E4833

Environmental and Social Management Framework

Indus Ecoregion Community Livelihood Project

Executive Summary

The Indus Ecoregion Community Livelihood Project (IECLP) is being developed by WWF-Pakistan to improve the livelihoods of local communities through improved natural resource management. The project is aims to (i) link farmers to markets to strengthen value chains (ii) facilitate rural non-farm income; and (iii) reduce risk, vulnerability, and gender inequality.

The project will focus on four priority sites of the Indus Ecoregion, where WWF -Pakistan is already present and has an understanding of the local communities' needs and socio-economic potential. The project will cover an area of 2,168 km^2 with at least 187 villages, in the Sindh Province of Pakistan. The priority areas are:

(i) Keenjhar Lake in Thatta District;
(ii) Chotiari Reservoir in Sanghar District;
(iii) Nara Canal and surrounding communities in Khairpur District; and
(iv) Manchar Lake and surrounding communities in Jamshoro District

The project has been divided into three main components: Component-I is related to improvement in fishing practices and establishment of fisher groups, and is inclusive of advocacy for better management practices through fisher sustainability schools (FSS), establishment of four fisher groups, establishment of chilling units, ice boxes and packaging units; Component-II is related to promotion of alternative livelihood for women and youth and includes organization of targeted communities and establishment of community based livelihood activities, provision of assets and capacity building. Component-II also encompasses monitoring and evaluation and knowledge dissemination. The project has been categorized as Category B since most proposed interventions are soft in nature, include capacity building and community organization and do not include any physical activity. The project will however provide some basic assets like stoves, chillers, indigo seeds and processing units, and packaging units spread over the project area. The activities are not expected to have any physical footprint and any adverse environmental or social impacts.

It has been revealed that most of these potential impacts are localized in nature with low severity. Furthermore, with the help of appropriate mitigation and control measures, most of these potential impacts will either be avoided altogether, or their likelihood of occurrence and severity will be further reduced, thus making these schemes environmentally responsible and socially acceptable. Separate environmental and social mitigation plans have been prepared for each type of interventions. These Plans will be used during the scheme inception and design stage, and will be made part of the scheme proposal preparation and approval process. Where required, the project will acquire land through Voluntary Land Donation (VLD) procedures. Such procedures will ensure that the donated land (i) is made available freely by the legal/designated owner(s) and not as a result of coercion (ii) does not lead to resettlement of any kind (iii) does not lead to adverse impacts on the livelihoods of any group and meet other criteria of VLD included in ESMF. These aspects will be monitored as part of project implementation and through World Bank's own monitoring mechanisms. The land screening checklist and sample VLD agreement format is provided in the document.

IECLP is a Community Demand Driven (CDD) project; hence, consultations are its integral part. Key stakeholders of the Project include low income fisherman communities, landowners, officials and staff of line departments, relevant political administration and local level civil society organizations and NGOs. It is anticipated that the community members will participate in project activities by participating in the Community Based Organization (CBOs). The consultations will be carried out during the implementation of project and a consultation framework has been included in the ESMF.

The ESMF includes institutional arrangements for the environmental and social management of the project. This has a three tier approach to implementing livelihood projects. At the micro level, the project execution and implementation will be done by Program Implementation Unit (PIU) in collaboration with CBOs and Fisher Cooperatives (FCs). At meso level, District Coordination Committees (DCCs) headed by Deputy Commissioner (DC) of respective district, Area Coordination Committees (ACCs) and other NGOs working in the area will be coordinated by PIU for consultation on project implementation. At macro level, WWF-Pakistan's Program Management Unit (PMU) led by technical experts and managers will execute the project while the Programme Support Unit (PSU) led by senior managers and directors will oversee and monitor the its progress. PIU and PMU, among other team members will include Environmental and Social Focal Points (ESFPs) with defined roles and responsibilities related to the implementation of ESMF. Moreover, Indus Eco-region Steering Committee (IESC) will be the highest forum to review the project implementation.

The project has proposed a multi-tier GRM with designated staff at each level i.e. PIU, PMU and IESC, as the apex forum for redressal of a complaint. The mechanism for redressal of any grievances received by the project has been defined clearly with designated timelines and roles and responsibilities.

ESMF also specifies the training requirements, documentation and reporting procedures and monitoring and evaluation. In addition to the internal monitoring, ESMF also specifies the third party monitoring to be carried out by an outside agency (such as an independent consultant/firm) twice: once before the mid-term review of the project and second and last time three months prior to the closing of the project implementation.

The cost of ESMF implementation is estimated as PKR 15,000,000.

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1 Introduction

This section provides background, aims and objectives of the Project and structure of Environmental and Social Management Framework (ESMF).

1.1 Background

The Indus Ecoregion Community Livelihood Project (IECLP) is being developed by WWF-Pakistan to improve the livelihoods of local communities. The proposed project is well aligned with Government of Sindh's Draft Sindh Vision 2030 and a component of the 2010–13 Country Partnership Strategy (CPS); it aims to improve human development and social protection through enhanced livelihood opportunities for the rural poor and increased market access for small farmers. The project is also in line with the Indus Eco region program, the PRSP II and the government's policies and plans for the Sindh Province. It complements Sindh Government's 50-year vision for the Indus Ecoregion, which is inclusive of the 5 year Indus For All Programme (IFAP), that has now been completed.

The Indus Ecoregion Programme was undertaken with the Government of Sindh via its relevant departments; it was conceived to address the poverty-environment nexus in the region and thus tailored to directly contribute towards Millennium Development Goals (MDGs) in the key areas: (i) Eradicate extreme poverty and hunger but improving incomes of the poorest - reducing the proportion of the people living on less than $1 a day (Goal 1); (ii) Promote gender equality and empower women (Goal 3); (iii) Ensure environmental sustainability (Goal 7).

1.2 Aims and Objectives

The project is aimed to improve the livelihoods of the local communities by (i) linking farmers to markets and Strengthening Value Chains (ii) Facilitating Rural Non-Farm Income; and (iii) Reducing Risk, Vulnerability, and Gender Inequality. Support through this project will therefore focus on enhancing rural livelihoods and community-based programs, involving: building institutions for the poor, especially for women, youth and minorities so that they can better articulate their demands; facilitating achievement of economies of scale; improving access to public and private services; and making rural producers more attractive to private enterprises

1.3 Purpose and Structure of the Environmental and Social Management Framework

ESMF has been prepared to fulfill the WB policy requirement setting out principals and guidelines to identify and assess the potential impacts and prepare mitigation plans as a part of preparation of the sub-projects. The objective of the ESMF is to ensure that the project has no negative environmental and social impacts, and personnel health and safety of project staff and beneficiaries.

The ESMF lays down principles and procedures for impact assessment and mitigation, institutional arrangements, grievance redress, consultation, participation, documentation and reporting, disclosure, monitoring and evaluation, training and budget. Based on the ESMF, mitigation plans/checklists will be prepared for the sub projects.

2 Project Description

2.1 General

The project will focus on four priority sites[1] of the Indus Ecoregion, where WWF -Pakistan is already present and has an understanding of the local communities' needs and socio-economic potential. The project will cover an area of 2,168 km^2 with at least 187 villages, in the Sindh Province of Pakistan. The priority areas are:

(i) Keenjhar Lake in Thatta District;
(ii) Chotiari Reservoir in Sanghar District;
(iii) Nara Canal and surrounding communities in Khairpur District; and
(iv) Manchar Lake and surrounding communities in Jamshoro District

These areas have hitherto been overlooked by most government departments and sectors, due to limited resources, despite their potential for generating considerable economic returns for rural communities and possibly the relevant government sector. Issues like weak infrastructure, inadequate investment, and weak management of the fisheries sector will be addressed through establishing fisher sustainability schools and fisher groups, provision of chilling and packaging units. Livelihood development will be facilitated through provision of assets and capacity building trainings for alternate livelihood; these are entrepreneurial in nature and are limited to bakeries, milk chillers, indigo units, and recycling units, which would improve the sector's sustainability and productive potential.

Improving the poor infrastructure in the project areas is not in the scope of this pilot project - however this project will attempt to address the issue of landing sites and road access through a two-pronged approach: 1) collaboration with the government to improve landing sites and infrastructure therein through lobbying effort and, awareness; 2) organization of fishermen into groups to increase their opportunity to gain a stronger voice and generate economies of scale which could increase their access to markets, reduce post-harvest losses and fetch better prices, and 3) Improvement of local market conditions to reduce losses for local sellers and ultimately enhancing the quality of the fish for consumer.

The project incorporates a component for adaptation to climate change since the introduced interventions are climate resilient. For instance, the use of new practices to influence spawning periods, enhance fish growth, reduce post-harvest losses and the Better Management Practices (BMP) are all aimed at improving climate resilience.

This pilot project will adopt a Community Demand Driven (CDD) approach to meet the needs of fisher folk in this region. It will allow them the opportunity to break out of this low-equilibrium trap through a set of necessary and complementary interventions at the household level, as well as develop direct linkages, registration and extension services across the: Union level; District Coordination Committees (DCCs), which are headed by the District Commissioner (DC); federal government offices and cooperative boards; and Area Coordination Committees (ACCs), which are recently established networks of Community Based Organizations (CBOs) and Non-Governmental Organizations (NGOs) from the projects target sites. Several of WWF – Pakistan's projects focus on the Indus Ecoregion since it is a global priority for WWF. Project donors include the European Commission and the Planning and Development Department – Government of Sindh. However, some of the target sites are not being targeted by other projects and no work on freshwater fisheries management is being done either.

[1] All four priority areas are well defined in terms of boundary delineation. At least half of the selected areas are vulnerable to severe flooding, as has been witnessed during the 2010 and subsequent floods.

The project activities have been designed are to be the first of their kind in the area, especially in Nara Canal and Manchar Lake. Although there is an ongoing skill development and livelihood project in Chotiari, it is not being implemented in the villages proposed in this pilot project. This will also serve as a good opportunity to build up on lack project activity near Keenjhar Lake since completion of IFAP.

There are skill enhancement and capacity building activities interwoven throughout the components of the project, which will enhance the capacities of the communities, CBOs and fisher cooperatives to sustain and manage the project interventions. Various other measures, such as cost sharing (up to 15% in this particular project) will also be employed to foster a sense of ownership and responsibility among target communities to ensure sustainability of project initiatives beyond the project period. Collaboration with the local government authorities, particularly representatives of the provincial fisheries department, will also help ensure the sustainable operation of the installed chilling units.

The project has been divided into three main components as briefly described below:

2.2 Component 1: Improvement in Fishing Practices and Establishment of Fisher Groups

The objective of this component is to improve the capacity of fisher communities to better manage their fish resources using appropriate management practices. Fishing is one of the main sources of livelihoods in the Indus Ecoregion , which, despite having significant commercial potential, has not been addressed by the public sector and lacks the sufficient infrastructure and support for fisher communities. Under this component, better management practices would be promoted through establishment of fisher sustainability schools (FSS) at four priority sites. In addition to this, four fisher groups will be set up. Establishment of chilling units, ice boxes and packaging units, which will be used to process the fish catch for consumption in local markets and the surplus quantity of selected species would be exported through the Community Based Organizations and Fisher Cooperatives. This component will address this through the following 3 sub-components:

2.2.1 Sub-component 1 (a): Promoting Better Management Practices through Fisher Sustainability Schools (FSS)

This will be achieved for targeted fishing communities in four districts (Thatta, Sanghar, Khairpur and Jamshoro) by training master trainers based in their respective villages and will facilitate the implementation of different BMPs related activities in collaboration with local activists, by conducting FSSs in these villages. Trainings will follow a curriculum covering BMPs for managing different fish species, types of fishing, stock management, how to record fish catch data and how to calculate basic fish stock assessments, water requirements for aquaculture, and integrated resource management. (Although the training shall target fish species, freshwater shrimp may also be covered, adding an advantage for fishers who also sell shrimps as part of their catch). The FSSs will include demonstration areas, a landing site (per area) where they can display BMPs such as pen culture, cage culture, stock management, habitat management, improved landing, fish handling, and processing; Refresher courses will be held for master-trainers, to update them in new innovations and brush up on existing techniques/practices as well as exposure visits to see successful sites in the region.

2.2.2 Sub-component 1 (b): Establishment of four fisher groups2

These will be established at one water body in each district to promote rights based and co-management in the industry. Co-management will be introduced from the start of the project, using past initiatives such as an MoU with the fisheries department for access rights (both legal and physical)3. A bottom-

[2] Such groups have previously been established under WWF – Pakistan's Indus for All Program for the agriculture sector. Neighboring countries such as Bangladesh and India have introduced the concept of fisher groups or cooperatives which have been successful and we hope to replicate that in Pakistan.

[3] It should be noted that this is based on existing best practices and guaranteeing the laws is outside the scope of this pilot project.

up approach will be employed as fisher folk will be organized at the village level and authorized to select their village representatives who will federate into registered cluster groups with the government so as to become a legal entity. Fishery groups will be formed entirely for marketing purposes to minimize extra expenses, gather market information and adjust exploitation. The fishery groups will be linked to the ACCs to ensure that their needs in terms of facilities (access roads, ice factories, or alternative practices such as drying, salting etc.) are met and that the water-bodies are protected from pollution and over- or improper exploitation.

2.2.3 Sub-component 1 (c): Establishment of chilling units, ice boxes and packaging units

These will be used to process selected species for direct export, with the support of the CBOs. There are a number of fish species found in Pakistan, such as the River Sole, that fetch higher prices compared to those being exported from India and Bangladesh. This innovation will rely on the entrepreneurship of local fisheries, with support from the project, fisher groups, and district and provincial governments, to export these species. The emphasis will be on quality rather than quantity, so that fishers may receive more income from a lesser amount of good quality, well preserved fish rather than over-fishing a water body for a larger amount of low grade fish. All in all, 4 large chilling units or freezers and 4 packaging[4] units will be installed at landing sites and 200 ice boxes will be distributed to fishermen – which do not require any electricity. A Cost benefit Analysis will be done prior to distributing these four chilling and packaging units – whereby costs, maintenance, ownership and other fees will be taken into consideration to assess its long term feasibility.

2.3 Component 2: Promotion of Alternative Livelihood for Women and Youth

This component focuses on building capacities for alternative sources of income to address issues high dependence on fishing for livelihoods. The objective of this component is to support women, youth and minority community members at the project sites to establish sustainable community based livelihood initiatives through provision of required assets, technical assistance and establishment of market linkages. It encompasses establishment of:

1. **Village Bakeries** to cater to the existing local demand for bakery products by restaurants, schools and residents.
2. **Milk Shops** to facilitate collection in every village for supply to the main chiller**,** which provides access to a large market.
3. **Indigo Units** to cater to the local demand for indigo products
4. **Recycling units** to improve sales of environmentally friendly paper and products

. The project will support mechanisms to identify and sustain innovative approaches to help the rural poor organize themselves around livelihood based businesses, especially community contributions (in-kind or cash) that will build on projects investments. This component has three sub-components:

2.3.1 Sub-component 2 (a): Organization of targeted communities and Establishment of community based livelihood activities

These are based on existing community demands and identified as having a high potential for generating revenues in the local environment. These will include initiatives such as a demand and skill assessment to identify the needs and potential of the target communities, prior to setting up organization and acquiring assets and support for the organization and federation of the targeted poor as well as establishment of: a) Community managed village bakeries; (b) Community based milk groups by organizing milk producers and establishing demonstration shops; (c) Indigo production units for the selling of locally produced 100% natural dye to handicrafts, which will also support local farmers growing indigo plants; and (d) Local 'recycling groups' of youth and marginalized community members, who collect waste, residing in and around large towns such as Sanghar and Thatta. Savings

[4] This would entail setting up an area used to process, prepare and store fish for storage purposes.

and Internal lending activities will be piloted with a few groups with a view to improve the sustainability of livelihood activities. Prior to this activity commencing a savings and internal lending manual will be developed to ensure that the activity is suited to the context.

2.3.2 Sub-component 2 (b): Provision of assets

These will include assets such as Bakery cooking equipment, milk chillers and marketing outlets, indigo seeds and processing units, recycling kits, etc. Indigo production plots and raw materials would be acquired through "sub-grants," details of which will be outlined in the operations manual and finalized during the appraisal stage. It should be noted that a 15% community contribution5 (e.g. space for shops, cash, labor, as well as provisions for maintenance of assets) towards livelihood activities will be required from community members.

2.3.3 Sub-component 2 (c): Capacity building

This will include capacity building of project beneficiaries to start and sustain alternative livelihood initiatives listed above and to strengthen their business operations through activities such as training in packaging, marketing, book-keeping, savings, value-addition, training master trainers on paper recycling and indigo production which will include growing, processing and marketing of the indigo dye. Providing trainings in producing and marketing to improve the sale of local handmade products, to be marketed as 100% recycled and environmentally friendly paper and products, will also indirectly aid in conserving the environment. Project field staff will also receive capacity building trainings to increase project implementation efficiency.

2.4 Component 3: Monitoring and Evaluation and Knowledge Dissemination

As a pilot project, this component will finance a number of learning activities that will allow for up-scaling of successful approaches as well as facilitate governance, project management, implementation, conducting a baseline survey, reporting and coordination efforts. It will consist of the following two sub-components:

2.4.1 Sub-component 3 (a): Governance and project management:

This will be done by supporting an effective project management system, through the provision of operating costs, training and technical assistance to strengthen the implementing agencies capacity through technical trainings with regards to new and changing technology, as well as CBOs regarding Participatory Monitoring. Monitoring visits; Quarterly planning and review meetings; Program Support Unit meetings; and Annual review and networking meetings will also be conducted regularly for ensuring timely and effective implementation, reporting and communications of the project.

2.4.2 Sub-component 3 (b): Monitoring and evaluation and learning:

This will ensure efficient and thorough monitoring of project activities (both ongoing and post-implementation monitoring), conducting a baseline survey of project households, sharing of lessons learnt through exposure visits and workshops for project beneficiaries; regular reporting on progress and results (against the baseline); conducting research studies on various approaches adopted,

[5] WWF-Pakistan has maintained a cost/time-sharing principle in all its projects that target the local community for inculcating a sense of ownership and ensuring project sustainability. In our experience, communities in these areas have readily agreed to contribute in kind or through cash and the targeted communities in this project have already been contacted and informed of the contribution aspect of the project.

monitoring changes in trends in poverty using Poverty Environment indicators; conducting a comprehensive project completion report; and yearly financial audits.

3 Policy and Legal Framework

3.1 General

This section provides an overview of the legislative structure and environmental assessment process in the province of Sindh as well as a list of key environmental legislation applicable in Pakistan. It also provides an overview of World Bank and other relevant international requirements including identification of applicable World Bank Operational Policies and applicable World Bank Group Environmental, Health and Safety Guidelines.

3.2 Applicable National Environmental Policies and Legislation

3.2.1 National Environmental Policies and Guidelines

a) National Conservation Strategy (1992)

The Pakistan National Conservation Strategy (NCS) is the principal policy document for environmental issues in the country which was developed and approved by the Government of Pakistan on 1st March 1992. The NCS works on a ten-year planning and implementation cycle.

b) The National Environmental Policy (2005)

The National Environmental Policy (NEP) describes integration of the environment into development planning through the implementation of the Environmental Impact Assessment (EIA) process at the scheme level. The NEP is the overarching framework which aims to protect, conserve and restore Pakistan’s environment in order to improve the quality of life of the citizens through sustainable development’.

The policy includes guidelines to Federal, Provincial and Local Governments under the following headings:

- Water supply and management
- Air quality and noise
- Waste management
- Forestry
- Biodiversity and protected areas
- Climate change and ozone depletion
- Energy efficiency and renewable
- Multilateral environmental agreements

c) National Environmental Quality Standards (2010)

The National Environmental Quality Standards (NEQS) were first promulgated in 1993 and have been subsequently amended including standards for liquid effluent and gaseous emissions. The latest standards for ambient air, drinking water quality and noise levels were published on November, 2010 and standards for motor vehicle exhaust, diesel vehicle and petrol vehicle were published in August, 2009. The following standards are specified therein:

- Maximum allowable concentration of pollutants (32 parameters) in municipal and liquid industrial effluents discharged to inland waters, sewage treatment facilities, and the sea;
- Maximum allowable concentration of pollutants (16 parameters) in gaseous emissions from industrial sources;
- Maximum allowable concentration of pollutants (8 parameters) in ambient air quality;

- Maximum allowable concentration of pollutants (3 parameters) in motor vehicle exhausts;
- Drinking water standards; and
- Noise standards.

d) Guidelines for Sensitive and Critical Areas (1997)

The Guidelines for Sensitive and Critical Areas, 1997, identify officially notified protected areas in Pakistan, including critical ecosystems, archaeological sites, etc., and present checklists for environmental assessment procedures to be carried out inside or near such sites. Environmentally sensitive areas include, among others, archaeological sites, biosphere reserves and natural parks, wildlife sanctuaries and game reserves.

e) Guidelines for the Preparation and Review of Environmental Reports (1997)

These guidelines are a part of package of Pakistan Environmental Protection Act 1997 and National Environmental Quality Standards, regulations and other guidelines. The scope of this guideline is confined to those aspects of environmental report preparation and review which are of general nature. Sector specific provisions are not included, nor are the subject of public consultation, which is dealt with separately.

f) Guidelines for Public Consultation (1997)

The Pakistan Environmental Protection Act 1997 requires public participation during the review of an EIA (section 12 (3)). The "policy and procedure for the filing, review and approval of environmental assessments" requires the proponents to consult with the affected community and relevant NGO's during the preparation of an environmental report.

3.2.2 National Legislation

a) Forest Act (1927)

Federal Forestry Act of 1927 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.

b) Protection of Trees and Brushwood Act (1949)

The Protection of Trees and Brushwood Act prohibits illegal cutting or lopping of trees along roads and canals planted by the Forest Department.

c) Antiquity Act (1975)

The Antiquity Act ensures the protection of cultural resources in Pakistan. This act is designed to protect antiquities from destruction, theft, negligence, unlawful excavation, trade and export. Antiquities have been defined in this act as "Ancient products of human activity, historical sites, sites of anthropological or cultural interest and national monuments etc."

The act 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 archaeological significance.
Under this act, the proponents are obligated to ensure that no activity is undertaken in the proximity of a protected antiquity, and during the course of the project if an archaeological discovery is made, it should be reported to the Department of Archaeology accordingly.

d) Wildlife Act (1975)

The Wildlife Act consolidates the laws approach to protection, preservation, conservation and management of wildlife in the country.

f) Local Government Ordinance (2001)

The Local Government Ordinance empowers the Government of Pakistan and provincial governments to enforce laws for land use; conservation of natural vegetation; air, water, and land pollution; disposal of solid waste and wastewater effluents; and public health and safety, including some provisions for environmental protection. Section 93 of this Ordinance pertains to environmental pollution, under which the local councils are authorized to restrict actions causing pollution to air, water or land.

g) 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 labour in the country. The ECA defines a child to mean a person who has not completed his/her fourteenth year 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 are carried out.

3.3 Provincial Environmental Policies and Legislation

3.3.1 Sindh Environmental Protection Act (SEPA), 2014

The Sindh Environmental Protection Act (SEPA) was enacted on March 20, 2014. SEPA is the basic legislative tool empowering the Sindh government to frame regulations for the protection of the environment. The Act provides the framework for protection and conservation of species, wildlife habitats and biodiversity, conservation of renewable resources, establishment of standards for the quality of the ambient air, water and land, establishment of Environmental Tribunals, appointment of Environmental Magistrates, Initial Environmental Examination (IEE) and EIA approval. It also describes the powers and functions of the Sindh Environmental Protection Agency (Sindh EPA). The requirement to conduct environmental IEE or EIA before commencing developmental projects is a requirement under this Act.

3.3.2 Sindh Wildlife Protection Ordinance (2001)

The Sindh Wildlife Protection Ordinance of 1972, as amended in 2001, 2010 provides for the preservation, protection, and conservation of wildlife by the formation and management of protected areas and prohibition of hunting of wildlife species declared protected under the ordinance. The ordinance also specifies three broad classifications of the protected areas:

- National Parks: Hunting and breaking of land for mining are prohibited in national parks, as removing vegetation or polluting water flowing through the park;
- Wildlife Sanctuaries: Wildlife sanctuaries are areas which are left as undisturbed breeding grounds for wildlife. Cultivation, grazing and residing is prohibited in the demarcated areas. Special permission is required for entrance of general public. However, in exceptional circumstances, these restrictions are relaxed for scientific purpose or betterment of the respective area on the discretion of the authority; and

- Game Reserves: Game reserves are designated as areas where hunting or shooting is not allowed except under special permits.

3.3.3 Wild Birds and Animals Protection Act (1912)

The Wild Birds and Animals Protection Act of 1912 provides for the protection of wild animals, birds and plants and for matters connected therewith or ancillary or incidental thereto.

3.3.4 Sindh Fisheries Ordinance (1980)

The Sindh Fisheries Ordinance of 1980 provides rules and regulations for marketing, handling, and transportation, storage of fish and shrimps for commercial purpose and sale of fish used for the provincial trade in the Province of Sindh. Contravention of this Ordinance leads to imprisonment up to 6 months or a fine of 10,000 rupees or both. A provision is made for total ban on use of destructive fishing gear and closed season during June and July.

3.3.5 Sindh Strategy for Sustainable Development (2007)

The Sindh Strategy for Sustainable Development proposes a ten year sustainable development agenda for Sindh level. Its purpose is to highlight the ecological, economic and social issues of the province and to provide recommendations and strategic actions to address them. The strategy promotes the sustainable use of natural resources to achieve the objectives of poverty alleviation and social development through the participation of the people of Sindh.

3.4 International Treaties and Conventions

Pakistan is a signatory to a number of Multilateral Environmental Agreements (MEAs). 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 non-existent. The following are the relevant international treaties and conventions that have been ratified by Pakistan:

- Basel Convention,
- Convention on Biological Diversity, Convention on Wetlands (Ramsar convention),
- Convention on International Trade in Endangered Species (CITES),
- United Nations Framework Convention on Climate Change,
- Kyoto Protocol,
- Montreal Protocol,
- UN Convention to Combat Desertification,
- UN Convention on the Law of Seas ,
- Stockholm Convention on Persistent Organic Pollutants,
- Convention concerning the Protection of World Culture and Natural Heritage (World Heritage Convention), 1972; and
- International Plant Protection Convention, 1951.

3.5 World Bank Safeguard Policies

The World Bank's environmental and social safeguard policies are summarized in Table 3.1 and some are described in the following sections:

3.5.1 Environmental Assessment (OP 4.01)

OP 4.01 provides the framework for World Bank environmental safeguard policies and describes project screening and categorization to determine the level of environmental assessment required. Most proposed project interventions are soft in nature, include capacity building and community organization and do not include any physical activity. The project will however also provide some basic assets like stoves, chillers, indigo seeds and processing units, and packaging units spread over the project area. The activities may have some adverse environmental or social impacts, therefore, the project has been categorized as Category "B".

3.5.2 Natural Habitat (OP 4.04)

The policy recognizes the importance of natural habitat in sustaining biodiversity, and requires that projects strictly avoid their significant conversion or degradation (particularly for critical natural habitat), and minimize and mitigate impacts to them including, as appropriate, through creation of offsets and restoration measures. Though no degradation of natural habitats is expected due to project activity, the policy is triggered to screen for and monitor any potential impacts on the mangrove habitats.

3.5.3 Access to Information

This policy sets out the Bank's requirements for disclosing and sharing information. The policy reaffirms the Bank's commitment to transparency and accountability in its activities for promoting development effectiveness and poverty reduction. ESMF and its executive summary will be disclosed at WWF website and World Bank Info Shop in addition to sharing them with the stakeholders including the local community.

In addition, the following policies and guidelines have been taken into account in the project design:

3.5.4 Environmental Health and Safety Guidelines

The World Bank Group Environment, Health, and Safety (EHS) General Guidelines (2007) contain performance levels and measures for development of industrial projects that are considered to be achievable in new facilities at reasonable costs by existing technology.

3.5.5 Gender Policy (OP 4.20)

The World Bank's Gender Policy aims to reduce gender disparities and enhance women's participation in the economic development of member countries.

3.5.6 Indigenous People (OP 4.10)

This policy has defined Indigenous Peoples for policy application as well as the planning process to be followed if a Bank-funded project affects Indigenous Peoples. In Pakistan, the World Bank has concluded through its operational experiences that only Kalash people in Chitral district of Khyber Pakhtunkhwa province meet the definition of Indigenous Peoples as described in this policy. Since no Kalash people live in the project area, this policy is not applicable.

3.5.7 Involuntary Resettlement (OP 4.12)

The OP 4.12 on Involuntary Resettlement provides detailed guidance on Land Acquisition and Involuntary Resettlement. This lays out the Bank's mandatory guidelines where land is to be acquired for any project. The Project is likely to use Voluntary Land Donation (VLD) for small community infrastructure schemes which is only allowed under certain conditions and as an exception to the rule. However, there are strict protocols for ensuring that the donation is truly voluntary, does not exacerbate poverty and is done in a transparent manner.

Table 3.1: Triggering the World Bank Policies

Safeguard Policies	Yes	No
Environmental Assessment (OP/BP 4.01)	X	
Natural Habitats (OP/BP 4.04)	X	
Forests (OP/BP 4.36)		No forests in project area
Pest Management (OP 4.09)		No pesticide usage
Physical Cultural Resources (OP/BP 4.11)		No physical resources of cultural value in project area
Indigenous Peoples (OP/BP 4.10)		No indigenous communities in the area
Involuntary Resettlement (OP/BP 4.12)		No resettlement or loss of livelihood is expected
Safety of Dams (OP/BP 4.37)		No dams to be built
Projects on International Waterways (OP/BP 7.50)		No activity on international waterways
Projects in Disputed Areas (OP/BP 7.60)		No activity in disputed areas

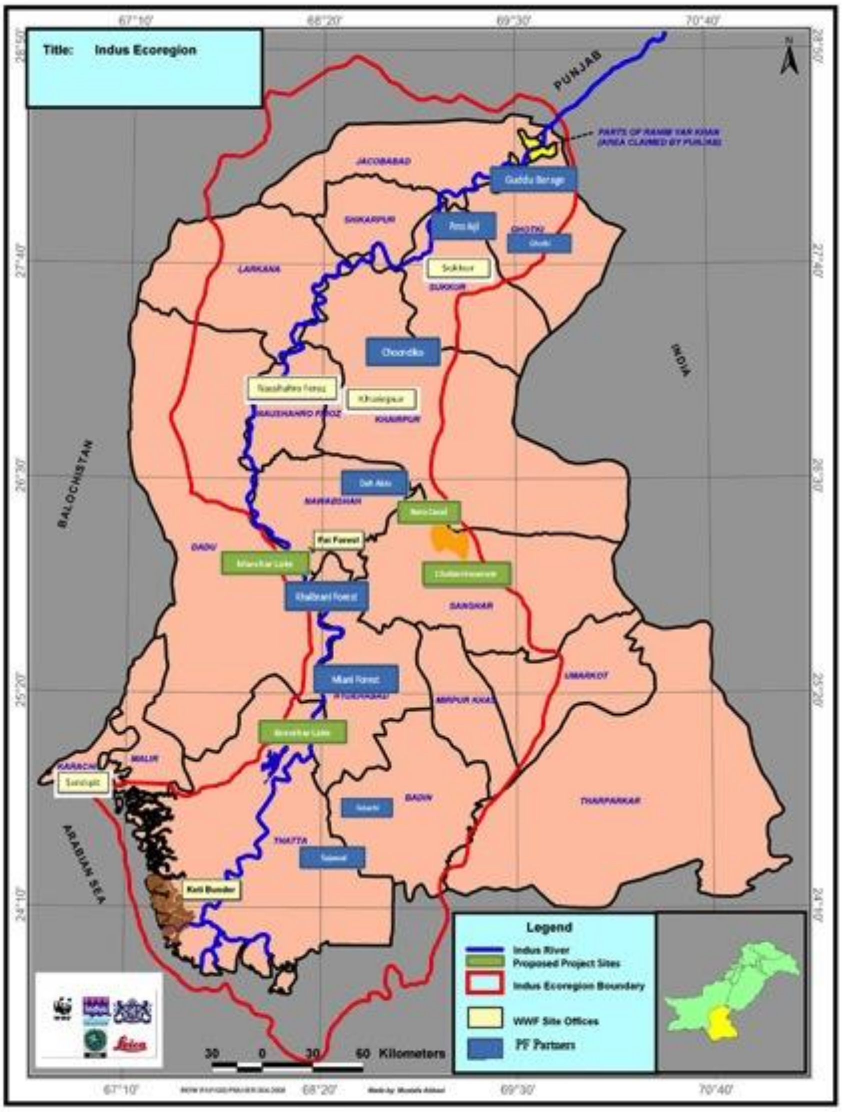
3.5.8 World Bank Environmental and Social Guidelines

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

- Environmental Assessment Sourcebook, Volume I: Policies, Procedures, and Cross-Sectoral Issues;
- Involuntary Resettlement Sourcebook;
- Social Analysis Sourcebook;
- Physical Cultural Resources Sourcebook; and
- World Bank Group - Environmental Health and Safety Guidelines.

