A4 NATURAL ENVIRONMENT

A4.1 Existing Natural Conditions

A4.1.1 Terrestrial Flora and Fauna

(1) Characteristics of Flora and Fauna of Sulawesi

Around 40 million years ago, a northward Australian plate crashed into the Asian plate creating eastern Sulawesi, beginning the fusion between the two around 15 million years ago. Since the two parts of Sulawesi came from different places – Asian origin and Australian origin, they each brought with them a different mix of plants and animals. Sulawesi has one of the highest levels of species endemism in the world. (Rob Lee and Suparman Rais: "Bogani Nani Wartabone National Park, a Stronghold for Threatened Wildlife in Sulawesi.")

Gorontalo is one of the five provinces of Sulawesi. The geological history of Sulawesi determines its flora and fauna, which are different from those of other bio-geographical regions. The flora and fauna of the Sulawesi bio-geographical region are unique, and there are many endemic species. Fewer botanical specimens, however, have been collected in Sulawesi than in any other regions in Indonesia. Only seven genera of higher plant are known to be endemic compared with 17 in Sumatra, 59 in Kalimantan and 124 in New Guinea. But the fauna of Sulawesi is one of the most distinctive in all Indonesia particularly for the mammals. There are 127 mammal species existing in Sulawesi, out of which 79 species are considered to be endemic. There are 332 species of birds known from Sulawesi of which 92 are endemic, and 81 are migratory. Regarding reptiles, there are 40 species of lizards known from Sulawesi mainland, 13 of which are endemic, but the group is poorly known. As for amphibians, only 29 species are so far known from Sulawesi, whereas 100 species have been collected on Kalimantan. Of this 29 species, 25 are indigenous, of which 19 are endemic. ("The Ecology of Sulawesi." 1988.)

The Limboto-Bolango-Bone basin (LBB basin), however, is now densely populated and is undergoing various activities including agriculture and industry in and around the Lake Limboto, and consequently flora and fauna in it is suffering from human modifications as a whole.

(2) Flora

Based on the secondary data listed in "The Ecology of Sulawesi," and "Report on Data Compilation of Potential Forest Resources of North Sulawesi, Jan. 2000," the following species of flora listed in Table A4.1.1 are found mostly in lowland of Gorontalo Province. Some of Sulawesi endemic trees growing in Gorontalo are fish tail palm (*Caryota mitis*), fan palm (*Livistona rotundifolia*), pangi (*Pangium edule*), rao (*Dracontomelum mangiferum* and *D. dao*), licola (*Licuala celebensis*), leda (*Eucalyptus deglupta*) and ebonies (*Diospiros celebica*). Other characteristic trees are bamboo (*Shizoztachyum* sp), rattans (*Calamus* spp), figs (*Ficus* spp), nantu (*Palaquin obstusifolium*), cempaka (*Elmerrillia ovalis*), linggua (*Pterocarpus indicus*), damar (*Shorea* sp), gophasa (*Lagerstroemia ovalifolia*), bolangitan (*Tetrameles nudiflora*), beremban (*Duabanga moluccana*), bintangar (*Kleinhovia hospita*), blotched figs (*Ficus variegatus*), she-oak (*Casuarina* sp), oaks (*Lithocarpus* spp), sirih hutan *(Piper aduncum*), kenanga (*Canangium odoratum*).

During field reconnaissance conducted in July and August 2001, the following species of urban vegetation, i.e., crops, listed in Table A4.1.2 were identified in Gorontalo Province. Most of those listed in the table are found year round reflecting that there is only slight change of temperature throughout a year in this region.

(3) Mammals

Bogani Nani National Park, spreading over upstream of the Bone River and western part of North Sulawesi Province, holds a special position in global biodiversity and mammals in it, reflecting the mechanism and process of the birth of Sulawesi island, showing the high level of endemism. Large mammals including babirusa, anoa, Gorontalo macaque and two cuscus species, bear cuscus and dwarf cuscus, are representative and remarkable ones.

In contrast to the national park, surrounding area of Lake Limboto does not show such a remarkable biodiversity. According to "Lake Limboto Management Plan, Environmental Screening," 1996, CIDA, mammals observed near Lake Limboto includes rats including the rice field rat, Sulawesi civet, and deer only.

(4) Birds

Indonesia is divided into two faunal regions: Western Indonesia and Eastern Indonesia between Kalimantan and Sulawesi with Wallace's Line. The latter, Eastern Indonesia is a zone with a mixture of oriental and Australasian region bird species and has a high degree of endemism. The Eastern Indonesia region is further divided into three sub-regions: Sulawesi, Nusa Tenggara and Maluku ("A Photographic Guide to the Birds of Indonesia," 2001).

According to the report mentioned above, 24 bird species were observed at the western end of the lake. Among those observed, 9 species, including great egrets, wandering tree ducks, gray teals, little egrets, munia, pond herons, yellow bitterns, milky storks, and wooly-necked storks are most common, counting up almost 90 % of all the observed birds. These observed bird species have a strong dependence on the wetland or near-shore habitats, feeding on small fish, invertebrates, and submerged vegetation. Less frequently observed birds are kingfishers, terns, hawks, eagles, and night herons, showing affinity for aquatic habitats. Sunbirds are common in the area during the dry season.

During the field reconnaissance conducted on 7-10th August, 2001, at least 8 species of birds were observed, including alap-alap, bangoo putih, coklat, raja udang, walet perut putih (all in local name), eagle sp., plover sp., mew sp., sparrow at south shore of the lake. The most common is the bangoo putih, i.e. egret sp., forming communities in the near-shore with aquatic weeds growing areas. Eagle is known as an umbrella species, occupying the summit of ecological pyramid, and its presence indicates that there is a wealthy ecosystem on which eagles can feed. The ecosystem formed in around the Lake Limboto, therefore, seems to be wealthy and there is plenty of food at present.

(5) Reptiles and Amphibians

According to the report mentioned above, the reptiles reported from Lake Limboto include soa-soa (*Hyrtosaurus amboinensis*) and lizards (*Paranus salvator*), and some snakes occurring near the lake during the rainy season. There is a description that three crocodiles were observed in the lake in 1992, but local people deny its presence. Regarding amphibians, observed species in Lake Limboto were not many. They were frogs, toads, and tree frogs.

A4.1.2 Aquatic Ecology of Lake Limboto

(1) Aquatic Macrophytes

According to Sarnita, 1993, through the report: "Lake Limboto Management Plan, Environmental Screening," 1996, CIDA, aquatic weeds (macrophytes) grow and spread over the shallower part of the lake, occupying the most of the near-shoreline of the lake. The species listed in Table A4.1.3, composed of both submerged and floating species, were recorded, all of which are not endemic.

During the field reconnaissance conducted on August 8, 2001 the following macrophytes were observed in Lake Limboto: i.e., local name: Dumalo (Latin name: *Ceratophyllum demersum),* Kangkung (*Ipomoea aquatica),* - (*Hydrilla verticillata),* - (*Eichhornia crasspes),* - (*Salvinia molesta),* - (*Nymphoides indica),* Iduk (*Ludwigia adscendens),* and Teratai (*Nelumbium nelumbo)*

Generally, in the case of clear lakes with the light penetration of more than 10 m, submerged macrophytes can grow as deep as 10 m. In the case of Lake Limboto, however, high turbidity seems to prevent the submerged plants colonized at relatively shallower areas. Floating macrophytes, on the other hand, are found in whole area in spite of its depth. Macrophytes would continue to spread towards the center of the lake without any human interventions.

Aquatic macrophytes have both positive and negative impacts in terms of aquatic ecology as shown in Table A4.1.4. Although macrophytes can bring some benefits to aquatic fauna, its rapid growth beyond the natural transition velocity would damage aquatic ecosystem in the lake and eventually human activities including fisheries.

(2) Nekton

According to the report mentioned above, fish species listed in Table A4.1.5, including native and introduced, are reported from the Lake Limboto. Of all the fishes listed, the following species are indigenous: they are manggabai (*Glossogobius giurus*) and payangka (*Ophiocara porocephala*) and sidat (*Anguilla sp.*). Theses two species are economically important as well. Such species as Ikan mas (*Cyprinus carpio*), mujair (*Oreochromis niloticus*), nila (*Oreochromis mossambicus*), tawes (*Puntius gonionotus*), nilem (*Osteochilus hasselti*) and sepat siam (*Trichogaster pectoralis*) are the introduced

ones into Lake Limboto for aquaculture. Out of the indigenous species, sidat, or eel, is a migratory fish which swims upriver, as an "elver" to grow into adults in the Lake Limboto and rivers, and after a certain period of time, mostly more than 10 years, it returns to the ocean again to breed.

Field reconnaissance was conducted on August 8, 2001 intending to investigate the existing species by checking the landed fishes by fishermen. Market surveys were undertaken at Taraga Market and Tapa Market on July 28 and August 9, 2001 respectively. Results of these surveys are shown in Tables A4.1.6 and A4.1.7. Fifteen (15) species of fresh water fishes were included in landed fishes by fishermen, and 13 species were recorded at two markets. The most common species are Nila, Mujair, Manggabai, Gabus, Huluu and Payangka. Among those listed in the Table, Nila, Mujair and Ikan mas are cultured in fish cage in the Lake Limboto. Most of tilapias (Nila and Mujair) are less than 10 cm in length and only a few of them are more than 15 cm, which is supposedly caused by overfishing as pointed out by the report mentioned above.

(3) Benthos

According to the "Lake Limboto Management Plan, Environmental Screening," 1996, CIDA, benthic community in the Lake Limboto (organisms living in and on the lake bottom) is very impoverished. Formerly observed three mollusk species (all gastropods) were not observed in 1996. A bivalve (*Anodonta woodiana*) was observed at the deepest stations near the middle of the lake, but this species was the recently introduced one from China and Taiwan. No in-fauna (animals living in the sediment as deposit feeders) were collected in the grab samples, indicating a very diminished benthic community, which may reflect very low oxygen conditions in or near the lake bottom sediments.

(4) Phytoplankton and Zooplankton

According to the said report, phytoplankton has been sampled on a number of occasions in Lake Limboto so far. Sampling in 1993 indicated high concentration of phytoplankton in the order of 1,000 cells per liter, whereas sampling in 1996 indicated smaller concentrations ranging from 21 to 236 cells per liter. The results of sampling done in 1996 showed a gradation from low concentrations in west to high along south side of the lake. The said report pointed out that this was caused by nutrients increase

from west to south end of the lake due to human waste and fish faeces, which would support phytoplankton growth.

According to the said report, zooplankton community in Lake Limboto comprises cladocerans (such as *Daphnia sp.*), rotifers (such as *Brachionus sp.*, *Keratella sp*.), copepods and nauplius larvae. Predominance of protozoans was indicated by Sarnita (1994), and that of rotifers followed by cladocerans as results of samplings. Densities of zooplankton ranged from 6 to 201 organisms/liter with the highest densities observed towards the west end of the lake and the lowest at the outlet. But yet, no clear explanation for this zooplankton distribution was done in the secondary documents.

(5) Lake Limboto in Evolutionary Process

The Lake Limboto is evidently at the mature stage of its evolutionary process, being supported by the facts of heavy sedimentation, high eutrophication, growth and spread of aquatic weeds, and getting shallower and semi-terrestrial conditions along the shoreline. This evolutionary process seems to be accelerated by human activities such as forest clearing and improper farming causing soil erosion and sedimentation, discharges of fertilizer, other chemical compounds including pesticides, and untreated domestic effluent, and so on.

A4.1.3 Endemic and Protected Species

Regarding endangered, threatened, and/or vulnerable species, both flora and fauna listed in Table A4.1.8 are designated as species needed to be protected by the Indonesian Law No. 5 of 1990 regarding "Conservation of Biological Resources and Its Ecosystems."

Endemic species are enumerated in Section (2) Flora, A4.1.1 Terrestrial Flora and Fauna on page A4-2. According to Dr. Ir. Lawrence Janneman Lucky, a professor of Sam Ratulangi University, four flora species are found growing in LBB basin; including Pohon Beringin, Kayu Hitam, Kayu Damar, and Benuang as checked in Table A4.1.8.

Regarding fauna, many endemic species of animals are identified in North Sulawesi, so far. They are Anoa dataran tinggi (*Buballus depresicornis*), Anoa dataran rendah (*Buballus quarlesi*), Tangkasi (*Tarsius spectrum*), Babirusa (*babirussa babirusa*), Kera hitam (*Macaca tongkeana*), Maleo (*Macrocephalom maleo*), Gosong (*Megapodius*), Mandar Sulaweisi (*Aramiotopsi platennis*), Serindit Sulawesi (*Coraculus exhillis*), and

Nuri Sulawesi (*Tanygnatus sumatranus*) - Source: Report on Data Compilation of Potential Forest Resources of North Sulawesi, Jan. 2000.

Among those listed above, 5 species, Anoa dataran tinggi, Anoa dataran rendah, Babirusa, Kera hitam, and Maleo (refer to the checked in the table), are reported to live in LBB watershed according to provincial government officials.

A bird named Maleo (*Macrocephalom maleo*) was formerly widespread in Sulawesi but has disappeared from south of Sulawesi due to habitat loss and is now vulnerable to global extinction. There is a Maleo nesting site in Panua Nature Reserve between Grontalo and Marisa where the large expanse of Rhizophora forest, coastal forest and the two small lakes ("The ecology of Sulawesi," 2002.). The threatened status was featured on the local newspaper "Harian Gorontalo Post" on August 24, 2001.

A4.1.4 Forest

(1) Forest Classification

Forest is classified from the standpoint of ownership rights provided by the New Forest Law (Law No. 41/ 1999) as follows:

1) State Forest is a forest in arable land which is not undertaken by authority rights. Customary Forest (*Hutan Adat*) which is located in an *adat* land (traditional jurisdictional area) is also classified into the State Forest.
2) Private Forest is a forest in arable land which is undertaken by authority rights.

