection between containers to monitor leaks or spills. Examples include sufficient space between incompatibles or physical separation such as walls or containment curbs
- Store in closed containers away from direct sunlight, wind and rain
- Secondary containment systems should be constructed with materials appropriate for the wastes being contained and adequate to prevent loss to the environment
- Secondary containment is included wherever liquid wastes are stored in volumes greater than 220 liters. The available volume of secondary containment should be at least 110 percent of the largest storage container, or 25 percent of the total storage capacity (whichever is greater), in that specific location
- Provide adequate ventilation where volatile wastes are stored.

Hazardous waste storage activities should also be subject to special management actions, conducted by employees who have received specific training in handling and storage of hazardous wastes:

- Provision of readily available information on chemical compatibility to employees, including labeling each container to identify its contents
- Limiting access to hazardous waste storage areas to employees who have received proper training
- Clearly identifying (label) and demarcating the area, including documentation of its location on a facility map or site plan
- Conducting periodic inspections of waste storage areas and documenting the findings
- Preparing and implementing spill response and emergency plans to address their accidental release (additional information on Emergency Plans in provided in Section 3 of this document)
- Avoiding underground storage tanks and underground piping of hazardous waste

Transportation

On-site and Off-site transportation of waste should be conducted so as to prevent or minimize spills, releases, and exposures to employees and the public. All waste containers designated for off-site shipment should be secured and labeled with the contents and associated hazards, be properly loaded on the transport vehicles before leaving the site, and be accompanied by a shipping paper (i.e., manifest) that describes the load and its associated hazards, consistent with the guidance provided in Section 3.4 on the Transport of Hazardous Materials.

Treatment and Disposal

In addition to the recommendations for treatment and disposal applicable to general wastes, the following issues specific to hazardous wastes should be considered:

Commercial or Government Waste Contractors

In the absence of qualified commercial or government-owned waste vendors (taking into consideration proximity and transportation requirements), facilities generating waste should consider using:

- Have the technical capability to manage the waste in a manner that reduces immediate and future impact to the environment
- Have all required permits, certifications, and approvals, of applicable government authorities

- Have been secured through the use of formal procurement agreements

In the absence of qualified commercial or government-owned waste disposal operators (taking into consideration proximity and transportation requirements), project sponsors should consider using:

- Installing on-site waste treatment or recycling processes
- As a final option, constructing facilities that will provide for the environmental sound long-term storage of wastes on-site (as described elsewhere in the General EHS Guidelines) or at an alternative appropriate location up until external commercial options become available

Small Quantities of Hazardous Waste

Hazardous waste materials are frequently generated in small quantities by many projects through a variety of activities such as equipment and building maintenance activities. Examples of these types of wastes include: spent solvents and oily rags, empty paint cans, chemical containers; used lubricating oil; used batteries (such as nickel-cadmium or lead acid); and lighting equipment, such as lamps or lamp ballasts. These wastes should be managed following the guidance provided in the above sections.

Monitoring

Monitoring activities associated with the management of hazardous and non-hazardous waste should include:

- Regular visual inspection of all waste storage collection and storage areas for evidence of accidental releases and to verify that wastes are properly labeled and stored. When significant quantities of hazardous wastes are generated and stored on site, monitoring activities should include:
  - Inspection of vessels for leaks, drips or other indications of loss
  - Identification of cracks, corrosion, or damage to tanks, protective equipment, or floors
  - Verification of locks, emergency valves, and other safety devices for easy operation (lubricating if required and employing the practice of keeping locks and safety equipment in standby position when the area is not occupied)
  - Checking the operability of emergency systems
  - Documenting results of testing for integrity, emissions, or monitoring stations (air, soil vapor, or groundwater)
  - Documenting any changes to the storage facility, and any significant changes in the quantity of materials in storage
- Regular audits of waste segregation and collection practices
- Tracking of waste generation trends by type and amount of waste generated, preferably by facility departments
- Characterizing waste at the beginning of generation of a new waste stream, and periodically documenting the characteristics and proper management of the waste, especially hazardous wastes
- Keeping manifests or other records that document the amount of waste generated and its destination
- Periodic auditing of third party treatment, and disposal services including re-use and recycling facilities when significant quantities of hazardous wastes are managed by third parties. Whenever possible, audits should include site visits to the treatment storage and disposal location

- Regular monitoring of groundwater quality in cases of Hazardous Waste on site storage and/or pretreatment and disposal
- Monitoring records for hazardous waste collected, stored, or shipped should include:
  - Name and identification number of the material(s) composing the hazardous waste
  - Physical state (i.e., solid, liquid, gaseous or a combination of one, or more, of these)
  - Quantity (e.g., kilograms or liters, number of containers)
  - Waste shipment tracking documentation to include, quantity and type, date dispatched, date transported and date received, record of the originator, the receiver and the transporter
  - Method and date of storing, repacking, treating, or disposing at the facility, cross-referenced to specific manifest document numbers applicable to the hazardous waste
  - Location of each hazardous waste within the facility, and the quantity at each location

1.7 Noise

Applicability

This section addresses impacts of noise beyond the property boundary of the facilities. Worker exposure to noise is covered in Section 2.0 on Occupational Health and Safety.

Prevention and Control

Noise prevention and mitigation measures should be applied where predicted or measured noise impacts from a project facility or operations exceed the applicable noise level guideline at the most sensitive point of reception.[52] The preferred method for controlling noise from stationary sources is to implement noise control measures at source.[53] Methods for prevention and control of sources of noise emissions depend on the source and proximity of receptors. Noise reduction options that should be considered include:

- Selecting equipment with lower sound power levels
- Installing silencers for fans
- Installing suitable mufflers on engine exhausts and compressor components
- Installing acoustic enclosures for equipment casing radiating noise
- Improving the acoustic performance of constructed buildings, apply sound insulation
- Installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m^2 in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective
- Installing vibration isolation for mechanical equipment
- Limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas
- Re-locating noise sources to less sensitive areas to take advantage of distance and shielding
- Siting permanent facilities away from community areas if possible
- Taking advantage of the natural topography as a noise buffer during facility design
- Reducing project traffic routing through community areas wherever possible
- Planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas
- Developing a mechanism to record and respond to complaints

Noise Level Guidelines

Noise impacts should not exceed the levels presented in Table 1.7.1, or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

[52] A point of reception or receptor may be defined as any point on the premises occupied by persons where extraneous noise and/or vibration are received. Examples of receptor locations may include: permanent or seasonal residences; hotels / motels; schools and daycares; hospitals and nursing homes; places of worship; and parks and campgrounds.

[53] At the design stage of a project, equipment manufacturers should provide design or construction specifications in the form of *"Insertion Loss Performance"* for silencers and mufflers, and "*Transmission Loss Performance"* for acoustic enclosures and upgraded building construction.

Table 1.7.1- Noise Level Guidelines[54]		
	One Hour L_{Aeq} (dBA)	
Receptor	Daytime 07:00 - 22:00	Nighttime 22:00 - 07:00
Residential; institutional; educational[55]	55	45
Industrial; commercial	70	70

Highly intrusive noises, such as noise from aircraft flyovers and passing trains, should not be included when establishing background noise levels.

Monitoring

Noise monitoring[56] may be carried out for the purposes of establishing the existing ambient noise levels in the area of the proposed or existing facility, or for verifying operational phase noise levels.

Noise monitoring programs should be designed and conducted by trained specialists. Typical monitoring periods should be sufficient for statistical analysis and may last 48 hours with the use of noise monitors that should be capable of logging data continuously over this time period, or hourly, or more frequently, as appropriate (or else cover differing time periods within several days, including weekday and weekend workdays). The type of acoustic indices recorded depends on the type of noise being monitored, as established by a noise expert. Monitors should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface (e.g., wall). In general, the noise level limit is represented by the background or ambient noise levels that would be present in the absence of the facility or noise source(s) under investigation.

[54] Guidelines values are for noise levels measured out of doors. Source: Guidelines for Community Noise, World Health Organization (WHO), 1999.

[55] For acceptable indoor noise levels for residential, institutional, and educational settings refer to WHO (1999).

[56] Noise monitoring should be carried out using a Type 1 or 2 sound level meter meeting all appropriate IEC standards.

1.8 Contaminated Land

Applicability and Approach

This section provides a summary of management approaches for land contamination due to anthropogenic releases of hazardous materials, wastes, or oil, including naturally occurring substances. Releases of these materials may be the result of historic or current site activities, including, but not limited to, accidents during their handling and storage, or due to their poor management or disposal.

Land is considered contaminated when it contains hazardous materials or oil concentrations above background or naturally occurring levels.

Contaminated lands may involve surficial soils or subsurface soils that, through leaching and transport, may affect groundwater, surface water, and adjacent sites. Where subsurface contaminant sources include volatile substances, soil vapor may also become a transport and exposure medium, and create potential for contaminant infiltration of indoor air spaces of buildings.

Contaminated land is a concern because of:

- The potential risks to human health and ecology (e.g. risk of cancer or other human health effects, loss of ecology);
- The liability that it may pose to the polluter/business owners (e.g., cost of remediation, damage of business reputation and/or business-community relations) or affected parties (e.g. workers at the site, nearby property owners).

Contamination of land should be avoided by preventing or controlling the release of hazardous materials, hazardous wastes, or oil to the environment. When contamination of land is suspected or confirmed during any project phase, the cause of the uncontrolled release should be identified and corrected to avoid further releases and associated adverse impacts.

Contaminated lands should be managed to avoid the risk to human health and ecological receptors. The preferred strategy for land decontamination is to reduce the level of contamination at the site while preventing the human exposure to contamination.

To determine whether risk management actions are warranted, the following assessment approach should be applied to establish whether the three risk factors of 'Contaminants', 'Receptors', and 'Exposure Pathways' co-exist, or are likely to co-exist, at the project site under current or possible future land use:

- *Contaminant(s)*: Presence of hazardous materials, waste, or oil in any environmental media at potentially hazardous concentrations
- *Receptor(s)*: Actual or likely contact of humans, wildlife, plants, and other living organisms with the contaminants of concern
- *Exposure pathway(s)*: A combination of the route of migration of the contaminant from its point of release (e.g., leaching into potable groundwater) and exposure routes

(e.g., ingestion, transdermal absorption), which would allow receptor(s) to come into actual contact with contaminants

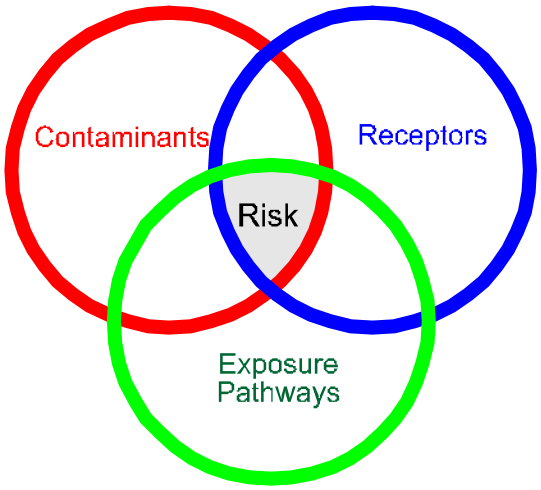


FIGURE 1.8.1: Inter-Relationship of Contaminant Risk Factors

When the three risk factors are considered to be present (in spite of limited data) under current or foreseeable future conditions, the following steps should be followed (as described in the remaining parts of this section):

1) Risk screening;
2) Interim risk management;
3) Detailed quantitative risk assessment; and
4) Permanent risk reduction measures.

Risk Screening

This step is also known as "problem formulation" for environmental risk assessment. Where there is potential evidence of contamination at a site, the following steps are recommended:

- Identification of the location of suspected highest level of contamination through a combination of visual and historical operational information;
- Sampling and testing of the contaminated media (soils or water) according to established technical methods applicable to suspected type of contaminant[57,58];
- Evaluation of the analytical results against the local and national contaminated sites regulations. In the absence of such regulations or environmental standards, other sources of risk-based standards or guidelines should be consulted to obtain comprehensive criteria for screening soil concentrations of pollutants.[59]
- Verification of the potential human and/or ecological receptors and exposure pathways relevant to the site in question

The outcome of risk-screening may reveal that there is no overlap between the three risk-factors as the contaminant levels identified are below those considered to pose a risk to human health or the environment. Alternatively, interim or permanent

[57] BC MOE. http://www.env.gov.bc.ca/epd/epdpa/contam_sites/guidance

[58] Massachusetts Department of Environment. http://www.mass.gov/dep/cleanup

[59] These may include the USEPA Region 3 Risk-Based Concentrations (RBCs). http://www.epa.gov/reg3hwmd/risk/human/index.htm. These RBCs are considered acceptable for specific land use and contaminant exposure scenarios as they have been developed by governments using risk assessment techniques for use as general targets in the site remediation. Separate PRGs have been developed or adopted for soil, sediment or groundwater, and often a distinction is made between land uses (as noted earlier) because of the need for more stringent guidelines for residential and agricultural versus commercial/industrial landuse. The RBC Tables contains Reference Doses (RfDs) and Cancer Slope Factors (CSFs) for about 400 chemicals. These toxicity factors have been combined with "standard" exposure scenarios to calculate RBCs--chemical concentrations corresponding to fixed levels of risk (i.e., a Hazard Quotient (HQ) of 1, or lifetime cancer risk of 1E-6, whichever occurs at a lower concentration) in water, air, fish tissue, and soil for individual chemical substances. The primary use of RBCs is for chemical screening during baseline risk assessment (see EPA Regional Guidance EPA/903/R-93-001, "Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening"). Additional useful soil quality guidelines can also be obtained from Lijzen et al. 2001.

risk reduction measures may need to be taken with, or without, more detailed risk assessment activities, as described below.