4 Baseline

Sindh Province which is one of five provinces in Pakistan has a hot arid to semi-arid climate, with agricultural activity concentrated around the River Indus. It also has considerable freshwater fisheries potential since it has over 65% of the freshwater resources of Pakistan. Overall, Sindh has the second highest per-capita income among the provinces. With a relatively high population growth rate of 2.8%, Sindh's population is expected to more than double by 2025 to 64.2 million (Draft Sindh Vision 2030). However, over 50% of this population is rural and has been disproportionately affected by natural disasters that have devastated the rural economy, whereas the urban economy bears the brunt of the worst electrical power crisis in the country's history.



The Indus Ecoregion[6] in Sindh Province is the most prioritized of the five ecoregions in Pakistan, and is one of the 40 most significant Ecoregions in the world (out of more than 240). Based on the most recent data available in Pakistan Economic Survey 2013-14, despite its living natural resource potential, the number of people living below the poverty line set by the World Bank in this region has almost tripled from 17.2% in 2007-08 to more than 50% in 2013-14. This increase in poverty, coupled with a rapid rise in population and over 10 years of severe droughts and flash floods with heavy rainfalls (2010-11) have created enormous stress on the declining living natural resources.

According to the Economic Survey of Pakistan 2012, fisheries plays an important role in the national economy and provides employment to about 300,000 fishermen directly and the total production of fish from inland and marine waters in Sindh is approximately 450,000 tons of which marine fish constitute 75% while freshwater and inland fisheries constitute 25%. The sustainability of the sector and the growth potential is being affected by the over exploitation of recourses and high

[6] Indus Ecoregion is a regional priority for the WWF Network and is one of the Global 200 Ecoregions. The Global 200 is a ranking of the earth's most biologically outstanding terrestrial, freshwater and marine ecosystems.

poverty levels among fisherfolk communities who are compelled to sell their catch to middlemen and contractors as they have very little access to improved practices, finance or assets of their own.

The underlying development hypothesis for this project is therefore that more than 60% of fishing communities in the Indus Ecoregion are living below the poverty line and are typically the first to experience the consequences of natural disasters and weak natural resource management, as they are not equipped for adapting or switching to better fishing practices or alternate livelihoods.

Detailed socio-economic surveys conducted along the River Indus for Chashma and Taunsa - Punjab and Sukkur - Sindh (2012) by WWF – Pakistan reveal that monthly incomes of fisher households (with an average household size of 7) is around PKR 2,000 which in US $ is estimated to be around US$20. Around 75% (WWF – Pakistan surveys) of the population in target communities lies below Pakistan's poverty line of US$60 (PKR 6000) per month per person (2012-13). Fisher communities face a multitude of challenges such as social exclusion in some areas due to their ethnicity and caste; Insufficient infrastructure (such as landing sites, chilling units, and roads) and; lack of access to capital and poor investment in the sector which has forced many fisherfolk to seek underpaid manual labor as a source of income or to migrate to other water-bodies, which often leads to further entrapment in debt. The multi-purpose usage of freshwater (for power, irrigation, leisure, etc.) also means that fisheries services have been neglected or not valued highly and as a result, very little effort and resource has been allocated to management of inland fisheries. Fishing, which is their main livelihood source, is also known to be particularly susceptible to climate change, as erratic rainfall significantly affects fish breeding patterns and their success rates and there are currently no interventions in place to assist fisher communities in managing such changes or the over-exploitation of fish resources (see **Annex A** for rainfall data of Sindh).

Some more gender disaggregated district level socioeconomic baselines[7] of the target areas are described below:

Gender

Women observe pardah and confine themselves to household work. In the rural areas, however, they help their males in the agriculture pursuits. In Thatta district, the sex ratio is 112.5 with a variation in rural and urban areas at 112.96 and 108.94 percent respectively. Out of total female population 47.26 percent is in reproductive ages i.e. 15 to 59 years. The percentages for urban and rural areas are 49.54 and 46.96 respectively. For Sanghar district, the sex ratio is 110.36. Out of the total female population, 45.52 percent is in the reproductive ages i.e. 15-49 years. The percentages for urban and rural areas are 47.01 and 45.07 respectively. In Khairpur district, the sex ratio is 110.09 with a variation in rural and urban areas at 110.32 and 109.38 percent respectively. Out of total female population 42.25 percent is in reproductive ages i.e. 15 to 49 years. The percentages for urban and rural areas are 44.79 and 46.73 respectively. The sex ratio of Jamshoro district is 115.97.

Health

Thatta district has five main hospitals having approximately 400 beds, one is in district headquarters and four in Taluka headquarters. Besides, there are 8 rural health centres and 46 basic health units. In Sanghar district, there are several hospitals and dispensaries, health centers and clinics including Civil hospital, Taluka headquarter hospital, basic health unit, rural health center, government dispensary, maternity homes, experimental dispensary and district council dispensary. The medical installations/facilities in the Khairpur include teaching and district hospital, Taluka hospital, rural health center, basic health center, dispensary, veterinary hospital and mobile unit. In Jamshoro district, there are 32 health facilities including Government hospitals, rural health centers, mother child health center, basic health units and government dispensaries.

Education

As per the literacy definition in 1998 Census, it is defined as "the ability of a person to read a newspaper or write a simple letter in any language". The literacy ratio in Thatta is 22.14 percent. The male literacy

[7] The information is based on the District Census Report of 1998.

ratio is three times higher at 31.58 percent as compared to females. The ratio in urban area is 45.92 percent which is higher as compared to only 18.99 percent in rural. In Sanghar, the literacy is 30.87 percent. The male literacy ratio is 42.88 percent which is higher as compared to 17.45 percent for females. The literacy ratio of Khairpur district is 35.5 percent. The male literacy ratio is 49.69 percent which is much higher as compared to the female. The literacy ratio of the district Jamshoro is 43.6 percent.

Housing

In Thatta district, the huts in rural areas are made of wood and lao. The roofs' have slops on opposite sides covered with think mud plaster. In villages cattle sheds are beside the residential houses. A hut has two compartments, one is used for the living while the other is used as a kitchen and for storing things. The dwellings of rich people in the urban areas are generally made of stone, bricks cement and wood. The house of an average town's man is made of timber framework covers with mud plaster having flat roofs. Rooms are lime plastered while floors may be cemented. The people of urban area of Sanghar district are living in cemented, pucca, semi-pucca and katcha houses. People also live in huts. There is hardly any use of furniture in rural and desert areas. The people mostly use cots in their houses. In Khairpur district, most houses are built of mud bricks dried and hardened in the sun with flat roofs. However, in the cities brick built houses, sometimes many storied, are common.

Employment

The main occupation of the people in Thatta district is agriculture. Women assist their men in the fields and generally do transplantation of paddy and reaping of the harvest. The children graze cattle and irrigate fields. The economically active population in the district is 25.07 percent of its total population and 37.05 percent of the population aged 10 years and above. A high rate of unemployment at 17.82 percent has been recorded in the district. It varies for males and females as well as for rural and urban areas. Of the total employed population in the district, 64.24 percent is in the Major Occupation group i.e. Skilled Agricultural and Fisheries Workers. Most of this population has been located in rural areas (69.54 percent). About two-third i.e. 63.07 percent of the employed population is Self-Employed in the district. Among them, male percentage is 63.47 percent. There were only 5.78 percent government employees in the district.

In Sahghar district, the main occupation of the people is agriculture. Almost all members of a family including women are involved in this profession. The economically active population of the district is 22.33 percent of its total population and 33.22 percent of the population aged 10 years and above. The unemployment rate of the district is 14.26 percent. It varies for males and females as well as for rural and urban areas. Of the total employed population in the district, 56.54 percent is in the Major Occupation group i.e. Skilled Agricultural and Fisheries Workers.

The main occupation in Khairpur districtis agriculture. In rural areas, like other part of the country, women and children work in the home and also do light farm work in the field like harvesting and grazing to assists their male members. The economically active population in the district is 18.88 percent of its total population and 28.80 percent of the population aged 10 years and above. An unemployment rate of 8.55 percent has been recorded in the district. It varies for males and females as well as for rural and urban areas. Of the total employed population in the district, 61 percent is in the Major Occupation group i.e. Skilled Agricultural and Fisheries Workers.

NGOs in the Districts[8]

Few of the popular NGOs working in Thatta district are Thatta Youth Development Organization (working for the development of youth), Aasthan Latif Welfare Society (working for girls education), Web for Human Development Thatta (working for human development and human values), and Thatta Rural Development Society (working for the development of rural areas in the district). Other NGOs working in Sanghar, Khairpur and Jamshoro districts are listed below:

[8] www.ngos.org.pk

Sanghar district

- Citizens' Commission for Human Development
- Pakistan Fisher Folk Forum
- Al-Mehran Welfare Association
- Association for Health, Education & Agriculture Development
- Sindh Welfare Development Organization
- Sindh Human Welfare Organization Sanghar
- Sanghar NGOs Council Sanghar
- Sindh Successful Partners Organization
- Rural Women Welfare Organization
- Shadab Rural Development Organization
- Desert & Rural Development Organization Khipro
- Sustainable Development Foundation

Khairpur district

- SRSO- Sindh Rural Support Organization
- Young Welfare Society
- National Relief Foundation
- IDSO-Insan Dost Social Organization
- Seswa Development Trust Sindh
- YSWA-Young Students Welfare Association
- Thar Deep Rural Development
- WATAN Development Organization

Jamshoro district

- Thar Deep Rural Development
- Indus Resource Center
- Rani Kot Development Organization
- Indus Rural Development Organization
- Brighter Sindh Association, Jamshoro, Pakistan
- RBB Colony social welfare association Jamshoro
- Seharwo Development Foundation
- Sindh Qaumi Welfare Association

Religion

In district Thatta, the population is predominantly Muslim which constitutes 96.72 percent of the total population, with a higher share in rural areas at 97.45 percent as compared to 90.93 percent in urban areas. Hindu (Jati) are 2.70 percent in the district as whole who are mostly concentrated of 7.69 percent in urban areas compared to only 2.07 percent in rural areas. Presence of other minorities in the district as well as rural and urban areas is quite insignificant. Other minorities include Christians, Ahmadi etc.

The major population of the Sanghar district is Muslim which constitutes 79.15 percent of the total population, 76.50 percent in rural and 88.12 percent in urban areas. The important minority is Hindu about 19.28 percent in the district, higher in rural areas at 21.94 percent as compared to 10.24 percent in urban areas. The percentages of other minorities have been reported quite insignificant. The Muslim population of the Khairpur district is 96.86 percent of the total population; 95.03 percent in urban and 97.43 percent in rural areas. The important minority is Hindu constituting 2.82 percent. The percentage of remaining minorities has been reported quite negligible. In Jamshoro district, the Muslim population is 94.6 percent of the total population. The important minority is Hindu constituting 4.22 percent. The percentage of remaining minorities has been reported quite negligible.

Livelihood Options for Youth, Gender and Minorities

Women in interior Sindh, are generally subjected to cultural barriers that prevent them from engaging in outdoor activities for formal employment. Hence, they usually assist the men of the house for value-added services. In Thatta, Khairpur, and Sanghar, the prevalent culture inhibits women mobility; they are not allowed to travel between villages or engaged in chores that are traditionally associated to men. In Jamshoro, similar norms are practiced in the name of religion. Although not breadwinners, women tend to engage in fish processing, milk collection from livestock, looking after livestock's sustenance, harvesting of crops, threshing, and handicrafts. Additionally, in the older days when organic waste was composted for fertilizer, the activity was undertaken by females of the house; however they were not paid for it.

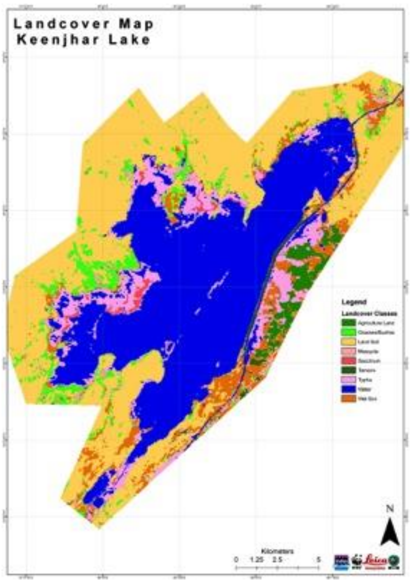
The youth in Thatta, Khairpur, Sanghar, and Jamshoro generally assist their parents in their respective livelihood. Young girls primarily participate in fish processing, harvesting and handicraft activities. On the other hand, it has been observed that 90% of the livestock shepherding is conducted young boys, below the ages of 15.

Non inclusive behavior for minorities is not an issue in the province of Sindh. It is observed that they generally undertake entrepreneurial roles and are not as inclined towards livestock, agriculture, or fisheries.

The maps, legal protection status, and endangered species of fauna and flora for each project site is enlisted below:

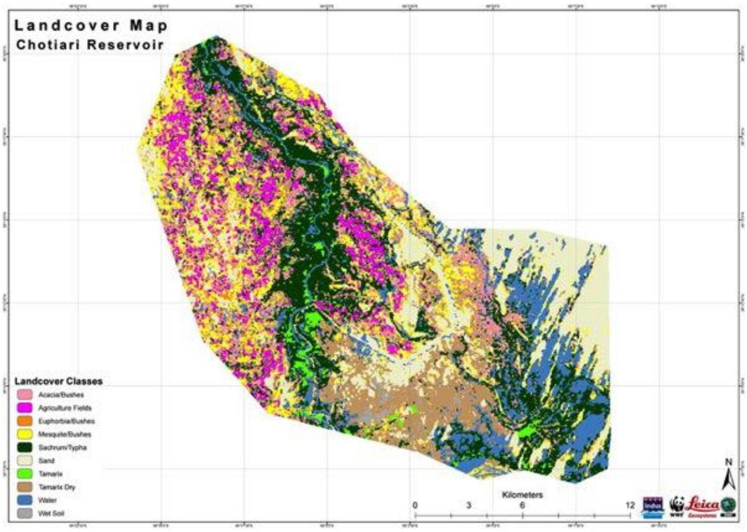
Keenjhar Lake is a wildlife sanctuary and Ramsar site. It is home to the following endangered species:

Fauna/Flora	Species
Fauna	Black-bellied tern (*Sterna acuticauda)*



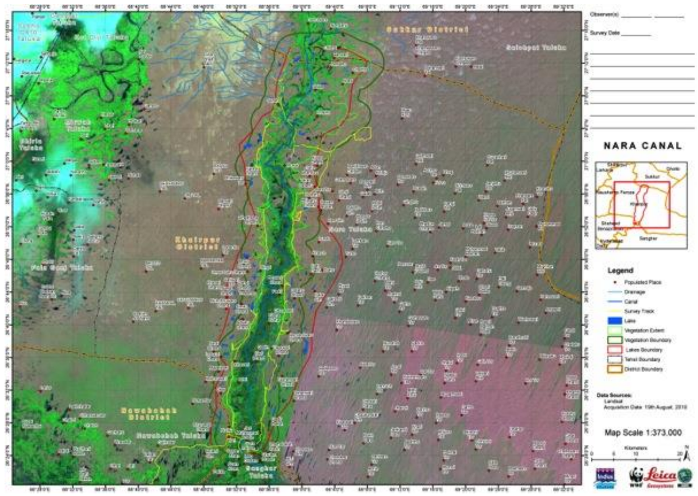
Chotiari Reservoir does not, currently, have a legal protection status. It is home to the following endangered species:

Fauna/Flora	Species
Fauna	Smooth-coated otter (*Lutrogale perspicillata*)



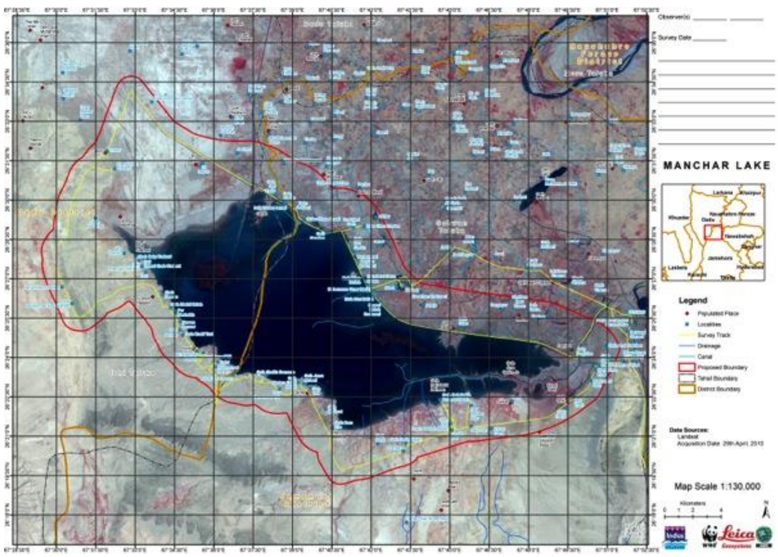
Nara Canal is a Game Reserve; its protection status change to Ramsar site is underway. It is home to the following endangered species:

Fauna/Flora	Species
Fauna	Smooth-coated otter (*Lutrogale perspicillata*)
Fauna	Hog deer (*Hyelaphus porcinus*)



Manchar Lake does not have a legal protection status. . It is home to the following endangered species:

Fauna/Flora	Species
Fauna	Hog deer (*Hyelaphus porcinus*)


Observer(s)
Survey Date
MANCHAR LAKE
Legend
Populated Place
Localities
Survey Track
Drainage
Canal
Proposed Boundary
Tehsil Boundary
District Boundary
Data Sources:
Landsat
Acquisition Date 29th April, 2010
Map Scale 1:130,000
Kilometers
0 1 2 4

5 Environmental and Social Impact Assessment of Proposed Interventions

The project is not expected to have significant social impacts. The impacts may include the resistance of the communities towards the genetically modified fish, location and design of scheme socially unacceptable, inequitable distribution of benefits and construction related impacts, community/user conflict on ownership of natural water bodies may arise due to installation of cages, low selling rates of the product, land requirements. There might also be some social risks involved around the elite capture, inequitable access to benefits and VLD. These risks will be overcome by the social mobilization, community consultations/participation and strict implementation of the VLD criteria laid down in the ESMF. Strong social mobilization will be undertaken by the community mobilization specialist and local CBOs which will be overseen by the ESFP at PIU and PMU levels to ensure that there are no biases and all groups will benefit and to avoid the elite capture phenomena.

It has been revealed that most of these potential impacts are localized in nature with low severity. Furthermore, with the help of appropriate mitigation and control measures, most of these potential impacts will either be avoided altogether, or their likelihood of occurrence and severity will be further reduced, thus making these schemes environmentally responsible and socially acceptable.

	Major Interventions	Environmental and Social Impacts	Mitigation Measure	Responsibility
1	**Installation of fish cage and pen culture in freshwater bodies:**	Though no significant negative environmental impact of small-scale pen/cage culture is expected, however, if the fishermen rear non-indigenous fish species (*Tilapia*) in the cages, there are chances that individuals may escape the cages and enter natural water bodies, which may disturb the aquatic ecosystem.	Native/indigenous species will preferably be reared in pen and cage culture, while in case of exotic species (*Tilapia*) mono sex seed of right size will be ensured;	Community Mobilization and Training Specialist
		Resistance towards genetically modified fish, as most of communities/ consumers tend to prefer indigenous/ wild fish to exotic fish Local communities may resist the introduction of cage/ pen culture	Native/indigenous species will be preferred while in case of exotic species (*Tilapia*) will be discouraged. Awareness regarding nutritional values and economic importance will develop communities' acceptance for cage and pen culture. Awareness raising will also address the need to limit the exotic species to the ponds and not releasing them in the natural water bodies. PMU will develop standard operating procedures for fisheries with the help of Environment, Health and	

	Major Interventions	Environmental and Social Impacts	Mitigation Measure	Responsibility
			Safety (EHS) Guidelines on Aquaculture (**Annex B**) and General EHS Guidelines (**Annex C**)	
		A small amount of ammonia impact can be observed if there is insufficient water flow, which may cause disease outbreak and effect wild/ indigenous species.	Disease transfer and other adverse effects on wild and cultured fish stocks would also be minimized through adaptation of Better Management Practices (BMP) such as, keeping right quantity, adequate feed supply, organic feed preparation, testing water quality, proper size seed and net selection etc.	Community Mobilization and Training Specialist
		Community / user conflict on ownership of natural water bodies may arise due to installation of cages.	Freshwater flow and environmental condition criteria (cage bottom and lake bottom would be at least 6 feet) would also be ensured to minimize the mentioned issues. Water quality can be regularly monitored around the cages to assess any harmful impact	Capacity Building Specialist
			Active community based organizations (CBOs) and fisher cooperatives (FCs) will be made effective to resolve community conflicts and ensure benefit of shared resources; Social mobilization will ensure effective community participation and will help minimize as well as resolve the conflicts. Village organizations will be formed, with equal representation from various social group and influential locals who will be responsible for resolving all conflicts internally.	

	Major Interventions	Environmental and Social Impacts	Mitigation Measure	Responsibility
		Floods might be expected	Suitable site selection e.g. will avoid waterways and flood prone sites, suitable design and right material for cage frames will minimize negative impacts of heavy floods, rains and fluctuating level of water bodies;	Capacity Building Specialist
			As cage frames are movable, they can easily be shifted to safe locations during the harsh weather conditions;	
		land may be required which can be socially unacceptable.	The water bodies for cage installation will be identified after a consultation with VOs and CBOs to prevent conflicts. In addition, fisher cooperatives will also be formed to ensure that each stakeholder gets an equal share of resources. A voluntary land donation form will be signed for documentation of land donation (if required)	Community Mobilization and Training Specialist ESFP/PIU/PMU
		Use of child labor	No child labor will be used in the fishing and associated activities	
2	**Establishment of 24 bakeries at four sites:**	Though there is very little environmental and social risk associated with establishment of bakeries due to the lack of gas supplies in the proposed villages, small amount of wood would be used as fuel. This might release minor quantity of CO^2 in the air;	Proper site selection e.g. bakeries' oven will be constructed away from living rooms) and tree plantation will developed in the vicinity of the bakeries to reduce smoke impact and to off-set any wood cutting for fuel; Proper personal hygiene and cleanliness trainings will be provided to the shopkeepers	Capacity Building Specialist
		Community/ user conflict on ownership of bakery may arise due selection of beneficiaries	Beneficiary's selection criteria based on poverty assessment and socio-economic baseline would help in selection of	Community Mobilization and Training Specialist

	Major Interventions	Environmental and Social Impacts	Mitigation Measure	Responsibility
			deserving needy beneficiaries;	
		Conflict may arise on benefit sharing among beneficiaries	CBO's will also be made responsible for equal benefits sharing amount right beneficiaries.	Community Mobilization and Training Specialist
		Floods may be expected	Training to beneficiaries in DRR and effective early warning system will reduce the impact.	Capacity Building Specialist
			Training to beneficiaries in DRR and effective early warning system will reduce the impact	
		Land may be required for the establishment of bakeries.	Land if required for the scheme will be donated by the community on voluntary basis. Checklist and agreement format in ESMF will be used for this purpose.	PMU/PIU/ESFP
		Location and design of scheme socially unacceptable, inequitable distribution of benefits and construction related impacts.	Locating and designing the scheme using the following criteria: ▪ ensuring equitable distribution of scheme benefits through community participation ▪ ensuring no blocked access, avoiding damage to crops, cultivation fields, cultivation fields, graveyards and cultural heritage sites ▪ after carrying out consultation with the beneficiary community, including women - ensuring that the scheme is socially acceptable and suitable to women.	PMU/PIU/ESFP
		Use of child labor	No child labor will be used in establishing or running the bakeries	

	Major Interventions	Environmental and Social Impacts	Mitigation Measure	Responsibility
3	**Installation of Milk Chillers/shops at central points (at nearest towns) shops, collection points at village level**	No construction work will be required for installation of central milk chillers and milk collection units at village level. Therefore no negative environmental impact is expected. However, unhygienic conditions around chilling units and personal hygiene of handlers may create minor health hazards	Personal hygiene and milk handling trainings would be arranged for the chilling operators and milk collectors and proper cleaning of units will be ensured to minimize expected risks PMU will develop standard operating procedures (SOPs) for milk handling in line with best industry practice and with the help of EHS Guidelines for Dairy Processing (**Annex D**) and General EHA Guidelines (**Annex C**).	Community Mobilization and Training Specialist PMU
		Livestock herders may receive low rates for the milk sold to the chillers and delayed payment may raise some social issues;	Efficient price control mechanism would be ensured through CBOs/ networks for fair price and timely payments to milk suppliers;	Community Mobilization and Training Specialist
		Floods may be expected	As the milk chillers are movable items therefore they could be shifted at safer places in case of floods	Capacity Building Specialist
			Early warnings and disaster preparedness would be an effective tool to minimize expected losses;	
			Operational and maintenance cost would be set apart if any repair is required in case of damages caused by rainfalls/ floods/ other unforeseen situation.	Community Mobilization and Training Specialist
		Land may be required	Land if required for the scheme will be donated by the community on voluntary basis. It will be screened in line with World Bank's guidelines to rule out displacement or other negative impacts.	PMU/PIU/ESFP

	Major Interventions	Environmental and Social Impacts	Mitigation Measure	Responsibility
			Checklist and agreement format in ESMF will be used for this purpose.	
		Location and design of scheme socially unacceptable, inequitable distribution of benefits and construction related impacts.	Locating and designing the scheme using the following criteria: ▪ ensuring equitable distribution of scheme benefits through community participation ▪ ensuring no blocked access, avoiding damage to crops, cultivation fields, cultivation fields, graveyards and cultural heritage sites ▪ after carrying out consultation with the beneficiary community, including women - ensuring that the scheme is socially acceptable and suitable to women.	PMU/PIU/ESFP
		Use of child labor	No child labor will be used in establishing or running milk chillers and associated facilities	
4	**Indigo plantation and processing:**	Indigo is a native species that is mostly cultivated for commercially valuable blue dye. Its cultivation does not require any fertilizers or hazardous pesticides/ herbicidal sprays. Indigo roots have symbiotic activities; the nitrogen fixation bacteria continuously fix the free nitrogen in the roots of plant that ultimately improve land fertility. Hence, it has no negative environmental impact. Preparation of indigo dye does not require any chemical processing; therefore no environmental risk is expected. Moreover,	No pesticides will be used in the plantation of these dyes and BMP would be adopted to ensure that there is no use of pesticides or chemical fertilizers; PMU will develop standard operating procedures (SOPs) for the plantation and processing and with the help of EHS Guidelines for Annual Crop Production (**Annex E**) and General EHA Guidelines (**Annex C**).	Community Mobilization and Training Specialist

	Major Interventions	Environmental and Social Impacts	Mitigation Measure	Responsibility
		this indigo dye would rather replace the synthetic or chemical dye which causes skin allergies to workers in the dying industries;		
		Natural dye including indigo is commonly used in fashion industry and businessmen fetch higher profits through these natural dyed clothes, while indigo grower sometimes do not get their fair share. Artisans using this natural dye in printing fabrics are also not receiving proper returns for their artisanal crafts either which could cause frustration among artisans and growers alike.	Indigo grower's artisans and entrepreneurs would be linked to fair price shops/market for better prices;	Community Mobilization and Training Specialist
		Floods may occur	Suitable site selection for indigo plantation and suitable water drainage system would be ensured to minimize the risk factors;	Capacity Building Specialist
			Tree plantations will be planted to act as a wind breakers will stabilize the soil and prevent wind damage during the winter	
		Land may be required.	Land if required for the scheme will be donated by the community on voluntary basis. It will be screened in accordance with World Bank's guidance to avoid displacement and other negative impacts. Checklist and agreement format in ESMF	PMU/PIU/ESFP

	Major Interventions	Environmental and Social Impacts	Mitigation Measure	Responsibility
			(**Annex F**) will be used for this purpose.	
		Location and design of scheme socially unacceptable, inequitable distribution of benefits and construction related impacts.	Locating and designing the scheme using the following criteria: ▪ ensuring equitable distribution of scheme benefits through community participation ▪ ensuring no blocked access, avoiding damage to crops, cultivation fields, cultivation fields, graveyards and cultural heritage sites ▪ after carrying out consultation with the beneficiary community, including women - ensuring that the scheme is socially acceptable and suitable to women.	PMU/PIU/ESFP
		Use of child labor	No child labor will be used in plantation and associated activities	
5	**Solid Waste Management**	Solid waste management is a step towards minimizing environmental pollution. Agriculture and paper waste is considered a great alternative fiber from which paper can be made such as wheat, rice residue, banana leaves and other agriculture left over. Rather than burning the agricultural and paper waste, it would be beneficially used in paper making	No use of bleaching agents such as chlorine would be encouraged in recycling process, because the unbleached paper is being widely used for different purposes;	Community Mobilization and Training Specialist
		Local people may not be able to purchase the recycled paper products due to their high prices. As these products are costly,	Local people would be encouraged to produce the widely used items to reduce the cost. The increased production and	Community Mobilization and Training Specialist

	Major Interventions	Environmental and Social Impacts	Mitigation Measure	Responsibility
		therefore, the average person may not afford these.	better quality will reduce the price	
		Floods may be expected	Community awareness and effective early warning system will ensure preparedness and protection from disaster risk impacts on processing and recycling assets.	Capacity Building Specialist
		Land may be required.	Land if required for the scheme will be donated by the community on voluntary basis. It will be screened in accordance with World Bank's guidance to avoid displacement and other negative impacts. Checklist and agreement format in ESMF will be used for this purpose.	PMU/PIU/ESFP
		Location and design of scheme socially unacceptable, inequitable distribution of benefits and construction related impacts.	Locating and designing the scheme using the following criteria: ▪ ensuring equitable distribution of scheme benefits through community participation ▪ ensuring no blocked access, avoiding damage to crops, cultivation fields, cultivation fields, graveyards and cultural heritage sites ▪ after carrying out consultation with the beneficiary community, including women - ensuring that the scheme is socially acceptable and suitable to women.	PMU/PIU/ESFP

6 Environmental and Social Management Plans

The project will not produce any negative environmental and social impact so does not require environmental assessment, either IEE or EIA to comply with local legislation, however World Bank policies require that the project should not have any negative environmental and social impacts or work safety hazards associated with its operations.