The State Forest is further divided into 3 categories in terms of its function defined as follows, and is further classified as shown in Figure A4.1.1, while all the Private Forest is categorized as Production Forest:

1) Production Forest is a district of forest that functions mainly to produce forest yield/product.
2) Conservation Forest is a district of forest that has certain characteristics to preserve the diversity of flora and fauna and their ecosystem.
3) Protection Forest is a district of forest that function mainly to protect the life-supporting system in regulating water system, preventing flood, erosion, intrusion of seawater and maintaining soil fertility.

Converted Production Forest is a forest which is to be converted into other land use such as farm land, estate and so on. Even though it has been designated as Converted Production Forest, an approval is needed prior to the actual land use conversion from the authority (formerly central government but under the decentralization, now shifting to local government, according to the officials in provincial government). Likewise, even in the Private Forest, which is categorized as Production Forest, an approval is needed to cut trees from the authority by submitting the purpose for cutting and clearing.

(2) Forest Management in Gorontalo

Among the forest mentioned above, all categories of forests, except for the Hunting Park, exist in the LBB basin at the moment as illustrated on Figure A4.1.2. With respect to Conservation Forest, there is one Game Reserve and one Permanent Nature Conservation Area in the LBB basin as indicated in Table A4.1.9. Basically, all the activities of both commercial and domestic are prohibited in Protection Forest area or Conservation Forest area. However, some activities done by traditional communities are permitted based on their need, including building houses and planting trees for harvesting and so on.

Community Forest (*Hutan Kemasyarakatan*, HKM) is a forest developed by government (Decision of Ministry of Forest and Estate Crops No. 677/Kpts-Ⅱ/1998) to improve community participation. The local residents dwelling close to the Community Forest are given common rights to manage and utilize the forest for their livelihood. However, a lot of informal community forests with no permission or approval, are found in upland area of the LBB basin. Nevertheless, it is recognized and passed over the usage of forests because the farmers in upland area are very poor and they can do nothing but utilize the forest for living. Such activities as cutting trees and clearing forest (slash and burn agriculture), accelerate the erosion pressure especially on steep slope. But most of them are carried out in traditional methods and in small area. Beside this type of informal community forest, there is another type of informal community forest, in which commercial brokers from urban area provoke the informal community to cut trees for sale giving money as temporally income. This type of informal community forest is larger in extent and therefore has more pressure to devastate the forest.

The forest in the LBB basin is managed by two levels of local government: they are

Provincial level and Kabupaten level. Each level of government has a forestry service office and formulates program and/or work plan on which forest management activities are to be implemented. Provincial Office (*Dinas Pertanian, Kehutanan dan Perkebunan, Provinsi Gorontalo*) formulated a 5 year (2000-2005) forest management program.

(3) Measures being undertaken

Provincial Forestry Department Office is initiating the Forest Inventory and Monitoring Projects funded by European Union. This project is considered as a pre-condition project for the improvement of forest database system and for the development of master plan of forest and land rehabilitation. In addition, the provincial office is proposing the following project with an assistance of FAO (Food and Agriculture Organization of the United Nations):

1) Forest, land use, agriculture and estate change analysis of province of Gorontalo to improve sustainable development for maintaining food and improving rural welfare.
2) Forest assessment for a welfare improvement of rural people by creating activities of farming, breeding & husbandry.
3) Environmental economic analysis in preserving forest regarding improving rural development and forest safety.

According to the official of provincial government, these projects aim at providing necessary laws and regulations, and tackling the various problems arising in forest such as conflicts between urban and rural people and those among local people near forest.

Land Rehabilitation and Soil Conservation Office of North Sulawesi Province are conducting several projects aiming to manage and rehabilitate the devastated forest lands in LBB basin. They include the following:

Dry Land Rehabilitation Project is being undertaken in the upland areas on the total area of 8,000 ha. Bench terrace system is adopted aiming at reducing the soil erosion risks. Strip cropping is also applied for this project.

Afforestation is being conducted with a re-greening campaign, providing some tree species, e.g. Kayu Jati, and perennial crop seedlings for local people. This project is funded by ADB (Asian Development Bank) and subsidized by the central government.

Community Forest Program had been initiated many years ago, but it was three years ago that this project was fully implemented by involving local people. The devastated forest lands are to be planted by 70% of trees and 30% of perennial crop plants. Seedlings are subsidized by the Forestry Department of Provincial Government.

A4.1.5 Physical Conditions of Lake Limboto

According to "Lake Limboto Management Plan Environmental Screening," CIDA, 1996, Lake Limboto is currently suffering from sedimentation through rivers and domestic effluent. The inflow rate of suspended loads are assumed to be about 33 mg/l at low flow and up to 1,100 mg/l at high flow. The sources of sediments are coming from the deforested watershed areas and agricultural lands as well as the solid waste, debris, etc. produced from human activities. Sediments are also supplied in the form of bed load during flash floods. In addition to these, there is sedimentation of organic matters produced in the lake, including bacteria, phytoplankton, zooplankton, macrophyte detritus, and faeces from fish and various invertebrates.

The thickness of the bottom sediments in the lake varies throughout the lake, accounting for 3 to 5 m on the east, 5.8 to 6.4 m along the north and west, 8.8 to 10.2 m along the south side, and 12.4 m in the center of the lake. Correspondingly, dry season depth in the lake decreased from some 7 m in 1950's to some 3 m in 1980's, according to "LBB Water Resources Development Master Plan, Interim Report, Annex 2," 1994. The measurement of the depth at the deepest point in the lake recorded 3.0 m in September and 3.9 m in December, 2001.

In a eutrophicated lake as Limboto, sedimentation may account for a significant part of the accretion on the lake bed and result in shallowing over the years. With the assumptions of discharge, suspended sediment load, usual annual flood discharge and annual deposition load etc., John Carter, 1996, estimated the time periods reaching to a terminal point ranging from 45 to 50 years for the worst case and 75 to 90 years for the optimistic case with or without human waste and debris.

A4.1.6 Groundwater

The CIDA Report (Limboto-Bolango-Bone Basin Watershed Management Master Plan, Volume 2, Annexes, March 1999), discussed on groundwater condition. Based on

geological characteristics, occurrence of groundwater and productivity of the aquifer, Limboto-Bolango-Bone basin area can be divided into four units as described in Table A4.1.10. The LBB basin is divided into several recharge zones based on net rainfall, land use, topography (slope and relief) and geology. A recharge coefficient which is expressed as a percentage of rainfall is shown in Table A4.1.11. Quaternary alluvial plain deposits (Unconsolidated deposits: Qal) and Quaternary limestone (Ql) shows higher recharge coefficient with more than 20 % while Tertiary volcanic deposits and intrusive rock have relatively lower figure less than 10 %.

Table A4.1.12 shows the estimation of recharge in each hydrological unit. The Limboto and Bolango basin have some 180 mm/yr of recharge while the Bone basin accounts approximately 300 mm/yr. The Bone river has the largest land cover of undisturbed forest (84%) in the middle and upper catchment and the forest cover will increase transpiration and sub-surface flow but decrease direct runoff. The annual rainfall in the areas lower than 100m in elevation in the central portion of the LBB basin ranges from less than 1,000 to 1,280 mm whereas it increases to over 1,300 mm on the eastern side of the basin and may exceed 2,000 mm at the higher elevations to the eastern portions of the LBB basin. The high recharge in Bone watershed seems to be caused by the high amount of rainfall and partly caused by low direst runoff.

The groundwater balance in the LBB basin can be calculated by considering groundwater abstraction (deep and shallow), groundwater flows as an output and infiltration through irrigation system and rivers, and net-rainfall as inputs. Table A4.1.13 indicates a summary of groundwater balance in the LBB basin, which shows the groundwater potential is by far higher than the current abstraction rate.

A4.1.7 Water Quality

(1) Summary of Existing Data

Water Quality of Lake Limboto was measured in 1977 by Lembaga Penelitian Perikanan Darat Cabang Ujung Pandang. The results are shown in Table A4.1.14. Another water quality analysis was conducted in 1993 taking water samples from Lake Limboto, major rivers and wells. The results of the analysis are shown in Table A4.1.15.

Water Quality of Lake Limboto: The results of water quality analysis in Lake

Limboto are outlined as follows:

1) Water temperature near the lake surface showed very little seasonal variation ranging from 27 to 33 ℃. The very little variation of water temperature were also observed for vertical profile with only 0.5 to 1.5 ℃ lower than that near surface. This means that there was little stratification in the lake.
2) Secchi disk readings for light penetration in the lake were less than 50 cm, indicating very turbid conditions with suspended sediments and plankton in the lake.
3) The lake was significantly polluted in terms of high organic load and subsequent bacterial decomposition, supported by high values of BOD (29-49 mg/l), COD (40-57 mg/l) and organic matter concentration 828-50 mg/l).
4) The results also indicated high Faecal Coliform ranging from 400 to 46,000 MPN/100 ml, reflecting faecal contamination of the lake.
5) In contrast, dissolved oxygen (DO) near the lake surface ranged form 6 to 10.1 mg/l, showing good condition for habitat (*This 10.1 mg/l of DO indicates that the lake water was over saturated with DO.*). However, DO values close to the lake bottom were lower (5.3 to 7.2 mg/l), which seems to reflect the effect of decomposition of organic matter.
6) The pH value shows slight alkaline condition (7 –7.8) and this level was still quite suitable for freshwater fish, irrigation and drinking water. But the level of alkalinity might encourage flocculation of the organic matter and sediments, accelerating sedimentation in the lake (UNESCO, 1985). This, in turn, can cause reductions in DO and consequently deteriorate the habitat condition of fish.
7) Nutrient levels in Lake Limboto have not been well studied so far. According to John Carter, 1996, however, the data on concentration of nitrate, phosphate and ammonia indicates eutrophication of the lake and can lead to algal blooms.

River Water Quality: The results of quality analysis of river water in various sampling points shown in Table A4.1.15 indicated all the samples were below the maximum admissible concentration limits for analyzed parameters. From the standpoint of water use for irrigation (agriculture), fishery and animal watering purposes, these waters were therefore quite safe. However, illegal mining of gold is now reported to undergo in the upstream basin of the Bone River. The high concentration of mercury in the river water would be caused by the gold mining procedure. But the real fact has not been clarified yet due to lack of objective data.

Groundwater Quality from Wells: As listed in Table A4.1.15, except for BOD_5, COD and organic matter, all other parameters were below the maximum admissible concentration limits for drinking water. Regarding BOD_5 and COD and organic matter, the wells were not suitable for this use.

(2) Investigation of Water Quality and Bottom Sediment

Purpose and Methodology: In order to evaluate the current conditions of water quality and bottom sediment as a basis of the management of water environment, an investigation of water quality and bottom sediment was undertaken by JICA Study Team.

The water sediment sampling was done in both dry season and rainy season: The dry season sampling was conducted on 25th and 26th, September 2001, whereas the rainy season one was conducted on 4th and 5th, December 2001. The bottom sediment sampling was done once only in dry season on the same date as that of water sampling. The samples taken were kept cool with temperature of some 4℃ and brought to the laboratory of Institute of Industrial Research and Development (Balai Industri) in Manado for the laboratory tests.

A total of 15 sampling points were chosen commonly for water and bottom sediment samples including the Bone river including its estuary (3 points), the Bolango river including the Tapodu river (4 points), the Tamalate river (2 points), the Biyonga river (1 point), the Alo-Pohu river (3 points) and Lake Limboto (2 points). These points are shown in Figure A4.1.3.

Parameters for water quality test are composed of three categories, i.e., fundamental parameters, heavy metals and others. The fundamental parameters were chosen to evaluate the current environmental conditions as ambient water. The heavy metals were chosen to evaluate the suitability for water use and possibility of contamination. The other parameters were chosen to evaluate the suitability for water use. On the other hand, the parameters for bottom sediment quality were selected aiming to evaluate the possibility of contamination and its accumulation caused by industrial activities and mining.

Results of the analyses: The results of the analyses of water quality and bottom sediment are listed in Tables A4.1.16 through A4.1.18.

Remarks on Water Quality

Temperature: Water temperature of rivers ranged from 21.0 to 31.6℃ in September, ranged and from 22.7 to 28.6℃ in December. Lower temperatures were recorded on the Bolango river and upper Bone. Higher temperatures recorded on the Pohu river, lower Biyonga and the Tapodu river (Lake Outlet). Water temperatures of Lake Limboto ranged from 25.8 to 27.2℃ in September, and ranged from 28.0 to 28.1℃ in December. Vertical variation of water temperature was not observed in the lake, indicating that there was no stratification formed.

pH: The pH value of rivers ranged from 7.0 to 8.2 in September, and ranged from 7.3 to 7.8 in December. All the measurement results are consistent with water quality criteria of Indonesia. The pH value of Lake Limboto ranged from 7.8 to 8.0 in September, and ranged from 7.5 to 8.0 in December, being consistent with the criteria.

Biochemical Oxygen Demand (BOD_5): BOD_5 of rivers ranged from 5.6 to 16.8 mg/l in September, and ranged from 8.5 to 38.7 mg/l in December. These results, as a whole, indicate that the rivers are severely polluted by organic matter. Even the sampling points located at upper reaches of the river, e.g. upper Bone, recorded unusually high values (5.6 to 10.85 mg/l). The reason for the high concentration or the cause of pollution is not found out at this moment. According to the contractor, the rain on the previous day of the sampling undertaken might have caused. Higher concentrations are recorded on Pohu river, Tapodu river (an outlet from the lake), lower Tamalate and lower Bone, respectively. These points may have been affected by waste water from residential area along the rivers. BOD_5 of Lake Limboto ranged from 5.6 to 7.5 in September, and ranged from 8.1 to 10.3 in December. Judging from these results, Lake Limboto is evaluated as α-mesosaprobic water which is defined as a water body with the BOD concentration of 5 – 10 mg/l. The measurement results have reflected that there are high organic load in Lake Limboto. These results, however, are relatively low compared with the results obtained in 1994, which ranged from 29 to 49 mg/l (Ref. Table A4.1.15). Judging simply from these figures, the water quality of Lake Limboto has improved substantially during the past 7 years (during 1994 and 2001).

