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INLAND WATERWAYS PROJECT (LN. 39106-CHA)

ENVIRONMENTAL IMPACT ASSESSMENT SUMMARY

PART B

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ENVIRONMENTAL IMPACT ASSESSMENT SUMMARY REPORT FOR HUNAN XIANGJIANG (HENGYANG-ZHUZHOU) NAVIGATIONAL PROJECT

1. DESCRIPTION OF PREPARATION

In accordance with the Bank's Comments on Brief Environmental Impact Assessment Report of the Port Construction And Shipping Route Regulation Project in the Xiangjiang River (Hengyang-Zhuzhou) on August 11, 1994, further modifications and explanations were made to the above report. Based on Environmental Impact Assessment Summary Report for Hunan Xiangjiang (Hengyang-Zhuzhou) Navigational Project prepared in May 1994 and incorporating all amendment and modifications, the present revised edition is reprepared and published.

2 THE PURPOSE, IMPORATNCE AND DESCRIPTION OF THE PROJECT

2.1 Necessity of the Project

Hunan is an inland province, whose general development strategy is to open the south and north, widen 3 channels, construct "Five zones, one gallery" and speed up construction of the west. Due to history, a strong mutual complementary is among the provinces in the Yangtze River basin. Such products made in Hunan province as the agricultural products, metal, non-metal, coal for domestic use, and construction materials are exported to everywhere in the Yangtze River basin; and such products as industry coal, iron ore, petroleum, etc., are imported form the East China and everywhere in the Yangtze River basin for a long period. The transport between the East

China and Hunan province has depended on railway and water transport for a long period.

The coal output in Hunan province is larger, but it can not meet the requirements for local province. Most of industrial coking coal and coal for power generation are imported from other provinces. With the development of power industry and development of steel and iron industry, the coal demand will greatly increase. It is predicted that 24 million tons of coal will be imported by 2,000, whose transport will mainly depend on such three railway trunks as Jing-Guang, Xiang-Qian and Zhi-Liu and part of which will be handled by highways. There is a gap of 7.76 million tons between transport capacity and demand in Hunan province in coal transportation, for which it is necessary to be handled by water transport. In addition, iron ore is another large transport cargo in Hunan province. The steel and iron industry develops very fast and the iron ore required mainly imported from other provinces or such countries as Australia, Brazil, Korea. For the Xiangtan Steel and Iron Plant and the Lianyuan Steel and Iron Plant, located within the heart of the Xiangjiang River basin, will have an external transport volume demand of up to 23 million tons at year 2,000, which can not be handled only by means of the railway system. At present, the cargo handling capacity for many railway sections have been saturated and no capacity to assume more transport task. Although a series of technical innovation measures have been taken, only about 50 per cent of the cargo transport volume required in Hunan Province can be handled by railway system. The tension of railway transport results in a large overstocking of material, which seriously constrained the development of economy in Hunan Province.

The Xiangjiang River basin is an important region in Hunan Province, whose area makes up half of the total province. From Hengyang to Chenglingji, there are such five industrial cities along the river as Hengyang, Zhuzhou, Xiangtan, Changsha and Yueyang, which have formed an important industrial and economy gallery. The main railway trunks encompassing the gallery involve: (a) Jing-Guang in south-north direction, (b) Zhe-Gan, Xiang-Qian and Xiang-Gui in east-west direction. The highways through the region involve the national highways No. 106 and 107 in south-north direction and the national highways No. 319 and 320 in east-west direction. The railway transport to south is confined by the Pingshi section, in which the cargo handled in 1991 was 7.4 million tons, which was only 52 percent of the requirement. The railway transport to east is confined by the Liling section, in which the cargo handled in 1991 was 2.6 million

tons, which was only 42 percent of the requirement. The railway transport to north is confined by the Puqi section, in which only 80 percent of the coal requirements for Hunan province from the north. The passenger transport is of more tension. According to the statistics of the railway cargo volume flow between Hengyang and Zhuzhou, the cargo volume flow was 53.92 million tons in 1987, and 64.67 million tons in 1990. The cargo volume flow had an increment of 10.75 million tons in the past four years with an average growth rate of 5.4 percent. At the same time, the railway transport volume in Hengyang section was increased by 1.19 million with an average growth rate of 0.5 percent. This indicates that the newly increased cargo handling volume mainly goes to the cargo volume passing through the province and that the growth rate in the province is low, which can not meet the requirements for the economic development in the region. The cargo handling situation of the Zhe-Gan railway trunk is tensile too, which results in a long period traffic jam and an overstocking of cargo to the East China.

The Xiangjiang River, the largest one in Hunan Province, is a main tributary of the Yangtze River and a major inland waterway with a superior natural condition. She has been a transport artery of the province in south-north direction since ancient time and played an important role in economic construction of Hunan Province in history. However, since the investment for water transport construction was comparably little in the past long period, the navigation condition of the Xiangjiang River has been backward characterized by lower grade and small ship capacity, incompatible port facilities, lower management level, and a high water transport cost, which is lack of marketing capability. Since large vessels on the Yangtze river can not come in and the goods along the Xiangjiang River can not be transported out at lower price, semi-closed situation has lasted for along time. The railway transport is currently very tensile in Hunan Province, the highway transport pressure is increasing, but the Xiangjiang River can not undertake the larger diversion task. Under this background, a strategy has been made by the Hunan Provincial Government (HPG) of development of the Xiangjiang navigation, whose concrete targets are to (a) construction of a 1,000 ton waterway with a total length of 439 km; (b) construction of a batch of railway and water transport transfer ports which will be open to the foreign countries; (c) establishment of a river-sea vessel team; and (d) construction of a navigation DWC Project involving power generation while rapid development of the "five zones, One gallery". Completion of the targets will promote the Xiangjiang river to a new place and assign new historic task to the river. Supported by such five railway and water transport

transfer ports as Hengyang, Zhuzhou, Xiangtan, Changsha and Chenglingji foreign trade port, a water transport main channel taking the Xiangjiang as its main will be formed, which will ease the tension of transport in Hunan and is significant in terms of development of Hunan Province and further development of the Xiangjiang River basin. Therefore, it is very necessary to develop the Xiangjiang navigation regarding to Hunan Province and the Yangtze River basin.

After justification in many aspects, the construction of the Xiangjiang 1,000 ton waterway is to be at two stages.

Construction of the waterway from Chenglingji to Zhuzhou is at the first stage. The design waterway dimensions are (a) the minimum depth 2.0m; (b) minimum width 60-90m and, (c) minimum curve radius 720m under the condition of navigable guaranty rate 98 percent. Since the natural condition in the section is good, the design dimension can be obtained by means of such engineering measures as construction of regulation buildings, dredging, rapid explosion, etc., which commenced in 1989 and is expected to be completed in 1994.

Construction of the waterway from Zhuzhou to Hengyang is at the second stage. The section from Chenglingji to Hengyang is an integral economy zone, and a complete transport one on the lower reaches of the Xiangjiang River, of which the subsection from Zhuzhou to Hengyang is an important one in the section. The minimum water depth is only 1.3m at present, which is only navigable for 300 ton ships all year around. However, after the completion of the 1,000 ton waterway from Zhuzhou to Chenglingji, these two waterway sections are not compatible, which will result in that larger vessels can not sail up to Hengyang and the goods there can not be moved out at lower price. It is estimated that the transport cost for a 300t ship is 35-40 percent higher than that for a 1,000 DWT ship. So, 300t ships are lack of competitiveness. Construction of Xiangjiang second phase project is a further extension of the 1,000t waterway and is required by deep development of water transport resources, development of local water transport, and adjustment of transport structure for rational diversion of railway transport. To sum up, construction of the Xiangjiang second phase project and further development of Xiangjiang navigation is of significance regarding to the construction of "Five zone, One gallery" and promotion of reform and opening to the outside and economic development of Hunan Province.