6.1 Mitigation Plans/Checklists

Environmental and social mitigation Plans have been prepared for each type of intervention discussed in Chapter 5. These Plans will be used during the scheme inception and design stage, and will be made part of the scheme proposal preparation and approval process – thus ensuring integration of environmental and social considerations in the entire identification-design-implementation cycle. These checklists will be filled and submitted to the Bank for clearance and approval before the start of scheme implementation.

6.2 HSE and Social Checklists

The following checklists have been developed for ensuring that there are no negative environmental and social impacts and there is no risk to personnel health and safety.

- Generic Environmental and Social Checklist
- Checklist for fish cage and pen
- Checklist for chillers
- Checklist for bakeries
- Checklist for Indigo dye
- Checklist for solid waste management
- Health and Safety Checklist
- Land-use Checklist

These checklists shall be completed by the field environment and HSE coordinator before, during and after project activities are initiated.

Generic Environment and Social Checklist

Brief description of the baseline conditions of the area

____

____

____

____

____

Activity	**Yes/No (please explain)**
Pre-installation	
Has it been ensured that the site will not disrupt any critical surface water flows?	
Has it been ensured that the site will not disrupt any human or wildlife access to water or other natural resources?	
Has it been ensured that the site is not being used as critical habitat by any species (burrows, feeding/breeding grounds etc.)?	
Have pictures been taken of site pre-installation?	
Have consultations been conducted with the community? If yes, please provide details	
Will there be any need for the alternative routes during the scheme implementation?	
Will there be any encroachment in privacy?	
Will there be any damage to infrastructure and compensation required?	
Will there be any problem to the mobility especially of women?	
Has community participation been ensured at planning stage for equitable distribution of scheme benefits?	
Has social mobilization been done adequately to avoid risks like elite capture?	
Are there any other social concerns related to the project?	
During and after installation	
Will the installation require removal of any plantation?	
Have compensatory plantation by the ratio of 1:4 planted for each plant removed?	
Have fences been installed to protect the wildlife from the equipment and vice versa?	
Has all waste and debris been removed from site?	
Will there be social/community related issues due to the construction activities (if any construction activity is involved)?	

Will the consultations be conducted during the installation period?	
Are there any other social concerns related to the project during this phase?	
Restoration	
Has the site been restored to its original condition prior to closure?	
Has all the waste been removed from site and adequately disposed off?	
Are there any other social concerns related to the project during this phase?	

Checklist for Fish cage and pen culture

Please answer the following questions	Yes/No
Are there chances that individuals may escape the cages and enter natural water bodies, which may disturb the aquatic ecosystem?	
Is there potential for resistance towards genetically modified fish, as most of communities/ consumers tend to prefer indigenous/ wild fish to exotic fish?	
Would local communities resist the introduction of cage/ pen culture?	
Could there be Ammonia input from insufficient water flow, which may cause disease outbreak and effect wild/ indigenous species?	
Community / user conflict on ownership of natural water bodies may arise due to installation of cages?	
could any activity cause flooding (localized)?	
Is any land acquisition involved?	
Have Standard Operating Procedures been developed and disseminated?	
Please select the mitigation measures that may be needed	**Yes/No**
Native/indigenous species will preferably be reared in pen and cage culture, while in case of exotic species (Tilapia) mono sex seed of right size will be ensured;	
Native/indigenous species will be preferred while in case of exotic species (Tilapia) will be discouraged. Awareness regarding nutritional values and economic importance will develop communities acceptance for cage and pen culture	
Disease transfer and other adverse effects on wild and cultured fish stocks would also be minimized through adaptation of Better Management Practices (BMP) such as, keeping right quantity, adequate feed supply, organic feed preparation, testing water quality, proper size seed and net selection etc.	
Freshwater flow and environmental condition criteria (cage bottom and lake bottom would be at least 6 feet) would also be ensured to minimize the mentioned issues. Water quality can be regularly monitored around the cages to assess any harmful impact	
Active community based organizations (CBOs) and fisher cooperatives (FCs) will be made effective to resolve community conflicts and ensure benefit of shared resources;	
Social mobilization will ensure effective community participation and will help minimizes well as resolve the conflicts. Village organisations will be formed, with equal representation from various social group and influential locals who will be responsible for resolving all conflicts internally.	
Suitable site selection e.g. will avoid waterways and flood prone sites, suitable design and right material for cage frames will minimize negative impacts of heavy floods, rains and fluctuating level of water bodies;	
As cage frames are movable, they can easily be shifted to safe locations during the harsh weather conditions;	

Please answer the following questions	Yes/No
The water bodies for cage installation will be identified after a consultation with VOs and CBOs to prevent conflicts. In addition, fisher cooperatives will also be formed to ensure that each stakeholder gets an equal share of resources.	
A voluntary land donation form will be signed for documentation of land donation (if required)	
Child labor will not be used.	
Other:	

Checklist for Establishing Bakeries

Please select the impacts that may apply	Yes/No
Is there any risk from establishment of gas connections?	
Community/ user conflict on ownership of bakery may arise due selection of beneficiaries	
Conflict may arise on benefit sharing among beneficiaries	
Land acquisition for establishment of bakeries	
Location and design of scheme socially unacceptable, inequitable distribution of benefits and construction related impacts.	
Have personal hygiene training been provided to shopkeepers?	
Please select the mitigation measures that may be needed	**Yes/No**
Proper site selection e.g. bakeries' oven will be constructed away from living rooms) and tree plantation will developed in the vicinity of the bakeries to reduce smoke impact and to off-set any wood cutting for fuel;	
Beneficiary's selection criteria based on poverty assessment and socio-economic baseline would help in selection of deserving needy beneficiaries;	
CBO's will also be made responsible for equal benefits sharing amount right beneficiaries.	
Training to beneficiaries in DRR and effective early warning system	
Land if required for the scheme will be donated by the community on voluntary basis. Checklist and agreement format in ESMF will be used for this purpose.	
Locating and designing the scheme using the following criteria: § ensuring equitable distribution of scheme benefits through community participation § ensuring no blocked access, avoiding damage to crops, cultivation fields, cultivation fields, graveyards and cultural heritage sites § after carrying out consultation with the beneficiary community, including women – ensuring that the scheme is socially acceptable and suitable to women.	
Child labor will not be used.	
Other:	

Checklist for Chillers

Please select the impacts that may apply	Yes/No
Livestock herders may receive low rates for the milk sold to the chillers and delayed payment may raise some social issues;	
Flood risk to enterprise	
Land may be required	
Location and design of scheme socially unacceptable, inequitable distribution of benefits and construction related impacts.	

Please select the impacts that may apply	Yes/No
Personal hygiene and milk handling trainings would be arranged for the chilling operators and milk collectors and proper cleaning of units will be ensured to minimize expected risks	
Efficient price control mechanism would be ensured through CBOs/ networks for fair price and timely payments to milk suppliers;	
As the milk chillers are movable items therefore they could be shifted at safer places in case of floods	
Early warnings and disaster preparedness would be an effective tool to minimize expected losses;	
Operational and maintenance cost would be set apart if any repair is required in case of damages caused by rainfalls/ floods/ other unforeseen situation.	
Land if required for the scheme will be donated by the community on voluntary basis. It will be screened in line with World Bank's guidelines to rule out displacement or other negative impacts. Checklist and agreement format in ESMF will be used for this purpose.	
Locating and designing the scheme using the following criteria: § ensuring equitable distribution of scheme benefits through community participation § ensuring no blocked access, avoiding damage to crops, cultivation fields, cultivation fields, graveyards and cultural heritage sites § after carrying out consultation with the beneficiary community, including women - ensuring that the scheme is socially acceptable and suitable to women.	
Others:	

Checklist for Indigo Dye

Please select the impacts that may apply	Yes/No
Natural dye including indigo is commonly used in fashion industry and businessmen fetch higher profits through these natural dyed clothes, while indigo grower sometimes do not get their fair share. Artisans using this natural dye in printing fabrics are also not receiving proper returns for their artisanal crafts either which could cause frustration among artisans and growers alike.	
Flood risks to enterprise	
Land may be required.	
Location and design of scheme socially unacceptable, inequitable distribution of benefits and construction related impacts.	
Have the Standard Operating Procedures been developed and disseminated?	
Please select the mitigation measures that may be needed	**Yes/No**
BMP practices would be ensured to control the chemical fertilizers and use of pesticides;	
Indigo grower's artisans and entrepreneurs would be linked to fair price shops/market for better prices;	
Suitable site selection for indigo plantation and suitable water drainage system would be ensured to minimize the risk factors;	
Tree plantations will be planted to act as a wind breakers will stabilize the soil and prevent wind damage during the winter	
Land if required for the scheme will be donated by the community on voluntary basis. It will be screened in accordance with World Bank's guidance to avoid displacement and other negative impacts. Checklist and agreement format in ESMF will be used for this purpose.	
Locating and designing the scheme using the following criteria: § ensuring equitable distribution of scheme benefits through community participation	

Please select the impacts that may apply	**Yes/No**
§ ensuring no blocked access, avoiding damage to crops, cultivation fields, cultivation fields, graveyards and cultural heritage sites § after carrying out consultation with the beneficiary community, including women – ensuring that the scheme is socially acceptable and suitable to women.	
No child labor will be used.	
Other:	

Checklist for solid waste management

Please select the impacts that may apply	**Yes/No**
Local people may not be able to purchase the recycled paper products due to their high prices	
Floods may be expected	
Land may be required.	
Location and design of scheme socially unacceptable, inequitable distribution of benefits and construction related impacts.	
Please select the mitigation measures that may be needed	**Yes/No**
Use of bleaching agents such as chlorine would be discouraged	
Local people would be encouraged to produce the widely used items to reduce the cost	
Community awareness and effective early warning system will ensure preparedness and protection from disaster risk impacts on processing and recycling assets	
Land if required for the scheme will be donated by the community on voluntary basis. It will be screened in accordance with World Bank's guidance to avoid displacement and other negative impacts	
Locating and designing the scheme using the following criteria: ▪ ensuring equitable distribution of scheme benefits through community participation ▪ ensuring no blocked access, avoiding damage to crops, cultivation fields, cultivation fields, graveyards and cultural heritage sites ▪ after carrying out consultation with the beneficiary community, including women - ensuring that the scheme is socially acceptable and suitable to women.	

Health and Safety Checklist for the Proposed Project

Activity	**Yes/No (Please explain if no)**
Preparation	
Have all field team members undergone medical test during the last six months?	
Are the vehicles four-wheel drive and adequate for working in mountainous terrain?	
Have all field team members' undergone training for working in high altitude and cold environments? Have they received refresher training during the last twelve months?	
Does the team have a nominated field environment and HSE coordinator and has he been provided adequate training?	
Is the team of adequate size to ensure there is no strain on individual members to meet field targets?	
Prior to Departure for Site	
Is adequate PPE available for all personnel? (Attach PPE list)	
Is adequate hiking, climbing and snow traversing gear available for all personnel? (Attach list)	

Is adequate camping and survival equipment available for all personnel? (Attach list)	
Is an appropriately stocked first aid kit available?	
Are adequate water and nourishment stocks available (for at least seven days survival in case of emergency)?	
Before civil works and during installation	
Is the site accessible?	
Are there at least two people in each field team (including reconnaissance teams)?	
Is the weather adequate for carrying out civil works?	
Have the local labor been provided the requisite HSE instructions and PPE?	
Are all personnel using adequate PPE?	
Are any children involved in installation or civil works?	

Land Use Checklist

1	**Potential Impacts**	**Y/N**	**Expected**	**Remarks**
	Does the sub-project involve any physical construction work, i.e. rehabilitation, reconstruction or new construction? Specify in "remarks" column.			
2	Will the sub-project need to acquire land?(If yes, fill the following)			
	Will the donated land impede access to livelihoods for any individual/group?			
A	**Size of land to be acquired**			
I	**Ownership**			
	Government			
	Private			
	Public			
II	Status of Ownership			
	Disputed			
	Undisputed			
B	**Type of land acquisition**			

	Voluntary donation (No. of people donating and how much per person)			
	Is the donated land no more than 10% of an individual's total land holding?			
	Government or state owned land free of occupation (agriculture or settlement)			
C	**Type of land to be acquired**			
	• Unused/vacant			
	• Residential			
	• Commercial			
	• Agriculture			
	• Others (specify in "remarks").			
D	**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")			
E	**Agriculture related impacts**			
	• Crops and vegetables (specify types and cropping area in "remarks).			
	• Trees (specify number and types in "remarks").			
	• Others (specify in "remarks").			
F	Residents			
	Owners			
	Are there any tenants on the land			
	Are there any squatters or illegally settled persons			
G	**Affected Persons (DPs)**			
	• Number of DPs			
	• Males			

	• Females			
	• Titled land owners			
H	**Mitigation Measure**			
	Has the Voluntary Land Donation Performa Completed and Signed?			

6.4 Voluntary Land Donation (VLD)

Larger infrastructure schemes requiring acquisition of private lands for public purposes are not part of the project scope, therefore, the project does not involve land acquisition. Once an intervention has been agreed upon, the land will be identified by the community through a participatory approach and the project will ensure that each of the donor(s) understand their rights to refuse the land donation. The VLD criteria mentioned in the ESMF will be strictly followed to ensure that land donation is without any coercion and fulfilling the other conditions specified below. Keeping in view the small scale interventions, only those schemes will be implemented where voluntary land donation will be possible. The schemes will be dropped if the VLD criteria is not met. Voluntary land contribution will be accepted with the following conditions:

- Contribution is truly voluntary without pressure
- The donated land does not have other claimants
- The land contributed is free of occupation
- Contribution is less than 10% of the total land holding of an individual
- The contributing household is not below the national poverty line
- There is no displacement of any kind including tenants and squatters
- The donated land does not impact on access to livelihoods of any individual or group
- The contribution is documented
- Donated Land is transferred in the name of the recipient through proper documentation (a formal agreement on Stamp Paper, duly registered)
- Voluntary contribution should be clearly documented to confirm the voluntary nature of the transition. The documentation should specify that the land is free of any squatters, encroachers or other claims

Once land screening is completed, VLD agreement (a legal document) will be duly signed and registered. If there are more than one land owners, land will only be donated with the consent of all donors and VLD agreement will be signed with all land owners donating the land. Sample VLD format is annexed as Annex-B. The VLD agreements will be translated in Urdu for easy understanding of the community members having low literacy and illiterate members will be facilitated by the literate members of the community. This agreement will be properly documented and kept as a record by the project to avoid any future issues that may arise due to land donation in the agencies. The VLD procedures will be carried out with extreme care and due diligence to ensure that all such donations should not add to further poverty, communal land issues or any other problem or disputes.

7 Consultation and Participation

IECLP being a CDD project, consultations are its integral part. Key stakeholders of the Project include low income fisherman communities, landowners, officials and staff of line departments, relevant political administration and local level civil society organizations and NGOs. It is anticipated that the community members will participate in project activities by joining the CBOs. These consultations facilitate community mobilization and needs assessment at the local level.

The consultations will also be carried out during the implementation of project. The consultations will be carried out with the objectives to develop and maintain communication linkages between the project promoters and stakeholders, provide key project information to the stakeholders, and to solicit their views on the project and its potential or perceived impacts, and ensure that views and concerns of the stakeholders are incorporated during the implementation with the objectives of reducing or offsetting negative impacts and enhancing benefits of the proposed project. The framework for the future consultations is elaborated in **Table 7.1** below.

Consultation will be carried out throughout during the schemes' identification and implementation. All feasible schemes will be identified through consultations with the targeted communities. During community consultations at scheme identification stage, the project will consult closely and openly with communities to ensure that technical and social aspects of VLD are discussed and mutually agreed. The consultations will be continued during the implementation as specified in the framework above. Consultation and participation of the community will be ensured by the community mobilisation and training expert via identification of focal points, development of CBOs and their subsequent facilitation to provide insight regarding implementation of project activities. These processes will ensure community engagement and provide a means for sustainability of the project. They will be carried out with the objectives to develop and maintain communication linkages between the project promoters and stakeholders, provide key project information to the stakeholders, and to solicit their views on the project and its potential or perceived impacts, and ensure that views and concerns of the stakeholders are incorporated during the implementation with the objectives of reducing or offsetting negative impacts and enhancing benefits of the proposed project.

Table7.1 : Stakeholder Consultations for Extended Project

Stakeholders	Phase	Timings
Bank Staff	▪ Pre-Implementation ▪ During the Project Implementation	▪ First round of consultation to be completed before start of implementation of project. ▪ Monthly during project implementation.
Fishermen Community/Land Owners/ Community Organizations	▪ Pre-Implementation ▪ During Screening and Project Implementation	▪ First round of consultations to be completed before start of implementation of project. ▪ Weekly during implementation of each sub-project.
Political Administration and concerned line departments	▪ Pre-Implementation ▪ During the Screening and Project Implementation	▪ First round of consultations to be started and completed before start of implementation. ▪ Weekly during implementation of each sub-project.
Local Elders	▪ Pre-Implementation ▪ During Screening and Project Implementation	▪ First round of consultation to be started and completed before start of implementation. ▪ Weekly during implementation of each sub-project.
Women	▪ Pre-Implementation ▪ During Screening and Project Implementation	▪ First round of consultation to be started and completed before start of implementation. ▪ Monthly during implementation of each sub-project.

8 Institutional Arrangements

WWF-Pakistan usually works as a catalyst for instigating and supporting change within the key stakeholders from the grass root level up to the government. This has a three tier approach to implementing livelihood projects – micro, meso and macro, helps coordinate interventions at the different levels and promote synergy. At the micro level, the project execution and implementation will be done by Program Implementation Unit (PIU) in collaboration with Community Based Organizations (CBOs) and Fisher Cooperatives at the grass-root level. All activities and initiatives will be channelized through Community Based Organizations (CBOs), which will empower and aid them to build their capacity for planning, implementation and sustainability. At each PIU, a professional team consisting of field officers, mobilizers, trainers and technical experts will be deputed to execute and implement project interventions. This team will also include an Environmental and Social Focal Point (ESFP), Manager Conservation for Sindh Region, who will be responsible for the field level implementation of ESMF, filling in of mitigation checklists, carrying out the consultation, preparing ESMF monitoring reports, training and oversight of ESMF implementation. The ESFPs at PIU level will be responsible for spreading awareness on essential aspects of VLD, field level implementation of the VLD procedures including the community consultations, identification of the land owners and signing the VLD agreement ensuring that the VLD criteria is complied with.

At meso level, District Coordination Committee (DCCs) headed by Deputy Commissioner of respective district, Area Coordination Committees (ACCs) and other NGOs working in the area will be coordinated by PIU for consultation of project implementation. DCC will review quarterly progress of the ongoing activity and provide support and feedback. The PIU will share the progress of project with DCC time to time and seek feedback and support where required. The members of DCC will also be provided capacity building trainings and exposure on different technical, environmental and livelihood components of the project.

At macro level, WWF-Pakistan's Program Management Unit (PMU) led by technical experts and managers will execute the project while the Programme Support Unit (PSU) led by senior managers and directors will oversee and monitor the project progress. Moreover, Indus Eco-region Steering Committee (IESC), which is the topmost decision making body regarding development initiatives in the Indus Eco-region, representing the government (chaired by the Additional Chief Secretary of Sindh), academia, and various organizations will oversee and review the overall progress towards achieving the targets and millstones set out in the Conservation and Ecoregion Livelihood plan. PMU team will also include an ESFP who will be responsible for the verification and monitoring of the field level implementation of ESMF and VLD process, checking and finalizing the mitigation checklists, carrying out the consultation, internal monitoring etc. The ESFP at PMU level will be responsible for the monitoring and verification of VLD process being implemented by ESFP at PIU level. ESFP, PMU will maintain a complete record of VLDs for all the schemes.

WWF-Pakistan has conducted two projects in collaboration with World Bank, "Conservation of Chiltan Markhor in the Hazarganji Chiltan National Park" in 2000 and "Protected Area Management". Over the course of these projects, the teams were responsible for implementing relevant policies, in line with World Bank's protocols. WWF capacity to implement the ESMF (filling in of mitigation checklists, implementation of VLD process, carrying out the consultation, preparing ESMF monitoring) will be further enhanced through the training programme as specified in the Section 10 of ESMF.

9 Grievance Redress Mechanism

9.1 General

The Grievance Redress Mechanism (GRM) of the project is an institutional arrangement that provides an avenue to address complaints and issues raised by the target groups or project stakeholders. It also provides important feedback on the operational activities of the Project. The main purpose of the GRM of the project is to put in place an appropriate mechanism whereby the aggrieved or affected individual(s) or community(ies) who believe that they have mistreated or deprived of their rights by any act of the management or connected implementation system, is provided a fair opportunity to record and redress their concerns.

9.2 Objectives

The detailed objectives of GRM are:

- To establish an organizational framework to address and resolve the grievances of individuals or communities, fairly and equitability;
- To provide enhanced level of satisfaction to the aggrieved party or person(s);
- To provide easy access to the aggrieved/affected individual or community for an immediate grievance redressal;
- To ensure that the targeted communities and individuals are treated fairly at all times; and
- To identify systemic flaws in the operational system of the Project and suggest corrective measures for effective implementation.

GRM will also act as an effective tool for early identification, assessment, and resolution of complaints on projects objective; providing project staff with practical suggestions/feedback that allow them to be more accountable, transparent, and responsive to beneficiaries; assessing the effectiveness of internal organizational processes.

9.3 GRM

The project will develop a multi-tier GRM with designated staff at each level i.e. PIU, PMU and IESC, as the apex forum for redressal of a complaint and with representation from community at each level. A grievance lodged by an aggrieved person/party at first stage shall be seen by a responsible person at a level (i.e. PIU) where the cause of grievance had occurred.

Any complaint from the community related to any of the project’s interventions will be formally submitted to the PIU. Grievance Redress Officer (GRO), PIU shall record the complaint and shall report the matter/complaint to the Project Director PMU within three days of registration of a complaint. GRO, PIU will address the complaint in 7 days at the field level in consultation with the two designated representatives of CBOs/FC. Given the community-based approach of the Project, it is expected that most of the complaints, grievances and conflicts would be generated at the local level. This would be the most important Grievance Redress unit with a more proactive role. For easy access to the community a complaint box would be provided in the office of the PIU for receiving complaints. GRO, PIU may refer the community based issues to arbitration/reconciliation for resolution at village/community level with satisfaction to the parties.

A system of recording and tracking all the complaints will be maintained by the PIU. Supportive evidence in the form of complainant signatures will be required once a decision has been communicated. The system will also record the deliberations of the PIU and the evidence presented to it in the course of handling a complaint.

Grievances related to the decisions taken by the PIU shall be forwarded to the next higher forum i.e. PMU. Any such complaint received by PMU along with the action so taken shall be shared with the Bank immediately. In case, the complaint is against the PIU by an individual or community it shall be forwarded to the Project Director PMU for redress.

The Project Director (PD) will be the GRO at PMU level. It is expected that all kinds of complaints, issues and conflicts would be addressed positively at this stage. Community elders from the respective area nominated by the PD in consultation with the aggrieved will also assist the redress at this level.

For easy access to the community a complaint box would be provided in the office of the PD for receiving the complaints. Similarly a toll free telephone number will be installed in the office of the PD. PD shall notify a staff member who shall record the complaints, enter it in the complaint register and report it in writing to the PD immediately. Appeals can be made against the decisions of the PIU to the PMU. The Complaint will be dealt with within ten days of being received.

In case, the complaint is regarding PMU, it is lodged with and addressed directly by IESC in not more than three weeks ensuring the representation of two selected members of CBOs in meetings to discuss grievances. All redressal depend upon the nature of complaint whereas responsibilities to hear and resolve issues/complaints will be assigned to the designated officers at all three levels.

Complaints at all levels will be properly recorded and a serial number will be assigned to it together with the date of receipt. A written acknowledgement to a complainant shall be sent promptly and in any case within not more than 3 working days.

The complaint shall be considered as disposed off and closed when:

- The designated GRO/authority has acceded to the request of the complainant fully;
- Where the complainant has indicated acceptance of the response of the insurer in writing;
- Where the complainant has not responded to the Grievance Redress staff within one month of being intimated the final decision of the grievance officer on his grievance/ complaint;
- Where the complainant fails to attend the proceedings of the Grievance Officer with in the stipulated period of the disposal of the complaint; and
- Where the complainant withdraws his/her complaint.

The following allegations/complaints shall not be construed or taken up for consideration and disposal as ‘Grievances’:

- Anonymous complaints or Frivolous cases in respect of which inadequate supporting details are provided;
- Cases involving decisions/policy matters in which the complainant has not been affected directly/indirectly;
- Cases that are sub-judice; and
- A Grievance which has already been disposed off by the higher level of GRM.

GRM will be communicated widely, both among the staff and beneficiary communities through the consultations, use of electronic and print media among other stakeholders.

10 Training and 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 ESFPs.

The training plan is presented in Table 10.1. The PMU's ESFP will be responsible for the implementation of this plan.

Table 10.1: Environmental and Social Training Plan

Description	Aspects to be Covered	Participants	Frequency
Environmental and social orientation	▪ Environmental and social awareness ▪ Key environmental and social issues related with the project ▪ ESMF components and its findings	▪ PIU ▪ PMU ▪ Line departments ▪ ESFPs	At the start of project. Afterwards, as requried
ESMF implementation	▪ ESMF components and its findings ▪ Mitigation plans ▪ Environmental monitoring ▪ Documentation and reporting ▪ Monitoring and evaluation ▪ Conducting consultation	▪ PIU ▪ PMU ▪ Line departments ▪ ESFPs	At the start of project. Quarterly during project implementation
GRM and VLD	▪ GRM Process ▪ VLD Process Modules on VLD and GRM will be developed by PMU and shared with Bank for approval	▪ PIU ▪ PMU ▪ Line departments ▪ ESFPs ▪ IESC ▪ Communities	At the start of project. Quarterly during project implementation

11 Documentation and Reporting Requirements

11.1 Documentation and Reporting

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

- Environmental and social Mitigation Plans filled by the PIUs/line directorates,
- Environmental and social monitoring checklists filled by ESFP of PMU and PIU,
- Quarterly reports on overall ESMF implementation of the project, to be prepared by the PMU's ESFP on the basis of the PIU quarterly reports described above,
- Third party monitoring reports,
- Project completion report on overall ESMP implementation for the entire duration of the project – to be prepared by PMU's ESFP.

The PMU's ESFP will be overall responsible for the above documentation and reporting. These reports will be shared with the Bank and other stakeholders on a regular basis.

11.2 Disclosure Requirements

The present ESMF will be shared with all relevant agencies, line directorates and concerned community organizations. Subsequently, it will be disclosed in Urdu and English by the WWF, and also made available at the websites of WWF and the relevant line directorates. Copies of ESMF will also be sent to Sindh EPA. It will also be made available at the World Bank's InfoShop. Relevant project specific safeguard documents/mitigation plans to be prepared subsequently will also be disclosed in a similar manner.

12 Monitoring and Evaluation

12.1 Monitoring and Evaluation

The purpose of the environmental and social monitoring is to ensure the effective implementation of the ESMF, particularly the environmental and social Mitigation Plans described in Section 6 above.

The monitoring will be carried out at two tiers. At the first tier, the ESFPs of the PIUs will carry out monitoring during their routine visits to the field, with the help of visual observations and discussions with the communities/farmers/beneficiaries. At the second tier, the ESFP of the PMU will provide top supervision of the monitoring carried out by the PIUs, with the help of spot checks during his/her field visits. Monitoring checklists will be prepared on the basis of the environmental and social Mitigation Plans described in Section 6 and will be used for the environmental and social monitoring described above.

It is recommended that use of hi-tech equipment such as GPS, mobile phones with GPS facility, and digital camera is maximized in obtaining, recording, processing, and disseminating the baseline and monitoring data collected in the field. Furthermore, satellite imagery and geographical information system (GIS) should also be used to document and process the field data.

12.2 Third Party Monitoring.

In addition to the monitoring described above, an outside agency (such as an independent consultant/firm) will carry out the third party monitoring (or third party validation – TPV) twice, once before the mid-term review of the project and second and last time three months prior to the closing of the project implementation. The objective of this monitoring would be to review the entire ESMF implementation process and its effectiveness, to identify any environmental and/or social issues caused by the project that may exist on ground, and to frame recommendations to improve ESMF and its various components.

13 ESMF Cost

The tentative cost for the implementation of ESMF is estimated as bellow:

Sr. No.	Item	Amount (Rs.)
1.	Training	13,500,000/-
2.	Internal Monitoring	1,000,000/-
2.	Third Party Monitoring	500,000/-
3.	Total	15,000,000

Annex A. Rainfall Data

Long-term average precipitation of Sindh is 162.2 mm taking into account the data of 50 years from twelve metrological stations. Annual deviation of the precipitation (in millimeters) over the province depicts it as a drought prone area with occasional surplus extremes resulting into flooding conditions. The province has a long history of droughts which persisted over a stretch of at least a couple of years. For instance, 1968-69, 19971-744, 1885-87, 1999-2002 are known for their damages to crops, livestock, soil and natural ecosystem in addition to massive migrations increasing pressure on marginal natural resources in surrounding areas. Floods were relatively uncommon in the province due to local rain storms as 10 such events occurred during last fifty years. The problem of Sindh floods has been connected mostly to upstream water flowing downstream through the mighty Indus. Hence attention should be focused simultaneously on local conditions as well as changing behavior of precipitation in the upper Indus Basin. Both such flooding phenomenon have co-occurred in the province during 2010 when heavy downpour of Khyber Pakhtunkhwa inundated the delta followed by 2011 localized province scale heavy rainfall. Just, looking at precipitation data of Sindh, one cannot guess the vulnerability of floods for the province. Similarly, adverse effects of drought conditions resulting due to lack of rainfall in the Indus delta can be mitigated if required water supply is maintained through canal irrigation from upstream water reservoirs.

Fishing Practices in Indus Ecoregion

Fishing communities, mostly living beside River Indus and other water bodies, have been doing fishing for sustenance and income generation. Freshwater fisheries in Sindh are dominated by Indus River which is home to about 179 species and is the major source of fresh water to lakes and other water bodies. Fisheries in lakes, ponds and reservoirs contributes major portion in freshwater fish production. In Sindh there are more than 100 natural lakes which include large lakes of Keenjhar Lake, Manchar Lakes and Haleji Lakes. These and other lakes support thousands of fishing families mainly depending on fishing resources.