Chemical Oxygen Demand (COD): COD of rivers ranged from 12 to 23 mg/l in September, and ranged from 11 to 45 mg/l in December. These results indicate that the

rivers are severely polluted by organic matter as is BOD_5. COD of Lake Limboto ranged from 12 to 13 in September, and ranged from 9 to 12 in December. The measurement results are considered to be rather high, or polluted, in general. However, they are remarkably low comparing with the COD concentration (40 - 57 mg/l) obtained by CIDA in 1994 (Ref. Table A4.1.15). This fact is consistent with the results of BOD_5. But the reason why the COD concentration has decreased is not clarified.

Dissolved Oxygen (DO): DO of rivers ranged from 6.6 to 7.1 mg/l in September, and ranged from 3.2 to 5.2 mg/l in December. These values are evaluated as suitable in September or good in December from the viewpoint of aquatic ecology and fisheries. DO of Lake Limboto showed 6.8 mg/l in September, and it ranged from 4.0 to 5.5 mg/l in December. The concentration in September shows that Lake Limboto is suitable for aquaculture although the measurement results in December are considered to be slightly low. All the measurement results satisfied the water quality criteria Class II for aquaculture, i.e. DO concentration of 3 mg/l or more.

Total Suspended Solids (TSS): TSS of rivers ranged from 12 to 1,052 mg/l in September, and ranged from 6 to 265 mg/l in December. According to researchers who conducted the water samplings, the extremely high concentration (1,052 mg/l) on the Bone river was due to the heavy rain which occurred on the previous day. TSS of Lake Limboto ranged form 27 to 29 mg/l in September, and ranged from 2 to 5 mg/l in December. The measurement results in September were much higher than that in December. The reason for this might be attributed to be the rainfall.

Coliform Bacillus: Coliform Bacillus of rivers ranged from <300 to 2,300 MPN/100ml in September, and ranged from <300 to 24,000 MPN/100ml in December. Higher numbers recorded at on Alo-Pohu and Tamalate rivers in December. These high numbers does not satisfy even Class III or Class IV of the water quality criteria. Coliform Bacillus of Lake Limboto ranged form <300 to 1,400 MPN/100ml in September, and ranged from 300 to 2,000 mg/l in December. These two results showed almost the same order, and are consistent with the criteria Class II. The results of Faecal Coliform measured in 1994 by CIDA ranged from 400 to 46,000 MPN/100ml (Ref. Table A4.1.15). Faecal Coliform is the Coliform bacteria originated only from feces of animals while Coliform Bacillus is not limited to the Coliform originated from feces. Therefore, the number of Faecal Coliform should be lower than that of Coliform Bacillus. Considering this point, the results of Coliform Bacillus obtained this time are considered much lower than that obtained in 1994, indicating the less

contaminated by Coliform bacteria.

Total Nitrogen (T-N): T-N of rivers ranged from 0.79 to 2.77 mg/l in September, and ranged from 1.02 to 4.69 mg/l in December. In general, when the concentration of T-N is 0.2 mg/l or more, the water body is considered to be under the eutrophication ("The Methodology of Water Quality Investigation for Water Supply," 1997.), although the definition of the threshold level depends on the various factors. Judging from this threshold level, the rivers in LBB basin are considered to be eutrophic. T-N of Lake Limboto ranged from 1. 18 to 1.41 mg/l in September, and ranged from 1.28 to 1.58 mg/l in December. These four results have narrow range, but all of them exceed the said threshold level of eutrophication; hence, Lake Limboto is considered to be eutrophic in terms of Nitrate concentration.

Total Phosphorus (T-P): T-P of rivers ranged from 0.002 to 0.008 mg/l in September, and ranged from 0.039 to 0.082 mg/l in December. In general, when the concentration of T-P is 0.02 mg/l or more, the water body is considered to be under the eutrophication (Same source mentioned above.), although the definition of the threshold level of eutrophication depends on the various factors. Comparing the T-P concentration measured with this threshold, the results in September was considered to be lower than eutrophication level while in December the rivers were considered to be eutrophic. T-P of Lake Limboto ranged from 0.002 to 0.003 mg/l in September, and ranged from 0.039 to 0.042 mg/l in December. These results have the similar tendency to that of river water, and the results in December exceeded the said threshold level of eutrophication; hence, Lake Limboto is considered to be eutrophic in terms of phosphorus concentration.

Electric Conductivity (EC): EC of rivers ranged from 125 to 560 μS/cm in September, and ranged from 127 to 340 μS/cm in December. Higher values were recorded on the Alo-Pohu river. Meanwhile, the results of EC obtained CIDA in 1994, ranged from 102 to 855 μS/cm (Ref. Table A4.1.15), showing the same level as that obtained by JICA Study Team. EC of Lake Limboto ranged from 351 to 387 μS/cm in September, and ranged from 298 to 425 μS/cm in December. The two results of the lake showed almost the same range as those of rivers.

Color: Color of rivers ranged from 5 to 18 TCU in September, and ranged from 1 to 34 TCU in December. Higher values were recorded on the Bone river, which might be related to the mining activities in the upstream area of the basin. Color of Lake

Limboto ranged from 9 to 10 TCU in September, and ranged from 8 to 12.5 TCU in December.

Turbidity: Turbidity of rivers ranged from 0.62 to 30.1 NTU in September, and ranged from 0.09 to 7.92 NTU in December. The higher values of turbidity recorded on the Bone river, which can be explained by the rain on the previous day as mentioned earlier. Turbidity of Lake Limboto ranged from 1.61 to 2.81 NTU in September, and ranged from 0.34 to 0.61 NTU, showing higher values in September than those in December for both rivers and the Lake Limboto.

Cadmium (Cd), Total-Mercury (T-Hg), Lead (Pb) and Hexavalent Chromium (C^{6+}): All the measurement results, including both of rivers and Lake Limboto, of these heavy metal parameters were less than their detection limit. These detection limits are less than the water quality criteria for Cd and T-Hg or similar level for Pb and C^{6+}; hence, it is not considered that there is a problem in terms of these parameters.

Selenium (Se): Se of rivers ranged from 0.014 to 0.133 mg/l in September, and was less than the detection limit, 0.005 mg/l, in December. Likewise, Se of Lake Limboto ranged from 0.046 to 0.074 mg/l in September, and was less than the detection limit, 0.005 mg/l, in December. The concentration has a wide range and all the September results exceeded the criterion (0.01 mg/l). Meanwhile, Se is contained in environmental water, and the concentration is less than 0.01 mg/l in most of the cases (" Guidebook for Water Quality Criteria of Drinking Water," 2000.). It is said that high concentration of Selenium exceeding the natural condition is often caused by mining and/or industrial activities. Thus, the September results of selenium suggest the influence of mining or industrial waste.

Arsenic (As): As of rivers recorded less than the detection limit, 0.002 mg/l in September, and ranged from less than the detection limit to 0.009 mg/l in December. But, even in December, eight out of 13 measurement results were less than the detection limit. Likewise, the results of Lake Limboto were less than the detection limit in September, and recorded 0.005 mg/l in December. Comparing with water quality criteria, Class I (0.05 mg/l) and Class II – IV (1.0 mg/l), all the results are less than the criteria. Thus, it is not considered that there is a problem with this parameter.

Zinc (Zn): Zn of rivers recorded less than 0.057 mg/l in September, mostly less than the detection limit, 0.005 mg/l, and ranged from 0.05 to 1.11 mg/l in December. Zn of

Lake Limboto recorded less than the detection limit in September, and ranged 0.07 to 0.08 mg/l in December. Thus, there are big differences between the September result and the December one. Meanwhile, Zn is said to be contained in environmental water in general, and its concentration is around 0.005 mg/l in most of the cases (Same source described above.). Most of the December results exceeded the criteria Cass I – III (0.05 mg/l) and Class IV (2.0 mg/l), although the September ones did not exceed the criteria.

Iron (Fe): Measurement results of Fe showed the similar tendency to those of Zn, namely, there was a big difference between the two results in September and in December. However, the highest value, 19.28 mg/l, was recorded in September on the Bone river, which is different from the case of Zn. Fe of Lake Limboto recorded less than the detection limit, 0.02 mg/l, in September, and ranged 0.19 to 0.95 mg/l in December. There was a big difference in the two results as the case of rivers. Meanwhile, Fe is said to be contained in environmental water in general, and the concentration is usually less than 1.5 mg/l, and 0.24 mg/l on average in most of the cases (Same source described above.). The higher values recorded on rivers, especially on the Bone river could be attributed to mining.

Manganese (Mn): Mn of rivers ranged from 0.012 to 0.768 mg/l, in September, and ranged from 0.072 to 0.495 mg/l in December. Mn of Lake Limboto ranged from 0.135 to 0.174 mg/l in September, and ranged 0.089 to 0.179 mg/l in December. The two results in September and in December indicated similar level for both rivers and the lake. Meanwhile, Mn usually coexists with Fe with the concentration of around one tenth of that of Fe (Same source described above.). Therefore, if the ratio of Mn and Fe is far from one tenth, there considered to be some reason. Checking the measurement results, many of the results are far from the expected ratio of one tenth. This could suggest that there are some influences of human modification.

Cyanide (CN): All of measurement results of CN were less than its detection limit, 0.026 mg/l, for both rivers and Lake Limboto. The water quality criteria of Class I – III are 0.02 mg/l; hence, it is not estimated that there is a problem in terms of these substances.

Nitrate Nitrogen (NO_3-N) and Nitrite Nitrogen (NO_2-N): All the measurement results of NO_3-N were less than 0.5 mg/l for both river water and lake water, and that of NO_2-N were less than 0.3 mg/l. NO_3-N results are far below the water quality criteria whereas

some of NO_2-N results exceeded the criteria. Meanwhile, NO_3-N and NO_2-N are usually contained in environmental water, with the average concentration of 0.3 mg/l (Same source described above.). NO_3 easily changes into NO_2 with reversible reaction in the environment and vise versa. Therefore, total contents of the two is often examined and evaluated instead of one of the two. If one intakes of the water containing the NO_3 and/or NO_2 with the total concentration of more than 10 mg/l, a disease of circulatory organ may happen, and especially it is dangerous for an infant. Judging from the measurement results, however, none of the measurement results are threatening.

Fluorine (F): All the measurement results of F were less than 0.5 mg/l, meeting with the water quality criteria. F contained in environmental water originates from geology, and high contents of F are often observed in the area near volcanoes or in granite geology. It is said that if one intakes the water containing F with the concentration of more than 0.8 mg/l continuously, a disease of teeth might happen (Same source described above.). The measurement results were far below this threshold, and it is considered to be no problem in terms of using for drinking water.

Chloride Ion (Cl^-): Cl^- is contained in environmental water more or less, and usually originates from geology or salt transported by wind. This effect caused by the wind-transported salt often reaches to the area up to 25 km from the sea. Additionally, Cl^- is contained in domestic effluent, including urine and feces, as well as industrial waste water. All the measurement results of Cl^- were less than 42.63 mg/l for both river water and lake water, showing far below the water quality criteria Class I (600 mg/l).

Calcium Ion (Ca^{2+}) and Magnesium Ion (Mg^{2+}): The value which is converted from the sum of Ca^{2+} and Mg^{2+} into the one equivalent to Calcium Carbonate ($CaCO_3$) is defined as "Hardness (Definition in the USA Hardness)." Since the atomic weights of Ca^{2+}, Mg^{2+} and $CaCO_3$ are approximately 40, 24.3 and 100, respectively, Hardness is calculated as following: Hardness (mg/l) = 2.5 × [Concentration of Ca^{2+}] + 4 × [Concentration of Mg^{2+}]. The calculated results of Hardness by this formula range from 72 to 382 mg/l in September and form 73 to 202 mg/l. If the hardness of water is less than 100 mg/l, the water is evaluated as "soft water," while when more than 200 mg/l, it is evaluated as "hard water." Therefore, most of the measurement results are located to be in between soft water and hard water. Higher Hardness recorded on the Alo-Pohu river for September results with the value of more than 300 mg/l. The quality criterion is not given for Hardness by the Indonesian water quality criteria.

However, it is said, in general, that if one takes water with high hardness of more than 300 mg/l continuously, it is likely to have a disease of urinary calculus (Same source described above.). In this respect, the attention should be paid for using the river water in the Alo-Pohu river as a drinking water.

Phenolic Substances: All of measurement results were less than its detection limit, 0.005 mg/l, for both rivers and Lake Limboto. Thus, it is not considered that there is a problem with this parameter.

Remarks on Bottom Sediment Quality

Temperature and pH: Measurement results of both bottom sediment temperature and pH of rivers showed similar fluctuation tendency among sampling points to those of water temperature and pH, except for the pH value of Lake Limboto, showing rather high, or alkalinity, ranging from 8.46 to 8.57.

Total Mercury (T-Hg) and Hexavalent Chromium (Cr^{6+}): Out of nine parameters, T-Hg and Cr^{6+} have not been detected at any sampling points including both rivers and Lake Limboto. As far as judging from these measurements results, bottom sediments of these water bodies are not considered to be contaminated by gold mining, being conducted in upstream area of the Bone river.

Selenium (Se): Se was detected at all the sampling points with the concentration up to 1.7 mg/kg. The high concentration of Se in bottom sediment is in consistent with that in rivers and lake water, which implies the influence of some human activities.