Interim Risk Management

Interim risk management actions should be implemented at any phase of the project life cycle if the presence of land contamination poses an "imminent hazard", i.e., representing an immediate risk to human health and the environment if contamination were allowed to continue, even a short period of time. Examples of situations considered to involve imminent hazards include, but are not restricted to:

- Presence of an explosive atmosphere caused by contaminated land
- Accessible and excessive contamination for which short-term exposure and potency of contaminants could result in acute toxicity, irreversible long term effects, sensitization, or accumulation of persistent biocumulative and toxic substances
- Concentrations of pollutants at concentrations above the Risk Based Concentrations (RBCs[60]) or drinking water standards in potable water at the point of abstraction

Appropriate risk reduction should be implemented as soon as practicable to remove the condition posing the imminent hazard.

Detailed Risk Assessment

As an alternative to complying with numerical standards or preliminary remediation goals, and depending on local regulatory requirements, a detailed site-specific, environmental risk assessment may be used to develop strategies that yield acceptable health risks, while achieving low level contamination on-site. An assessment of contaminant risks needs to be considered in the context of current and future land use, and development scenarios (e.g., residential, commercial, industrial, and urban parkland or wilderness use).

A detailed quantitative risk assessment builds on risk screening (problem formulation). It involves first, a detailed site investigation to identify the scope of contamination.[61] Site investigation programs should apply quality assurance/quality control (QA/QC) measures to ensure that data quality is adequate for the intended data use (e.g., method detection limits are below levels of concern). The site investigation in turn should be used to develop a *conceptual site model* of how and where contaminants exist, how they are transported, and where routes of exposure occur to organisms and humans. The risk factors and conceptual site model provide a framework for assessing contaminant risks.

Human or ecological risk assessments facilitate risk management decisions at contaminated sites. Specific risk assessment objectives include:

- Identifying relevant human and ecological receptors (e.g., children, adults, fish, wildlife)
- Determining if contaminants are present at levels that pose potential human health and/or ecological concerns (e.g., levels above applicable regulatory criteria based on health or environmental risk considerations)
- Determining how human or ecological receptors are exposed to the contaminants (e.g., ingestions of soil, dermal contact, inhalation of dust)

[60] For example, USEPA Region 3 Risk-Based Concentrations (RBCs). http://www.epa.gov/reg3hwmd/risk/human/index.htm.

[61] Examples include processes defined by the American Society of Testing and Materials (ASTM) Phase II ESA Process; the British Columbia Ministry of Environment Canada (BC MOE) http://www.env.gov.bc.ca/epd/epdpa/contam_sites/guidance); and the Massachusetts Department of Environment http://www.mass.gov/dep/cleanup.

- Identifying the types of adverse effects that might result from exposure to the contaminants (e.g., effect on target organ, cancer, impaired growth or reproduction) in the absence of regulatory standards
- Quantifying the magnitude of health risks to human and ecological receptors based on a quantitative analysis of contaminant exposure and toxicity (e.g. calculate lifetime cancer risk or ratios of estimated exposure rates compared to safe exposure rates)
- Determining how current and proposed future land use influence the predicted risks (e.g. change of land use from industrial to residential with more sensitive receptors such as children)
- Quantifying the potential environmental and/or human health risks from off-site contaminant migration (e.g., consider if leaching and groundwater transport, or surface water transport results in exposure at adjacent lands/receptors)
- Determining if the risk is likely to remain stable, increase, or decrease with time in the absence of any remediation (e.g., consider if the contaminant is reasonably degradable and likely to remain in place, or be transported to other media)[62]

Addressing these objectives provides a basis to develop and implement risk reduction measures (e.g., clean-up, on-site controls) at the site. If such a need exists, the following additional objectives become relevant:

- Determining where, and in what conceptual manner, risk reduction measures should be implemented
- Identifying the preferred technologies (including engineering controls) needed to implement the conceptual risk reduction measures
- Developing a monitoring plan to ascertain whether risk reduction measures are effective
- Considering the need and appropriateness for institutional controls (e.g. deed restriction, land use restrictions) as part of a comprehensive approach

Permanent Risk Reduction Measures

The *risk factors* and *conceptual site model* within the contaminant risk approach described also provide a basis to manage and mitigate environmental contaminant health risks. The underlying principle is to reduce, eliminate, or control any or all of the three risk factors illustrated in Figure 1.8.1. A short list of examples of risk mitigation strategies is provided below, although actual strategies should be developed based on site-specific conditions, and the practicality of prevailing factors and site constraints. Regardless of the management options selected, the action plan should include, whenever possible, *contaminant source reduction* (i.e., net improvement of the site) as part of the overall strategy towards managing health risks at contaminated sites, as this alone provides for improved environmental quality.

Figure 1.8.2 presents a schematic of the inter-relationship of risk factors and example strategies to mitigate contaminant health risk by modifying the conditions of one or more risk factors to ultimately reduce contaminant exposure to the receptor. The selected approach should take into consideration the technical and financial feasibility (e.g. operability of a selected technology given the local availability of technical expertise and equipment and its associated costs).

Example risk mitigation strategies for contaminant source and exposure concentrations include:

[62] An example of a simplified quantitative risk assessment method is the ASTM E1739-95(2002) Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites and the ASTM E2081-00(2004)e1 Standard Guide for Risk-Based Corrective Action (at chemical release sites).

- Soil, sediment, and sludge:
  - In situ biological treatment (aerobic or anaerobic)
  - In situ physical/chemical treatment (e.g., soil vapor extraction with off-gas treatment, chemical oxidation)
  - In situ thermal treatment (e.g., steam injection, 6-phase heating)
  - Ex situ biological treatment (e.g., excavation and composting)
  - Ex situ physical/chemical treatment (e.g., excavation and stabilization)
  - Ex situ thermal treatment (e.g., excavation and thermal desorption or incineration)
  - Containment (e.g. landfill)
  - Natural attenuation
  - Other treatment processes
- Groundwater, surface water, and leachate:
  - In situ biological treatment (aerobic and/or aerobic)
  - In situ physical/chemical treatment (e.g., air sparging, zero-valent iron permeable reactive barrier)
  - Ex situ biological, physical, and or chemical treatment (i.e., groundwater extraction and treatment)
  - Containment (e.g., slurry wall or sheet pile barrier)
  - Natural attenuation
  - Other treatment processes
- Soil vapor intrusion:
  - Soil vapor extraction to reduce VOC contaminant source in soil
  - Installation of a sub-slab depressurization system to prevent migration of soil vapor into the building
  - Creating a positive pressure condition in buildings
  - Installation (during building construction) of an impermeable barrier below the building and/or an alternative flow pathway for soil vapor beneath building foundations (e.g., porous media and ventilation to shunt vapors away from building)

Example risk mitigation strategies for receptors include:

- Limiting or preventing access to contaminant by receptors (actions targeted at the receptor may include signage with instructions, fencing, or site security)
- Imposing health advisory or prohibiting certain practices leading to exposure such as fishing, crab trapping, shellfish collection
- Educating receptors (people) to modify behavior in order to reduce exposure (e.g., improved work practices, and use of protective clothing and equipment)

Example risk mitigation strategies for exposure pathways include:

- Providing an alternative water supply to replace, for example, a contaminated groundwater supply well
- Capping contaminated soil with at least 1m of clean soil to prevent human contact, as well as plant root or small mammal penetration into contaminated soils
- Paving over contaminated soil as an interim measure to negate the pathway of direct contact or dust generation and inhalation
- Using an interception trench and pump, and treat technologies to prevent contaminated groundwater from discharging into fish streams

The above-reference containment measures should also be considered for immediate implementation in situations where source reduction measures are expected to take time.

Occupational Health and Safety Considerations

Investigation and remediation of contaminated lands requires that workers be mindful of the occupational exposures that could arise from working in close contact with contaminated soil or other environmental media (e.g., groundwater, wastewater, sediments, and soil vapor). Occupational health and safety precautions should be exercised to minimize exposure, as described in Section 2 on Occupational Health and Safety. In addition, workers on contaminated sites should receive special health and safety training specific to contaminated site investigation and remediation activities.[63]

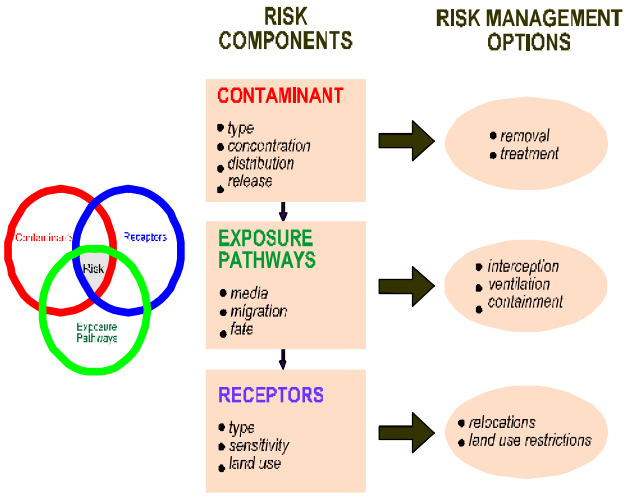


FIGURE 1.8.2: Inter-Relationship of Risk Factors and Management Options

[63] For example, US Occupational Safety and Health Agency (OSHA) regulations found at 40 CFR 1910.120. http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9765

2.0 Occupational Health and Safety

Applicability and Approach

Employers and supervisors are obliged to implement all reasonable precautions to protect the health and safety of workers. This section provides guidance and examples of reasonable precautions to implement in managing principal risks to occupational health and safety. Although the focus is placed on the operational phase of projects, much of the guidance also applies to construction and decommissioning activities. Companies should hire contractors that have the technical capability to manage the occupational health and safety issues of their employees, extending the application of the hazard management activities through formal procurement agreements.

Preventive and protective measures should be introduced according to the following order of priority:

- *Eliminating the hazard* by removing the activity from the work process. Examples include substitution with less hazardous chemicals, using different manufacturing processes, etc;
- *Controlling the hazard* at its source through use of engineering controls. Examples include local exhaust ventilation, isolation rooms, machine guarding, acoustic insulating, etc;
- *Minimizing the hazard* through design of safe work systems and administrative or institutional control measures. Examples include job rotation, training safe work procedures, lock-out and tag-out, workplace monitoring, limiting exposure or work duration, etc.
- *Providing appropriate personal protective equipment (PPE)* in conjunction with training, use, and maintenance of the PPE.

The application of prevention and control measures to occupational hazards should be based on comprehensive job

safety or job hazard analyses. The results of these analyses should be prioritized as part of an action plan based on the likelihood and severity of the consequence of exposure to the identified hazards. An example of a qualitative risk ranking or analysis matrix to help identify priorities is described in Table 2.1.1.

Table 2.1.1. Risk Ranking Table to Classify Worker Scenarios Based on Likelihood and Consequence

Likelihood	Consequences				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Catas-trophic 5
A. Almost certain	L	M	E	E	E
B. Likely	L	M	H	E	E
C. Moderate	L	M	H	E	E
D. Unlikely	L	L	M	H	E
E. Rare	L	L	M	H	H

Legend
E: extreme risk; immediate action required
H: high risk; senior management attention needed
M: moderate risk; management responsibility should be specified
L: low risk; manage by routine procedures

2.1 General Facility Design and Operation

Integrity of Workplace Structures

Permanent and recurrent places of work should be designed and equipped to protect OHS:

- Surfaces, structures and installations should be easy to clean and maintain, and not allow for accumulation of hazardous compounds.
- Buildings should be structurally safe, provide appropriate protection against the climate, and have acceptable light and noise conditions.
- Fire resistant, noise-absorbing materials should, to the extent feasible, be used for cladding on ceilings and walls.
- Floors should be level, even, and non-skid.
- Heavy oscillating, rotating or alternating equipment should be located in dedicated buildings or structurally isolated sections.

Severe Weather and Facility Shutdown

- Work place structures should be designed and constructed to withstand the expected elements for the region and have an area designated for safe refuge, if appropriate.
- Standard Operating Procedures (SOPs) should be developed for project or process shut-down, including an evacuation plan. Drills to practice the procedure and plan should also be undertaken annually.

Workspace and Exit

- The space provided for each worker, and in total, should be adequate for safe execution of all activities, including transport and interim storage of materials and products.
- Passages to emergency exits should be unobstructed at all times. Exits should be clearly marked to be visible in total darkness. The number and capacity of emergency exits should be sufficient for safe and orderly evacuation of the greatest number of people present at any time, and there should be a minimum two exits from any work area.