2.2 General Scheme and Major Technical Indexes

2.2.1 General Scheme

The technical scheme study for the Xiangjiang Navigational Construction Program (XJNCP) initiated in 1987 and the study on the Xiangjiang Navigation Development Technology was listed as a key subject in the Scientific and Technology Study in the Seventh-five Year Plan. In 1989, a breakthrough study result was obtained after comprehensive study based on the Plan for the Xiangjiang Main Stem. A deep feasibility study has been done by the Designer, which has established the general scheme of the Project.

The general scheme involves (a) construction of a navigation DWC Project at Dayuandu, which is to raise water level with its backwater level up to Hengyang and to create a reservoir waterway, which will meet the requirements of 1,000 DWT waterway; (b) the reservoir created can be for power generation, regulation of flow downstream in dry season required for navigation; (c) dredging and regulation of the river section between Dayuandu and Zhuzhou, which will make the river section to meet the requirements of 1,000 DWT ships and to be connected with the waterway constructed in the Xiangjiang Navigation First-phase Project; (d) 1,000 DWT berths in such two Ports as Hengyang and Zhuzhou; and (e) navigation aids and telecommunication facilities. The Project will make the 439 km long river section between Hengyang and Yueyang to be main water transport channel for 1,000 DWT tow barges. In addition to solving the navigation issue, the multi-purpose development includes a hydropower stations in the DWC Project, which can not only supply power to local region but also to greatly increase financial income and capability in repayment of project loan, to accumulate fund for further navigation development and to form a good circle in rolling development.

2.2.2 General Layout of the DWC Project and Major Technical Indexes

The Hunan Provincial Communications Design Institute (HPCDI) takes the general responsibility of the Project design and such institutes as the Hunan Water Control & Hydroelectric Power Design Institute, Hunan Electric Power Design Institute, and Hunan Provincial Waterway Engineering Design Institute participate the design. For the general scheme of the Project and the general layout of the DWC Project, several alternatives and optimization have been studied by the design institutes considering the model tests done in scientific research departments. The design was

submitted to the Panel of Experts (POE) invited by the Ministry of Communication (MOC) for review, confirmed as follows:

a. The Dayuandu Water Control (DWC) Project includes a dam, a ship lock, a power station, a fish way, a dam crest bridge, transmission lines, etc.. The dam has 24 flood release gates with a net width of 20 m each in the middle of the river, a total overflow dam section length of 552 m and a total overflow section length of 480m. A straight line type ship lock with an annual passing capacity of 12 million ton is on the left bank, which has a lock chamber dimension of $180 \times 23 \text{ m}^2$ to be navigable for 1×2 two barges with a capacity of 1,000 DWT each barge. On the right bank are 4 sets of turbine-generator with an installed capacity of 30 MW each and 120 MW total and a fish way.

For this general layout, the separate arrangement of ship lock and power house on left and right banks will not result in interference between navigation and power generation and be favorable for normal operation and maintenance. The ship lock of a straight line type at hill-side can create a straight downstream and upstream approach, a smooth connection between downstream approach and downstream waterway, which is better than the alternative in which the ship lock is located along the river side close to the left bank in terms of hydraulic condition for navigation at the interface between downstream approach and downstream waterway. The right side of the river is a concave bank at the dam site, a main stream of the river, has a lower river bed and larger discharge compared with the left side, which is not only favorable for deep excavation of the power house foundation but also for sufficient development of power efficiency. This is the optimum option in many alternatives in project layout.

b. Port works consist of 3 public berths at 1,000 DWT level in Dingjiaqiao, Hengyang City, with a design annual cargo handling capacity of 850,000 t, 2 bulk berths in Baishigang port, Zhuzhou City, with a design annual cargo handling capacity of 700,000 t and 1 piece and bulk berth in Yongli Port, Zhuzhou City, with a design annual cargo handling capacity of 220,000 t.

c. Waterway regulation works involve the regulation of 120 km long waterway from Dayuandu to Zhuzhou, including 23 shallow rapids of 16 rapid groups.

d. Aid works involve a distribution of class A aid, construction of aid management stations and provision of beacon maintenance ships in line with class III waterway.

e. Communication works involve a program control telephone system with 300 extensions, an extremely high frequency radio telephone system, an exchanger between radio telephone and wire telephone and long distance, small capacity digital micro wave communication telephone system.

3 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) SCOPE AND BASELINE DATA ABOUT THE EIA SCOPE

3.1 EIA Scope

The EIA Scope of the DWC project concludes the region impacted by the backwater of the reservoir, from Tugutang which is 90 km upstream from the project to Hengshan town which is 12 km downstream from the project, the estuary regions of the Lei River and the Zheng River where they join the Xiang River, the flood protection areas along the Xiang River in Hengyang County, Hengnan County, Hengdong County, Hengshan County, Hengyang Proper and Construction area of the project.

To sum up in a word, the EIA scope of the DWC project comprises the reservoir area (60 km²), the construction zone (1km²) (the total is about 1,000 km²).

The EIA scope of the port project covers the region in which the port area is taken as the center and the radius is 2 km, the EIA scope of the water route regulation project is the 120 km water route from the Dayuandu dam to Zhuzhou city.

3.2 Baseline Data about the EIA Scope

3.2.1 Surrounding Area of the Reservoir

The surrounding area of the DWC project is mainly located in Hengshan County and Hengdong County. The total area of the two counties is about 3033 km².

Being situated at Jiuliangdeng shallow of the Xiang River mainstream, the DWC project is 2.5 km upstream from the Mi River estuary. The river valley is of unsymmetry. The width and the maximum depth of the river are about 600 m and 3.5 m, respectively. During the dry season the river is approximately 460 m wide. The dam site belongs to hilly land with low mountains. top altitude of the mountain on the right bank is 124.55 m. The left bank is on the terrace of the first or second grade.

The climate of the reservoir and surrounding areas is the moist monsoon climate in subtropical zone. The average annual temperature is from 16-18°C. the perennial average precipitation is from 1200 - 1400 mm. The perennial average evaporation is from 700 - 1500 mm.

The runoff of the Xiang River is mainly supplemented by precipitation. The runoff is closely relate to the precipitation, which changes greatly from year to year. Flood is mostly induced by strom. Rainy seasons generally begins in early April and ends in late June.

At hengshan Hydrological Station near the dam site the perennial average flow, the perennial maximum flow and minimum flow are 1650 m³/s, 18400 m³/s and 58.2 m³/s, respectively. The ratio of the maximum flow to the minimum flow is 316. The perennial average runoff volume are 45.5 billion m³, 78.8 billion m³ and 23.0 billion m³, respectively. The annual maximum flow volume is 3.42 times the minimum.

The Xiang River is low in sediment concentration. According to the statistics of 32 years from 1953-1985, the perennial sediment concentration and the perennial maximum sediment concentration at the dam site are 0.168 kg/m³ and 1.73 kg/m³, respectively.

From April to June every year the river carries a high sediment load and the discharged volume amount to 72% of the yearly quantity of the sediment.

Much of soil in surrounding area of the reservoir is red soil. Much of soil along the river is mainly alluvial soil.

Soil erosion is a serious problem in the surrounding area of the reservoir, from which the area suffered amounts to 980 km², 32% of the total area in the two counties. Eroded topsoil approximately amounts to 4.60 million ton per year. This problem is more serious in townships along the Xiang River, where about 40% of the total topsoil is eroded.