Lead (Pb): Pb is a component of crust of the earth and it is considered that the average concentration in the crust is approximately 16 mg/l (Same source described above.). The measurement results of Pb were less than the detection limit, 0.05 mg/l, except for several sampling points whose concentrations were up to 1.63 mg/kg. Judging from the average concentration of Pb in the crust, the measurement results are thought to be rather low.

Arsenic (As): It is considered that soil contains Arsenic with the concentration ranging from 0.003 to 0.01 mg/kg on average (Same source described above.). The measurements results of Arsenic were ranging from 0.00 to 0.046 mg/kg, with the average of 0.02 mg/kg. Judging from the average concentration in soil, the

measurement results were relatively high. But there is a case that some volcanic soils can contain 40 mg/kg of Arsenic. It can not be concluded that the measurement results are simply extraordinary.

Zinc (Zn): It is considered that the concentration of Zn of soil ranges 10 to 300 mg/kg, with the average of 80 mg/kg in general (Same source described above.). The measurement results ranged from 1.61 to 9.93 mg/l. Comparing the average values and the measurement results, the results showed rather low values.

Iron (Fe): Clarke number, which indicates the average concentration in the surface layer of the earth, of Fe is 4.7 %, or 47,000 mg/kg. The measurement results ranged from 746.7 mg/kg to 7,664 mg/kg, which, therefore, shows rather low content judging from Clarke number.

Manganese (Mn): Mn is the fourth biggest contents in the crust of the earth and its Clark number is 0.09 %, or 900 mg/kg. The measurement results ranged from 148.6 mg/kg to 411.4 mg/kg, with the average of 248.9 mg/kg. Comparing with Clark number, the measurement results were slightly low but in the same order. Comparing with the concentration of Fe, many of the values of Mn showed around 1/10 of that of Fe.

(3) Evaluation of Water Quality and Bottom Sediment Quality

The measurement results were analyzed and evaluated as follows:

Water Quality

The water quality of the Alo-Pohu, Biyonga, Bolango, Tamalate and Bone rivers as well as Lake Limboto can be evaluated as being polluted by biological pollutants as a whole. Especially, lower Pohu, lower Tamalate and lower Bone river reaches are highly polluted in terms of high concentration of BOD_5, ranging 5.6 to 38.7 mg/l, COD, ranging from 12 to 45 mg/l, and Coliform Bacillus, ranging from <300 to 24,000 MPN/100ml. Turbidity is also high especially on lower reaches of rivers. The Secchi disk reading is usually less than 0.5 m in Lake Limboto, according to the existing data.

In spited of the fact mentioned above, water quality of Lake Limboto, whose BOD_5 concentration ranged from 5.6 to 10.3 mg/l, has considered to have improved, when it is compared the measurement results obtained by CIDA in 1994. This tendency is

supported by the Coliform Bacillus of Lake Limboto, ranged from <300 to 2,000 MPN/100ml in 2001, which has improved from the 1994 measurements which ranged from 400 to 46,000 MPN/100ml.

The pH value and DO shows that water quality is adequate for aquatic ecology and fisheries. All the measurement results of pH were contained between 7.0 and 8.2. Those of DO ranged from 3.2 to 7.1 mg/l, all of which are consistent with the water quality criteria of Indonesia.

Total Nitrogen (T-N) and Total Phosphorus (T-P) showed that Lake Limboto is under the eutrophic condition. The lake water is evaluated as α-mesosaprobic water judging from the BOD_5 concentration.

As for heavy metals, the results indicated that the concentrations of Cadmium (Cd), Total Mercury (T-Hg), Lead (Pb) and Hexavalent Chromium (Cr^{6+}) were lower than the detection limits. However, Selenium (Se), Arsenic (As), Zinc (Zn), Iron (Fe) and Manganese (Mn) were detected, suggesting the effect of some human modification such as industrial activities or mining.

Bottom Sediment Quality

The results of bottom-sediment quality test showed that analyzed parameters (heavy metals) were rather low or within Clarke number, which indicates the average concentration in the surface layer of the earth, meaning no contamination with heavy metals. Total Mercury (T-Hg) and Hexavalent Chromium (Cr^{6+}) were lower than their detection limits. However, the measurement results of Selenium (Se) implied the effect of some human activities.

A4.1.8 Other Environmental Issues

Water treatment system: Sewage or wastewater treatment system has not been established in the LBB basin. Wastewater from individual houses is discharged directly into rivers or other water body, including Limboto Lake. In Kota Gorontalo, the drainage system is developed along roads through which domestic effluent is drained into the rivers. Especially, the Tamalate river is polluted with domestic effluent, because it collects discharges from densely populated areas and the low channel discharge worsens its water quality.

Solid Waste: Regarding solid waste, Kota Gorontalo has a cleaning system. Garbage from individual houses and commercial and industrial enterprises is collected by city service on their request basis. The cleaning activities are carried out from 4:00 to 9:00 in the morning and 16:00 to 18:00 in the evening. According to the city officials, a total of 54 workers (as of August 2001) are allocated in the whole city of Gorontalo. The tourists as well as citizens can receive a benefit from the cleaning system.

The feces collecting system has also been developed in Kota Gorontalo with an assistance of World Bank. Two trucks are now allocated to collect feces from individual houses on a request basis. The official in charge says that because the collection is charged by Rp. 200,000, only some 20 houses use the collection system a month on the average. The collected faces are separated into solid and liquid, and the solid substances, after dried up, are sold as organic fertilizer to farmers.

Air quality, Noise and Vibration: According to the officials in Kota Gorontalo, there is no data available on air quality, noise pollution or ambient vibration in LBB area.

Land subsidence: According to the PU officials of Gorontalo Province, the issue or problem on land subsidence caused by lowering of groundwater level has not been reported.

A4.2 Legislations for Natural Environmental Conservation

(1) Law, Regulation and Guidelines on Natural Environment

The legislative structure in Indonesia forms a hierarchy as illustrated in Figure A4.2.1. Higher level legislations are oriented more for basic principles and the lower level ones describe articles and paragraphs more specifically.

A number of laws, decrees and regulations on natural environment, including those provided by local governments have been enacted so far. They have been revised or repealed in line with the then political administration. Among laws and regulations being enacted, those currently effective and considered to be important are introduced in Table A4.2.1 with their objective and brief contents.

(2) Criteria on Water Quality

Criteria on water quality are provided by "Government Regulation No. 82/ 2001 concerning Management of Water Quality and Water Pollution Control." According to the regulation, water quality classification is divided into four (4) as follows:

1) Class I water is utilized for drinking water,
2) Class II water is utilized for recreational activity, freshwater fish culture, animal husbandry, irrigation,
3) Class III water is utilized for freshwater fish culture, animal husbandry, irrigation, and
4) Class IV water is utilized for irrigation.

Water quality criteria for the four classes of water are listed in Table A4.2.2.

On the other hand, the criteria on wastewater are provided by "Ministry Decree No. 51/ 1995, regarding Criteria for Waste Water from Industrial Activities." Wastewater from industrial activities and businesses with a certain size are enforced to meet the criteria for its effluent. The criteria are provided by type of industry/business with respective parameters and concentrations to be met.

A4.3 Procedures for Environmental Impact Assessment

(1) Laws and Regulations on Environmental Impact Assessment

Laws and Regulations on Environmental Impact Assessment are provided by Regional Environmental Impact Management Agency in 2001, as shown in Table A4.3.1.

(2) The Procedure of AMDAL

Procedural low of environmental Impact Assessment is illustrated in Figure A4.3.1. The procedure begins with the public notice of the proposed project and ends at the decision making of project implementation based of the validity of the proposed project, checking and evaluating the results of ANDAL, RKL and RPL. During the procedure, there are several times of participation opportunities of local residents/stakeholders, by means of submission of questions, opinions and/or requests in a form of documents and/or oral through public consultation.

The supervisory agency, BAPEDALDA (Environmental Management Agency), coordinates necessary procedures between project proponents and local residents/ stakeholders. AMDAL Commission is also organized being composed of government officials from project-related sectors, stakeholders and NGOs. The main task of AMDAL Commission is to review and appraise the documents on AMDAL including KA-ANDAL, ANDAL, RKL and RPL, and to give necessary recommendations to project proponents.

The time period of whole procedure of AMDAL ranges from 6 months to 2 years depending on the size of the proposed projects/activities and vulnerability of stakeholders and the project site, etc. The duration of appraisal of KA-ANDAL (TOR of Environmental Impact Study) by AMDAL Commission is supposed to be less than 75 day. During the appraisal procedure, public participation procedure such as consultation meetings, or disseminations, are to be held twice, through which stakeholders can submit or announce their questions, opinions and requests. On the other hand, regarding the appraisal procedure of ANDAL, RKL and RPL, the consultation meeting is to be held several times. Similar to appraisal procedure of KA-ANDAL, stakeholders can submit their questions, opinions and requests during the procedure within 75 days. Taking into account the feedback from stakeholders, project proponent revises and finalizes the ANDAL including PKL and RPL to prepare final report of AMDAL within 15 to 30 days on average. Finally, the Head of BAPEDALDA in respective provincial government evaluates the validity of the proposed project and makes a decision on implementation of the project.

After the implementation of the project, the project proponent has an obligation to undertake RKP and RPL in line with their plans. Once the decision of the project implementation was made, the implementation of the project can be postponed up to the maximum periods of 3 years.

(3) Current Institutional Status on Environmental Management

The supervisory agency of environmental management (BAPEDALDA) is supposed to be installed in provincial, kabupaten and kota governments. In Gorontalo Province, however, BAPEDALDA has not been established yet. According to officials of BAPEDA, Gorontalo Province, BAPEDALDA of Gorontalo Province will be established after the election of Provincial Governor to be undertaken in September 2001. The regional office (Regional Environmental Impact Management Agency)

located in Makassar is now temporarily covering the functions of BAPEDALDA of Gorontalo Province, being supported by BAPEDALDA, North Sulawesi Province.

Regarding Kabupaten Gorontalo and Kota Gorontalo in the LBB basin, BAPEDALDA has not been organized yet, either. Instead, Kabupaten Gorontalo has two sections in Economics and Environmental Division, such sections as Pollution Prevention and Environmental Impact Assessment (EIA). The EIA section covers supervision of EIA procedure for small size business and/or activities by consulting with AMDAL Commission of Provincial Government. On the other hand, Kota Gorontalo has an environment related division consisting of 3 sections such as Environment, City planning and Cleaning. The environment section is composed of 5 staff members covering AMDAL, living environment and conservation of natural environment. The section has an experience of AMDAL formerly, with which dumping site of solid waste project was evaluated in 1998.

A4.4 NGOs and Other Organizations Acting in Study Area

There are at least 9 non-government organizations (NGOs) acting in Kabupaten Gorontalo on environmental issues including water management. They are listed as in Table A4.4.1 with their main activities according to information from the leader of LSM MERDEKA.

Among the NGOs listed in the table, an interview was made to LSM MERDEKA on 22nd of August 2001. MERDEKA was founded in August 1997 but formal notary was in 1998. It is composed of 10 members, i.e., leader, 3 deputy leaders, 2 secretaries, one accountant and other 3 staff members. MERDEKA is 1) sending missions concerning one environmental issues of marine and Lake Limboto, 2) supporting the structural measures for flood mitigation and 3) developing a livelihood with business plans. It is currently focusing on capacity building and empowerment of communities around Lake Limboto for better understanding of cause of erosion and flooding in cooperation with other NGOs. The capacity building and empowerment are conducted by means of seminars and/or communications with individuals concerned.

In addition, an NGO named Yayasan KELOLA was also interviewed. Its headquarters is located in Manado and a branch is located in the north of Gorontalo Province facing to Sulawesi Sea. According to the result of interview and broacher provided, Yayasan KELOLA, an Indonesian community based coastal zone management NGO, was

founded on January 10, 1995 in Manado, aiming at restoring the management of the coastal zone of both North Sulawesi and Gorontalo provinces. Together with the communities, KELOLA has undertaken studies and surveys of coastal and oceanic natural resource potentials, and activities for developing the coastal zone management techniques and for implementing sustainable livelihood alternatives.

KELOLA's programs are carried out by several departments in two major program divisions, i.e., Technical Programs and Facilitation of Activities Program. The Technical Program consists of four departments, 1) surveys and investigations, 2) information and documentation, 3) mediation and advocacy, and 4) facilitation and group development as follows:

1) Surveys and Investigations: This department is involved gathering and evaluating data and information, especially pertaining to costal issues such as biodiversity loss, destructive fishing practices and the socio-economic welfare of costal communities. Output of these activities is then managed by the department of Information and Documentation.
2) Information and Documentation: This department is KELOLA's backbone with regards to the sustainability of its programs. Activities include: database management, GIS, publication of coastal issues, and coastal zone management campaigns vis-a-vis the mass media.
3) Mediation and Advocacy: This department acts as the catalyst to increase public involvement regarding coastal resource management in North Sulawesi. Activities include developing support for local community movements, hosting dialogues amongst local stakeholders, and undertaking analyses and studies of current and traditional management practices.
4) Facilitation and Group Development: Activities include the development of coastal zone studies, participatory planning for farmers and artisanal fisher-folk, legal studies, and inclusion of coastal villagers in coastal zone policy-making processes.

According to the interview to the leader, KELOLA's main concern is to improve equitable distribution of benefits from marine resources. The big enterprises from cities outside Sulawesi including Java, try to buy marine resources from local fisher-folks with cheap price. If the fisher-folk does not know the fire market price of the resources, the enterprises can easily convince them to sell with the unfair cheap price. KELOLA is now actively contact the local fisher-folks and inform the situation

the unfair trade and strategies of big enterprises by means of participatory activities including investigation, documentation, seminars and advocacy described above.

KELOLA is also intending to promote the community awareness on environmental conservation through the land rehabilitation activities involving local people. The NGO prepared a proposal on the said activity and has submitted it to Japanese Embassy in Jakarta in July 2002, for the Grant Assistance for Grassroots Projects funded by Ministry of Foreign Affairs of Japan.