- Facilities also should be designed and built taking into account the needs of disabled persons.

Fire Precautions

The workplace should be designed to prevent the start of fires through the implementation of fire codes applicable to industrial settings. Other essential measures include:

- Equipping facilities with fire detectors, alarm systems, and fire-fighting equipment. The equipment should be maintained in good working order and be readily accessible. It should be adequate for the dimensions and use of the premises, equipment installed, physical and chemical properties of substances present, and the maximum number of people present.
- Provision of manual firefighting equipment that is easily accessible and simple to use
- Fire and emergency alarm systems that are both audible and visible

The IFC Life and Fire Safety Guideline should apply to buildings accessible to the public (See Section 3.3).

Lavatories and Showers

- Adequate lavatory facilities (toilets and washing areas) should be provided for the number of people expected to work in the facility and allowances made for segregated facilities, or for indicating whether the toilet facility is "In Use" or "Vacant". Toilet facilities should also be provided with adequate supplies of hot and cold running water, soap, and hand drying devices.
- Where workers may be exposed to substances poisonous by ingestion and skin contamination may occur, facilities for showering and changing into and out of street and work clothes should be provided.

Potable Water Supply

- Adequate supplies of potable drinking water should be provided from a fountain with an upward jet or with a sanitary means of collecting the water for the purposes of drinking
- Water supplied to areas of food preparation or for the purpose of personal hygiene (washing or bathing) should meet drinking water quality standards

Clean Eating Area

- Where there is potential for exposure to substances poisonous by ingestion, suitable arrangements are to be made for provision of clean eating areas where workers are not exposed to the hazardous or noxious substances

Lighting

- Workplaces should, to the degree feasible, receive natural light and be supplemented with sufficient artificial illumination to promote workers' safety and health, and enable safe equipment operation. Supplemental 'task lighting' may be required where specific visual acuity requirements should be met.
- Emergency lighting of adequate intensity should be installed and automatically activated upon failure of the principal artificial light source to ensure safe shut-down, evacuation, etc.

Safe Access

- Passageways for pedestrians and vehicles within and outside buildings should be segregated and provide for easy, safe, and appropriate access
- Equipment and installations requiring servicing, inspection, and/or cleaning should have unobstructed, unrestricted, and ready access
- Hand, knee and foot railings should be installed on stairs, fixed ladders, platforms, permanent and interim floor openings, loading bays, ramps, etc.

- Openings should be sealed by gates or removable chains
- Covers should, if feasible, be installed to protect against falling items
- Measures to prevent unauthorized access to dangerous areas should be in place

First Aid

- The employer should ensure that qualified first-aid can be provided at all times. Appropriately equipped first-aid stations should be easily accessible throughout the place of work
- Eye-wash stations and/or emergency showers should be provided close to all workstations where immediate flushing with water is the recommended first-aid response
- Where the scale of work or the type of activity being carried out so requires, dedicated and appropriately equipped first-aid room(s) should be provided. First aid stations and rooms should be equipped with gloves, gowns, and masks for protection against direct contact with blood and other body fluids
- Remote sites should have written emergency procedures in place for dealing with cases of trauma or serious illness up to the point at which patient care can be transferred to an appropriate medical facility.

Air Supply

- Sufficient fresh air should be supplied for indoor and confined work spaces. Factors to be considered in ventilation design include physical activity, substances in use, and process-related emissions. Air distribution systems should be designed so as not to expose workers to draughts
- Mechanical ventilation systems should be maintained in good working order. Point-source exhaust systems required for maintaining a safe ambient environment should have local indicators of correct functioning.
- Re-circulation of contaminated air is not acceptable. Air inlet filters should be kept clean and free of dust and microorganisms. Heating, ventilation and air conditioning (HVAC) and industrial evaporative cooling systems should be equipped, maintained and operated so as to prevent growth and spreading of disease agents (e.g. *Legionnella pneumophilia*) or breeding of vectors (e.g. mosquitoes and flies) of public health concern.

Work Environment Temperature

- The temperature in work, rest room and other welfare facilities should, during service hours, be maintained at a level appropriate for the purpose of the facility.

2.2 Communication and Training

OHS Training

- Provisions should be made to provide OHS orientation training to all new employees to ensure they are apprised of the basic site rules of work at / on the site and of personal protection and preventing injury to fellow employees.
- Training should consist of basic hazard awareness, site-specific hazards, safe work practices, and emergency procedures for fire, evacuation, and natural disaster, as appropriate. Any site-specific hazard or color coding in use should be thoroughly reviewed as part of orientation training.

Visitor Orientation

- If visitors to the site can gain access to areas where hazardous conditions or substances may be present, a visitor orientation and control program should be established to ensure visitors do not enter hazard areas unescorted.

New Task Employee and Contractor Training

- The employer should ensure that workers and contractors, prior to commencement of new assignments, have received adequate training and information enabling them to

understand work hazards and to protect their health from hazardous ambient factors that may be present.
The training should adequately cover:

- Knowledge of materials, equipment, and tools
- Known hazards in the operations and how they are controlled
- Potential risks to health
- Precautions to prevent exposure
- Hygiene requirements
- Wearing and use of protective equipment and clothing
- Appropriate response to operation extremes, incidents and accidents

Basic OHS Training

- A basic occupational training program and specialty courses should be provided, as needed, to ensure that workers are oriented to the specific hazards of individual work assignments. Training should generally be provided to management, supervisors, workers, and occasional visitors to areas of risks and hazards.
- Workers with rescue and first-aid duties should receive dedicated training so as not to inadvertently aggravate exposures and health hazards to themselves or their co-workers. Training would include the risks of becoming infected with blood–borne pathogens through contact with bodily fluids and tissue.
- Through appropriate contract specifications and monitoring, the employer should ensure that service providers, as well as contracted and subcontracted labor, are trained adequately before assignments begin.

Area Signage

- Hazardous areas (electrical rooms, compressor rooms, etc), installations, materials, safety measures, and emergency exits, etc. should be marked appropriately.
- Signage should be in accordance with international standards and be well known to, and easily understood by workers, visitors and the general public as appropriate.

Labeling of Equipment

- All vessels that may contain substances that are hazardous as a result of chemical or toxicological properties, or temperature or pressure, should be labeled as to the contents and hazard, or appropriately color coded.
- Similarly, piping systems that contain hazardous substances should be labeled with the direction of flow and contents of the pipe, or color coded whenever the pipe passing through a wall or floor is interrupted by a valve or junction device.

Communicate Hazard Codes

- Copies of the hazard coding system should be posted outside the facility at emergency entrance doors and fire emergency connection systems where they are likely to come to the attention of emergency services personnel.
- Information regarding the types of hazardous materials stored, handled or used at the facility, including typical maximum inventories and storage locations, should be shared proactively with emergency services and security personnel to expedite emergency response when needed.
- Representatives of local emergency and security services should be invited to participate in periodic (annual) orientation tours and site inspections to ensure familiarity with potential hazards present.

2.3 Physical Hazards

Physical hazards represent potential for accident or injury or illness due to repetitive exposure to mechanical action or work activity. Single exposure to physical hazards may result in a wide range of injuries, from minor and medical aid only, to disabling, catastrophic, and/or fatal. Multiple exposures over prolonged

periods can result in disabling injuries of comparable significance and consequence.

Rotating and Moving Equipment

Injury or death can occur from being trapped, entangled, or struck by machinery parts due to unexpected starting of equipment or unobvious movement during operations. Recommended protective measures include:

- Designing machines to eliminate trap hazards and ensuring that extremities are kept out of harm's way under normal operating conditions. Examples of proper design considerations include two-hand operated machines to prevent amputations or the availability of emergency stops dedicated to the machine and placed in strategic locations. Where a machine or equipment has an exposed moving part or exposed pinch point that may endanger the safety of any worker, the machine or equipment should be equipped with, and protected by, a guard or other device that prevents access to the moving part or pinch point. Guards should be designed and installed in conformance with appropriate machine safety standards.[64]
- Turning off, disconnecting, isolating, and de-energizing (Locked Out and Tagged Out) machinery with exposed or guarded moving parts, or in which energy can be stored (e.g. compressed air, electrical components) during servicing or maintenance, in conformance with a standard such as CSA Z460 Lockout or equivalent ISO or ANSI standard
- Designing and installing equipment, where feasible, to enable routine service, such as lubrication, without removal of the guarding devices or mechanisms

[64] For example: CSA Z432.04 Safe Guarding of Machinery, CSA Z434 Robot Safety, ISO 11161 Safety of Machinery – Integrated Manufacturing Systems or ISO 14121 Safety of Machinery – Principals of Risk Management or equivalent ANSI standard.

Noise

Noise limits for different working environments are provided in Table 2.3.1.

- No employee should be exposed to a noise level greater than 85 dB(A) for a duration of more than 8 hours per day without hearing protection. In addition, no unprotected ear should be exposed to a peak sound pressure level (instantaneous) of more than 140 dB(C).
- The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reach 140 dB(C), or the average maximum sound level reaches 110dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85 dB(A).
- Although hearing protection is preferred for any period of noise exposure in excess of 85 dB(A), an equivalent level of protection can be obtained, but less easily managed, by limiting the duration of noise exposure. For every 3 dB(A) increase in sound levels, the 'allowed' exposure period or duration should be reduced by 50 percent.[65]
- Prior to the issuance of hearing protective devices as the final control mechanism, use of acoustic insulating materials, isolation of the noise source, and other engineering controls should be investigated and implemented, where feasible
- Periodic medical hearing checks should be performed on workers exposed to high noise levels

Vibration

Exposure to hand-arm vibration from equipment such as hand and power tools, or whole-body vibrations from surfaces on which the worker stands or sits, should be controlled through choice of equipment, installation of vibration dampening pads or devices, and limiting the duration of exposure. Limits for vibration and

[65] The American Conference of Governmental Industrial Hygienists (ACGIH), 2006

action values, (i.e. the level of exposure at which remediation should be initiated) are provided by the ACGIH[66]. Exposure levels should be checked on the basis of daily exposure time and data provided by equipment manufacturers.

Electrical

Exposed or faulty electrical devices, such as circuit breakers, panels, cables, cords and hand tools, can pose a serious risk to workers. Overhead wires can be struck by metal devices, such as poles or ladders, and by vehicles with metal booms. Vehicles or grounded metal objects brought into close proximity with overhead wires can result in arcing between the wires and the object, without actual contact. Recommended actions include:

Table 2.3.1. Noise Limits for Various Working Environments

Location /activity	Equivalent level LA_{eq},8h	Maximum LA_{max},fast
Heavy Industry (no demand for oral communication)	85 dB(A)	110 dB(A)
Light industry (decreasing demand for oral communication)	50-65 dB(A)	110 dB(A)
Open offices, control rooms, service counters or similar	45-50 dB(A)	-
Individual offices (no disturbing noise)	40-45 dB(A)	-
Classrooms, lecture halls	35-40 dB(A)	-
Hospitals	30-35 dB(A)	40 dB(A)

- Marking all energized electrical devices and lines with warning signs
- Locking out (de-charging and leaving open with a controlled locking device) and tagging-out (warning sign placed on the lock) devices during service or maintenance
- Checking all electrical cords, cables, and hand power tools for frayed or exposed cords and following manufacturer recommendations for maximum permitted operating voltage of the portable hand tools
- Double insulating / grounding all electrical equipment used in environments that are, or may become, wet; using equipment with ground fault interrupter (GFI) protected circuits
- Protecting power cords and extension cords against damage from traffic by shielding or suspending above traffic areas
- Appropriate labeling of service rooms housing high voltage equipment ('electrical hazard') and where entry is controlled or prohibited (see also Section 3 on Planning, Siting, and Design);
- Establishing "No Approach" zones around or under high voltage power lines in conformance with Table 2.3.2
- Rubber tired construction or other vehicles that come into direct contact with, or arcing between, high voltage wires may need to be taken out of service for periods of 48 hours and have the tires replaced to prevent catastrophic tire and wheel assembly failure, potentially causing serious injury or death;
- Conducting detailed identification and marking of all buried electrical wiring prior to any excavation work

[66] ACGIH, 2005

Table 2.3.2. No Approach Zones for High Voltage Power Lines	
Nominal phase-to-phase voltage rating	Minimum distance
750 or more volts, but no more than 150,000 volts	3 meters
More than 150,000 volts, but no more than 250,000 volts	4.5 meters
More than 250,000 volts	6 meters

Eye Hazards

Solid particles from a wide variety of industrial operations, and / or a liquid chemical spray may strike a worker in the eye causing an eye injury or permanent blindness. Recommended measures include:

- Use of machine guards or splash shields and/or face and eye protection devices, such as safety glasses with side shields, goggles, and/or a full face shield. Specific Safe Operating Procedures (SOPs) may be required for use of sanding and grinding tools and/or when working around liquid chemicals. Frequent checks of these types of equipment prior to use to ensure mechanical integrity is also good practice. Machine and equipment guarding should conform to standards published by organizations such as CSA, ANSI and ISO (see also Section 2.3 on Rotating and Moving Equipment and 2.7 on Personal Protective Equipment).
- Moving areas where the discharge of solid fragments, liquid, or gaseous emissions can reasonably be predicted (e.g. discharge of sparks from a metal cutting station, pressure relief valve discharge) away from places expected to be occupied or transited by workers or visitors. Where machine or work fragments could present a hazard to transient workers or passers-by, extra area guarding or proximity restricting systems should be implemented, or PPE required for transients and visitors.
- Provisions should be made for persons who have to wear prescription glasses either through the use overglasses or prescription hardened glasses.