Fishing practices in Sindh include cost net, gill net and lines which are the most common type of fishing gears. Some of the net use techniques are locally called as jar, **Bhandho**, **Pathiro, Piriri, Kurhi and Dhaar**. Fishermen use these methods to catch fish from lakes, ponds and other reservoirs. Fish farming is also practiced in Sindh where people release the fish seed into the farms and catch it when fish is mature for sale. Majority of fish farms in Sindh are located in Thatta, Badin, Sanghar and Dadu districts. These areas are considered suitable for fish farming because they have waterlogged floodplains. Cage and pen culture have also been introduced recently where cages are established in lakes or reservoirs and fish stock is released in them.

Use of unsustainable practices such as overfishing and use of harmful nets is undermining long term sustainability of fishing in the Indus River and lakes. Currently, the degradation of freshwater fisheries resources poses a potential threat to the livelihood of local fishermen communities engaged in the fishing. Discharge of untreated waste and sewerage water into freshwater bodies affects the water quality and causes a decline in fish stocks and aquatic resources. Shortage of the freshwater is also affecting the hydrological regimes of lakes in the Indus Ecoregion.

Annex B. EHS Guidelines on Aquaculture

Please see the following pages.

Environmental, Health, and Safety Guidelines for Aquaculture

Introduction

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

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

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

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

Applicability

The EHS Guidelines for Aquaculture provide information relevant to semi-intensive and intensive/super-intensive, commercial aquaculture production of the main aquatic species, including crustaceans, mollusks, seaweeds and finfish, located in developing countries in temperate and tropical regions. Annex A contains a full description of industry activities for this sector.

This document is organized according to the following sections:

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

1.0 Industry-Specific Impacts and Management

The following section provides a summary of EHS issues associated with aquaculture, along with recommendations for their management. Recommendations for the management of EHS issues common to most projects during the construction and decommissioning phases are provided in the **General EHS Guidelines**.

1.1 Environment

Environmental issues associated with the aquaculture sector primarily include the following:

- Threats to biodiversity
- Contamination of aquatic systems
- Hazardous Materials

Threats to Biodiversity

Threats to biodiversity are mainly associated with conversion of natural habitats during construction; potential release of alien species into the natural environment during operations; potential loss of genetic resources due to collection of larvae, fry, or juveniles for aquaculture production; potential release of artificially propagated seed into the wild (e.g. there are more farmed than wild Atlantic salmon in existence); sustainability of fish meal and fish oil ingredients for fish and crustacean feeds; and development of antibiotic resistance in pathogenic bacteria that can then spread from farms to wild stock.

Conversion of Natural Habitats

The construction and operational phases of the project cycle of an aquaculture facility may require conversion of the natural environment including, for example, the removal of mangroves for excavation of ponds, or alteration of the natural hydrology of lagoons, bays, rivers, or wetlands.[2] Operational phase issues may also include alteration of aquatic habitats and substrates (e.g. under sea cages or shellfish farms).

A range of management measures can be taken to prevent and reduce the environmental impacts caused by the construction of aquaculture facilities, as presented below. Further potential impacts are related to changes to stream hydrology caused by the construction of barriers to flow (e.g. dams may cause disruption of wetland areas and changes in stream morphology, potentially affecting migratory species, including birds, and nursery areas for juvenile fish). Measures should include all of the following:

- Survey the project area before land and water conversion to aquaculture production is undertaken to identify, categorize, and delineate natural and modified habitats and ascertain their biodiversity importance at the national or regional level;
- Ensure that the area to be converted to aquaculture use does not represent a habitat that is unique or protected (such as mangrove areas), or includes high biodiversity value, such as known sites of critically endangered or endangered species, or important wildlife breeding, feeding, and staging areas;
- Be aware of the presence of critically endangered or endangered species in the areas already used for aquaculture production, and implement management processes that take them into account;
- Design facilities so that as much as possible of the natural vegetation habitat is left intact (e.g. through the use of vegetated buffer zones and habitat corridors) and that

[2] Hydrological changes may also contribute to changes in the natural geochemistry such as the release of pyrite from formerly submerged soils of cleared mangrove areas. When pyrite comes into contact with oxygen, it creates acid sulfate soil, which in turn has potentially serious impacts on the health of the aquaculture organisms for many years to come.

conversion and degradation of the natural habitat is minimized;

- Design and implement mitigation measures to achieve no net loss of biodiversity where feasible, for instance through post-operation restoration of habitats; offset of losses through the creation of ecologically comparable area(s) managed for biodiversity; and compensation to direct users of biodiversity;
- Avoid the need to frequently abandon and replace improperly designed and built aquaculture ponds:
  - o Assess soil properties prior to pond construction to ensure that the bottom-sealing layer of the soil with percolation rates/porosity low enough to satisfactorily hold pond water. If there is not enough clay, then the ponds may demonstrate high seepage rates and require additional expenditure (e.g. pumping in water, or relining with clay-rich or possibly bentonite-rich topsoil from other sites) or eventual abandonment. High seepage rates can also pollute groundwater required for other purposes in the vicinity with use for drinking water a major concern.
  - o Assess the soil pH and the presence of pesticide and pollutant residues (especially on land that was previously used for intensive agriculture), as well as the natural occurrence of pyrite, prior to construction as the presence of anthropogenic or natural pollutants may hinder the viability of the pond.

Conversion of Agricultural Land - Salinization

If new land areas are not available for aquaculture, an alternative is to convert former agricultural land. If the selected production is based on brackish water, this may pose a risk of salinization of surrounding agricultural land. The following measures can be taken to avoid salinization of agricultural land:

- Ensure that the embankments around brackish water pond systems are high enough to form a physical division between agriculture and aquaculture;
- Ensure that the saline / brackish water discharges are appropriately treated and disposed of (e.g. through use of discharge canals) for the receiving waters;
- Ensure that appropriate discussions are held at the community level to avoid conflicts of interest when agricultural land is transferred to aquaculture production.

Introduction of Alien, Selectively Bred, or Genetically Engineered Species

Introductions can result in interactions with the wild, including escapes from farms, or open systems (such as mussel rafts). As such, introductions can disturb the existing ecological balance; cause loss of species biodiversity; cause loss of genetic diversity of the wild populations; reduce fitness of wild population through breeding with genetically altered escapees; and result in the transmission or spread of fish diseases. The widespread seeding of an alien genotype is of considerable concern both as regards species biodiversity and genetic biodiversity.

Management measures to reduce the risks from introductions of alien, selectively bred, or genetically modified species include the following:

- Application of codes and guidelines (see Section 3.0);
- Farming of sterile fish;
- Preventing the escape of species from pond-based aquaculture systems. Examples of common escape prevention measures include:
  - o Installation and maintenance of screens with a mesh that is small enough to prevent the entry and potential escape of aquatic species in the drainage channels connecting production ponds to sedimentation ponds,

as well as those connecting sedimentation ponds to the receiving water
  - Installation of fish-proof strainer dams
  - Installation and maintenance of gravel filtration on pond discharge structures
  - When necessary, consider chemical treatment of water released from hatcheries(e.g. with chlorine at acceptable concentrations for the receiving waters) to destroy escaping larvae or juveniles
  - Consider the hydrology of the region in the design of the pond system and ensure that the pond embankments are high enough to contain the pond water and prevent escape of the species during periods of heavy rainfall and potential flooding
  - Establish a contingency plan if there is an escape of the species being cultivated into the wild
- Preventing the escape of species from open water aquaculture systems. Examples of common escape prevention measures include:
  - Regularly inspect the cage and pen netting for holes(e.g. before crowding of the harvest and at intervals during the operation)
  - Design and construct cage and pen units, including choice of nets, to deal with the worst weather and environmental conditions likely to occur on the site
  - Provide for containment during periods of storm surges and excessively high tides
  - For cage culture in open waters, use submersible cages that can be submerged during storms below damaging wave action
  - Provide adequate marking of the fish farm system to warn navigators of the potential obstruction and reduce the risk of collision[3]
  - Establish a contingency plan for harvest of escapees of the species being cultivated into the wild.

Impacts of Harvesting on Ecosystem Functions

The practice of capturing females, eggs, fry, juveniles, or even fingerlings from the wild for the purpose of stocking aquaculture systems may threaten ecosystem biodiversity. Fry and larvae may be gathered from fresh or brackish water using very fine meshed nets resulting in considerable by-catch, as well as the removal of large number of larvae, fry, and juveniles from the food chain.[4] The recommended prevention of this type of ecosystem pressure is the breeding of stock material in captivity. However, for some species, careful harvesting of hatchlings/ and or fry (less than 3 cm) that are still at a stage of expected high mortality can result in relatively little impact on the overall population as compared to collecting larger fingerlings from a smaller population for grow-out.

Fish meal and fish oil

Fish meal and oil are derived from the capture and processing of wild pelagic fish stocks (e.g. anchovy, pilchard, herring, sardine, sand eel, sprat, and capelin). Although the production of fish meal and oil is not covered by these Guidelines, processed fishmeal and oil are the primary sources of protein and dietary lipids in fish feed for farmed fish in aquaculture operations. The aquaculture sector is an important consumer of fish meal and fish oil, and there are concerns regarding the sustainability of the pelagic fish stocks from which fish meal and fish oil are derived. Aquaculture operations should consider incorporating the use of alternatives to supplies of fish feed produced from fish meal and fish oil. Alternatives for fish feed ingredients may include use of plant material substitutes [e.g.

[3] Shetland Aquaculture (2006).

[4] Some jurisdictions have outlawed the larvae and fry collection or export although the practice still represents a source of income for the poor in some developing countries.

soya for bulk protein and single-cell protein (yeast for lysine and other amino acids)] and biotechnology options (e.g. bio-fermentation products).[5]

Source Water Quality

The quality of source water can also have a major effect on the viability of an aquaculture operation whether it is water used for hatchery and ponds systems or the water in which cages and pens are established. The water itself can affect the health of the organism as well as contribute to the accumulation of substances or pathogens toxic to consumers. Quality guidelines have been developed for aquaculture and vary depending upon the organism cultured.[6]

Contamination of Aquatic Systems

Aquaculture activities, particularly pond-based systems, may affect aquatic systems due to construction and operation activities, primarily the mobilization of soils and sediments during construction and through the release of effluents during operation. Fish cage culture can also be a major contributor to marine pollution in areas of high density use.

Soil Erosion and Sedimentation

Earth excavation and moving activities conducted during construction of some types of aquaculture projects may result in soil erosion and the subsequent sedimentation of nearby water bodies. Sedimentation of aquatic resources may contribute to eutrophication and overall degradation of water quality. Recommended management strategies include the following:

- Construct pond and canal levees with a 2:1 or 3:1 slope (based on soil type) as this adds stability to the pond banks, reduces erosion, and deters weeds. Avoid pond construction in areas that have a slope of more than 2 percent, as this will require energy-intensive construction and maintenance;
- Stabilize the embankments to prevent erosion;
- Reduce excavation and disturbance of acid sulfate soils during construction;
- Carry out construction work during the 'dry' season to reduce sediment runoff that may pollute adjacent waters;
- Install temporary silt fences during construction to slow down and catch any suspended sediments. Silt fences can be made of woven plastic or fabric, or hay bales.

Wastewater Discharges

Industrial Process Wastewater: The effluent released from aquaculture systems typically contains a high organic and nutrient load, suspended solids, and may also contain chemical residues including feed supplements and antibiotics. The possible impacts include contamination of groundwater and surface water from release of effluents or communication to receiving water from unconfined process and storage tanks (such as ponds and lagoons). Impacts on aquatic systems include creation of eutrophic zones within receiving waters, increased fluctuation of dissolved oxygen levels, creation of visible plumes, and accumulation of nutrients within the receiving waters.[7]

The high nutrient load results from efforts to artificially boost production levels by increasing the food supply for the cultured species. This is done by increasing nutrient availability either directly through supplemental feed or indirectly by fertilizing

[5] Further information is available from Use of Fishmeal and Fish Oil in Aquafeeds: Further Thoughts on the Fishmeal Trap, FAO (2001) Available at http://www.fao.org/docrep/005/y3781e/y3781e07.htm#bm07.3.3 and Assessment of the Sustainability of Industrial Fisheries Producing Fish Meal and Fish Oil, Royal Society for the Protection of Birds (2004) available at http://www.rspb.org.uk/Images/fishmeal_tcm5-58613.pdf

[6] Zweig, R. D., J. D. Morton and M. M Stewart.1999. Source Water Quality for Aquaculture: A Guide for Assessment. The World Bank. 62 pp.

[7] Department of Primary Industries and the Queensland Finfish Aquaculture Industry (1999).

ponds to increase primary productivity. Pond ecosystems have a limited capacity to recycle organic matter and nutrients, and increasing the stocking rate removes this capacity, resulting in the build-up of organic matter, nitrogenous waste, and phosphorus both in the water mass and on the bottom of the pond or pen / cage.[8] The suspended solids are derived from particulate organic matter and erosion of pond floor, walls, and discharge channels.

The chemical residues may include the remains of veterinary drugs (e.g. antibiotics) that may have been applied to the cultivated species, and toxic substances such as formalin and malachite green, a cancer causing agent, that may have been that are used to treat finfish for parasites and their eggs for fungal growth. Malachite green is banned in most countries and must not be used. Formalin should only be used under controlled conditions (e.g. in dipping containers) and with proper care – it should not be introduced directly into production systems.[9]

A range of measures can be taken in pond systems and pen / cage systems to (i) reduce the amount of contamination of the effluent; (ii) prevent pond effluent from entering surrounding water bodies; and (iii) treat the effluent before its release into the receiving waters to reduce contaminant levels. Aquaculture operations in large water bodies, however, are open to the surrounding environment and do not have the second or third options, therefore any contamination takes effect immediately.[10] The following management measures can prevent the contamination of effluent:

[8] Center for Tropical and Subtropical Aquaculture (2001).
[9] Because the use of these highly toxic substances is primarily an occupational health and safety issue, refer to the Occupational Health and Safety section for a more detailed review of their application and for practical guidance.
[10] Aquaculture is also somewhat self-regulating in that if the water is highly eutrophic or laden with dissolved or particulate nutrients or BOD, this will adversely affect many cultured organism and thus would be counterproductive not to manage it to a high quality level. This would somewhat reduce impacts of effluents.

Feed:

- Ensure that pellet feed has a minimum amount of "fines" or feed dust. Fines are not consumed and add to the nutrient load in the water;
- Match the pellet size to the species' life-cycle stage (e.g. smaller pellets should be fed to fry or juvenile animals to reduce the unconsumed fraction);
- Regularly monitor feed uptake to determine whether it is being consumed and adjust feeding rates accordingly. Feed may be wasted due to overfeeding or not feeding at the right time of day;
- Where feasible, use floating or extruded feed pellets as they allow for observation during feeding time;
- Store feed in cool, dry facilities and ideally for no longer than 30 days to avoid reduction in vitamin contents. Moldy feed should never be used as it may cause disease;
- Spread feed as evenly as possible throughout the culture system, ensuring that as many animals as possible have access to the feed. Some species are highly territorial, and uneaten feed adds to the nutrient load;
- Feed several times a day, especially when animals are young, allowing better access to food, better feed conversion ratios and less waste;
- Halt feeding at a suitable interval before harvest to eliminate the presence of food and / or fecal material in the animal's gut;
- During harvesting, contain and disinfect blood water and effluent to reduce the risk of disease spread and to contain effluent matter.

Other organic materials:

- Perform slaughter and processing in an area where the effluent is contained;
- Prevent effluent leakage from harvest rafts and bins by using harvest bins in good condition with sealed bin liners and secure lids and bindings;

- Equip off-loading bays with a waterproof apron and surround with a bund to contain potential spills and prevent contamination with effluent.[11]

Suspended solids:

- Avoid discharging waters from ponds while they are being harvested with nets, as this will add to the suspended solids in the effluent drainage;
- If feasible, use partial draining techniques to empty ponds that have been harvested. The last 10–15 percent of pond water contains the highest quantities of dissolved nutrients, suspended solids, and organic matter. After harvest, hold the remaining water in the pond for a number of days before discharge, or transfer to a separate treatment facility.

Fertilizers:

- Plan the rate and mode of application of fertilizers to maximize utilization and prevent over-application, taking into account predicted consumption rates;
- Increase the efficiency of application and dispersion through such practices as dilution of liquid fertilizers or solution of granulated fertilizers prior to application. Other options include the use of powdered fertilizers or the placement of powdered fertilizer bags in shallow water to allow solution and dispersion;
- Consider the use of time-released fertilizer in which resin coated granules release nutrients into the pond water, with the rate of release corresponding to water temperature and movement;
- Avoid the use of fertilizers containing ammonia or ammonium in water with pH of 8 or above to avoid the formation of toxic unionized ammonia (NH_3);[12]
- Depending on the system (e.g., freshwater aquaculture), grow organic fertilizer (e.g. natural grass) in the pond basin after harvest;
- Initiate pond fertilization only in static ponds with no pond water overflow that can impact downstream waters and watersheds;
- Conduct pond fertilization to avoid or minimize consequences of potential runoff due to floods or heavy rain and avoid application to overflowing ponds.

Chemicals:

- Design the pond depth to reduce the need for chemical control of aquatic weeds and reduce thermal stratification;
- Do not use antifoulants to treat cages and pens. The chemically active substances used in antifouling agents are very poisonous and highly stable in an aquatic environment. Clean nets manually or in a net washing machine.

The following management measures can be taken in pond-based systems to prevent pond effluent from entering surrounding water bodies:

- In some fish systems, avoid automatic drainage of ponds at the end of the production cycle as the same pond water may be used to cultivate several crop rotations of certain species (e.g. catfish);[13]
- Reuse water from harvested ponds by pumping it into adjacent ponds to help complement their primary productivity, provided that the level of BOD is controlled; This process is called "bloom seeding," and requires careful timing of harvests;
- Consider the hydrology of the region in the design of the pond system and ensure that the pond embankments are

[11] Shetland Aquaculture (2006).
[12] WRAC (2000).
[13] Not applicable to shrimp farming which requires the drying out of pond bottoms between harvests.

high enough to contain the pond water and prevent loss of effluent during periods of increased rainfall and potential flooding.

Process Wastewater Treatment: Techniques for treating industrial process wastewater in this sector include grease traps, skimmers or oil water separators for separation of floatable solids; flow and load equalization; sedimentation for suspended solids reduction using clarifiers or settling ponds; biological treatment, typically aerobic treatment, for reduction of soluble organic matter (BOD); biological nutrient removal for reduction in nitrogen and phosphorus; chlorination of effluent when disinfection is required; dewatering and disposal of residuals; in some instances composting or land application of wastewater treatment residuals of acceptable quality may be possible. Additional engineering controls may be required (i) for removal of residual feed supplements, chemicals, antibiotics, etc. which may pass through the wastewater treatment system, and (ii) to contain and neutralize nuisance odors. For sea water applications, unit operations for wastewater treatment may have to be suitably adapted to the relatively high salinity of the water.

Management of industrial wastewater and examples of treatment approaches are discussed in the **General EHS Guidelines**. Through use of these technologies and good practice techniques for wastewater management, facilities should meet the Guideline Values for wastewater discharge as indicated in the relevant table of Section 2 of this industry sector document.

Other Wastewater Streams & Water Consumption: Guidance on the management of non-contaminated wastewater from utility operations, non-contaminated stormwater, and sanitary sewage is provided in the **General EHS Guidelines**. Contaminated streams should be routed to the treatment system for industrial process wastewater. Recommendations to reduce water consumption, especially where it may be a limited natural resource, are provided in the **General EHS Guidelines**.

Hazardous Materials

The aquaculture sector may involve the handling and use of hazardous materials (e.g. oil, fertilizers, and other chemicals). Recommendations for the safe storage, handling, and use of hazardous materials, including guidance on oil spills and containment, is provided in the **General EHS Guidelines**.

1.2 Occupational Health and Safety

As a general approach, health and safety management planning should include the adoption of a systematic and structured approach for prevention and control of physical, chemical, biological, and radiological health and safety hazards described in the **General EHS Guidelines**. Occupational health and safety hazards related to the daily operations of the aquaculture sector can be grouped into two categories:

- Physical hazards
- Exposure to chemicals
- Exposure to water borne disease

Physical hazards

A number of hazards are connected with the daily working routines in aquaculture, including heavy lifts, electric shock, and drowning.

Heavy Lifts

A number of activities involving heavy lifts are carried out during daily operations (e.g. refilling automatic feeders in the ponds and grading the fish). The following management measures can be taken to reduce exposure of personnel to injuries as a result of heavy lifts:

- Use mechanical and / or automated equipment to facilitate lifts heavier than 25 kg;

- Design workstations that can be adapted to individual workers, especially if fish are processed post-harvest;
- Construct ponds that are rectangular in shape to facilitate harvesting. If ponds are of sufficient size, and the embankments are at least 2.5 meters wide, vehicles can be used on the embankments to drag harvest seines.

Electric Shock

Electrical devices typically used in aquaculture include manifold and cover water pumps, paddlewheels, and lighting installations. The risk of electrical shock is therefore present during all operations in which the workers are in contact with the water. Measures to reduce the risk of electric shock include:

- Waterproof all electrical installations;
- Ensure that fuses are used and that there is an appropriate connection to the ground;
- Ensure that all cables are intact, waterproof, and without connection;
- Provide training in the correct handling of electric equipment (e.g. pumps and) to avoid the risk of short circuits;
- Employ lock out / tag out procedures.

Drowning

The risk of drowning is present in almost all aquaculture operations and, especially, in cage aquaculture at sea. Management measures to reduce the risk of drowning among workers and site visitors include the following:

- Provide lifejackets and harnesses with safety clips (karabiners) that lock on to lines or fixed points;
- Ensure that personnel are experienced swimmers;
- Train personnel in safety at sea, including procedures for supervision of personnel;
- Require that personnel wear lifejackets at all times on exposed sites and at sea;
- Where large vessels are used to transport personnel and equipment to marine sites, ensure that the vessel can be securely berthed on the pontoons, reducing the risk of falling into the gap between the vessel and the pontoon.

Exposure to Chemicals

A variety of chemicals may be used in the operation of an aquaculture facility to treat and / or control disease organisms or to facilitate production (e.g. lime, diluted chlorine, or salt). Fertilizers are also generally caustic materials and care should be taken in their application. Recommended guidance for the management of occupational chemical exposure is discussed in the **General EHS Guidelines**.

Water-borne Disease

Workers may be directly or indirectly exposed to water-borne diseases due to frequent contact with water (ponds) and the close proximity of living quarters to surface water bodies. The potential for transmission of water-borne disease should be addressed as part of the occupational health and safety program including specific additional medical screening for the labor force and implementation of preventive measures (e.g. mosquito nets in living quarters). Additional guidance on the prevention and control of communicable diseases is provided in the **General EHS Guidelines**.

1.3 Community Health and Safety

Community health and safety hazards arising from aquaculture operations include the following:

- Salinization of neighboring agricultural land;
- Effects on water resources;
- Food safety impacts and management

- Physical hazards

Effects on Water Resources

Water resources used in aquaculture may include the sea, estuaries, rivers, lakes, and groundwater. The extraction of water from these resources may result in changes to the natural water regime, potentially affecting fish stocks and commercial / recreational activities (e.g. fisheries and recreational activities downstream of the extraction point), or the availability and quality of groundwater. Water management strategies should target the maintenance of hydrologic conditions which provide water quality and quantity consistent with community needs and uses; and, in the case of coastal facilities, prevent salt water intrusion from affecting drinking and agricultural water supplies.

Aquaculture operations may act as breeding grounds for different insects, especially the mosquito and tsetse fly, thus increasing the risk of insect-borne disease among communities in the region. Operators should plan site design and operation to prevent and control these potential impacts. Additional information is provided in the Disease Prevention section of the **General EHS Guidelines**.

Food Safety Impacts and Management

Development of Resistance to Veterinary Drugs

The main veterinary drugs used in aquaculture are antibiotics, which are employed to prevent and treat bacterial diseases. Antibiotics are generally administered in feed, having either been added during manufacture or surface-coated onto the pellets by the manufacturer or the farmer. The development of antibiotic resistance by pathogenic bacteria may arise when bacteria acquire resistance to one or more of the antibiotics to which they were formerly susceptible. That resistance eventually makes the antibiotics ineffective in treating specific microbial diseases in humans.[14] In addition, when antibiotics are unintentionally consumed as residues in food, the amount ingested cannot be quantified or monitored and may cause direct health concerns (e.g. aplastic anemia), posing a serious risk to human health. This can also occur with integrated fish farming systems where antibiotic residues, from livestock manures used for fertilizer, can be introduced to fishpond culture.

Recognition of the risks brought about by consumption of veterinary drugs has led to the banning of certain antibiotics in aquaculture production and the establishment of maximum residue limits (MRLs)[15] for those with known risks. Observance of MRLs is required by law under some national jurisdictions and is encouraged elsewhere.[16] Use of resistant strains should be encouraged and good farm practices to maintain healthy fish stocks promoted.

The following actions can be taken to limit the use of antibiotics:

- Vaccination should be adopted where possible as a way of limiting the use of antibiotics;
- Where appropriate, aquaculture facilities should fallow sites on an annual basis as part of a strategy to manage pathogens in pen production units. The minimum fallow period should be four weeks at the end of each cycle;
- Facilities involved in aquaculture production should use a veterinary service on a frequent basis to review and assess the health of the stock and employees' competence and training. With the assistance of the veterinary service,

[14] FAO (2002b).

[15] Annex IV of Regulation 2377/90/EEC lists nine substances that may not be used in food-producing species because no safe level of residue can be determined: chloramphenicol, chloroform, chlorpromazine, colchicine, dapsone, dimetridazole, metronidazole, nitrofurans (including furazolidone), and ronidazole.

[16] The *Codex Alimentarius* contains maximum residue limits (MRLs) for veterinary drug residues in all major food products, including salmon and giant prawn. A simple MRL database is provided by FAO/WHO at the following Web site: http://www.codexalimentarius.net/mrls/vetdrugs/jsp/vetd_q-e.jsp

facilities should develop a Veterinary Health Plan to include the following aspects:[17]

- o Summary of major diseases present and potentially present;
- o Disease prevention strategies;
- o Treatments to be administered for regularly encountered conditions;
- o Recommended vaccination protocols;
- o Recommended parasite controls;
- o Medication recommendations for feed or water.

If antibiotics are recommended, the following measures should be considered:

- Apply approved over-the-counter antibiotics in strict accordance with the manufacturer's instructions to ensure responsible use;
- Apply approved antibiotics that are purchased and utilized by prescription under the guidance of a qualified professional;
- Develop a contingency plan covering how antibiotics should be applied following the identification of disease outbreaks;
- Store antibiotics in their original packaging, in a dedicated location that:
  - o Can be locked, is properly identified with signs, and limits access to authorized persons
  - o Can contain spills and avoid uncontrolled release of antibiotics into the surrounding environment
  - o Provides for storage of containers on pallets or other platforms to facilitate the visual detection of leaks
- Avoid stockpiles of waste antibiotics by adopting a "first-in, first-out" principle so that they do not exceed their expiration date. Any expired antibiotics should be disposed of in compliance with national regulations.

[17] For more information, see EUREPGAP guidance on integrated aquaculture assurance at: http://www.eurepgap.org/fish/Languages/English/index_html

Physical Hazards

Communities may be exposed to a number of physical hazards, including drowning, associated with the presence of pond systems or other project infrastructure in proximity or in between community areas, requiring frequent crossing and physical interaction. Community use should be taken into consideration in the design of access routes, for example by providing wide enough walking areas with fall protection along potentially hazardous locations.

2.0 Performance Indicators and Monitoring

2.1 Environment

Table 1 presents effluent guidelines for this sector. Guideline values for process emissions and effluents in this sector are indicative of good international industry practice as reflected in relevant standards of countries with recognized regulatory frameworks. These guidelines are achievable under normal operating conditions in appropriately designed and operated facilities through the application of pollution prevention and control techniques discussed in the preceding sections of this document. These levels should be achieved, without dilution, at least 95 percent of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours. Deviation from these levels in consideration of specific, local project conditions should be justified in the environmental assessment.

Emissions guidelines are applicable to process emissions. Combustion source emissions guidelines associated with steam- and power-generation activities from sources with a capacity equal to or lower than 50 MWth are addressed in the

General EHS Guidelines with larger power source emissions addressed in the **EHS Guidelines for Thermal Power**. Guidance on ambient considerations based on the total load of emissions is provided in the **General EHS Guidelines**.

Effluent guidelines are applicable for direct discharges of treated effluents to surface waters for general use. Site-specific discharge levels may be established based on the availability and conditions in use of publicly operated sewage collection and treatment systems or, if discharged directly to surface waters, on the receiving water use classification as described in the **General EHS Guidelines**.

Table 1. Effluent levels for aquaculture

Pollutants	Units	Guideline Value
pH	pH	6 – 9
BOD_5	mg/l	50
COD	mg/l	250
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Temperature increase	°C	<3[b]
Total coliform bacteria	MPN[a] / 100 ml	400
Active Ingredients / Antibiotics	To be determined on a case specific basis	

Notes:
[a] MPN = Most Probable Number
[b] At the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity

Environmental Monitoring

Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the particular project. Monitoring frequency should be sufficient to provide representative data for the parameter being monitored. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Additional guidance on applicable sampling and analytical methods for emissions and effluents is provided in the **General EHS Guidelines**.

2.2 Occupational Health and Safety

Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, of which examples include the Threshold Limit Value (TLV®) occupational exposure guidelines and Biological Exposure Indices (BEIs®) published by American Conference of Governmental Industrial Hygienists (ACGIH),[18] the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),[19] Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),[20] Indicative Occupational Exposure Limit Values published by European Union member states,[21] or other similar sources.

Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to

[18] Available at: http://www.acgih.org/TLV/ and http://www.acgih.org/store/
[19] Available at: http://www.cdc.gov/niosh/npg/
[20] Available at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992
[21] Available at: http://europe.osha.eu.int/good_practice/risks/ds/oel/

a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources (e.g. US Bureau of Labor Statistics and UK Health and Safety Executive)[22].

Occupational Health and Safety Monitoring

The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals as part of an occupational health and safety monitoring program. [23] Facilities should also maintain a record of occupational accidents, diseases, and dangerous occurrences and other kinds of accident. Additional guidance on occupational health and safety monitoring programs is provided in the **General EHS Guidelines**.

[22] Available at: http://www.bls.gov/iif/ and http://www.hse.gov.uk/statistics/index.htm
[23] Accredited professionals may include certified industrial hygienists, registered occupational hygienists, or certified safety professionals or their equivalent.

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Annex A: General Description of Industry Activities

The aquaculture sector is very diverse, in terms of products and production methods, as detailed in Table A-1.

Extensive systems[24] use low stocking densities and no supplemental feeding. Extensive systems may use man-made ponds or, more often, existing natural structures (e.g. lakes or lagoons) that are typically large (>2 ha). Semi-intensive systems[25] (approximately 2 to 20 tons/ha/yr) use higher stocking densities, supplemental feeding, and additional management (such as water changes) and typically utilize man-made ponds, pens, or cages. Some semi-intensive systems, especially polycultures, utilize natural lakes (e.g. filter feeders and omnivorous fish can be cultured in cages in shrimp or prawn ponds).[26]

Intensive systems[27] use maximum stocking densities and are dependent on a mixture of natural and formulated feeds. Semi-intensive and intensive systems typically use small pond compartments of up to 1 ha for ease of management. Site selection for the aquaculture facility is often the most important issue related to environmental health and safety. Criteria for site selection include water supply and quality; soil quality; protection from natural hazards; and accessibility to inputs, including markets and labor.[28] An aquaculture facility requires a steady supply of water in adequate quantities throughout the year. Water supply should be pollution-free and have a stable and suitable pH, adequate dissolved oxygen, and low turbidity. Some producers may treat the intake water to remove unwanted substances, for example, using a filter to remove potential predators. In addition, aquaculture farms should not be located close to each other, as this could increase the risk of disease transfer and may have a detrimental effect on the water quality of the intake water.