Water quality in the reservoir area has been affected by the waste water discharged from upstream industry. Owing to large environmental capacity of the Xiang River and strict administration and control of local environmental protection agencies, the water quality can basically meet the standard of the third grade of water use except that the concentrations of total Hg and total Pb sometimes are slightly higher than the standard values.

The surrounding area of the reservoir is an agriculture region where grain production is dominant, the natural vegetation has been destroyed and there are many barren hills.

There are more than 200 kinds of cash crops, including rice, wheat, potato, bean, rape, etc..

The families of xylophyta are more than 90, and the special more than 600, including china fir, pine, camphor tree, bamboo, tea-oil tree, tung tree, chestnut, jujube tree, orange, etc.

Wild animals include wild ox, river deer, deer, raccoon dog, wild boar, pargolin, etc., and various kinds of birds, frogs and butterflies. Domestic animals mainly comprise pig, ox, chicken and duck.

In the Xiang River, there are 114 kinds of fish belonging to 11 orders and 26 families. Main economic fish comprise black carp, grass carp, silver carp, variegated carp, etc..

The 75 km reach of the Xiang River from Zhanghepu of Changning County to Linghekou is one of the three largest spawning grounds for the four large species of fish in the Yangtze River. From April to June every year fish from the Yangtze River and the Dongting Lake follow the river upstream to the spawning ground to spawn. Fish roes will be driven 200 km along the Xiang River. After 3-4 months the fish roes will hatch and the fries will flow into rivers and lakes.

The total population of the two counties which surround the reservoir area is 990 thousand, 914 thousand of which are agricultural registration. The density of population is 332 people per square kilometer. The seven towns along the Xiang River upstream from the DWC project have a population of 151 thousands, 15.4% of the total population in the two counties. Density of population in the seven towns is 450 people per square kilometer, higher than other districts of the two counties. More than 99% of the total population in the towns belongs to the Han Nationality.

Infectious diseases subjected by the people in the surrounding area of the reservoir comprise virus hepatitis, dysentery, typhoid, malaria, etc..

3.2.2 Zhuzhou City and Hengyang City

Zhuzhou City, governing the city proper, Liling County, Zhuzhou County, Youxian County, and Ruxian County, has a territory of 11420 km². Hengyang City, governing the city proper, Leiyang City, Hengyang County, Hengnan County, Hengdong County, Changning County, Qidong County, has a territory of 15295 km². The total territory of the 2 cities takes a proportion of 12.6% of the province and 25.2% of the Xiang River valley in the province. According to the statistic information at the end of 1990, the cities, having a total population of 10.0067 million which is about 16.4% of the province, have gross output Value of Industry and Agriculture (VIA) of 21.372 billion RMB yuan.

According to the economics developing plan of the 2 cities, the GNP, national income and VIA will reach 23.4, 17.8, 40.8 billion RMB Yuan, respectively, by the end of this century. Now the transportation and communication of the 2 cities are very tight. Railway transportation takes a proportion of 30% of the volume of goods transported, which only increased by 0.12% from 1990 to 1991, while highway takes 62% and shipping takes 8%, among which highway transportation costs 6-8 times as much as shipping. To optimize the transportation construction and reduce the transportation cost so as to accelerate the economic development, it is necessary to extend the existing 5 grade water route of Hengyang reach of the Xiang River into 3 grade to make it possible for one-thousand-ton ships to pass.

The volume of goods transported by shipping in Hengyang to Zhuzhou route in 1990 is 3090 thousand tons, which is estimated to be 8580 and 11150 thousand tons in 2010, 2020, respectively.

4 EIA OF THE CONSTRUCTION AND OPERATION OF THE PROJECT

4.1 EIA for the DWC Project

4.1.1 Impact of Flood Control and Inundation

In order to decrease inundation and not to affect the flood control in the reservoir region, careful studies and justification have been made of the layout of the DWC Project and the normal pool level, which results in a wider overflow dam section, a lower sill elevation (which is close to the natural river bed elevation), a lower open gate dam. At flood release, the flood level is close to that without the DWC Project. For a 20-year flood, the water level with the reservoir is only 0.07-0.17m higher than that without the reservoir, which results in very small impact on the flood control upstream and very small inundation loss.

4.1.2 Impact of Water Level Rise on the Reservoir Region

The flood control dike for Hengyang city is designed at 50-year flood and is under implementation now. The dike along both bank of the reversion is based on 20-year flood. Compared with the natural condition without the reservoir, the water level rises 0.07m and 0.17m after creation of the reservoir in Hengyang and in the location near the Dayuandu dam respectively. Therefore, the impact of impoundment of the reservoir on the

flood control dike on both banks is very small, to which only a few dike sections having thin dike body are required to appropriately heighten. Corresponding protection and innovation measurers should be employed for the impact on reservoir bank, drainage culvert gates and anti-water logging in polders.

A. Bank Protection

After the reservoir filling, the water level all year round is to rise and the water surface is to be wider, which will result in a longer immersion of the platform on both banks and more serious water and wave erosion. Therefore, it is required for a few steep, soft vulnerable bank section to use such measures as masonry and slope cut with vegetation for protection and strengthening in order to guarantee the safety of the dike.

B. Innovation of the Drainage Culvert Gates in the Reservoir Region

A few drainage culvert gates are to be inundated since the exit bottom elevation is low and the water level in the reservoir rises, which will affect the function of drainage of water logging and sewage. Therefore, innovation and provision of supporting facilities should be done before the reservoir filling.

C. Water logging Control for the Land Below Normal Pool Level (NPL) Within Polders

the land below NPL within polders is estimated at more than 15,000 mu based on mapping, of which more than 6,000 mu (2 per cent of the total farmland) and 9,000 mu (1.8 percent of the total farmland) are in Hengshan county and Hengdong country respective. The low land is in Longyingang, Huangningang of Hengshan County, Baiyigang, Dayuandu and Dapu of Hengdong county. When the water level in the reservoir rises, the water table will rise. Since the above mentioned land is low in terrain, it is difficult to drain the water logging and easy to result in water logging which will affect the output of crops. Drainage of water logging in the peri-reservoir area will be done based on local condition. For the extensive water logging area, a drainage principle involving high level drainage for high level water logging, low level drainage for low level water logging, separation of local and guest water and separation of internal water and external water will be employed based on local water logging proof experience for constructor of flood by-pass, by which the rainfall in the extensive catchment area can be drained into the reservoir. For the low land in the water logging can not be drained by gravity, electric pumps will be used. For the flood detention area and sparse farmland in low land (about 2,000 mu), change of plantation plan will be employed or plantation will be changed into aquatic farm, which

will allow local people to further improve their living standard and have a better life than before.

4.1.3 Protection of Fish Resources

Completion of the DWC Project will impede the migration channel, which will not allow parent fish to migrate to Hengyang and upstream for spawn and result in a loss in fish resources. In order to keep ecological balance in the Xiangjiang River and to protect fish resources, a fishway will be integrated in the DWC Project based on the nature of fishway and successful experience for the migration of fish, which will provide access for fishes in the Xiangjiang River and Dongtin Lake. The aquatic production departments should make full use of the reservoir for development of fishery.

4.1.4 Treatment of Pollutant and Noise Control in the Construction Site

A. Water quality pollution:

The increase of the suspended solids in the river water is mainly due to the discharge of the waste water during the processing of sand and stone in the construction of the key project. In order to mitigate this adverse impact, precipitating ponds are going to be built in the construction sites.

All kinds of waste water are to be gathered into precipitating ponds to be precipitated to be discharged into the river.

The river bed at the construction site of the key project is of rock structure. Two-step-weir-enclosure method will be applied in the key project (all construction work will be done on dry land inside the weir enclosure). Waste rocks and dregs are going to be regularly removed to the river banks. They are not going to influence the turbidity of the river water.