Welding / Hot Work

Welding creates an extremely bright and intense light that may seriously injur a worker's eyesight. In extreme cases, blindness may result. Additionally, welding may produce noxious fumes to which prolonged exposure can cause serious chronic diseases. Recommended measures include:

- Provision of proper eye protection such as welder goggles and/or a full-face eye shield for all personnel involved in, or assisting, welding operations. Additional methods may include the use of welding barrier screens around the specific work station (a solid piece of light metal, canvas, or plywood designed to block welding light from others). Devices to extract and remove noxious fumes at the source may also be required.
- Special hot work and fire prevention precautions and Standard Operating Procedures (SOPs) should be implemented if welding or hot cutting is undertaken outside established welding work stations, including 'Hot Work Permits, stand-by fire extinguishers, stand-by fire watch, and maintaining the fire watch for up to one hour after welding or hot cutting has terminated. Special procedures are required for hotwork on tanks or vessels that have contained flammable materials.

Industrial Vehicle Driving and Site Traffic

Poorly trained or inexperienced industrial vehicle drivers have increased risk of accident with other vehicles, pedestrians, and equipment. Industrial vehicles and delivery vehicles, as well as private vehicles on-site, also represent potential collision scenarios. Industrial vehicle driving and site traffic safety practices include:

- Training and licensing industrial vehicle operators in the safe operation of specialized vehicles such as forklifts, including safe loading/unloading, load limits
- Ensuring drivers undergo medical surveillance
- Ensuring moving equipment with restricted rear visibility is outfitted with audible back-up alarms
- Establishing rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures (e.g. prohibiting operation of forklifts with forks in down position), and control of traffic patterns or direction
- Restricting the circulation of delivery and private vehicles to defined routes and areas, giving preference to 'one-way' circulation, where appropriate

Working Environment Temperature

Exposure to hot or cold working conditions in indoor or outdoor environments can result temperature stress-related injury or death. Use of personal protective equipment (PPE) to protect against other occupational hazards can accentuate and aggravate heat-related illnesses. Extreme temperatures in permanent work environments should be avoided through implementation of engineering controls and ventilation. Where this is not possible, such as during short-term outdoor work, temperature-related stress management procedures should be implemented which include:

- Monitoring weather forecasts for outdoor work to provide advance warning of extreme weather and scheduling work accordingly
- Adjustment of work and rest periods according to temperature stress management procedures provided by ACGIH[67], depending on the temperature and workloads
- Providing temporary shelters to protect against the elements during working activities or for use as rest areas
- Use of protective clothing
- Providing easy access to adequate hydration such as drinking water or electrolyte drinks, and avoiding consumption of alcoholic beverages

Ergonomics, Repetitive Motion, Manual Handling

Injuries due to ergonomic factors, such as repetitive motion, over-exertion, and manual handling, take prolonged and repeated exposures to develop, and typically require periods of weeks to months for recovery. These OHS problems should be minimized or eliminated to maintain a productive workplace. Controls may include:

- Facility and workstation design with 5th to 95th percentile operational and maintenance workers in mind
- Use of mechanical assists to eliminate or reduce exertions required to lift materials, hold tools and work objects, and requiring multi-person lifts if weights exceed thresholds
- Selecting and designing tools that reduce force requirements and holding times, and improve postures
- Providing user adjustable work stations
- Incorporating rest and stretch breaks into work processes, and conducting job rotation
- Implementing quality control and maintenance programs that reduce unnecessary forces and exertions
- Taking into consideration additional special conditions such as left handed persons

Working at Heights

Fall prevention and protection measures should be implemented whenever a worker is exposed to the hazard of falling more than two meters; into operating machinery; into water or other liquid; into hazardous substances; or through an opening in a work surface. Fall prevention / protection measures may also be warranted on a case-specific basis when there are risks of falling from lesser heights. Fall prevention may include:

[67] ACGIH, 2005

- Installation of guardrails with mid-rails and toe boards at the edge of any fall hazard area
- Proper use of ladders and scaffolds by trained employees
- Use of fall prevention devices, including safety belt and lanyard travel limiting devices to prevent access to fall hazard area, or fall protection devices such as full body harnesses used in conjunction with shock absorbing lanyards or self-retracting inertial fall arrest devices attached to fixed anchor point or horizontal life-lines
- Appropriate training in use, serviceability, and integrity of the necessary PPE
- Inclusion of rescue and/or recovery plans, and equipment to respond to workers after an arrested fall

Illumination

Work area light intensity should be adequate for the general purpose of the location and type of activity, and should be supplemented with dedicated work station illumination, as needed. The minimum limits for illumination intensity for a range of locations/activities appear in Table 2.3.3.

Table 2.3.3. Minimum Limits For Workplace Illumination Intensity

Location / Activity	Light Intensity
Emergency light	10 lux
Outdoor non working areas	20 lux
Simple orientation and temporary visits (machine storage, garage, warehouse)	50 lux
Workspace with occasional visual tasks only (corridors, stairways, lobby, elevator, auditorium, etc.)	100 lux
Medium precision work (simple assembly, rough machine works, welding, packing, etc.)	200 lux
Precision work (reading, moderately difficult assembly, sorting, checking, medium bench and machine works, etc.), offices.	500 lux
High precision work (difficult assembly, sewing, color inspection, fine sorting etc.)	1,000 – 3,000 lux

Controls should include:

- Use of energy efficient light sources with minimum heat emission
- Undertaking measures to eliminate glare / reflections and flickering of lights
- Taking precautions to minimize and control optical radiation including direct sunlight. Exposure to high intensity UV and IR radiation and high intensity visible light should also be controlled
- Controlling laser hazards in accordance with equipment specifications, certifications, and recognized safety standards. The lowest feasible class Laser should be applied to minimize risks.

2.4 Chemical Hazards

Chemical hazards represent potential for illness or injury due to single acute exposure or chronic repetitive exposure to toxic, corrosive, sensitizing or oxidative substances. They also represent a risk of uncontrolled reaction, including the risk of fire and explosion, if incompatible chemicals are inadvertently mixed. Chemical hazards can most effectively be prevented through a hierarchical approach that includes:

- Replacement of the hazardous substance with a less hazardous substitute
- Implementation of engineering and administrative control measures to avoid or minimize the release of hazardous substances into the work environment keeping the level of exposure below internationally established or recognized limits
- Keeping the number of employees exposed, or likely to become exposed, to a minimum

- Communicating chemical hazards to workers through labeling and marking according to national and internationally recognized requirements and standards, including the International Chemical Safety Cards (ICSC), Materials Safety Data Sheets (MSDS), or equivalent. Any means of written communication should be in an easily understood language and be readily available to exposed workers and first-aid personnel
- Training workers in the use of the available information (such as MSDSs), safe work practices, and appropriate use of PPE

Air Quality

Poor air quality due to the release of contaminants into the work place can result in possible respiratory irritation, discomfort, or illness to workers. Employers should take appropriate measures to maintain air quality in the work area. These include:

- Maintaining levels of contaminant dusts, vapors and gases in the work environment at concentrations below those recommended by the ACGIH[68] as TWA-TLV's (threshold limit value)—concentrations to which most workers can be exposed repeatedly (8 hours/day, 40 hrs/week, week-after-week), without sustaining adverse health effects.
- Developing and implementing work practices to minimize release of contaminants into the work environment including:
  - Direct piping of liquid and gaseous materials
  - Minimized handling of dry powdered materials;
  - Enclosed operations
  - Local exhaust ventilation at emission / release points
  - Vacuum transfer of dry material rather than mechanical or pneumatic conveyance
  - Indoor secure storage, and sealed containers rather than loose storage
- Where ambient air contains several materials that have similar effects on the same body organs (additive effects), taking into account combined exposures using calculations recommended by the ACGIH[69]
- Where work shifts extend beyond eight (8) hours, calculating adjusted workplace exposure criteria recommended by the ACGIH[70]

Fire and Explosions

Fires and or explosions resulting from ignition of flammable materials or gases can lead to loss of property as well as possible injury or fatalities to project workers. Prevention and control strategies include:

- Storing flammables away from ignition sources and oxidizing materials. Further, flammables storage area should be:
  - Remote from entry and exit points into buildings
  - Away from facility ventilation intakes or vents
  - Have natural or passive floor and ceiling level ventilation and explosion venting
  - Use spark-proof fixtures
  - Be equipped with fire extinguishing devices and self-closing doors, and constructed of materials made to withstand flame impingement for a moderate period of time
- Providing bonding and grounding of, and between, containers and additional mechanical floor level ventilation if materials are being, or could be, dispensed in the storage area
- Where the flammable material is mainly comprised of dust, providing electrical grounding, spark detection, and, if needed, quenching systems

[68] ACGIH, 2005

[69] ACGIH, 2005.

[70] ACGIH, 2005.

- Defining and labeling fire hazards areas to warn of special rules (e.g. prohibition in use of smoking materials, cellular phones, or other potential spark generating equipment)
- Providing specific worker training in handling of flammable materials, and in fire prevention or suppression

Corrosive, oxidizing, and reactive chemicals

Corrosive, oxidizing, and reactive chemicals present similar hazards and require similar control measures as flammable materials. However, the added hazard of these chemicals is that inadvertent mixing or intermixing may cause serious adverse reactions. This can lead to the release of flammable or toxic materials and gases, and may lead directly to fires and explosions. These types of substances have the additional hazard of causing significant personal injury upon direct contact, regardless of any intermixing issues. The following controls should be observed in the work environment when handling such chemicals:

- Corrosive, oxidizing and reactive chemicals should be segregated from flammable materials and from other chemicals of incompatible class (acids vs. bases, oxidizers vs. reducers, water sensitive vs. water based, etc.), stored in ventilated areas and in containers with appropriate secondary containment to minimize intermixing during spills
- Workers who are required to handle corrosive, oxidizing, or reactive chemicals should be provided with specialized training and provided with, and wear, appropriate PPE (gloves, apron, splash suits, face shield or goggles, etc).
- Where corrosive, oxidizing, or reactive chemicals are used, handled, or stored, qualified first-aid should be ensured at all times. Appropriately equipped first-aid stations should be easily accessible throughout the place of work, and eye-wash stations and/or emergency showers should be provided close to all workstations where the recommended first-aid response is immediate flushing with water

Asbestos Containing Materials (ACM)

The use of asbestos containing materials (ACM) should be avoided in new buildings or as a new material in remodeling or renovation activities. Existing facilities with ACM should develop an asbestos management plan which clearly identifies the locations where the ACM is present, its condition (e.g. whether it is in friable form with the potential to release fibers), procedures for monitoring its condition, procedures to access the locations where ACM is present to avoid damage, and training of staff who can potentially come into contact with the material to avoid damage and prevent exposure. The plan should be made available to all persons involved in operations and maintenance activities. Repair or removal and disposal of existing ACM in buildings should only be performed by specially trained personnel[71] following host country requirements, or in their absence, internationally recognized procedures.[72]

2.5 Biological Hazards

Biological agents represent potential for illness or injury due to single acute exposure or chronic repetitive exposure. Biological hazards can be prevented most effectively by implementing the following measures:

- If the nature of the activity permits, use of any harmful biological agents should be avoided and replaced with an agent that, under normal conditions of use, is not dangerous or less dangerous to workers. If use of harmful agents can not be avoided, precautions should be taken to keep the risk of exposure as low as possible and maintained below internationally established and recognized exposure limits.

[71] Training of specialized personnel and the maintenance and removal methods applied should be equivalent to those required under applicable regulations in the United States and Europe (examples of North American training standards are available at: http://www.osha.gov/SLTC/asbestos/training.html)

[72] Examples include the American Society for Testing and Materials (ASTM) E 1368 - Standard Practice for Visual Inspection of Asbestos Abatement Projects; E 2356 - Standard Practice for Comprehensive Building Asbestos Surveys; and E 2394 - Standard Practice for Maintenance, Renovation and Repair of Installed Asbestos Cement Products.

- Work processes, engineering, and administrative controls should be designed, maintained, and operated to avoid or minimize release of biological agents into the working environment. The number of employees exposed or likely to become exposed should be kept at a minimum.
- The employer should review and assess known and suspected presence of biological agents at the place of work and implement appropriate safety measures, monitoring, training, and training verification programs.
- Measures to eliminate and control hazards from known and suspected biological agents at the place of work should be designed, implemented and maintained in close co-operation with the local health authorities and according to recognized international standards.