Table A4.1.1 LIST OF FLORA FOUND IN LOWLAND OF GORONTALO PROVINCE

No.	Local Name	English Name	Latin Name
1	Palem ekor ikan	Fish tail palm	*Caryota mitis*
2	Pangi	Pangi	*Pangium edule*
3	Bambu	Bamboo	*Shizoztachyum sp*
4	Woka	Fan palms	*Livistona torundifolia*
5	Rotan	Rattans	*Calamus spp*
6	Beringin	Figs	*Ficus spp*
7	Nira	Wild sugar palms	*Arenga pinnata*
8	Nantu	Gutta percha	*Palaquin obsturifolium*
9	Cempaka	Cempaka	*Elmerrillia ovalis*
10	Linggua	Linggua	*Pterocarpus indicus*
11	Damar	-	*Shorea sp.*
12	Rao	Rao	*Dracontomelum dao*
13	Gopara	Gophasa	*Lagerstroemia ovalifolia*
14	Bolangitan	Bolangitan	*Tetrameles nudiflora*
15	Aras	Beremban	*Duabanga moluccana*
16	Licola	Trunkless (Licola)	*Licuala celebensis*
17	Bintangar	-	*Kleinhovia hospita*
18	Coro	Blotched figs	*Ficus variegatus*
19	Leda	Leda	*Eucalypus deglupta*
20	Pinang	Palma	*Pinanga sp*
21	Pinang	Betel-nut palm	*Areca catechu*
22	Cemara	She-oak	*Casuarina sp.*
23	Kayu Hitam	Ebonies	*Diospiros celebica*
24	Pisang	Banana	*Musa paradisiaca*
25	Jati	Teak	*Tectona grandis*
26	Akasia	Acacia	*Acacia tomentosa*
27	Kenari	Kenari	*Canarium asperum*
28	Loyan	Oaks	*Lithocarpus spp*
29	Sirih Hutan	-	*Pafer adukmu*
30	Wanga	-	*Pigafetta fillaria*
31	Kenanga	Ylang-ylang	*Canangium odoratum*

Source: The Ecology of Sulawesi, 1988
Report on Data Compilation of Potential Forest Resources of North Sulawesi, Jan. 2000.

Table A4.1.2 URBAN VEGETATION (CROPS) FOUND DURING FIELD RECONNAISSANCE IN GORONTALO

No.	Indonesian Name	English Name	Latin Name
1	Advokat	Alligator pear	*Persea americana*
2	Belimbing	-	*Averrhoa carambola*
3	Belimbing Botol	Ginger lily	*Averrhoa Bilimbi*
4	Srikaya	Cusdard apple	*Anona riticulata*
5	Srikaya	Sugar apple	*Anona squamosa*
6	Coklat	Cocoa plant	*Theobroma cacao*
7	Jambu Biji	Gueva	*Psidium guajava*
8	Jeruk Kasturi	Chinese orange	*Citrus microcarpa*
9	Mangga	Manggo	*Mangifera indica*
10	Nenas	Pineapple	*Ananas comosus*
11	Nangka	Jack fruit	*Artocarpus heterophylla*
12	Popaya	Melon tree	*Carica papaya*
13	Pinang	Betel-nut palm	*Areca catechu*
14	Lamtoro	Santa Elena	*Leucaena glauca*
15	Pisang	Banana	*Musa paradisiaca*
16	Jagung	Corn	*Zea mays*
17	Jeruk Besar	-	*Citrus maxima*
18	Kopi	Coffee	*Coffea robusta*
19	Kelapa	Coconut	*Cocos nucifera*
20	Cengkih	Clove	*Euginea aromatica*
21	Panili	Vanilla	*Vanilla planifolia*
22	Langsa	-	*Lansium domesticum*
23	Manggis	Mangosteen	*Garcinia mangostana*
24	Sirsak	Soursop	*Anona muricata*
25	Durian	Durian	*Durio Zibethinus*
26	Rambutan	Rambutan	*Nephelium lappoceau*
27	Kemiri	Candlenut	*Alentitas mollucana*

Table A4.1.3 LIST OF MACROPHYTES

Local Name	Latin Name
• Alata (genjer)	*Limnocharis flava*
• Alata (eceng)	*Monochoria hastate*
• Bombanga	*Hydrochloa* sp.
• Buangga	*Cyperus* spp.
• Dumalo	*Nayas* sp.
	Ceratophyllum sp.
	Utricularia sp.
• Iduk	*Ludwigia adscendens*
• Kangkung	*Ipomoea aquatica*
• Kayu Kelong	*Aeschynomene* sp.
• Kiambang	*Azolla pinnata*
	Lemna sp.
• Plambungo	*Ipomoea crassicaulis*
• Rumput	*Panicum* sp.
	Scirpus sp.
	Leersia sp.
• Teratai	*Nelumbium* sp.
	Orellia alismoides
• Toloe	*Polygomum* sp.
• Tombii	*Pistia* sp.

Source: "Limboto-Bolango-Bone Water Resources Development Master Plan, Interim Report ANNEX 2," 1994.

Table A4.1.4 IMPACTS OF AQUATIC MACROPHYTES

Positive/negative	Impact
Positive	• Provide organic matters that enter food chain as a source of food. • Provide shelter and habitat for both fish and invertebrate.
Negative	• Reduce dissolved oxygen (DO) concentrations through decomposition of dead plants. • Increase sedimentation rates caused by retarded water inflow/circulation • Increase the water losses through transpiration, which impacts on the water balance of the lake.

Source: "Limboto-Bolango-Bone Water Resources Development Master Plan, Interim Report ANNEX 2," 1994.

Table A4.1.5 FISH SPECIES REPORTED IN LAKE LIMBOTO

No.	Indonesian Name	English Name	Scientific Name	Introduction
1	Ikan mas	Common carp	*Cyprinus carpio*	1950, 1989
2	Mujair	Nile tilapia	*Oreochromis niloticus*	1944
3	Nila	Common tilapia	*Oreochromis mossambicus*	1972
4	Tawes	Barb	*Puntius gonionotus*	1954
5	Nilem	Carp	*Osteochilus hasselti*	1950
6	Payangka merah	Gedgeon	*Ophiocara porocephaia*	Indigenous
7	Payangka hitam	Gudgeon	*Ophiocara* sp.	Indigenous
8	Manggabai	Goby	*Glossogobius striatus*	Indigenous
9	Gabus	Snakehead	*Channa striata*	Century ago
10	Lele	Walking catfish	*Clarias batrachus*	?
11	Sidat	Freshwater eel	*Anguilla* sp.	Indigenous
12	Betook	Climbing perch	*Anabas testudineus*	Century ago
13	Sepat siam	Gourami	*Trichogaster pectoralis*	1947

Source: "Limboto-Bolango-Bone Water Resources Development Master Plan, Interim Report ANNEXE 2," 1994.

Table A4.1.6 RECORDED FISH SPECIES DURING FIELD RECONNAISSANCE (on Aug. 8th, 2001)

No	Local Name	Indonesian Name	English Name	Latin Name
1	Mujair	Mujair	Common tilapia	*Oreochromis mossambicus*
2	Nila	Nila	Nile tilapia	*Oreochromis niloticus*
3	Tawes	Tawes	Java barb	*Puntius goniotus*
4	Huluu	Payangka	Gudgeon	*Ophieleotris aporos*
5	Manggabai	Manggabai	Goby	*Glossogobius giurus*
6	Ikan mas	Ikan mas	Common carp	*Cypinus carpio*
7	Seribu	Gorami	Gourami	*Osphronemus gomary*
8	Sapa	Sepat	Two-spots gourami	*Trichogaster trichopterus*
9	Sapa	Sepat	No-spot gourami	*Trichogaster pectoralis*
10	Nilem	Nilem	Carp	*Osteochilus rasselti*
11	Tola	Gabus	Snakehead	*Channa striata*
12	Belut (Otili)	Sidat	Eels	*Anguilla bicolor*
13	Dumbaya	Betook	Climbing perch	*Anabas testudineus*
14	Lele	Lele	Walking catfish	*Clarias batrachus*
15	Kepala timah	Kepala timah	Mosquito fish	*Aplocheilus pachax*

Table A4.1.7 RESULTS OF MARKET SURVEY

(on July 28th and Aug. 9th, 2001)

Local name	English name	July 28th	Aug. 9th	Amount	Cultured/Non-cultured
Nila	Common tilapia	○	○	Numerous	Cultured in fish gauge
Mujair	Nile tilapia	○	○	Numerous	Cultured in fish gauge
Huluu	Gudgeon	○	○	Numerous	
Udang	Shrimp	○	○	Numerous	
Belut (Otili)	Eel	○	○	Present	
Tawes	Java barb	○	○	Present	
Manggabai	Goby	○	○	Numerous	
Payangka	Gudgeon	○	○	Numerous	
Ikan mas	Common carp	○	○	Present	Cultured in fish gauge
Sogili	Eel	(-)	○	Numerous	
Gabus	Snakehead	○	○	Numerous	
Kepiting	Crab	○	○	Numerous	
Gorami	Gourami	(-)	○	Present	

* (-) means not to have been seen in a market.

Table A4.1.8 PROTECTED SPECIES OF FLORA AND FAUNA IN NORTH SULAWESI(1/2)

DESIGNATED BY THE LAW NO. 5 OF 1990 REGARDING "CONSERVATION OF BIOLOGICAL RESOURCES AND ITS ECOSYSTEMS."

No.	Item	Indonesian name	Latin name	LBB basin
I	**Flora**	Pohon Beringin	*Langusei, Ficus minahasae*	○
		Kayu Hitam	*Diospiros celebica*	○
		Gaharu	*Aquilaria malacensis*	
		Kayu Damar	*Shorea sp*	○
		Pohon Kulit Lawang	*Cinnamomum cullilawan*	
		Kayu ipil	*Intsia sp*	
		Benuang	*Duabanga moluccana*	○
		Anggrek Bulan	*Phalaenopsis sp*	
		Anggrek jingga	*Renanthera matutina*	
		Bunga bangkai	*Amorpophallus sp*	
		Edelweis		
II	**FAUNA**			
A	**Mamalia**	Anoa dataran rendah	*Buballus depresicornis*	○
		Anoa dataran tinggi	*Buballus quarlesi*	○
		Kera hitam sulawesi	*Cynopithecus niger*	
		Rusa	*Cervus temorensis*	
		Kera/monyet	*Macaca tongkeana*	○
		Babirusa	*Babyrousa babyrousa*	○
		Musang sulawesi	*Macrogadilia*	
		Kuskus	*Musschenbroky*	
		Tangkasi	*Phalanger celebencis*	
		Duyung	*Dugong dugong*	
		Lumba-lumba	*Ziphiidae dolphinidae*	
		Paus	*Cetacea order*	
B	**Aves**	Rangkong	*Rhiticeros cassidix*	
		Maleo	*Macrochepalon maleo*	○
		Kuntul kolam	*Ardeola speciosa*	
		Cangak merah	*Ardea purpurea*	
		Pecuk ular	*Anginga melanogaster*	
		Elang Laut	*Accipiter trinotalus*	
		Raja Udang	*Alceda meinting*	
		Alap-alap	*Accipiter rhodogaster*	
		Sesap madu	*Acthopyga siparaja*	
		Mandar Sulawesi	*Aramidopsi platennis*	
		Kuntul Kerbau	*Bubujus ibis*	
		Raja Udang	*Ceyx fallax*	
		Bangau Hitam	*Ciconia episcopus*	
		Kuntul Kecil	*Egretta garzetta*	
		Kuntul Besar	*Egretta alba*	
		Raja Udang Biru	*Halcyon cloris*	
		Serindit Sulawesi	*Loruculus exhillis*	
		Elang ikan kelabu	*Lectyopaga inchtyatus*	
		Elang Hitam	*Milvus migras*	
		Kowak merah	*Nyctticorax celedonicus*	
		Kokareng	*Penlopides exorthatus*	
		Betet raket bercak merah	*Prioniturus plaricanus*	
		Betet raket bercak emas	*Prioniturus platurus*	
		Raja udang kepala putih	*Pelargopsis melanorhyncus*	
		Nuri Sulawesi	*Tanygnatus sumatranus*	

Table A4.1.8 PROTECTED SPECIES OF FLORA AND FAUNA IN NORTH SULAWESI(2/2)

C	**Reptilia**	Ular sanca bodo	*Phyton molurus*	
		Ular sawah	*phyton reticulatus*	
		Buaya	*Crocodylus porosa*	
		Soa soa	*Hydrosaurus sp*	
		Penyu belimbing	*Dermochelys coricca*	
		Kura-kura	*Carettochelys sp.*	
D	**Pisces**	Napoleon	*Cheilinus undulates*	
E	**Insecta**	Kupu-kupu bidadari	*Cethosia myrana*	
		Kupu-kupu raja	*T. amphrysus*	
		Kupu-kupu raja	*T. miranda*	
		Kupu-kupu raja	*T. meoris*	
		Kupu-kupu raja	*T. palato*	
		Kupu-kupu raja	*T. riedeli*	
		Kupu-kupu raja	*O. paradisea*	
F	**Benthos**	Akar bahar	*Anthipates spp*	
		Kima raksasa	*Tridacna gigas*	
		Kima selatan	*Tridacna derasa*	
		Kima cina	*Hippopus porcellanus*	
		Kima kunia lobang	*Tridacna crocea*	
		Kima sisik	*Tridacna squarmosa*	
		Kima kecil	*Tridacna maxima*	
		Kima tapak kuda	*Hippopus hippopus*	
		Triton trompet	*Charonia tritanis*	
		Telapak kuda	*Birgus latro*	
		Ketam tapak kuda	*Tachipleus gigas*	
		Kepala kambing	*Cassis cornuta*	
		Batu laga	*Turbo marmoratus*	
		Nautilus berongga	*Nautilus pompilus*	

Remark: The circled are the species seemed to inhabit in LBB basin.
Report on Data Compilation of Potential Forest Resources of North Sulawesi, Jan. 2000.