B. Noise control: The noise at construction sites mainly results from construction machinery and sand and gravel processing, which is abrupt, irregular, discontinuous, and very intense. However, since the construction sites are in a wild and the near residential quarter is more than 300 m away from the construction center, the impact is little. But in order to abate the impact of noise on construction workers at sites, contractors should select construction equipment with excellent property and adjust the operation time of the equipment.

The operation with big noise should be arranged in daytime and the noise sources should be located away from contractor camp.

C. Solutions to the waste earth of the construction

The design department of the project has paid consideration to the earth problem. Besides the 825,900 cubic meters of earth that can be consumed during the construction, the rest 2.7911 million cubic meters of waste earth will be distributed according to the following table

Distribution of Waste Earth

Name of Waste Earth-Distribution Place	Location	Distribution Volume 1,000 m ³
Mihe Station Dregs Distribution Area	Right Side of the Bank	140
Datongkan	Upper Reaches of Right Side of the Bank	50
Jinhuagang	Upper Reaches of Right Side of the Bank	261.7
Linzichong	3000m along the left side of the bank	1169.4
Heihechong	1200m along the left side of the bank	400
Liujiayuan Dregs Distribution Area	200m along the left side of the bank	200
Xiajuyuan Dregs Distribution Area	2000m along the left side of the bank	250
Hujiazhan Reservoir Dregs Distribution Area	500m beneath the Bank	50
Xinwuwan Dregs Distribution Area	100m of the upper reaches of bank	200
Liujianong Dregs Distribution Area	400m of the upper reaches of the bank	70

The waste earth of the construction is mainly to fill up the low-lying land near the construction area or be used as foundation material for road pavement.

D. Atmosphere pollution: The atmosphere pollution mainly involves waste air discharge from construction equipment driven by internal combustion engines and flying dust stemming from earth and rock excavation and embankment. Since the construction site is open, villages far away from the site and wet natural environment in water conservancy works, the atmosphere pollution will not result in an impact on public. However,

topsoil excavation and destroy of vegetation originating from earth and rock excavation and quarry excavation will result in soil erosion and destroy of natural landscape, and constrictors should be responsible for forestation and protection after construction to prevent from soil erosion.

4.1.5 Impact due to Transport of Construction Material at Dayuandu Site

The needed materials for the Dayuandu key project are shown as in table

Table Materials for the Key Project

Name of the Material	Quantity	Provider	Way of Transportation
steel	9000 tons	Xiangtan and Lianyuan Steel Works	railroad and highway
cement	155,000 tons	Xiangxiang and Dongjiang Cement Works	highway
sand & stone	820,000 cubic meter	6 km river bed around the key project	water way
timber	10,000 cubic meter	forestry center in the upper reaches of the key project	water way
equipment			water way and railroad
bricks, tiles & lime		village-run companies around the key project	short distance transportation
rocks		quarries around the key project	short distance transportation

Water way would be the main way for the transportation of construction materials of the key project. Goods by railroad would be unloaded at the Mihe train station 2 km away from the key project.

The biggest load by high-way for this key project construction is 155,000 tons of cement. In order to reduce the cost and mitigate the

environmental pollution caused by the high-way transportation of cement, we are going to use tank cars to transport cement. If we use 10 ton capacity tank cars for the transportation of all the cement needed in the key project construction during the construction period, there are going to be 21 tank car times of transportation of cement on the high way every day, plus the transportation for the other goods needed in the key project construction, car times of transportation for this key project will not be over 50 car times per day. The construction will not exert much influence on the normal order of the high way.

Roads near the key project construction are going to be broadened and sand paved roads are going to be re-paved with cement or tar to improve the transportation condition and reduce environmental pollution. The road leading to the key project is quite out-of-the-way. Along the 200 meters road leading to the entrance of the project, there is no environmental sensitive points like schools, business departments, etc.

Flying dust and noise monitoring shall be carried on the access road during construction period.

4.1.6 Public Hygiene

The large water surface area in the reservoir and wet ecological environment in the peri-reservoir region are favorable for multiplication of mosquitoes and fly. The rise of water level will force wild mice to migrate, which is likely to result in increase of incidence rate for mosquito-transmitted diseases and mice-transmitted infectious disease. Therefore, it is necessary to adopt the following measures:

- a. The reservoir bed needs to be cleared up. The tombs and animals died of epidemic diseases are not allowed to be moved and should be burned instead.
 - b. Choose a clean and qualified potable water sources for the people around. We should severely protect the potable water source, in case any water borne disease might occur.
 - c. Garbage should be collected and put together for treatment. Sewerage and manure are not allowed to be discharged into the river.
- Therefore the reservoir will not bring any adverse impact on the public health and the environment around.

4.1.7 Navigation Safety in Construction Period of the DWC Project

In the construction of the DWC Project, particularly the construction period of cofferdam, the flow speed will be higher, which will bring some

unsafe factor to navigation. In addition to preparation of a good navigation scheme for temporary use in construction period, it is advisable to strengthen navigation administration, to perfect navigation aids, to set up care stations in order to efficiently guide the navigation of ships.

4.2 EIA for the Port Works

4.2.1 Flood Control

Part of flood channel to be occupied by the hydraulic structures in ports will affect flood releasing, for which a careful justification has been done in design, which has been approved by the flood channel administration department and will not decrease the flood control standard.

4.2.2 Operation of the Port

Port works, characterized by small scale and short period, will not result in an environmental impact exceeding the conventional impact caused by urban building construction. The environmental impact of the works mainly involves water quality and atmosphere pollution caused by sewage and flying dust.

A. Flying Dust Pollution

The Baishigang Port in Zhuzhou is a coal berth and the Dingjiaqiao berth takes some loading task of phosphorous ore. In their handling process and open stockpile period, the flying dust will exceed the class 2 standard for atmosphere. It is necessary to install efficient sprinkling equipment. According to the experience at home and abroad, the flying dust can decrease by 80 percent when the water content for coal is above 6 percent. The phosphorous ore has larger grain size and high cohesive force, which will not exert large impact on environment. After calculation, the deposition depth of flying dust at the edge of the ports is less than the class 2 standard value for atmosphere quality at an environmental average wind speed of 2 m/s, a water content of 2 percent for ore and atmosphere stability value of class 1. However, the flying dust will begin to exceed the standard when the wind speed is faster. Therefore, timely sprinkling is required based on the wind speed. In addition, forestation should be strengthened for sheltering flying dust and having a beautiful environment.

B. Some of coal and phosphorous ore are spread in the handling process and washed away in the stockpile, which will exert an impact on the water quality in the port areas. Therefore, in addition to strengthening management, timely cleaning and that cleaning ship is not allowed in the

port areas, cut-off ditches shall be provided, by which sewage can be led to the setting basins and discharged after purification. The setting material will be collected for reuse.

C. Impact of Waste from Ships on Water Quality

The discharge of water with oil from ships will exert an impact on the water quality in the port area, particularly on the sensitive water area—a class 1 protection region for drinking water. Therefore, effective measures should be employed for strict control. Particular attention has been given by the P.R. China and the Hunan Provincial Government. According to the Inspection Regulation for Equipment on Ships and Sea, P. R. China issued by the State Council in No. 109 and Specification for Pollution Control Structure and Equipment for Inland Ships issued by the State Ship Inspection Bureau, oil-water separating equipment and control system for discharge and waste oil tank should be provided by March 1, 1994, when the oil pollution issues can be effectively controlled.

The collected waste oil will be treated through special facilities set by water transport sectors of Zhuzhou and Heangyang Ports.