Biological agents should be classified into four groups[73]:

- ***Group 1:*** Biological agents unlikely to cause human disease, and consequently only require controls similar to those required for hazardous or reactive chemical substances;
- ***Group 2:*** Biological agents that can cause human disease and are thereby likely to require additional controls, but are unlikely to spread to the community;
- ***Group 3***: Biological agents that can cause severe human disease, present a serious hazard to workers, and may present a risk of spreading to the community, for which there usually is effective prophylaxis or treatment available and are thereby likely to require extensive additional controls;
- ***Group 4:*** Biological agents that can cause severe human disease, are a serious hazard to workers, and present a high risk of spreading to the community, for which there is usually no effective prophylaxis or treatment available and are thereby likely to require very extensive additional controls.

The employer should at all times encourage and enforce the highest level of hygiene and personal protection, especially for activities employing biological agents of Groups 3 and 4 above. Work involving agents in Groups 3 and 4 should be restricted only to those persons who have received specific verifiable training in working with and controlling such materials.

Areas used for the handling of Groups 3 and 4 biological agents should be designed to enable their full segregation and isolation in emergency circumstances, include independent ventilation systems, and be subject to SOPs requiring routine disinfection and sterilization of the work surfaces.

HVAC systems serving areas handling Groups 3 and 4 biological agents should be equipped with High Efficiency Particulate Air (HEPA) filtration systems. Equipment should readily enable their disinfection and sterilization, and maintained and operated so as to prevent growth and spreading of disease agents, amplification of the biological agents, or breeding of vectors e.g. mosquitoes and flies of public health concern.

[73] World Health Organization (WHO) Classification of Infective Microorganisms by Risk Group (2004).

2.6 Radiological Hazards

Radiation exposure can lead to potential discomfort, injury or serious illness to workers. Prevention and control strategies include:

- Places of work involving occupational and/or natural exposure to ionizing radiation should be established and operated in accordance with recognized international safety standards and guidelines.[74] The acceptable effective dose limits appear Table 2.6.1.
- Exposure to non-ionizing radiation (including static magnetic fields; sub-radio frequency magnetic fields; static electric fields; radio frequency and microwave radiation; light and near-infrared radiation; and ultraviolet radiation) should be controlled to internationally recommended limits[75].

Table 2.6.1. Acceptable Effective Dose Limits for Workplace Radiological Hazards

Exposure	Workers (min.19 years of age)	Apprentices and students (16-18 years of age)
Five consecutive year average – effective dose	20 mSv/year	
Single year exposure – effective dose	50 mSv/year	6 mSv/year
Equivalent dose to the lens of the eye	150 mSv/year	50 mSv/year
Equivalent dose to the extremities (hands, feet) or the skin	500 mSv/year	150 mSv/year

- In the case of both ionizing and non-ionizing radiation, the preferred method for controlling exposure is shielding and limiting the radiation source. Personal protective equipment is supplemental only or for emergency use. Personal protective equipment for near-infrared, visible and ultraviolet range radiation can include appropriate sun block creams, with or without appropriate screening clothing.

2.7 Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) provides additional protection to workers exposed to workplace hazards in conjunction with other facility controls and safety systems.

PPE is considered to be a last resort that is above and beyond the other facility controls and provides the worker with an extra level of personal protection. Table 2.7.1 presents general examples of occupational hazards and types of PPE available for different purposes. Recommended measures for use of PPE in the workplace include:

- Active use of PPE if alternative technologies, work plans or procedures cannot eliminate, or sufficiently reduce, a hazard or exposure
- Identification and provision of appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors, without incurring unnecessary inconvenience to the individual
- Proper maintenance of PPE, including cleaning when dirty and replacement when damaged or worn out. Proper use of PPE should be part of the recurrent training programs for employees

[74] International Basic Safety Standard for protection against Ionizing Radiation and for the Safety of Radiation Sources and its three interrelated Safety Guides.

IAEA. http://www-ns.iaea.org/standards/documents/default.asp?sub=160

[75] For example ACGIH (2005) and International Commission for Non-Ionizing Radiation (ICNIRP).

- Selection of PPE should be based on the hazard and risk ranking described earlier in this section, and selected according to criteria on performance and testing established by recognized organizations[76].

Table 2.7.1. Summary of Recommended Personal Protective Equipment According to Hazard

Objective	Workplace Hazards	Suggested PPE
Eye and face protection	Flying particles, molten metal, liquid chemicals, gases or vapors, light radiation.	Safety Glasses with side-shields, protective shades, etc.
Head protection	Falling objects, inadequate height clearance, and overhead power cords.	Plastic Helmets with top and side impact protection.
Hearing protection	Noise, ultra-sound.	Hearing protectors (ear plugs or ear muffs).
Foot protection	Falling or rolling objects, pointed objects. Corrosive or hot liquids.	Safety shoes and boots for protection against moving & falling objects, liquids and chemicals.
Hand protection	Hazardous materials, cuts or lacerations, vibrations, extreme temperatures.	Gloves made of rubber or synthetic materials (Neoprene), leather, steel, insulating materials, etc.
Respiratory protection	Dust, fogs, fumes, mists, gases, smokes, vapors.	Facemasks with appropriate filters for dust removal and air purification (chemicals, mists, vapors and gases). Single or multi-gas personal monitors, if available.
	Oxygen deficiency	Portable or supplied air (fixed lines). On-site rescue equipment.
Body/leg protection	Extreme temperatures, hazardous materials, biological agents, cutting and laceration.	Insulating clothing, body suits, aprons etc. of appropriate materials.

2.8 Special Hazard Environments

Special hazard environments are work situations where all of the previously described hazards may exist under unique or especially hazardous circumstances. Accordingly, extra precautions or rigor in application of precautions is required.

Confined Space

A confined space is defined as a wholly or partially enclosed space not designed or intended for human occupancy and in which a hazardous atmosphere could develop as a result of the contents, location or construction of the confined space or due to work done in or around the confined space. A "permit-required" confined space is one that also contains physical or atmospheric hazards that could trap or engulf the person.[77]

Confined spaces can occur in enclosed or open structures or locations. Serious injury or fatality can result from inadequate preparation to enter a confined space or in attempting a rescue from a confined space. Recommended management approaches include:

- Engineering measures should be implemented to eliminate, to the degree feasible, the existence and adverse character of confined spaces.
- Permit-required confined spaces should be provided with permanent safety measures for venting, monitoring, and rescue operations, to the extent possible. The area adjoining an access to a confined space should provide ample room for emergency and rescue operations.

[76] Examples include the American National Standards Institute (ANSI), http://www.ansi.org/; National Institute for Occupational Safety and Health[76] (NIOSH), http://www.cdc.gov/niosh/homepage.html; Canadian Standards Association[76] (CSA), http://www.csa.ca/Default.asp?language=english; Mine Safety and Health Administration[76] (MSHA), http://www.msha.gov.

[77] US OSHA CFR 1910.146

- Access hatches should accommodate 90% of the worker population with adjustments for tools and protective clothing. The most current ISO and EN standards should be consulted for design specifications;
- Prior to entry into a permit-required confined space:
  - Process or feed lines into the space should be disconnected or drained, and blanked and locked-out.
  - Mechanical equipment in the space should be disconnected, de-energized, locked-out, and braced, as appropriate.
  - The atmosphere within the confined space should be tested to assure the oxygen content is between 19.5 percent and 23 percent, and that the presence of any flammable gas or vapor does not exceed 25 percent of its respective Lower Explosive Limit (LEL).
  - If the atmospheric conditions are not met, the confined space should be ventilated until the target safe atmosphere is achieved, or entry is only to be undertaken with appropriate and additional PPE.
- Safety precautions should include Self Contained Breathing Apparatus (SCBA), life lines, and safety watch workers stationed outside the confined space, with rescue and first aid equipment readily available.
- Before workers are required to enter a permit-required confined space, adequate and appropriate training in confined space hazard control, atmospheric testing, use of the necessary PPE, as well as the serviceability and integrity of the PPE should be verified. Further, adequate and appropriate rescue and / or recovery plans and equipment should be in place before the worker enters the confined space.

Lone and Isolated Workers

A lone and isolated worker is a worker 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.

- Where workers may be required to perform work under lone or isolated circumstances, Standard Operating Procedures (SOPs) should be developed and implemented to ensure all PPE and safety measures are in place before the worker starts work. SOPs should establish, at a minimum, verbal contact with the worker at least once every hour, and ensure the worker has a capability for summoning emergency aid.
- If the worker is potentially exposed to highly toxic or corrosive chemicals, emergency eye-wash and shower facilities should be equipped with audible and visible alarms to summon aid whenever the eye-wash or shower is activated by the worker and without intervention by the worker.

2.9 Monitoring

Occupational health and safety monitoring programs should verify the effectiveness of prevention and control strategies. The selected indicators should be representative of the most significant occupational, health, and safety hazards, and the implementation of prevention and control strategies. The occupational health and safety monitoring program should include:

- *Safety inspection, testing and calibration:* This should include regular inspection and testing of all safety features and hazard control measures focusing on engineering and personal protective features, work procedures, places of work, installations, equipment, and tools used. The inspection should verify that issued PPE continues to provide adequate protection and is being worn as required. All instruments installed or used for monitoring and recording of working environment parameters should be regularly tested and calibrated, and the respective records maintained.
- *Surveillance of the working environment:* Employers should document compliance using an appropriate combination of

portable and stationary sampling and monitoring instruments. Monitoring and analyses should be conducted according to internationally recognized methods and standards. Monitoring methodology, locations, frequencies, and parameters should be established individually for each project following a review of the hazards. Generally, monitoring should be performed during commissioning of facilities or equipment and at the end of the defect and liability period, and otherwise repeated according to the monitoring plan.

- *Surveillance of workers health:* When extraordinary protective measures are required (for example, against biological agents Groups 3 and 4, and/or hazardous compounds), workers should be provided appropriate and relevant health surveillance prior to first exposure, and at regular intervals thereafter. The surveillance should, if deemed necessary, be continued after termination of the employment.
- *Training:* Training activities for employees and visitors should be adequately monitored and documented (curriculum, duration, and participants). Emergency exercises, including fire drills, should be documented adequately. Service providers and contractors should be contractually required to submit to the employer adequate training documentation before start of their assignment.

Accidents and Diseases monitoring

- The employer should establish procedures and systems for reporting and recording:
  - Occupational accidents and diseases
  - Dangerous occurrences and incidents

  These systems should enable workers to report immediately to their immediate supervisor any situation they believe presents a serious danger to life or health.
- The systems and the employer should further enable and encourage workers to report to management all:
  - Occupational injuries and near misses
  - Suspected cases of occupational disease
  - Dangerous occurrences and incidents
- All reported occupational accidents, occupational diseases, dangerous occurrences, and incidents together with near misses should be investigated with the assistance of a person knowledgeable/competent in occupational safety. The investigation should:
  - Establish what happened
  - Determine the cause of what happened
  - Identify measures necessary to prevent a recurrence
- Occupational accidents and diseases should, at a minimum, be classified according to Table 2.10.1. Distinction is made between fatal and non-fatal injuries. The two main categories are divided into three sub-categories according to time of death or duration of the incapacity to work. The total work hours during the specified reporting period should be reported to the appropriate regulatory agency.

Table 2.9.1. Occupational Accident Reporting

a. Fatalities (number)	**b. Non-fatal injuries** (number) [78]	**c. Total time lost** non-fatal injuries (days)
a.1 Immediate	**b.1** Less than one day	
a.2 Within a month	**b.2** Up to 3 days	**c.1** Category b.2
a.3 Within a year	**b.3** More than 3 days	**c.2** Category b.3

[78] The day on which an incident occurs is not included in b.2 and b.3.

3.0 Community Health and Safety

This section complements the guidance provided in the preceding environmental and occupational health and safety sections, specifically addressing some aspects of project activities taking place outside of the traditional project boundaries, but nonetheless related to the project operations, as may be applicable on a project basis. These issues may arise at any stage of a project life cycle and can have an impact beyond the life of the project.

3.1 Water Quality and Availability

Groundwater and surface water represent essential sources of drinking and irrigation water in developing countries, particularly in rural areas where piped water supply may be limited or unavailable and where available resources are collected by the consumer with little or no treatment. Project activities involving wastewater discharges, water extraction, diversion or impoundment should prevent adverse impacts to the quality and availability of groundwater and surface water resources.

Water Quality

Drinking water sources, whether public or private, should at all times be protected so that they meet or exceed applicable national acceptability standards or in their absence the current edition of WHO Guidelines for Drinking-Water Quality. Air emissions, wastewater effluents, oil and hazardous materials, and wastes should be managed according to the guidance provided in the respective sections of the General EHS Guidelines with the objective of protecting soil and water resources.

Where the project includes the delivery of water to the community or to users of facility infrastructure (such as hotel hosts and hospital patients), where water may be used for drinking, cooking, washing, and bathing, water quality should comply with national acceptability standards or in their absence the current edition of with WHO Drinking Water Guidelines. Water quality for more sensitive well-being-related demands such as water used in health care facilities or food production may require more stringent, industry-specific guidelines or standards, as applicable. Any dependency factors associated with the deliver of water to the local community should be planned for and managed to ensure the sustainability of the water supply by involving the community in its management to minimize the dependency in the long-term.