Table A4.1.9 LIST OF CONSERVATION FOREST IN LBB WATERSHED

Category	Name	Location (Kabupaten)	Area (ha)
Game Refuge	CA.Tangale	Gorontalo	113
Permanent Nature Conservation Area	TN. Bogani Nani Wartabone National Park	Gorontalo and Bolmong	287,115

Source: Report on Data Compilation of Potential Forest Resources of North Sulawesi, Jan. 2000.

Table A4.1.10 OCCURRENCE OF GROUNDWATER AND PRODUCTIVITY OF AQUIFER

Code	Hydro-geological Unit	Aquifer Characteristics
I	**Aquifers in which flow in intergranular**	
I B	Extensive productive aquifer	Aquifer of moderate transmisivity, water table or 'piezometric head of groundwater near or above ground surface (up to 3 m). Well yield range from 10 to 30 l/s.
I C	Extensive moderately productive aquifer	Aquifer of moderate to low transmisivity, water table less than 5 m below ground surface. Well yield may reach 10 l/s.
I D	Locally moderately productive aquifer	Mostly incoherent aquifer of low thickness and transmisivity, water table vary in depth less than 8 m below ground surface. Springs yields may reach 25 l/s.
II	**Aquifer in which flow is both through fissures and interstices**	
II B	Extensive moderately productive aquifer	Aquifer of largely varying transmisivity, depth to the groundwater generally great, springs yield may reach 15 l/s.
II C	Locally productive aquifer	Aquifer of largely varying transmisivity, generally no exploitable groundwater due to the great depth to the groundwater table. Locally springs discharge may reach 300 l/s.
III	**Aquifer in which flow is through fissures, fractures and channels**	
III C	Locally productive aquifer	Groundwater flow limited to fissures, fractures zones and solution channels, groundwater table generally deep.
IV	**Aquifer (fissures or porous of poor productivity and regions without exploitable groundwater**	
IV C	Poorly productive aquifer of local importance	Generally very low transmisivity, locally limited shallow groundwater resources, may be obtained in weathered zones of solid rocks.
IV D	Region without exploitable importance	-

Source: Limboto-Bolango-Bone Basin Watershed Management Master Plan, Volume 2, Annexes, March 1999

Table A4.1.11 AVERAGE RECHARGE COEFFICIENT IN LBB AREAS

Recharge Zone	Hydrogeology Code	Recharge Coefficient Index (%)
Unconsolidated deposits	Qal	20-24
Old volcanic deposits	Qtv	15
Conglomerate, breccia, sandstone deposits	Qc	15
Tertiary volcanic deposits	Tmv	10
	Tms	10
Limestone	Ql	25-30
	Tml	15
Intrusive rocks	I	7

Source: Limboto-Bolango-Bone Basin Watershed Management Master Plan, Volume 2, Annexes, March 1999

Remark: hydrological Code is as indicated below:

STRATIGRAPHY	CODE	GEOLOGICAL UNIT	HYDROGEOLOGICAL UNIT	CODE
QUATERNARY (Holocene)	Qal	Alluvial: Lake, river and coastal deposits: Clay, sand, mud, silt, gravel and pebble.	SUPERFICIAL DEPOSITS Alluvial deposits	Qal
QUATERNARY (Pleistocene)	Ql	Reef limestone: Coralline limestone.	LIMESTONE Limestone	Ql
QUAT-TERTIARY (Plio-Pleistocene)	Qtl	Clastic Limestone: Calcarenite, calcirudite, coralline limestone.	Limestone	Ql
QUAT-TERTIARY (Plio-Pleistocene)	Qts	Celebes Molasse of Sarasin and Sarasin: conglomerate, breccia and sandstone.	Celebes Molasse	Qcm
QUAT-TERTIARY (Plio-Pleistocene)	Qtpv, Qtv	Pinogu volcanic: Volcanic breccia, agglomerate, tuff, andesitic to basaltic lava.	VOLCANIC DEPOSITS Old Volcanic deposits	Qtv
TERTIARY (Miocene)	Tmds	Dolokapa Formation: greywacke, siltstone, mudstone, conglomerate, tuff, lapilli tuff, agglomerate, volcanic breccia, andesitic to basaltic lava.	VOLCANIC SEDIMENTARY ROCKS Volcanic rocks	Tmv
TERTIARY (Miocene)	Tml	Massive Limestone: limestone, light, grey, massive, contains fragment of volcanic rocks	Limestone	Tml
TERTIARY (Miocene)	Tmbv, Tmv	Bilomgula Volcanic: breccia, tuff and andesitic to basaltic lava.	Volcanic rocks	Tmv
TERTIARY (Eocene-Oligocene)	Tnts, Tts	Tinombo Formation: basaltic lava, spilitic basalt and andesitic composition, volcanic, breccia, greywacke, siltstone, green sandstone, red limestone, grey limestone, and low metamorphic rocks.	Mixed volcanic and Sedimentary rocks	Tms
TERTIARY (Miocene)	I	Intrusive Rocks: granite, diorite, granodiorite, quarts Diorite, adamelite.	Intrusive rocks	I

Source: Limboto-Bolango-Bone Basin Watershed Management Master Plan, Volume 2, Annexes, March 1999

Table A4.1.12 ANNUAL GROUNDWATER RECHARGE IN LIMBOTO-BOLANGO-BONE WATERSHED

Recharge Area Code	Limboto		Bolango		Bone	
	Area (km^2)	Recharge ($10^6 m^3/yr$)	Area (km^2)	Recharge ($10^6 m^3/yr$)	Area (km^2)	Recharge ($10^6 m^3/yr$)
Qal	144.7	28.2	59.4	9.6	75.6	23.9
Qtv	116.3	18.7	-	-	425.3	184.5
Qc	-	-	-	-	58.4	23.4
Ql	201.0	51.6	2.9	0.5	-	-
Tml	-	-	24.4	4.3	-	-
Tmv	229.5	45.9	193.8	54.6	590.1	142.2
Tms	28.1	3.2	-	-	-	-
I	170.0	14.3	239.6	24.7	181.1	28.4
Total	889.6	161.9	520.0	93.70	1,331.0	402.0
Recharge (mm)	-	182.0	-	180.2	-	302.0

Source: Limboto-Bolango-Bone Basin Watershed Management Master Plan, Volume 2, Annexes, March 1999

Table A4.1.13 GROUNDWATER BALANCE IN LIMBOTO-BOLANGO-BONE

Area	INPUT		OUTPUT		
	Recharge 10^6 m^3/yr	Infiltration from irrigation 10^6 m^3/yr	Shallow GW abstraction 10^6 m^3/yr	Deep GW abstraction 10^6 m^3/yr	GW throughflow 10^6 m^3/yr
Limboto	161.9	31.5	3.04	5.570	2.76
Bolango	93.7	12.6	1.77	0.050	1.14
Bone	402.0	14.8	6.56	0.005	0.42

Source: Limboto-Bolango-Bone Basin Watershed Management Master Plan, Volume 2, Annexes, March 1999

Table A4.1.14 LAKE LIMBOTO WATER QUALITY DATA IN DECEMBER 1977

Station	Hour	Air Temp. (^oC)	Water Temp. (^oC)	Secchi Depth. (cm)	O_2 (ppm)	CO_2 (ppm)	pH	Cl (ppm)
1	17:00	27	33	11	7.2	1.9	8.5	0.38
2	16:00	28	30	21	7.0	1.8	8.0	0.26
3	13:30	32	31	40	8.2	0	8.3	0.49
4	10:35	38	29	30	7.6	0.8	8.4	0/36
5	12:15	30	31	25	7.8	0	8.4	0.59
6	14:30	26	30	45	7.8	0.7	7.5	0.61
7	15:30	39	30	20	7.6	1.4	8.0	0.36

Source: Limboto-Bolango-Bone Water Resources Development Master Plan, Interim Report, ANNEX 2, 1994.

Table A4.1.15 LABORATORY ANALYSIS OF SOME WATER QUALITY PARAMETERS

	Water quality parameter	pH	TDS	EC	T.S.S.	Boron	Total Iron	BOD	COD	Organic Matter	Faecal Coliform	Phosphate
	High (Norm/a)	9.0	-		2000		5.0	60	10.0	10.0	2000	10.0
	High (Norm/b)	9.0			2000					1.0		
	High (Norm/c)		2000	2250	1440	1.0						
	Low (Norm/a)	5.0	-					0.0	0.0	0.0	100	
	Low (Norm/b)	5.0								0.0		
	Low (Norm/c)		1000	1750	60	0.0						
Sample	Unit	-	(mg/l)	(µS/cm)	(ppm)	(ppm)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	MPN/100 ml	(mg/l)
Number	Location											
River Water												
1	Huludupitango weir		175.0		32.0	0.12	0.0					
4	Alo weir		377.0	855.0	17.0	0.21	0.05					
5	Molalahu Weir		277.0	430.0	14.0	0.15	0.25					
6	Pohu Weir		322.0	516.0	43.0	0.15	0.38					
7	Alopohu weir		341.0	102.0	14.0	0.12	0.12					
8	Bolango river near sea		758.0	235.0	14.0	0.26	0.25					
9	Bolango river mid stream		193.0	210.0	12.0	0.20	0.22					
10	Pilohayanga weir		187.0	215.0	21.0	0.24	0.05					
11	Lomaya weir		195.0	225.0	29.0	0.26	0					
Lake Limboto												
12	Dembe 1 near Staff gauge	7.8						39.02 (xxx)	40.07 (xxx)	27.97 (xxx)	400	0.04
13	Dembe 2 near shore	7.6						48.77 (xxx)	57.24 (xxx)	44.75 (xxx)	7500 (xxxx)	0.005
14	Kayubulan	7.5						29.27 (xxx)	40.07 (xxx)	50.34 (xxx)	46000 (xxxx)	0.024
15	Huto near shore	7.1						29.27 (xxx)	48.65 (xxx)	33.56 (xxx)	400	0.0125
16	Huto near centre	7.4						48.77 (xxx)	57.24 (xxx)	44.75 (xxx)	21000 (xxxx)	0.028
Groundwater												
2	Molawahu II	7.6	285.0	555.0	30.0	0.12		68.28 (xxx)	20.03	1.96 (x)	110.0	
3	Molawahu I	7.6	474.0	520.0	36	0.12		58.50 (xxx)	31.5	33.6/700 (xxx)	110.0	

Norm/a National Water Quality Standard for drinking water and clean water PU, 1990
Norm/b National Water Quality Standard for fishery and agriculture PU, 1990
Norm/c Based on National Water Quality Standard, PU 1990
Category c of ambient water quality being used for agriculture, industry, and hydropower

x : minor polluted
xxx : moderately polluted
xxxx : serous pollution

Table A4.1.16 SUMMARY OF WATER QUALITY (IN SEPTEMBER 2001)

No.	Parameter	Unit	Alo-Pohu		Biyonga	Bolango inc. Topadu		Tamalate		Bone		Lake Limboto		Water Quality Criteria			
			Min.	Max.		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Class I	Class II	Class III	Class IV
A	**Fundamentals**																
1	Temperature	°C	26.9	28.4	31.6	24.7	29.8	27.6	28.1	21.0	25.9	25.8	27.2	1)	1)	1)	2)
2	pH	-	7.8	8.2	7.7	7.2	8.0	7.2	7.5	7.1	7.8	7.8	8.0	6 - 9	6 - 9	6 - 9	5 - 9
3	BOD_5	mg/l	7.5	16.8	11.2	5.6	13.1	11.2	13.1	5.6	13.1	5.6	7.5	2	3	6	12
4	COD	mg/l	15	23	17	12	18	18	22	12	14	12	13	10	25	50	100
5	DO	mg/l	6.62	7.06	6.71	6.8	7.08	6.71	6.99	6.71	6.99	6.8	6.8	>6	>4	>3	>0
6	TSS(Total Suspended Solids)	mg/l	22.0	38.0	24	15	23	12	14	214	1052	27	29	-	-	-	-
7	Coliform Bacillus	MPN/100ml	<300	2,300	<300	<300	900	400	400	<300	<300	< 300	1,400	1,000	5,000	10,000	10,000
8	Total Nitrogen (T-N)	mg/l	1.065	1.2836	2.0278	0.7934	2.7683	0.9811	1.6445	1.0049	2.114	1.1778	1.4106	-	-	-	-
9	Total Phosphorus (T-P)	mg/l	0.003	0.0065	0.0082	0.0029	0.0065	0.0033	0.0049	0.002	0.0065	0.0023	0.0029	0.2	0.2	1	5
10	Electric Conductivity (EC)	μS/cm	507	560	347	182.7	348	267	276	125.1	206.9	351	387	-	-	-	-
11	Color	TCU	5	12.5	12	6	13.5	9	9.5	8	17.5	9	10	-	-	-	-
12	Turbidity	NTU	1.82	3.9	1.64	1.24	5.28	0.62	2.2	6.9	30.1	1.61	2.81	-	-	-	-
B	**Heavy Metals**																
13	Cadmium (Cd)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	0.01	0.01	0.01
14	Total Mercury (T-Hg)	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.001	0.002	0.002	0.005
15	Selenium (Se)	mg/l	0.032	0.05	0.014	0.037	0.065	0.042	0.047	0.042	0.133	0.046	0.074	0.01	0.05	0.05	0.05
16	Lead (Pb)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.03	0.03	0.03	1
17	Arsenic (As)	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.05	1	1	1
18	Hexavalent Chromium (Cr^{6+})	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05	0.05	0.05	0.01
19	Zinc (Zn)	mg/l	<0.005	0.057	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.037	<0.005	<0.005	0.05	0.05	0.05	2
20	Iron (Fe)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	6.18	19.28	<0.02	<0.02	0.3	(-)	(-)	(-)
21	Manganese (Mn)	mg/l	0.07	0.076	0.139	0.033	0.13	0.075	0.349	0.012	0.768	0.135	0.174	0.1	(-)	(-)	(-)
C	**Others**																
22	Cyanide (CN)	mg/l	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	0.02	0.02	0.02	(-)
23	Nitrate Nitrogen (NO_3-N)	mg/l	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.03	0.01	0.01	0.01	0.01	10	10	20	20
24	Nitrite Nitrogen (NO_2-N)	mg/l	<0.001	0.002	0.298	<0.001	0.002	0.002	0.016	<0.001	0.002	0.021	0.126	0.06	0.06	0.06	(-)
25	Fluorine (F)	mg/l	0.24	0.26	0.14	0.11	0.14	0.11	0.14	0.05	0.1	0.11	0.12	0.5	1.5	1.5	(-)
26	Chloride Ion (Cl^-)	mg/l	35.9	42.63	23.56	7.85	19.07	7.85	20.19	20.19	35.9	42.63	42.63	600	(-)	(-)	(-)
27	Calcium (Ca^{2+})	mg/l	109.0	127.1	75.9	60.7	72.9	65.6	75.9	21.1	35.4	71.8	75.4	-	-	-	-
28	Magnesium (Mg^{2+})	mg/l	13.0	17.5	13.5	4.7	10.1	7.7	12.3	4.7	6.9	9.7	12.8	-	-	-	-
29	Phenolic Substances	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	-	-

* Class I water is utilized for drinking water, Class II water is utilized for recreational activity, freshwater fish culture, animal husbandry, irrigation, Class III water is utilized for freshwater fish culture, animal husbandry, irrigation, and Class IV water is utilized for irrigation.

