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ORGANIZER'S FOREWORD

It was told in Chinese mythology that dragon kings of the fo seas control rainfall; however, they are notoriously irresponsible to earthly needs. Fortunately, we representing four major responsible departments of water management, The National Environmental Protection Agency(NEPA), The Patriotic Campaign Committee of the Ministry of Health, The Urban Construction Bureau of the Ministry of Urban and Rural Construction and Environmental Protection, and the Office of Water Conservancy of the Ministry of Hydraulic and Power, are gathering here with distinguished experts from home and abroad to discuss issues related to water management in China.

The importance of water management was recognized as pollution and water shortage become acute. In fact, many places in China, pollution and water shortage are dictating their further growth of economy, well being of human health and balance of • ecology. The significance of this workshop marks a beginning that all of us are unified to take concerted action to establish a sound water management program, and always open for suggestions and criticisms.

Those papers presented by experts from countries they represent or international aid agencies and from home will be edited as proceeding of this workshop. It is going to be the first one of this kind on water management in China with papers that include views of govermental bodies, experience and guidelines of international agencies and home cases' experiences as well.

Finally, I myself on behalf of the National Environmental Protection Agency and Tongji University am honored by the participation of many distinguished experts. In particular, I would like to thank Professor Daniel A. Okun and Dr. Arthur Bruestle for their efforts in organizing the foreign experts are indispensable to the success of this workshop.

Zhang Chonghua
Deputy Chief Engineer of NEPA
Tongji University, Shanghai, May 1987

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(I)

OUTLINE OF THE OPENING SPEECH AT THE NATIONAL WATER ENVIRONMENTAL MANAGEMENT WORKSHOP (SUMMARY)

Qu Geping
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1. As far as pollution is concerned, water and air pollution are two main environmental problems of China at present. Now, the annual quantity of wastewater discharged is 34,000 million tons, and may reach about 80,000 million tons in 2000. Toxic substants in wastewater may increase from 90,000 tons in 1985 up to 250,000 tons in 2000. The development of water pollution is going on. Thus, water pollution control is a very important task.

2. Just like energy resources, water resources is becoming short and short, which has been an important factor limiting the development of economy, especially in areas which are to the north of Yangzhi River. The goal of water environment policy is: to take rationally developing water resources, saving use of water, and preventing water pollution as three parallel ways, among which saving use of water is the key point.

3. Although water resources per capita in China is not ample, the total water resources is very great, and China is one of the countries having rich water resources in the world. If we reasonally develop the water resources, there is no problem that the resources can meet the need of the realization of social production value doubled.

The key step of reasonally developing water resources is comprehensively planning, that is, arranging the development program of economics and society according to the capacity of water resources. Except that some areas may consider the posibility of taking water from distant source, the development aims can only be planned based on the water resources in local area/river basin.

4. There are six big water basins in China. It is reasonable and practical to carry out the development planning based on water basin. Only under the guide of the comprehensive planning of whole water basin, the area's planning may be reasonable and practical. We have established six effective management agencies (including water quality management) for each of these water basins, so that we are capable to carry out such planning. Now, the problem is that we must give these agencies the power to implement planning. Only in this way, can we change the present confusion situation that every one does matter himself, and ensure the reasonal development of water resources.

5. The waste of water is one of the important factors that sharpen the water resources shortage problem in many areas. Although we have spent a lot of cost in developing water resources, some people still bear such a concept at present that water resources is a kind of cheap and inexhaustible natural resources. It makes the situation of the waste of water very popular in some areas. In order to change such a situation, we must persuade people to change their concept about water resources through education in one side, and adopt the economic measures to control the wasting in another side.

6. Out of the total amount of water consumed in China, 70% is used in agriculture, 21% in industry, 5% only in municipal domestic water supply, and the rest is lost. Great stress should be placed on the thrifty use of water in both agriculture and industry fields. Reasonal industrial structure is needed for thrifty use of water resources at first. That is, in the water shortage areas, the areas of cultivation of crops with high water consumption should be strictly limited, and the production of industries which consume a great amount of water, too; the permissible amount of used water should still be cut. The technique of spray and trickling types of irrigation should be promoted in agriculture, and the water re-use rate in industry should be increased.

7. It is necessary to put in strict claim for industrial use of water. The reasons are: 1) industry consumes a great amount of water and is the main factor causing the shortage of water resources in many cities or areas; 2) it is the most important sources of water pollution (70% pollutants come from industry); 3) it has relatively strong economic power and technical potential. Because increasing the water re-use rate is the key step of thrifty use of water, it is necessary to put in a higher claim for it.

8. The active measure of preventing water pollution is to carry out technique renovation of industry, improve equipments and processes, develop industries with little or no water consumption, make the wastewater of one enterprise as the raw material of another, and carry out the necessary treatment of wastewater.

9. As for treatment of wastewater, the strategy is thecombination of building scattered and central wastewater treatment plants, the latter showed be given the first priority. There are up to 90% of industrial wastewater being treated through scattered treatment plant in each enterprise at present. It is because there are not enough wastewater net and big municipal wastewater treatment plants, and the industries themselves in many areas are scattered. From the view points of economic, social and environmental benefits, the strategy of building wastewater treatment plants in each scattered enterprise is not good.

Example 1. It is said that the cost of preventing of water pollution of big and middle scale enterprises in Beijing is 50 million yuan per year. Because that the treated industrial wastewater is discharged into the pipeline which has no water quality control, the cost makes little sense for the water pollution control. If all of these money spent in three years are collected, for example, then, this 150 million yuan can be used to construct a big scale wastewater treatment plant, the economic benefit and environmental benefit would be better.

Example 2. The cost of treating wastewater for Ji Zhuang Zi wastewater treatment plant, Tianjin, is 0.136 yuan/ton, but generally speaking, the same for wastewater treated in scattered wastewater plant is 0.648 yuan/ton. Comparing these two Ji Zhuang Zi wastewater treatment plant can save 5000 yuan per year on treatment cost.

So industrial wastewater should be treated by central treatment plant except the following cases: 1) the wastewater contains toxic substances or heavy metals which are difficult to be degraded by ordinary wastewater treatment plant; 2) enterprise operating own industrial wastewater treatment plant can obtain a good economic benefit as the quantity of wastewater is very large; 3) enterprises are located far from the existing treatment plant or from each other, it is very difficult to collect wastewater to be collected and send to sewage net; et al.

10. The regulation for controlling quality of wastewater discharged on the basis of concentration of pollutants it contains should be improved and the policy of total permissible amount of pollutants discharged should be carried out. The policy would be put into effect in cities and heavy polluted areas at first, and step by step all over the country.

THE WAY FOR DEVELOPMENT OF PREVENTION AND

CONTROL OF WATER POLLUTION IN CHINA

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Water environment is an important component part of the natural environment. Water is an important and unreplaceable natural resource, and occupies a very important position in economic construction, social development and human livelihood. The environment problem of a nation is always closdy connected with the problems of balanced economic development and rationally used resources. Different nations have different problems, therefore copying the models adopted by developed nations to solve their environment problems may not fit the actual conditions of developing nations. In order to establish correct policy, we must first understand the present environmental condition of our country.

During recent years, China has gradually strengthened her work on protection of water resources and prevention and control of water pollution, and has put in large amount of manpower, material, and financial resources. According to statistics, there are altogether 21,969 wastewater treatment plants in the enterprises throughout the country with an investment of 4.38 billion yuan, and a treatment capacity of 26.82 million tons/day; and municipal wastewater treatment plants with a treatment capacity of 1.45 million tons/day; and 38 oxidation ponds with a treatment capacity of 1.18 million tons/day. Large amount of monitor data shows that during the sixth five-year plan period heavy metals, phenol, and cyanide in water were definitely reduced, organic pollution which was rapidly deteriorated in certain districts was retarded. On the whole, the water quality in the main streams of the nations's large river system was good or comparatively good.

Water convervation is one main measure of pollution control, according to statistics of 40 cities, 1.1 billion tons of water was conserved in 1984-1985. The reuse rate of industrial water in many districts and enterprices was greatly increased. During the sixth five-year period, the quantity of wastewater disposed for every 10,000 yuan worth of production was reduced from 470 tons to 310 tons. While the total social production value was doubled, the quantity of wastewater disposed increased was less than 10%. (Fig. 1 - Fig. 3).

In the field of water environment management, legislation on prevention and control of water pollution was carried out, management of main rivers was strengthened, and river system agencies were established, water environment and pollution sources were investigated, microscopic management of pollution sources and macroscopic management of districts and basins were integrated, thus promoted works on water quality monitor, planning, and research, etc.

However, we must realize that water resources in China is not ample, average amount per capita and per acre is small, and its distribution geographically in a year is very uneven. About a half of our cultivated land is always under the threat of drought, and 60% - 70% of the cities lack water to a certain degree. Due to lack of unified planning and scientific management, plus the fact that quantities of untreated wastewater and domestic sewage discharged to water bodies were already very large, and during the past two years the disposal was further increased (Fig. 4 - 5), all these have made nearly 90% of the water basins near the cities suffered various degrees of pollution. The black and smelly conditions of small rivers near or pass through towns and cities become intensified. For economically well developed and popous districts like Beijing, Tiangjing, Tangshan, Shanghai, Suzhou, Hangzhou, and city groups in central Liaoning provinces, pollution of water environment problems becomes very acute. The pollution and contamination of water further reduced the usable water resources, and made the shortage of water resources a more serious problem. The lack of water and contamination of water have caused great damage to economic development, urban construction, and human health. It was estimated that the direct economic loss due to water pollution was at least 30 billion yuan annually. Thus the control of pollution of water bodies and the protection of water resources are problems of utmost urgency.

During the seventh five year period, the basic task of water pollution prevention and control is that the disposal of Mercury (Hg), Cadmium (Cd), Lead (Pb), Arsenic (As), Chromium (Cr), Cyanide, and radio-active materials be reduced 5-10%, and make the water quality of rivers, reservoirs and lakes used for water sources of municipal water supplied reaches 2nd class natural water standard. The reuse rate of industrial water reaches 60% for cities in the nouth and 40% for cities in the south, and the water quality of drinking water sources reaches 2nd class national water standard. In order to accomplish these tasks, the prevention and protection of water pollution should work according to the following lines.

1. Put stress on program of water pollution prevention and control

Prevention and control of water pollution is a long term and arduous task, it covers many fields, and should be planned systematically, and put into practice step by step. Water pollution prevention and control program is the overall planning of prevention and control of water environment pollution, and is the basis for control, development, and utilization of water environment.

(1) Work out water quality control program for river basins and districts and bring this into line with the society's economic development program. Overall consideration should be given to balance the quantity of water and to control the water quality of water resources, rational development, utilization, and protection, are then carried out. The integrated planning should be based on the economic development of river basins and districts, layout of industries, population growth, water body level, amount of pollutants disposed, control of pollution sources, construction of municipal sewage treatment plants, and the selfassimilation capacity of water bodies, system analysis methods should be used, considering all the aims and all the factors involved. Besides guarantee the quantity of water needed for industrial and agricultural production and human domestic consumption, the quantity of water used to improve water quality during the drought period should also be ensured. For example, in the design and construction of water for environment use, and this must be added to the reservoir capacity, thus ensuring the minimum flow required down-stream of the dam. In the comprehensive control of water pollution of river basins and districts, the total amount of pollutants should be controlled. Considering the specialities of pollution sources of cities and districts within the basin together with the function of water bodies and quality of water, the permissible load of pollutants and the total amount of main pollutants can be determined. The total amount of pollutants to be reduced is then distributed to the various cities and districts concerned. In order to protect the water quality of up-stream Huang-pu, total amount of pollutants disposed as well as concentration of pollutants are controlled within the 1st class protection zone and 2nd class protection zone of water sources. According to the requirements of water environment, the maximum allowable amount of pollutants discharged should be worked out beforehand, and then this should be distributed to every enterprise concerned as the total

amount of pollutants legally permitted to be discharged. In determining the total permissible amount of discharged pollutants, the method employed is the combination of Water Quality modeling calculation as well as estimation by experience. The upstream Huang-pu district is convenient in land and water communication, and has a good industrial foundation, so the district has great potential in economic development. But there is contradiction between economic development and upstream water source protection, for according to environment capacity, the district is already saturated, but if we control the total amount of pollutants discharged and the concentration of pollutants, this contradiction can be solved. Because within the total controlled amount of pollutants, every enterprise can use new technique and carry out renovation. Not only this can promote development of production, but also control the pollution load within environment capacity, this will raise the enthusiasm of the enterprises in the district to prevent and control pollution.

(2) The municipality should work out overall wastewater control program and bring this in line with the program of the district. The following problems should be properly dealt with: industrial wastewater and domestic sewage, treatment of single event single item and overall treatment, dispersed treatment and treatment all wastewater (collected treatment), treatment and recovery and utilization, natural purification and artificial treatment. The water pollution prevention and control program of the city should be worked out with the following problems in mind: development of city's economy, water resources, increase of wastewater, aim of water environment, hydrogeology, collection of wastewater. The sewage and drainage system of the city, construction of sewage treatment plants, reused water system etc., should all be put into consideration under an unified planning. When conditions permit, discharge to a river or discharge to the sea may be used as treatment of city sewage. But in laying out treatment plans, feasible studies must be carried out and environmental impact study be made, these should be approved by experts and then reported to local and higher departments for approval. For rivers and lakes that have already been polluted, they must be controlled and treated piece by piece according to program.

(3) When work out national and district economic development program, regulation of structure and lay out of industries should be given due consideration so as to avoid pollution of water environment due to irrational structure and layout of industries. Especially in districts where water is short or in cities where water pollution program is already very acute, construction of industries consuming large quantities of water or causing pollution must be avoided. Development

of village enterprises must be combined with the agricultural program and the village construction program. Development of village enterprises must be based on local resources, power and labor, as well as local tradition and local foundation. Development of agriculture in China is focused on planting, agriculture, and processing system, business with plantion and agriculture as basis and with less pollution should be given priority consideration, small paper mills, small electro-planting works, small chemical works, and small smelting plants with pollution should be strictly controlled. Maintenance of agricultural ecological balance must be given due consideration.

2. Strengthen protection of drinking water sources

Drinking water source is the lifeline of a city, and must be protected just like we protect our eyes. Every district in our country, especially the water quality of drinking water sources of the 51 environmentally key cities must reach 2nd class water standard in the seventh five year period. Water source protection zones must be clearly designated, and signs set up for all city drinking water sources (including lakes, reservoirs, ground water sources, rivers, conduits, etc.) Within a 1st class protection zone, the construction of industrial and mining enterprises which will pollute the environment, the setting up of wastewater outfalls, the development of scenic sites, and any other activity which will cause pollution will not be permitted. Within a 2nd class protection zone, all wastewater discharged must strictly conform to the national and local pollutants discharge standards and water environment quality standard. Excess tapping of ground water should be limited, for those cities that have already overtapped, technical process (such as recharge) should be taken so as to improve ground water table. At the same time, engineering items which will pollute ground water must be prohibited. In order to protect water sources, entro phication of all lakes in the country should be investigated, organic cancerogenic substances in drinking water (both surface water and ground water) should be analysed and investigated, the production and use of harmful chemicals must be traced and investigated. Rules on drinking water source protection should be laid down, thus strengthen the legislation of drinking water source protection.

3. Strengthen the control of industrial pollution source and carry out control of municipal wastewater.

All engineering departments and enterprises in towns and villages must carry out technical renovation and to improve their equipment, develop industries with little or no water, and to make the water of one enterprise as the raw material of another. Increase the utilization rate of resources and power, and try to have all waste and pollution eliminated during the production process. Renovation of technology must start from raw materials, improve production management, strictly control the loss of materials, development techniques to treat those waste water that must be discharged, try to minimize the amount of pollutants discharged.

The Ministry of Chemical Works has carry out works on research and promotion of controlling total pollutant loss. Four years of trial work have been carried out (1980-1984) on the measurements of total pollutant loss of ten products for 100 enterprises. Through many years of improvement and perfection, loss measurement regulations for 231 kinds of products were set up. Those units that promote control of total material loss obtained comparatively good economic benefit and environment benefit. Enterprises under Bureau of Chemical Industries in Shenyang have carried out such work, pollutant loss has decreased form 36,000 tons in 1979 to 27,800 tons in 1983, a decrease of 24.7%. At the same time, the production worth has increased from 608 million yuan to 756 million yuan, an increase of 24.2%. Tai-yuan Chemical works which produce phenol after practised such management, the loss of phenol per ton of production has decreased from 237 kg. to 153 kg. At present, enterprises that carried out such pollution loss control spread over 20 provinces and municipalities, thus the environment control of chemical industries has gradually changed from qualitative control to quantitative control.

Promote the establishment of tidy and civilized plants. Since the beginning of the eighties, China has promoted the establishment of tidy and civilized plants, every industrial department has separately set up and promulgated standards of tidy and civilized plants, and this work was well developed. In 1983, the Ministry of Chemical Industries alone has checked and approved 384 tidy and civilized plants. In order to help enterprises and mines to check and approve tidy and civilized plants, many departments have set up detailed rules for checking, thus the work is standardized. Those enterprises that established tidy and civilized plants have strengthened their equipment management, their rate of leakage at tight points has reduced to 5 per ten thousand, main pollution sources have been controlled, the discharge of "three wastes" has met the required standards, and this has greatly reduced the pollution of water bodies.

Pay close attention to the control of pollution sources of key points and promote the work of prevention and control of water pollution of the whole district. In connection with the modification of production structure, eliminate those products with serious pollution. Those medium and small enterprises with high consumption and serious pollution and difficult to control, are closed, stopped and transferred. For example, benzene hexachloride, D.D.T., mercury reagents and arsenic reagents pesticides are already eliminated. The municipality of Nanjing took the control of wastewater from electroplating industry as a break-through. All electroplating points and plants in Nanjing were investigated, for those that are irrationally laid out with serious pollution, and control at site is difficult, are closed, stopped, and transferred. Up to the end of 1985, 94 electroplating points was moved away and Nanjing Electroplating Center was established. The difficult problem of serious pollution in populous districts is thus solved. For those electroplating points that remained there must control their pollution in due course and only by permit can raw material for electroplating be obtained. The control of electroplating wastewater greatly reduced the pollution of waterbodies by heavy metals.

According to the principle of multiple treatment, it is encouraged that the wastewater of one industry may be treated together with wastewater from another industry or with municipal domestic sewage, in the treatment works in plants, a part of domestic sewage outside the plants may be allowed to be treated in order to avoid too high construction investment and treatment cost due to dispersed and repeated treatment. Lan-Zhou Chemical Company constructed a big district sewage treatment plant, it treats in main, the wastewater from Lan-Zhou Chemical Company, but besides that, industrial wastewater from some 20 enterprises in Xi-gu district and city domestic sewage also enter the treatment plant, the quantity of waste water treated increased from 10,000 tons per month to 50,000 tons, and from originally primary treatment, the plant is now a secondary biochemical treatment plant. This treatment plant made use of the management technique of Lan-Zhou Chemical Company, it reduced municipal investment in construction and maintenance, the treatment plant can collect fee from those units that have their wastewater treated in the plant. The combination of dispersed treatment and collected treatment control of single item and overall control is a good way for its low investment, high efficiency and convenience in management. Combined treatment of municipal domestic sewage and industrial wastewater in a district is an important policy for prevention and control of water pollution, if this is properly carried out, great environment benefit, economic benefit, and social benefit can be attained. Tienjin has constructed the Ji Zhang Zi sewage treatment plant with a treatment capacity of 260,000 tons per day, the cost of treating one ton of waste water is 0.136 yuan, while the cost for biochemical treatment of industrial wastewater is 0.648 yuan per ton, compare collected treatment with dispersed treatment, a Ji Zhang Zi treatment plant can save 50 million yuan a year on treatment cost.

In the planning of sewage treatment plants, consideration should be given as to combine what is needed in the near future and what in the distant future, and construction should be carried out in stages. Municipal sewage is generally treated by means of secondary treatment in developed countries, out this needs large amount of investment and consumes a lot of power, even U.S.A. felt the buden is too heavy. So in 1977 "Water Pollution Control Law" was amended, and "Clear water

Law" was promulgated. The time set for sewage treatment plants in all key cities to use secondary treatment was prolonged from 1977 to 1983, and techniques like land treatment, methane recovery, recovery after treatment etc. should be used to substitute traditional secondary treatment. China is a developing nation, at present her financial resources and power resources are limited. In the near future, sewage treatment plants in cities should use primary treatment, and only in places where conditions permit or under emergency cases can secondary treatment techniques be used. In planning sewage treatment for small and medium cities and in arid and semiarid regions with suitable geographical conditions, primary consideration should be given to the utilization of uncultivated land, waste land, poor land and natural ponds, and different kinds of oxidation ponds to treat sewage and wastewater. Where conditions permit, oxidations ponds and other treatment techniques are combined to raise treatment efficiency, cut power consumption and develop multiple recovery. The sewage treatment of village enterprises should utilize local natural and geographic conditions, develop sewage treatment ponds, sewage irrigation, sewage fishery, sewage breeding of aquatic lives, land disposal and other combined ecological engineering system. For highly concentrated organic waste water and waste refuse, anaerobic biological treatment processes are recommended and to develop biological power source.

4. Promote water conservation, establish water saving society

Out of the total amount of water consumed in China, 70% is used in agriculture, 21% in industry, and 5% only in municipal domestic water supply and 4% in reservoir evaporation. In order to solve our problem of insufficient water resources and to prevent and control water pollution, great stress should be placed on the thrifty use of both agricultural and industrial use of water. Our long term policy is the development of water saving agriculture and water saving industries.

(1) Strengthen the control of water used in agricultural irrigation, improve the engineering works connected with it. Practice scientific irrigation systems and irrigation techniques, such as the use of conduits to prevent seepage and to use pipes to convey water, thus raise the rate of utilization. In water shortage regions, cultivation of high water consumption crops should be strictly limited in area.

The time of irrigation and amount of water used in agricultural irrigation must be scientifically mastered, while conserving water usage at the same time, it will increase production, save fertilizer and power. The strengthening of management of irrigation system is an efficient means of increasing agricultural production as well as conserving water consumption. For example, if the irrigation conducts are lined, this will help to reduce water losses, to prevent water logging and to prevent weed growth. But conduit lining increases construction cost, so a cost-benefit analysis must be made.

Regulate quantity of irrigation water according to weather condition, rate of evaporation, soil humidity, and quantity of water needed by the crops. After careful arrangement 20-30% of water consumption may be saved. Only a small fraction of water reaches the root of the crop in traditional gravity irrigation system while a large part of remainder flows away from the land, with the splashing type of irrigation especially those with a central rotating installation, irrigation efficiency will be very good, but this consumes more power and investment will be larger. Using the installation of tricking irrigation a water to the root of the crop which reduces evaporation and seepage loss. Although the investment is higher, this type of irrigation equipment is especially suitable in water shortage regions and in irrigating agricultural products of high economic value. As reported, the average water utilization rate of each type is as follows: - gravity irrigation 40-80%, central rotating irrigation 75-80%, trickling irrigation 60-90%, the key point is management. Even with the ordinary gravity irrigation system, by using interceptors and recirculating the water running away from the land, 30% of the water can be saved. The electricity cost for pumping the recirculating water to the irrigation conduit is less than the cost of pumping water from deep wells.

Automatic irrigation should be developed. Using computor to control the time, quantity of water supply, and irrigation water flow. The quantity of water should be regulated according to wind velocity, soil humidity and fertilizer used. It is estimated that the saving of water and electric power, and the increase of agricultural production can cover that cost of equipment installed within 3-5 years can cover that cost of equipment installed.

(2) Promote industries that do not consume water or consume little water, promote techniques on recirculation of water, multiple use of water and recovery of wastewater, raise the rate of repeated utilization of industrial water. At present, the increase of industrial consumption of water is more rapid than that of agricultural consumption. Economize on water consumed in industries not only guarantees the development of industries, but also greatly reduces the amount of pollutions discharged to the water bodies.

Cooling water and other uses of industrial water do not need to meet drinking water standard, most of the water can be used many times before disposal. Electric power plant using cooling tower to cool water and use it repeatedly can save 95% of cooling water, compared with water used only once. Fully utilize water in production can greatly reduce consumption of industrial water as well as wastewater disposal. For example, waste material used to smelt aluminium will discharge 90% less waste water than if aluminium is used. A ton of waste paper can produce 0.8 ton of pulp, thus saving 4 cubic meters of lumber, 300 kg of alkaline, 350 kw of electricy, 500 tons of water, if 1/4 - 1/3 of the paper produced is recovered, the economic, social and environment benefit is very great. If less-poisonous or poisonless raw material is used in production, amount of pollutants produced and industrial wastewater disposed will be greatly reduced.