Table A-1. Diversity of Aquaculture Production Methodologies

Resource	System	Installations
Water (fresh, brackish, or marine)	Stillwater	Ponds and lakes
	Flow-through	Ponds, raceways, tanks (land-based) Cages (lake and sea based) Large offshore units (sea based)
	Re-use or recirculation	Tanks and land-based ponds
Nutrition	Extensive (No feed)	Ponds (land-based) Substrate - shellfish (sea-based) Substrate - seaweeds (sea-based)
	Semi-intensive systems (Supplemental feeding and/or fertilizer)	Ponds (land-based) Raceways (land-based)
	Intensive systems (Feed)	Ponds (land-based) Cages (lake and sea based) Raceways (land and sea-based) Silos and tanks (land-based)
Species	Monoculture	Animals (ponds and tanks, cages/pens in lakes or sea) Plants (ponds and tanks, cages/pens in lakes or sea)
	Polyculture	Animals (fish species)

24 Production system characterized by (i) a low degree of control (e.g. of environment, nutrition, predators, competitors, disease agents); (ii) low initial costs, low-level technology, and low production efficiency (yielding no more than 500 kg/ha/yr); (iii) high dependence on local climate and water quality; use of natural water bodies (e.g. lagoons, bays, embayments) and of natural often unspecified food organisms.]

25 System of culture characterized by a production of 0.5-5 tons/ha/yr, possibly supplementary feeding with low-grade feeds, stocking with wild-caught or hatchery-reared fry, regular use of organic or inorganic fertilizers, rain or tidal water supply and/or some water exchange, simple monitoring of water quality, and normally in traditional or improved ponds; also some cage systems e.g. with zooplankton feeding for fry.

26 Center for Tropical and Subtropical Aquaculture (2001). Other polyculture systems are practiced in Asia, primarily carp in association with duckeries and piggeries and the growth of crops on pond embankments.

27 Systems of culture characterized by a production of 2 to 20 tons/ha/yr, which are dependent largely on natural food, which is augmented by fertilization or complemented by use of supplementary feed, stocking with hatchery-reared fry, regular use of fertilizers, some water exchange or aeration, often pumped or gravity supplied water, and normally in improved ponds, some enclosures, or simple cage systems.

28 Food and Agriculture Organization of the United Nations (FAO), 1989, ADCP/REP/89/43, Aquaculture Systems and Practices: A Selected Review. http://www.fao.org/docrep/T8598E/t8598e00.HTM.

The site should have soils adequate for the intended structures (e.g. clay-loam or sandy-clay soil for ponds, and firm bottom mud for pens) to allow the structure to be driven deep into substrate for better support. Aquaculture facilities should be protected from high wind, waves, and tides; excessive storm water runoff; predators; and other natural hazards. Moderate tides, however, may help to ensure adequate water exchange through ponds, pens, and cages.

Figure A-1 presents the typical production cycle for an aquaculture facility. The production period varies from species to species and from region to region, depending on the market requirements for size and on the growth rates for the species, which is dependent on temperature, feed quality, and feed allocation. Most operations have a grow-out period of 4 to 18 months.

Preparation and Stocking

Freshwater Ponds

Ponds are most commonly constructed by excavating soils and using the spoils from excavation for the embankments. Soils that are suitable for earthen pond construction have the following characteristics: adequate clay content (clay slows down or may even eliminate seepage), low organic content, proper soil texture, and preferably alkaline pH. When producing at high densities, or during the early stages of fry or juveniles, ponds can be sealed with a plastic sheet or concrete, or production can take place in sealed raceways or tanks to facilitate cleaning.

Pens and Cages

Pen and cage systems involves the rearing of fish within fixed or floating net enclosures supported by rigid frameworks and set in sheltered, shallow portions of lakes, bays, rivers, estuaries, or the seacoast. Pens and cages are largely similar. Pens are anchored to the lake or sea bottom, which serves as the floor of the pen, while cages are suspended in the water, and can be either fixed or floating. Cages can typically be located in more exposed situations and in deeper water than pens. Fry may be grown to fingerling size in special nursery compartments and then released to pens or cages for grow-out, or fingerlings for stocking may be purchased from land-based facilities. In some cases, the stocking material may be wild caught.

Open Water Culture

Seaweed and mollusks are typically farmed in open marine waters. Structures (e.g. rafts, racks, or stakes) that provide a growth surface for the intended species are placed in suitable areas. Often the species to be grown settle by themselves on the structures, and the producer will only remove unwanted species and occasionally thin the stock. The aquaculture of other species, notably oysters, requires more active management and the spat or other juvenile stages are added to the structures for on-growing.

Start-Feeding

The early stages of fish and crustaceans production often demand a special feeding regimen, and the use of artificial feeds for these early stages can be problematic. During the initial feeding phase, organic and / or inorganic fertilizers (e.g. nitrogen and phosphorus) are often added to create an algal bloom. The algal bloom boosts primary productivity levels in the pond by generating a food source for microorganisms such as zooplankton, which are eaten by the fry or larvae of the organisms being cultivated. The algal bloom also prevents the establishment of aquatic plants. Veterinary drugs may be added at this stage to reduce the risk of disease or in response to actual outbreaks. A broad spectrum antibiotic is the most frequently used medication.

On-growing

After start-feeding, a transition toward on-growing takes place. The quality of the feed used can vary widely, depending on the species grown and / or the level of sophistication of the farm setup. A simple solution involves the use of minced fish meat prepared at the farm site and offered daily throughout the grow-out period. Intensive operations may exclusively use high-quality, pelletized, formulated feed throughout the production period.

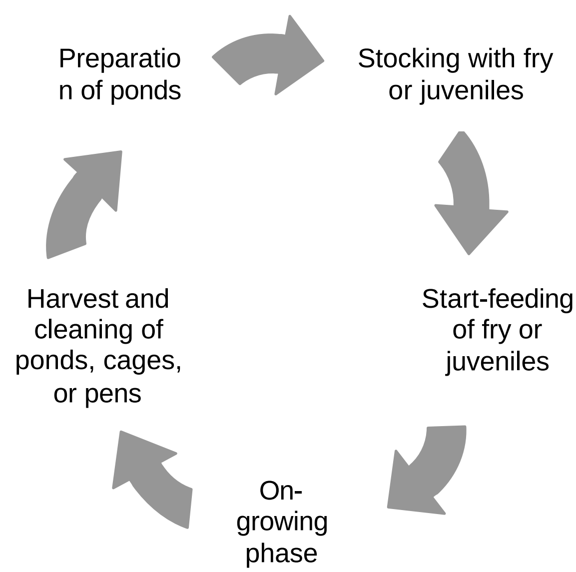
During feeding, the biomass will increase, resulting in increased oxygen consumption, and pond aerators (e.g. paddlewheels and diffusers) are often used to aerate the water. During the on-growing period, the stock are monitored regularly for disease and willingness to eat, allowing the pond manager to intervene (e.g. applying antibiotics and changing the pond water) if unsuitable conditions develop.

Harvesting and Cleaning

Once the stock has reached the desired size, they are harvested and marketed. Some species are sold live, and others are slaughtered before sale. In the latter situation, special facilities for slaughtering may be installed at the farm (e.g. to control the "blood water" resulting from harvest of the organisms). The slaughtered product is then iced and may be sent out for further processing off-site at a specialized fish processing plant, or sold fresh to local markets.[29]

After harvesting, the aquaculture effluent may be conveyed into a sedimentation basin before being discharged to the receiving water. After the pond has been emptied, the pond bottom is cleaned to remove the sediment of uneaten feed and feces. For intensive and semi-intensive systems, ponds are usually allowed to dry completely and are treated (e.g. with lime or pesticides) to control diseases, competing organisms, and predators before the next production cycle begins. In the case of cages and pens, fouling on the nets may be removed in a mechanical cleaning process, which is often followed by bathing the nets in chemicals to reduce settling on the nets in the grow-out period.

Figure A.1: Typical Production Cycle for an Aquaculture Facility



[29] Refer to the EHS Guidelines for Fish Processing for practical guidance on EHS issues in this sector.

Annex C. General EHS Guidelines

Please see the following pages.

Environmental, Health, and Safety Guidelines for Aquaculture

Introduction

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

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

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

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

Applicability

The EHS Guidelines for Aquaculture provide information relevant to semi-intensive and intensive/super-intensive, commercial aquaculture production of the main aquatic species, including crustaceans, mollusks, seaweeds and finfish, located in developing countries in temperate and tropical regions. Annex A contains a full description of industry activities for this sector.

This document is organized according to the following sections:

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

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

1.0 Industry-Specific Impacts and Management

The following section provides a summary of EHS issues associated with aquaculture, along with recommendations for their management. Recommendations for the management of EHS issues common to most projects during the construction and decommissioning phases are provided in the **General EHS Guidelines**.

1.1 Environment

Environmental issues associated with the aquaculture sector primarily include the following:

- Threats to biodiversity
- Contamination of aquatic systems
- Hazardous Materials

Threats to Biodiversity

Threats to biodiversity are mainly associated with conversion of natural habitats during construction; potential release of alien species into the natural environment during operations; potential loss of genetic resources due to collection of larvae, fry, or juveniles for aquaculture production; potential release of artificially propagated seed into the wild (e.g. there are more farmed than wild Atlantic salmon in existence); sustainability of fish meal and fish oil ingredients for fish and crustacean feeds; and development of antibiotic resistance in pathogenic bacteria that can then spread from farms to wild stock.

Conversion of Natural Habitats

The construction and operational phases of the project cycle of an aquaculture facility may require conversion of the natural environment including, for example, the removal of mangroves for excavation of ponds, or alteration of the natural hydrology of lagoons, bays, rivers, or wetlands.[2] Operational phase issues may also include alteration of aquatic habitats and substrates (e.g. under sea cages or shellfish farms).

A range of management measures can be taken to prevent and reduce the environmental impacts caused by the construction of aquaculture facilities, as presented below. Further potential impacts are related to changes to stream hydrology caused by the construction of barriers to flow (e.g. dams may cause disruption of wetland areas and changes in stream morphology, potentially affecting migratory species, including birds, and nursery areas for juvenile fish). Measures should include all of the following:

- Survey the project area before land and water conversion to aquaculture production is undertaken to identify, categorize, and delineate natural and modified habitats and ascertain their biodiversity importance at the national or regional level;
- Ensure that the area to be converted to aquaculture use does not represent a habitat that is unique or protected (such as mangrove areas), or includes high biodiversity value, such as known sites of critically endangered or endangered species, or important wildlife breeding, feeding, and staging areas;
- Be aware of the presence of critically endangered or endangered species in the areas already used for aquaculture production, and implement management processes that take them into account;
- Design facilities so that as much as possible of the natural vegetation habitat is left intact (e.g. through the use of vegetated buffer zones and habitat corridors) and that

[2] Hydrological changes may also contribute to changes in the natural geochemistry such as the release of pyrite from formerly submerged soils of cleared mangrove areas. When pyrite comes into contact with oxygen, it creates acid sulfate soil, which in turn has potentially serious impacts on the health of the aquaculture organisms for many years to come.

conversion and degradation of the natural habitat is minimized;

- Design and implement mitigation measures to achieve no net loss of biodiversity where feasible, for instance through post-operation restoration of habitats; offset of losses through the creation of ecologically comparable area(s) managed for biodiversity; and compensation to direct users of biodiversity;
- Avoid the need to frequently abandon and replace improperly designed and built aquaculture ponds:
  - o Assess soil properties prior to pond construction to ensure that the bottom-sealing layer of the soil with percolation rates/porosity low enough to satisfactorily hold pond water. If there is not enough clay, then the ponds may demonstrate high seepage rates and require additional expenditure (e.g. pumping in water, or relining with clay-rich or possibly bentonite-rich topsoil from other sites) or eventual abandonment. High seepage rates can also pollute groundwater required for other purposes in the vicinity with use for drinking water a major concern.
  - o Assess the soil pH and the presence of pesticide and pollutant residues (especially on land that was previously used for intensive agriculture), as well as the natural occurrence of pyrite, prior to construction as the presence of anthropogenic or natural pollutants may hinder the viability of the pond.

Conversion of Agricultural Land - Salinization

If new land areas are not available for aquaculture, an alternative is to convert former agricultural land. If the selected production is based on brackish water, this may pose a risk of salinization of surrounding agricultural land. The following measures can be taken to avoid salinization of agricultural land:

- Ensure that the embankments around brackish water pond systems are high enough to form a physical division between agriculture and aquaculture;
- Ensure that the saline / brackish water discharges are appropriately treated and disposed of (e.g. through use of discharge canals) for the receiving waters;
- Ensure that appropriate discussions are held at the community level to avoid conflicts of interest when agricultural land is transferred to aquaculture production.

Introduction of Alien, Selectively Bred, or Genetically Engineered Species

Introductions can result in interactions with the wild, including escapes from farms, or open systems (such as mussel rafts). As such, introductions can disturb the existing ecological balance; cause loss of species biodiversity; cause loss of genetic diversity of the wild populations; reduce fitness of wild population through breeding with genetically altered escapees; and result in the transmission or spread of fish diseases. The widespread seeding of an alien genotype is of considerable concern both as regards species biodiversity and genetic biodiversity.

Management measures to reduce the risks from introductions of alien, selectively bred, or genetically modified species include the following:

- Application of codes and guidelines (see Section 3.0);
- Farming of sterile fish;
- Preventing the escape of species from pond-based aquaculture systems. Examples of common escape prevention measures include:
  - o Installation and maintenance of screens with a mesh that is small enough to prevent the entry and potential escape of aquatic species in the drainage channels connecting production ponds to sedimentation ponds,

as well as those connecting sedimentation ponds to the receiving water
   - Installation of fish-proof strainer dams
   - Installation and maintenance of gravel filtration on pond discharge structures
   - When necessary, consider chemical treatment of water released from hatcheries(e.g. with chlorine at acceptable concentrations for the receiving waters) to destroy escaping larvae or juveniles
   - Consider the hydrology of the region in the design of the pond system and ensure that the pond embankments are high enough to contain the pond water and prevent escape of the species during periods of heavy rainfall and potential flooding
   - Establish a contingency plan if there is an escape of the species being cultivated into the wild
- Preventing the escape of species from open water aquaculture systems. Examples of common escape prevention measures include:
   - Regularly inspect the cage and pen netting for holes(e.g. before crowding of the harvest and at intervals during the operation)
   - Design and construct cage and pen units, including choice of nets, to deal with the worst weather and environmental conditions likely to occur on the site
   - Provide for containment during periods of storm surges and excessively high tides
   - For cage culture in open waters, use submersible cages that can be submerged during storms below damaging wave action
   - Provide adequate marking of the fish farm system to warn navigators of the potential obstruction and reduce the risk of collision[3]
   - Establish a contingency plan for harvest of escapees of the species being cultivated into the wild.

Impacts of Harvesting on Ecosystem Functions

The practice of capturing females, eggs, fry, juveniles, or even fingerlings from the wild for the purpose of stocking aquaculture systems may threaten ecosystem biodiversity. Fry and larvae may be gathered from fresh or brackish water using very fine meshed nets resulting in considerable by-catch, as well as the removal of large number of larvae, fry, and juveniles from the food chain.[4] The recommended prevention of this type of ecosystem pressure is the breeding of stock material in captivity. However, for some species, careful harvesting of hatchlings/ and or fry (less than 3 cm) that are still at a stage of expected high mortality can result in relatively little impact on the overall population as compared to collecting larger fingerlings from a smaller population for grow-out.

Fish meal and fish oil

Fish meal and oil are derived from the capture and processing of wild pelagic fish stocks (e.g. anchovy, pilchard, herring, sardine, sand eel, sprat, and capelin). Although the production of fish meal and oil is not covered by these Guidelines, processed fishmeal and oil are the primary sources of protein and dietary lipids in fish feed for farmed fish in aquaculture operations. The aquaculture sector is an important consumer of fish meal and fish oil, and there are concerns regarding the sustainability of the pelagic fish stocks from which fish meal and fish oil are derived. Aquaculture operations should consider incorporating the use of alternatives to supplies of fish feed produced from fish meal and fish oil. Alternatives for fish feed ingredients may include use of plant material substitutes [e.g.

[3] Shetland Aquaculture (2006).

[4] Some jurisdictions have outlawed the larvae and fry collection or export although the practice still represents a source of income for the poor in some developing countries.

soya for bulk protein and single-cell protein (yeast for lysine and other amino acids)] and biotechnology options (e.g. bio-fermentation products).[5]

Source Water Quality

The quality of source water can also have a major effect on the viability of an aquaculture operation whether it is water used for hatchery and ponds systems or the water in which cages and pens are established. The water itself can affect the health of the organism as well as contribute to the accumulation of substances or pathogens toxic to consumers. Quality guidelines have been developed for aquaculture and vary depending upon the organism cultured.[6]

Contamination of Aquatic Systems

Aquaculture activities, particularly pond-based systems, may affect aquatic systems due to construction and operation activities, primarily the mobilization of soils and sediments during construction and through the release of effluents during operation. Fish cage culture can also be a major contributor to marine pollution in areas of high density use.

Soil Erosion and Sedimentation

Earth excavation and moving activities conducted during construction of some types of aquaculture projects may result in soil erosion and the subsequent sedimentation of nearby water bodies. Sedimentation of aquatic resources may contribute to eutrophication and overall degradation of water quality. Recommended management strategies include the following:

- Construct pond and canal levees with a 2:1 or 3:1 slope (based on soil type) as this adds stability to the pond banks, reduces erosion, and deters weeds. Avoid pond construction in areas that have a slope of more than 2 percent, as this will require energy-intensive construction and maintenance;
- Stabilize the embankments to prevent erosion;
- Reduce excavation and disturbance of acid sulfate soils during construction;
- Carry out construction work during the 'dry' season to reduce sediment runoff that may pollute adjacent waters;
- Install temporary silt fences during construction to slow down and catch any suspended sediments. Silt fences can be made of woven plastic or fabric, or hay bales.

Wastewater Discharges

Industrial Process Wastewater: The effluent released from aquaculture systems typically contains a high organic and nutrient load, suspended solids, and may also contain chemical residues including feed supplements and antibiotics. The possible impacts include contamination of groundwater and surface water from release of effluents or communication to receiving water from unconfined process and storage tanks (such as ponds and lagoons). Impacts on aquatic systems include creation of eutrophic zones within receiving waters, increased fluctuation of dissolved oxygen levels, creation of visible plumes, and accumulation of nutrients within the receiving waters.[7]

The high nutrient load results from efforts to artificially boost production levels by increasing the food supply for the cultured species. This is done by increasing nutrient availability either directly through supplemental feed or indirectly by fertilizing

[5] Further information is available from Use of Fishmeal and Fish Oil in Aquafeeds: Further Thoughts on the Fishmeal Trap, FAO (2001) Available at http://www.fao.org/docrep/005/y3781e/y3781e07.htm#bm07.3.3 and Assessment of the Sustainability of Industrial Fisheries Producing Fish Meal and Fish Oil, Royal Society for the Protection of Birds (2004) available at http://www.rspb.org.uk/Images/fishmeal_tcm5-58613.pdf

[6] Zweig, R. D., J. D. Morton and M. M Stewart.1999. Source Water Quality for Aquaculture: A Guide for Assessment. The World Bank. 62 pp.

[7] Department of Primary Industries and the Queensland Finfish Aquaculture Industry (1999).

ponds to increase primary productivity. Pond ecosystems have a limited capacity to recycle organic matter and nutrients, and increasing the stocking rate removes this capacity, resulting in the build-up of organic matter, nitrogenous waste, and phosphorus both in the water mass and on the bottom of the pond or pen / cage.[8] The suspended solids are derived from particulate organic matter and erosion of pond floor, walls, and discharge channels.

The chemical residues may include the remains of veterinary drugs (e.g. antibiotics) that may have been applied to the cultivated species, and toxic substances such as formalin and malachite green, a cancer causing agent, that may have been that are used to treat finfish for parasites and their eggs for fungal growth. Malachite green is banned in most countries and must not be used. Formalin should only be used under controlled conditions (e.g. in dipping containers) and with proper care – it should not be introduced directly into production systems.[9]

A range of measures can be taken in pond systems and pen / cage systems to (i) reduce the amount of contamination of the effluent; (ii) prevent pond effluent from entering surrounding water bodies; and (iii) treat the effluent before its release into the receiving waters to reduce contaminant levels. Aquaculture operations in large water bodies, however, are open to the surrounding environment and do not have the second or third options, therefore any contamination takes effect immediately.[10] The following management measures can prevent the contamination of effluent:

[8] Center for Tropical and Subtropical Aquaculture (2001).
[9] Because the use of these highly toxic substances is primarily an occupational health and safety issue, refer to the Occupational Health and Safety section for a more detailed review of their application and for practical guidance.
[10] Aquaculture is also somewhat self-regulating in that if the water is highly eutrophic or laden with dissolved or particulate nutrients or BOD, this will adversely affect many cultured organism and thus would be counterproductive not to manage it to a high quality level. This would somewhat reduce impacts of effluents.

Feed:

- Ensure that pellet feed has a minimum amount of "fines" or feed dust. Fines are not consumed and add to the nutrient load in the water;
- Match the pellet size to the species' life-cycle stage (e.g. smaller pellets should be fed to fry or juvenile animals to reduce the unconsumed fraction);
- Regularly monitor feed uptake to determine whether it is being consumed and adjust feeding rates accordingly. Feed may be wasted due to overfeeding or not feeding at the right time of day;
- Where feasible, use floating or extruded feed pellets as they allow for observation during feeding time;
- Store feed in cool, dry facilities and ideally for no longer than 30 days to avoid reduction in vitamin contents. Moldy feed should never be used as it may cause disease;
- Spread feed as evenly as possible throughout the culture system, ensuring that as many animals as possible have access to the feed. Some species are highly territorial, and uneaten feed adds to the nutrient load;
- Feed several times a day, especially when animals are young, allowing better access to food, better feed conversion ratios and less waste;
- Halt feeding at a suitable interval before harvest to eliminate the presence of food and / or fecal material in the animal's gut;
- During harvesting, contain and disinfect blood water and effluent to reduce the risk of disease spread and to contain effluent matter.

Other organic materials:

- Perform slaughter and processing in an area where the effluent is contained;
- Prevent effluent leakage from harvest rafts and bins by using harvest bins in good condition with sealed bin liners and secure lids and bindings;

- Equip off-loading bays with a waterproof apron and surround with a bund to contain potential spills and prevent contamination with effluent.[11]

Suspended solids:

- Avoid discharging waters from ponds while they are being harvested with nets, as this will add to the suspended solids in the effluent drainage;
- If feasible, use partial draining techniques to empty ponds that have been harvested. The last 10–15 percent of pond water contains the highest quantities of dissolved nutrients, suspended solids, and organic matter. After harvest, hold the remaining water in the pond for a number of days before discharge, or transfer to a separate treatment facility.

Fertilizers:

- Plan the rate and mode of application of fertilizers to maximize utilization and prevent over-application, taking into account predicted consumption rates;
- Increase the efficiency of application and dispersion through such practices as dilution of liquid fertilizers or solution of granulated fertilizers prior to application. Other options include the use of powdered fertilizers or the placement of powdered fertilizer bags in shallow water to allow solution and dispersion;
- Consider the use of time-released fertilizer in which resin coated granules release nutrients into the pond water, with the rate of release corresponding to water temperature and movement;
- Avoid the use of fertilizers containing ammonia or ammonium in water with pH of 8 or above to avoid the formation of toxic unionized ammonia (NH_3);[12]
- Depending on the system (e.g., freshwater aquaculture), grow organic fertilizer (e.g. natural grass) in the pond basin after harvest;
- Initiate pond fertilization only in static ponds with no pond water overflow that can impact downstream waters and watersheds;
- Conduct pond fertilization to avoid or minimize consequences of potential runoff due to floods or heavy rain and avoid application to overflowing ponds.

Chemicals:

- Design the pond depth to reduce the need for chemical control of aquatic weeds and reduce thermal stratification;
- Do not use antifoulants to treat cages and pens. The chemically active substances used in antifouling agents are very poisonous and highly stable in an aquatic environment. Clean nets manually or in a net washing machine.

The following management measures can be taken in pond-based systems to prevent pond effluent from entering surrounding water bodies:

- In some fish systems, avoid automatic drainage of ponds at the end of the production cycle as the same pond water may be used to cultivate several crop rotations of certain species (e.g. catfish);[13]
- Reuse water from harvested ponds by pumping it into adjacent ponds to help complement their primary productivity, provided that the level of BOD is controlled; This process is called "bloom seeding," and requires careful timing of harvests;
- Consider the hydrology of the region in the design of the pond system and ensure that the pond embankments are

[11] Shetland Aquaculture (2006).
[12] WRAC (2000).
[13] Not applicable to shrimp farming which requires the drying out of pond bottoms between harvests.

high enough to contain the pond water and prevent loss of effluent during periods of increased rainfall and potential flooding.

Process Wastewater Treatment: Techniques for treating industrial process wastewater in this sector include grease traps, skimmers or oil water separators for separation of floatable solids; flow and load equalization; sedimentation for suspended solids reduction using clarifiers or settling ponds; biological treatment, typically aerobic treatment, for reduction of soluble organic matter (BOD); biological nutrient removal for reduction in nitrogen and phosphorus; chlorination of effluent when disinfection is required; dewatering and disposal of residuals; in some instances composting or land application of wastewater treatment residuals of acceptable quality may be possible. Additional engineering controls may be required (i) for removal of residual feed supplements, chemicals, antibiotics, etc. which may pass through the wastewater treatment system, and (ii) to contain and neutralize nuisance odors. For sea water applications, unit operations for wastewater treatment may have to be suitably adapted to the relatively high salinity of the water.

Management of industrial wastewater and examples of treatment approaches are discussed in the **General EHS Guidelines**. Through use of these technologies and good practice techniques for wastewater management, facilities should meet the Guideline Values for wastewater discharge as indicated in the relevant table of Section 2 of this industry sector document.

Other Wastewater Streams & Water Consumption: Guidance on the management of non-contaminated wastewater from utility operations, non-contaminated stormwater, and sanitary sewage is provided in the **General EHS Guidelines**. Contaminated streams should be routed to the treatment system for industrial process wastewater. Recommendations to reduce water consumption, especially where it may be a limited natural resource, are provided in the **General EHS Guidelines**.

Hazardous Materials

The aquaculture sector may involve the handling and use of hazardous materials (e.g. oil, fertilizers, and other chemicals). Recommendations for the safe storage, handling, and use of hazardous materials, including guidance on oil spills and containment, is provided in the **General EHS Guidelines**.

1.2 Occupational Health and Safety

As a general approach, health and safety management planning should include the adoption of a systematic and structured approach for prevention and control of physical, chemical, biological, and radiological health and safety hazards described in the **General EHS Guidelines**. Occupational health and safety hazards related to the daily operations of the aquaculture sector can be grouped into two categories:

- Physical hazards
- Exposure to chemicals
- Exposure to water borne disease

Physical hazards

A number of hazards are connected with the daily working routines in aquaculture, including heavy lifts, electric shock, and drowning.

Heavy Lifts

A number of activities involving heavy lifts are carried out during daily operations (e.g. refilling automatic feeders in the ponds and grading the fish). The following management measures can be taken to reduce exposure of personnel to injuries as a result of heavy lifts:

- Use mechanical and / or automated equipment to facilitate lifts heavier than 25 kg;

- Design workstations that can be adapted to individual workers, especially if fish are processed post-harvest;
- Construct ponds that are rectangular in shape to facilitate harvesting. If ponds are of sufficient size, and the embankments are at least 2.5 meters wide, vehicles can be used on the embankments to drag harvest seines.

Electric Shock

Electrical devices typically used in aquaculture include manifold and cover water pumps, paddlewheels, and lighting installations. The risk of electrical shock is therefore present during all operations in which the workers are in contact with the water. Measures to reduce the risk of electric shock include:

- Waterproof all electrical installations;
- Ensure that fuses are used and that there is an appropriate connection to the ground;
- Ensure that all cables are intact, waterproof, and without connection;
- Provide training in the correct handling of electric equipment (e.g. pumps and) to avoid the risk of short circuits;
- Employ lock out / tag out procedures.

Drowning

The risk of drowning is present in almost all aquaculture operations and, especially, in cage aquaculture at sea. Management measures to reduce the risk of drowning among workers and site visitors include the following:

- Provide lifejackets and harnesses with safety clips (karabiners) that lock on to lines or fixed points;
- Ensure that personnel are experienced swimmers;
- Train personnel in safety at sea, including procedures for supervision of personnel;
- Require that personnel wear lifejackets at all times on exposed sites and at sea;
- Where large vessels are used to transport personnel and equipment to marine sites, ensure that the vessel can be securely berthed on the pontoons, reducing the risk of falling into the gap between the vessel and the pontoon.

Exposure to Chemicals

A variety of chemicals may be used in the operation of an aquaculture facility to treat and / or control disease organisms or to facilitate production (e.g. lime, diluted chlorine, or salt). Fertilizers are also generally caustic materials and care should be taken in their application. Recommended guidance for the management of occupational chemical exposure is discussed in the **General EHS Guidelines**.

Water-borne Disease

Workers may be directly or indirectly exposed to water-borne diseases due to frequent contact with water (ponds) and the close proximity of living quarters to surface water bodies. The potential for transmission of water-borne disease should be addressed as part of the occupational health and safety program including specific additional medical screening for the labor force and implementation of preventive measures (e.g. mosquito nets in living quarters). Additional guidance on the prevention and control of communicable diseases is provided in the **General EHS Guidelines**.

1.3 Community Health and Safety

Community health and safety hazards arising from aquaculture operations include the following:

- Salinization of neighboring agricultural land;
- Effects on water resources;
- Food safety impacts and management

- Physical hazards

Effects on Water Resources

Water resources used in aquaculture may include the sea, estuaries, rivers, lakes, and groundwater. The extraction of water from these resources may result in changes to the natural water regime, potentially affecting fish stocks and commercial / recreational activities (e.g. fisheries and recreational activities downstream of the extraction point), or the availability and quality of groundwater. Water management strategies should target the maintenance of hydrologic conditions which provide water quality and quantity consistent with community needs and uses; and, in the case of coastal facilities, prevent salt water intrusion from affecting drinking and agricultural water supplies.

Aquaculture operations may act as breeding grounds for different insects, especially the mosquito and tsetse fly, thus increasing the risk of insect-borne disease among communities in the region. Operators should plan site design and operation to prevent and control these potential impacts. Additional information is provided in the Disease Prevention section of the **General EHS Guidelines**.