Regulations have also been made for the treatment of other wastes from boats and ships. According to the "Standards for the Discharge of Wastes from Boats and Ships (GB 3552-83)", we should take the following treatments for the solid wastes from boats and ships:

- a. All kinds of plastics, floating things, waste food and other garbage are not allowed to be discharged into the river.
- b. Toilets on the boats or ships are not allowed to be directly connected to the water of the river.
- c. Garbage on boats or ships should be put together and transferred into land or garbage collecting boats for treatment.

4.2.3 Hygiene Management in Port Areas

The port administration departments should strengthen hygiene management in production and living areas in ports. Domestic sewage shall be separately drained to urban sewage system and domestic dust shall be integrated into urban dust handling system in order not exert an impact on water quality in port areas.

4.2.4 Noise

The noise mainly stems from the machinery for construction. It is

predicted that the average noise value in the region is about 60-70dB (A), which meets the environmental noise standard [55-65dB(A)] in urban area issued by the State, and the value set in port design norm, and has not much impact on the surroundings.

4.3 EIA for Dredging Works

4.3.1 EIA for Dredged Spoil

The dredging works involve 23 rapids with a total of 780,000 m³ dredged spoil to be displaced. The design of dumping ground will aim at improving shallow rapid's flow condition and strengthening regulation effect. The spoil will be for embankment, filling of branches of river, rising river side shores and filling of adverse deep water area. Contractors should dump in line with design requirements. Therefore, dumping will not create adverse impact on flood relief and bank erosion. The river bed material is sand and gravel consisting of no pollutant and the transfer of silt will not result in environmental pollution.

4.3.2 Impacts of dredging activities: The background value of Table 9.2 is a arithmetic average of a number of monitoring values at various sites of the Xiangjiang River from the national "sixth-five-year" scientific and technological project "the Environmental Background Value Research of the Xiangjiang River" in 1985, which was finished by Hunan Environmental Protection Bureau. It is possible that the Hg concentrations in the river may exceed the national standards during dredging activities. But as the dredging activities once a time are in short period and in limited river area there will be no possibility that the dredging activities will result in the Hg concentration exceeding the national standard in large river area and in long time period. There are no example in history that the Xiangjiang River's water quality exceeding the national standards in large river area with long time period resulting from the dredging activities. We will provide sufficient information in the bidding documents and request the contractor to ensure the dredging activities' impact on the environment be minimized.

4.3.3 Safety in Rapid Explosion

The rapid explosion construction should be approved by public security department and navigation administration and a navigation

notice will be announced by the navigation administration. Contractors should predict the extent of explosion, employ effective safety and warning lines and disperse the population and ships in time. Explosion should be done carefully and a whole safety check should be done well.

4.4 Cultural Relics Around the Construction Project

The 51 sites of ancient or historical buildings appointed by the provincial government in 1983 are not in the impact ranges of the construction areas of Dayuandu key project and port construction, the 120 km waterways from Dayuandu to Zhuzhou and the river valley based reservoir in the upper reaches of the key project on river.

So far no traces of underground cultural relics have been found from our survey and investigation.

The prediction item and content, the prediction method, the standard applied, the environmental impact and the protection measure for the DWC Project, the port works and dredging works are all listed in attached table 1, the control measures and responsible agency are listed in attached table 2.

5 Environmental Monitoring Planning

5.1 Monitoring Target

5.1.1 Monitoring of Water Quality

The purpose of the water quality monitoring is to monitor and control the impact of construction of the project on the water quality of the Xiangjiang River and to maintain the river water quality functional district standard. So control and treatment of the waste water from the aggregate processing should be regarded as the major measure for the Dayuandu hydro complex project. With domestic water treatment plants provided 1 km downstream, Hengyang Port and Zhuzhou Port belong to the drinking water protection area. The importance of the environmental protection measures in the water quality protection during the project construction, especially during its operation is confirmed through monitoring.

5.1.2 Atmospheric Monitoring

The atmospheric monitoring is intended to determine the degree of impact of the project on atmosphere during its construction and operation after carrying out various protection measures, according to the requirements for different districts' atmosphere quality. Atmospheric monitoring for the project is performed mainly in Hengyang and Zhuzhou ports during operation, taking the Class II standard for the total suspended particle (TSP=0.03 mg/m³) specified in the atmospheric environmental quality standard as the control indexes.

5.1.3 Noise Monitoring

According to the analysis and prediction in the environmental impact assessment report, the impact of the project in terms of the noise produced by the machinery as the major pollution source during both the construction and operation will not exceed the "Limit Value of Noise on the Construction Site" and the standard for industry

concentrated area from "Ambient Noise Standard for the Cities" (GB 3096-82). The noise produced by machinery in the port will be controlled within the standard in the port design specification. So only the impact on the operators at the construction site and during operation will be taken into consideration for noise control.

5.1.4 Monitoring of Fishery Resources

The effectiveness of the fish-way works and the impact of the Dayuandu reservoir on spawning area will be confirmed by means of investigation of variety and amount of fish.

5.2 Environmental Monitoring Items

In order to find out the impacts of handling activities on wharfs, shipping operation and the Dayuandu project in the construction period on the surrounding environment, monitoring should be carried out, which should include water quality, atmosphere and noises within the range of their impacts.

The water quality monitoring involves DO, BOD, COD, SS, oil, pH, volatic phenol, nitrogen compound, Hg, Cd, Cr⁺, Pb, Cu, Zn, oil, ammonia and nitrogen, and group of bacillus coli, etc; the atmosphere monitoring items mainly include suspended solid and falling dust; and the noise monitoring is required to determine the noise intensity in the residence nearby the operation zone. and the fish monitoring mainly involve a complete variety and amount of fish.

For more detail see attached table 3--5

5.3 Training of Environmental Protection Personnel

The environmental monitoring of the Project in the construction and operation period will be performed by the environmental protection departments at city and county levels along the river, Each environmental protection station has qualified staff and is equipped with equipment which meet the requirements of the Project, and no personnel training at these stations is required. The personnel of the environmental protection institute will take part in medium term, short term training programs and visits.

5.4 Monitoring organs

Considering that there are five cities and counties of Hengyang, Hengnan, Hengshan, Hengdong and Zhuzhou located evenly along the 182km-long project reach of the Xiangjiang River from Hengyang City to Zhuzhou City, and the monitoring items of the environmental management departments at various river sections have involved controlled the water quality along the river and the environment quality on other environmental sensitive points, and both the quality of the personnel and monitoring means can meet the demands of the monitoring target and items, furthermore they are very close to the project site, so the monitoring operation related to the proposed project will be carried out by the environmental management departments of the above-mentioned counties and cities on the basis of entrustment by the Xiangjiang River Navigation Development and Construction Corporation and its subordinate environmental management units at Dayuandu, Hengyang Port and Zhuzhou Port. And additional monitoring network for the construction site should be provided and monitoring frequency for part of items increased according to the actual situations of the project.

6 LAND ACQUISITION AND RESETTLEMENT

According to the property of the site and the project, the land acquisition and resettlement involve the dam site of the DWC Project, the reservoir inundation area, two 1,000 DWT berths in Hengyang and Zhuzhou ports, which are as follows:

6.1 Extent and Amount of Land Acquisition and Resettlers

6.1.1. Dam site of the DWC Project: The major land for engineering use is the location for ship lock, which requires a resettlement of a small village, 367 people of 77 households, a relocated housing of 17.019 m² (including shed area of 2543m²), 494.3Mu of cultivated land, vegetable land 37.4Mu, forest land 128.4Mu, economic forest land 110.6Mu, forest land for material use 17.8Mu and housing foundation area 25.5Mu will be occupied for use.