The water system in industrial and mining enterprises must perfect their water-measuring-appliances. Starting from water-using units, water consumed by piece of machinery, by every shop, and then by the whole factory should be measured and balanced. Water consumption file should be established. For those units that use water wastefully, effective measures must be taken to cut down their water consumption and to reduce pollutants produced. For those construction items that have a high water utilization rate, their investment should be guaranteed. Those who wastes water, administrative and economic means should be taken to cut down their water supply.

An important means to raise the repeated use of industrial water is the separation of waste water and clear water. In the non-ferrous metal industry, a very large part of water is used in cooling. The quality of water after use is still comparatively good, and can be reused without complicated treatment. Besides evaporation and seepage, about 95% can be reused. Many enterprises have considered the reuse of cooling water during their construction and have good recirculation process. Many old factories may not have water recirculation process in their original design, but have later put then up in recent years. The rate of repeated use of industrial water have greatly increased in many districts, in Dalian it has reached 80%.

(3) Economic domestic water consumption.
The domestic water consumption in cities occupies a comparatively small ratio, but as the standard of living is raising, absolute quantity of water used is increasing every year, and the cost for treating and distributing that portion of water is very high, and a high investment is needed. Reduction of domestic water consumption can cut down financial expenditure, and at the same time reduce the burden of the sewage treatment plant. Water saving devices must be used in order to cut down domestic water consumption. For instance, to flush the toilet once, 20 liters of water is required, but with a water saving device, this can be cut down to 7 liters. Shower nozzles use about 20 liters per minite, but with water saving nozzles 50% can be saved. A high efficiency washer can save 25-30% of water compared with an ordinary washer. Installation of water meters helps the consumer to cut down the

quantity of water used. Economize in water consumption also save electric power. Use of water in public places needs special attention, prompt maintenance and repair, so as to reduce leakage. Through thrifty use of water, the rate of ground water tapping can be retarded, electric power can be saved.
The thrifty use of water in cities should be looked upon as along term policy.

(4) Turn wastewater into resource, utilize wastewater rationally and the same time prevent pollution
Study the techniques how wastewater can be recirculated and reused. Construct "reused water" water system at places where condition permits. Wastewater after treated can be used to flush toilet, to wash cars, to sprinkle lawns and fountains. During the seventh five year period, Beijing has made Huangcun in Daxing county as an experimental unit, and then extend it to other localities.

Use treated sewage to irrigate farm lands, promote scientific sewage irrigation techniques and irrigation system, fully utilize fertilizer value in sewage and land treatment system. Obviously, if sewage is used for irrigation the quality of sewage must meet the standard of water quality for farm land irrigation. Besides, a part of brackish water may be utilized to irrigate salt containing crops. Some industries may use brackish or sea water for cooling or industrial use, thus saving fresh water.

5. Assessment of economic loss caused by water pollution and benefit gained from control of water pollution

For a long time, prople have made large analysis on economy so as to get economic benefit, but few analysis has been carried out as to the economic loss, and social danger caused by pollution of water environment. As to how much economic loss is caused by pollution of water environment, it shall be expressed quantitatively, and put into our overall economic aim, so that environment benefit and economic benefit can really be combined together and thus provide scientific basis for set up national economic development aim and environment aim. We have just started to study the cost-benefit analysis in our environmental and policy decision. The departments concerned have already given attention to this matter. As to how environmental benefit analysis are carried out abroad is worth our study. We should work out a set of economic evaluation index system applicable to our country. On one side, it should develop our industries while at the same time environment pollution caused by economic development should be restricted within bearable limits. From the principle that economic law and ecological law should be united, and using a mathematical model, the economic benefit relationship between environment pollution and environment protection can be worked out, studies should also be made as to how environment investment is put into practice, and the optimum proportion it occupies in the item is worked out. While on one side, pollution should be controlled and on the other side, we must consider the variation of different industries, of different locations set up suitable mathematical model to find out the relationship between the environment investment and economic benefit of the item, thus obtaining the optimum proportion for those imported industrial waste water treatment processes, the investment on environment and the technology and economic and environment benefit of departments of mechanical engineering, of chemical industries, of light industries, of aviation etc., shall be analysed and assessed.

From the practice of economically developed countries, the policy of pollution first and treatment later will have a poor cost benefit, as many bad social and economic consequences will result from pollution of water environment or water district such as: 1) increase of disease of people, reduction of labor, and these will result in more social insurance and more medical services, 2) qualitative and quantitative losses of biological resources such as aqua products, agricultural products, forest will be increased, some products (such as precious fishes) may be lost for ever, 3) poor water quality may lead to degradation of quality of industrial products, and of foodstuff, 4) increase of cost, power, and material in treatment of wastewater, 5) destroy beautiful scenery, causing economic and mental losses to tourism, atheletics, cultural amusement, 6) economic development will be hindered due to increase of uncultivated land and polluted land.

After comprehensive prevention and control, water pollution will to recovery of water environment, money spent on pollution control will produce great social and economic benefit, harnessing of a river will bring economic boom and promote development of cities and industries.

China is a developing county, compared with developed countries there exists a great gap. Great effort must be spent in the future to solve the environment problems. At the same time, we hope to cooperate with experts from abroad, and contribute our efforts in searching for a way as how to protect water resources and to prevent and control water pollution in developing countries.

WATER SAVING AND WASTEWATER TREATMENT — TWO IMPORTANT MEASURES IN WATER ENVIRONMENT MANAGEMENT

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High rate of economic development in the world has brought about high demand on water resource. On the other hand, the limit of fresh water resource is being subjected to unlimited over exploitation, and water pollution is intensifying daily. The sharpening of the contradiction between supply and demand has caused serious concern of related departments and experts. It is of great significance to have experts from various contries come together and discuss seriously the issues relating to the management of water environment at this workshop. I am engaged in the management of municipal water supply and drainage at the Ministry of Urban and Rural Construction and Environmental Protection, and I take a great interest in this workshop. I would like to have the pleasure to give an introduction to our work in the management of municipal water supply and management. And I also hope the experts present here would give us advices on the development of municipal water supply and drainage. I will mainly deal with two issues: one is how do cities implement the policy of water saving? and two, actively carry out the work in municipal wastewater treatment.

A. Firmly Implement the Policy of "Finding New Water Sources and Saving Water"

Since the founding of New China, infrustructures in water supply have been developed in a fairly big way. By the end of 1985, tap water supply and reached over 41 million M^3 per day, an increase of 15 times as compared with the amount before New China was founded. There were more than 67000 km of water pipe and 82% of the city residents used tap water with an average per-capita consumption of 151 L/day. Besides, factories, mines and other enterprises had their own water sources with a capacity of 60.60 million M^3 per day. Much progress has been made in the construction of water supply infrustructures, however, the development in the conditions of water resource and capacity of water supply still cannot meet the actual need. Therefore many cities in China are seriously short of water. According to the investigation made in over 200 cities, the total shortage of water is about 10 million M^3 per day. Apart from this, many county towns and rural small towns lack water supply facilities. People have to drink well water or untreated surface water, causing great difficulties to their life.

While water supply is inadequate and can not meet the demand in China's cities, there exist waste of water. The general situation is high consumption of industrial use and low level of consumption for domestic use. Many factories neglect water recycling and reutilization. The reutilization rate can be as high as 50% and more in some cities in shortage of water, but the average of the country is only less than 30%. There is also waste in domestic use, a main reason of which is that the water price is too low. One cubic meter of water for domestic use is only 0.12 yuan which is equal to the price of a popsicle. Therefore, people do not treasure and save water.

Water supply in cities is in a tense situation and it is expected that there will be no assurance for the adequate supply within 10 years and more. China plans to increase its total agricultural and industrial output value by 3 times by the year 2000. Water consumption in cities will be greatly increased. According to the estimation based on present consumption level, an increase of 180 million M^3 of water supply capacity for industrial production and 40 million M^3 for domestic use per day is needed. To solve the problem in water supply, it will not work if we just rely on building new water works. Not only water resource conditions do not permit this, but also the country has difficulties in financial resources. The leaders of the State Council attach great importance to the solving of water problems. And on several occasions pointed out that we must find new water sources on the one hand, and on the other, we must save water; we must solve short-term water problems, and at the same time we must also make efforts to ensure long-term use of water. To achieve this, the quickest means is to save water. The leaders of the State Council have assigned the responsibility of water saving in rural areas to the water conservancy department and saving of water in cities to the urban construction department. The State Council sent out a "Circular on Saving Water in Cities in a Big Way". To strengthen the leadership in water saving, the Office of Water Saving in Cities was established in the Ministry of Urban and Rural Construction and Environmental Protection, with the following terms of reference: study and develop guidelines, policies and regulations on water saving in cities; give guidance to the work in water saving in the cities all over the country; coordinate the work of different departments in water saving; organize the exchange and dissemination of experiences in water saving and strengthen the management in the exploitation, utilization, distribution of water, during the sixth five-year plan period, the medium-sized and big cities in the country conscientiously implemented the policy of finding new sources and saving water, which yielded good results in water saving, energy conservation, protection and reasonable exploitation of water resources in cities, easing of the contradiction and tense situation in municipal water supply. Up to now, there are more than 200 cities which have carried out the work in water saving. Institutions for the management of water saving have been set up in more than 160 cities; management procedures have been issued and incentive measures taken; consumption quotas for different industries and professions have been determined; the management in the use of water in a planned way have been strengthened; exploitation of groundwater in cities are strictly controlled, water saving equipments and devices are disseminated. As a result, the work in water saving have developed into an important continuing routine work. In the work of water saving, mainly the following measures have been taken:

1. Emphasis of water saving in cities is on the saving of industrial water. Factories and mines are chief users of water in cities which consumes about 80% of the total consumed (not including agriculture use). Among them, 70% is cooling water. At the same time, many factories are backward in technology, their equipments are outdated. Coupled with inproper management of water use, water consumption is very high. Much of water is discharged after used once. Therefore the focus of water saving in cities is on the saving of industrial water. In recent years, many cities have strengthened scientific management of water saving. As the first step, they determine consumption quotas ensuring the supply of water in a planned way. At the same time, incentive measures are taken, awarding those who save water and fining those who waste water so as to fascilitate the saving of water in factories. According to the statistics of 1983-1985 from 40 cities, totally 1500 million M^3 of water were saved, that is an average of 500 million M^3 per year. This equals to the saving of a water work with a capacity of 1.5 million M^3 per day and a water treatment plant of the same capacity. Togethe with the drainage system, an investment of 2 billion yuan was saved. For example, after those factories consuming over 5000 M^3 of water per month is supplied in a planned way, the water consumption was reduced by over 30%. Good experiences have been obtained in water saving in Beijing, Shenyang, Shanghai, Xian and Qingdao.

2. Encourage in factories to improve industrial processes so as to reduce water consumption per unit of products.

Because of differences in the level of technology and processes, water consumption per unit of products varies a great deal. For example, to produce one ton of steel, the highest consumption is 37 tons while the lowest is 1.5 tons. For paper mills, to produce one ton of paper of the same variety, the highest water consumption is 480 tons while the lowest is 43.7 tons. Even the lowest consumption for producing one unit of products in China is higher than the water consumption in advanced foreign countries. Without the improvement in processes and equipments, there will be not only waste of water, but also waste of raw materials and resources and increase of wastewater in cities. Therefore, to reduce water consumption by improving processes is an important approach in saving industrial water. In recent years, rejoycing results have been achieved in water saving through technical measures in Beijing, Shenyang, Tianjing. In 1986, 247 technical renovation projects in water saving were completed in Beijing, which saved over 30 million tons of water while in Shenyang in the same year 190 projects were completed which saved 39 million tons of water. Other cities also have good experiences.

3. Raise the reutilization rate of industrial water

First of all, cooling water should be reused. Where conditions exist, factories should adopt closed-circuit circulation to reduce discharge. It is hoped that with several years' effort, the reutilization rate of industrial water could be raised from over 20% to 40% so as to save water as well as the capital construction investment for water supply projects. The capital investment for a capacity of 1 M^3 of water per day is 300-400 yuan. The investment for the construction of sewage pipes and water treatment facilities is 400-500 yuan/M^3·day. That is to say, for 1 M^3 of additional water supply, the total construction investment will be 700-900 yuan/M^3·day. On the other hand, the investment for the construction of water saving technical renovation projects is 100 yuan/M^3·day, which is both economical and safe and reliable. The knowledge about water reutilization has been improved now in many factories, which is the reason why industrial water consumption has been reduced a great deal in recent years. It should be made a rule that any city whose industrial water reutilization rate is lower than 40% shall not be permitted to construct new water supply projects. Efforts should be made to encourage cities to reutilize industrial water.

4. Encourage multiple-usage of the same water and reutilization by other factories.

One factory can utilize the wastewater produced in another factory. In Dalian and Qingdao, sea water is used instead of fresh water with improvements of equipments, which can save fresh water resource and investment for the construction of water supply facilities.

5. Avoid waste in the consumption of water for domestic use.

Water gauges should be installed in every household and charge determined according to the amount of water consumed. At the same time, the water price should be adjusted reasonably so as to encourage people to save water.

To sum up, there is great potential in water saving and many things can be done in this respect. We should firmly persist in the work to save water. However, with the development of urbanization, economic growth and improvement of people's living standards, the demand for water still can not be met just by water saving. Efforts should be made to increase new water sources for cities so as to increase water supply capacity. It is expected that during the seventh five-year plan the demand for water brought about by urban development can only be met if an increase of 3-4 million M^3/day of water supply capacity can be achieved every year. Therefore, we are having a very heavy task in the construction of urban water supply projects. New water works should be built on the basis of local conditions, new technology and processes should be adopted, and efforts should be made to reduce investment. At present, groundwater is over exploited in many cities which causes the sinking of the ground. Therefore, a big subject area for study in municipal water supply is how to protect groundwater and actively make use of surface water. The trend in the construction of water supply projects is that the distance of water transportation is becoming bigger and bigger. Sometimes water has to be transported across watersheds.

When we construct long distance water pipes and municipal water supply works, we should first take into consideration the application of advanced water purification technology, the raising of purification efficiency, saving of investment and reducing of land. Technologies such as accelerated clarification method, slanted plate settler, automatic baskwash filter, are applied in many cities, which has improved water supply efficiency. Many cities are very strict with water quality making sure that water quality meets the sanitation standards. Water quality should be further improved in some small cities.

B. Implement the Principle of Treatment following Drainage, Actively Treat Municipal Wastewater

Since the establishment of new China, wastewater drainage and treatment have been progressing gradually. Since 1950's the people's government have mobilized the masses of the people to rely on themselves in dredging sewage pipes and repairing and modifying wastewater ditches so as to improve the living environment of the people. Subsequently a series of medium-sized and big wastewater drainage and treatment projects have been built. Especially since 1979, the state has supported some big cities and tourist cities in building wastewater drainage projects and wastewater treatment plants. About 1800 km of new sewage pipes are laid every year and new wastewater treatment plants with a capacity of 150,000 M^3 per day are built. Now there are more than 30,000 km of sewage pipes in the country which is 5 times that of the period before new China was founded. There are over 50 wastewater treatment plants with a capacity of 1.6 million tons per day. The biggest wastewater treatment plant was built in Tianjin in 1984, which adopts secondary biological treatment and has a capacity of 260,000 tons per day. A series of medium-sized and small wastewater treatment plants have been built in Shanghai, Xian, Chansha, Suzhou, Wuxi, Changzhou and other cities. The main problems in wastewater drainage and treatment existing now are: lack of planning in the past, inadequacy in facilities and construction capital, and irrational management system which cannot meet the need of the environmental protection. I many cities, systems of sewage pipes are not formed. In half of the city proper, there are no sewage facilities. Rivers and ditches within the city have become waste sink, causing serious pollution to the city environmental and groundwater system. There are few municipal wastewater treatment plants with low capacity and low level of treatment, which cause large amount of wastewater discharged into rivers without treatment, causing pollution to water resources. Because of the pollution of water sources near the city, many cities have to take in water from a long distance increasing the cost of water supply. Cities lack funds for maintenance and construction of drainage systems, therefore the planned construction of drainage and treatments projects can not be implemented. Because of sewage pipes getting old and lacking timely maintenance, drainage is affected and drainage workers are subjected to risks. Management system is unreasonable. Discharge of water is not charged in China for long, causing waste of water and negligence of the protection of sewage pipes. All these problems will have to be solved in the process of economic reform. In order to change the state of backwardness in the work of drainage, we propose to take the following measure for improvement:

1. In the construction of drainage facilities, we should first improve and complete drainage system in cities, gradually construct rain water and wastewater separation projects so as to reduce the pressure on wastewater treatment plant and save treatment costs. Through modification, rain water and wastewater mixed in sewage pipes of old city areas can be improved. As for the newly developed areas, separated sewage pipes should be constructed.

In order to ensure the normal life and safety of sewage pipes, wastewater discharged by factories must be controlled according to standards. The wastewater containing corrossive materials or materials that can clog pipes and other hazardous substances such as heavy metals should be treated first be factories before it can be discharged into sewage system. Change must be made as quickly as possible to the practice in some cities that waste water is discharged into the rivers within the city. Sewage pipes should be built along the rivers or in areas where wastewater is concentrated to stop wastewater flowing into rivers and to introduce it to the outside of the city as a first step.

The maintenance and dredging of existing drainage facilities must be strengthened. Many cities have been increasing their industrial and municipal wastewater, however, the capacity of the sewers is too small or old and outdated without maintenance for many years. Therefore modification and renewal must be done to these sewers. I plain and low-lying areas, the construction of sewage pumping stations must be increased and maintenance must be done regularly so as to ensure timely drainage of municipal wastewater and rain water and avoid damage caused by flood.

2. Actively treat municipal wastewater. Municipal wastewater is the mixture of industrial and domestic wastewater with some rain water in some cities during rainy season. With the development of industries in cities, the composition of industrial wastewater becomes more and more complicated with an increasing amount of hazardous substances. For several years, we have followed the policy of "whoever pollutes shall be responsible for its control". It is stipulated that for those factories discharging wastewater containing hazardous and toxic substances, efforts should be made to modify processes to recover useful materials and recycle as much wastewater as possible. The wastewater then should be pretreated before it is discharged into municipal sewage system to be treated in municipal wastewater treatment plant.

The municipal wastewater treatment plant should have an apapropriate size. An overall plan should be made, but its implementation should be executed in stages. For big plants, investment is comparatively low, land occupied is less and cost of treatment is also less, so it is rational to build wastewater treatment plants with reasonably big size. However, the financial resources in local areas are limited, so they have difficulties in building big treatment plants. Therefore, on the basis of the total amount of ddscharge, an overall plan should be made, under which small treatment plants can be built as the first stage of the big plants which will be completed step by step. This approach is in conformity with the actual ability of many cities in China. Some big cities have fairly adequate funds and it is the best for them to build big plants all at once, but they are few after all.

The standards of treatment depend on the requirement in environmental protection as well as financial and technical feasibility. Where conditions allow, secondary biological treatment plant can be built, enabling the water after treatment to reach the standards set for the receiving water body. In places where it is difficult to do so, primary mechinical treatment plant can be built to precipitate hazardous materials and sludges so as to reduce pollution to rivers. In some cities, the wastewater which has been treated by mechanical or biological means can be treated again by oxidation ponds, this is the best solution. In some cities, oxidation ditches for wastewater treatment are being built and subsequently land treatment systems will be established gradually to improve the result of treatment. To sum up, the standards of wastewater treatment should be determined according to local conditions, progressing gradually from low standards to high standards.

3. The purpose of wastewater treatment is to protect urban environment and to turn as much wastewater as possible into useful resources. In cities where water is scarce, efforts should be made to treat wastewater into the extent that it could be used as cooling water or for watering trees and grasses. Some wastewater can be used for irrigation after hazardous substances are removed. At present the wastewater is gradually being reused after treatment in Taiyuan, Qingdao, Dalian and some other cities. We must be cautious in reutilizing wastewater, especially for agricultural irrigation, we must take different crop conditions into consideration and avoid harmful effects and secondary pollution.

Approaches for sludge disposal are scarce in China. The general practice is to dry it naturally and then dispose it in landfills. In some plants, sludges are thickened and dewatered mechanically, but this method is costly and is difficult for all factories to adopt.

4. The funds for wastewater drainage and treatment are mainly from construction maintenance tax and partially from subsidies provided by the state. The present practice is that the drainage facilities are used free of charge. The more drainage and treatment facilities are built, the heavier the economic burden of a city will bear. This will have adverse effect on the enthusiasm of local authorities in building drainage projects. In recent years, reform has been started in some cities to change the present method of free use of drainage facilities. That is, drainage fee is collected according to the quality and amount of the

wastewater discharged. By doing so, not only part of the funds for drainage construction and management can be secured, but also factories and other enterprises are encouraged to save water.

In a word, our work in wastewater drainage started late and working foundation is poor. Although some achievements have been made, there are still many problems and difficulties. This is manifested first in the fact that the importance of the construction in wastewater drainage and treatment is not fully understood. Some people think that drainage projects do not create value and profits. On the contrary, they incur operation fees all the year round. Therefore they are reluctant to put investment into the construction of drainage projects. Controversy also exist regarding the technology. For instance, what wastewater treatment processes should be adopted? The construction of secondary biological wastewater treatment plant is very costly and the operational fees are also high. If the wastewater is just treated with primary mechanical treatment, the water quality cannot reach the standards set for the receiving water body. How to find a treatment method which is both economical and effective and suitable to China's conditions is a subject which needs to study.

On the materilization of wastewater, people generally have a consensus in that wastewater should be reutilized. But how to utilize it? People have different ideas, especially in sewage irrigation. Though there are many good results and experiences, there are also problems such as pollution to crops and damages to soil which need to be solved. These problems can be solved only when education on the importance of wastewater drainage and treatment has been carried out among the people and their understanding of the issue has been raised.

We sincerely hope that experts and friends present here will provide us with their valuable advises so as to promote the cause in municipal wastewater drainage.

WATER MANAGEMENT AND RIVER BASIN PROTECTION IN CHINA

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ABSTRACT

This paper will present a brief overview of the current situation of water resources development and utilization, the principles and methods of water management and river basin protection in China. At the same time, a series of policies and measures being adopted by government department responsible for the work as well as the priliminary effects achieved will be stated

1. Current Situation of Water Resources Development and Utilization

i. In China, the mean annual rainfall is 648 mm, that is, the total precipitation is 6,000,000 million cubic meters; the mean annual total water resources is about 2,800,000 million cubic meters, 2700 cubic meters per capita which is nearly one fourth of the world average.

ii. The main rivers of China are: Heilongjiang river, Liaohe river, Haihe and Luanhe rivers, Huanghe (Yellow) river, Huaihe river, Changjiang (Yangtze) river, Zhujiang (Pearl) river, the total flow of which accounts for two third of the annual total water resources, especially the Changjiang river which amounts to 40 percent of it.

iii. The levels of developing and utilizing rainoff are different among the rivers above mentioned, while there are higher levels in the north regions, see as follows:

Liaohe river, Haihe and Luanhe rivers	60 ∿ 65 %
Huanghe river and Huaihe river	40 %
Changjiang river	16 %
Zhujiang river	15 %
rivers in southwest China	<1 %

In the North Plain, the utilization factor of shallow groundwater has been 90 percent, and local drawdown cones have been formed in the regions of about 3,000 square kilometers.

iv. The total water supply capacity of the existing water conservancy projects amounts to over 470,000 million cubic meters per year, about 17 percent of the mean annual water resources, in which 420,000 million cubic meters comes from streamflows, 15,9 percent of the mean annual streamflows; 45,800 million cubic meter from groundwater, the utilization factor of the shallow groundwater is 24.3 percent.

v. The total water consumption in China is over 470,000 million cubic meter, 85 percent of which is by agriculture, 11 percent by industry and 4 percent by daily life. The yearly water consumption per capita is 460 cubic meters.

vi. From 1949 to 1980, the average growth rate of water consumption was 5.2 percent, and the ratio of the growth rate of gross output value of industry and agriculture to that of the total water consumption was 1:0.56. For recent years, the growth rate of water consumption has become a bit lower as the result of water-saving measures. It is predicted that the water consumption will be about 550,000 million cubic meter at the end of this century, and growth rate of it is estimated from 1 to 1.5 percent.