** 1) Air Temperature ±3℃. 2) Air Temperature ±5℃.

Table A4.1.17 SUMMARY OF WATER QUALITY (IN DECEMBER 2001)

No.	Parameter	Unit	Alo-Pohu		Biyonga	Bolango inc. Topadu		Tamalate		Bone		Lake Limboto		Water Quality Criteria			
			Min.	Max.		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Class I	Class II	Class III	Class IV
A	**Fundamentals**																
1	Temperature	°C	26.8	28.6	25.7	23.6	27.8	26.6	26.8	22.7	26.3	28	28.1	1)	1)	1)	2)
2	pH	-	7.8	7.8	7.7	7.3	7.4	7.3	7.5	7.4	7.6	7.5	8.0	6 - 9	6 - 9	6 - 9	5 - 9
3	BOD_5	mg/l	11.0	34.9	14.7	8.5	24.4	24.4	34.7	10.9	38.7	8.1	10.3	2	3	6	12
4	COD	mg/l	17	40	18	11	30	30	40	16	45	9	12	10	25	50	100
5	DO	mg/l	3.5	4.4	4.2	3.7	5.2	3.5	3.8	3.2	4.3	4	5.5	>6	>4	>3	>0
6	TSS(Total Suspended Solids)	mg/l	95	229	84	6	22	7	265	44	131	2	5	-	-	-	-
7	Coliform Bacillus	MPN/100ml	9,300	24,000	21,000	900	9,300	9,300	12,000	<300	4300	300	2,000	1,000	5,000	10,000	10,000
8	Total Nitrogen (T-N)	mg/l	1.81	2.22	1.54	1.02	2.12	1.51	4.69	2.04	3.52	1.28	1.58	-	-	-	-
9	Total Phosphorus (T-P)	mg/l	0.046	0.055	0.0522	0.039	0.049	0.0554	0.0815	0.049	0.055	0.0391	0.0424	0.2	0.2	1	5
10	Electric Conductivity (EC)	μS/cm	322	340	231	185.2	338	236	273	127	283	298	425	-	-	-	-
11	Color	TCU	10.5	14	10	1.5	12	1	24	1.5	34	8	12.5	-	-	-	-
12	Turbidity	NTU	1.3	4.98	3.26	0.12	0.98	0.22	7.92	0.09	3.21	0.34	0.65	-	-	-	-
B	**Heavy Metals**																
13	Cadmium (Cd)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	0.01	0.01	0.01
14	Total Mercury (T-Hg)	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.001	0.002	0.002	0.005
15	Selenium (Se)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	0.05	0.05	0.05
16	Lead (Pb)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.03	0.03	0.03	1
17	Arsenic (As)	mg/l	<0.002	0.009	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.008	0.005	0.005	0.05	1	1	1
18	Hexavalent Chromium (Cr^{6+})	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05	0.05	0.05	0.01
19	Zinc (Zn)	mg/l	0.12	0.35	0.12	0.06	0.18	0.09	1.11	0.05	0.12	0.07	0.08	0.05	0.05	0.05	2
20	Iron (Fe)	mg/l	4.68	9.56	4.69	0.77	1.98	0.81	6.64	1.51	7.34	0.19	0.95	0.3	(-)	(-)	(-)
21	Manganese (Mn)	mg/l	0.14	0.34	0.213	0.072	0.136	0.111	0.495	0.116	0.28	0.089	0.179	0.1	(-)	(-)	(-)
C	**Others**																
22	Cyanide (CN)	mg/l	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	0.02	0.02	0.02	(-)
23	Nitrate Nitrogen (NO_3-N)	mg/l	0.07	0.07	0.04	0.06	0.48	0.03	0.06	0.05	0.44	0.03	0.05	10	10	20	20
24	Nitrite Nitrogen (NO_2-N)	mg/l	<0.001	0.012	<0.001	<0.001	0.034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.06	0.06	0.06	(-)
25	Fluorine (F)	mg/l	0.1	0.24	0.09	0.007	0.44	0.05	0.09	0.03	0.09	0.08	0.08	0.5	1.5	1.5	(-)
26	Chloride Ion (Cl^-)	mg/l	10.09	11.44	6.28	4.94	19.29	4.49	8.53	11.44	14.13	13.35	31.52	600	(-)	(-)	(-)
27	Calcium (Ca^{2+})	mg/l	32.4	39.5	38.66	21.37	62.91	33.82	36.48	30.36	56.94	25.26	34.94	-	-	-	-
28	Magnesium (Mg^{2+})	mg/l	9.9	10.7	10.62	4.84	11.12	5.32	14.13	4.6	7.48	9.91	10.56	-	-	-	-
29	Phenolic Substances	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	-	-

* Class I water is utilized for drinking water, Class II water is utilized for recreational activity, freshwater fish culture, animal husbandry, irrigation, Class III water is utilized for freshwater fish culture, animal husbandry, irrigation, and Class IV water is utilized for irrigation.

** 1) Air Temperature ±3℃. 2) Air Temperature ±5℃.

Table A4.1.18 SUMMARY OF BOTTOM SEDIMENT (IN SEPTEMBER IN 2001)

No.	Parameter	Unit	Alo-Pohu		Biyonga	Bolango inc. Topadu		Tamalate		Bone		Lake Limboto	
			Min.	Max.		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
A	**Fundamentals**												
1	Temperature	°C	25.8	27.7	30.7	23.9	28.9	26.6	27.1	20.2	25.2	24.9	26.4
2	pH	-	7.03	7.93	7.37	7.17	7.94	7.7	7.72	7.41	8.51	8.46	8.57
B	**Heavy Metals**												
3	Cadmium (Cd)	mg/kg	0.018	0.047	0.043	0.027	0.046	0.032	0.036	0.033	0.057	0.031	0.058
4	Total Mercury (T-Hg)	mg/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Selenium (Se)	mg/kg	0.222	1.073	0.431	0.254	0.56	0.338	0.414	0.095	1.098	0.377	1.17
6	Lead (Pb)	mg/kg	0.00	1.11	0.00	0.00	1.63	0.00	0.16	0.00	0.09	0.00	0.00
7	Arsenic (As)	mg/kg	0.014	0.019	0	0.015	0.038	0.017	0.021	0.007	0.026	0.02	0.046
8	Hexavalent Chromium (Cr^{6+})	mg/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	Zinc (Zn)	mg/kg	2.21	6.35	5.93	2.99	6.57	4.13	5.95	3.78	9.03	1.61	1.72
10	Iron (Fe)	mg/kg	1682	4080	746.67	2033	7664	1368	2716	2236	4880	896	1032
11	Manganese (Mn)	mg/kg	192.3	411.4	304.3	148.6	290	198.6	303.5	174.3	393.5	149	205

Table A4.2.1 LIST OF LAW, DECREE, REGULATIONS ON NATURAL ENVIRONMENT

Subject/ Scope	Laws (No. / Year)	Decree/ Regulation (No. / Year)	Principle/ Objective	Brief contents provided
Living Environmental Management	Living Environmental Management (N0.23/1997)	-	To harmonize the man with living environment in terms of utilization of natural resources, development with environmental consideration etc.	• Rights, Obligations and Authorities. • Protection of the Living Environment. • Institutions. • Compensation and Restoration, etc.
Pollution Control (Water)	-	Water Quality Management and Water Pollution Control (No.82/2001)	To manage and control the water quality and water pollution so as to maintain the benefit of water as a natural resources.	• Inventory of quality and quantity of water. • Categories of water. • Control effort. • The Issue of licenses. • Surveillance and Monitoring, etc.
	-	Criteria for waste water from industrial activities. (No.51/1995)	To prevent the water pollution and/or contamination by industrial activities for sustainability of environment that gives benefits to human life.	• Criteria for waste water quality from industry by type of industrial activities, etc.
Pollution Control (Air: Udara)	-	Air pollution control (No.41/1990)	To take care of the quality of ambient air for sustainability of environment. To prevent form air pollution by emission gas form vehicles.	• Principle and methodology of prevention of air pollution. • Establishment of institutions. • Monitoring of ambient air, etc.
Wild life (Plants & Animals)	Conservation of Biological Resources and their ecosystem. (No. 5/ 1990)	-	To protect flora and fauna and its endemism of Indonesia and/or . To protect the endangered, rare and/or vulnerable species of animals and plants.	• Principles and criteria of protected species. • Determination of protected species. • Protection of protected species, etc.
Protected Area for Landscape, Cultural Heritage	-	Management of Protected Zone (Presidential Decree No. 32/1990)	To protect natural resources, history and culture that is important for living environment, planning and development.	• Principles and criteria of protected zone. • Determination of protected zone. • Protection of protected zone, etc.
Forest Protection	Forestry (No. 41/1999)	-	To improve sustainability, fair, equity and unity in forestry development. To improve and optimize a variety of forest function such as production, protection and conservation.	• Classification, definition and function, etc. of forest. • Obligation and service of relevant organization. • Determination of status and function of forest. • Management of Customary forest (Adat), etc.
	-	Management of Protected Zone (Presidential Decree No. 32/1990)	To protect natural resources, history and culture that is important for living environment, planning and development.	• Principles and criteria of protected zone. • Determination of protected zone. • Protection of protected zone, etc.

Table A4.2.2 WATER QUALITY CRITERIA (1/2)
(Government Regulation Number 82, 2001)

PARAMETER	UNIT	CLASS				REMARKS
		I	II	III	IV	
PHYSICAL						
Temperature	^{0}C	Deviation 3	Deviation 3	Deviation 3	Deviation 5	Deviation of temperature from it's nature
Dissolved Residue	mg/l	1,000	1,000	1,000	2,000	
Suspended Residue	mg/l	50	50	400	400	For processing of drinking water conventionally, the suspended residue are $\leq$ 5000 mg/l.
INORGANIC CHEMICALS						
pH		6-9	6-9	6-9	5-9	If in naturally out of that distance, therefore determination base on local condition.
BOD	mg/l	2	3	6	12	
COD	mg/l	10	25	50	100	
DO	mg/l	6	4	3	0	Minimum limit.
Total Phosphate as P	mg/l	0.2	0.2	1	5	
Nitrate as NO_3-N	mg/l	10	10	20	20	
NH_3-N	mg/l	0.5	(-)	(-)	(-)	The content of free ammonia for sensitive fish is $\leq$ 0.002 mg/L as NH_3.
Arsenic (As)	mg/l	0.05	1	1	1	
Cobalt (Co)	mg/l	0.2	0.2	0.2	0.2	
Barium (Ba)	mg/l	1	(-)	(-)	(-)	
Boron (B)	mg/l	1	1	1	1	
Selenium (Se)	mg/l	0.01	0.05	0.05	0.05	
Cadmium (Cd)	mg/l	0.01	0.01	0.01	0.01	
Chromium (VI) (Cr^{6+})	mg/l	0.05	0.05	0.05	0.01	
Copper (Cu)	mg/l	0.02	0.02	0.02	0.2	Cu $\leq$ 1 mg/l for processing of drinking water conventionally.
Iron (Fe)	mg/l	0.3	(-)	(-)	(-)	Fe $\leq$ 5 mg/l for processing of drinking water conventionally.
Lead (Pb)	mg/l	0.03	0.03	0.03	1	Pb $\leq$ 0.1 mg/l for processing of drinking water conventionally.
Manganese (Mn)	mg/l	0.1	(-)	(-)	(-)	
Mercury (Hg)	mg/l	0.001	0.002	0.002	0.005	
Zinc (Zn)	mg/l	0.05	0.05	0.05	2	Zn $\leq$ 5 mg/l for processing of drinking water conventionally.
Chloride (Cl)	mg/l	600	(-)	(-)	(-)	
Cyanide (CN)	mg/l	0.02	0.02	0.02	(-)	
Fluoride (F)	mg/l	0.5	1.5	1.5	(-)	
Nitrite as NO_2-N	mg/l	0.06	0.06	0.06	(-)	NO_2-N $\leq$ 1 mg/l for processing of drinking water conventionally.
Sulfate	mg/l	400	(-)	(-)	(-)	
Free Chlorine	mg/l	0.03	0.03	0.03	(-)	For ABAM is not under or without conditional.
Sulfide as H_2S	mg/l	0.002	0.002	0.002	(-)	S as H_2S $\leq$ 0.1 mg/l for processing of drinking water conventionally.