Water Availability

The potential effect of groundwater or surface water abstraction for project activities should be properly assessed through a combination of field testing and modeling techniques, accounting for seasonal variability and projected changes in demand in the project area.

Project activities should not compromise the availability of water for personal hygiene needs and should take account of potential future increases in demand. The overall target should be the availability of 100 liters per person per day although lower levels may be used to meet basic health requirements.[79] Water volume requirements for well-being-related demands such as water use in health care facilities may need to be higher.

3.2 Structural Safety of Project Infrastructure

Hazards posed to the public while accessing project facilities may include:

- Physical trauma associated with failure of building structures
- Burns and smoke inhalation from fires
- Injuries suffered as a consequence of falls or contact with heavy equipment
- Respiratory distress from dust, fumes, or noxious odors
- Exposure to hazardous materials

Reduction of potential hazards is best accomplished during the design phase when the structural design, layout and site modifications can be adapted more easily. The following issues should be considered and incorporated as appropriate into the planning, siting, and design phases of a project:

- Inclusion of buffer strips or other methods of physical separation around project sites to protect the public from major hazards associated with hazardous materials incidents or process failure, as well as nuisance issues related to noise, odors, or other emissions
- Incorporation of siting and safety engineering criteria to prevent failures due to natural risks posed by earthquakes, tsunamis, wind, flooding, landslides and fire. To this end, all project structures should be designed in accordance with engineering and design criteria mandated by site-specific risks, including but not limited to seismic activity, slope stability, wind loading, and other dynamic loads
- Application of locally regulated or internationally recognized building codes[80] to ensure structures are designed and constructed in accordance with sound architectural and engineering practice, including aspects of fire prevention and response
- Engineers and architects responsible for designing and constructing facilities, building, plants and other structures should certify the applicability and appropriateness of the structural criteria employed.

International codes, such as those compiled by the International Code Council (ICC)[81], are intended to regulate the design, construction, and maintenance of a built environment and contain detailed guidance on all aspects of building safety, encompassing methodology, best practices, and documenting compliance. Depending on the nature of a project, guidance provided in the ICC or comparable codes should be followed, as appropriate, with respect to:

- Existing structures
- Soils and foundations
- Site grading
- Structural design
- Specific requirements based on intended use and occupancy
- Accessibility and means of egress
- Types of construction
- Roof design and construction
- Fire-resistant construction
- Flood-resistant construction

[79] World Health Organization (WHO) defines 100 liters/capita/day as the amount required to meet all consumption and hygiene needs. Additional information on lower service levels and potential impacts on health are described in "Domestic Water Quantity, Service Level and Health" 2003. http://www.who.int/water_sanitation_health/diseases/wsh0302/en/index.html

[80] ILO-OSH, 2001. http://www.ilo.org/public/english/protection/safework/cops/english/download/e000013.pdf

[81] ICC, 2006.

- Construction materials
- Interior environment
- Mechanical, plumbing and electrical systems
- Elevators and conveying systems
- Fire safety systems
- Safeguards during construction
- Encroachments into public right-of-way

Although major design changes may not be feasible during the operation phase of a project, hazard analysis can be undertaken to identify opportunities to reduce the consequences of a failure or accident. Illustrative management actions, applicable to hazardous materials storage and use, include:

- Reducing inventories of hazardous materials through inventory management and process changes to greatly reduce or eliminate the potential off-site consequences of a release
- Modifying process or storage conditions to reduce the potential consequences of an accidental off-site release
- Improving shut-down and secondary containment to reduce the amount of material escaping from containment and to reduce the release duration
- Reducing the probability that releases will occur through improved site operations and control, and through improvements in maintenance and inspection
- Reducing off-site impacts of releases through measures intended to contain explosions and fires, alert the public, provide for evacuation of surrounding areas, establish safety zones around a site, and ensure the provision of emergency medical services to the public

3.3 Life and Fire Safety (L&FS)

Applicability and Approach

All new buildings accessible to the public should be designed, constructed, and operated in full compliance with local building codes, local fire department regulations, local legal/insurance requirements, and in accordance with an internationally accepted life and fire safety (L&FS) standard. The Life Safety Code[82], which provides extensive documentation on life and fire safety provisions, is one example of an internationally accepted standard and may be used to document compliance with the Life and Fire Safety objectives outlined in these guidelines. With regard to these objectives:

- Project sponsors' architects and professional consulting engineers should demonstrate that affected buildings meet these life and fire safety objectives.
- Life and fire safety systems and equipment should be designed and installed using appropriate prescriptive standards and/or performance based design, and sound engineering practices.
- Life and fire safety design criteria for all existing buildings should incorporate all local building codes and fire department regulations.

These guidelines apply to buildings that are accessible to the public. Examples of such buildings include:

- Health and education facilities
- Hotels, convention centers, and leisure facilities
- Retail and commercial facilities
- Airports, other public transport terminals, transfer facilities

Specific Requirements for New Buildings

The nature and extent of life and fire safety systems required will depend on the building type, structure, construction, occupancy, and exposures. Sponsors should prepare a Life and Fire Safety Master Plan identifying major fire risks, applicable codes, standards and regulations, and mitigation measures. The Master

[82] US NFPA. http://www.nfpa.org/catalog/product.asp?category%5Fname=&pid=10106&target%5Fpid=10106&src%5Fpid=&link%5Ftype=search

Plan should be prepared by a suitably qualified professional, and adequately cover, but not be limited to, the issues addressed briefly in the following points. The suitably qualified professional selected to prepare the Master Plan is responsible for a detailed treatment of the following illustrative, and all other required, issues.

Fire Prevention

Fire prevention addresses the identification of fire risks and ignition sources, and measures needed to limit fast fire and smoke development. These issues include:

- Fuel load and control of combustibles
- Ignition sources
- Interior finish flame spread characteristics
- Interior finish smoke production characteristics
- Human acts, and housekeeping and maintenance

Means of Egress

Means of Egress includes all design measures that facilitate a safe evacuation by residents and/or occupants in case of fire or other emergency, such as:

- Clear, unimpeded escape routes
- Accessibility to the impaired/handicapped
- Marking and signing
- Emergency lighting

Detection and Alarm Systems

These systems encompass all measures, including communication and public address systems needed to detect a fire and alert:

- Building staff
- Emergency response teams
- Occupants
- Civil defense

Compartmentation

Compartmentation involves all measures to prevent or slow the spread of fire and smoke, including:

- Separations
- Fire walls
- Floors
- Doors
- Dampers
- Smoke control systems

Fire Suppression and Control

Fire suppression and control includes all automatic and manual fire protection installations, such as:

- Automatic sprinkler systems
- Manual portable extinguishers
- Fire hose reels

Emergency Response Plan

An Emergency Response Plan is a set of scenario–based procedures to assist staff and emergency response teams during real life emergency and training exercises. This chapter of the Fire and Life Safety Master Plan should include an assessment of local fire prevention and suppression capabilities.

Operation and Maintenance

Operation and Maintenance involves preparing schedules for mandatory regular maintenance and testing of life and fire safety features to ensure that mechanical, electrical, and civil structures and systems are at all times in conformance with life and fire safety design criteria and required operational readiness.

L&FS Master Plan Review and Approval

- A suitably qualified professional prepares and submits a Life and Fire Safety (L&FS) Master Plan, including preliminary drawings and specifications, and certifies that the design

meets the requirements of these L&FS guidelines. The findings and recommendations of the review are then used to establish the conditions of a Corrective Action Plan and a time frame for implementing the changes.

- The suitably qualified professional conducts a review as part of the project completion test at the time of life and fire safety systems testing and commissioning, and certifies that construction of these systems has been carried out in accordance with the accepted design. The findings and recommendations of the review are used as the basis for establishing project completion or to establish the conditions of a Pre-Completion Corrective Action Plan and a time frame for implementing the changes.

Specific Requirements for Existing Buildings

- All life and fire safety guideline requirements for new buildings apply to existing buildings programmed for renovation. A suitably qualified professional conducts a complete life and fire safety review of existing buildings slated for renovation. The findings and recommendations of the review are used as the basis to establish the scope of work of a Corrective Action Plan and a time frame for implementing the changes.
- If it becomes apparent that life and fire safety conditions are deficient in an existing building that is not part of the project or that has not been programmed for renovation, a life and fire safety review of the building may be conducted by a suitably qualified professional. The findings and recommendations of the review are used as the basis to establish the scope of work of a Corrective Action Plan and a time frame for implementing the changes.

Other Hazards

- Facilities, buildings, plants, and structures should be situated to minimize potential risks from forces of nature (e.g. earthquakes, tsunamis, floods, windstorms, and fires from surrounding areas).
- All such structures should be designed in accordance with the criteria mandated by situation-, climatic-, and geology-specific location risks (e.g. seismic activity, wind loading, and other dynamic loads).
- Structural engineers and architects responsible for facilities, buildings, plants and structures should certify the applicability and appropriateness of the design criteria employed.
- National or regional building regulations typically contain fire safety codes and standards[83] or these standards are found in separate Fire Codes.[84,85] Generally, such codes and regulations incorporate further compliance requirements with respect to methodology, practice, testing, and other codes and standards[86]. Such nationally referenced material constitutes the acceptable fire life safety code.

3.4 Traffic Safety

Traffic accidents have become one of the most significant causes of injuries and fatalities among members of the public worldwide. Traffic safety should be promoted by all project personnel during displacement to and from the workplace, and during operation of project equipment on private or public roads. Prevention and control of traffic related injuries and fatalities should include the adoption of safety measures that are protective of project workers and of road users, including those who are most vulnerable to road traffic accidents[87]. Road safety initiatives proportional to the scope and nature of project activities should include:

[83] For example, Australia, Canada, South Africa, United Kingdom

[84] Réglementation Incendie [des ERP]

[85] USA NFPA, 2006.

[86] Prepared by National Institutes and Authorities such as American Society for Testing and Materials (ASTM), British Standards (BS), German Institute of Standardization (DIN), and French Standards (NF)

[87] Additional information on vulnerable users of public roads in developing countries is provided by Peden et al., 2004.

- Adoption of best transport safety practices across all aspects of project operations with the goal of preventing traffic accidents and minimizing injuries suffered by project personnel and the public. Measures should include:
  - Emphasizing safety aspects among drivers
  - Improving driving skills and requiring licensing of drivers
  - Adopting limits for trip duration and arranging driver rosters to avoid overtiredness
  - Avoiding dangerous routes and times of day to reduce the risk of accidents
  - Use of speed control devices (governors) on trucks, and remote monitoring of driver actions
- Regular maintenance of vehicles and use of manufacturer approved parts to minimize potentially serious accidents caused by equipment malfunction or premature failure.

Where the project may contribute to a significant increase in traffic along existing roads, or where road transport is a significant component of a project, recommended measures include:

- Minimizing pedestrian interaction with construction vehicles
- Collaboration with local communities and responsible authorities to improve signage, visibility and overall safety of roads, particularly along stretches located near schools or other locations where children may be present. Collaborating with local communities on education about traffic and pedestrian safety (e.g. school education campaigns)[88]
- Coordination with emergency responders to ensure that appropriate first aid is provided in the event of accidents
- Using locally sourced materials, whenever possible, to minimize transport distances. Locating associated facilities such as worker camps close to project sites and arranging worker bus transport to minimizing external traffic
- Employing safe traffic control measures, including road signs and flag persons to warn of dangerous conditions

3.5 Transport of Hazardous Materials

General Hazardous Materials Transport

- Projects should have procedures in place that ensure compliance with local laws and international requirements applicable to the transport of hazardous materials, including:
  - IATA requirements[89] for air transport
  - IMDG Code[90] sea transport
  - UN Model Regulations[91] of other international standards as well as local requirements for land transport
  - Host-country commitments under the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their disposal and Rotterdam Convention on the prior Inform Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, if applicable to the project activities
- The procedures for transportation of hazardous materials (Hazmats) should include:
  - Proper labeling of containers, including the identify and quantity of the contents, hazards, and shipper contact information
  - Providing a shipping document (e.g. shipping manifest) that describes the contents of the load and its associated hazards in addition to the labeling of the containers. The shipping document should establish a chain-of-custody using multiple signed copies to show that the waste was properly shipped, transported and received by the recycling or treatment/disposal facility

[88] Additional sources of information for implementation of road safety measures is available at WHO, 1989, Ross et al., 1991, Tsunokawa and Hoban, 1997, and OECD, 1999

[89] IATA, 2005. www.iata.org

[90] IMO. www.imo.org/safety

[91] United Nations. Transport of Dangerous Goods - Model Regulations. 14th Revised Edition. Geneva 2005. http://www.unece.org/trans/danger/publi/unrec/rev14/14files_e.html

- Ensuring that the volume, nature, integrity and protection of packaging and containers used for transport are appropriate for the type and quantity of hazardous material and modes of transport involved
- Ensuring adequate transport vehicle specifications
- Training employees involved in the transportation of hazardous materials regarding proper shipping procedures and emergency procedures
- Using labeling and placarding (external signs on transport vehicles), as required
- Providing the necessary means for emergency response on call 24 hours/day

Major Transportation Hazards

Guidance related to major transportation hazards should be implemented in addition to measures presented in the preceding section for preventing or minimizing the consequences of catastrophic releases of hazardous materials, which may result in toxic, fire, explosion, or other hazards during transportation.