6.1.2 Reservoir inundation area: The land to be inundated mainly involves the paddy field and dry land on flood plain outside dike with a total area of 355.5Mu, and the inundation will only involve 16 persons of 3 households and a relocated housing area of 804m² including shed area of 112m².

6.1.3 1,000 DWT berths in two ports:

Dingjiaqiao berth area in Hengyang

Land acquisition 82 mu

Relocated population 48 people (10 households)

Housing area to be relocated 2,400 m²

Yongli and Baishigang berth areas in Zhuzhou (the resettlement will be done within the integrated urban innovation)

Land acquisition 35.84 mu

Relocated population 279 people (92 households)

Housing area to be relocated 11,576 m²

According to extent of the land acquisition and resettlers, the Project will totally entail a land acquisition of 1286.74mu, a population to be displaced of 710 (179 households) and a housing area to be relocated of 31799m².

6.2 Compensation Standard for Land Acquisition and Rehabilitation and Resettlement Program

6.2.1 Compensation standard for land acquisition

a. Land acquisition fee: According to the Implementation Regulation for Land Administration, Hunan Province, charge for land acquisition involves such three components as compensation for young crops (CYC), compensation for land (CYL) and compensation for resettlement (CYR).

CYC = the annual output value for acquired land × 1

CYL = the annual output value for acquired land × 3

CYR = the annual output value for acquired land × 2
× agricultural population /total land area

b. The compensation for relocation of house is usually determined in accordance with the method of replacement price for relocated house.

The steps for determination of compensation of the relocation of house are as follows:

Step I: determination of replacement price for relocated house (Yuan/m²);

Step II: determination of "quality coefficient", by means of time used and damage degree; and

Step III: determination of net basic price of relocated house, which will be calculated by the formula given below:

Net basic price = replacement price × quality coefficient

c. Compensation standards for power transmission, telecommunication and broadcasting lines will be determined in accordance with standards issued by line administration departments or determined by means of field investigation and consultation.

6.2.2 Rehabilitation and Resettlement Program (RRP)

a. There are 330 people of 75 households to be displaced in the dam site of the DWC Project, concentrating in Yonghe Village. Most of the people to be displaced are mainly engaged in agriculture production and some are in the field of handicraft industry and commercial activity. According to the plan prepared by local county government, a new town with a planned population of 8,000 and 30,000 in the near and far future respectively will be established relying on the living quarter on the right bank of the DWC Project, in which the villagers in Yonghe village will be resettled. The resettlers will be engaged in (a) agriculture production mainly involving paddy; (b) vegetable plantation and fishery; (c) construction industry; (d) restaurant, tourism industry and commercial activity; and (e) handicraft, which are given below in detail:

Each township made their relatively detailed plans according to the number of relocatees and resource conditions. There are 75 planned production relocatees in Hengdong County, among which 42 person will obtain the same quality and quantity paddy field which responsible by Local government, the other 33 person will go in for the 2nd and 3rd industry. The planned production relocatees in Hengshan county is 517 person. Among them 16 go in for agriculture, 427 person will be engaged in the 2nd and 3rd industry and the other 74 person in agriculture. In Mayuanlong of Hengnan county 59 person need to be relocate among which 9 person still go in for agriculture, the other 50 person will be engaged in the 2nd and 3rd industry.

b. In the reservoir inundation area, since the inundation involves only a few people and houses to be displaced, the resettlement can be done within their villages. The loss in farmland income can be compensated by the income from development of fishery and engagement of 2nd and 3rd industry which will be larger than their previous income.

c. RRP in the port areas: The resettlement in Hengyang and Zhuzhou ports will only involve the relocation of houses, which will be integrally done based on the urban planning in cooperation with urban construction departments in these two cities.

6.3 Public Participation and Confirmation in Land Acquisition and RRP of the Local Government

The land acquisition and resettlement involved in the major work of the Project are within the area under the jurisdiction of the Hengyang Municipal Government. Only the land acquisition and resettlement for the Zhuzhou port area are in the location under the jurisdiction of the Zhuzhou Municipal Government. So the participation and confirmation of the Hengyang Municipal is a key to the implementation of the major work of the Project.

On May 14, 1992, a discussion meeting about the reservoir inundation of the DWC Project was held by the Hengyang Municipal Government, in which relevant departments at provincial and municipal levels and officials from Hengshan and Hengdong county governments participated. The meeting obtained a consensus on the inundation

compensation handling principle and standard and confirmed in principle the schemes for land acquisition standard, inundation compensation and resettlement proposed by the Designer. In addition, the local governments agreed that a lump sum contract for performing the RRP in the dam site and reservoir area of the DWC Project would be practiced, preferential policies and active cooperation would be provided to ensure the smooth implementation of the Project in the meeting (for detail, see the Compile of Confirmation Documents).

In March 18, 1993, an official letter on concrete implementation plan for RRP for the DWC Project from the Hengshan County Government was received. It is planned to construct a Yonghe town with agriculture, industry, trade, tourism and service industry relying on the construction of the living quarter of the DWC Project, in which local people to be displaced can be resettled. The production and living of the resettlers will not be adversely affected. The mean annual net per capita income for local farmers will rise by means of resettlement and having opportunities to work (for detail, see Compile of Confirmation Documents)

7 ENVIRONMENTAL MANAGEMENT

7.1 Environmental Management Target

A. In the implementation and operation of the Project, the water, air and noise pollution resulting from engineering activities, ship navigation, cargo handling activities in port areas should be controlled in order to meet the standards issued by the environmental protection agencies.

B. Adverse impact of the reservoir on ecological environment in the peri-reservoir area should be controlled to such an extent that the adverse impact can be minimized.

7.2 Implementation Institution for Environmental Management

The Environmental Management Program will be implemented, supervised, and managed by the Project Owner-XNDCC, in which an environmental protection office (EPO) is to be established and an environmental monitoring station is to be set up at DWC Project, Zhuzhou and Hengyang ports to be responsible for environmental management.

The EPO's work is subject to guidance and supervision of the environmental protection administrations at provincial, municipal and county levels.

7.3 Environmental Mitigation and Cost in the Implementation and Operation of the Project

Construction of the DWC Project will change local ecological environment to some extent in the peri-reservoir and the reservoir area. In the implementation of the Project, a fish way is provided for fish migration, innovation of and upgrading drainage outlets and pump stations is used in low land in the peri-reservoir area and plantation is changed into aquatic farm for sparsely distributed low land, which allow the economic activities not to be adversely affected by the Project.

A. For the impact of the construction of the DWC Project on the water quality, air quality and natural landscape near the construction site, corresponding measures will be employed to control the impact to the minimum extent.

B. The key component of the environmental protection in port areas is in the operation period. The flying dust resulting from coal handling operation in the coal berth will have some impact on the air quality and quality of downstream portable water sources. Such measures as shrinking for control of fly dust, setting basin for control of sewage pollution in port area and shelter forest will be employed in the implementation of the Project to make the environmental quality to meet the standards issued by the State.

C. The impact of waterway regulation works on environment only occurs in the construction period, which means the impact of dumping of dredging soil on pollutant absorption capacity of the river. According to survey, the river bed material consist of coarse grain sand and gravel, whose pollution is few. In addition, since the works are sparsely distributed in 23 shallow rapids within 120 km long river section, the impact of suspended solidsmaterial resulting from construction on water quality is very limited in duration and extent, which will not result in environmental pollution.

D. In operation period of the Project, among the pollutant from ship, the water pollution resulting from the waste water with oil in the reservoir and port area is the key point in terms of evaluation and control. By means of strict enforcement of relevant regulations set in the Regulation for Pollution Control Structure and Equipment for Inland River Ships, ships are

required to install oil-water separating equipment and discharge control system, which can efficiently control the pollution.