Food Safety Impacts and Management

Development of Resistance to Veterinary Drugs

The main veterinary drugs used in aquaculture are antibiotics, which are employed to prevent and treat bacterial diseases. Antibiotics are generally administered in feed, having either been added during manufacture or surface-coated onto the pellets by the manufacturer or the farmer. The development of antibiotic resistance by pathogenic bacteria may arise when bacteria acquire resistance to one or more of the antibiotics to which they were formerly susceptible. That resistance eventually makes the antibiotics ineffective in treating specific microbial diseases in humans.[14] In addition, when antibiotics are unintentionally consumed as residues in food, the amount ingested cannot be quantified or monitored and may cause direct health concerns (e.g. aplastic anemia), posing a serious risk to human health. This can also occur with integrated fish farming systems where antibiotic residues, from livestock manures used for fertilizer, can be introduced to fishpond culture.

Recognition of the risks brought about by consumption of veterinary drugs has led to the banning of certain antibiotics in aquaculture production and the establishment of maximum residue limits (MRLs)[15] for those with known risks. Observance of MRLs is required by law under some national jurisdictions and is encouraged elsewhere.[16] Use of resistant strains should be encouraged and good farm practices to maintain healthy fish stocks promoted.

The following actions can be taken to limit the use of antibiotics:

- Vaccination should be adopted where possible as a way of limiting the use of antibiotics;
- Where appropriate, aquaculture facilities should fallow sites on an annual basis as part of a strategy to manage pathogens in pen production units. The minimum fallow period should be four weeks at the end of each cycle;
- Facilities involved in aquaculture production should use a veterinary service on a frequent basis to review and assess the health of the stock and employees' competence and training. With the assistance of the veterinary service,

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[14] FAO (2002b).

[15] Annex IV of Regulation 2377/90/EEC lists nine substances that may not be used in food-producing species because no safe level of residue can be determined: chloramphenicol, chloroform, chlorpromazine, colchicine, dapsone, dimetridazole, metronidazole, nitrofurans (including furazolidone), and ronidazole.

[16] The *Codex Alimentarius* contains maximum residue limits (MRLs) for veterinary drug residues in all major food products, including salmon and giant prawn. A simple MRL database is provided by FAO/WHO at the following Web site: http://www.codexalimentarius.net/mrls/vetdrugs/jsp/vetd_q-e.jsp

facilities should develop a Veterinary Health Plan to include the following aspects:[17]

- o Summary of major diseases present and potentially present;
- o Disease prevention strategies;
- o Treatments to be administered for regularly encountered conditions;
- o Recommended vaccination protocols;
- o Recommended parasite controls;
- o Medication recommendations for feed or water.

If antibiotics are recommended, the following measures should be considered:

- Apply approved over-the-counter antibiotics in strict accordance with the manufacturer's instructions to ensure responsible use;
- Apply approved antibiotics that are purchased and utilized by prescription under the guidance of a qualified professional;
- Develop a contingency plan covering how antibiotics should be applied following the identification of disease outbreaks;
- Store antibiotics in their original packaging, in a dedicated location that:
    - o Can be locked, is properly identified with signs, and limits access to authorized persons
    - o Can contain spills and avoid uncontrolled release of antibiotics into the surrounding environment
    - o Provides for storage of containers on pallets or other platforms to facilitate the visual detection of leaks
- Avoid stockpiles of waste antibiotics by adopting a "first-in, first-out" principle so that they do not exceed their expiration date. Any expired antibiotics should be disposed of in compliance with national regulations.

Physical Hazards

Communities may be exposed to a number of physical hazards, including drowning, associated with the presence of pond systems or other project infrastructure in proximity or in between community areas, requiring frequent crossing and physical interaction. Community use should be taken into consideration in the design of access routes, for example by providing wide enough walking areas with fall protection along potentially hazardous locations.

2.0 Performance Indicators and Monitoring

2.1 Environment

Table 1 presents effluent guidelines for this sector. Guideline values for process emissions and effluents in this sector are indicative of good international industry practice as reflected in relevant standards of countries with recognized regulatory frameworks. These guidelines are achievable under normal operating conditions in appropriately designed and operated facilities through the application of pollution prevention and control techniques discussed in the preceding sections of this document. These levels should be achieved, without dilution, at least 95 percent of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours. Deviation from these levels in consideration of specific, local project conditions should be justified in the environmental assessment.

Emissions guidelines are applicable to process emissions. Combustion source emissions guidelines associated with steam- and power-generation activities from sources with a capacity equal to or lower than 50 MWth are addressed in the

[17] For more information, see EUREPGAP guidance on integrated aquaculture assurance at: http://www.eurepgap.org/fish/Languages/English/index_html

General EHS Guidelines with larger power source emissions addressed in the **EHS Guidelines for Thermal Power**. Guidance on ambient considerations based on the total load of emissions is provided in the **General EHS Guidelines**.

Effluent guidelines are applicable for direct discharges of treated effluents to surface waters for general use. Site-specific discharge levels may be established based on the availability and conditions in use of publicly operated sewage collection and treatment systems or, if discharged directly to surface waters, on the receiving water use classification as described in the **General EHS Guidelines**.

Table 1. Effluent levels for aquaculture

Pollutants	Units	Guideline Value
pH	pH	6 – 9
BOD_5	mg/l	50
COD	mg/l	250
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Temperature increase	°C	<3[b]
Total coliform bacteria	MPN[a] / 100 ml	400
Active Ingredients / Antibiotics	To be determined on a case specific basis	

Notes:
[a] MPN = Most Probable Number
[b] At the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity

Environmental Monitoring

Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the particular project. Monitoring frequency should be sufficient to provide representative data for the parameter being monitored. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Additional guidance on applicable sampling and analytical methods for emissions and effluents is provided in the **General EHS Guidelines**.

2.2 Occupational Health and Safety

Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, of which examples include the Threshold Limit Value (TLV®) occupational exposure guidelines and Biological Exposure Indices (BEIs®) published by American Conference of Governmental Industrial Hygienists (ACGIH),[18] the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),[19] Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),[20] Indicative Occupational Exposure Limit Values published by European Union member states,[21] or other similar sources.

Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to

[18] Available at: http://www.acgih.org/TLV/ and http://www.acgih.org/store/
[19] Available at: http://www.cdc.gov/niosh/npg/
[20] Available at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992
[21] Available at: http://europe.osha.eu.int/good_practice/risks/ds/oel/

a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources (e.g. US Bureau of Labor Statistics and UK Health and Safety Executive)[22].

Occupational Health and Safety Monitoring

The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals as part of an occupational health and safety monitoring program.[23] Facilities should also maintain a record of occupational accidents, diseases, and dangerous occurrences and other kinds of accident. Additional guidance on occupational health and safety monitoring programs is provided in the **General EHS Guidelines**.

[22] Available at: http://www.bls.gov/iif/ and http://www.hse.gov.uk/statistics/index.htm
[23] Accredited professionals may include certified industrial hygienists, registered occupational hygienists, or certified safety professionals or their equivalent.

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Annex A: General Description of Industry Activities

The aquaculture sector is very diverse, in terms of products and production methods, as detailed in Table A-1.

Extensive systems[24] use low stocking densities and no supplemental feeding. Extensive systems may use man-made ponds or, more often, existing natural structures (e.g. lakes or lagoons) that are typically large (>2 ha). Semi-intensive systems[25] (approximately 2 to 20 tons/ha/yr) use higher stocking densities, supplemental feeding, and additional management (such as water changes) and typically utilize man-made ponds, pens, or cages. Some semi-intensive systems, especially polycultures, utilize natural lakes (e.g. filter feeders and omnivorous fish can be cultured in cages in shrimp or prawn ponds).[26]

Intensive systems[27] use maximum stocking densities and are dependent on a mixture of natural and formulated feeds. Semi-intensive and intensive systems typically use small pond compartments of up to 1 ha for ease of management. Site selection for the aquaculture facility is often the most important issue related to environmental health and safety. Criteria for site selection include water supply and quality; soil quality; protection from natural hazards; and accessibility to inputs, including markets and labor.[28] An aquaculture facility requires a steady supply of water in adequate quantities throughout the year. Water supply should be pollution-free and have a stable and suitable pH, adequate dissolved oxygen, and low turbidity. Some producers may treat the intake water to remove unwanted substances, for example, using a filter to remove potential predators. In addition, aquaculture farms should not be located close to each other, as this could increase the risk of disease transfer and may have a detrimental effect on the water quality of the intake water.

Table A-1. Diversity of Aquaculture Production Methodologies

Resource	System	Installations
Water (fresh, brackish, or marine)	Stillwater	Ponds and lakes
	Flow-through	Ponds, raceways, tanks (land-based) Cages (lake and sea based) Large offshore units (sea based)
	Re-use or recirculation	Tanks and land-based ponds
Nutrition	Extensive (No feed)	Ponds (land-based) Substrate - shellfish (sea-based) Substrate - seaweeds (sea-based)
	Semi-intensive systems (Supplemental feeding and/or fertilizer)	Ponds (land-based) Raceways (land-based)
	Intensive systems (Feed)	Ponds (land-based) Cages (lake and sea based) Raceways (land and sea-based) Silos and tanks (land-based)
Species	Monoculture	Animals (ponds and tanks, cages/pens in lakes or sea) Plants (ponds and tanks, cages/pens in lakes or sea)
	Polyculture	Animals (fish species)

24 Production system characterized by (i) a low degree of control (e.g. of environment, nutrition, predators, competitors, disease agents); (ii) low initial costs, low-level technology, and low production efficiency (yielding no more than 500 kg/ha/yr); (iii) high dependence on local climate and water quality; use of natural water bodies (e.g. lagoons, bays, embayments) and of natural often unspecified food organisms.]

25 System of culture characterized by a production of 0.5-5 tons/ha/yr, possibly supplementary feeding with low-grade feeds, stocking with wild-caught or hatchery-reared fry, regular use of organic or inorganic fertilizers, rain or tidal water supply and/or some water exchange, simple monitoring of water quality, and normally in traditional or improved ponds; also some cage systems e.g. with zooplankton feeding for fry.

26 Center for Tropical and Subtropical Aquaculture (2001). Other polyculture systems are practiced in Asia, primarily carp in association with duckeries and piggeries and the growth of crops on pond embankments.

27 Systems of culture characterized by a production of 2 to 20 tons/ha/yr, which are dependent largely on natural food, which is augmented by fertilization or complemented by use of supplementary feed, stocking with hatchery-reared fry, regular use of fertilizers, some water exchange or aeration, often pumped or gravity supplied water, and normally in improved ponds, some enclosures, or simple cage systems.

28 Food and Agriculture Organization of the United Nations (FAO), 1989, ADCP/REP/89/43, Aquaculture Systems and Practices: A Selected Review. http://www.fao.org/docrep/T8598E/t8598e00.HTM.

The site should have soils adequate for the intended structures (e.g. clay-loam or sandy-clay soil for ponds, and firm bottom mud for pens) to allow the structure to be driven deep into substrate for better support. Aquaculture facilities should be protected from high wind, waves, and tides; excessive storm water runoff; predators; and other natural hazards. Moderate tides, however, may help to ensure adequate water exchange through ponds, pens, and cages.

Figure A-1 presents the typical production cycle for an aquaculture facility. The production period varies from species to species and from region to region, depending on the market requirements for size and on the growth rates for the species, which is dependent on temperature, feed quality, and feed allocation. Most operations have a grow-out period of 4 to 18 months.

Preparation and Stocking

Freshwater Ponds

Ponds are most commonly constructed by excavating soils and using the spoils from excavation for the embankments. Soils that are suitable for earthen pond construction have the following characteristics: adequate clay content (clay slows down or may even eliminate seepage), low organic content, proper soil texture, and preferably alkaline pH. When producing at high densities, or during the early stages of fry or juveniles, ponds can be sealed with a plastic sheet or concrete, or production can take place in sealed raceways or tanks to facilitate cleaning.

Pens and Cages

Pen and cage systems involves the rearing of fish within fixed or floating net enclosures supported by rigid frameworks and set in sheltered, shallow portions of lakes, bays, rivers, estuaries, or the seacoast. Pens and cages are largely similar. Pens are anchored to the lake or sea bottom, which serves as the floor of the pen, while cages are suspended in the water, and can be either fixed or floating. Cages can typically be located in more exposed situations and in deeper water than pens. Fry may be grown to fingerling size in special nursery compartments and then released to pens or cages for grow-out, or fingerlings for stocking may be purchased from land-based facilities. In some cases, the stocking material may be wild caught.

Open Water Culture

Seaweed and mollusks are typically farmed in open marine waters. Structures (e.g. rafts, racks, or stakes) that provide a growth surface for the intended species are placed in suitable areas. Often the species to be grown settle by themselves on the structures, and the producer will only remove unwanted species and occasionally thin the stock. The aquaculture of other species, notably oysters, requires more active management and the spat or other juvenile stages are added to the structures for on-growing.

Start-Feeding

The early stages of fish and crustaceans production often demand a special feeding regimen, and the use of artificial feeds for these early stages can be problematic. During the initial feeding phase, organic and / or inorganic fertilizers (e.g. nitrogen and phosphorus) are often added to create an algal bloom. The algal bloom boosts primary productivity levels in the pond by generating a food source for microorganisms such as zooplankton, which are eaten by the fry or larvae of the organisms being cultivated. The algal bloom also prevents the establishment of aquatic plants. Veterinary drugs may be added at this stage to reduce the risk of disease or in response to actual outbreaks. A broad spectrum antibiotic is the most frequently used medication.

On-growing

After start-feeding, a transition toward on-growing takes place. The quality of the feed used can vary widely, depending on the species grown and / or the level of sophistication of the farm setup. A simple solution involves the use of minced fish meat prepared at the farm site and offered daily throughout the grow-out period. Intensive operations may exclusively use high-quality, pelletized, formulated feed throughout the production period.

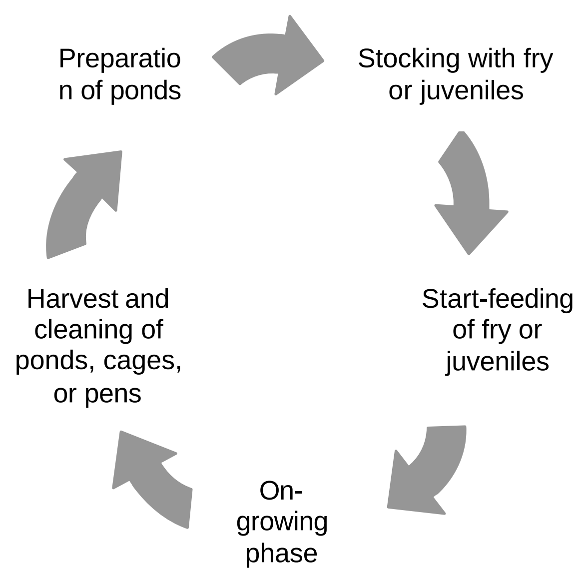
During feeding, the biomass will increase, resulting in increased oxygen consumption, and pond aerators (e.g. paddlewheels and diffusers) are often used to aerate the water. During the on-growing period, the stock are monitored regularly for disease and willingness to eat, allowing the pond manager to intervene (e.g. applying antibiotics and changing the pond water) if unsuitable conditions develop.

Harvesting and Cleaning

Once the stock has reached the desired size, they are harvested and marketed. Some species are sold live, and others are slaughtered before sale. In the latter situation, special facilities for slaughtering may be installed at the farm (e.g. to control the "blood water" resulting from harvest of the organisms). The slaughtered product is then iced and may be sent out for further processing off-site at a specialized fish processing plant, or sold fresh to local markets.[29]

After harvesting, the aquaculture effluent may be conveyed into a sedimentation basin before being discharged to the receiving water. After the pond has been emptied, the pond bottom is cleaned to remove the sediment of uneaten feed and feces. For intensive and semi-intensive systems, ponds are usually allowed to dry completely and are treated (e.g. with lime or pesticides) to control diseases, competing organisms, and predators before the next production cycle begins. In the case of cages and pens, fouling on the nets may be removed in a mechanical cleaning process, which is often followed by bathing the nets in chemicals to reduce settling on the nets in the grow-out period.

Figure A.1: Typical Production Cycle for an Aquaculture Facility



[29] Refer to the EHS Guidelines for Fish Processing for practical guidance on EHS issues in this sector.

Annex D. EHS Guidelines on Dairy Processing

Please see the following pages.

Environmental, Health, and Safety Guidelines for Aquaculture

Introduction

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

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

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

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

Applicability

The EHS Guidelines for Aquaculture provide information relevant to semi-intensive and intensive/super-intensive, commercial aquaculture production of the main aquatic species, including crustaceans, mollusks, seaweeds and finfish, located in developing countries in temperate and tropical regions. Annex A contains a full description of industry activities for this sector.

This document is organized according to the following sections:

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

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

1.0 Industry-Specific Impacts and Management

The following section provides a summary of EHS issues associated with aquaculture, along with recommendations for their management. Recommendations for the management of EHS issues common to most projects during the construction and decommissioning phases are provided in the **General EHS Guidelines**.

1.1 Environment

Environmental issues associated with the aquaculture sector primarily include the following:

- Threats to biodiversity
- Contamination of aquatic systems
- Hazardous Materials

Threats to Biodiversity

Threats to biodiversity are mainly associated with conversion of natural habitats during construction; potential release of alien species into the natural environment during operations; potential loss of genetic resources due to collection of larvae, fry, or juveniles for aquaculture production; potential release of artificially propagated seed into the wild (e.g. there are more farmed than wild Atlantic salmon in existence); sustainability of fish meal and fish oil ingredients for fish and crustacean feeds; and development of antibiotic resistance in pathogenic bacteria that can then spread from farms to wild stock.

Conversion of Natural Habitats

The construction and operational phases of the project cycle of an aquaculture facility may require conversion of the natural environment including, for example, the removal of mangroves for excavation of ponds, or alteration of the natural hydrology of lagoons, bays, rivers, or wetlands.[2] Operational phase issues may also include alteration of aquatic habitats and substrates (e.g. under sea cages or shellfish farms).

A range of management measures can be taken to prevent and reduce the environmental impacts caused by the construction of aquaculture facilities, as presented below. Further potential impacts are related to changes to stream hydrology caused by the construction of barriers to flow (e.g. dams may cause disruption of wetland areas and changes in stream morphology, potentially affecting migratory species, including birds, and nursery areas for juvenile fish). Measures should include all of the following:

- Survey the project area before land and water conversion to aquaculture production is undertaken to identify, categorize, and delineate natural and modified habitats and ascertain their biodiversity importance at the national or regional level;
- Ensure that the area to be converted to aquaculture use does not represent a habitat that is unique or protected (such as mangrove areas), or includes high biodiversity value, such as known sites of critically endangered or endangered species, or important wildlife breeding, feeding, and staging areas;
- Be aware of the presence of critically endangered or endangered species in the areas already used for aquaculture production, and implement management processes that take them into account;
- Design facilities so that as much as possible of the natural vegetation habitat is left intact (e.g. through the use of vegetated buffer zones and habitat corridors) and that

[2] Hydrological changes may also contribute to changes in the natural geochemistry such as the release of pyrite from formerly submerged soils of cleared mangrove areas. When pyrite comes into contact with oxygen, it creates acid sulfate soil, which in turn has potentially serious impacts on the health of the aquaculture organisms for many years to come.

conversion and degradation of the natural habitat is minimized;

- Design and implement mitigation measures to achieve no net loss of biodiversity where feasible, for instance through post-operation restoration of habitats; offset of losses through the creation of ecologically comparable area(s) managed for biodiversity; and compensation to direct users of biodiversity;
- Avoid the need to frequently abandon and replace improperly designed and built aquaculture ponds:
    - o Assess soil properties prior to pond construction to ensure that the bottom-sealing layer of the soil with percolation rates/porosity low enough to satisfactorily hold pond water. If there is not enough clay, then the ponds may demonstrate high seepage rates and require additional expenditure (e.g. pumping in water, or relining with clay-rich or possibly bentonite-rich topsoil from other sites) or eventual abandonment. High seepage rates can also pollute groundwater required for other purposes in the vicinity with use for drinking water a major concern.
    - o Assess the soil pH and the presence of pesticide and pollutant residues (especially on land that was previously used for intensive agriculture), as well as the natural occurrence of pyrite, prior to construction as the presence of anthropogenic or natural pollutants may hinder the viability of the pond.

Conversion of Agricultural Land - Salinization

If new land areas are not available for aquaculture, an alternative is to convert former agricultural land. If the selected production is based on brackish water, this may pose a risk of salinization of surrounding agricultural land. The following measures can be taken to avoid salinization of agricultural land:

- Ensure that the embankments around brackish water pond systems are high enough to form a physical division between agriculture and aquaculture;
- Ensure that the saline / brackish water discharges are appropriately treated and disposed of (e.g. through use of discharge canals) for the receiving waters;
- Ensure that appropriate discussions are held at the community level to avoid conflicts of interest when agricultural land is transferred to aquaculture production.

Introduction of Alien, Selectively Bred, or Genetically Engineered Species

Introductions can result in interactions with the wild, including escapes from farms, or open systems (such as mussel rafts). As such, introductions can disturb the existing ecological balance; cause loss of species biodiversity; cause loss of genetic diversity of the wild populations; reduce fitness of wild population through breeding with genetically altered escapees; and result in the transmission or spread of fish diseases. The widespread seeding of an alien genotype is of considerable concern both as regards species biodiversity and genetic biodiversity.

Management measures to reduce the risks from introductions of alien, selectively bred, or genetically modified species include the following:

- Application of codes and guidelines (see Section 3.0);
- Farming of sterile fish;
- Preventing the escape of species from pond-based aquaculture systems. Examples of common escape prevention measures include:
    - o Installation and maintenance of screens with a mesh that is small enough to prevent the entry and potential escape of aquatic species in the drainage channels connecting production ponds to sedimentation ponds,

as well as those connecting sedimentation ponds to the receiving water
  - Installation of fish-proof strainer dams
  - Installation and maintenance of gravel filtration on pond discharge structures
  - When necessary, consider chemical treatment of water released from hatcheries(e.g. with chlorine at acceptable concentrations for the receiving waters) to destroy escaping larvae or juveniles
  - Consider the hydrology of the region in the design of the pond system and ensure that the pond embankments are high enough to contain the pond water and prevent escape of the species during periods of heavy rainfall and potential flooding
  - Establish a contingency plan if there is an escape of the species being cultivated into the wild
- Preventing the escape of species from open water aquaculture systems. Examples of common escape prevention measures include:
  - Regularly inspect the cage and pen netting for holes(e.g. before crowding of the harvest and at intervals during the operation)
  - Design and construct cage and pen units, including choice of nets, to deal with the worst weather and environmental conditions likely to occur on the site
  - Provide for containment during periods of storm surges and excessively high tides
  - For cage culture in open waters, use submersible cages that can be submerged during storms below damaging wave action
  - Provide adequate marking of the fish farm system to warn navigators of the potential obstruction and reduce the risk of collision[3]
  - Establish a contingency plan for harvest of escapees of the species being cultivated into the wild.

Impacts of Harvesting on Ecosystem Functions

The practice of capturing females, eggs, fry, juveniles, or even fingerlings from the wild for the purpose of stocking aquaculture systems may threaten ecosystem biodiversity. Fry and larvae may be gathered from fresh or brackish water using very fine meshed nets resulting in considerable by-catch, as well as the removal of large number of larvae, fry, and juveniles from the food chain.[4] The recommended prevention of this type of ecosystem pressure is the breeding of stock material in captivity. However, for some species, careful harvesting of hatchlings/ and or fry (less than 3 cm) that are still at a stage of expected high mortality can result in relatively little impact on the overall population as compared to collecting larger fingerlings from a smaller population for grow-out.

Fish meal and fish oil

Fish meal and oil are derived from the capture and processing of wild pelagic fish stocks (e.g. anchovy, pilchard, herring, sardine, sand eel, sprat, and capelin). Although the production of fish meal and oil is not covered by these Guidelines, processed fishmeal and oil are the primary sources of protein and dietary lipids in fish feed for farmed fish in aquaculture operations. The aquaculture sector is an important consumer of fish meal and fish oil, and there are concerns regarding the sustainability of the pelagic fish stocks from which fish meal and fish oil are derived. Aquaculture operations should consider incorporating the use of alternatives to supplies of fish feed produced from fish meal and fish oil. Alternatives for fish feed ingredients may include use of plant material substitutes [e.g.

[3] Shetland Aquaculture (2006).

[4] Some jurisdictions have outlawed the larvae and fry collection or export although the practice still represents a source of income for the poor in some developing countries.

soya for bulk protein and single-cell protein (yeast for lysine and other amino acids)] and biotechnology options (e.g. bio-fermentation products).[5]

Source Water Quality

The quality of source water can also have a major effect on the viability of an aquaculture operation whether it is water used for hatchery and ponds systems or the water in which cages and pens are established. The water itself can affect the health of the organism as well as contribute to the accumulation of substances or pathogens toxic to consumers. Quality guidelines have been developed for aquaculture and vary depending upon the organism cultured.[6]

Contamination of Aquatic Systems

Aquaculture activities, particularly pond-based systems, may affect aquatic systems due to construction and operation activities, primarily the mobilization of soils and sediments during construction and through the release of effluents during operation. Fish cage culture can also be a major contributor to marine pollution in areas of high density use.

Soil Erosion and Sedimentation

Earth excavation and moving activities conducted during construction of some types of aquaculture projects may result in soil erosion and the subsequent sedimentation of nearby water bodies. Sedimentation of aquatic resources may contribute to eutrophication and overall degradation of water quality. Recommended management strategies include the following:

- Construct pond and canal levees with a 2:1 or 3:1 slope (based on soil type) as this adds stability to the pond banks, reduces erosion, and deters weeds. Avoid pond construction in areas that have a slope of more than 2 percent, as this will require energy-intensive construction and maintenance;
- Stabilize the embankments to prevent erosion;
- Reduce excavation and disturbance of acid sulfate soils during construction;
- Carry out construction work during the 'dry' season to reduce sediment runoff that may pollute adjacent waters;
- Install temporary silt fences during construction to slow down and catch any suspended sediments. Silt fences can be made of woven plastic or fabric, or hay bales.

Wastewater Discharges

Industrial Process Wastewater: The effluent released from aquaculture systems typically contains a high organic and nutrient load, suspended solids, and may also contain chemical residues including feed supplements and antibiotics. The possible impacts include contamination of groundwater and surface water from release of effluents or communication to receiving water from unconfined process and storage tanks (such as ponds and lagoons). Impacts on aquatic systems include creation of eutrophic zones within receiving waters, increased fluctuation of dissolved oxygen levels, creation of visible plumes, and accumulation of nutrients within the receiving waters.[7]

The high nutrient load results from efforts to artificially boost production levels by increasing the food supply for the cultured species. This is done by increasing nutrient availability either directly through supplemental feed or indirectly by fertilizing

[5] Further information is available from Use of Fishmeal and Fish Oil in Aquafeeds: Further Thoughts on the Fishmeal Trap, FAO (2001) Available at http://www.fao.org/docrep/005/y3781e/y3781e07.htm#bm07.3.3 and Assessment of the Sustainability of Industrial Fisheries Producing Fish Meal and Fish Oil, Royal Society for the Protection of Birds (2004) available at http://www.rspb.org.uk/Images/fishmeal_tcm5-58613.pdf

[6] Zweig, R. D., J. D. Morton and M. M Stewart.1999. Source Water Quality for Aquaculture: A Guide for Assessment. The World Bank. 62 pp.

[7] Department of Primary Industries and the Queensland Finfish Aquaculture Industry (1999).

ponds to increase primary productivity. Pond ecosystems have a limited capacity to recycle organic matter and nutrients, and increasing the stocking rate removes this capacity, resulting in the build-up of organic matter, nitrogenous waste, and phosphorus both in the water mass and on the bottom of the pond or pen / cage.[8] The suspended solids are derived from particulate organic matter and erosion of pond floor, walls, and discharge channels.

The chemical residues may include the remains of veterinary drugs (e.g. antibiotics) that may have been applied to the cultivated species, and toxic substances such as formalin and malachite green, a cancer causing agent, that may have been that are used to treat finfish for parasites and their eggs for fungal growth. Malachite green is banned in most countries and must not be used. Formalin should only be used under controlled conditions (e.g. in dipping containers) and with proper care – it should not be introduced directly into production systems.[9]

A range of measures can be taken in pond systems and pen / cage systems to (i) reduce the amount of contamination of the effluent; (ii) prevent pond effluent from entering surrounding water bodies; and (iii) treat the effluent before its release into the receiving waters to reduce contaminant levels. Aquaculture operations in large water bodies, however, are open to the surrounding environment and do not have the second or third options, therefore any contamination takes effect immediately.[10] The following management measures can prevent the contamination of effluent:

[8] Center for Tropical and Subtropical Aquaculture (2001).
[9] Because the use of these highly toxic substances is primarily an occupational health and safety issue, refer to the Occupational Health and Safety section for a more detailed review of their application and for practical guidance.
[10] Aquaculture is also somewhat self-regulating in that if the water is highly eutrophic or laden with dissolved or particulate nutrients or BOD, this will adversely affect many cultured organism and thus would be counterproductive not to manage it to a high quality level. This would somewhat reduce impacts of effluents.

Feed:

- Ensure that pellet feed has a minimum amount of "fines" or feed dust. Fines are not consumed and add to the nutrient load in the water;
- Match the pellet size to the species' life-cycle stage (e.g. smaller pellets should be fed to fry or juvenile animals to reduce the unconsumed fraction);
- Regularly monitor feed uptake to determine whether it is being consumed and adjust feeding rates accordingly. Feed may be wasted due to overfeeding or not feeding at the right time of day;
- Where feasible, use floating or extruded feed pellets as they allow for observation during feeding time;
- Store feed in cool, dry facilities and ideally for no longer than 30 days to avoid reduction in vitamin contents. Moldy feed should never be used as it may cause disease;
- Spread feed as evenly as possible throughout the culture system, ensuring that as many animals as possible have access to the feed. Some species are highly territorial, and uneaten feed adds to the nutrient load;
- Feed several times a day, especially when animals are young, allowing better access to food, better feed conversion ratios and less waste;
- Halt feeding at a suitable interval before harvest to eliminate the presence of food and / or fecal material in the animal's gut;
- During harvesting, contain and disinfect blood water and effluent to reduce the risk of disease spread and to contain effluent matter.

Other organic materials:

- Perform slaughter and processing in an area where the effluent is contained;
- Prevent effluent leakage from harvest rafts and bins by using harvest bins in good condition with sealed bin liners and secure lids and bindings;

- Equip off-loading bays with a waterproof apron and surround with a bund to contain potential spills and prevent contamination with effluent.[11]

Suspended solids:

- Avoid discharging waters from ponds while they are being harvested with nets, as this will add to the suspended solids in the effluent drainage;
- If feasible, use partial draining techniques to empty ponds that have been harvested. The last 10–15 percent of pond water contains the highest quantities of dissolved nutrients, suspended solids, and organic matter. After harvest, hold the remaining water in the pond for a number of days before discharge, or transfer to a separate treatment facility.

Fertilizers:

- Plan the rate and mode of application of fertilizers to maximize utilization and prevent over-application, taking into account predicted consumption rates;
- Increase the efficiency of application and dispersion through such practices as dilution of liquid fertilizers or solution of granulated fertilizers prior to application. Other options include the use of powdered fertilizers or the placement of powdered fertilizer bags in shallow water to allow solution and dispersion;
- Consider the use of time-released fertilizer in which resin coated granules release nutrients into the pond water, with the rate of release corresponding to water temperature and movement;
- Avoid the use of fertilizers containing ammonia or ammonium in water with pH of 8 or above to avoid the formation of toxic unionized ammonia (NH_3);[12]
- Depending on the system (e.g., freshwater aquaculture), grow organic fertilizer (e.g. natural grass) in the pond basin after harvest;
- Initiate pond fertilization only in static ponds with no pond water overflow that can impact downstream waters and watersheds;
- Conduct pond fertilization to avoid or minimize consequences of potential runoff due to floods or heavy rain and avoid application to overflowing ponds.