In addition to these aforementioned procedures, projects which transport hazardous materials *at or above the threshold quantities*[92] should prepare a Hazardous Materials Transportation Plan containing all of the elements presented below[93].

Hazard Assessment

The hazard assessment should identify the potential hazard involved in the transportation of hazardous materials by reviewing:

- The hazard characteristics of the substances identified during the screening stage
- The history of accidents, both by the company and its contractors, involving hazardous materials transportation
- The existing criteria for the safe transportation of hazardous materials, including environmental management systems used by the company and its contractors

This review should cover the management actions, preventive measures and emergency response procedures described below. The hazard assessment helps to determine what additional measures may be required to complete the plan.

Management Actions

- *Management of Change:* These procedures should address:
  - The technical basis for changes in hazardous materials offered for transportation, routes and/or procedures
  - The potential impact of changes on health and safety
  - Modification required to operating procedures
  - Authorization requirements
  - Employees affected
  - Training needs
- *Compliance Audit:* A compliance audit evaluates compliance with prevention requirements for each transportation route or for each hazardous material, as appropriate. A compliance audit covering each element of the prevention measures (see below) should be conducted at least every three years. The audit program should include:
  - Preparation of a report of the findings
  - Determination and documentation of the appropriate response to each finding
  - Documentation that any deficiency has been corrected.
- *Incident Investigation:* Incidents can provide valuable information about transportation hazards and the steps needed to prevent accidental releases. The implementation of incident investigation procedures should ensure that:
  - Investigations are initiated promptly
  - Summaries of investigations are included in a report
  - Report findings and recommendations are addressed

[92] Threshold quantities for the transport of hazardous materials are found in the UN – Transport of Dangerous Goods – Model Regulations cited above.

[93] For further information and guidance, please refer to International Finance Corporation (IFC) Hazardous Materials Transportation Manual. Washington, D.C. December 2000.

- Reports are reviewed with staff and contractors

- *Employee Participation:* There should be a written plan of action regarding the implementation of active employee participation in the prevention of accidents.

- *Contractors:* The plan should include procedures to ensure that:
  - The contractor is provided with safety performance procedures and safety and hazard information
  - Contractors observe safety practices
  - Verify that the contractor acts responsibly

  The plan should also include additional procedures to ensure the contractors will:
  - Ensure appropriate training for their employees
  - Ensure their employees know process hazards and applicable emergency actions
  - Prepare and submit training records
  - Inform employees about the hazards presented by their work

- *Training:* Good training programs on operating procedures will provide the employees with the necessary information to understand how to operate safely and why safe operations are needed. The training program should include:
  - The list of employees to be trained
  - Specific training objectives
  - Mechanisms to achieve objectives (i.e. hands-on workshops, videos, etc.)
  - Means to determine the effectiveness of the training program
  - Training procedures for new hires and refresher programs

Preventive Measures

The plan should include procedures to implement preventive measures specific to each hazardous material offered for transportation, including:

- Classification and segregation of hazardous materials in warehouses and transport units
- Packaging and packaging testing
- Marking and labeling of packages containing hazardous materials
- Handling and securing packages containing hazardous materials in transport units
- Marking and placarding of transport units
- Documentation (e.g. bills of lading)
- Application of special provisions, as appropriate

Emergency Preparedness and Response

It is important to develop procedures and practices for the handling of hazardous materials that allow for quick and efficient responses to accidents that may result in injury or environmental damage. The sponsor should prepare an Emergency Preparedness and Response Plan that should cover:

- *Planning Coordination:* This should include procedures for:
  - Informing the public and emergency response agencies
  - Documenting first aid and emergency medical treatment
  - Taking emergency response actions
  - Reviewing and updating the emergency response plan to reflect changes and ensuring that the employees are informed of such changes

- *Emergency Equipment:* The plan should include procedures for using, inspecting, testing, and maintaining emergency response equipment.

- *Training:* Employees should be trained in any relevant procedures

3.6 Disease Prevention

Communicable Diseases

Communicable diseases pose a significant public health threat worldwide. Health hazards typically associated with large development projects are those relating to poor sanitation and living conditions, sexual transmission and vector-borne infections. Communicable diseases of most concern during the construction phase due to labor mobility are sexually-transmitted diseases (STDs), such as HIV/AIDS. Recognizing that no single measure is likely to be effective in the long term, successful initiatives typically involve a combination of behavioral and environmental modifications.

Recommended interventions at the project level include[94]:

- Providing surveillance and active screening and treatment of workers
- Preventing illness among workers in local communities by:
  - Undertaking health awareness and education initiatives, for example, by implementing an information strategy to reinforce person-to-person counseling addressing systemic factors that can influence individual behavior as well as promoting individual protection, and protecting others from infection, by encouraging condom use
  - Training health workers in disease treatment
  - Conducting immunization programs for workers in local communities to improve health and guard against infection
  - Providing health services
- Providing treatment through standard case management in on-site or community health care facilities. Ensuring ready access to medical treatment, confidentiality and appropriate care, particularly with respect to migrant workers
- Promoting collaboration with local authorities to enhance access of workers families and the community to public health services and promote immunization

Vector-Borne Diseases

Reducing the impact of vector-borne disease on the long-term health of workers is best accomplished through implementation of diverse interventions aimed at eliminating the factors that lead to disease. Project sponsors, in close collaboration with community health authorities, can implement an integrated control strategy for mosquito and other arthropod-borne diseases that might involve:

- Prevention of larval and adult propagation through sanitary improvements and elimination of breeding habitats close to human settlements
- Elimination of unusable impounded water
- Increase in water velocity in natural and artificial channels
- Considering the application of residual insecticide to dormitory walls
- Implementation of integrated vector control programs
- Promoting use of repellents, clothing, netting, and other barriers to prevent insect bites
- Use of chemoprophylaxis drugs by non-immune workers and collaborating with public health officials to help eradicate disease reservoirs
- Monitoring and treatment of circulating and migrating populations to prevent disease reservoir spread
- Collaboration and exchange of in-kind services with other control programs in the project area to maximize beneficial effects
- Educating project personnel and area residents on risks, prevention, and available treatment
- Monitoring communities during high-risk seasons to detect and treat cases

[94] Additional sources of information on disease prevention include IFC, 2006; UNDP, 2000, 2003; Walley et al., 2000; Kindhauser, 2003; Heymann, 2004.

- Distributing appropriate education materials
- Following safety guidelines for the storage, transport, and distribution of pesticides to minimize the potential for misuse, spills, and accidental human exposure

3.7 Emergency Preparedness and Response

An emergency is an unplanned event when a project operation loses control, or could lose control, of a situation that may result in risks to human health, property, or the environment, either within the facility or in the local community. Emergencies do not normally include safe work practices for frequent upsets or events that are covered by occupational health and safety.

All projects should have an Emergency Preparedness and Response Plan that is commensurate with the risks of the facility and that includes the following basic elements:

- Administration (policy, purpose, distribution, definitions, etc)
- Organization of emergency areas (command centers, medical stations, etc)
- Roles and responsibilities
- Communication systems
- Emergency response procedures
- Emergency resources
- Training and updating
- Checklists (role and action list and equipment checklist)
- Business Continuity and Contingency

Additional information is provided for key components of the emergency plan, as follows below.

Communication Systems

Worker notification and communication

Alarm bells, visual alarms, or other forms of communication should be used to reliably alert workers to an emergency. Related measures include:

- Testing warning systems at least annually (fire alarms monthly), and more frequently if required by local regulations, equipment, or other considerations
- Installing a back-up system for communications on-site with off-site resources, such as fire departments, in the event that normal communication methods may be inoperable during an emergency

Community Notification

If a local community may be at risk from a potential emergency arising at the facility, the company should implement communication measures to alert the community, such as:

- Audible alarms, such as fire bells or sirens
- Fan out telephone call lists
- Vehicle mounted speakers
- Communicating details of the nature of the emergency
- Communicating protection options (evacuation, quarantine)
- Providing advise on selecting an appropriate protection option

Media and Agency Relations

Emergency information should be communicated to the media through:

- A trained, local spokesperson able to interact with relevant stakeholders, and offer guidance to the company for speaking to the media, government, and other agencies
- Written press releases with accurate information, appropriate level of detail for the emergency, and for which accuracy can be guaranteed

Emergency Resources

Finance and Emergency Funds

- A mechanism should be provided for funding emergency activities.

Fire Services

- The company should consider the level of local fire fighting capacity and whether equipment is available for use at the facility in the event of a major emergency or natural disaster. If insufficient capacity is available, fire fighting capacity should be acquired that may include pumps, water supplies, trucks, and training for personnel.

Medical Services

- The company should provide first aid attendants for the facility as well as medical equipment suitable for the personnel, type of operation, and the degree of treatment likely to be required prior to transportation to hospital.

Availability of Resources

Appropriate measures for managing the availability of resources in case of an emergency include:

- Maintaining a list of external equipment, personnel, facilities, funding, expert knowledge, and materials that may be required to respond to emergencies. The list should include personnel with specialized expertise for spill clean-up, flood control, engineering, water treatment, environmental science, etc., or any of the functions required to adequately respond to the identified emergency
- Providing personnel who can readily call up resources, as required
- Tracking and managing the costs associated with emergency resources
- Considering the quantity, response time, capability, limitations, and cost of these resources, for both site-specific emergencies, and community or regional emergencies
- Considering if external resources are unable to provide sufficient capacity during a regional emergency and whether additional resources may need to be maintained on-site

Mutual Aid

Mutual aid agreements decrease administrative confusion and provide a clear basis for response by mutual aid providers.

- Where appropriate, mutual aid agreements should be maintained with other organizations to allow for sharing of personnel and specialized equipment.

Contact List

- The company should develop a list of contact information for all internal and external resources and personnel. The list should include the name, description, location, and contact details (telephone, email) for each of the resources, and be maintained annually.

Training and Updating

The emergency preparedness facilities and emergency response plans require maintenance, review, and updating to account for changes in equipment, personnel, and facilities. Training programs and practice exercises provide for testing systems to ensure an adequate level of emergency preparedness. Programs should:

- Identify training needs based on the roles and responsibilities, capabilities and requirements of personnel in an emergency
- Develop a training plan to address needs, particularly for fire fighting, spill response, and evacuation

- Conduct annual training, at least, and perhaps more frequent training when the response includes specialized equipment, procedures, or hazards, or when otherwise mandated
- Provide training exercises to allow personnel the opportunity to test emergency preparedness, including:
  - Desk top exercises with only a few personnel, where the contact lists are tested and the facilities and communication assessed
  - Response exercises, typically involving drills that allow for testing of equipment and logistics
- Debrief upon completion of a training exercise to assess what worked well and what aspects require improvement
- Update the plan, as required, after each exercise. Elements of the plan subject to significant change (such as contact lists) should be replaced
- Record training activities and the outcomes of the training

Business Continuity and Contingency

Measures to address business continuity and contingency include:

- Identifying replacement supplies or facilities to allow business continuity following an emergency. For example, alternate sources of water, electricity, and fuel are commonly sought.
- Using redundant or duplicate supply systems as part of facility operations to increase the likelihood of business continuity.
- Maintaining back-ups of critical information in a secure location to expedite the return to normal operations following an emergency.

4.0 Construction and Decommissioning

Applicability and Approach

This section provides additional, specific guidance on prevention and control of community health and safety impacts that may occur during new project development, at the end of the project life-cycle, or due to expansion or modification of existing project facilities. Cross referencing is made to various other sections of the General EHS Guidelines.

4.1 Environment{ TC "4.1 Environment" \f C \l "2" }

Noise and Vibration

During construction and decommissioning activities, noise and vibration may be caused by the operation of pile drivers, earth moving and excavation equipment, concrete mixers, cranes and the transportation of equipment, materials and people. Some recommended noise reduction and control strategies to consider in areas close to community areas include:

- Planning activities in consultation with local communities so that activities with the greatest potential to generate noise are planned during periods of the day that will result in least disturbance
- Using noise control devices, such as temporary noise barriers and deflectors for impact and blasting activities, and exhaust muffling devices for combustion engines.
- Avoiding or minimizing project transportation through community areas

Soil Erosion

Soil erosion may be caused by exposure of soil surfaces to rain and wind during site clearing, earth moving, and excavation activities. The mobilization and transport of soil particles may, in turn, result in sedimentation of surface drainage networks, which may result in impacts to the quality of natural water systems and ultimately the biological systems that use these waters. Recommended soil erosion and water system management approaches include:

Sediment mobilization and transport

- Reducing or preventing erosion by:
  - Scheduling to avoid heavy rainfall periods (i.e., during the dry season) to the extent practical
  - Contouring and minimizing length and steepness of slopes
  - Mulching to stabilize exposed areas
  - Re-vegetating areas promptly
  - Designing channels and ditches for post-construction flows
  - Lining steep channel and slopes (e.g. use jute matting)
- Reducing or preventing off-site sediment transport through use of settlement ponds, silt fences, and water treatment, and modifying or suspending activities during extreme rainfall and high winds to the extent practical.