2. Overview of Water Management

i. With the development of social economy and the exploitation and utilization of water resources, the goals and focal points of water management should vary with different periods.

ii. In the 50's and 60's, constructing water conservancy projects took place on a large scale in our country in order to prevent drought, flood and water logging disasters. At that time, the flood control and irrigation were addressed, and the goal of water resources management was to ensure the our society against flood for increasing agricultural yield.

iii. Under the leadership of the people's governments at all levels, the people went in for the development and utilization of water resources and the prevention of water-concerned disasters with great enthusiasm and had obtained remarkable achievements. But the following issues were not fully realized:

a. Water is a kind of valuable natural resources and should be developed reasonably and utilized economically like other ones.

b. Water is also an environment factor. Thus, human activities can cause the water body pollution. Much more emphasise should be put on water resources protection so that it can be utilized permanently.

c. Water can be used for various objectives. So, it should be developed with multiple purposes to get better benefits in all the social, economic and environmental aspects.

d. It is more arduous to maintain the existing water conservancy project systems intact and well operated than to construct them. The policies to make these systems self-maintain and self-develop are indeed wanted.

iv. Since 1970, with the growth of population and economy, the water supply and demand have become more and more unbalanced. The following problems have gradually been revealed:

a. In the North Plain, where water resources are in scarcity, the water supply is not enough to meet the demand so that the demand required by some cities development went beyond the scope of bearing capacity in local water resources. And water shortages occurred for a time. In some areas at north China, the groundwater has been overdrawn regionally.

b. Water qualities of rivers passing along or lakes located near large and medium-sized cities have deteriorated. And the water environmental qualities have evidently been degenerated.

c. In the development of water resources in the river basins, an importance to the multiple purposes of water conservancy projects has not been attached sufficiently with the results that some negative effects on navigation, fishery and the ecological environment were raised.

d. The functions of existing water conservancy projects are becoming declined because of falling short of their operating maintenances and normal repairs.

v. Now, the goals of water management have gradually shifted from mainly facing the growth of agricultural yields to comprehensively serving the national economy and social development. In these ones, to economize the use of water resources and to reinforce the management of existing water conservancy projects have been put on a significant position. To achieve these goals, a series of policies and measures adopted by the state are as follows:

a. Establish the institution that the water resources management are unified by the state combined with the agencies of the local people's governments at all levels or different departments subordinate to the State Council. And found the national coordinate organization and strengthen the legislation of water resources management. Draft the National Water Law, issue the Water Pollution Prevention Law ect.

b. Carry out the zoning and assessment of water and land resources and the unified planning of river basins development so as to provide scientific basis for the development of water resources.

c. Take it as a basic national policy to effectively preserve and economically utilize water resources, and enfore the planned and saving water use by the administrative, economic and technical measures.

d. Adjust water rate to form the institution under which users must pay for the cost of water supply.

e. Put forward the proposals in the planned way to construct inter-basin water transfer projects and other facilities which will compose of new water sources to relax the tension of water supply in the North and some coastal cities.

f. Keep the appropriate investment proportion of water conservancy projects in the national economy as a whole to be suited for the water consumption required by increasing the gross output value of industry and agriculture and improving the living conditions of the people.

3. River Basin Protection

Since the 80's, more and more widespread attention to the river basin protection has been paid in water management.

i. Establishing Administive system

In 1983, Ministry of Water Resources & Electric Power and Ministry of Urban and Rural Construction & Environment Protection decided together for founding six river basin protection agencies (or offices), that is, Changjiang, Huanghe, Zhujiang, Huaihe, Haihe and Shonghuajiang rivers. In the Taihu lake, a basin protection agency was set up after that time. These agencies hold themselves responsible to and led by both Ministrys. The main functions of them are as follows:

a. to make the plans for the river basin protection and to implement it.

b. to coordinate the activities of water quality monitoring within the basin.

c. to coorperate with the relevant environmental protection agencies in both the control of water pollution and the management of water quality.

Additionally, there exist some united administrative bodies analogous to provinces which are consist of the staffs from the department of water resources management and the local people's governments in order to implement the unified leadership and coordination. For examples, Heilongjiang Province, Jilin Province and Nei Mongol (Inner Mongolia) Autonomous Region have jointly founded a leading group for the Shonghuajiang river basin protection, two Ministrys above mentioned as well as Tianjin City and Hebei Province have caome to the same thing, a leading group for the water resources protection of the water transfer into Tianjin from Luanhe river. In China, most of the departments of water resources at province level have their own authority for getting on with the water resources protection and coordinating its activities in the planning of water resources protection and water quality monitoring with respective river basin protection agency.

ii. Developing water quality monitoring and assessment

Basically, a water quality monitoring network based on the river basins has been formed within the range of the whole country. It has 2150 water quality monitoring sections, 196 analytical laboratories, 1145 personnels who are devoted to the water quality analysis. In six water quality monitoring centers of this network which belong to six river basin protection agencies above mentioned respectively, the data precision has been improved because the analytical apparatus and instruments have been gradually renewed and the level of monitoring and analytical techniques of the analysts is being enhanced. The water Quality Bulletin which reflects the water quality conditions of main rivers of China is released five years since 1982. The first national surveying and assessment of surface-water quality which began from 1980 has been ended. It dealt with the current situations of pollution sources, surface-water quality and water qualities of river basins as well as the trend analysis of water quality. By analysing about 300 thousand data, the assessment results of water quality for the whole nation and each river basins and provinces were presented to provide a scientific basis for the water quality planning and the control and management of water pollution. According to the results, the central sources causing river pollution are industrial wastewater and sewage from cities and towns. In 1980, total wastewater emission per day amounted to 86 million tons (not including the cooling water of power plants and the mine drainage), 83 percent of which is from industrial wastewater, 17 percent from municipal sewage. Wastewater was nearly all drained into river without treating. In 95 thousand kilometers long rivers surveyed, 20 percent of them has been already polluted in varying degrees, 5.2 percent in serious polluted situation, certain natural lakes and reservoirs as well as the partial groundwater have been also polluted. The rivers passing along large and medium-sized cities raised the polluted zone at their banks by which the quality of water supply in some cities have been affected.

iii. Drawing up river basin protection planning

On the basis of water quality assessment, the planning of river basin protection centred upon the distribution and discharge condition of pollution sources within the basin, the pollution trend predications at year-planning, drafting the water quality goals by the functions of water body and the zoning of river reaches, selecting a perfect plan of water quality management through the water quality models, determining the permissible pollutant load and the control standards for major pollutants, computing the controlled emission and distributing total pollutant emission which needs to be abated among the cities or areas to implement water quality control, and presenting the synthetical control policies and the cost-benefit analysis of the investment.

The mean annual water resources of Changjiang river is more than 920,000 million cubic meters, which is about 31 percent of the whole nation one. There are 21 pollution sources formed by cities at both river banks. These cities drained 5,000 million tons of wastewater per year into rivers, 82 percent of which is from five main cities, that is, Dukou, Chongqing, Wuhan, Nanjing and Shanghai. It is shown that the municipal sewage has an important impact on the water quality of river reaches near a city. Therefore, the river basin planning of water quality should be based on the control of river reaches near a city, combined with the comprehensive prevention and control of water pollution in it and to provide a perfect plan in the optimization methods. In process of water quality plan for the reaches of Changjiang river near Wuhan City, the short-term control target required is to keep fourth class surface water quality standard at both river banks. By this standard, the permissible pollutant load was only about 24 percent of the predicated total wastewater emission from Wuhan City. The treatment measures of the catch-sewage and diversion constructions and the sewage treatment plants are able to reduce 18 percent of wastewater, and 30 percent reduced if combined with the realignment of a river reach and the irrigation with sewage, 28 percent reduced if increasing the water reuse rate of enterprises. The total emission control has been performed for the main pollutants reflected stream quality, especially the pollutants from paper factory and steal mill, where a target date shall be set for elimination and control of the pollution.

Having ratified by the state and local people's governments according to the specific program, the planning of water resources protection should be brought into line with the national economic and social development plan and gradually implemented in the light of the national finance and material resources.

iv. The important water sources, such as drinking water sources of cities, should be protected by the state and local people's governments. The Water Pollution Prevention Law stipulates: The people's governments above the counties may delimit the protection zones for the places of drinking water source, historic interest and scenic beauty, the important fishery water and other water bodies with the special value for economy and culture. Every place where is a drinking water source of the city should be delimited as a protection zone against pollution, such as lakes, reservoirs, rivers for water transfer, channels and groundwater within the river basin. The first class protection zone is a forbidden one to the industrial or mineral enterprises, the sewage pipe, the tourist area and other activities polluting environment. In second class protection zone, all of wastewater emission must strictly excute the pollutant emission standard and the water environmental quality standard specified by the state and local governments. The protection and management regulations of Guanting reservoir and its river system which supplies water for Beijing City stipulates that the river basin is divided into three kinds of protection zones. First class protection zone consists of the areas which is within the range of highest flood water level of the reservoir and 100 meters distance from both side of rivers for water transfer and channels; second class protection zone includes the area within 5 kilometers and outside highest flood water level of the reservoir; other areas within catchment form third class protection zone.

v. Drafting the laws about water protection.

The Water Pollution Prevention Law has been issued in 1984. Now, the Water Law of The People's Republic of China is being drafted, which will specify a licence system for use of water. The key cities have already tried out this system. In every river basins, the relevant laws and regulations are being drafted.

vi. The effects of river basin protection are obvious.

Because of economizing use of water and controlling pollution sources, the growth rate of total wastewater emission is less than 10 percent which has notably dropped and the heavy metal, phenol and cyanogen pollution for water environment has evidently decreased upon condition of the urban population growth in whole country and the gross value of industrial output increase of 65 percent. Hence, in the Lijiang river, Lanzhou reach of Huanghe river, Second Shonghuajiang river and Guanting reservoir which has been seriously polluted, the improvement of water qualities is distinct now. The downstream reaches of Second Shonghuajiang river from Jilin city in which the water pollution was most serious appear recently a shoal of fish. The famous Xihu lake where has raised light eutrophication recovered clear through the water transfer into it from Qiantangjiang river.

4. Conclusion

Water resource is an extremely important factor which affects the social and economic development in China. Therefore, the requirements for goals and keynotes of water management should be constantly provided. It need a long-term, arduous efforts to set up a good and perfect water management system.

For further increasing the efficient and benefit of water management to accept a challenge of water environmental pollution that is becoming deteriorative day by day, the proper policies and measures of water management and the principles and methods of water protection must be implemented, combined with using the experience of other countries for reference.

PRELIMINARY ANALYSIS ON CHINA'S RURAL WATER SUPPLY MANAGEMENT DURING "SIXTH FIVE-YEAR PLAN" PERIOD

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Rural Water Supply Project Office
Central Patriotic Health Campaign Committee

I feel much honoured to have this opportunity to participate in the symposium on the management of water environment as sponsored by the State Bureau of Environment Protection and to discuss with all celebrated experts within and outside the country on the important subject of the management of water environment which has a very important bearing on people's livelihood. Please permit me, on behalf of the General Administration of the Central Patriotic Health Campaign Committee, to make a brief introduction on our work for the improvement of the rural drinking water sanitation of this country.

1. The significance of the improvement of rural drinking water sanitation:

Water can be seen as the source of human life. Its resources, however, have been inadequate if to compare with the rapid growth of population and the ever increasing of people's demand both the rural and the urban of this country and the world over. The water pollution has become all the more serious constituting a grave threats to human life. Hence the strengthening of the control of water environment is an issue with strategic importance.

Water has a very close bearing on people's health. The importance of water to human body is next only to that of air. Water ranks the first in its proportion in all elements that human body contains. Water, if contaminated, can bring about illness and death. It is reported that there are over 50 kinds of diseases caused by the drinking and using of unhygienic water. Other than those water-borne diseases such as dysentery, cholers, diarrhes, hepatitis type A and fluorosis detrimental to people's health, medical workers of this country have found in the hyperendemic area that the unhygienic water is among the main risks causing liver cancer. Incidence of liver cancer among those taking surface water shows 9 times higher than those taking water from drinking wells. Unhygienic water may give rise to cardiovescular diseases and infantile congenital defect. According to the World Health Organization, there are altogether 1.5 billion population in the world derived of the safe drinking water. The United Nations has decided in its 35th session in 1980 of an International Decade for Drinking Water and Sanitation from 1981 to 1990 with "safe water to all" as its goal. In its strategic goal of "Health for all by the year 2000", the World Health Organization has made the provision of safe drinking water to the community as its important constituent.

Government of this country has attached great importance to this two world-wide activities and has taken measures for the attainment in this country of the goal as set forth.

China has a population of 1 billion, of which, 800 millions are at the rural side. Since the past 30 years or so after the founding of the People's Republic, health departments at all levels have made every effort to reduce the incidence and transmission of diseases in the rural areas by improving drinking water supply through the carrying out of the patriotic sanitation campaign. Its progress has been much lagging due to certain historic limitations. As an incomplete statistic as shown that the improvement of water sanitation in an area covering 500 million rural population has long been a matter of urgent must. It has thus been decided by government of this country that the priority of this country's participation to the International decade of drinking water and sanitation lies on the improvement of the water supply in the rural side of the country.

2. Summary of the work implemented during the "6th 5-year plan" period for the improvement of rural drinking water sanitation:

According to a statistic that covering 28 provinces, municipalities and autonomous regions that by the end of 1985, drinking water sanitation has been improved to various extents in an area peopled by more than 423 million rural population, or 49.8% of the total rural population which numbers in more than 848 millions. There have been more than 144,000 waterworks constructed for the provision of tap water to more than 119 million rural population constituting 28.3% of the total beneficiaries of the water improvement project; and more than 14.8 million hand-pump water wells have been sunk for more than 200 million rural population, or 23.4% of the total beneficiaries. Reformations have been made to the existing water wells into one both for drinking and irrigation and to the existing water reservoirs that hold raining water capable of supplying water to more than 200 million of the rural population, or 48.3% of the total beneficiaries.

With the implementation of the general policy of this country to shift its stress of work to the economic construction, and the constant growth of the rural economy and continuous raising of the livelihood of people, our work for the improvement of rural drinking water sanitation is, if to compare with the efforts in the past 30 years or so, specificially characterized in the following 3 aspects: -

1) The rural population have taken on an active attitude instead of the passive attitude they used to adopt for waiting to be aroused;

2) The rural water supply project, which was taken up merely by health departments for the control of diseases, has been taken as a major issue drawing the attention of governments at various levels. Take for instance, The People's Government in Beijing, Shanghai, Hunan, Guizhou, etc., have all incorporated the water supply project in their mandatory function for the general welfare of the community, and annual allocation is made specifically for the project; and,

3) In those areas where the economic conditions are better of, instead of the simply-constructed facilities, the local people are looking forward to the installation of tap-water facilities which has gradually become the general direction into which the project is developing.

The rapid development of the project in this period is mainly due to the correct policy of carrying out reformation domestically and opening to the outside world. Proceeding from the actual realities, we have set forth the following 3 principles: -

i. Seeking for financial inputs from all possible sources, and mainly depending on the community and financially assisted by the government:
It is not practicable at this stage to rely soly on the government for the funding of the project which is ecomous in amount, nor is it feasible to wait till the government is capable financially of covering all required expenditures before taking on a move. In order to cope with the difficulties, methods have been taken in which, part of the funds are collected from the community benefit from the project, and financial inputs are also made by the collectivity and subsidized by the state. It has been proved that this method is applicable, and is welcome to the community. And furthermore, the participation of the community in the investment and construction is beneficial to its operation and maintainance after the completion of the construction of the project. A preliminary estimates has indicated that the total investment in this period for the project amounted to more than RMB 32.5 billion yuan, of which, 70% were from local community and collectivity, 25.6% from the local financial and other concerned departments, and 4.3% from other sources.

In order to further support and accelerate the implementation of the project, the state Council of this country has decided to finance the construction of rural water supply facilities with the loan from the World Bank. The first rural water supply project has received from the World Bank with a soft loan to the amount of 82.1 million SDR for the construction of water supply facilities in 25 counties of 5 provinces and/or municipalities. The World Food Programme, the government of the Federal Republic of Germany, the European Economic Community and the United Nations Development Programme have rendered assistance gratis amounting to US$ 14 millions approximately. The assistance given through multilateral and bilateral channels have been proved helpful to our efforts for the improvement of rural water supply.

ii. Developing the project in a phased manner by measures suitable to local conditions:
Installation of tap-water facilities for rural areas is naturally the best solution, yet not applicable if taking into account of the huge amount of financial and material inputs. And again, since China is large in territory with diversified natural and geographical features, and inbalanced economic and cultural development which differs from area to area of this country, it is in-applicable and undersirable if to adopt indiscriminately an uniformed and stereotyped way for a solution. The implementation of the project is thus required to proceed from the local reality in its programming, and in a form and method suitable and affordable to the local community, and to develop it in a phased manner. Encouragements and supports are given so long as the measures taken, be it modern of indigenous local, proved helpful to the project.

iii. Stressing the importance of manpower training for all categories of technical workers at all levels to overcome the inadequacy of technical personnel:
The implementation of rural drinking water supply project is highly technical in nature requiring large number of professionals. However, those technical personnel turned out from all kinds of schools since the founding of the People's Republic have remained at cities while leaving the vast rural areas blank. It would not be possible to wait for the regular schools to train in a short period of time with enough technical personnel for the rural drinking water supply project. It is imperative therefore to take a flexible, problem-oriented way of teaching and the "learning by doing" method to meet the needs of the fast developing project.

The project is also one with high socio-economic benefits. According to a random survey covering 27,000 inhabitants of 6,000 households supplied with water from 5 newly-constructed waterworks in the 5 project counties with the World Bank loan in Liaoning Province, the socio-economic benefits manifest mainly in the following aspects:

i. The incidence of intestinal infection has been notably reduced and the health of local people has been raised. As the survey has shown that, after the construction of the waterworks, the incidence of enteritis has decreased by 64%, dysentery by 66% and hepatitis by 76%. The waterworks are located in areas where floods occurred in the past two years. However, with the provision of safe drinking water, there has been no epidemic that follows the floods as it often occurred in the past.

ii. Fetching for water in rural areas of this country is no more a labour- and time-consuming task as it used to be in the past which lasted for thousands of years. The survey has shown that, in the 6,000 household surveyed, an annual average of some 130,000 labour-days can be saved from the work of fetching for water, but instead, spent in agriculture production.

iii. The enterprises run by township have been further developed as a result of the adequate water supply for industrial use. The number of township enterprises have been increased from 30 to 200 with the output value increased from RMB 1.71 million yuan to RMB 9.34 million yuan.

iv. The environmental sanitation has been improved.

Both the community and the governments at all levels appreciate the project and take the project as one that is for the people and to the interests of the people. Upon the completion of the peoject construction, local community are often taking it as a festival to celebrate by singing, dancing and firing crackers. They take it as a cornerstone that marks the end of the suffering past in which people were given only with the unhygienic water.

Reviewing our work in the past and analysing it from the management point of view, the point that merits our attention is the fact that our past efforts were focused mainly on the management of water supply. The proper disposal of water drainage has been more or less overlooked due to economic constraints and the limits of the customs and habits of peasant population. It has been mentioned though that equal attention shall be given to the issue of water drainage, however, the disposal of domestic and industrial water has been carried out only in areas where economic conditions are better, and not yet carried out elsewhere in the country.

3. Future plans envisaged in the 7th 5-year plan:

It has been stipulated in the 7th 5-year plan for the National Economic and Social Development that efforts shall be made for the provision of saft drinking water to 80% of the rural population by 1990. This is a herculean task. The Central Patriotic Health Campaign Committee has convened a national conference for the implementation of the project and has decided that the basic principles and measures having been proved feasible and practical shall be implementated continuously during the 7th 5-year plan period, and at the same time, attention shall be given to the following 3 aspects: -

i. All departments and units are required to act in accordance with the stipulations of the 7th 5-year plan and to incorporate the rural water supply project into the local socio-economic development plan and into the rural construction plan, and to exert all efforts for the implementation of all measures for the fulfilment of the rural water supply project.

ii. It is imperative to further strengthen the mangerial process, to further improve the designing of water supply project, to further develop scientific research of water supply facilities and equipments, to formulate rules and regulations for the management of rural water supply project, and to raise continuously the socio-economic benefits of the project.

iii. Vast efforts shall be exerted to the project carried out in areas of the remote places, of places inhabited by national minorities, and areas where used to be the revolutionary basis before the founding of the People's Republic.

We are convinced that, with the development of our socialist construction materially and spiritually, the prospect of the task ahead of us for the improvement of rural drinking water supply as stipulated in the 7th 5-year plan in promising.

While coming to the end of my introduction, I wish sincerely that all experts both of this country and of foreign countries, as well as all representatives from departments concerned who are here present, will benefit us with your most pertinent and valuable comments on our work done in the past 6th 5-year plan period as well as our future consideration, so as to improve our work for the rural water supply project.

Thank you.

WATER POLLUTION CONTROL IN CHINA

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Since the First National Environmental Protection Conference in 1973, environmental protection has gradually become part of the work in the agenda of the governments at all levels. And it has been integrated into the national plan for economic and social development since the Sixth Five-year plan. The environmental awareness of the leaders at various levels and broad masses of the people have been raised. Four levels of environmental protection departments from the central government to the local level have been established(see Figure I) A series of environmental laws and regulations have been enacted. The supervision and control of pollution sources have been tightened. The forces in the field of environmental monitoring, scientific research, education and dissemination have also been strengthened. Attention has been paid to international cooperation and exchange. Thus environmental protection is undergoing an all round development.

A. Guidelines, Policies and Laws

At the U.N. Conference on Human Environment held in the Stockholm, China put forward the environmental protection policy of "overall planning,rational layout,comprehensive utilization, conversion of harm into good, reliance upon the masses with everybody taking part in the protection of the environment for the benefit of the people". At the First National Environmental Protection Conference in 1973, " Regulations on the Protection and Improvement of the Environment" was promulgated. Subsequently, some other policies were worked out, such as"whoever pollutes shall be responsible for its control" for existing pollution sources and "the designing, construction and putting into operation of the environmental protection facilities should be carried out at the same time with the main project" for new projects, and renovation and extension projects. In early 1980's, on the basis of the experiences of the past, environmental protection was made one of the basic policies of the country. Some strategic policies were put forward, such as "simultaneous planning, implementation and development of economic construction, urban and rural construction and environmental construction", and "integration of economic benifit, social benifit and environmental benifit". At the same time, "Environmental Protection Law of the People's Republic of China (for trial implementation)", "Marine Environmental Protection Law", "Water Pollution Prevention and Control Law" and "Technological Policies for the Prevention and Control of Water Pollution" were enacted. In order to protect water sources and prevent water pollution, the following standards have been issued: "Discharge Standards of Industrial Wastes", "Fishery Water Quality Standards", "Farmland Irrigation Water Quality Standards", "Industrial Waste Water Discharge Standards" for some of the industries. "Surface Water Environmental Quality Standards", "Waste Water Discharge Standards at Outfall", and "Standard Water Quality Analytical Methods" of 64 items are under revision.

In order to strengthen pollution control through economic means, the State Council enacted in 1982 "Tentative Method for Collecting Discharge Fees". Discharging Fees should be collected from those enterprises and institutions which have failed to meet the national standards according to the amount and concentration of pollutants they discharge. The purpose is to create incentive for enterprises and institutions to improve management, to practice resource conservation and comprehensive utilization, control and abate pollution, and improve the environment. The total amount of discharge fees collected in the country has increased from 200 million yuan per year at the beginning to 1100 million yuan in 1986, most of which were collected from non-coompliance of waste water discharge standards.

In the past ten years and more, a series of guidelines, policies, regulations, and standards in environmental protection, particularly in water pollution prevention and control have been worked out. However, they are not adequate and need to be expanded and improved gradually, Much effort is required in carrying out these guidelines, policies, regulations and standards fully.

B. Control and Abatement of Industria Wastewater

With the development of industry in China, discharge of industrial wastewater has been increasing daily. Out of the total 34,200 million tons of wastewater discharged per year by the end of 1985, 25,700 million tons are industrial wastewater, which was 75% of the total. Because of the complexity of the composition of industrial wastewater and its high concentration of toxic and hazardous substances, we have been paying particular attention to the control and treatment of industrial wastewater since the beginning of the environmental protection in China. In the last ten years and more, 21,969 units of industrial wastewater treatment facilities have been built. Industries like electric plating, coking, oil refining, chemical industry and textile and dyeing have done a better job in the treatment of their wastewater. Up to now, 5700 million tons of industrial wastewater are treated every year, which consists of 22% of the total industrial discharges. While the total industrial output was increased by 65% and the total discharge of industrial wastewater was increased by 2700 million tons per year as compared between 1985 and 1980, the discharge of toxic and hazardous substances in the wastewater has had a big decrease, of which mercury was reduced by 79.4%, cadmium 28.2%, Cr^{+6} 76.5%, arsenic 83.6%, lead 51.8%, acid 73.9% and cyanide 57.9%.