Chemicals:

- Design the pond depth to reduce the need for chemical control of aquatic weeds and reduce thermal stratification;
- Do not use antifoulants to treat cages and pens. The chemically active substances used in antifouling agents are very poisonous and highly stable in an aquatic environment. Clean nets manually or in a net washing machine.

The following management measures can be taken in pond-based systems to prevent pond effluent from entering surrounding water bodies:

- In some fish systems, avoid automatic drainage of ponds at the end of the production cycle as the same pond water may be used to cultivate several crop rotations of certain species (e.g. catfish);[13]
- Reuse water from harvested ponds by pumping it into adjacent ponds to help complement their primary productivity, provided that the level of BOD is controlled; This process is called "bloom seeding," and requires careful timing of harvests;
- Consider the hydrology of the region in the design of the pond system and ensure that the pond embankments are

[11] Shetland Aquaculture (2006).
[12] WRAC (2000).
[13] Not applicable to shrimp farming which requires the drying out of pond bottoms between harvests.

high enough to contain the pond water and prevent loss of effluent during periods of increased rainfall and potential flooding.

Process Wastewater Treatment: Techniques for treating industrial process wastewater in this sector include grease traps, skimmers or oil water separators for separation of floatable solids; flow and load equalization; sedimentation for suspended solids reduction using clarifiers or settling ponds; biological treatment, typically aerobic treatment, for reduction of soluble organic matter (BOD); biological nutrient removal for reduction in nitrogen and phosphorus; chlorination of effluent when disinfection is required; dewatering and disposal of residuals; in some instances composting or land application of wastewater treatment residuals of acceptable quality may be possible. Additional engineering controls may be required (i) for removal of residual feed supplements, chemicals, antibiotics, etc. which may pass through the wastewater treatment system, and (ii) to contain and neutralize nuisance odors. For sea water applications, unit operations for wastewater treatment may have to be suitably adapted to the relatively high salinity of the water.

Management of industrial wastewater and examples of treatment approaches are discussed in the **General EHS Guidelines**. Through use of these technologies and good practice techniques for wastewater management, facilities should meet the Guideline Values for wastewater discharge as indicated in the relevant table of Section 2 of this industry sector document.

Other Wastewater Streams & Water Consumption: Guidance on the management of non-contaminated wastewater from utility operations, non-contaminated stormwater, and sanitary sewage is provided in the **General EHS Guidelines**. Contaminated streams should be routed to the treatment system for industrial process wastewater. Recommendations to reduce water consumption, especially where it may be a limited natural resource, are provided in the **General EHS Guidelines**.

Hazardous Materials

The aquaculture sector may involve the handling and use of hazardous materials (e.g. oil, fertilizers, and other chemicals). Recommendations for the safe storage, handling, and use of hazardous materials, including guidance on oil spills and containment, is provided in the **General EHS Guidelines**.

1.2 Occupational Health and Safety

As a general approach, health and safety management planning should include the adoption of a systematic and structured approach for prevention and control of physical, chemical, biological, and radiological health and safety hazards described in the **General EHS Guidelines**. Occupational health and safety hazards related to the daily operations of the aquaculture sector can be grouped into two categories:

- Physical hazards
- Exposure to chemicals
- Exposure to water borne disease

Physical hazards

A number of hazards are connected with the daily working routines in aquaculture, including heavy lifts, electric shock, and drowning.

Heavy Lifts

A number of activities involving heavy lifts are carried out during daily operations (e.g. refilling automatic feeders in the ponds and grading the fish). The following management measures can be taken to reduce exposure of personnel to injuries as a result of heavy lifts:

- Use mechanical and / or automated equipment to facilitate lifts heavier than 25 kg;

- Design workstations that can be adapted to individual workers, especially if fish are processed post-harvest;
- Construct ponds that are rectangular in shape to facilitate harvesting. If ponds are of sufficient size, and the embankments are at least 2.5 meters wide, vehicles can be used on the embankments to drag harvest seines.

Electric Shock

Electrical devices typically used in aquaculture include manifold and cover water pumps, paddlewheels, and lighting installations. The risk of electrical shock is therefore present during all operations in which the workers are in contact with the water. Measures to reduce the risk of electric shock include:

- Waterproof all electrical installations;
- Ensure that fuses are used and that there is an appropriate connection to the ground;
- Ensure that all cables are intact, waterproof, and without connection;
- Provide training in the correct handling of electric equipment (e.g. pumps and) to avoid the risk of short circuits;
- Employ lock out / tag out procedures.

Drowning

The risk of drowning is present in almost all aquaculture operations and, especially, in cage aquaculture at sea. Management measures to reduce the risk of drowning among workers and site visitors include the following:

- Provide lifejackets and harnesses with safety clips (karabiners) that lock on to lines or fixed points;
- Ensure that personnel are experienced swimmers;
- Train personnel in safety at sea, including procedures for supervision of personnel;
- Require that personnel wear lifejackets at all times on exposed sites and at sea;
- Where large vessels are used to transport personnel and equipment to marine sites, ensure that the vessel can be securely berthed on the pontoons, reducing the risk of falling into the gap between the vessel and the pontoon.

Exposure to Chemicals

A variety of chemicals may be used in the operation of an aquaculture facility to treat and / or control disease organisms or to facilitate production (e.g. lime, diluted chlorine, or salt). Fertilizers are also generally caustic materials and care should be taken in their application. Recommended guidance for the management of occupational chemical exposure is discussed in the **General EHS Guidelines**.

Water-borne Disease

Workers may be directly or indirectly exposed to water-borne diseases due to frequent contact with water (ponds) and the close proximity of living quarters to surface water bodies. The potential for transmission of water-borne disease should be addressed as part of the occupational health and safety program including specific additional medical screening for the labor force and implementation of preventive measures (e.g. mosquito nets in living quarters). Additional guidance on the prevention and control of communicable diseases is provided in the **General EHS Guidelines**.

1.3 Community Health and Safety

Community health and safety hazards arising from aquaculture operations include the following:

- Salinization of neighboring agricultural land;
- Effects on water resources;
- Food safety impacts and management

- Physical hazards

Effects on Water Resources

Water resources used in aquaculture may include the sea, estuaries, rivers, lakes, and groundwater. The extraction of water from these resources may result in changes to the natural water regime, potentially affecting fish stocks and commercial / recreational activities (e.g. fisheries and recreational activities downstream of the extraction point), or the availability and quality of groundwater. Water management strategies should target the maintenance of hydrologic conditions which provide water quality and quantity consistent with community needs and uses; and, in the case of coastal facilities, prevent salt water intrusion from affecting drinking and agricultural water supplies.

Aquaculture operations may act as breeding grounds for different insects, especially the mosquito and tsetse fly, thus increasing the risk of insect-borne disease among communities in the region. Operators should plan site design and operation to prevent and control these potential impacts. Additional information is provided in the Disease Prevention section of the **General EHS Guidelines**.

Food Safety Impacts and Management

Development of Resistance to Veterinary Drugs

The main veterinary drugs used in aquaculture are antibiotics, which are employed to prevent and treat bacterial diseases. Antibiotics are generally administered in feed, having either been added during manufacture or surface-coated onto the pellets by the manufacturer or the farmer. The development of antibiotic resistance by pathogenic bacteria may arise when bacteria acquire resistance to one or more of the antibiotics to which they were formerly susceptible. That resistance eventually makes the antibiotics ineffective in treating specific microbial diseases in humans.[14] In addition, when antibiotics are unintentionally consumed as residues in food, the amount ingested cannot be quantified or monitored and may cause direct health concerns (e.g. aplastic anemia), posing a serious risk to human health. This can also occur with integrated fish farming systems where antibiotic residues, from livestock manures used for fertilizer, can be introduced to fishpond culture.

Recognition of the risks brought about by consumption of veterinary drugs has led to the banning of certain antibiotics in aquaculture production and the establishment of maximum residue limits (MRLs)[15] for those with known risks. Observance of MRLs is required by law under some national jurisdictions and is encouraged elsewhere.[16] Use of resistant strains should be encouraged and good farm practices to maintain healthy fish stocks promoted.

The following actions can be taken to limit the use of antibiotics:

- Vaccination should be adopted where possible as a way of limiting the use of antibiotics;
- Where appropriate, aquaculture facilities should fallow sites on an annual basis as part of a strategy to manage pathogens in pen production units. The minimum fallow period should be four weeks at the end of each cycle;
- Facilities involved in aquaculture production should use a veterinary service on a frequent basis to review and assess the health of the stock and employees' competence and training. With the assistance of the veterinary service,

[14] FAO (2002b).

[15] Annex IV of Regulation 2377/90/EEC lists nine substances that may not be used in food-producing species because no safe level of residue can be determined: chloramphenicol, chloroform, chlorpromazine, colchicine, dapsone, dimetridazole, metronidazole, nitrofurans (including furazolidone), and ronidazole.

[16] The *Codex Alimentarius* contains maximum residue limits (MRLs) for veterinary drug residues in all major food products, including salmon and giant prawn. A simple MRL database is provided by FAO/WHO at the following Web site: http://www.codexalimentarius.net/mrls/vetdrugs/jsp/vetd_q-e.jsp

facilities should develop a Veterinary Health Plan to include the following aspects:[17]

- Summary of major diseases present and potentially present;
- Disease prevention strategies;
- Treatments to be administered for regularly encountered conditions;
- Recommended vaccination protocols;
- Recommended parasite controls;
- Medication recommendations for feed or water.

If antibiotics are recommended, the following measures should be considered:

- Apply approved over-the-counter antibiotics in strict accordance with the manufacturer's instructions to ensure responsible use;
- Apply approved antibiotics that are purchased and utilized by prescription under the guidance of a qualified professional;
- Develop a contingency plan covering how antibiotics should be applied following the identification of disease outbreaks;
- Store antibiotics in their original packaging, in a dedicated location that:
  - Can be locked, is properly identified with signs, and limits access to authorized persons
  - Can contain spills and avoid uncontrolled release of antibiotics into the surrounding environment
  - Provides for storage of containers on pallets or other platforms to facilitate the visual detection of leaks
- Avoid stockpiles of waste antibiotics by adopting a "first-in, first-out" principle so that they do not exceed their expiration date. Any expired antibiotics should be disposed of in compliance with national regulations.

[17] For more information, see EUREPGAP guidance on integrated aquaculture assurance at: http://www.eurepgap.org/fish/Languages/English/index_html

Physical Hazards

Communities may be exposed to a number of physical hazards, including drowning, associated with the presence of pond systems or other project infrastructure in proximity or in between community areas, requiring frequent crossing and physical interaction. Community use should be taken into consideration in the design of access routes, for example by providing wide enough walking areas with fall protection along potentially hazardous locations.

2.0 Performance Indicators and Monitoring

2.1 Environment

Table 1 presents effluent guidelines for this sector. Guideline values for process emissions and effluents in this sector are indicative of good international industry practice as reflected in relevant standards of countries with recognized regulatory frameworks. These guidelines are achievable under normal operating conditions in appropriately designed and operated facilities through the application of pollution prevention and control techniques discussed in the preceding sections of this document. These levels should be achieved, without dilution, at least 95 percent of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours. Deviation from these levels in consideration of specific, local project conditions should be justified in the environmental assessment.

Emissions guidelines are applicable to process emissions. Combustion source emissions guidelines associated with steam- and power-generation activities from sources with a capacity equal to or lower than 50 MWth are addressed in the

General EHS Guidelines with larger power source emissions addressed in the **EHS Guidelines for Thermal Power**. Guidance on ambient considerations based on the total load of emissions is provided in the **General EHS Guidelines**.

Effluent guidelines are applicable for direct discharges of treated effluents to surface waters for general use. Site-specific discharge levels may be established based on the availability and conditions in use of publicly operated sewage collection and treatment systems or, if discharged directly to surface waters, on the receiving water use classification as described in the **General EHS Guidelines**.

Table 1. Effluent levels for aquaculture

Pollutants	Units	Guideline Value
pH	pH	6 – 9
BOD_5	mg/l	50
COD	mg/l	250
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Temperature increase	°C	<3[b]
Total coliform bacteria	MPN[a] / 100 ml	400
Active Ingredients / Antibiotics	To be determined on a case specific basis	

Notes:
[a] MPN = Most Probable Number
[b] At the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity

Environmental Monitoring

Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the particular project. Monitoring frequency should be sufficient to provide representative data for the parameter being monitored. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Additional guidance on applicable sampling and analytical methods for emissions and effluents is provided in the **General EHS Guidelines**.

2.2 Occupational Health and Safety

Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, of which examples include the Threshold Limit Value (TLV®) occupational exposure guidelines and Biological Exposure Indices (BEIs®) published by American Conference of Governmental Industrial Hygienists (ACGIH),[18] the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),[19] Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),[20] Indicative Occupational Exposure Limit Values published by European Union member states,[21] or other similar sources.

Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to

[18] Available at: http://www.acgih.org/TLV/ and http://www.acgih.org/store/
[19] Available at: http://www.cdc.gov/niosh/npg/
[20] Available at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992
[21] Available at: http://europe.osha.eu.int/good_practice/risks/ds/oel/

a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources (e.g. US Bureau of Labor Statistics and UK Health and Safety Executive)[22].

Occupational Health and Safety Monitoring

The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals as part of an occupational health and safety monitoring program.[23] Facilities should also maintain a record of occupational accidents, diseases, and dangerous occurrences and other kinds of accident. Additional guidance on occupational health and safety monitoring programs is provided in the **General EHS Guidelines**.

[22] Available at: http://www.bls.gov/iif/ and http://www.hse.gov.uk/statistics/index.htm
[23] Accredited professionals may include certified industrial hygienists, registered occupational hygienists, or certified safety professionals or their equivalent.

3.0 References and Additional Sources

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Annex A: General Description of Industry Activities

The aquaculture sector is very diverse, in terms of products and production methods, as detailed in Table A-1.

Extensive systems[24] use low stocking densities and no supplemental feeding. Extensive systems may use man-made ponds or, more often, existing natural structures (e.g. lakes or lagoons) that are typically large (>2 ha). Semi-intensive systems[25] (approximately 2 to 20 tons/ha/yr) use higher stocking densities, supplemental feeding, and additional management (such as water changes) and typically utilize man-made ponds, pens, or cages. Some semi-intensive systems, especially polycultures, utilize natural lakes (e.g. filter feeders and omnivorous fish can be cultured in cages in shrimp or prawn ponds).[26]

Intensive systems[27] use maximum stocking densities and are dependent on a mixture of natural and formulated feeds. Semi-intensive and intensive systems typically use small pond compartments of up to 1 ha for ease of management. Site selection for the aquaculture facility is often the most important issue related to environmental health and safety. Criteria for site selection include water supply and quality; soil quality; protection from natural hazards; and accessibility to inputs, including markets and labor.[28] An aquaculture facility requires a steady supply of water in adequate quantities throughout the year. Water supply should be pollution-free and have a stable and suitable pH, adequate dissolved oxygen, and low turbidity. Some producers may treat the intake water to remove unwanted substances, for example, using a filter to remove potential predators. In addition, aquaculture farms should not be located close to each other, as this could increase the risk of disease transfer and may have a detrimental effect on the water quality of the intake water.

Table A-1. Diversity of Aquaculture Production Methodologies

Resource	System	Installations
Water (fresh, brackish, or marine)	Stillwater	Ponds and lakes
	Flow-through	Ponds, raceways, tanks (land-based) Cages (lake and sea based) Large offshore units (sea based)
	Re-use or recirculation	Tanks and land-based ponds
Nutrition	Extensive (No feed)	Ponds (land-based) Substrate - shellfish (sea-based) Substrate - seaweeds (sea-based)
	Semi-intensive systems (Supplemental feeding and/or fertilizer)	Ponds (land-based) Raceways (land-based)
	Intensive systems (Feed)	Ponds (land-based) Cages (lake and sea based) Raceways (land and sea-based) Silos and tanks (land-based)
Species	Monoculture	Animals (ponds and tanks, cages/pens in lakes or sea) Plants (ponds and tanks, cages/pens in lakes or sea)
	Polyculture	Animals (fish species)

24 Production system characterized by (i) a low degree of control (e.g. of environment, nutrition, predators, competitors, disease agents); (ii) low initial costs, low-level technology, and low production efficiency (yielding no more than 500 kg/ha/yr); (iii) high dependence on local climate and water quality; use of natural water bodies (e.g. lagoons, bays, embayments) and of natural often unspecified food organisms.]

25 System of culture characterized by a production of 0.5-5 tons/ha/yr, possibly supplementary feeding with low-grade feeds, stocking with wild-caught or hatchery-reared fry, regular use of organic or inorganic fertilizers, rain or tidal water supply and/or some water exchange, simple monitoring of water quality, and normally in traditional or improved ponds; also some cage systems e.g. with zooplankton feeding for fry.

26 Center for Tropical and Subtropical Aquaculture (2001). Other polyculture systems are practiced in Asia, primarily carp in association with duckeries and piggeries and the growth of crops on pond embankments.

27 Systems of culture characterized by a production of 2 to 20 tons/ha/yr, which are dependent largely on natural food, which is augmented by fertilization or complemented by use of supplementary feed, stocking with hatchery-reared fry, regular use of fertilizers, some water exchange or aeration, often pumped or gravity supplied water, and normally in improved ponds, some enclosures, or simple cage systems.

28 Food and Agriculture Organization of the United Nations (FAO), 1989, ADCP/REP/89/43, Aquaculture Systems and Practices: A Selected Review. http://www.fao.org/docrep/T8598E/t8598e00.HTM.

The site should have soils adequate for the intended structures (e.g. clay-loam or sandy-clay soil for ponds, and firm bottom mud for pens) to allow the structure to be driven deep into substrate for better support. Aquaculture facilities should be protected from high wind, waves, and tides; excessive storm water runoff; predators; and other natural hazards. Moderate tides, however, may help to ensure adequate water exchange through ponds, pens, and cages.

Figure A-1 presents the typical production cycle for an aquaculture facility. The production period varies from species to species and from region to region, depending on the market requirements for size and on the growth rates for the species, which is dependent on temperature, feed quality, and feed allocation. Most operations have a grow-out period of 4 to 18 months.

Preparation and Stocking

Freshwater Ponds

Ponds are most commonly constructed by excavating soils and using the spoils from excavation for the embankments. Soils that are suitable for earthen pond construction have the following characteristics: adequate clay content (clay slows down or may even eliminate seepage), low organic content, proper soil texture, and preferably alkaline pH. When producing at high densities, or during the early stages of fry or juveniles, ponds can be sealed with a plastic sheet or concrete, or production can take place in sealed raceways or tanks to facilitate cleaning.

Pens and Cages

Pen and cage systems involves the rearing of fish within fixed or floating net enclosures supported by rigid frameworks and set in sheltered, shallow portions of lakes, bays, rivers, estuaries, or the seacoast. Pens and cages are largely similar. Pens are anchored to the lake or sea bottom, which serves as the floor of the pen, while cages are suspended in the water, and can be either fixed or floating. Cages can typically be located in more exposed situations and in deeper water than pens. Fry may be grown to fingerling size in special nursery compartments and then released to pens or cages for grow-out, or fingerlings for stocking may be purchased from land-based facilities. In some cases, the stocking material may be wild caught.

Open Water Culture

Seaweed and mollusks are typically farmed in open marine waters. Structures (e.g. rafts, racks, or stakes) that provide a growth surface for the intended species are placed in suitable areas. Often the species to be grown settle by themselves on the structures, and the producer will only remove unwanted species and occasionally thin the stock. The aquaculture of other species, notably oysters, requires more active management and the spat or other juvenile stages are added to the structures for on-growing.

Start-Feeding

The early stages of fish and crustaceans production often demand a special feeding regimen, and the use of artificial feeds for these early stages can be problematic. During the initial feeding phase, organic and / or inorganic fertilizers (e.g. nitrogen and phosphorus) are often added to create an algal bloom. The algal bloom boosts primary productivity levels in the pond by generating a food source for microorganisms such as zooplankton, which are eaten by the fry or larvae of the organisms being cultivated. The algal bloom also prevents the establishment of aquatic plants. Veterinary drugs may be added at this stage to reduce the risk of disease or in response to actual outbreaks. A broad spectrum antibiotic is the most frequently used medication.

On-growing

After start-feeding, a transition toward on-growing takes place. The quality of the feed used can vary widely, depending on the species grown and / or the level of sophistication of the farm setup. A simple solution involves the use of minced fish meat prepared at the farm site and offered daily throughout the grow-out period. Intensive operations may exclusively use high-quality, pelletized, formulated feed throughout the production period.

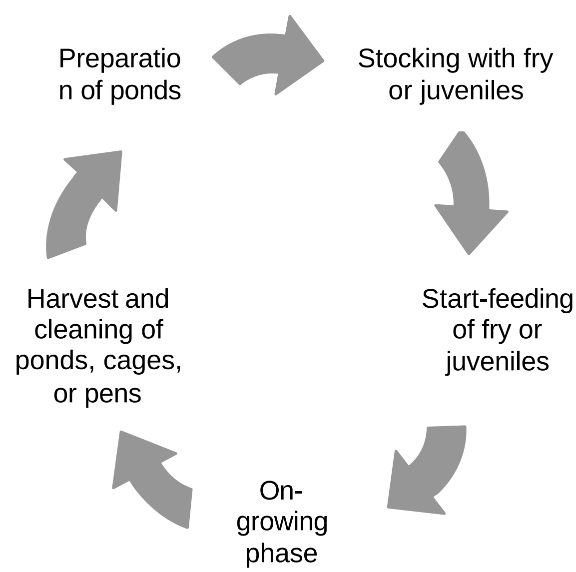
During feeding, the biomass will increase, resulting in increased oxygen consumption, and pond aerators (e.g. paddlewheels and diffusers) are often used to aerate the water. During the on-growing period, the stock are monitored regularly for disease and willingness to eat, allowing the pond manager to intervene (e.g. applying antibiotics and changing the pond water) if unsuitable conditions develop.

Harvesting and Cleaning

Once the stock has reached the desired size, they are harvested and marketed. Some species are sold live, and others are slaughtered before sale. In the latter situation, special facilities for slaughtering may be installed at the farm (e.g. to control the "blood water" resulting from harvest of the organisms). The slaughtered product is then iced and may be sent out for further processing off-site at a specialized fish processing plant, or sold fresh to local markets.[29]

After harvesting, the aquaculture effluent may be conveyed into a sedimentation basin before being discharged to the receiving water. After the pond has been emptied, the pond bottom is cleaned to remove the sediment of uneaten feed and feces. For intensive and semi-intensive systems, ponds are usually allowed to dry completely and are treated (e.g. with lime or pesticides) to control diseases, competing organisms, and predators before the next production cycle begins. In the case of cages and pens, fouling on the nets may be removed in a mechanical cleaning process, which is often followed by bathing the nets in chemicals to reduce settling on the nets in the grow-out period.

Figure A.1: Typical Production Cycle for an Aquaculture Facility



[29] Refer to the EHS Guidelines for Fish Processing for practical guidance on EHS issues in this sector.

Annex E. EHS Guidelines on Annual Crops

Please see the following pages.

Environmental, Health, and Safety Guidelines for Aquaculture

Introduction

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

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

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

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

Applicability

The EHS Guidelines for Aquaculture provide information relevant to semi-intensive and intensive/super-intensive, commercial aquaculture production of the main aquatic species, including crustaceans, mollusks, seaweeds and finfish, located in developing countries in temperate and tropical regions. Annex A contains a full description of industry activities for this sector.

This document is organized according to the following sections:

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

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

1.0 Industry-Specific Impacts and Management

The following section provides a summary of EHS issues associated with aquaculture, along with recommendations for their management. Recommendations for the management of EHS issues common to most projects during the construction and decommissioning phases are provided in the **General EHS Guidelines**.

1.1 Environment

Environmental issues associated with the aquaculture sector primarily include the following:

- Threats to biodiversity
- Contamination of aquatic systems
- Hazardous Materials

Threats to Biodiversity

Threats to biodiversity are mainly associated with conversion of natural habitats during construction; potential release of alien species into the natural environment during operations; potential loss of genetic resources due to collection of larvae, fry, or juveniles for aquaculture production; potential release of artificially propagated seed into the wild (e.g. there are more farmed than wild Atlantic salmon in existence); sustainability of fish meal and fish oil ingredients for fish and crustacean feeds; and development of antibiotic resistance in pathogenic bacteria that can then spread from farms to wild stock.

Conversion of Natural Habitats

The construction and operational phases of the project cycle of an aquaculture facility may require conversion of the natural environment including, for example, the removal of mangroves for excavation of ponds, or alteration of the natural hydrology of lagoons, bays, rivers, or wetlands.[2] Operational phase issues may also include alteration of aquatic habitats and substrates (e.g. under sea cages or shellfish farms).

A range of management measures can be taken to prevent and reduce the environmental impacts caused by the construction of aquaculture facilities, as presented below. Further potential impacts are related to changes to stream hydrology caused by the construction of barriers to flow (e.g. dams may cause disruption of wetland areas and changes in stream morphology, potentially affecting migratory species, including birds, and nursery areas for juvenile fish). Measures should include all of the following:

- Survey the project area before land and water conversion to aquaculture production is undertaken to identify, categorize, and delineate natural and modified habitats and ascertain their biodiversity importance at the national or regional level;
- Ensure that the area to be converted to aquaculture use does not represent a habitat that is unique or protected (such as mangrove areas), or includes high biodiversity value, such as known sites of critically endangered or endangered species, or important wildlife breeding, feeding, and staging areas;
- Be aware of the presence of critically endangered or endangered species in the areas already used for aquaculture production, and implement management processes that take them into account;
- Design facilities so that as much as possible of the natural vegetation habitat is left intact (e.g. through the use of vegetated buffer zones and habitat corridors) and that

[2] Hydrological changes may also contribute to changes in the natural geochemistry such as the release of pyrite from formerly submerged soils of cleared mangrove areas. When pyrite comes into contact with oxygen, it creates acid sulfate soil, which in turn has potentially serious impacts on the health of the aquaculture organisms for many years to come.

conversion and degradation of the natural habitat is minimized;

- Design and implement mitigation measures to achieve no net loss of biodiversity where feasible, for instance through post-operation restoration of habitats; offset of losses through the creation of ecologically comparable area(s) managed for biodiversity; and compensation to direct users of biodiversity;
- Avoid the need to frequently abandon and replace improperly designed and built aquaculture ponds:
    - o Assess soil properties prior to pond construction to ensure that the bottom-sealing layer of the soil with percolation rates/porosity low enough to satisfactorily hold pond water. If there is not enough clay, then the ponds may demonstrate high seepage rates and require additional expenditure (e.g. pumping in water, or relining with clay-rich or possibly bentonite-rich topsoil from other sites) or eventual abandonment. High seepage rates can also pollute groundwater required for other purposes in the vicinity with use for drinking water a major concern.
    - o Assess the soil pH and the presence of pesticide and pollutant residues (especially on land that was previously used for intensive agriculture), as well as the natural occurrence of pyrite, prior to construction as the presence of anthropogenic or natural pollutants may hinder the viability of the pond.

Conversion of Agricultural Land - Salinization

If new land areas are not available for aquaculture, an alternative is to convert former agricultural land. If the selected production is based on brackish water, this may pose a risk of salinization of surrounding agricultural land. The following measures can be taken to avoid salinization of agricultural land:

- Ensure that the embankments around brackish water pond systems are high enough to form a physical division between agriculture and aquaculture;
- Ensure that the saline / brackish water discharges are appropriately treated and disposed of (e.g. through use of discharge canals) for the receiving waters;
- Ensure that appropriate discussions are held at the community level to avoid conflicts of interest when agricultural land is transferred to aquaculture production.

Introduction of Alien, Selectively Bred, or Genetically Engineered Species

Introductions can result in interactions with the wild, including escapes from farms, or open systems (such as mussel rafts). As such, introductions can disturb the existing ecological balance; cause loss of species biodiversity; cause loss of genetic diversity of the wild populations; reduce fitness of wild population through breeding with genetically altered escapees; and result in the transmission or spread of fish diseases. The widespread seeding of an alien genotype is of considerable concern both as regards species biodiversity and genetic biodiversity.

Management measures to reduce the risks from introductions of alien, selectively bred, or genetically modified species include the following:

- Application of codes and guidelines (see Section 3.0);
- Farming of sterile fish;
- Preventing the escape of species from pond-based aquaculture systems. Examples of common escape prevention measures include:
    - o Installation and maintenance of screens with a mesh that is small enough to prevent the entry and potential escape of aquatic species in the drainage channels connecting production ponds to sedimentation ponds,

as well as those connecting sedimentation ponds to the receiving water
  - Installation of fish-proof strainer dams
  - Installation and maintenance of gravel filtration on pond discharge structures
  - When necessary, consider chemical treatment of water released from hatcheries(e.g. with chlorine at acceptable concentrations for the receiving waters) to destroy escaping larvae or juveniles
  - Consider the hydrology of the region in the design of the pond system and ensure that the pond embankments are high enough to contain the pond water and prevent escape of the species during periods of heavy rainfall and potential flooding
  - Establish a contingency plan if there is an escape of the species being cultivated into the wild
- Preventing the escape of species from open water aquaculture systems. Examples of common escape prevention measures include:
  - Regularly inspect the cage and pen netting for holes(e.g. before crowding of the harvest and at intervals during the operation)
  - Design and construct cage and pen units, including choice of nets, to deal with the worst weather and environmental conditions likely to occur on the site
  - Provide for containment during periods of storm surges and excessively high tides
  - For cage culture in open waters, use submersible cages that can be submerged during storms below damaging wave action
  - Provide adequate marking of the fish farm system to warn navigators of the potential obstruction and reduce the risk of collision[3]
  - Establish a contingency plan for harvest of escapees of the species being cultivated into the wild.

Impacts of Harvesting on Ecosystem Functions

The practice of capturing females, eggs, fry, juveniles, or even fingerlings from the wild for the purpose of stocking aquaculture systems may threaten ecosystem biodiversity. Fry and larvae may be gathered from fresh or brackish water using very fine meshed nets resulting in considerable by-catch, as well as the removal of large number of larvae, fry, and juveniles from the food chain.[4] The recommended prevention of this type of ecosystem pressure is the breeding of stock material in captivity. However, for some species, careful harvesting of hatchlings/ and or fry (less than 3 cm) that are still at a stage of expected high mortality can result in relatively little impact on the overall population as compared to collecting larger fingerlings from a smaller population for grow-out.

Fish meal and fish oil

Fish meal and oil are derived from the capture and processing of wild pelagic fish stocks (e.g. anchovy, pilchard, herring, sardine, sand eel, sprat, and capelin). Although the production of fish meal and oil is not covered by these Guidelines, processed fishmeal and oil are the primary sources of protein and dietary lipids in fish feed for farmed fish in aquaculture operations. The aquaculture sector is an important consumer of fish meal and fish oil, and there are concerns regarding the sustainability of the pelagic fish stocks from which fish meal and fish oil are derived. Aquaculture operations should consider incorporating the use of alternatives to supplies of fish feed produced from fish meal and fish oil. Alternatives for fish feed ingredients may include use of plant material substitutes [e.g.