Clean runoff management

- Segregating or diverting clean water runoff to prevent it mixing with water containing a high solids content, to minimize the volume of water to be treated prior to release

Road design

- Limiting access road gradients to reduce runoff-induced erosion
- Providing adequate road drainage based on road width, surface material, compaction, and maintenance

Disturbance to water bodies

- Depending on the potential for adverse impacts, installing free-spanning structures (e.g., single span bridges) for road watercourse crossings
- Restricting the duration and timing of in-stream activities to lower low periods, and avoiding periods critical to biological cycles of valued flora and fauna (e.g., migration, spawning, etc.)
- For in-stream works, using isolation techniques such as berming or diversion during construction to limit the exposure of disturbed sediments to moving water
- Consider using trenchless technology for pipeline crossings (e.g., suspended crossings) or installation by directional drilling

Structural (slope) stability

- Providing effective short term measures for slope stabilization, sediment control and subsidence control until long term measures for the operational phase can be implemented
- Providing adequate drainage systems to minimize and control infiltration

Air Quality

Construction and decommissioning activities may generate emission of fugitive dust caused by a combination of on-site excavation and movement of earth materials, contact of construction machinery with bare soil, and exposure of bare soil and soil piles to wind. A secondary source of emissions may include exhaust from diesel engines of earth moving equipment, as well as from open burning of solid waste on-site. Techniques to consider for the reduction and control of air emissions from construction and decommissioning sites include:

- Minimizing dust from material handling sources, such as conveyors and bins, by using covers and/or control equipment (water suppression, bag house, or cyclone)
- Minimizing dust from open area sources, including storage piles, by using control measures such as installing enclosures and covers, and increasing the moisture content
- Dust suppression techniques should be implemented, such as applying water or non-toxic chemicals to minimize dust from vehicle movements
- Selectively removing potential hazardous air pollutants, such as asbestos, from existing infrastructure prior to demolition
- Managing emissions from mobile sources according to Section 1.1
- Avoiding open burning of solid (refer to solid waste management guidance in Section 1.6)

Solid Waste

Non-hazardous solid waste generated at construction and decommissioning sites includes excess fill materials from grading and excavation activities, scrap wood and metals, and small concrete spills. Other non-hazardous solid wastes include office, kitchen, and dormitory wastes when these types of operations are part of construction project activities. *Hazardous solid waste* includes contaminated soils, which could potentially be encountered on-site due to previous land use activities, or small

amounts of machinery maintenance materials, such as oily rags, used oil filters, and used oil, as well as spill cleanup materials from oil and fuel spills. Techniques for preventing and controlling non-hazardous and hazardous construction site solid waste include those already discussed in Section 1.6.

Hazardous Materials

Construction and decommissioning activities may pose the potential for release of petroleum based products, such as lubricants, hydraulic fluids, or fuels during their storage, transfer, or use in equipment. These materials may also be encountered during decommissioning activities in building components or industrial process equipment. Techniques for prevention, minimization, and control of these impacts include:

- Providing adequate secondary containment for fuel storage tanks and for the temporary storage of other fluids such as lubricating oils and hydraulic fluids,
- Using impervious surfaces for refueling areas and other fluid transfer areas
- Training workers on the correct transfer and handling of fuels and chemicals and the response to spills
- Providing portable spill containment and cleanup equipment on site and training in the equipment deployment
- Assessing the contents of hazardous materials and petroleum-based products in building systems (e.g. PCB containing electrical equipment, asbestos-containing building materials) and process equipment and removing them prior to initiation of decommissioning activities, and managing their treatment and disposal according to Sections 1.5 and 1.6 on Hazardous Materials and Hazardous Waste Management, respectively
- Assessing the presence of hazardous substances in or on building materials (e.g., polychlorinated biphenyls, asbestos-containing flooring or insulation) and decontaminating or properly managing contaminated building materials

Wastewater Discharges

Construction and decommissioning activities may include the generation of sanitary wastewater discharges in varying quantities depending on the number of workers involved. Adequate portable or permanent sanitation facilities serving all workers should be provided at all construction sites. Sanitary wastewater in construction and other sites should be managed as described in Section 1.3.

Contaminated Land

Land contamination may be encountered in sites under construction or decommissioning due to known or unknown historical releases of hazardous materials or oil, or due to the presence of abandoned infrastructure formerly used to store or handle these materials, including underground storage tanks. Actions necessary to manage the risk from contaminated land will depend on factors such as the level and location of contamination, the type and risks of the contaminated media, and the intended land use. However, a basic management strategy should include:

- Managing contaminated media with the objective of protecting the safety and health of occupants of the site, the surrounding community, and the environment post construction or post decommissioning
- Understanding the historical use of the land with regard to the potential presence of hazardous materials or oil prior to initiation of construction or decommissioning activities
- Preparing plans and procedures to respond to the discovery of contaminated media to minimize or reduce the risk to health, safety, and the environment consistent with the approach for Contaminated Land in Section 1.6
- Preparation of a management plan to manage obsolete, abandoned, hazardous materials or oil consistent with the approach to hazardous waste management described in Section 1.6.

Successful implementation of any management strategy may require identification and cooperation with whoever is responsible and liable for the contamination.

4.2 Occupational Health and Safety{ TC "4.2 Occupational Health and Safety" \f C \l "2" }

Over-exertion

Over-exertion, and ergonomic injuries and illnesses, such as repetitive motion, over-exertion, and manual handling, are among the most common causes of injuries in construction and decommissioning sites. Recommendations for their prevention and control include:

- Training of workers in lifting and materials handling techniques in construction and decommissioning projects, including the placement of weight limits above which mechanical assists or two-person lifts are necessary
- Planning work site layout to minimize the need for manual transfer of heavy loads
- Selecting tools and designing work stations that reduce force requirements and holding times, and which promote improved postures, including, where applicable, user adjustable work stations
- Implementing administrative controls into work processes, such as job rotations and rest or stretch breaks

Slips and Falls

Slips and falls on the same elevation associated with poor housekeeping, such as excessive waste debris, loose construction materials, liquid spills, and uncontrolled use of electrical cords and ropes on the ground, are also among the most frequent cause of lost time accidents at construction and decommissioning sites. Recommended methods for the prevention of slips and falls from, or on, the same elevation include:

- Implementing good house-keeping practices, such as the sorting and placing loose construction materials or demolition debris in established areas away from foot paths
- Cleaning up excessive waste debris and liquid spills regularly
- Locating electrical cords and ropes in common areas and marked corridors
- Use of slip retardant footwear

Work in Heights

Falls from elevation associated with working with ladders, scaffolding, and partially built or demolished structures are among the most common cause of fatal or permanent disabling injury at construction or decommissioning sites. If fall hazards exist, a fall protection plan should be in place which includes one or more of the following aspects, depending on the nature of the fall hazard[95]:

- Training and use of temporary fall prevention devices, such as rails or other barriers able to support a weight of 200 pounds, when working at heights equal or greater than two meters or at any height if the risk includes falling into operating machinery, into water or other liquid, into hazardous substances, or through an opening in a work surface
- Training and use of personal fall arrest systems, such as full body harnesses and energy absorbing lanyards able to support 5000 pounds (also described in this section in Working at Heights above), as well as fall rescue procedures to deal with workers whose fall has been successfully arrested. The tie in point of the fall arresting system should also be able to support 5000 pounds
- Use of control zones and safety monitoring systems to warn workers of their proximity to fall hazard zones, as well as

[95] Additional information on identification of fall hazards and design of protection systems can be found in the United States Occupational Health and Safety Administration's (US OSHA) web site: http://www.osha.gov/SLTC/fallprotection/index.html

securing, marking, and labeling covers for openings in floors, roofs, or walking surfaces

Struck By Objects

Construction and demolition activities may pose significant hazards related to the potential fall of materials or tools, as well as ejection of solid particles from abrasive or other types of power tools which can result in injury to the head, eyes, and extremities. Techniques for the prevention and control of these hazards include:

- Using a designated and restricted waste drop or discharge zones, and/or a chute for safe movement of wastes from upper to lower levels
- Conducting sawing, cutting, grinding, sanding, chipping or chiseling with proper guards and anchoring as applicable
- Maintaining clear traffic ways to avoid driving of heavy equipment over loose scrap
- Use of temporary fall protection measures in scaffolds and out edges of elevated work surfaces, such as hand rails and toe boards to prevent materials from being dislodged
- Evacuating work areas during blasting operations, and using blast mats or other means of deflection to minimize fly rock or ejection of demolition debris if work is conducted in proximity to people or structures
- Wearing appropriate PPE, such as safety glasses with side shields, face shields, hard hats, and safety shoes

Moving Machinery

Vehicle traffic and use of lifting equipment in the movement of machinery and materials on a construction site may pose temporary hazards, such as physical contact, spills, dust, emissions, and noise. Heavy equipment operators have limited fields of view close to their equipment and may not see pedestrians close to the vehicle. Center-articulated vehicles create a significant impact or crush hazard zone on the outboard side of a turn while moving. Techniques for the prevention and control of these impacts include:

- Planning and segregating the location of vehicle traffic, machine operation, and walking areas, and controlling vehicle traffic through the use of one-way traffic routes, establishment of speed limits, and on-site trained flag-people wearing high-visibility vests or outer clothing covering to direct traffic
- Ensuring the visibility of personnel through their use of high visibility vests when working in or walking through heavy equipment operating areas, and training of workers to verify eye contact with equipment operators before approaching the operating vehicle
- Ensuring moving equipment is outfitted with audible back-up alarms
- Using inspected and well-maintained lifting devices that are appropriate for the load, such as cranes, and securing loads when lifting them to higher job-site elevations.

Dust

- Dust suppression techniques should be implemented, such as applying water or non-toxic chemicals to minimize dust from vehicle movements
- PPE, such as dusk masks, should be used where dust levels are excessive

Confined Spaces and Excavations

Examples of confined spaces that may be present in construction or demolition sites include: silos, vats, hoppers, utility vaults, tanks, sewers, pipes, and access shafts. Ditches and trenches may also be considered a confined space when access or egress is limited. In addition to the guidance provided in Section 2.8 the occupational hazards associated with confined spaces and excavations in construction and decommissioning sites should be prevented according to the following recommendations:

- Controlling site-specific factors which may contribute to excavation slope instability including, for example, the use of excavation dewatering, side-walls support, and slope gradient adjustments that eliminate or minimize the risk of collapse, entrapment, or drowning
- Providing safe means of access and egress from excavations, such as graded slopes, graded access route, or stairs and ladders
- Avoiding the operation of combustion equipment for prolonged periods inside excavations areas where other workers are required to enter unless the area is actively ventilated

Other Site Hazards

Construction and decommissioning sites may pose a risk of exposure to dust, chemicals, hazardous or flammable materials, and wastes in a combination of liquid, solid, or gaseous forms, which should be prevented through the implementation of project-specific plans and other applicable management practices, including:

- Use of specially trained personnel to identify and remove waste materials from tanks, vessels, processing equipment or contaminated land as a first step in decommissioning activities to allow for safe excavation, construction, dismantling or demolition
- Use of specially trained personnel to identify and selectively remove potentially hazardous materials in building elements prior to dismantling or demolition including, for example, insulation or structural elements containing asbestos and Polychlorinated Biphenyls (PCBs), electrical components containing mercury[96]
- Use of waste-specific PPE based on the results of an occupational health and safety assessment, including respirators, clothing/protective suits, gloves and eye protection

4.3 Community Health and Safety{ TC "4.3 Community Health and Safety" \f C \l "2" }

General Site Hazards

Projects should implement risk management strategies to protect the community from physical, chemical, or other hazards associated with sites under construction and decommissioning. Risks may arise from inadvertent or intentional trespassing, including potential contact with hazardous materials, contaminated soils and other environmental media, buildings that are vacant or under construction, or excavations and structures which may pose falling and entrapment hazards. Risk management strategies may include:

- Restricting access to the site, through a combination of institutional and administrative controls, with a focus on high risk structures or areas depending on site-specific situations, including fencing, signage, and communication of risks to the local community
- Removing hazardous conditions on construction sites that cannot be controlled affectively with site access restrictions, such as covering openings to small confined spaces, ensuring means of escape for larger openings such as trenches or excavations, or locked storage of hazardous materials

Disease Prevention

Increased incidence of communicable and vector-borne diseases attributable to construction activities represents a potentially serious health threat to project personnel and residents of local communities. Recommendations for the prevention and control of communicable and vector-borne diseases also applicable to

[96] Additional information on the management and removal of asbestos containing building materials can be found in ASTM Standard E2356 and E1368

construction phase activities are provided in Section 3.6 (Disease Prevention).

Traffic Safety

Construction activities may result in a significant increase in movement of heavy vehicles for the transport of construction materials and equipment increasing the risk of traffic-related accidents and injuries to workers and local communities. The incidence of road accidents involving project vehicles during construction should be minimized through a combination of education and awareness-raising, and the adoption of procedures described in Section 3.4 (Traffic Safety).

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