For the control and treatment of the wastewater of existing industries, our policy is "polluter should be responsible for its control". Depending on the extent of the harm, deadlines are set for their control. Apart from utilizing their own resources, industries can apply to environmental departments and financial departments for subsidies in their control of the wastewater. However, such subsidies can not exceed 80% of the discharge fees they have paid. In 1983, the State Council enacted "Regulations on the Prevention and Control of Industrial Pollution in Combination with Technical Renovation", which provides that when carrying out technical renovation, industries should take the prevention and control of pollution as one of their major objectives, and raise the efficiency of resources utilization, energy and pollutants removal in production processes by applying advanced technologies and equipments.

In order to prevent the pollution caused by newly-build industries, the Environmental Commission under the State Council, the State Planning Commission jointly enacted "Guidelines of Environmental Protection of Construction Projects", which explicitly provides that when carrying out construction projects that will have environmental impacts, the examination and approval system of Environmental Impact Statement (EIS) and "the Three at the same Time" system (the designing , construction, and putting into operation of environmental protection facilities must be carried out at the same time with the main projects) must be followed. In 1985, the ratio of compliance with EIS system and " the Three at the Same Time" system of the newly -built projects were 90% and 85% respectively. This has effectively controlled new pollution sources.

Much work has been done in the control and treatment of industrial wastewater. However, the increase of the capacity of wastewater treatment can not catch up with the growth of the pollution caused by industrial wastewater. Pollution caused by industrial waste water is still expanding. Much effort will have to be made before we can realize our objective of controlling industrial wastewater pollution in 1990.

C. Integrated Control and Abatement of Municipal Wastewater

By the end of 1986, there are 349 cities in China. In a long period of time in the past, we only paid attention to industrial production while neglecting the construction of municipal infrastructures especially the construction of sewages and waste water treatment facilities, resulting the growth of pollution caused by municipal waste water. Take Shanghai for example, wastewater discharged everyday now has reached 5 million tons, most of which are not treated and are discharged to Suzhou River and Huang-pu River making Suzhou River become a stinking dead river and Huang-pu river have 140 days of stinking time with no dissolved oxygen. Water source for drinking water supply in Shanghai is thus seriously polluted, which has forced the city to construct a new water in-take project in the upper reaches of the Huang-pu. Many other cities have the similar situation with water bodies polluted.

The above mentioned 21,969 units of industrial wastewater treatment facilities have played a positive role in eliminating pollution caused by industrial wastewater. However, because of their irrational layout, poor quality of the equipments and failure in prompt maintenance and other reasons, 30% of the units have stopped operating and the ratio of the water after treated in compliance with standards is only 38%. Therefore, totally depending on the construction of dispersed waste water treatment facilities without building concentrated municipal wastewater treatment plants for the purpose of eliminating pollution caused by municipal wastewater is not a satisfactory solution.

In October 1985, the Environmental Protection Commission under the State Council held "National Urban Environmental Protection Conference", at which it was made clear that a comprehensive approach should be adopted in the prevention and control of the urban pollution (including water pollution) under the leadership of municipal people's government and within a unified plan. "Regulations on Technological Policies for the Prevention and Control of Water Pollution" issued in 1986 clearly stated that except for a few big enterprises and those which are far away from cities or towns can treat their wastewater separately, other factories when possible should discharge their wastewater into municipal sewage system and have their wastewater treated collectively in district municipal wastewater treatment facilities in a comprehensive manner instead of treating wastewater separately. Wastewater containing toxic and hazardous pollutants such as heavy metals and those which are difficult to degrade biologically must be treated separately and reach the standards before they can be discharged into municipal sewers. Ji-zhuang-zi Wastwater Treatment Plant in Tianjin with a capacity of treating 260,000 tons per day was built in 1983 according to the above principle. It collects wastewater from an area of 37.7 KM^2 and serves 1.08 million people and 621 factories. An analysis was made to some 26 units of industrial wastewater facilities built earlier within this area, of which 13 units were properly designed and built and they should remain for operation. Six plants no longer need operation because of the Ji-zhuang-zi Wastewater Treatment Plant, and seven plants need only primary treatment only for the same reason. This approach of concentrated treatment and dispersed treatment existing at the same time, and combined treatment of industrial wastewater and domestic sewage are common experiences of many countries in the world. The estimation made at Ji-zhuang-zi Wastewater Treatment Plant shows that the capital investment for the concentrated treatment can be reduced by 17% as compared with separate treatment, the operation cost can reduce by 66%, while the water quality after the treatment can be guaranteed and the water can be reutilized.

D. Prevention and Control of Marine Pollution

China has a large area of territorial seawaters with 18,000 KM of coast lines from the north to the south. With 42 districts and cities, and 2 municipalities of eight provinces and two automounous regions are located along a narrow coastal area of 410,000 KM^2 which is approximately 4.3% of the country's total area, but with a population of 176 million which is 17.2 % of the total.

The coastal area in China is characterized by its fertile land, mild climate and good irrigation conditions and it is a major area for the production of grain, economic crops and fruits. According to statistics of 1983, there are more than 80,000 factories and mines of various types with 32% of the country's industrial output. There are about 4.70 million KM^2 of sea area adjacent to the mainland of China with rich resources like sea food, petroleum and natural gas.

We have strengthened marine pollution control since late 1970's. About 2000 scientific and technical personnel spend 4 years on the survey of the pollution and its control in the waters of Buhai Sea and Yellow Sea. With an investment of 130 million yuan, 189 pollution control projects were completed, improving the water quality of some seriously polluted sea areas. On the basis of this, a survey was made on the land-based pollution sources, which revealed that 5000 million tons of wastewater per year are discharged into seas from the land. Twelve major pollutants including COD, ammonia nitrogen, phenol and oils discharge about 3.50 million tons per year constituting 85% of the total marine pollution load. The main sinks for those pollutants are the sea area at the Ynagtze River estuary, Liaodong Gulf, Dalian Gulf, sea areas at the Pearl River estuary and Minjiang estuary, Hangzhou Gulf, Buhai Gulf, Laizhou Gulf, sea waters to the east of Guangdong Province, the total pollution load of which is 82.1% of the total land-based pollution.

Sea-based pollution is mainly from ships, oil drilling platforms and ship dismantling factories and the main pollutants are petroleum products which amounts to about 70,000 tons each year.

"Marine Environmental Protection Law" and "Sea Water Quality Standards" were enacted in 1982, which provide that National Environmental Protection Agency is the authority responsible for the marine environmental protection and National Marine Administration, port control authority , fishery management departments and the environmental departments in the army are responsible for marine environmental monitoring, prevention of pollution damages caused by the oil exploitation and dumping of waste into the sea, and supervision and control of pollution caused by ships in civilian ports, fishery ports and military ports. Following this, "Regulations on the Prevention of Damages to the Marine Environment by Pollution of Ships", "Regulations on Prevention of Damages to the Marine Environment by Pollution of Off-shore Oil Exploration and Exploitation", "Regulations on Prevention of Damages to the Marine Environment by Pollution of Waste Dumping" and "Regulations of Prevention of Environmental Pollution by ship Dismantling" were enacted. Furthermore, the study on the prediction of pollution by year 2000 in China's coastal seas and its control policies has also been completed.

On the whole, China's coastal environmental quality is fairly good at present, but coastal seas are polluted to different degrees by organic pollutants and oils and few areas are seriously polluted with red tides occuring at times. Up to 2000, pollution tends to increase in some major sea waters, to which we must not take a casual attitude. Control and abatement of land-based pollution sources and supervision of discharges of pollutants from ships must be strengthened.

E. Control of Water Pollution by Rural Industries

With the economic reform in China's rural areas, there has been a rapid development of rural industries in recent years. According to 1985 statistics, there are 11 million factories in China's countryside with 70 million of employees which has exceeded the total number of workers in the state-owned enterprises. Their total production has reached 272.8 billion yuan, constituting 18% of the total social production value of the country. They are playing an important role in China's economic development.

In order to prevent the adverse impact of rural industries on the environment, the State Council promulgated in 1984 " Resolution on the Strengthening of Environment Management of Rural and Neighbourhood Industries" which explicitly points out that rural or neighbourhood enterprises should develop low-pollution or no-pollution industries under the unified guidance of the local governments in accordance with local conditions of resources, technology and the environment and under an all-round plan and rational layout. No industries which can cause serious pollution shall be developed and those factories which have already been built should undergo necessary adjustment.

However, because of the rapid development of rural industries, wastewater discharged every year by rural enterprises amounts to 2,700 million tons, most of which are not treated. The pollution caused by wastewater from small electric plating plants, chemical plants and paper mills are most serious.

Now, environmental protection management of rural industries in many areas is being strengthened. Professional environmental protection staff have been established. Adjustments have been made to the factories serious polluting the environment; control of pollution sources have been tightened.

To sum up, in the past 10 years and more, much progress has been made in China's environmental protection including water pollution control and abatement. While we have already had a good beginning, heavy tasks are still ahead of us and much efforts need to be made.

ENVIRONMENT, GROWTH, AND DEVELOPMENT *

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EXECUTIVE SUMMARY

The fundamental recommendation of this report is that sound environment management, which is critical for sustained economic growth, should be an integral part of economic policymaking at all levels of government. Although rapid population growth is fueling the over-exploitation of natural resources in many countries, there are important instances in which proper planning can reconcile objectives of economic growth, poverty alleviation, and environmental protection. The ecological, behavioral, and economic links between natural resource-using activities demand a multisectoral and multidisciplinary approach. They also demand policies that can influence the countless small-scale activities throughout an economy. This will require a rethinking of the importance of resource management and environmental issues in many developing countries, and assignments of responsibility and the development of analytical and policymaking capacity in both line ministries and central agencies. It will also require substantial external assistance and greater collaboration in the development community.

The foregoing conclusions are based on the development community's recent experience in addressing economic and environmental issues. Twenty years ago, environmental concern was preoccupied with pollution in industrial countries. Since then, the meaning of the term "environment" has evolved, and the scope of environmental concern has broadened considerably. It now extends to such diverse issues as biodiversity, global atmospheric pollution, soil and forest deterioration, and the welfare of tribal peoples in developing countries. This broad concern is evident in the changing attitudes in developing countries, the efforts of non-governmental organizations (NGOs), and the policies and lending operations of the World Bank.

Environmental degradation threatens the sustainability of development, particularly in poor countries heavily dependent on a declining base

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of natural resources. The poorest members of society typically suffer most from environmental degradation, and economic growth, combined with measures to alleviate poverty is therefore required. It is now generally accepted that the objectives of economic growth, poverty alleviation, and environmental protection are often complementary. There nevertheless are occasions when governments have to make difficult choices between economic and environmental considerations -- choices made all the more difficult by institutional impediments and inadequate financial resources. Even where economic and environmental objectives coincide, policy reforms may be resisted by special interests: political will is therefore required to take unpopular measures.

Development projects can be designed to meet economic and environmental objectives, but complex ecological and sociological factors often have major, and sometimes unforeseen impacts on what may appear to be relatively straight forward investments. For example, water supply projects can entail waste-water disposal problems, irrigation schemes can damage health, livestock projects can affect wildlife, projects that attract settlers can threaten indigenous peoples, and industrial andenergy projects can cause air or water pollution. These factors must be anticipated to enable preventive or ameliorative measures to be taken. The cost of these safeguards seldom affects a project's viability. But simply building safeguards into project design does not ensure success, especially when the agency that implements the project does not bear the costs of environmental deterioration. Implementation difficulties must be anticipated and project performance carefully monitored, if both economic and environmental objectives are to be achieved.

The traditional approach to environmental problems -- to invest in "environmental" projects or to build preventive or ameliorative components into projects -- is important and should be continued. However, the biggest environmental problems stem not only from individual large-scale development projects but from the interactions and accumulated impact of numerous small-scale activities that use natural resources day-to-day. Safeguards in individual projects cannot address these wider problems. Therefore, a comprehensive countrywide or regional approach must supplement the project-by-project approach to environmental management.

Government policies also have a powerful influence on the use of natural resources, sometimes positive, sometimes negative. For example, both economic and environmental objectives can be served by reducing heavy government subsidies for irrigation, pesticides, mechanization, or forest exploitation . They can be served, too, by reducing government intervention inagricultural pricing, thus allowing market forces to stimulate production and rural incomes, and enhancing the ability of farmers to invest in measures necessary for sustainable production. But when market forces cannot be relied on, governments may need to introduce economic incentives and regulations to manage the environment.

Country Policies

The following action plan is recommended for individual countries to bring about a better integration of natural resource management into country economic planning:

- Assess the country's natural resource base, trends and patterns in resource use, and the prospects for the future under various scenarios of economic growth.
- Estimate the economic and social consequences of major categories of resource use, making any tradeoffs between economic and environmental objectives as explicit as possible.
- Identify the economic, sociological, and other causes of environmental deterioration.
- Based on the foregoing, set priorities for investment programming and policy intervention, with a special emphasis on population policy.
- Amend government policies that have negative economic and environmental impacts.
- Design and introduce interventions to serve environmental objectives when market forces are inadequate.
- Continue efforts to address major underlying causes of natural resource degradation and to improve understanding of what affects the environment and how.

If governments are to improve their natural resource management substantially, they will have to devote more resources to this task. And they will sometimes have to introduce difficult and controversial measures. In this, the poorest countries particularly face financial, institutional and human resource constraints. Substantial external assistance will therefore be required. One prerequisite for this assistance is a major political commitment by governments, a commitment that will set the bounds for action by external agencies.

Development Community

The growing recognition of interdependence of resource-using activities and the corresponding expansion of "environmental" concerns calls for unprecedented cooperation among various development institutions. To achieve this, the development community needs to develop mechanisms to ensure that skills and resources, including those of non-governmental organizations, are used to best advantage in addressing environmental problems. Attention also needs to focus on global environmental deterioration and on the global interest in combatting it. Rainforest depletion, atmospheric pollution, and other instances of environmental degradation often pose threats that go far beyond the countries where they originate.

World Bank

The World Bank, which has pioneered the introduction of appropriate project methodologies in development lending institutions, can also play a major role in developing and implementing improved policy instruments. The Bank can also contribute by raising with policy-makers the importance of integrating natural resource management into country economic planning, helping governments to take the actions required to do so, and reflecting this concern in its own analytical work. More specifically, the World Bank will:

- Increase its efforts to integrate natural resource management into its country economic and sector work.

- Continue to ensure that all Bank-financed projects follow appropriate environmental policies and include the necessary safeguards.

- Continue to invest in projects and encourage policies that meet the three objectives of environmental protection, poverty alleviation, and economic growth. Special emphasis will continue to be given to population projects.

- In cooperation with interested countries, initiate a pilot series of country assessments, in cooperation with the UNDP and other donors.

Within the Bank's restrained budget for FY1988, the Executive Directors have approved a modest allocation of additional resources to enhance the Bank's capacity in environmental and natural resource management.

1. THE ENVIRONMENTAL PROBLEM

1) Attitudes toward environmental matters have changed greatly over the last two decades in both industrial and developing countries. Concern for air and water pollution began in the industrialized countries in the 1960s. The developing countries, apart from their concern with such immediate problems as unsanitary living conditions, generally regarded environmental issues as a luxury that only the rich nations could afford. And they resented the efforts of interest groups in the industrial countries to persuade them otherwise.

2) This general difference of opinion characterized the 1972 Stockholm Conference, a milestone in the development of international environmental policy that led to the United Nations Environment Program (UNEP). That conference was also a forum for discussing a wider range of environmental issues. In the years that followed, the resource degradation from large development projects, such as irrigation and hydroelectric schemes, became a matter of increasing concern. Today the developing countries-

faced with conspicuous evidence of soil erosion and deforestation and increasingly concerned with rapid population growth -- recognize that the environment concerns them as much as it does the industrial countries. Particulary in land and water management for agriculture, environmental protection is now generally recognized as necessary for sustainable economic development, not as an alternative to it. And in parallel with the interdependence of countries in their economic and financial flows, it is now observed that environmental interdependence is equally important. The effects of tropical deforestation and industrial emissions on the global climate - and of overfishing and agricultural and industrial pollution on the productivity of the oceans - have spawned a host o f international institutions and legal arrangements.

Environmental Degradation

3) Today's wide-ranging environmental issues include deforestation, biodiversity, soil erosion, climatic change; pesticide buildup, threats to indigenous peoples, and industrial and municipal pollution. These issues arise in both industrial and developing countries, but their importance varies considerably, depending on a country's stage of development, its geographical location, and its industrial or agricultural base. In many instances, the differences are more in degree than in kind. Industrial pollution is worse in industrial countries, but it is nevertheless a major problem in many cities in the developing world. Soil erosion and deforestation, by contrast, are worse in developing countries, most of which have tropical environments that are more fragile and complicated than temperate environments.

4) Among the most urgent environmental problems facing the developing countries are those relating to the use of land. Of particular concern are deforestation, devegetation, and)in the extreme) desertification - the outcomes of many interrelated activities. Overgrazing, land clearance, commercial logging, and slash-and-burn agriculture rob soil of its cover and fertility and reduce agricultural yields. They also increase flooding, sedimentation, and the silting up of dams and reservoirs. The problems are worse where inadequate fuelwood compels rural families to burn agricultural residues and dung, further depleting the soil's fertility and accelerating its erosion. Such deforestation deprives peoplle of other essential products for their daily servival and threatens wildlife reserves and fragile ecosystems. Resources that in principle are renewable are, due to overexp loitation, rapidly disappearing. And the extinction of plant and animal species, proceeding all too rapidly, may have major, as-yet-unknown consequences for the future of mankind.

5) Environmental pollution, though typically associated with industrialization, is also a great and growing concern in developing countries. Air and water pollution in such cities as Lagos, Calcutta, Sao Paulo, and Mexico City are at least as bad as in most

developed countries. And as evidenced by the Bhopal disaster, industrial catastrophes are not confined to the industrial world. Moreover, one aspect of the environmental problem — unsanitary living conditions from inadequate water supply and waste disposal — is observed almost exclusively in the poorer countries. Throughout the developing world, water polluted by pesticides and municipal and industrial wastes causes disease, malnutrition, and death.

6) Over the last few years air pollution has been seen increasingly as a regional or global problem, not a local one. Acid rain may fall to earth thousands of miles from the emissions of sulfur dioxide and nitrogen oxides that cause it. The destruction of forests in Northern Europe is perhaps the clearest consequence. Other global phenomena include damage to the ozone layer by chlorofluorocarbons and the "greenhouse" warming of the planet by carbon dioxide emissions and tropical deforestation. The consequences of these phenomena for climate and health are highly uncertain but potentially catastrophic. In this, there is shared responsibility: industrial countries tend to be the main culprits in industrial emissions, but some of the larger developing countries, with lower emission standards, are adding much to the problem.

7) The causes of environmental degradation are as many and varied as its manifestations. But at the heart of the problems is the rapid rate of population growth in many developing countries. This growth, particularly critical in the poorest countries, puts direct pressure on environmental resources through the depletion of fuelwood and the cultivation of increasingly unsuitable land. With agricultural productivity falling, "ecological refugees" flood into urban areas which often lack the economic and environmental capacity to absorb them. In 1980, three-fifths of the people in developing countries did not have safe drinking water, and three-quarters had no sanitary facilities -- not even a pit or bucket atrine. But rapid population growth is rarely the sole culprit. Instead, it typically exacerbates the problems from inadequate environmental policies.

8) The effects of environmental degradation are difficult to establish with precision, but physical indicators alone give grounds for concern. For example, desertification worldwide is proceeding at 6 million hectares (almost the size of Ireland) a year, and tropical deforestation at 10 million hectares a year. Due to soil erosion, 20 million hectares of agricultural land are lost every year. And over the next 20 years, a fifth of the world's plant and animal species may become extinct.

9) Countries and continents do not share the burden of environmental degradation evenly. Two fifths of Africa's nondesert land risks being turned into desert, as does a third of Asia's and a fifth of Latin America's. Tropical deforestation is massive in

Southeast Asia, Africa, and the Amazon basin. In Nepal and Haiti deforestation and soil erosion have taken most of the productive land. Not all soil erosion involves a loss, but in Turkey more than three-quarters of the land has been adversely affected, in India one-quarter.

10) Land and water degradation, even under the most optimistic assumptions about technical progress and the ability to adapt to depleted resources, clearly threatens economic development in many countries. The evidence for this is fragmentary, but telling. Because of the scarcity of fuelwood, an estimated 400 million tons of dung are burned each year. That robs the soil of its fertility and depresses each year's grain harvest by 20 million tons. Enough to feed 100 million people for a year, this lost grain would cost about US$3 billion at international prices. The alternatives to burning crop residues and dung are to travel further and further afield to obtain fuelwood or to pay more for it. But in Gambia and Tanzania households already spend 250 to 300 man-days a year gathering wood. In Addis Ababa fuelwood costs up to a fifth of a household's income. And in the Sahel of West Africa, the consumption of fuelwood is far in excess of the capacity to regenerate it. Nor can the mining of forest resources for short-term gain go on indefinitely. Between now and the end of the century the number of developing countries that are net exporters of forest products will fall from 33 to fewer than 10 -- and developing country experts of industrial forest products will drop from US$7 billion to less than US$2 billion.

11) Soil erosion in India removes nutrients worth US$6 billion a year in chemical fertilizer replacements. In parts of Mexico it reduces maize yields from 3.8 tons a hectare to 0.6 tons, and in parts of Nigeria from 6.5 tons a hectare to 1 ton. Other sectors pay for soil erosion as well. Flood-prone lands in India doubled from 20 million to 40 million hectares between 1970 and 1980, and in the Ganges valley alone, the annual cost of flood damage to crops and other property averages about US$1 billion. Sedimentation's reduction in the capacity of hydroelectric facilities will cost the developing countries about US$3 billion over the next 15 years. And deforestation's disruption of major water flows threatens water supply systems throughout the world — a grim prospect, because acute water shortages combined with pollution now cause 25,000 deaths a day.

12) Water pollution, in addition to its impact on health, may have more readily quantifiable economic consequences. Pollution of the Rimac River, Lima's water source, has increased the cost of chemicals and disinfectants by almost 30 percent. Pollution of the Isser in Algiers, and the Han in Seoul, has substantially increased water supply costs because of the need to move water intakes upstream. A similar situation in Shanghai, where a water intake for the public water supply system had to be moved more

than 40 kilometers upstream, cost about US$300 million.

Growth, Poverty, and the Environment

13) Promoting growth, alleviating poverty, and protecting the environment are mutually supportive objectives in the long run. So, rather than address environmental issues in isolation, decisionmakers in governments and international institutions should consider the preservation of the environment with other issues central to development policymaking. In so doing, they should take maximum advantage of the complementarities to help the poor, promote better resource management, and contribute to sustainable development. In the short run, however, the three objectives are not always compatible, and decisionmakers often confront difficult choices in pursuing them simultaneously. That makes it important to consider the implications of competing claims and to determine the approaches that will help achieve the most appropriate balance.

14) The evidence in the preceding section substantiates the view that environmental degradation threatens sustained economic growth in many countries. Even today's per capita income may be difficult to maintain, especially in the poorest countries, many of which depend heavily on a declining natural resource base and have rapidly growing populations. In these countries, such as those in the Sahel, the search for projects and policies that satisfy the objectives of environmental protection and economic growth needs to be rigorously pursued.

15) Because the problems of many developing countries are so extreme and urgent, real tradeoffs often arise between protecting the environment and satisfying basic short-term needs. For example, given the high rates of population growth in many countries, it is hard to find alternatives to rapidly drawing down fuelwood stocks, or burning dung, in the short term. Similarly, the air and water pollution in many cities in the developing world would be intolerable in the industrial countries. Such pollution persists in part because immediate improvements in quality of life and health are deemed to be worth more than the immediate benefits of abatement, and in part because long-term benefits are heavily discounted.

16) Those affected most adversely by such degradation are the disadvantaged -- the poor, less educated, and politically less powerful elements of society. Without safe drinking water, the urban poor live in unsanitary conditions and are hurt most by noise, flooding, and water pollution. They cannot afford to pay for better services or to defend themselves against damage. Similarly, the rural poor farm flood-prone valleys and swiftly eroding hillsides. They cannot afford to invest in conservation measures

or to grow crops which have long gestation periods. Nor can they move to more productive land. They immediately spend any income on consumption goods.

17) This urgency among the poor, implying the heavy discounting of future costs and benefits, is paralleled by the governments of poor countries, which often must think first about short-term budgetary and balance-of-payments constraints. For them, immediate needs preempt adequate provisions for the future, even the near future. Poverty — of people and countries — is thus a major cause of environmental degradation. That makes it essential, if environmental degradation is not to become completely unmanageable, to devise policies oriented to economic growth with special emphasis on improving the incomes of the poor.