E. Within the extent affected by the implementation and operation of the project, no historic relic sites exist based on field investigations.

F. In order to supervise the actual effect after implementation of the environmental mitigation and meet the control target of environment protection, 6 local environmental management and monitoring departments at municipal (county) levels, entrusted by the owner, will take the responsibility of monitoring water quality, air quality, noise, and fish, which direct, supervise and improve the care implementation of various mitigation measures.

The summary of measures for environmental protection management and monitoring, the monitoring plan --- air quality, water quality and noise, investment for environmental protection measures, and the location map of air quality monitoring sites in Hengyang Port and Zhuzhou Port, and location map of water quality monitoring are all shown in Appendix 2 to Appendix 9, respectively.

The cost for environmental protection is estimated at about 38.69 million Yuan RMB, of which 3.737 million Yuan goes to the DWC Project, including farmland protection, innovation of culvert gates, strengthening embankment, bank protection and construction of the fishway, 0.5 million Yuan to Hengyang and Zhuzhou ports and 0.5 million Yuan RMB to environmental monitoring. The required fund is included in the project budget and disbursed in line with the project schedule.

Regarding the cost for environmental protection measures see attached table 7.

8. SUMMARY AND CONCLUSIONS

According to prediction, assessment and measure study, the DWC Project will effectively promote the economic development of its surrounding areas and improve the environmental quality of the locality.

The adverse impacts of the project, except that the reservoir's inundation of a little farmland is irreversible, will be prevented, minimized or mitigated through the implementation of appropriate environmental management and protection measures. Some resettlement problems caused by the reservoir's inundation and the unfavorable affect on part of the low-lying cultivated areas around the reservoir due to the rise of water level will

bring about some adverse impacts on the natural environment and socio-economic development, but they will be minimized and even offset through the implementation of the resettlement program and the project protection plan.

The ports and water route regulation project will effectively promote the economic development of Hengyang City and Zhuzhou City and improve the environmental quality of the Hengyang-Zhuzhou reach of the Xiangjiang River. From a long-term point of view, the development of the Xiangjiang River is of great benefit to the economics of Hunan -- an inland province.

The regulation of the river will increase the capacity of holding the pollutants. The volume of some water body pollutants and oil-bearing waste water which is sent out by ships adds to the pollution load of the Xiangjiang River with the increase of the number of ship and the volume of goods handled at the port. But they will have no great effect on the quality of water environment and the raised dust caused by the loading and unloading of goods at the port will be minimized through the implementation of the EMMs and the MPMs.

In a word, effective implementation of the environmental protection measures and the environmental management measures will minimize the adverse environmental effects caused by the Hunan Inland Waterways Multipurpose Project (the DWC Project, the Port Project and the Water Route Regulation Project).

**Appendix 1 Environmental Assessment of Summary of the Shipping Project in the Xiangjiang River
(from Hengyang to Zhuzhou)**

Project	Prediction		Prediction Method	Standard Applied	Environmental Impact	Protection Measure
	Item	Content				
The Dayuandu water control project	Water quality in the upstream of the reservoir	COD, Volatile phenol, cyanide, mercury, cadmium, chromium, arsenic, aluminium, oils	Two dimensional convection diffusion model, Oil gathering estimation model	The II grade surface water environmental quality standard (GB 3838-88)	Every index in the drinking protection area meets the II grade water quality standard	
	Aquatic	The fish's migration and spawning			The fish's migration and spawning will be influenced by the dam.	A fishpass will be built.
	The rise of water level	Reservoir inundation and resettlement		Designing Measures about the Irrigation and Hydroelectric project (SD130-84)	There will be 349 mu farmland to be inundated, 304m ² house to be dismantled and 16 people of 3 houses to be resettled.	The compensation will be made according to the Temporary Provisions of Land for building in Hengyang City.
		Banks and culverts surrounding the reservoir			The local flood level in the 20-year flood frequency	The water level will increase 0.07m to 0.17m, and it will have little influence on the banks but some influence on the drainage of the 69 culverts.

Appendix 1 (continued)

Project	Prediction		Prediction Method	Standard Applied	Environmental Impact	Protection Measure
	Item	Content				
	Impact during the construction stage	Production waste water, dust, noise, discarded soil and stone.			The river will become muddy and the air and noise environment in the construction region will worsen.	Precipitating ponds will be built and supervision of the construction region will be strengthened
Port project	The Dingjiaqiao Port in Hengyang	Flying dust of phosphate ores	Gauss continuous point source model	Air environmental quality standard (GB3095-85)	The port and the vicinity of the port	Spray water to restrain the dust.
		Oily water from vessels	One-group mono-dimensional model	Surface water quality standard (GB3838-88) Drinking water quality standard (GB5749-85)	Generally the drinking water quality is not affected	Vessels must be equipped with facilities for separating oil and water according to the NO. 011 provincial document concerning vessel examination.
		Noise	Point noise source model or line noise source model	Environmental noise standard for urban region (GB3086-82)	Noise in the port region can meet the standard. The noise has little influence on the environment	
	The Yongli port and the Baishi port in Zhuzhou	Coal dust in loading and unloading	Gauss point source model	Air environmental quality standard (GB3095-82)	The region about 440m far from the pollution center can meet GB3095-82	Spray water to restrain the coal dust

Appendix 1 (continued)

Project	Prediction		Prediction Method	Standard Applied	Environmental Impact	Protection Measure
	Item	Content				
	The Yongli port and the Baishi port in Zhuzhou	Oil water from vessels	One-group mono-dimensional model	Surface water quality standard (GB3838-88), Drinking water quality standard (GB5749-85).	Generally the drinking water quality is not affected.	Vessels must be equipped with facilities for separating oil and water according to the No. 011 provincial document concerning vessel examination
		Noise	Point noise source model or line noise source model	Environmental noise standard for urban region (GB3086-82)	Noise in the Baishi port can meet standard. Noise in the Yongli port sometimes exceeds standard.	The dock for sand and stone be moved.
Route Regulation and Increase of Freight Volume	Shipping Route Regulation	River's capacity of holding pollutants			The transport, mixture and deoxygenation of the pollutants will be speeded up and the river's capacity of holding pollutants is improved.	
		Aquatic animals and plants			The project will not produce new pollution sources or damage the spawning ground, or block the fish's migrating course. So the project will have little influence on aquatic animals and plants.	

Appendix I (continued)

Project	Prediction		Prediction Method	Standard Applied	Environmental Impact	Protection Measure
	Item	Content				
		The influence during the construction period.			Blasting rocks and excavation of river bed have little influence on water quality during short period.	
	Increase of freight volume	Vessel noise and discharged waste		The standard for pollutants discharged from vessel (GB3552--83).	The pollutants discharged from vessel according to the standard have little influence on water quality.	The law to control the discharged oily and waste water must be put into effect.