[3] Shetland Aquaculture (2006).

[4] Some jurisdictions have outlawed the larvae and fry collection or export although the practice still represents a source of income for the poor in some developing countries.

soya for bulk protein and single-cell protein (yeast for lysine and other amino acids)] and biotechnology options (e.g. bio-fermentation products).[5]

Source Water Quality

The quality of source water can also have a major effect on the viability of an aquaculture operation whether it is water used for hatchery and ponds systems or the water in which cages and pens are established. The water itself can affect the health of the organism as well as contribute to the accumulation of substances or pathogens toxic to consumers. Quality guidelines have been developed for aquaculture and vary depending upon the organism cultured.[6]

Contamination of Aquatic Systems

Aquaculture activities, particularly pond-based systems, may affect aquatic systems due to construction and operation activities, primarily the mobilization of soils and sediments during construction and through the release of effluents during operation. Fish cage culture can also be a major contributor to marine pollution in areas of high density use.

Soil Erosion and Sedimentation

Earth excavation and moving activities conducted during construction of some types of aquaculture projects may result in soil erosion and the subsequent sedimentation of nearby water bodies. Sedimentation of aquatic resources may contribute to eutrophication and overall degradation of water quality. Recommended management strategies include the following:

- Construct pond and canal levees with a 2:1 or 3:1 slope (based on soil type) as this adds stability to the pond banks, reduces erosion, and deters weeds. Avoid pond construction in areas that have a slope of more than 2 percent, as this will require energy-intensive construction and maintenance;
- Stabilize the embankments to prevent erosion;
- Reduce excavation and disturbance of acid sulfate soils during construction;
- Carry out construction work during the 'dry' season to reduce sediment runoff that may pollute adjacent waters;
- Install temporary silt fences during construction to slow down and catch any suspended sediments. Silt fences can be made of woven plastic or fabric, or hay bales.

Wastewater Discharges

Industrial Process Wastewater: The effluent released from aquaculture systems typically contains a high organic and nutrient load, suspended solids, and may also contain chemical residues including feed supplements and antibiotics. The possible impacts include contamination of groundwater and surface water from release of effluents or communication to receiving water from unconfined process and storage tanks (such as ponds and lagoons). Impacts on aquatic systems include creation of eutrophic zones within receiving waters, increased fluctuation of dissolved oxygen levels, creation of visible plumes, and accumulation of nutrients within the receiving waters.[7]

The high nutrient load results from efforts to artificially boost production levels by increasing the food supply for the cultured species. This is done by increasing nutrient availability either directly through supplemental feed or indirectly by fertilizing

[5] Further information is available from Use of Fishmeal and Fish Oil in Aquafeeds: Further Thoughts on the Fishmeal Trap, FAO (2001) Available at http://www.fao.org/docrep/005/y3781e/y3781e07.htm#bm07.3.3 and Assessment of the Sustainability of Industrial Fisheries Producing Fish Meal and Fish Oil, Royal Society for the Protection of Birds (2004) available at http://www.rspb.org.uk/Images/fishmeal_tcm5-58613.pdf

[6] Zweig, R. D., J. D. Morton and M. M Stewart.1999. Source Water Quality for Aquaculture: A Guide for Assessment. The World Bank. 62 pp.

[7] Department of Primary Industries and the Queensland Finfish Aquaculture Industry (1999).

ponds to increase primary productivity. Pond ecosystems have a limited capacity to recycle organic matter and nutrients, and increasing the stocking rate removes this capacity, resulting in the build-up of organic matter, nitrogenous waste, and phosphorus both in the water mass and on the bottom of the pond or pen / cage.[8] The suspended solids are derived from particulate organic matter and erosion of pond floor, walls, and discharge channels.

The chemical residues may include the remains of veterinary drugs (e.g. antibiotics) that may have been applied to the cultivated species, and toxic substances such as formalin and malachite green, a cancer causing agent, that may have been that are used to treat finfish for parasites and their eggs for fungal growth. Malachite green is banned in most countries and must not be used. Formalin should only be used under controlled conditions (e.g. in dipping containers) and with proper care – it should not be introduced directly into production systems.[9]

A range of measures can be taken in pond systems and pen / cage systems to (i) reduce the amount of contamination of the effluent; (ii) prevent pond effluent from entering surrounding water bodies; and (iii) treat the effluent before its release into the receiving waters to reduce contaminant levels. Aquaculture operations in large water bodies, however, are open to the surrounding environment and do not have the second or third options, therefore any contamination takes effect immediately.[10] The following management measures can prevent the contamination of effluent:

[8] Center for Tropical and Subtropical Aquaculture (2001).
[9] Because the use of these highly toxic substances is primarily an occupational health and safety issue, refer to the Occupational Health and Safety section for a more detailed review of their application and for practical guidance.
[10] Aquaculture is also somewhat self-regulating in that if the water is highly eutrophic or laden with dissolved or particulate nutrients or BOD, this will adversely affect many cultured organism and thus would be counterproductive not to manage it to a high quality level. This would somewhat reduce impacts of effluents.

Feed:

- Ensure that pellet feed has a minimum amount of "fines" or feed dust. Fines are not consumed and add to the nutrient load in the water;
- Match the pellet size to the species' life-cycle stage (e.g. smaller pellets should be fed to fry or juvenile animals to reduce the unconsumed fraction);
- Regularly monitor feed uptake to determine whether it is being consumed and adjust feeding rates accordingly. Feed may be wasted due to overfeeding or not feeding at the right time of day;
- Where feasible, use floating or extruded feed pellets as they allow for observation during feeding time;
- Store feed in cool, dry facilities and ideally for no longer than 30 days to avoid reduction in vitamin contents. Moldy feed should never be used as it may cause disease;
- Spread feed as evenly as possible throughout the culture system, ensuring that as many animals as possible have access to the feed. Some species are highly territorial, and uneaten feed adds to the nutrient load;
- Feed several times a day, especially when animals are young, allowing better access to food, better feed conversion ratios and less waste;
- Halt feeding at a suitable interval before harvest to eliminate the presence of food and / or fecal material in the animal's gut;
- During harvesting, contain and disinfect blood water and effluent to reduce the risk of disease spread and to contain effluent matter.

Other organic materials:

- Perform slaughter and processing in an area where the effluent is contained;
- Prevent effluent leakage from harvest rafts and bins by using harvest bins in good condition with sealed bin liners and secure lids and bindings;

- Equip off-loading bays with a waterproof apron and surround with a bund to contain potential spills and prevent contamination with effluent.[11]

Suspended solids:

- Avoid discharging waters from ponds while they are being harvested with nets, as this will add to the suspended solids in the effluent drainage;
- If feasible, use partial draining techniques to empty ponds that have been harvested. The last 10–15 percent of pond water contains the highest quantities of dissolved nutrients, suspended solids, and organic matter. After harvest, hold the remaining water in the pond for a number of days before discharge, or transfer to a separate treatment facility.

Fertilizers:

- Plan the rate and mode of application of fertilizers to maximize utilization and prevent over-application, taking into account predicted consumption rates;
- Increase the efficiency of application and dispersion through such practices as dilution of liquid fertilizers or solution of granulated fertilizers prior to application. Other options include the use of powdered fertilizers or the placement of powdered fertilizer bags in shallow water to allow solution and dispersion;
- Consider the use of time-released fertilizer in which resin coated granules release nutrients into the pond water, with the rate of release corresponding to water temperature and movement;
- Avoid the use of fertilizers containing ammonia or ammonium in water with pH of 8 or above to avoid the formation of toxic unionized ammonia (NH_3);[12]
- Depending on the system (e.g., freshwater aquaculture), grow organic fertilizer (e.g. natural grass) in the pond basin after harvest;
- Initiate pond fertilization only in static ponds with no pond water overflow that can impact downstream waters and watersheds;
- Conduct pond fertilization to avoid or minimize consequences of potential runoff due to floods or heavy rain and avoid application to overflowing ponds.

Chemicals:

- Design the pond depth to reduce the need for chemical control of aquatic weeds and reduce thermal stratification;
- Do not use antifoulants to treat cages and pens. The chemically active substances used in antifouling agents are very poisonous and highly stable in an aquatic environment. Clean nets manually or in a net washing machine.

The following management measures can be taken in pond-based systems to prevent pond effluent from entering surrounding water bodies:

- In some fish systems, avoid automatic drainage of ponds at the end of the production cycle as the same pond water may be used to cultivate several crop rotations of certain species (e.g. catfish);[13]
- Reuse water from harvested ponds by pumping it into adjacent ponds to help complement their primary productivity, provided that the level of BOD is controlled; This process is called “bloom seeding,” and requires careful timing of harvests;
- Consider the hydrology of the region in the design of the pond system and ensure that the pond embankments are

[11] Shetland Aquaculture (2006).
[12] WRAC (2000).
[13] Not applicable to shrimp farming which requires the drying out of pond bottoms between harvests.

high enough to contain the pond water and prevent loss of effluent during periods of increased rainfall and potential flooding.

Process Wastewater Treatment: Techniques for treating industrial process wastewater in this sector include grease traps, skimmers or oil water separators for separation of floatable solids; flow and load equalization; sedimentation for suspended solids reduction using clarifiers or settling ponds; biological treatment, typically aerobic treatment, for reduction of soluble organic matter (BOD); biological nutrient removal for reduction in nitrogen and phosphorus; chlorination of effluent when disinfection is required; dewatering and disposal of residuals; in some instances composting or land application of wastewater treatment residuals of acceptable quality may be possible. Additional engineering controls may be required (i) for removal of residual feed supplements, chemicals, antibiotics, etc. which may pass through the wastewater treatment system, and (ii) to contain and neutralize nuisance odors. For sea water applications, unit operations for wastewater treatment may have to be suitably adapted to the relatively high salinity of the water.

Management of industrial wastewater and examples of treatment approaches are discussed in the **General EHS Guidelines**. Through use of these technologies and good practice techniques for wastewater management, facilities should meet the Guideline Values for wastewater discharge as indicated in the relevant table of Section 2 of this industry sector document.

Other Wastewater Streams & Water Consumption: Guidance on the management of non-contaminated wastewater from utility operations, non-contaminated stormwater, and sanitary sewage is provided in the **General EHS Guidelines**. Contaminated streams should be routed to the treatment system for industrial process wastewater. Recommendations to reduce water consumption, especially where it may be a limited natural resource, are provided in the **General EHS Guidelines**.

Hazardous Materials

The aquaculture sector may involve the handling and use of hazardous materials (e.g. oil, fertilizers, and other chemicals). Recommendations for the safe storage, handling, and use of hazardous materials, including guidance on oil spills and containment, is provided in the **General EHS Guidelines**.

1.2 Occupational Health and Safety

As a general approach, health and safety management planning should include the adoption of a systematic and structured approach for prevention and control of physical, chemical, biological, and radiological health and safety hazards described in the **General EHS Guidelines**. Occupational health and safety hazards related to the daily operations of the aquaculture sector can be grouped into two categories:

- Physical hazards
- Exposure to chemicals
- Exposure to water borne disease

Physical hazards

A number of hazards are connected with the daily working routines in aquaculture, including heavy lifts, electric shock, and drowning.

Heavy Lifts

A number of activities involving heavy lifts are carried out during daily operations (e.g. refilling automatic feeders in the ponds and grading the fish). The following management measures can be taken to reduce exposure of personnel to injuries as a result of heavy lifts:

- Use mechanical and / or automated equipment to facilitate lifts heavier than 25 kg;

- Design workstations that can be adapted to individual workers, especially if fish are processed post-harvest;
- Construct ponds that are rectangular in shape to facilitate harvesting. If ponds are of sufficient size, and the embankments are at least 2.5 meters wide, vehicles can be used on the embankments to drag harvest seines.

Electric Shock

Electrical devices typically used in aquaculture include manifold and cover water pumps, paddlewheels, and lighting installations. The risk of electrical shock is therefore present during all operations in which the workers are in contact with the water. Measures to reduce the risk of electric shock include:

- Waterproof all electrical installations;
- Ensure that fuses are used and that there is an appropriate connection to the ground;
- Ensure that all cables are intact, waterproof, and without connection;
- Provide training in the correct handling of electric equipment (e.g. pumps and) to avoid the risk of short circuits;
- Employ lock out / tag out procedures.

Drowning

The risk of drowning is present in almost all aquaculture operations and, especially, in cage aquaculture at sea. Management measures to reduce the risk of drowning among workers and site visitors include the following:

- Provide lifejackets and harnesses with safety clips (karabiners) that lock on to lines or fixed points;
- Ensure that personnel are experienced swimmers;
- Train personnel in safety at sea, including procedures for supervision of personnel;
- Require that personnel wear lifejackets at all times on exposed sites and at sea;
- Where large vessels are used to transport personnel and equipment to marine sites, ensure that the vessel can be securely berthed on the pontoons, reducing the risk of falling into the gap between the vessel and the pontoon.

Exposure to Chemicals

A variety of chemicals may be used in the operation of an aquaculture facility to treat and / or control disease organisms or to facilitate production (e.g. lime, diluted chlorine, or salt). Fertilizers are also generally caustic materials and care should be taken in their application. Recommended guidance for the management of occupational chemical exposure is discussed in the **General EHS Guidelines**.

Water-borne Disease

Workers may be directly or indirectly exposed to water-borne diseases due to frequent contact with water (ponds) and the close proximity of living quarters to surface water bodies. The potential for transmission of water-borne disease should be addressed as part of the occupational health and safety program including specific additional medical screening for the labor force and implementation of preventive measures (e.g. mosquito nets in living quarters). Additional guidance on the prevention and control of communicable diseases is provided in the **General EHS Guidelines**.

1.3 Community Health and Safety

Community health and safety hazards arising from aquaculture operations include the following:

- Salinization of neighboring agricultural land;
- Effects on water resources;
- Food safety impacts and management

- Physical hazards

Effects on Water Resources

Water resources used in aquaculture may include the sea, estuaries, rivers, lakes, and groundwater. The extraction of water from these resources may result in changes to the natural water regime, potentially affecting fish stocks and commercial / recreational activities (e.g. fisheries and recreational activities downstream of the extraction point), or the availability and quality of groundwater. Water management strategies should target the maintenance of hydrologic conditions which provide water quality and quantity consistent with community needs and uses; and, in the case of coastal facilities, prevent salt water intrusion from affecting drinking and agricultural water supplies.

Aquaculture operations may act as breeding grounds for different insects, especially the mosquito and tsetse fly, thus increasing the risk of insect-borne disease among communities in the region. Operators should plan site design and operation to prevent and control these potential impacts. Additional information is provided in the Disease Prevention section of the **General EHS Guidelines**.

Food Safety Impacts and Management

Development of Resistance to Veterinary Drugs

The main veterinary drugs used in aquaculture are antibiotics, which are employed to prevent and treat bacterial diseases. Antibiotics are generally administered in feed, having either been added during manufacture or surface-coated onto the pellets by the manufacturer or the farmer. The development of antibiotic resistance by pathogenic bacteria may arise when bacteria acquire resistance to one or more of the antibiotics to which they were formerly susceptible. That resistance eventually makes the antibiotics ineffective in treating specific microbial diseases in humans.[14] In addition, when antibiotics are unintentionally consumed as residues in food, the amount ingested cannot be quantified or monitored and may cause direct health concerns (e.g. aplastic anemia), posing a serious risk to human health. This can also occur with integrated fish farming systems where antibiotic residues, from livestock manures used for fertilizer, can be introduced to fishpond culture.

Recognition of the risks brought about by consumption of veterinary drugs has led to the banning of certain antibiotics in aquaculture production and the establishment of maximum residue limits (MRLs)[15] for those with known risks. Observance of MRLs is required by law under some national jurisdictions and is encouraged elsewhere.[16] Use of resistant strains should be encouraged and good farm practices to maintain healthy fish stocks promoted.

The following actions can be taken to limit the use of antibiotics:

- Vaccination should be adopted where possible as a way of limiting the use of antibiotics;
- Where appropriate, aquaculture facilities should fallow sites on an annual basis as part of a strategy to manage pathogens in pen production units. The minimum fallow period should be four weeks at the end of each cycle;
- Facilities involved in aquaculture production should use a veterinary service on a frequent basis to review and assess the health of the stock and employees' competence and training. With the assistance of the veterinary service,

[14] FAO (2002b).

[15] Annex IV of Regulation 2377/90/EEC lists nine substances that may not be used in food-producing species because no safe level of residue can be determined: chloramphenicol, chloroform, chlorpromazine, colchicine, dapsone, dimetridazole, metronidazole, nitrofurans (including furazolidone), and ronidazole.

[16] The *Codex Alimentarius* contains maximum residue limits (MRLs) for veterinary drug residues in all major food products, including salmon and giant prawn. A simple MRL database is provided by FAO/WHO at the following Web site: http://www.codexalimentarius.net/mrls/vetdrugs/jsp/vetd_q-e.jsp

facilities should develop a Veterinary Health Plan to include the following aspects:[17]

- Summary of major diseases present and potentially present;
- Disease prevention strategies;
- Treatments to be administered for regularly encountered conditions;
- Recommended vaccination protocols;
- Recommended parasite controls;
- Medication recommendations for feed or water.

If antibiotics are recommended, the following measures should be considered:

- Apply approved over-the-counter antibiotics in strict accordance with the manufacturer's instructions to ensure responsible use;
- Apply approved antibiotics that are purchased and utilized by prescription under the guidance of a qualified professional;
- Develop a contingency plan covering how antibiotics should be applied following the identification of disease outbreaks;
- Store antibiotics in their original packaging, in a dedicated location that:
    - Can be locked, is properly identified with signs, and limits access to authorized persons
    - Can contain spills and avoid uncontrolled release of antibiotics into the surrounding environment
    - Provides for storage of containers on pallets or other platforms to facilitate the visual detection of leaks
- Avoid stockpiles of waste antibiotics by adopting a "first-in, first-out" principle so that they do not exceed their expiration date. Any expired antibiotics should be disposed of in compliance with national regulations.

Physical Hazards

Communities may be exposed to a number of physical hazards, including drowning, associated with the presence of pond systems or other project infrastructure in proximity or in between community areas, requiring frequent crossing and physical interaction. Community use should be taken into consideration in the design of access routes, for example by providing wide enough walking areas with fall protection along potentially hazardous locations.

2.0 Performance Indicators and Monitoring

2.1 Environment

Table 1 presents effluent guidelines for this sector. Guideline values for process emissions and effluents in this sector are indicative of good international industry practice as reflected in relevant standards of countries with recognized regulatory frameworks. These guidelines are achievable under normal operating conditions in appropriately designed and operated facilities through the application of pollution prevention and control techniques discussed in the preceding sections of this document. These levels should be achieved, without dilution, at least 95 percent of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours. Deviation from these levels in consideration of specific, local project conditions should be justified in the environmental assessment.

Emissions guidelines are applicable to process emissions. Combustion source emissions guidelines associated with steam- and power-generation activities from sources with a capacity equal to or lower than 50 MWth are addressed in the

[17] For more information, see EUREPGAP guidance on integrated aquaculture assurance at: http://www.eurepgap.org/fish/Languages/English/index_html

General EHS Guidelines with larger power source emissions addressed in the **EHS Guidelines for Thermal Power**. Guidance on ambient considerations based on the total load of emissions is provided in the **General EHS Guidelines**.

Effluent guidelines are applicable for direct discharges of treated effluents to surface waters for general use. Site-specific discharge levels may be established based on the availability and conditions in use of publicly operated sewage collection and treatment systems or, if discharged directly to surface waters, on the receiving water use classification as described in the **General EHS Guidelines**.

Table 1. Effluent levels for aquaculture		
Pollutants	**Units**	**Guideline Value**
pH	pH	6 – 9
BOD_5	mg/l	50
COD	mg/l	250
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Temperature increase	°C	<3[b]
Total coliform bacteria	MPN[a] / 100 ml	400
Active Ingredients / Antibiotics	To be determined on a case specific basis	

Notes:
[a] MPN = Most Probable Number
[b] At the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity

Environmental Monitoring

Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the particular project. Monitoring frequency should be sufficient to provide representative data for the parameter being monitored. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Additional guidance on applicable sampling and analytical methods for emissions and effluents is provided in the **General EHS Guidelines**.

2.2 Occupational Health and Safety

Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, of which examples include the Threshold Limit Value (TLV®) occupational exposure guidelines and Biological Exposure Indices (BEIs®) published by American Conference of Governmental Industrial Hygienists (ACGIH),[18] the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),[19] Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),[20] Indicative Occupational Exposure Limit Values published by European Union member states,[21] or other similar sources.

Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to

[18] Available at: http://www.acgih.org/TLV/ and http://www.acgih.org/store/
[19] Available at: http://www.cdc.gov/niosh/npg/
[20] Available at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992
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a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources (e.g. US Bureau of Labor Statistics and UK Health and Safety Executive)[22].

Occupational Health and Safety Monitoring

The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals as part of an occupational health and safety monitoring program. [23] Facilities should also maintain a record of occupational accidents, diseases, and dangerous occurrences and other kinds of accident. Additional guidance on occupational health and safety monitoring programs is provided in the **General EHS Guidelines**.

[22] Available at: http://www.bls.gov/iif/ and http://www.hse.gov.uk/statistics/index.htm
[23] Accredited professionals may include certified industrial hygienists, registered occupational hygienists, or certified safety professionals or their equivalent.

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Annex A: General Description of Industry Activities

The aquaculture sector is very diverse, in terms of products and production methods, as detailed in Table A-1.

Extensive systems[24] use low stocking densities and no supplemental feeding. Extensive systems may use man-made ponds or, more often, existing natural structures (e.g. lakes or lagoons) that are typically large (>2 ha). Semi-intensive systems[25] (approximately 2 to 20 tons/ha/yr) use higher stocking densities, supplemental feeding, and additional management (such as water changes) and typically utilize man-made ponds, pens, or cages. Some semi-intensive systems, especially polycultures, utilize natural lakes (e.g. filter feeders and omnivorous fish can be cultured in cages in shrimp or prawn ponds).[26]

Intensive systems[27] use maximum stocking densities and are dependent on a mixture of natural and formulated feeds. Semi-intensive and intensive systems typically use small pond compartments of up to 1 ha for ease of management. Site selection for the aquaculture facility is often the most important issue related to environmental health and safety. Criteria for site selection include water supply and quality; soil quality; protection from natural hazards; and accessibility to inputs, including markets and labor.[28] An aquaculture facility requires a steady supply of water in adequate quantities throughout the year. Water supply should be pollution-free and have a stable and suitable pH, adequate dissolved oxygen, and low turbidity. Some producers may treat the intake water to remove unwanted substances, for example, using a filter to remove potential predators. In addition, aquaculture farms should not be located close to each other, as this could increase the risk of disease transfer and may have a detrimental effect on the water quality of the intake water.

Table A-1. Diversity of Aquaculture Production Methodologies

Resource	System	Installations
Water (fresh, brackish, or marine)	Stillwater	Ponds and lakes
	Flow-through	Ponds, raceways, tanks (land-based) Cages (lake and sea based) Large offshore units (sea based)
	Re-use or recirculation	Tanks and land-based ponds
Nutrition	Extensive (No feed)	Ponds (land-based) Substrate - shellfish (sea-based) Substrate - seaweeds (sea-based)
	Semi-intensive systems (Supplemental feeding and/or fertilizer)	Ponds (land-based) Raceways (land-based)
	Intensive systems (Feed)	Ponds (land-based) Cages (lake and sea based) Raceways (land and sea-based) Silos and tanks (land-based)
Species	Monoculture	Animals (ponds and tanks, cages/pens in lakes or sea) Plants (ponds and tanks, cages/pens in lakes or sea)
	Polyculture	Animals (fish species)

24 Production system characterized by (i) a low degree of control (e.g. of environment, nutrition, predators, competitors, disease agents); (ii) low initial costs, low-level technology, and low production efficiency (yielding no more than 500 kg/ha/yr); (iii) high dependence on local climate and water quality; use of natural water bodies (e.g. lagoons, bays, embayments) and of natural often unspecified food organisms.]

25 System of culture characterized by a production of 0.5-5 tons/ha/yr, possibly supplementary feeding with low-grade feeds, stocking with wild-caught or hatchery-reared fry, regular use of organic or inorganic fertilizers, rain or tidal water supply and/or some water exchange, simple monitoring of water quality, and normally in traditional or improved ponds; also some cage systems e.g. with zooplankton feeding for fry.

26 Center for Tropical and Subtropical Aquaculture (2001). Other polyculture systems are practiced in Asia, primarily carp in association with duckeries and piggeries and the growth of crops on pond embankments.

27 Systems of culture characterized by a production of 2 to 20 tons/ha/yr, which are dependent largely on natural food, which is augmented by fertilization or complemented by use of supplementary feed, stocking with hatchery-reared fry, regular use of fertilizers, some water exchange or aeration, often pumped or gravity supplied water, and normally in improved ponds, some enclosures, or simple cage systems.

28 Food and Agriculture Organization of the United Nations (FAO), 1989, ADCP/REP/89/43, Aquaculture Systems and Practices: A Selected Review. http://www.fao.org/docrep/T8598E/t8598e00.HTM.

The site should have soils adequate for the intended structures (e.g. clay-loam or sandy-clay soil for ponds, and firm bottom mud for pens) to allow the structure to be driven deep into substrate for better support. Aquaculture facilities should be protected from high wind, waves, and tides; excessive storm water runoff; predators; and other natural hazards. Moderate tides, however, may help to ensure adequate water exchange through ponds, pens, and cages.

Figure A-1 presents the typical production cycle for an aquaculture facility. The production period varies from species to species and from region to region, depending on the market requirements for size and on the growth rates for the species, which is dependent on temperature, feed quality, and feed allocation. Most operations have a grow-out period of 4 to 18 months.

Preparation and Stocking

Freshwater Ponds

Ponds are most commonly constructed by excavating soils and using the spoils from excavation for the embankments. Soils that are suitable for earthen pond construction have the following characteristics: adequate clay content (clay slows down or may even eliminate seepage), low organic content, proper soil texture, and preferably alkaline pH. When producing at high densities, or during the early stages of fry or juveniles, ponds can be sealed with a plastic sheet or concrete, or production can take place in sealed raceways or tanks to facilitate cleaning.

Pens and Cages

Pen and cage systems involves the rearing of fish within fixed or floating net enclosures supported by rigid frameworks and set in sheltered, shallow portions of lakes, bays, rivers, estuaries, or the seacoast. Pens and cages are largely similar. Pens are anchored to the lake or sea bottom, which serves as the floor of the pen, while cages are suspended in the water, and can be either fixed or floating. Cages can typically be located in more exposed situations and in deeper water than pens. Fry may be grown to fingerling size in special nursery compartments and then released to pens or cages for grow-out, or fingerlings for stocking may be purchased from land-based facilities. In some cases, the stocking material may be wild caught.

Open Water Culture

Seaweed and mollusks are typically farmed in open marine waters. Structures (e.g. rafts, racks, or stakes) that provide a growth surface for the intended species are placed in suitable areas. Often the species to be grown settle by themselves on the structures, and the producer will only remove unwanted species and occasionally thin the stock. The aquaculture of other species, notably oysters, requires more active management and the spat or other juvenile stages are added to the structures for on-growing.

Start-Feeding

The early stages of fish and crustaceans production often demand a special feeding regimen, and the use of artificial feeds for these early stages can be problematic. During the initial feeding phase, organic and / or inorganic fertilizers (e.g. nitrogen and phosphorus) are often added to create an algal bloom. The algal bloom boosts primary productivity levels in the pond by generating a food source for microorganisms such as zooplankton, which are eaten by the fry or larvae of the organisms being cultivated. The algal bloom also prevents the establishment of aquatic plants. Veterinary drugs may be added at this stage to reduce the risk of disease or in response to actual outbreaks. A broad spectrum antibiotic is the most frequently used medication.

On-growing

After start-feeding, a transition toward on-growing takes place. The quality of the feed used can vary widely, depending on the species grown and / or the level of sophistication of the farm setup. A simple solution involves the use of minced fish meat prepared at the farm site and offered daily throughout the grow-out period. Intensive operations may exclusively use high-quality, pelletized, formulated feed throughout the production period.

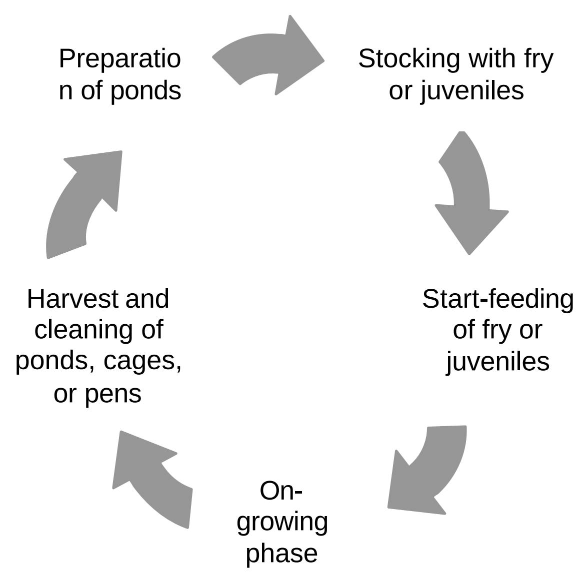
During feeding, the biomass will increase, resulting in increased oxygen consumption, and pond aerators (e.g. paddlewheels and diffusers) are often used to aerate the water. During the on-growing period, the stock are monitored regularly for disease and willingness to eat, allowing the pond manager to intervene (e.g. applying antibiotics and changing the pond water) if unsuitable conditions develop.

Harvesting and Cleaning

Once the stock has reached the desired size, they are harvested and marketed. Some species are sold live, and others are slaughtered before sale. In the latter situation, special facilities for slaughtering may be installed at the farm (e.g. to control the "blood water" resulting from harvest of the organisms). The slaughtered product is then iced and may be sent out for further processing off-site at a specialized fish processing plant, or sold fresh to local markets.[29]

After harvesting, the aquaculture effluent may be conveyed into a sedimentation basin before being discharged to the receiving water. After the pond has been emptied, the pond bottom is cleaned to remove the sediment of uneaten feed and feces. For intensive and semi-intensive systems, ponds are usually allowed to dry completely and are treated (e.g. with lime or pesticides) to control diseases, competing organisms, and predators before the next production cycle begins. In the case of cages and pens, fouling on the nets may be removed in a mechanical cleaning process, which is often followed by bathing the nets in chemicals to reduce settling on the nets in the grow-out period.

Figure A.1: Typical Production Cycle for an Aquaculture Facility



[29] Refer to the EHS Guidelines for Fish Processing for practical guidance on EHS issues in this sector.

Annex F. Voluntary Land Donation Performa

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 voluntarily donates to the Recipient this asset for the construction and development of ....for the benefit of the villagers a78nd the public at large.
   88]7

6. That the Owner affirms that he donates the land freely and under no coercion from any party.

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

8. That the Recipient shall construct and develop the……………...……and take all possible precautions to avoid damage to adjacent land/structure/other assets.

9. That both the parties agree that the………………………so constructed/developed shall be public premises.

10. That the provisions of this agreement will come into force from the date of signing of this deed.

11. 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. ------------------------------------Adjacent land owner

(Signature, name and address)

Countersigned/Attested by:

____

Revenue Department