18) Without growth, all other things suffer in the developing countries. It nevertheless is clear that economic growth may destroy the environment and further jeopardize the already tenuous lives of the poor. For example, agricultural development that further concentrates land holdings may drive the poor onto increasingly marginal land, unchecked urban commercial growth may create shantytowns, and roads may pave over the small properties of the poor. Thus, while growth is imperative for alleviating poverty, it may also adversely affect the poor and the environment if inadequate attention is paid to the poor and their needs.

19) As noted earlier, environmental problems vary from country to country. In some countries, the greatest concern is urban air and water pollution; in others, upland watershed management; in yet others, desertification. In many countries, sustained growth is likely to depend for some time on increasing productivity in agriculture. This applies throughout Africa. Other countries, such as Korea, have reduced their reliance on agriculture and switched to an increasingly industrial base. For them, adequate savings, an educated labor force, and the ability to adapt to changes in resource endowments have been critical factors in sustaining growth. Differences in factor endowments and in the prospects for industrial or agricultural growth suggest that no simple model of environmental policy applies equally to all circumstances.

20) In principle, however, policies and investment decisions involving natural resources should be subjected to a comparison of the likely benefits and costs. This holds true even where there are choices between economic and other values. Major differences of opinion may arise, however, because of all the uncertainties. The long-term consequences of air and water pollution are imperfectly understood. The losses from extinct species may never be known. And opinions about technical relationships vary greatly, as do the attitudes toward risk.

21) Uncertainties aside, decision makers tacitly make important value judgments about what alternative patterns of resource use mean for such things as the distribution of income, the impact on vulnerable indigenous peoples, the preservation of cultural property, the worth of genetic diversity, and the welfare of future generations. Economic analysis can, and should, help in making such jedgments. The consequences of decisions related to the environment should be estimated as far as possible in economic terms to make the choices explicit. Monetary values alone are typically inadequate as criteria for decisions. But the benefit-cost approach — in systematically setting out the consequences that, for good or ill, stem from alternative courses of action — is generally applicable.

22) It is sometimes claimed that conventional benefit-cost analysis fails because it uses discount rates that are too high, thereby giving inadequate weight to the costs of resource depletion or the benefits to future generations of conservation measures. In practic, however, intertemporal choices can typically be made satisfactorily by using discount rates that reflect the returns to capital in alternative uses based on fairly short-run market criteria. This applies where there is no reason to expect one generation to be very much worse or better off than another, or where effects are not irreversible. The gains from projects or activities that pass standard economic tests could, if future societies so choose, be reinvested for the benefit of generations still further in the future. In these circumstances, economic costs alone, using market-based discount rates to estimate present values, may be an adequate benchmark for evaluating policies or investments.

23) Where the effects are irreversible (an ambiguous term that certainly includes the extinction of species and probably includes desertification) or where future societies are expected to be significantly richer or poorer than the present one, economic cost calculations should be supplemented by analysis — possibly quantitative, certainly rigorous — of the likely physical and distributional consequences. The tremendous uncertainties in predicting events that will occur many years hence should not deter governments from serious consideration of the results of such analysis.

24) Even where the objectives of environmental protection and sustainable economic growth coincide, governments face politically difficult choices. Public interventions to address environmental issues are likely to have costs for some parties, benefits for others. For example, as is implied by the tendency of the poor to suffer most from environmental degradation, policy reform might have distributional consequences that powerful interests might resist. Combined with the urgency of current needs, the uncertainty

about the future, the legitimate differences in value judgments, and the short-term perspective of many decisionmakers, these difficulties make it clear that a major political commitment is required for substantially improving the management of natural resources. But such a commitment will be only the first step in a long process. Analytical and implementation capacity in this area is weak in most countries and both human resources and the institutional framework will have to be built or substantially strengthened. If the political commitment is to be translated into effective action, it will need to be nurtured through broader public understanding of the urgency of the problem and the need for remedial action.

2. LESSONS FROM DEVELOPMENT PROJECTS

25) The experimence of governments and development agencies over the last two decades provides several important lessons on the environmental aspects of development projects. The lessons relate to the potential of projects to satisfy the cultiple criteria of sustainable growth, poverty alleviation and environmental protection. They also relate to the importance of technical links and sociological and cultural factors, to the inherent difficulties of implementation, and to the need to supplement the project-by-project approach with more pervasive policy measures. These lessons are informing the policies of governments, international financial institutions, and other parts of the development assistance community.

Linking Economic and Environmental Objectives

26) There is ample evidence in a variety of sectors that development projects can be designed to ensure that economic and environmental objectives coincide. Improved water supply and sanitation projects can typically be shown to be economically justified on the basis of consumers' willingness to pay for them. For example, safe drinking water can be supplied through appropriately designed community systems in low-income urban neighborhoods at one-tenth the cost that slum dwellers without such systems now pay to water carriers and vendor for inferior supplies. Moreover, sanitation systems that reduce water pollution and facilitate resource recovery have been installed in third world cities at one-twentieth the cost of conventional sewerage systems. The relationship between such environmental projects and economic growth is direct: improvements in health from such investments are likely to show up in improved labor productivity.

27) Further evidence that the economic and environmental objectives of projects can coincide comes from a review of environmentally oriented projects that the World Bank has financed since

1968. This review shows that economic rates of return were between 10 and 30 percent for 23 social forestry projects and between 15 and 21 percent for five watershed rehabilitation projects.

28) Population is another area where the economic and environmental objectives of projects tend to coincide. Typically intensive in labor and low-cost in foreign exchange, population projects can have extensive impact by stimulating the demand for family planning services. But such projects are not alone in stimulating this demand. Education projects, which increasingly emphasize opportunities for women, can do the same. So can health and water supply projects, which by reducing infant mortality also reduce the cultural imperative for large families. Although the economic rates of return of such projects are difficult to assess, there is little doubt about the complementarities between economic and environmental objectives.

29) Economic and environmental objectives typically are mutually reinforcing in agriculture as well. But some types of projects, particularly irrigation schemes, would often lose the prospect of being economically viable if project analysis were to take environmental damage fully into account. Such tradeoffs between economic and environmental objectives are much more common with regard to pollution. Sometimes, however, even pollution control projects can be economically justified by the savings that may accrue to parties damaged by the discharge of industrial and domestic wastes. The pollution control projects for Sarajevo and the Lake of Tunis are examples. There also are cases in which industrial pollution and occupational hazards arise from inefficiency. Leakages of hazardous materials may be reduced by investments and improved operating procedures that are financially profitable and economically justified. This is specially true of small-scale industries, and technical and financial support to them may be the only way to control pollution. Monitoring their activities would cost too much, and improving their operational efficiency may, to some extent, be a substitute for this monitoring.

30) Growth-oriented activities — such as large and small industrial projects, including those for rural nonfarm enterprises — can also help achieve environmental objectives. By creating employment, they take some of the pressure off the land. And energy projects — for oil, gas, coal, and electric power — remove some of the dependence on biological fuels. Frequently the cost of building environmental safeguards or ameliorative measures into such projects — typically up to 5 percent of total project costs — does not significantly affect their economic viability.

31) In other cases, however, the economic benefits of pollution control projects are difficult to demonstrate in economic terms,

sometimes even in physical terms. Long-term health and environmental effects are particularly hard to predict — and indirect benefits in addition to the ones expected are particularly hard to track down. Sometimes the host country may not even feel some of the benefits of abating air and water pollution. Trade-offs may therefore loom large in decisionmaking. Several developing countries face such issues where, due to past neglect and the great costs of prevention, the pollution abatement problem is assuming staggering proportions. This is true of air pollution in Beijing, Sao Paulo, and Mexico City. It is also true of water pollution and sewerage projects in rapidly growing urban areas throughout the developing world.

Considering Technical Linds

32) Project planners have often overlooked technical links in cases where they are fairly obvious. An example is the typical municipal watersupply project. The increased water supply directly increases wastewater flows, yet water supply projects have frequently not been matched by provisions for the treatment and disposal of waste. Thus overlooked, as in the Bombay Water Supply and Sewerage Project, sewerage and sewage treatment facilities cannot keep up with increasing wastewater flows, and water pollution problems get worse, sometimes reaching intolerable levels.

33) In other cases the technical linkages are less direct. The potential of irrigation systems to degrade irrigated areas (by salinization, waterlogging and depletion of groundwater reserves) requires careful planning and investment in mitigating measures such as drainage. This has been demonstrated over many years in the Indus Basin, where the Pakistan Left Bank Outfall Drain Project has been designed to alloviate the adverse impact of irrigation works. Sedimentation, another common problem, reduces the effectiveness and useful life of dams built for irrigation, water supply, or hydropower. Cases in point include the Sudan Roseires Irrigation Project and the Mangla and Tarbela Dams in Pakistan.

34) Other problems with large dam projects include destroyed forests, increased stream-bed erosion, dried up downstream lakes, threatened wildlife, increased salinization and reduced nutrient flows in estuaries, impaired water quality in reservoirs, and increased human disease (such as malaria and schistosomiasis). These problems have been known for many years, but they remain cause for concern, and sometimes criticism, in such projects as the Narmada Valley Dams in India and the Mahaweli Ganga Development Scheme in Sri Lanka.

35) Forestry projects provide many illustrations of the complexity of technical links. Consider eucalyptus plantations and their sometimes adverse consequences. Such plantations often have an important economic function. But they cannot fulfill all

of the functions of natural forest and provide a variety of game, herbal medicines, natural fibers, and fodder and browse. Sometimes, such plantations do not even control erosion, usually a significant objective. In some eucalyptus plantations, erosion has been accelerated on steep slopes because the trees alone do not retain enough soil and they inhibit the growth of understory plants. Problems have also arisen because eucalyptus trees deplete groundwater much faster than other species. These effects have required such projects as the Candi Watershed Project in India to shift to other species.

36) Livestock projects may also involve and unanticipated network of ecological events. Much criticism of the recent livestock projects in Botswana relates to environmental damage from overstocking or poorly managed fragile areas, and the effects on wildlife (by exclusion from feeding areas and water sources and blocking of migration routes).

37) The more successful livestock projects such as Uganda's First Beef Project, have shown three prior measures to be important. One is to assess the resource base and environment (soil, water, vegetation, topography, pests and parasites). The second is to conduct small pilot projects to develop livestock management systems that are appropriate and sustainable under local conditions. The third is to investigate economic and social factors, such as markets and cultural values for livestock, that will significantly influence the motivation and activities of project beneficiaries and the overall success of the project.

Considering Behavioral and Sociological Factors

38) Behavioral and sociological factors influence the success of project in many and varied ways. Issues of land tenure have frequently been significant: providing groups or individuals with authority and security over land has improved conservation practices. For this reason, determining land ownership and, in some cases, promoting land reform is now becoming an increasingly important component of rural development projects.

39) Cultural values may influence the outcome of projects in unexpected ways. Well-planned livestock projects establish appropriate maximum stocking rates from the demonstrated carrying capacity of the land. But in some African cultures, cattle are the main measure of wealth, and a herd's size determines the status of individuals and families. So, some pastoralists have no desire to control the expansion of herds brought about by a project's improved breeding, nutrition, and veterinary services -- even when it is in their economic interest to do so.

40) Another issue is the distribution of project costs and benefits among different ethnic and socioeconomic groups. In the ex-

treme, indigenous people are displaced from their traditional areas by settlers drawn to regional development or highway projects — or when their land is used, say, for a reservoir for an irrigation project. Well-known cases of such problems include the Polonoroeste Project in Brazil and the Transmigration Projects in Indonesia.

41) These interrelationships between ecological, economic, political, and social factors — and the way they might influence the outcome of projects — are always more apparent in retrospect than during the design. But the more applicable links are now fairly well known and can be planned for early in the project cycle. Project preparation is also making greater use of sociological and anthropological skills. To be kept in mind, however, is that development projects bring changes both to people and to the environment. The key in these projects is to avoid unnecessary disruptions.

Overcoming Problems of Implementation

42) The unsatisfactory implementation of environmental projects, and of their preventive and ameliorative components, is apparent in sewerage projects. Poor maintenance and a lack of spare parts have rendered many municipal facilities inoperable or only partly operable. And many problems of industrial pollution are due in great part to the improper operation and maintenance of pollution control equipment, as exemplified by the Las Truchas Steel Project in Mexico. This is true for dust collection equipment, gas cleanup systems, and almost all industrial wastewater treatment systems.

43) The damage resulting from faulty operation and poor maintenance of hazard-prone facilities can be catastrophic. Witness the recent Bhopal. Chernobyl, and Rhine River disasters. Some countries have laws to deal with these problems, but monitoring and enforcement are generally lacking. Few institutions charged with monitoring and enforcing pollution are well equipped, well staffed, and well trained.

44) One big constraint in project implementation is the institutional or political weakness of the responsible authorities. A project may require much cooperation, which often is hampered by the narrowly defined sectoral objectives of Ministries of agriculture, forestry, energy, and health. A project can also affect a wide range of special interest groups, some of which may carry significant political weight. Major efforts are therefore needed to bring various parties — political, community, business, and religious leaders, as well as NGOs and the relevant government agencies — into all phases of decisionmaking. Sound implementation thus depends heavily on the commitment of governments to environmental management. It depends equally on their institutional

capability to ensure that monitoring and control are conscientious over extended periods.

Looking Beyond Individual Projects

45) In recent years recognition of the need to incorporate environmental safeguards in individual projects has been growing, and the methods of doing so are constantly improving. Environmental impact analyses are frequently applied to large development projects. Ameliorative measures (installing pollution abatement equipment or lining irrigation canals) and associated activities (environmental training) are also often built into projects. (More than 1,500 projects financed by the World Bank include ameliorative or preventive components.) Moreover, all countries invest in projects that have direct environmental objectives, such as sanitation, reforestation, water supply, and watershed management.

46) Such attention to individual projects is an important element of any environmental program. But recent experience clearly indicates that the project-by-project approach, taken alone, is inadequate. The reason is that the cause of most environmental degradation taking place is not the large development but the combined effect of countless relatively small natural-resource-using activities. Applying benefit-cost analysis and environmental impact assessments, and exercising public control over each of these activities is impossible. Needed instead are general policy instruments to influence the behavior of natural resource users in ways that are environmentally benign and conducive to sustainable development. Education and appeals to social conscience have an important role for individual projects, and they are crucial for getting and then sustaining the political and public compliance needed for environmental protection. But this is not enough: economic incentives, backed by investment programs and wide-ranging regulatory and institutional mechanisms, are indispensable for achieving major improvements in the way development projects influence the environment.

3. NATIONAL POLICIES AND INSTRUMENTS FOR ENVIRONMENTAL MANAGEMENT

47) Numerous interdependent physical and behavioral factors complicate the environmental problem. The underlying causes of resource degradation may often be activities that at first sight are remote from the observed effects. If project and policy measures are to succeed, they must originate in a sound understanding of the physical links between events, and of the equally complex social, economic, financial, and institutional links that parallel them. And that understanding must be refined to determine where project and policy interventions are required. One essential element in all this, relevant to a wide range of en-

vironmental problems, is to identify the environmental degradation that stems from natural events. Such degradation, particularly when compounded by human activities, may often dwarf the degradation from human activities alone.

National Planning and Environmental Management

48) The inadequacy of physical data has frustrated the establishment of links between economic analysis — particularly macroeconomic analysis — and environmental considerations. That situation is now changing rapidly. Recent developments in geographic information systems permit increasingly refined assessments of current natural resource endowments and trends. They also permit better projections of future resource endowments under various scenarios of economic growth and sectoral output. In assessing physical links and long-term trends, remote-sensing from space may offer the benefit of a broad view, repetitive coverage, and uniformity in the way information is collected. And integrating such information with socioeconomic data (on population, transportation systems, land use, and so forth) will make systematic linking of macroeconomic and resource planning increasingly feasible. Economic planners therefore have a major role in ensuring that the collection and analysis of technical and behavioral information are well focussed and geared to policy or operational requirements.

49) To a large degree, environmental management should be seen as a means of attaining the wider objectives of sustained economic growth and poverty alleviation. Environmentally related behavior and the policies toward that behavior should thus be a part of social, sectoral, and macroeconomic policies. And planning at all levels should be sensitive to the intersectoral consequences of activities. Governments should use the tools at their disposal to search rigorously for policy and project interventions that address economic growth and poverty alleviation in an environmentally benigh way. Important here is investment programming to accommodate the physical interdependence between sectors. Regional planning, based on natural rather than purely political boundaries, should increasingly become the basis for investment programs, to allow for intersectoral links and to improve environmental management. Projects for watershed management and regional pollution control could benefit from such an approach.

50) The most powerful tools that governments may use to accompany multisectoral investment programming are pricing and regulatory interventions, the effects of which may be felt throughout an economy or region. These interventions influence resource use (and the sustainability of growth) in various and often unanticipated ways. Frequently the link between the primary objective of such policies and their environmental consequences is not considered by governments. These effects, for good or ill, may be by-products

of investment programs or policies that apparently are aimed at unrelated objectives. Many such policies are incorrect, not simply environmentally but also according to standard economic criteria. Examples abound in the policies for agriculture, forestry, and pollution control.

Agricultural Output Pricing

51) Governments throughout the world intervene strongly in agricultural markets to change agricultural prices, relative to one another and to the prices of nonagricultural goods. Some of these interventions are direct, through taxes, price controls, price supports, and supply restrictions. But perhaps the most important intervention stems from the widespread tendency in developing countries to turn the internal terms of trade against agriculture and to depress agricultural prices. They do this by overvaluing their exchange rates, providing high levels of protection to nonagricultural industries, and effectively taxing farm output.

52) In general, depressing farm profitability reduces the demand for farmland, farm labor, and other inputs not supported by government subsidies. Agricultural land prices tend to be lower than otherwise since farmland is a factor of production that cannot shift easily into other uses. So, the returns on investments in farmland development or conservation are also depressed, reducing both the ability and incentive to invest in leveling, terracing, drainage, irrigation, and other land improvement. The resulting loss of land productivity through erosion, salinization, and nutrient depletion compounds the problem of rural poverty, even in the short term.

53) In the agricultural sector, different rates of implicit taxation for different commodities can strongly influence cropping patterns and land use. Many countries severely discriminate against export crops relative to such domestic food crops as cereals, primarily to keep food prices low. The environmental consequences of such discrimination can be severe, for export crops often are less damaging to soils than basic food crops. True, some export crops — such as cotton, groundnuts, and sometimes livestock — tend not to be environmentally benign. But others grow on trees and bushes that provide continuous root structure and canopy cover: coffee, cocoa, rubber, bananas, tea, spices, and so on. These crops are suitable for the hilly terrain where they are often grown, and they leave soil much less susceptible to erosion than such crops as yams, maize, sorghum, millet, and cassava.

54) Overall, bringing agricultural prices into line with international prices stimulates production and increases rural incomes. This policy tends to be in accord with alleviating poverty and with longer term environmental objectives. But market forces can-

not be relied on entirely to satisfy what sometimes are inconsistent objectives. And when conflicts arise, some public intervention is required. Unfortunately, however, there are numerous instances in which public intervention works in precisely the wrong direction, subsidization of certain agricultural inputs and forestry activities being examples.

Agricultural and Forestry Input Pricing

55) Many direct government subsidies are unsound in both environmental and economic terms. They add to a country's fiscal burden, encourage wasteful use of scarce resources, and frequently benefit the larger landowners. For example, a variety of subsidies including tax and tariff concessions, low interest loans, and incentives for local manufacturers encourage the use of pesticides in many developing countries. The subsidies often are large. In nine developing countries in Asia, Africa, and Latin America the subsidy rates range from 15 to 90 percent of full retail cost, with a median of 44 percent. In Egypt the subsidy works out ro US$4.70 per capita for the whole population, and in Honduras, US$3.00. This has increased people's exposure to toxic substances and fostered more resistant strains of mosquitoes (and other insects) and the resurgence of malaria. Pesticides are also poisoning fish in ponda and irrigation channels. The overuse of pesticides may therefore reduce their net economic benefits, possibly resulting in net economic losses, even in the short term.

56) Inappropriate incentives also adversely influence the use of irrigation schemes, which represent an investment in the developing world of US$250 billion so far and a further US$100 billion by the end of the century. The increased agricultural yields from these investments have been at the expense of significant environmental costs, these being exacerbated by large subsidies. When water charges do not vary with use, as is normal, the results of such subsidies are almost entirely adverse. The resulting excessive use of water can create the need for more dams and introduce problems downstream, including shortages. Overall, the subsidies typically reduce the net economic benefits from irrigation projects.

57) Governments also subsidize livestock production, frequently with unfortunate consequences. The provision of infrastructure and livestock services at little or no cost has greatly expanded livestock production in many parts of the world. In Africa, such support, often without adequate control over herd sizes, has encouraged stocking rates to climb well above range-carrying capacity in years of low rainfall. Land concessions, tax holidays, and low interest loans have also been instrumental in encouraging livestock production. Projects so encouraged, while showing healthy profits to private investors, have often yielded negative

economic returns to the economy as a whole. In general, the need for grazing land leads to forest clearing, soil erosion, and potential losses in agricultural productivity elsewhere. The consequences for income distribution may also be adverse: the benefits of tax and credit subsidies typically benefit the larger landowners: combined with skewed distribution of land ownership in many countries, such subsidies have tended to encourage livestock production at the expense of food crops, reducing employment and damaging the environment.

58) Agricultural mechanization is another target for subsidies. But machinery and equipment imported at overvalued exchange rates, financed by subsidized credit, and subject to lenient domestic taxes may result in undue reliance on mechanization. Inefficient patterns of agricultural production are the result. Labor may also be displaced, reducing rural incomes and exacerbating rural poverty. In addition, the environmental impact may be negative. For example, clearing forests manually or with winches tends to be ecologically superior to clearing them with buildozers. Although mechanization does not automatically bring negative environmental effects, the technical knowledge and institutional arrangements to ensure appropriate use of machinery are rarely available. And that is what leads to adverse environmental consequences.

59) Many countries have rapidly depleted their forest resources by handing much of their worth to logging interests on contractual terms that encourage short-sighted exploitation. Their tax systems leave the timber industry with large profits and provide little incentive for the practice of sustainable long-term forestry. The profits result from a variety of subsidies and tax concessions, including cheap leases, free access roads and port facilities, reduced export taxes on processed wood, subsidized credit and export finance, and tax holidays.

60) Control over the exploitation of woodlands is an even more urgent need in semi-arid Africa, where license fees, stumpage fees, and other charges from harvesting wood from government-managed forests cover only a small fraction of the costs of planting new stocks and tending them to maturity. Official stumpage fees (which probably overstate the revenues collected) are less than 1 percent of forest replacement costs in Nigeria, 2 percent in Senegal, and 12 percent in Sudan.

When Governments Should Intervene

61) Recent policy reform in agriculture and industry has stressed the greater reliance on market forces to provide correct signals to producers and consumers. In general, the consequences of such policies for economic efficiency and growth are conducive to sound environmental management. But not always: because of externalities or adverse income distributional effects, unregulated market

mechanisms often cannot automatically resolve environmental problems in an efficient or equitable manner. In such cases, public intervention is required. For example, due to the external damage they may impose, some of the activities cited earlier, such as livestock and forestry, should on occasion be more heavily taxed rather than subsidized.

62) Public intervention may also be warranted in other important instances. One of them relates to the "commons" problem, where the exploitation of a resource, which may continue to appear profitable for additional users is actually disastrous for all. Common ownership, say of grazing land, is not necessarily a problem, for tribal ownership of property is frequently characterized by sustainable methods. The more serious problems tend to be associated with the use of land and other resources for which ownership is not clearly defined. For such communal resources, measures to induce prudent management may include physical restrictions, pricing policies, property rights, and leasing arrangements. The financial and technical assistance and the water rights given to private pastoralist associations in some Western African countries exemplify public interventions aimed at the commons problem.

63) Public intervention may also be required to manage or ameliorate the effects of natural degradation from catastrophes and more gradual naturally occurring events, which may sometimes be exacerbated by inappropriate human activities. Governments should design measures in light of the costs and benefits of the ameliorative action. What is needed is to disentangle damage by natural forces and by human activity — and to design the set of incentives or other policies accordingly. For example, to avoid flooding caused by natural soil erosion and sedimentation, incentives might induce industrial or residential location in less damage-prone areas. But if commercial logging is partly responsible, the focus should be on incentives to improve the management of forest resources.

64) Developing countries almost invariably subsidize industrial pollution, in that polluters typically do not have to pay for damages caused. However, efficiency, equity, and fiscal considerations argue against subsidization of treatment works, and subsidies are in any case difficult to administer. Because of the difficulty of unambiguously determining whether changes in plant design are for pollution abatement or for productive purposes, only "end-of-the-pipe" works can in practice qualify for subsidy. But that encourages inefficient plant design.