Table A4.2.2 WATER QUALITY CRITERIA (2/2)
(Government Regulation Number 82, 2001)

PARAMETER	UNIT	CLASS				REMARKS
MICRO BIOLOGICAL						
Fecal Coliform	MPN/ 100 ml	100	1,000	2,000	2,000	For processing of drinking water conventionally, fecal coliform ≤ 2,000 MPN/100 ml and total coliform ≤ 10,000 MPN/100 ml.
Total Coliform	MPN/ 100 ml	1,000	5,000	10,000	10,000	
RADIO ACTIVITY						
Gross-Alpha	Bq/l	0.1	0.1	0.1	0.1	
Gross-Beta	Bq/l	1	1	1	1	
ORGANIC CHEMICAL						
Oil and Grease	µ g/l	1,000	1,000	1,000	(-)	
Detergent as MBAS	µ g/l	200	200	200	(-)	
Compound Phenol as Phenol	µ g/l	1	1	1	(-)	
BHC	µ g/l	210	210	210	(-)	
Aldrin / Dieldrin	µ g/l	17	(-)	(-)	(-)	
Chlordane	µ g/l	3	(-)	(-)	(-)	
DDT	µ g/l	2	2	2	2	
Heptachlor and Heptachlor epoxide	µ g/l	18	(-)	(-)	(-)	
Lindane	µ g/l	56	(-)	(-)	(-)	
Methoxychlor	µ g/l	35	(-)	(-)	(-)	
Endrine	µ g/l	1	4	4	(-)	
Toxaphan	µ g/l	5	(-)	(-)	(-)	

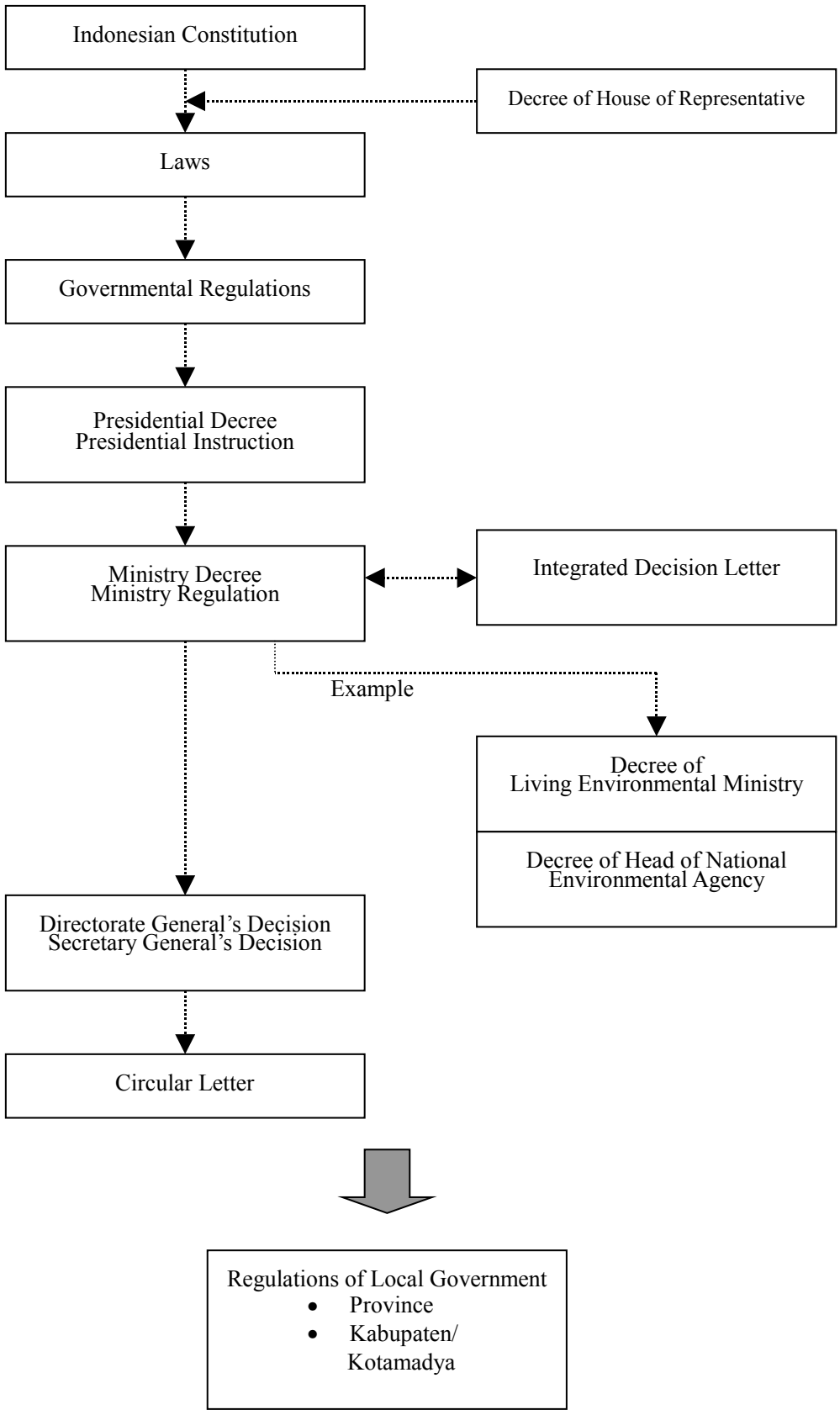
Remarks:
mg = milligram
µ g = microgram
ml = milliliter
l = liter
Bq = Bequerel
MBAS = Methylene Blue Active Substance.
ABAM = Raw water for drinking water (*Air Baku untuk Air Minum*).
Heavy metals are as dissolved metal.
All above value are maximum limit with an exception for pH and DO.
The value of pH are distance value which not more or less than recorded/inserted value.
DO is minimum limit.
The mark (-) means that the parameters are not under or without conditional.
The mark (≤) means less (smaller) than or same.
The mark (<) means less (smaller) than.

Table A4.3.1 LIST OF LAW AND REGULATIONS, AND TECHNICAL GUIDELINES ON ENVIRONMENT IMPACT ASSESSMENT

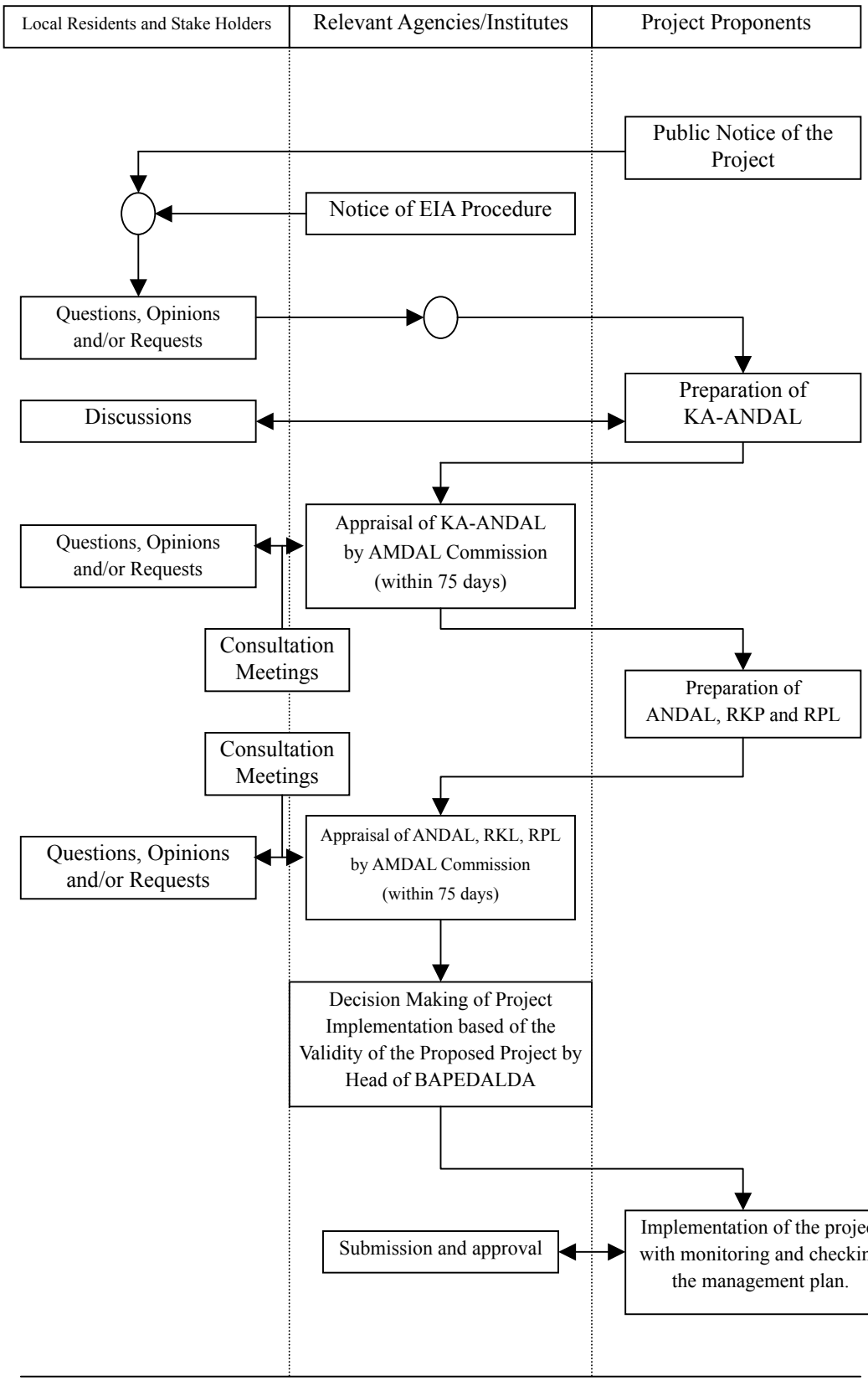
Subject/ Scope	Name (No. & Year)	Purpose/ Objective	Brief contents provided
Laws	Living Environmental Management (23/1997)	To harmonize the man with living environment in terms of utilization of natural resources, development with environmental consideration etc.	• Rights, Obligations and Authorities. • Protection of the Living Environment. • Institutions. • Compensation and Restoration etc.
Governmental Regulation	Environmental Impact Assessment (27/1999)	To Prevent in the impacts before implementation of the activity or business.	• Common definition and evaluation methodology in AMDAL. • Description on managing, establishing and monitoring of environment. • Disclosure of information on environment. • Methodology of community participation.
Ministry Decree	Decree of Living Environmental Ministry, No.2/ MENLH/ 02/2000, Regarding Guideline of EIA Document Evaluation	To improve the methodology and procedure of AMDAL, through which the business and/or activities will be improved. To promote the public participation, through which a better understanding to the business and/or activities will be build.	• The methodology on which AMDAL Commission evaluates KA-ANDAL, ANDAL, RKL and RPL.
	Decree of Living Environmental Ministry, No.3/ MENLH/ 02/2000, Regarding Type of Business and/or Activities requiring EIA Document.		• Type and Size of Business and/or Activities requiring EIA Document.
	Decree of Living Environmental Ministry, No.4/ MENLH/ 02/2000, Regarding Guideline of Preparing EIA Document for Integrated Residential Development Activity.		• Basic concept of Integrated Residential Development. • Guideline for Preparation of KA-ANDAL, ANDAL, RKL and RPL.
	Decree of Living Environmental Ministry, No.5/ MENLH/ 02/2000, Regarding Guideline of Preparing EIA Document for Development Activity in Wetland Area.		• Basic concept of Integrated Residential Development. • Guideline for Preparation of KA-ANDAL, ANDAL, RKL and RPL.
	Decree of Living Environmental Ministry, No.8/ MENLH/ 02/2000, Regarding People Involvement and Information Exposure on the Analytical Process Concerning EIA.		• Methodology of Community Participation in AMDAL. • Right and obligation during the procedure of community participation.
	Decree of Living Environmental Ministry, No.9/ MENLH/ 02/2000, Regarding Designing Guideline of Environmental Impact Assessment.		• TOR and Implementation plan of EIA (KA-ANDAL). • Contents of Environmental Impact Statement (ANDAL). • Environmental Management Plan (RKL). • Environmental Monitoring Plan (RPL). • Executive Summary.

Table A4.4.1 LIST OF NGOS ON ENVIRONMENT IN KABUPATEN GORONTALO

No.	Name of NGO	Name of the Leader	Mission
1	LSM LP2G	Ir. Arusdin Bone	Research on environment.
2	LSM PAYULIMO	Safrin Saifi, SE	Maintaining native culture.
3	LSM FK PCTI	Mansur Pakaya	Not detected because of new NGO.
4	LSM PERINTAS	Alex Djafri	Not detected because of new NGO.
5	LSM PERSADA	Yenny Bobihu, SE	Farming improvement.
6	LSM MERDEKA	Amin Mootalu	Water management improvement.
7	LSM PAYULIMO	Helmin P. Hippy	Not detected.
8	LSM LPNU	Ahmad P. Kuka Sag	Economic improvement.
9	LSM MITRA	Fadlly Yanto Koem	Not detected because of new NGO.



The Study on Flood Control and Water Management in Limboto-Bolango-Bone Basin in the Republic of Indonesia *Japan International Cooperation Agency*	**Figure A4.2.1** **LEGISLATIVE STRUCTURE IN INDONESIA**



The Study on Flood Control and Water Management in Limboto-Bolango-Bone Basin in the Republic of Indonesia

Japan International Cooperation Agency

Figure A4.3.1
PROCEDURAL FLOW OF ENVIRONMENTAL IMPACT ASSESSMENT