Appendix 2 Summary of Measures for Environmental
Protection Management and Monitoring

Project	Environmental Problem	Measure	Executive Organ
The Dayuandu Water Control Project	1. Flood control in reservoir area and inundation loss	Correctly choose site and type of dam, and flood discharge method and width	Provincial Communications Design Institute
	2. Longer immersion of the platform on both banks and more serious water and wave erosion resulted from the higher water level and wider water surface after the reservoir	Use such measures as masonry and slope cut with vegetation to protect and strengthen a few steep, soft vulnerable bank section.	Governments of Hengyan City Hengshan and Hengdong Counties
	3. Underflooding of farmland inside embankments by reservoir	Provide drainage devices, perfect plan of crop transformation, and do well support for production in later stage	Ditto
	4. Inundation of a few drainage culvert gates with low exit bottom elevations	Innovation and provision of supporting facilities will be done before the reservoir filling	Ditto
	5. Obstruction to the fish migration by dam	Provide fishway on the hydro complex	Provincial Communications Design Institute
	6. Waste water from sand and gravel manufacturing system at construction site	Waste water from the system will be discharged after deposition	Contractor

Appendix 2. (continued) Summary of Measures for
Environmental Protection Management and Monitoring

Project	Environmental Problem	Measure	Executive Organ
	7.Noise at construction site from sand and gravel manufacturing system	Select construction equipment with excellent property and adjust the operation time	Contractor
	8.Spoil and waste solids from the sand and gravel processing system at the construction site	Make use of spoil and waste solids for embankment of low land or for road construction material at the sites	Contractor
	9.Atmosphere pollution at construction site	Earth excavation and stocking be watered timely for dust-control in the light of wind force and direction; Earth slope be protected or planted with trees as soon as possible after stripping	Contractor
	10.Mosquito-transmitted diseases and mice-transmitted infectious disease at construction site and around reservoir	Kill mosquitoes and mice, purification of water sources for drinking,good reservoir clearance,epidemic prevention for construction staff, etc	Governments of Hengyan City Hengshan and Hengdong Counties

Appendix 2 (continued) Summary of Measures for
Environmental Protection Management and Monitoring

Project	Environmental Problem	Measure	Executive Organ
	11. Navigation impact during Project construction	Set temporary navigation scheme and provide devices during construction. Strengthen navigation administration, Perfect navigation mark, and provide additional caring stations if necessary	Constructor Hunan Provincial Navigation Channel Bureau
	12. Quarry	Various necessary safety ensurance measures	Constructor Public security departments of Cities and Counties
	13. Construction of the project on the water quality pollution	Periodical monitoring the water quality at the fixed sites	Constructor Environmental Protection agencies of Hengyan City, Hengshan and Hengdong Counties
	1. Impacts of wharfs on flood discharge and impacts of handling activities at port on city	Keep port site away from commencial and densely populated districts as far as possible; wharf structure type and its occupation of floodway shall not affect flood discharge	Provincial Communications Design Institute, Provincial Navigation Engineering Design and Research Institute

Appendix 2 (continued) Summary of Measures for
Environmental Protection Management and Monitoring

Project	Environmental Problem	Measure	Executive Organ
Port	2. Flying dust pollution from loading task of phosphorous ore at Dingjiaqiao berth	Install efficient sprinkling equipment	Harbour supervision agencies and their environmental protection departments
	3. Flying dust pollution on air and water quality from loading task of coal at Zhuzhou Baishigang berth	Install efficient sprinkling equipment, forestation	Ditto
Project	4. Water quality pollution by port activities	Rain water from stock yard be drained into river after precipitation; Household sewage be drained into city's sewer; operating ship be equipped with water and oil separator	Harbour Supervision agencies and their environmental protection departments; Harbour supervision office at port site
Dredging	1. ship wastes	Operating ship be equipped with water and oil separator; ship wastes be collected to be treated on land	Ditto
	2. Impacts of treatment of soil from dredging on flood water travel	Correctly choose dumping space in shallow regulation to raise regulation to raise regulation effect and favour flood water travel	Provincial Navigation Engineering Design and Research Institute

Appendix 2 (continued) Summary of Measures for
Environmental protection Management and Monitoring

Project	Environmental Problem	Measure	Executive Organ
	3. Danger to ship and people from rapids reef explosion	Release navigation announcement, estimate explosion influence circle, set time of blast, provide signals cordons, and do well security inspection during construction	Constructor; Hunan Provincial Navigation channel Bureau, Public Security Departments of Cities and Counties
	4. water quality pollution by dredging activities	periodical monitoring the water quality at the fixed sites	Constructor; Environmental Protection agencies of Hengyang City, Hengshan and Hengdong Counties
Environmental monitoring	Whether environmental quality conforms to standards	Monitoring data from monitoring stations along river be collected, processed, and analysed, Entrust counties to provide additional temporary monitoring points and carry out monitoring points and carry out monitoring items set by plan	Environmental Protection Agencies of the Cities and Counties Environmental Protection Division of the Owner
Transportation of construction materials	Flying dust and noise	Main construction material cement will be transported by canned car on tar-making roads and all transportation will be arranged during night as possible	Contractor

Appendix 2 (continued) Summary of Measures for
Environmental protection Management and Monitoring

Ship Operation	transport of dangerous articles	Strengthen Safty education to the operating personnels, strictly implement "Provisional Specification for the Inspection of Shipment of Loading/unloading Dangerous Goods" and "Regulations on Supervision and Management for the Shipment of Dangerous Good" of P. R. C	Communications department Public security department
	Ship noise	navigation is forbidden for the ship which is inconformity to the noise standard	Communications department
	Ship wastes	waste oil/substances will be ticated after collection without discharge to the river	Communications department

Appendix 3 Monitoring Plan— Air Quality

Monitoring Place	Item	Frequency	Sampling Hours	Responsible Agencies
Construction stage Construction site	TSP SO ₂ NO _x	once every week for one day period each time	7:00 11:00 15:00 19:00	Contractor
Operational stage The Dingjiqiao port	TSP SO ₂ NO _x	once every month for one day period each time	7:00 11:00 15:00 19:00	Environmental Protection Monitoring Station of Hengyang City
Operational stage The Bsishi port, The 2th waterworks of Zhuzhou City	TSP SO ₂ NO _x	once every month for one day period each time	7:00 11:00 15:00 19:00	Environmental Protection Monitoring Station of Zhuzhou City

Appendix 4 Monitoring Plan—Water Quality

Monitoring Place	Item	Frequency	Sampling Hours	Responsible Agencies
Operational stage Dingjiagiao Huangchaling Zhanmengian	BOD ₅ , Oil, SS, pH COD, Phenol, Cyanide, Mn, Cu, As, Cr ⁶⁺ , Zn, Cd, Pb, Hg	once every month for one day period each time	Morning and afternoon	Environmental Protection Monitoring Station of Hengyang City
Operational stage Dayuandu lieshimu	Ditto	Ditto	Ditto	Environmental Protection Monitoring Station of Hengshan County
Operational stage The Esishiga port, The 2th waterworks of Zhuzhou City	Ditto	Ditto	Ditto	Environmental Protection Monitoring station of Zhuzhou City
Construction stage Construction site	Ditto	once every week for one day period each time	Ditto	Constructor
Construction stage Dredging site	Ditto	once during every dredging activity for one day period each time	Ditto	Constructor

Appendix 5 Monitoring Plan—Fish

Monitoring Place	Item	Frequency	Sampling Hours	Responsible Agencies
Operational stage Dingjiagiao	Species, Quantity	once every month	day-time	Aquatic Agency of Hengyan City
Operational stage Dayuandu	Ditto	Ditto	Ditto	Aquatic Agency of Hengshan County
Operational stage Lieshimu	Ditto	Ditto	Ditto	Ditto

Appendix 6 Monitoring Plan—— Noise

Monitoring Place	Item	Frequency	Sampling Hours	Responsible Agencies
Construction stage construction site of the dam	Construction noise	once every week for one day period each time	Morning and afternoon	Contractor
Operational stage The Dingjiaqiao port	Navigation noise	Ditto	Ditto	Environmental Protection Monitoring Station of Hengshan City
Operational stage The Baishiga port, The Yongli port	Navigation noise	Ditto	Ditto	Environmental Protection Monitoring Station of Zhuzhou City
A number of Monitoring sites set along the highway to transport the construction material	Transportation noise	Ditto	Ditto	Contractor