65) In general, the "pollutet pays" principle should be followed. Taxes based upon the costs of damage to others may be applied either on polluting activities or on relevant equipment. Correctly designed, charges for effluents may be the cheapest way of improving air and water quality. Led by self-interest, each enter-

prise would maximize profits by investing in process changes or effluent treatment to the point where the cost of a unit reduction in effluents is equal to the amount of the charge. Enterprises with different cost characteristics are therefore likely to respond differently. Because their absorptive or regenerative capacities, and therefore the harm caused, will vary for different watersheds or airsheds, effluent charges should be set regionally.

66) Although the public ownership and operation of utility enterprises has potential for reconciling economic and environmental objectives, this potential is rarely achieved. The pricing of electric power shows why. Governments usually require consumers of electricity to pay charges that cover the utility's financial costs. But these costs frequently underestimate economic and social costs. They tend to be lower than economic costs, for example, if the future exploitation of resources costs more than previous schemes (typically true of hydro power systems) or if other costs, including those of pollution or of resettling displaced people, are not fully borne by the utility. It will therefore often be the case that increasing prices beyond those required to meet the financial objectives of power utilities will improve the efficiency of resource use and support environmental objectives. The same is true for municipal water supply: prices rarely cover the economic costs of supplying water, let alone the costs of waste water disposal. Government policies therefore typically encourage excessive consumption of both power and water.

Regulatory and Legal Mechanism

67) As noted, the cost of trying to deal with widespread environmental degradation, relying on a benefit-cost approach at the conceptual level, is likely to be excessive. But the design and implementation of incentive systems also have costs because they involve monitoring, policing, and regulating. A system of stumpage fees, for example, may require extensive monitoring. Irrigation water charges may need some kind of metering. And the administrative and legal costs of implementing land reform schemes may be overwhelming.

68) In general, the use of economic incentives and educational campaigns is the most efficient way of influencing sound environmental behavior and ensuring the use of appropriate technologies. Environmental regulations, an alternative, are immensely difficult to enforce. Witness the ineffectiveness of government efforts to prohibit certain land uses on steep slopes, to proscribe logging in certain areas, to preserve forests along water courses, or to restrict exploitation of designated national parks and wilderness areas. But some regulatory (or legal) conditions play a major role in conserving or degrading the environment often through their interaction with more overt economic incentives. Property

rights are an example.

69) The evolution to permanent land rights of individuals and enforcement mechanisms to implement and maintain such rights in rural areas is closely related to population density, advances in agricultural technology, and the emergence of product markets. As land becomes scarce, societies must adopt fertility-restoring technologies that will allow continuous exploitation of land. Such technologies require investments of capital and effort, and cultivators need an incentive to make those investments. Such an incentive is strengthened when the right to cultivate a given tract of land and the ability to transfer it by will or by sale are secured not only by social custom but also by an effective state-enforced legal system.

70) One aspect of this issue that deserves special attention is the role of women. In many developing societies, women support the household and perform most of the agricultural work. Without their involvement, natural resource policies are unlikely to succeed. Especially in Africa, women normally do not have title to land or adequate access to credit. They may therefore be in no position to take steps to protect the land and water resources under their control. And their generally poor schooling compounds the problem. If these decision makers in households and small farms are to respond effectively to incentives, they need equality of educational opportunity, of land ownership, and of access to credit.

71) In contrast to environmental management for agriculture, industrial and municipal pollution control in most cases depends heavily on regulatory mechanisms. This is true even though, as noted above, systems of effluent charges (including fees for sewage disposal) are generally preferable. Regulations usually rely on licenses or permits that allow a given volume and concentration of effluent discharge per unit of time, that establish minimum standards of water or air quality, or that specify the treatment equipment to be used. Uniform regulations are easiest to devise and, in theory, to enforce. But the advantage of administrative simplicity may be outweighed by the economic inefficiencies that can result. For example, uniform effluent standards do not permit enterprises to take advantage of local absorptive or regenerative capacities and variations in the costs of pollution at different sites. Furthermore, uniform standards ignore the fact that the cost of adjusting the quantity or quality of effluents differs among enterprises. Design of appropriate regulations, adequately reflecting considerations of tradeoffs between economic efficiency, equity and administrative considerations, present a formidable challenge to administrations that already are overburdened.

Coordination of Policy Instruments

72) The various tools that governments may use to address the goals of economic growth, poverty alleviation and environmental management, are likely to be more effective if they are designed to be mutually reinforcing. For example, the preservation of fragile ecosystems or areas that are environmentally important (tropical rainforests, wildlands, upland watersheds, tribal areas) will be more effective under a concerted approach that involves a variety of interventions. These might include land use controls, incentives to locate elsewhere, and special taxes on property or porducts in the protected area. Similarly, pollution control measures might work best if they consist of a coordinated set of interventions, including effluent charges, land use controls, relocation incentives, investments in pollution control projects, and prohibition of activities deemed environmentally harmful.

73) In practice, however, different agencies, often with conflicting objectives, have responsibility for planning and implementing policies that may have serious environmental consequences. For example, a power utility may not adequately take into account the costs of a hydroelectric scheme to farmers or indigenous peoples. Flooding downstream by a river development scheme may not influence a provincial government if the damage occurs outside its borders. Improved natural resource management may therefore depend on the creation of new agencies with wide-ranging authority over some aspects of the operations of functional ministries in a region or watershed area. In addition, it will also be necessary to devise innovative institutional incentive systems to encourage better collaboration between existing line ministries, and to foster activities that improve natural resource management. In short, environmental concerns should be incorporated in the planning for agriculture, cities, regions, industrial location, and transport. Achieving this, one of the most important challenges of public sector management in developing countries today, will not be easy for governments whose administrations are already overburdened by immediate concerns.

4. AN AGENDA FOR ACTION

74) Central among the lessons from recent years is the importance of elevating concern about environmental matters to the highest levels of country planning, and of developing the capacity to implement sound practices for environmental management. Both are needed for reconciling, and where appropriate, trading off the objectives of growth, poverty alleviation, and environmental management. And both can be assisted by an increased commitment of resources from all members of the development community and by a major collaborative effort between them.

Country Policies

75) Governments have at their disposal a wide array of project and policy interventions for addressing environmental and economic objectives. Some of them, such as investments in financially viable sanitation, water supply, and forestry projects, may involve few tradeoffs and be relatively uncontroversial. More powerful and wide-ranging interventions, such as those for agricultural pricing, are analytically and institutionally more complex. They affect a range of interests and may involve considerable redistribution of income. Even where environmental and economic objectives neatly coincide, governments may face politically difficult choices. Their problems are compounded when they have to make other value judgments, including those about the welfare of future generations or the benefits of biodiversity.

76) To address some of the major underlying causes of resource degradation, governments have to confront even more sensitive issues. Operating within existing social and economic structures, a country's projects and policies can achieve major improvements in natural resource management. But more fundamental causes -- among them, rapid population growth, the role and status of women, the distribution of land, income, and wealth, and existing institutional arrangements -- need to be addressed if long-term growth is to be sustained. In general, governments should search for and implement the many project and policy interventions that can satisfy environmental and economic criteria relatively easily. At the same time, they should improve their understanding of natural resource management, and make progress in addressing its more politically sensitive underpinnings. Each country should develop an action plan that incorporates the following steps:

- Assess their natural resource base, the trends and patterns in resource use, and prospects for the future under various scenarios of economic growth.
- Estimate the economic and social consequences of major categories of resource use, making any tradeoffs between economic and environmental objectives as explicit as possible.
- Identify the economic sociological, and other determinants of environmentally related behavior.
- Based on the foregoing, set priorities for investment programming and policy interventions, with a special emphasis on population policy.
- Amend government interventions in the market that are economically and environmentally perverse.
- Design and introduce interventions when market forces are inadequate.

Continue efforts to address major underlying causes of natural resource degradation and to improve understanding of what affects the environment and how.

77) The ability of governments to take sometimes unpopular measures will largely determine whether the degradation of natural resources will continue to threaten economic growth. Systematically integrating natural resource management into country economic planning along these lines calls for a substantial commitment from governments. They must devote the additional resources required to implement lessons from project experience. They must also be willing to make decisions that may adversely affect powerful interests. But if they are to overcome the financial and institutional constraints, particularly binding for the poorest countries, they will also require substantial external assistance.

Collaboration in the Development Community

78) Today's environmental concerns call for unprecedented cooperation among various development institutions. The World Bank stands ready to play a catalytic role in a collaborative effort to address environmental issues, drawing on its expertise in country, sector, and project analysis, and expanding its normal practice of relying heavily on other disciplines and agencies to assist it.

79) The U.N. technical agencies such as UNEP, UNFPA, UNICEF, FAO, WHO, and WMO are improving understanding of technical parameters, such as the extent and causes of resource degradation, its relationship to productivity, and the prospects for the future. The Bank can make an important contribution by helping to set priorities for data collection efforts in resource assessment. For example, it can help focus remote-sensing efforts to ensure their operational usefulness and avoid duplication of efforts. Such collaboration already takes place, but it should become more systematic.

80) Also needed is a better understanding of legal, cultural, and institutional factors that determine environmentally-related behavior. In this, the experience of non-governmental organizations (NGOs), both local and international, will be useful, for their experience at the community level can provide a sounder basis for policies to be introduced at a higher level.

81) Collaboration between the various agencies is required in policy development and research as much as in operations. Coordinating the activities of the many interested parties can help particularly in building bridges between conservationists and the development community. There is a need to demonstrate the importance of using economics to achieve environmental goals and also to show how other disciplines — physical and behavioral sciences

— are indispensable to economic analysis.

82) Even more complex issues lie ahead. Regional and global environmental degradation poses special problems for the international community, problems that will be extremely difficult to resolve. The adequacy of international institutions, the role of financial intermediaries, and the nature of international legal arrangements need to be reviewed in light of the prospects for addressing several major problems. Among these problems are marine pollution, acid rain, the greenhouse effect, stratospheric ozone changes, and the possible climatic change and genetic impoverishment resulting from cutting down tropical rain forests. The global or regional interest in such problems may not coincide with the interest of the country generating the damage. This may call for new kinds of international arrangements that go beyond such legal agreements as the Law of the Seas, beyond the technical support or advice of such international agencies as the UNEP, and beyond unilateral demostic policies to reduce global pollutants. Some form of compensatory mechanism may be required to induce governments to curtail environmental degradation in the global interest.

World Bank Actions

83) In general, the methods for addressing environmental, poverty, and growth objectives of projects are reasonably well established. Benefit-cost analysis, for example, provides for the estimation of externalities and is useful in highlighting the ethical judgments that governments must make. General instructions to Bank staff on project analysis are, subject to the inherent limitations of economics, adequate for dealing with environmental issues. Similarly, general instructions on environmental matters — supplemented by instructions on wildlands management, tribal peoples, resettlement, and so on — provide the correct framework for analyzing and conducting environmental projects. There is, however, a need to shift the traditional focus of environmental economics from benefit-cost analysis toward the use of economic instruments designed to reconcile environmental growth and poverty alleviation objectives. The Bank will play a leading role in developing such methods.

84) The Bank will also increase its efforts to raise the consciousness of policymakers about the importance of integrating natural resource management into country economic planning and to help governments plan and implement the requisite measures. The Bank will, in interested countries that have developed action plans, undertake pilot studies in cooperation with UNDP, other donors, and the countries concerned. Those studies will establish the link between natural resource policies and country economic planning. Their emphasis will be on the analysis of economic, institutional, and cultural constraints to efficient natural re-

source management. A major objective of these pilot studies will be to assist in the design of appropriate policy instruments to overcome such constraints — and to find out what can be done practically and at reasonable cost.

85) The cooperation between the Bank and NGOs will be expanded. The Bank has benefited from and sometimes supported the policy work of environmental NGOs (such as the World Resources Institute and the International Institute for Environment and Development). And such NGOs as the World Wildlife Fund and the International Union for the Conservation of Nature routinely provide technical assistance to the Bank on project design, notably surveys of species diversity and the identification of wetlands and wildlands of ecological importance. NGOs are also expected to play a role in the Bank's growing program of social forestry. They have participated in the development of the Tropical Forest Action Plan, sponsored by the UNDP, the World Bank, the Rockefeller Foundation, the World Resources Institute, and the Canadian International Development Agency (CIDA). That plan is being refined and promoted through regional meetings involving NGOs, governments, and international agencies.

86) While special emphasis will be given to the pilot studies, the Bank will increase its efforts to integrate natural resource management into country economic and sector work. In so doing, the Bank will maintain its concern for the projects it finances and devote increased effort to their assessment and implementation to ensure they follow appropriate environmental policies and include the necessary safeguards.

87) In sum, the Bank will continue to invest in projects and encourage policies that meet the three criteria of economic growth, poverty alleviation, and environmental protection.

REGULATORY ISSUES

"Keep a thing in order before disorder sets in"

Lao Tzu : Tao Te Ching (152a)

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1. A LONG TRADITION

1) Protecting the environment (water, air, and land) by regulation has had much attention by Governments of many countries in the last 20 years. So it appears a modern trend.

2) But it has a long history. From a period 500-700 years ago records exist of villages in England having rules about keeping the local stream in order and of people having to pay fines for polluting it or interfering with its banks. What signs are there of China having any similar rules in its long tradition of good public administration?

2. A CHANGE OF SYSTEM

1) In Britain and Europe, these rules were mostly expressed in legal terms related to property rights for land. Owners or users of land were allowed defined use of adjacent rivers, but no more than that. Other laws applied to navigation (in France, for example) and rights to fish (different in USA and England through some of the water laws in both countries are similar).

2) In this tradition, disputes had to be settled by judges sitting in court. They knew more about land law, which is usually rigid, than about river basins. This system grew weaker as rivers became subject to more complex multiple uses - for piped water supply, municipal sanitation, factories and larger hydro-power.

3) So in the last 60 years or so, the trend has changed to a more administrative system - with use of rivers controlled more by permits or licences issued by some kind of river basin agency or Environment Dept.

4) This modern trend - much stronger in the last 20 years - still has a legal foundation, because it depends usually on recent legislation setting up new agencies and defining their duties and powers. It may also seem to have a technical character, because the scientific and engineering aspects of preventing pollution are complex.

5) But there is a major economic side to permits and consents.

They represent allocations of resources such as river capacity to absorb pollution. In a system recognised as part-legal, part-technical, part-economic, a series of questions arise. This note will introduce these issues and the Workshop could select which ones they want to address most fully.

3. WHAT AGENCY IS TO PLAN RIVER ALLOCATIONS?

1) One answer to this question is often that it must be a specialist agency covering a whole river basin.

2) Yet a difficulty with a specialist agency is that use of the river is linked to irrigation and agriculture, to navigation, hydro-power and fisheries, and to land-use planning and urban development. One agency can hardly control all these activities. So it must try to plan river use with the help of many other agencies who do control these other activities.

3) That introduces the question whether the other agencies will carry out the actions and investments that the river agency wishes for the best care of the river. Rivers have often been used as state boundaries, so there are different authorities on each side.

If the river basin agency makes a plan, how can it be sure that all the other agencies will fulfil their part in it? This raises questions of authorisation, monitoring and enforcement.

4. AUTHORISING AND MONITORING

1) A first point on authorising is that the system can only relate to man-made activities. Yet the river picks up silt and much pollution from run-off from land and what are called non-point sources. Also, the flow and dilution vary greatly at different seasons. So the authorisations have to be definite in an environment subject to frequent variation.

2) Moreover, man-made activities produce many different pollutants. Are the permits to specify limits for every one of them or some general limit on the pollution load for each discharge?

3) These questions are relevant to the form of authorisation and to monitoring. The analysis of water samples can be costly, so taking many samples of varying situations is not easy. How is compliance with permit conditions to be secured?

5. MOTIVATION AND ENFORCEMENT

1) This is perhaps the issue getting special attention now. Laws and rules may only motivate good conduct by threat of prosecution

and punishment. Large factories or city councils are not easy to punish, and can often argue good reasons why the pollution laws may be unfair to them.

2) Another way of motivation is to offer rewards or incentives. In some European nations, charges are made for all discharges to rivers, and the income is used as grants to factories and municipaties to help pay for better facilities to reduce the pollution load discharged. This can involve a sort of bargaining about levels of pollution, which can seem very realistic in economic terms, yet alien to the legal tradition of laws having to be obeyed under threat of punishment.

3) But punishment depends on widespread enforcement. If some polluters escape notice while others are subject to strict enforcement, arguments of unfairness arise. Moreover, as the great Rhine pollution in 1986 showed, accidents can happen. How do we regard a huge accidental pollution compared to a small deliberate continuous one?

6. CONCLUDING BROAD ISSUES

1) The issues of protecting the water environment by regulating the many uses of it are very wide-ranging. This note has tried to expose specific types of problem so that, in its discussion periods, the workshop can select various ones to address in more depth. But in conclusion, two broader matters at least deserve mention, even if there is little scope to discuss them.

2) The water environment is only part of the wider environment, and any national environment only part of the international environment. The Chernobyl nuclear accident demonstrated this sharply in air pollution as well as the Rhine accident in river pollution. The acid rain argument also circulates politically. So pollution issues run across physical and political boundaries. Should the sludge left after good sewage treatment improving effluent discharges to rivers be spread on land, or moved partly into the air by incineration? Or dumped at sea where that is nearby? Whose sea? Whose air? Subject to what limits?

Cleaner rivers may not be so good if somebody has more air pollution instead.

3) Lastly, one may suggest that social issues are here ultimately more influential than technical ones. The water environment and the atmosphere are liable to be polluted because in water and air, pollution moves away, while on land it may stay on our own doorstep. Water and air are indeed resources we all have to share, without being able to own them by buying or selling, or putting up fences round them. How to share things well in these conditions is a severe

test of human character, for individuals and for whole communities.

4) In these matters, it may not be always true that those who are most technologically advanced or economically powerful are suited to be teachers. Perhaps we need to recognise that in such matters we are all students and apprentices.

"Do not constrict the living space: do not press down on the means of livelihood. It is because you do not press down on them that they will not weary of the burden".

Lao Tzu: Tao Te-Ching (175)

PAPER ON FUTURE ISSUES

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1. Introduction

Planning of any kind is an exercise in guessing the future. By this definition, all planning is likely to be proved partly wrong as the future becomes the present. Likewise my comments in this paper on future issues are likely to be proved partly wrong in due course.

Accordingly, good planning seeks to set out a range of possibilities, or scenarios, which attempt to predict the most likely outturn of future events. Usually this range of possibilities is bounded at one extreme by an "optimistic" forecast. At the opposite extreme, the range of possibilities is bounded by a "pessimistic" forecast. The "most likely" forecast occupies the middle ground between the two extremes.

In this paper my comments will be essentially in the most likely forecast category.

2. The major issues

In general, there are three major issues for the future in water environmental management. There are of course other, very important sub-issues arising.

The three major issues are:

i. the alleviation of freshwater flooding and tidal inundation from the sea;

ii. the achievement of a reasonable balance between water demands and water supplies;

iii. meeting the objectives of conservation of the water environment, in which water pollution control is a major factor. However, the relevance of river and lake water levels to the ecology of adjacent land must not be lost to sight.

To manage these issues satisfactorily in the future, two basic requirements must be met, namely:

a. provision of the legal and administrative framework of authorisation, regulation, planning, objective setting, and monitoring of performance against objectives, within which operational management of the future issues can proceed;

b. provision of the resources, primarily financial, to produce, or permit the buying in of, the materials, energy, technology and manpower resources necessary to enable operational management of the issues to be done.

Generally speaking, people being what they are, the administrator and the operational manager will usually tend to ask for more resources than they really need to manage future issues. This should be well understood and allowed for. One inevitable fact is that the administrator and the operational manager, and indeed the professional planner, not being clairvoyant, will not accurately foresee all needs. Good corporate planning will reduce, but never eliminate this risk. Another factor, controllable and by no means inevitable, is that the administrator and the operational manager will not be allowed to exercise reasonable flexibility in managing future issues. Some flexibility in the application of the legal and administrative framework, and in operational practice, is required to enable random problems that arise to be managed effectively and efficiently.

Thus reminded of the fallibilities of human endeavour, we can proceed to examine more closely the practical aspects of future issues in water management in China.

3. Flood alleviation and tidal defence

For certain there will be occasions in the future when gross excesses of rainfall, or of tidal surges, or a combination of both, lead to unacceptable flooding of urban or rural land. These events will be essentially of natural cause, although intense urban development can be an additional, and avoidable, cause of local flooding. Urban development of course exposes more people, property and services to the damaging effects of flooding. To deal with such events requires specific arrangements. Usually these embrace effective and efficient systems of flood prediction, warning, control and emergency rescue action. Control possibilities are limited. It is usual in any specific case to define the limits of control action in terms of defence against specifically chosen floodwater levels or river discharge rates. These standards of protection against flooding are set in the light of historical records of the magnitude and extent of past floods and the damage they have caused.

Fortunately, advances in information technology, especially in remote sensing, weather forecasting, rainfall radar, catchment-wide hydrological modelling, tidal surge modelling, etc now permit the development of much better flood management systems. The future use of these technologies and systems as much as reasonably possible is essential. This is particularly so in respect of urban areas and their associated industrial installations.

4. Water demands and supplies

Because of the variability, of the weather in the shorter-term, and the climate in the much longer-term, deficiencies in the natural availability of freshwater resources present problems opposite to those of flood alleviation. Fortunately there is much more operational scope for control of the consequences of deficiencies in the availability of water resources, although once again there are limits to which the consequences of freak extremes of drought can be managed. In this control, not only is the natural availability of water resources capable of engineering management, but also, and no less important, the management of water demand is feasible.

There is no need for me to recount here the various aspects of water supply engineering. But I should and will draw attention to two factors in water engineering which should play an increasing role in the future in China. First, the really big schemes of water impoundment or of inter-river basin water transfer do not appear attractive in the shorter-term future. Costs, engineering difficulties, water losses and environmental considerations are of such magnitude that such schemes should not be pursued until major efforts in reducing water demand have been applied. Such reduction in demand embraces reduction in user requirements, increasing water reuse, and reducing leakages of treated water supply in distribution systems. Here, for the avoidance of doubt, it should be understood that major water engineering schemes primarily for power generation are not included in the above comments.

Second, in areas where groundwater resources as well as surface water resources are available, important future issues will be the proper control of groundwater abstraction, the conjunctive use of surface and groundwater resources, and the development of groundwater recharge schemes.

That water demands in the future will need effective management, at least in some parts of China, seems irrefutable. Some 90% of water demand in China arises from agriculture. Increasing agricultural output in the future will call for the use of modern irrigation systems on a scientific basis to give greater output per unit of water irrigated. New crop varieties, and major changes in location of specific crop production are also issues of importance. The indirect reuse of purified wastewaters in agriculture via rivers and canals is also an important element in future water economy.

On the industrial scene, water economy must be a major future issue, not only in reducing water demand per unit of industrial output.

Good housekeeping in industrial use, waste-stream separation and reuse, and recovery and re-cycling of process materials are all powerful factors in reducing industrial pollution of water. Serious and detailed practical attention to reducing industrial water wastage and industrial water pollution should be integrated into factory process and drainage design. Otherwise, if industrial output increases as planned, the water environment will deteriorate drastically.

In respect of all uses of commodities the will to economise in commodity use and to reduce waste is strongly related to the value that users assign to that commodity. In the case of water supply that value generally reflects the cost of supply, that is the charges the user must pay for the supply he takes. In areas where demands often exceed the supply available, the levying of realistic water charges, properly reflecting the costs incurred in delivering that supply is an essential factor in demand management.

Minimising losses of treated water from distribution systems is seemingly a world-wide urban problem. It must be an issue of the future in China. The installation of computer-aided, telemetric control of distribution systems, including pressure control, is normally a very sound investment. Mains network analysis and subsequent optimisation of the network distribution system is also a sound investment. Programmes of leakage measurement and leak detection and repair, of a not-too-complicated and expensive kind also offer good returns in water savings. However, the fact should be faced that the quality of urban mains water supply in China is not impressive relative to European water supplies, and that a future issue must be to set and achieve improvements in supply quality. To neglect this, while striving for higher standards of river, canal and lake quality on environmental grounds, would not at all seem sensible.

5. Conservation of the water environment

As already indicated earlier in this paper, the major future issue arising here is in water pollution control.

There are three major activities, often basically in opposition, which somehow have to be managed in reasonable harmony if satisfactory environmental conservation is to be achieved. These three activities are:

i. the beneficial development of environmental resources, both non-living (water, fossil fuels, minerals) and living (the environmental biota of all kinds);

ii. the disposal of urban, industrial and agricultural wastes into the environment;

iii. ensuring that the harmful effects on the environment of activities i. and ii. above are minimised.

Fundamental requirements for satisfactory management of these activities are, first, environmental research to advance our knowledge of environmental processes. These are the processes which created environmental resources, and which regulate the present and will regulate the future environment. Second, the advancement of technology for the future purification, including recovery and reuse, of wastes, or for the safe containment of hazardous and intractable wastes.

Returning to the specific subject of the water environment, the results of environmental research enable us to specify sensible environmental quality objectives (EQOs) and standards of quality for disposal of wastewaters to surface waters or into the ground. These specifications themselves are a kind of "market pull" for the wider use of existing wastewater disposal technology and for the development of new (or improved) technologies. Yet the execution of basic research in science generally, followed through by applied research and development in the general engineering context, produce a "technological push" for the adoption of new technologies.

Considering the market pull for new technologies generated by the application of EQOs and discharge quality standards, a glimpse of the future is available through consideration of the position in the European Economic Community (EEC). The EEC has recently issued new Directives specifying standards of water the quality for various uses of water; they are having a profound technological effect. For example standards of freshwater quality and of drinking water quality are resulting in wider adoption of secondary treatment of urban sewage discharge. (This does not apply to the UK because widespread adoption of full sewage treatment was achieved some 25 years ago). New technologies for denitrification of drinking water have been developed. Increased use has been made of activated-carboon treatment for removal of undesirable organic residuals, such as chloromethanes in drinking water. To reduce the formation of chloromethanes in drinking water, the older technology of chloramination of drinking waters, instead of free chlorination, is being favoured. Yet chloramination is now suspected of causing levels of nitrite, in large urban water distribution systems, to be higher than the EEC limits. The banning of particular "black-list" residuals of dangerous chemicals in wastewater discharges has had a significant impact on industrial wastewater management. Further, stringent EEC Directives on the bacteriological quality of shellfish waters, and of waters overlying marine bathing beaches has accelerated the provision of new, long sea-outfalls from coastal sewage disposal sites. These are all issues which will affect future provisions in the management of the water environment in China, according to the stringency of standards that may be set.

There is however an important factor to be borne in mind here. It would be useless, and indeed damaging to the credibility of environmental management to set standards for environmental conservation which could not be attainable within a reasonable time. That is my view. Yet there are people who say that it is better to set high standards which cannot be met than to set lower standards which can be met. Personally I do not support any kind of "make believe" management — that is management that pretends to achievements that cannot be delivered. Good management gets the results it aims for. If management endeavours are not founded on that basis then that management will in due course fail and will be replaced by something better.

Turning now to consider the technological push for the use of new technologies in managing the water environment arising from advances in general scientific understanding, the future looks bright. In particular that brightness shines on two fields of research and development. One field, already well established, is that of materials science. It is this which has given us the microchip and fibre optics which are the essence of the information revolution now upon us, and of the future in instrumentation, control and automation of the operations and systems of water environmental management.

Even as many advances in science and engineering over the last 150 years gave man, through the steam engine, electro-magnetic generators and motors, and internal combustion engines, an immense extension of his natural physical power, so the advance of semi-conductor science and engineering gives man a massive extension of his mental power. But the latest findings of materials science in producing new superconducting ceramics and plastics, as well as new ceramics for mechanical engineering use, seem likely to increase greatly the efficiency of power generation, transmission, and use — and hence of wastewater purification and reuse in the future.

The second field is in genetic engineering and its applications in new biotechnology. Here future advances in microbial and enzyme processes for wastewater purification, and recovery of polluting but valuable substances, seem certain. However there is a major environmental question to be resolved in the genetic engineering field. Will deliberate or accidental releases of genetically engineered micro-organisms cause serious environmental damage? and, if so, how is the situation to be controlled? Will the view of the minority, that no unnatural biota should be released into the environment, prevail? I very much doubt this, but I must acknowledge the problem and that any risks must be contained. Certainly in the future the emphasis will move towards greater prevention of pollution at source, to the formulation and application of more, and more stringent, environment standards.

Increasingly those who wish to undertake new industrial developments, or to use potentially harmful materials or micro-organisms, will be required to demonstrate with greater certainty the safety of their intentions, in terms of environmental impact and the risk-containing precautions they intend to take.

In conclusion I would point out that we are now most certainly moving into a new era; an era where technological advance, applied in management of the water environment as "environmental technology", will at least be as powerful a tool of environmental conservation as technological advance in the past has been the cause of pollution of the water environment. Certainly one intention of the 4th Environmental Action Programme of the European Economic Community, that new industrial (and agricultural) technology must become much more "environmental friendly" than past and present technology has ever been, is a good pointer to the future. This intention does not arise solely from concern for the environment. It also arises from recognition of the strong likelihood that new or improved industrial technology will not be attractive to worldwide export markets unless it has "environmental friendliness" built into it. This is a major future issue for China to ponder, as it seeks to multiply rapidly its industrial development and output.

MAXIMUM CONTAMINANTS LEVELS AND WATER MANAGEMENT

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INTRODUCTION

No resource is more precious than water. However, many of our most difficult problems have also been associated with water, either from excesses or deficiencies. The problem is not lack of adequate quantity, but lack of sufficient water where it would be most useful. We have learned how to reduce damages from floods and hurricanes, and to store and transport water from wet regions to arid and semi-arid regions, but urbanization and higher standards of living have elevated the demand for water to almost unimaginable heights, the struggle for allocating water supplies among farmers, city dwellers and environment has been taking place, particularly in arid and semi-arid regions such as Southern California.

Most beneficial uses require water be of the proper quality. Only a small portion of the total water on earth has the quality suitable for most human needs, and difficulties are often experienced in keeping this free from contamination by municipal, industrial or agricultural wastes.

Synthetic organic chemicals, virtually unknown before World War II, now are part of many essential and beneficial products, from weed killers to pacemakers, from rubber tires to synthetic facrics. Most of these chemicals, more than 30,000 at present, appear harmless under normal conditions of use and exposure, yet many have unforeseen or harmful effects on humans and the environment. Cleaning compounds, paint removers and insecticides are examples of such potentially toxic chemicals in common use. When accidential spills and discharges occur, or in case of improper disposal, these synthetic organic chemicals often find their way into ground water supplies (4).

In early 1970's there was little or no analytical capability to detect and quantify many of organic compounds in water supplies at micrograms per liter levels. In 1975 the U.S. National Organic Reconnaisance Survey dealt with only six compounds, and in 1976-1977 that increased to twenty-seven. Today standard tests are available for several hundred organic chemicals in both surface and ground water supplies. The finding of these chemicals contradicts the previous perception of naturally high ground water quality, particularly since some of these chemicals present potential health risks. Continued improvement in monitoring and analytical technology will permit the detection of ever smaller concentrations of organic residuals. Therefore, the presence of known hazardous constituents will be determined while there is still no understanding of the degree of risk represented by that concentration.

U.S. Environmental Protection Agency (USEPA), under authority of the Safe Drinking Water Act, is proposing maximum contaminants levels (MCLs) for wide range of contaminants, including certain metals, pesticides, synthetic organic chemicals and volatile organic compounds (VOCs). This paper presents certain potential influences of MCLs on future water management.

U.S. DRINKING WATER STANDARDS

Under the Safe Drinking Water Act, USEPA is directed first to use the best scientific data available to determine the concentration below which there is no observable health danger. This is called the recommended maximum contaminant level (RMCL) (or under the new drinking water act revisions) the "MCL Goal". RMCL is a non-enforceable limit that U.S. Congress intended as a target only. The MCL Goal shows what the MCL would be in an ideal case where a water utility had unlimited money and technical capability to remove contaminants from drinking water.

USEPA considers the action of each contaminant working by itself, ignoring any intensifying effect that two or more contaminants might have been when acting together. Although one chemical might increase or cancel out the health danger of another, little is known about these synergistic effects.

Unfortunately, there is not a lot of data on human health available today, particularly with the references to the new pollutants. There are more data on aquatic life effects. The use of animal feeding experiments, mutagenic screening tests and epidemic survey to develop MCLs are currently under attack because of the inherently imprecise nature of these tools. Unfortunately, they are the best tools we have today. USEPA decision makers are unwilling to accept the risk that the evidence produced by these tools is too imprecise to be used. In fact, USEPA are obligated under the Safe Drinking Water Act to regulate these substances that may cause adverse health effects. There is a fear that another 10 to 20 years of population exposure might result in a real increase in cancer incidence not now measurable. Many of the contaminants for which MCLs are being developed go beyond the 126 Clean Water Act priority pollutants.

Certain U.S. Drinking Water Standards, USEPA Standards for Volatile

Organic Chemicals in Drinking Water, and proposed RMCLs for Chemicals and Microbiological Parameters are summarized in Tables 1, 2 and 3 respectively.

WATER SUPPLY

The largest blow to water utility engineers was the discovery that chlorine, which is added to protect the public from infections diseases, produces products in its reaction with natural organics that are called trihalomethanes or THMs. One of the THMs, chloroform, has been shown to produce specific cancers in laboratory animals at high dosages. On March 5, 1982 the U.S. EPA published a proposed rule in the Federal Register that would amend the current National Interim Primary Drinking Water Regulations with respect to the control of THMs. The proposed rule specifies criteria by which U.S. EPA and those states with primary enforcement responsibilities shall issue variances and compliance schedules. If this proposed rule is eventually promulgated as an amendment to the existing regulations, utilities would be required to investigate five General Available Treatment methods for reducing THMs as part of any variance:

1. Use of chloramines as an alternative or supplemental disinfectant or oxidant.

2. Use of chlorine dioxide as an alternate or supplemental disinfectant or oxident.

3. Improve existing clarification for THM precursor removal.

4. Moving the point of chlorination to reduce THM formation, and where necessary, substituting chloramine, chlorine dioxide, hydrogen peroxide or potassium permanganate for the use of chlorine as a preoxidant.

5. Use of powdered activated carbon for THM precursor or THM removal seasonally or intermittently at dosages not exceeding 10 mg/1 on an annual average basis.

In addition, five other methods may have to be investigated by the system being granted a variance to determine, first, the probability that any of these methods will significantly reduce the level of THMs for that system, and second, if such probability exists, whether any of these methods are technically feasible and economically reasonable. These five methods are:

1. Introduction of off-line water storage for THM precursor control.

2. Aeration for THM removal, where geographically and environmentally appropriate.

3. Introduction of clarification if clarification were not currently practiced.

4. Consideration of alternative sources of raw water.

5. Use of ozone as an alternative or supplemental disinfectant or oxidant.

If this proposal becomes a final regulation, this will better guide utilities as to what treatment methods they should be investigating in an effort to control trihalomethanes in their finished water. Additional treatment may have to be provided at water utilities that might exceed the Maximum Contaminants Levels (MCLs) established by U.S. EPA. Some of those that utilize groundwaters would be the most likely group affected. Some water treatment plants are incorporating ozone and other treatment facilities into their expansion program to reduce the THMs and to meet the MCLs in the water systems.

Incorporating state-of-the-art technology, including ozone disinfection, the City of Los Angeles Water and Power Department began operation of its new 600 MGD (2270-ML/day), $146 million water filtration plant which can handle about 75 percent of the city's water supply, on December 30, 1986. Los Angeles gets most of its drinking water from the Owens Valley and Mono Basin areas on the east slope of Sierra Nevada. The water is transported from the mountain watersheds to the city reservoir via a 338-mile-long (544-km) aqueduct.

The facility was constructed primarily in response to a ruling by the California State Department of Health Services that the aqueduct water supply met 1978 state water quality criteria that mandate filtration and disinfection. Federal water quality standards demand a turbidity level no greater than 1.0 ntu, but California imposed a 0.5 ntu standards in 1978 and required treatment of surface waters exposed to significant sewage hazards or recreational use. The City of Los Angeles new plant is designed to comply with the California standards and to have the flexibility to meet stricter standards. (The U.S. EPA has proposed a maximum contaminant level goal of 0.1 ntu for turbidity).

The City of Los Angeles plant features one of the largest nonindustrial ozonation systems in the world and is the first to incorporate large-scale use of ozone generated from high-purity oxygen. The use of ozone as the primary disinfecting agent will allow the plant to use less chlorine, thereby to reduce the THMs in the finished water. The new plant will allow the city to surpass existing THM standards and more stringent standards expected to be imposed under the amended Safe Drinking Water Act. Initial tests of the plant showed the turbidity levels ranging from 0.1 to 0.2 ntu, and THM levels in the distribution system dropping from an average of 30 to 40 ug/l to an average of 5 to 20 ug/l, well below the federal standard of 100 ug/l.

The City of Los Angeles water treatment process begins with water entering the plant by gravity from the nearby reservoir. After screening for large materials such as leaves, twigs, and pebbles, the water is disinfected by ozone that is generated on site. Coagulation chemicals (cationic polymer with ferric chloride as an aid) are introduced as the water flows into rapid mixing basins. Water then moves through a tapered flocculating system with three compartments per train; there is a variable speed, vertical turbine flocculator in each basin. Filtration basins utilize anthracite coal and gravel and incorporate air-water backwash system. Filtered water is chlorinated as it enters the distribution system, and backwash water is recycled through reclamation pond.

SURFACE WATER

What are the implications, if any, of these drinking water MCLs for the National Pollutant Discharge Elimination System (NPDES) program? It is a question that some USEPA policy makers have been asking. When NPDES program regulates a surface water discharger, do they adequately consider the effect on the downstream intake? Not all of the pollutants for which there are drinking water standards have been incorporated in NPDES program. NPDES program has until now been focusing on the 126 Clean Water Act priority pollutants. USEPA is currently embarking on the next round of permitting which is aimed at regulating toxics, synthetic chemicals, and other substances beyond the priority pollutants. The permit may be modified if the human health effect data suggest such a revision is required.

For substances regulated under both statutes, Clean Water Act (ambient water quality) criteria and standards are more stringent than those under the Safe Drinking Water Act which are determined by technological feasibility and economic constraints, as well as human health studies. The quality of surface waters designated for use as a drinking water supply, therefore, not only meets, but generally exceeds, the drinking water standards for conventional and some unconventional pollutants. If permit needed changing because of water supply problems, the change would take the form of adding effluent limits for new substances, not raising the existing ones.

The MCLs will have an impact on the NPDES program. As more MCLs are written, there is bound to be additional concern about the upstream sources of the contaminants. The fewer number of contaminants there are in the river, the lighter the burden on the downstream supplier. It is extremely difficult to assess the contribution of individual contaminant concentrations to the "organic mix" in ambient water. Nevertheless, we need to understand the engineering with respect to each organic compound.

GROUND WATER

The discovery of hundreds of trace chemicals in New Orleans' drinking water and subsequent analyses in 80 other cities produced the Safe

Drinking Water Act in 1974. Well water contamination, discovered first in Maine, then New York, California and eventually in hundred of communities across the United States produced the Resource Conservation and Recovery Act (RCRA), which is aimed at operating hazardous waste disposal sites.

Sources of contamination include improper waste disposal operations, abandoned hazardous waste disposal sites, agricultural pesticide use practices, mining wastes, leaky sewers, accidental spills of chemicals, septic tanks, cesspools, and salt water intrusion into aquifers also contribute chemical and pathogens to the pollution problems

At stake is a critical resource. According to USEPA, half of the country relies on wells for drinking water. One-third of all public water supplies and more than 90 percent of all rural domestic water is derived from aquifiers. Total water use in the U.S. is projected to triple over the next 20 years and ground water is being counted on for much of the increase.

Specifically, under the Resource Conservation and Recovery Act (RCRA) the owners of hazardous waste disposal sites must monitor ground water quality for various indicator contaminants and the MCLs would provide a useful yardstick with which to judge water quality. There is now some disagreement within USEPA, however, about whether MCLs should be officially incorporated into hazardous waste regulations. While the numbers would logically tie together the various USEPA programs dealing with water quality, they would also raise some philosophical conflicts. The MCLs are set using information about the ability of available technology to remove various contaminants from water economically at a drinking water treatment plant. The technology available for decontaminating an in-place aquifier could be a wholly different matter. Also, while cost considerations are part of choosing treatment technology under the Safe Drinking Water Act, RCRA specifically excludes cost as a factor in judging which disposal sites are unsafe.

Another problem, is that by using the same numbers to judge ground water contamination and drinking water treatment, regulator would be allowing water resources to be polluted to the exact point to which water utilities would have to clean them up. That would leave no margin of error to allow for the normal degradation of water quality over time or the variations in water quality throughout an aquifer. Regulators should aim to keep the levels of groundwater contamination lower than the MCLs required for drinking water supplies to consumers.

Some states, Wisconsin for example, already specify such a double-tier system for water supply. Like anything underground, ground water supplies will always be poorly understood. To ignore the lack of knowledge by neglecting to add a safety margin to environmental enforcement is "absurd". Once contaminated, there is no practical way to clean up the aquifer. In the future, groundwater can no longer be considered so pure that no treatment need be provided, even though the path by which pollutants reach groundwaters is not determined.

Our understanding of the processes by which groundwater moves and the mechanisms by which it transports and transforms contaminating materials is very limited. The study of these subjects may well be the fastest expanding area of research in the field of water pollution control. Because of its importance in western U.S. areas, more is known about the physical aspects of groundwater flow than about quality. A large body of research is presently focused on methods of monitoring groundwater quality to provide sound data for use in the new area of computer modeling. The data base available from which to assess the present state of the U.S. groundwater is marginal at best. Most of the data concern conventional pollutants, such as salinity, that affect potential use. The techniques to measure the low levels of toxic organic chemicals now being found in groundwater have been developed recently. USEPA does not expect that a comprehensive picture of the state of the U.S. national groundwater will ever be produced from ambient monitoring because the resources is so vast and so inaccessible. Whereas surface water can be sampled easily, groundwater can only be sampled by drilling test wells. The fact that contaminants tend to move in concentrated plumes within the aquifer makes it very difficult to pinpoint their location without extensive sampling.

WATER REUSE

Water reuse is nothing new. Raw sewage was used for agricultural irrigation in ancient China, in ancient Athens, in 17th century Germany, and in arid parts of the United States during the last century. The discharge or disposal of treated or untreated wastewaters into streams that subsequently used for a wide variety of purposes represents the extensive unplanned, indirect reuse of these waters. The method of disposal, or indirect reuse, had become a generally accepted practice until the Federal Water Pollution Control Act of 1972 became law in the United States.

Whether sophisticated in concept or not, whether providing good quality reclaimed water or not, the reuse projects of long standing in the U.S. reflect unique local responses to severe shortages of water for a specific agricultural or industrial need. The Federal Water Pollution Control Act of 1972 unmistakably influenced reuse planning. Faced with meeting stringent, new Federal and state-imposed discharge standards, which require construction of costly advanced wastewater treatment facilities, some wastewater managers turned to reuse programs as an alternative. Other agencies have gone ahead with upgrading of treatment facilities, but have recognized the intrinsic value of the high quality effluent being produced, which becomes a valuable resource for marketing for irrigation and industrial uses.

The increasing, and often conflicting, demands on the limited water resources in the U.S. make it necessary to evaluate carefully multiple uses of water in water resources planning, which now should include the consideration of wastewater reuse. The formalization for considering wastewater reuse is embodied in the Clean Water Act and the 1972 and 1977 amendments. Many states, especially in the arid western U.S., have encouraged reuse practices to augment water supplies. Interest in reuse is gaining momentum, and several U.S. federal agencies are supporting research into various aspects and types of wastewater reuse. One of the principal purposes of the Clean Water Act of 1977 is to achieve greater use of systems that reclaim and reuse water and productively recycle wastewater.

According to a study for the Office of Water Research and Technology, U.S. Department of Interior, the total reuse in 1975 was estimated at 678 MGD (2,566,000 cubic meter per day). The water that is reused is divided among 536 locations, with the largest volume usage in Arizona and the greatest number of reuse in Texas and California. In 1975 there were about 200 water reuse projects in California which represent about 7 percent of the total wastewater produced by industries and municipalities. Most of water reuse projects prior to 1975 were implemented only on a very small scale, principally for agricultural and industrial endeavors.

The control of pathogens is technically and economically achievable for all forms of reuse. Inorganic pollutants can be managed or removed to meet required limits. Organic pollutants pose a health concern of unknown magnitude which will impair our ability to proceed with any reuse scheme that might result in long-term ingestion of some fraction of reclaimed waters. This situation applies to planned groundwater recharge, potable reuse and irrigation projects as well as all domestic water supplies derived from contaminated surface and groundwaters.

Water reuse programs generally do entail a health risk. This risk is not significantly different than that associated with the use of water supplies containing trace organics from whatever source they are derived. Reuse programs should not have to meet standards any more stringent than domestic supplies drawn from contaminated sources. The U.S. Drinking Water Standards and the MCLs established by USEPA should be used as a guide for water reuse project planning.

The implementation of water reuse projects should and will be related to the need for the water. If the water is needed, the health risks discernible today are not significant to prevent a properly engineered and managed system from being accepted. If the water is not needed or economically attainable, the health risk will support arguments that it is not worth the gamble. The health consequences and inconvenience of insufficient water justify proceeding with those projects which meet a need, are economically feasible, and have a competent and stable management program.

STORMWATER

Stormwater pollution can be characterized in magnitude and in concentration of pollutants an intermittent or impulse-type discharges into receiving waters, which cause shock loading problems to the ecosystems of these water bodies[1] . Preliminary findings of the priority pollution monitoring project of the Nationwide Urban Runoff Program conducted by the U.S. Environmental Protection Agency in 1982 has detected 79 of 129 priority pollutants listed by the U.S. EPA. Some 49 priority pollutants (50, including dioxin) were not detected in any acceptable runoff samples, all of which were organics. This group of substances should be considered to pose a minimal threat to surface water quality from runoff contamination. The 24 pollutants (14 inorganics and 10 organics, excluding dichloromethane) detected in at least 10 percent of the runoff samples. Table 4 summarized water quality criteria and drinking water standard exceedances for pollution detected in at least 10 percent of Nationwide Urban Runoff Program samples[2] .

Recognizing the stormwater pollution creates water quality problems, U.S. Congress adopted 1986 amendments to the Clean Water Act requiring municipal and industrial dischargers to apply the permits for their storm drains for regular outfalls from rivers and sewage systems. Group I municipal and industrial dischargers have until December 1987 to file permit applications under USEPA stormwater rules issued in December 1986.

The rules offer industries, classified roughly according to the categories contained in the industrial categorical effluent guidelines, the operation to apply for an individual or group permit. Group permits would require data from only a representative sampling of outfalls. If an industry chose to obtain an individual permit, either EPA in the undelegated areas or the delegated state where the industry had operations, would be responsible for monitoring and enforcement.

Under the rules Group I municipalities are defined according to a selective classification scheme which includes cities with particular and unusual stormwater problems. In most cases a general permit would cover the entire municipality and data from only a representative sampling of outfalls would be required. Permits for both industry and municipalities would extend for five years. USEPA would be required to reissue the rules two years from enactment of the law. Group I applications would then be due one year later. Group II municipalities, whose applications would be due 18 months after that, would be defined as those cities serving populations of 100,000 to 250,000. Controls on discharges from commercial and residential sites would be held in abeyance, pending future study.

There are more than one million municipal storm sewers throughout the United States. USEPA's 1983 study concluded that stormwater has threatened the "beneficial use" of waterways in scattered, mainly urban areas throughout the nation. The intent of 1986 amendment to Clean Water Act is to get a handle on the extent of the potential pollution of the nation's streams, rivers, bays and oceans as a result of urban runoff and began to control it. USEPA takes the position that a selective approach to control is more appropriate than permitting every single stormwater point source, a requirement which it maintains would be prohibitively expensive and resource-draining.

But no one, not even the USEPA, is sure about how to clean up rainwater once permits are issued under the new federal regulations. The USEPA has proposed to look at that issue over the next two years, and USEPA officials anticipate that massive treatment plants of the kind envisioned by the city officials will not be required for all, or even very much, storm runoff. Instead, state and federal officials are looking at less expensive measures like erosion control, berms and settling basins that would clean up stormwater before it is discharged into public streams.

San Francisco, for example, is capitalizing on its antiquated combined sewer system, which mixes storm flows with regular sewage. While such systems have had the potential of spilling raw sewage into streets or waterways during heavy rains, San Francisco is in the midst of a massive project that will eventually allow pollutants to be removed from both sewage and storm water at city treatment plants.

The issue of who would pay for cleanup efforts has not been resolved. The cost issue alone would make the USEPA's group-permit concept unworkable, since municipalities would never be able to agree on how to share costs for cleanup.

Every city is unique in terms of its geographic location, in terms of the amount of rainfall, the frequency of rainfall. It is difficult to obtain a representative sample of cities' pollution. Forming assessment districts to help pay the bill would be difficult. Would cities, for example, be allowed to bill a garbage owner who washed battery acid down the gutter or a homeowner who used too much fertilizer? If so, how much should they pay? And even after we figure out how to treat the stormwater and who should pay, we must find what to do with the pollutants removed from the stormwater. These are some of the issues which USEPA must address to over the next two years.

AGRICULTURAL RETURN WATER

Agriculture has been basic industries in United States. An estimated 85 percent of freshwater consumed in U.S.A. goes to agriculture. In 1975 U.S. withdrew 222 cubic kilometers a year (160 billion gallons per day) of freshwater for agricultural uses. By reason of volume and geographic relationships, agricultural return flow appear as wastewater streams separate from domestic, municipal and industrial streams. Soil particules, soluble earth salts, fertilizer residues and pesticide residues generally comprise the spectrum of possible "waste" materials in irrigation return water.

Concern on agricultural return water are nitrates from fertilizers, which can cause "blue baby disease", nutrients and trace toxic elements from pesticides. Unlike industrial wastewaters, management of waste inputs at the source is infeasible. Therefore, quality management in the past has involved a simple ignoring of the problem. Federal policy makers has exempted agricultural return water from USEPA jurisdiction.

The use of agricultural pesticides in the United States has risen from 200,000 pounds per year (90 tons per year) in the 1950s to 1.1 billion pounds a year (500,000 tons a year) in 1986. Although many new pesticides are less persistent and more specific than the old DDT-like compounds that lasts for decades and kill species indiscriminately. Some are also more mobile, more water soluble and more acutely toxic. They leach into ground water, endanger those who work in sprayed fields and leave residues on fruits, vegetables and grain despite washing and processing. The dangers are considered so grave that U.S. Environmental Protection Agency has not catapulated pesticides to the top of its list of problem pollutants - above toxic wastes. In 1972 the USEPA was required by the Federal Insecticide, Fungicide and Rodenticide Act to reanalyze the impact on health and the environment of the 600 active ingredients in 50,000 pesticides approved for use before 1972 [3].

The USEPA is now turning its attention to the insidious problem of contaminated ground water. The conventional wisdom once was that pesticides would be degraded in the soil or evaporate away. Not so. In May 1986 the USEPA reported that 17 pesticides have now been found in the ground water of 23 states. In agricultural states the score is worse. Some 1,473 wells in California's Central Valley yield water unsafe for drinking, bathing or cooking because their levels of DBCP (Dibromochoropropane) used against insects. Trace toxic elements in agricultural pesticides are not only contaminating ground water, but also are being carried to the downstream river and bay through agricultural return waters. Due to the chronic toxicity posed by persistent toxic substances in the stream and bay environment, the threat of long-term ecological and human health effects does exist. But confounding variables and slow, subtle nature of these effects makes documentation very difficult.

SUMMARY

The Maximum Contaminants Levels (MCLs) are likely to influence more than drinking water as U.S. Environmental Protection Agency, states, and the courts use them officially or unofficially as standards for cleanup of hazardous-waste sites, groundwater contaminants, or regulating municipal and industrial discharges, urban and agricultural runoff, landfill operations, water reclamation and ground water recharge projects. It appears that these toxic substances to which the MCLs are being developed are mostly derived from industries, agricultural operation and urban runoff.

Industry appears to be the sources of the greatest number of toxic materials derived from the production and use of chemicals. Irrigation return water may be a source of nitrogen compounds and pesticides residues. Probable sources of the metals and organics in urban runoff are gasoline, and other fossil fuel combustion, metal alloy corrosion and other automobile related activities, pesticide application and water chlorination practices (for chloroform only).

Essentially all of the existing municipal sewer systems in U.S.A., Europe and other parts of the world today were designed to transport domestic and industrial wastewater together in a single pipe to the municipal wastewater treatment plant. In order to prevent these toxic chemical substances from being discharged into municipal sewer sys tems, USEPA in accordance with Section 304(f) of the Federal Water Pollution Control Act Amendments of 1972 developed National Pretreatment Standards, Federally enforceable, and Pretreatment Guidelines to assist states and municipalities in developing local pretreatment requirements. Under pretreatment program, each industrial user is required to obtain a permit from local sewer districts prior to discharging directly or indirectly to the public sewer systems. Currently many thousands of synthetic organic compounds are being manufactured at an accelerated rate. No one knows the long term human health and environmental effects of these synthetic organic compounds will be. Heavy metals and other toxic materials from industrial wastewater have been the main environmental and human health concern on reuse of sludge and reclaimed water from municipal treatment plants. Installation of a separate sewer to carry industrial wastewater to industrial wastewater treatment plant would minimize these problems. Domestic wastewater is non-toxic whereas industrial wastewaters contain toxic substances. Conventional municipal sewage treatment facilities are not designed for effectively removing toxic substances in industrial wastewaters. In developing countries where there is currently no existing sewerage systems, installation of an industrial sewer independent from domestic sewer would be worthwhile issue to be evaluated carefully. It may be beneficial to locate municipal wastewater treatment plant and industrial wastewater treatment plant side by side from operational stand point of view.

Enactment of federal legislation to protect the nation's ground water

supplies is urgently needed. The new legislation should also require industries to disclose which chemicals are being discharged from their facilities; establishes restrictions on the use of pesticides; establishes guidelines for local governments to identify, study, design solution for cleanup past sources of contaminations.

There is a need for greater inter program coordination between dischargers and water suppliers. Closer interaction among facilities sharing common water bodies would benefit both sides. It would be helpful if suppliers had evidence that their drinking water supplies were being threatened by upstream dischargers and conveyed that information to the upstream dischargers.

Table 1. Drinking water Standards

Contaminant	Maximum contaminant level, mg/l unless otherwise noted	
	EPA National Interim Primary Drinking Water Standards	EPA National Secondary Drinking Water Standards[a]
Chemical contaminants		
Arsenic, As	0.05	-
Barium, Ba	1.0	-
Cadmium, Cd	0.010	-
Chloride, Cl	-	250
Chromium, Cr	0.05	-
Copper, Cu	-	1
Fluoride, F		
50.0 - 53.7 F[b]	2.4	-
53.8 - 58.3	2.2	-
58.4 - 63.8	2.0	-
63.9 - 70.6	1.8	-
70.7 - 79.2	1.6	-
79.3 - 90.5	1.4	-
Foaming agents as Methylene Blue Active Substances	-	0.5
Hydrogen sulfide, H_2S	-	0.05
Iron, Fe	-	0.3
Lead, Pb	0.05	-
Manganese, Mn	-	0.05
Mercury, Hg	0.002	-
Nitrate nitrogen, N	10.0	-
Selenium, Se	0.01	-
Silver, Ag	0.05	-
Sulfate, SO_4	-	250
Zinc, Zn	-	5

Pesticides		
Endrin	0.0002	-
Lindane	0.004	-
Methoxychlor	0.1	-
Toxaphene	0.005	-
Chlorophenols		
2, 4-D	0.1	-
2, 4, 5-TP	0.01	-
Color, color units	-	15
Corrosivity	-	Non-corrosive
Odor, odor threshold number	-	3
pH, units	-	6.5-8.5
Total dissolved solids	-	500
Radioactivity		
Gross alpha activity, pCl/l	15	-
Gross beta activity, pCl/l	50	-

[a] National Secondary Drinking Water Standards, proposed on March 31, 1977, are intended only as guidelines to protect the esthetic qualities of drinking water

[b] Annual average of maximum daily air temperature

Table 2 USEPA Standards for Volatile Organic Chemicals in Drinking Water

Chemical	Final RMCL (µg/L)	Proposed MCL (µg/L)
Trichloroethylene	0	5
Carbon tetrachloride	0	5
Vinyl chloride	0	1
1,2-Dichloroethane	0	5
Benzene	0	5
1,1-Dichloroethylene	7	7
1,1,1-Trichloroethane	200	200
p-Dichlorobenzene	750	750

SOURCE: U.S. Federal Register November 13, 1985 Issue.

Table 3. Proposed RMCLs for Chemical and Microbiological Parameters

Parameter	Proposed RMCL (mg/L*)
Inorganic chemicals	
Arsenic	0.050
Asbestos	7.1×10^6 long fibers/L
Barium	1.5
Cadium	0.005
Chromium	0.12
Copper	1.3
Lead	0.020
Mercury	0.003
Nitrate	10
Nitrite	1
Selenium	0.045
Synthetic organic chemicals	
Acrylamide	0
Alachlor	0
Aldicarb (including two by-products, aldicarb sulfoxide & aldicarb sulfone)	0.009
Carbofuran	0.036
Chlordane	0
cis-1,2-Dichloroethylene	0.07
Dibromochloropropane (DBCP)	0
1,2-Dichloropropane	0.006
o-Dichlorobenzene	0.62
2,4-Dichlorophenoxyacetoc acid (2,4-D)	0.07
Epichlorohydrin	0
Ethylbenzene	0.68
Ethylenedibromide (EDB)	0
Heptachlor	0
Heptachlor epoxide	0
Lindane	0.0002
Methoxychlor	0.34
Monochlorobenzene	0.06
Pentachlorophenol	0.22
Polychlorinated biphenyls (PCBs)	0
Styrene	0.14
Toluene	2.0
Texaphene	0
trans-1,2-Dichloroethylene	0.07
2-(2,4,5-Trichlorophenoxy) propianic acid (2,4,5-TP)	0.052
Xylene	0.44
Microbiological parameters	
Giardia	0 organisms
Total coliforms	0 organisms
Turbidity	0.1 nephelometric turbidity unit
Viruses	0 organisms

* Units of measure are milligrams per litre unless otherwise specified.

SOURCE: U.S. Federal Register November 13, 1985 issue

RMCL - Recommended Maximum Contaminant Level

MCL - Maximum Contaminant Level

Table 4. Summary of water quality criteria and drinking water standard exceedances for pollutants detected in at least 10% of NURP samples: percentage of samples in which pollutant concentrations exceed criteria.[a] (2)

Pollutant	Frequency of detection (%)	Detections/samples[b]	Criteria esceeded (%)[c]						
			None	FA	FC	OL	HH	HC[d]	DW
I. Pesticides									
3. α-Hexachlorocyclohexans	20	16/79						11, 19, 20	
5. γ-Hexachlorocyclohexane (Lindane)	11	8/72			10			0, 11, 11	
12. α-Endosulfan	13	5/40			13				
II. Metals and Inorganics									
22. Antimony	14	10/71		x					
23. Arsenic	58	30/52						58, 58, 58	2
25. Beryllium	17	10/59			10*			17,17,17	
26. Cadmium[e]	55	31/56		9	55		2		2
27. Chromium[e,i]	57	26/46		x					
28. Copper[e]	96	52/54		50	87				
29. Cyanides	16	7/44			14				
30. Lead[e]	96	43/45		27	96		62		62
31. Mercury	16	9/56			16		16		
32. Nickel[e]	48	27/56			9		30		
33. Selenium	19	10/53			8		17		17
34. Silver[e]	12	7/58			12*				
35. Thallium	10	6/58					2		
36. Zinc[e]	95	56/59		12	78				
IV. Halogenated aliphatics									
47. Methane, dichloro	10	2/20						10,10,10	
51. Methane, trichloro-	12	9/76						7,12,12	
VII. Phenois and cresols									
94. Phenol, pentachloro-	15	12/82		1*	9*		1		

(continue, Tab. 4)

Pollutant	Frequency of detection (%)	Detections/samples[b]	Criteria exceeded (%)[c] None	FA	FC	OL	HH	HC[d]	DW
VIII. Phthalate esters									
105. Phthalate, bis (2-ethylhexyl)	13	7/54			13*				
IX. Polycyclic									
117. Fluoranthene	10	8/81	x						
120. Naphthalane	11	9/80	x						
121. Phenanthrene	12	10/81						12,12,12	
122. Pyrene	11	9/81						11,11,11	

* Indicates FTA or FTC value substituted where FA or FC criterion not available (see below).

[a] Based on 86 sample results received as of 7/31/82, adjusted for quality control review. Fifteen cities reporting.

[b] Number of times detected/number of acceptable samples.

[c] FA = Freshwater ambient 24-hour instantaneous maximum criterion ("acute" criterion)
FC = Freshwater ambient 24-hour average criterion ("chronic" criterion)
FTA = Lowest reported freshwater acute loxic concentration. (Used only when FA is not available.)
FTC = Lowest reported freshwater chronic toxic concentration. (Used only when FC is not available.)
OL = Taste and odor (organoleptic) criterion.
HH = Non-carcinogenic human health criterion for ingestion of contaminated water and organisms.
HC = Protection of human health from carcinogenic effects for ingestion of contaminated water and organisms.
DW = Primary drinking water criterion.

[d] Entries in this column indicate concentrations above the human carcinogen value at the 10^{-5}, 10^{-6} and 10^{-7} risk level, respectively. The numbers are cumulative; all those at 10^{-5} are included in those at 10^{-6}, and all those at 10^{-6} are included in those at 10^{-7}.

(continue, Tab. 4)

[e] Where hardness dependent, hardness of 100 mg/l $CaCO_3$ equivalent assumed.

[i] Different criteria are written for the trivalent and hexavalent forms of chronium. For purposes of this analysis, all chromium is assued to be in the less loxic trivalent form.

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WATER SUPPLY IN RURAL AREAS

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The critical water issue in rural areas throughout the developing world, the provision of an adequate supply of safe water, was highlighted by the designation of 1981-90 as "The International Drinking Water Supply and Sanitation Decade." In Asia, Africa and Latin America, only 30-40% of the rural population has access to an adequate supply of safe water, and the proportion of the rural population served with water in the home is far lower. The situation in the PRC is highly variable, with people in rural areas in some provinces being relatively well served, while people in other provinces must carry water, often of poor quality, long distances to their homes. In the PRC, responsibility for meeting the goals of the Decade rests with the Central Patriotic Health Campaign Committee (CPHCC), and similar committees at provincial, county and local levels.

The reason for focusing on rural water supply is that its role is so important in the life of the people. The provision of an adequate supply of safe water provides the following benefits.

Benefits of Piped Water

Prevention of Water-Borne Diseases:

In most rural areas of the world diarrheal diseases, such as cholera, typhoid and dysentery, are commonplace and account for high infant mortality rates. In the PRC, the practice of boiling water used for drinking protects against such diseases, but not diseases that result from chemical pollution; fluorosis, for example, afflicts about 45,000,000 people in the rural areas of China.

Prevention of Water-Related Diseases:

Schistosomiasis is an example of a water-related disease that is endemic throughout much of the developing world, including China. While programs for the control of the snails, which are intermediate hosts, have been successful, particularly in China, the provision of a proper water supply serves to reduce exposure to infested waters which has been shown to reduce the prevalence of the disease.

Improvement in Delivery of Health Care:

Safe water is needed in health clinics, for the ministration of medicines and as a tool for proper health education,

Service to Institutions:

Water is essential for schools and other community facilities.

Time Released for People in the Household:

In almost all other countries of the world, the burden of carrying water to the home falls on women and children. In the PRC, it is good to find men sharing the burden. (That may be why the rural water supply program in the PRC is so much more successful than elsewhere in the world.) The time spent carrying water, from 2 to 5 hours per day per household, can be used far more profitably for other enterprises.

Household Irrigation and Animal Watering:

A public water supply in a rural community can serve to irrigate crops especially those that are eaten raw, and be used for watering animals. Piped water in a rural household may be used for irrigating family gardens and watering family animals.

Support for Other Sectors:

A public water supply enhances prospects in other sectors such as housing, commercial development and industry.

Improved Quality of Life:

"Running water is happy water" is a phrase often heard in rural homes that have just been provided with piped water. Piped water, along with electricity, is highly prized in rural communities for the improvement in the standard of living that it provides.

Rural Water Supply Programs

Considerable efforts have been made over the last 40 years to assist rural communities in the developing countries of Asia, Africa and Latin America in the provision of adequate and safe water supplies. The World Health Organization, the United Nations Development Program, UNICEF, the World Bank, the Asian Development Bank, bilateral development assistance agencies of industrialized countries such as CIDA of Canada, GTZ of Germany, ADAB of Austràila , private organizations such as OXFAM and CARE, and religious organizations have made grants and loans for rural water supplies and provided technical assistance in the execution of the programs

The assistance programs have made some impact but in general they have not been nearly as successful as would be expected from the considerable sums invested. The reasons are many:

1. The initiative for the village water programs has been at the national level. Decisions as to which communities are to be selected for water supply systems, and the levels of service to be provided (public hand pumps on wells, public standposts on piped systems, or connections to the household, either in the yard or the house) are determined in some ministry in the nation's capital, with the villagers having little input in the decision.

2. Water has been assumed to be a free commodity, and householders initially were not expected to pay anything towards construction of the facility or its operation and maintenance (O&M). This situation has begun to change, and the trend now is towards collecting enough from those served to pay for O&M. Attempts to collect enough to recover the costs of construction are hardly ever made. This means that loans have to be repaid from the national treasury. In poor countries such loans, even when made at very favourable rates, become essentially grants. Therefore, the level of investment in rural water supply depends entirely upon the level of grant assistance, and programs collapse when the assistance ends. Furthermore, no matter how great the assistance from foreign donors and no matter how great the contributions from national treasuries, rural water supply programs cannot be expected to be variable unless those being served are responsible for providing a substantial portion of the funds required for the water supply systems.

3. The failure to collect funds from those served precludes obtaining adequate funds, and also gives the general impression that the water is free. What is free seldom earns respect. Water is wasted, leaks are not repaired, and much of the water produced at high cost is unaccounted for. The system becomes inadequate, service deteriorates, and customers are then loath to pay anything for the service

4. Rural projects have been characterized by lack of community participation, and this has been identified as the principal reason for failure of projects in the long term. Local residents, in addition to being involved in the decision-making, can reduce the costs of the project by providing some of the labor required for construction, particularly in trenching and the laying of pipes. more important, the community must be involved in the O&M, because O&M is not readily accomplished by remote control. Accordingly, along with construction of the facilities, the training of local personnel in routine operation and maintenance and the establishment of an organization for management of the system can help overcome the major constraints to sound performance of projects.

China's Rural Water Supply Program

China's village water supply projects have avoided many of the problems so common in other parts of the world. Visits in Quandong and Zhejiang provinces and in the Beijing-Tianjin region have demonstrated that villages have taken the initiative in procuring their water supply systems, have sought technical help from county offices, and have succeeded in keeping the systems operating satisfactorily by assuring adequate funds locally and by providing good operation. In large measure, this might be attributed to the fact that villages in China tend to be well organized, because the village is a production unit; the village organization serves many purposes and is available when villagers establish that water supply is their next priority for the village.

Moreover, the World Bank has made a loan for village water supplies to the PRC through the CPHCC. The loan is expected to provide water supply systems for about 4600 villages in 25 counties in Liaoning, Shanxi, Sichuan and Zhejiang provinces and the municipality of Beijing. This will provide water for only about 6,000,000 people of a total population of 800,000,000. However, funds are allocated to provincial banks for the establishment of revolving funds so that money collected from operating systems will provide finance for constructing water supply systems in other villages. The project will be successful only if repayment from the first round of villages permits financing additional rounds. The project has been assisted by the provision of training assistance from the Federal Republic of Germany.

The World Bank project has introduced some changes in the provision of water supply services which may affect practices in providing water to the more than 99% of the rural population not being serviced by this initial project.

The CPHCC, with the help of the World Bank, prepared a planning manual to provide guidance in estimating demands, selecting sources, treatment methods and sizing elements of the facilities, selecting from alternative solutions, providing personnel, etc. Design, construction and operation manuals are now in various stages of preparation. These manuals will assist provincial, country, and local officials in proceeding more rapidly with projects, achieving economics of scale, and reducing the numbers of different materials and equipment that need to be procured or to be stored as spares.

Competitive bidding has been introduced for construction of facilities. While this practice results in lower costs than when state agencies do the construction, the profit motive involved provides incentives for the contractor to save by using poor materials and low-cost construction methods that may be unsatisfactory. Hence, to attain the full benefits of this widely-used practice, the construction needs to be well supervised. Special provision needs to be made at the county level to assure that qualified personnel are available for this purpose. Assistance in such construction supervision might well be provided by specially selected personnel from the villages served. A useful practice is to have those who are to be employed for O&M of a water supply system involved in construction supervision. This profits by the self-interest of the individual who would like to avoid problems in O&M that result from poor construction, while serving to educate the individual about the facilities so a better job can be done when the operation begins.

Initially, water systems were to be provided for each village separately. However, efficiencies and economics of scale result from providing one system for villages located near one another and this practice, demonstrated in the planning manual, has been widely adopted.

One unforeseen impact of the rural water projects has resulted from the coincident new economic policy: the provision of piped water supply systems in villages in Liaoning has resulted in a 6-fold increase in the number of commercial and production enterprises. The provision of running water thus is seen as improving the quality of life in the community as well as for the individuals served.

While investment in rural water development proceeds, some issues are bound to arise. Among them are:

Level of Service

A water system that provides a piped service to every household is most costly. Lower cost levels of service include standposts in the streets, as is still common even in modern urban centers in China, and handpumps on public wells. In most developing countries, the lower cost options have been widely selected except where community involvement and provision for local payment for service is assured, in which case piped water into the homes, or at least the yards, is preferred. In China, most villages appear to have opted for piped water to the home, but this may need to be explored as water is brought into poorer villages.

Metering

In many village water projects, house meters represent a significant portion of the total cost. Nevertheless, meters are useful in encouraging household conservation and in establishing an equitable method for charging. Also, meters permit accounting for all water produced, thus enabling system losses to be identified and reduced. In many countries, where household meters are not used, or where they are used but not maintained and read regularly, unaccounted-for water often exceeds 50% of that produced. Metering needs to be examined.

Sanitation

The rural Chinese enjoy an excellent reputation for the management of their excreta and few foreigners would be bold enough to offer suggestions for improvement. On the other hand, night soil disposal practices are being threatened by the increasing popularity of chemical fertilizers which are so easy to apply. With farmers earning money from produce grown on their own plots, they are no longer so enthusiatic about the use of night soil, and other options for disposal may need to be considered.

Conclusion

The provision of piped water supplies for the villages of China promises improvement in health and the quality of life as well as increased economic productivity. If well managed, the water supply program will confer great benefits on the people of China while being a model for rural development in other parts of the world.

DAO/spd

WATER POLLUTION CONTROL IN THE UNITED STATES

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Water pollution has been a major problem in the United States for well over 100 years. It started as local problems that were handled at the local level; but soon grew to statewide problems and then interstate, national and international. Although the problems have increased with the passing of time, progress has been made in keeping water pollution under control. Progress has not come quickly nor has it come easily. Considerable effort and money have been spent over the past 100 years to arrive at the current level of control and much more needs to be done to provide the minimum level of control for an ever increasing population.

EARLY PROBLEMS

The early settlements grew up along the Atlantic coast and the ocean received most of the waste discharges from the early communities. As settlers moved inland, they travelled along the various waterways with the waterways providing the easiest mode of transportation, a source of drinking water and easy disposal of waste materials. Communities quickly learned that you collected your water supply upstream and discharged your wastes downstream. The self purification mechanisms in the rivers helped purify the waste discharges.

As cities grew and industries expanded, water pollution problems increased. Massachusetts was one of the first states to recognize that human health was being adversely affected by water pollution. Lowell and Lawrence were two major industrial cities in northern Massachusetts, located on the Merrimack River. Both cities derived their water supply from the river and both cities discharged their wastes back into the river. The distance between the two cities was only 9 miles apart, too close for much self purification. The Massachusetts State Health Department was reorganized in 1886 to focus on problems of water supply and water pollution. The major outcome of this reorganization was the establishment of the Lawrence Experiment Station in Lawrence, Massachusetts, to study the best methods to treat water for domestic consumption and to treat wastewaters to minimize river pollution.

The Lawrence Experiment Station was under the direction of Hiram F. Mills, an engineer. Dr. William T. Sedgwick of MIT assisted in the research in Lawrence. The research efforts, which started in 1887, showed that sewage filtration could greatly reduce the pollutional characteristics prior to being discharged into the nearby river. As the results of those studies were being presented in 1890, Dr. Sedgwick noted a rise in typhoid fever in Lowell and suggested that the situation be monitored very careful. The Lawrence Experiment Station was at the right place at the right time as they were able to demonstrate the transmission of typhoid fever from Lowell to Lawrence through the Merrimack River. The 1890-91 typhoid fever epidemic was one of the worst and demonstrated that the infection travelled to other communities downstream. With the direct transmission of disease by polluted water clearly established. The Massachusetts State Board of Health moved to require communities to construct wastewater collection and treatment systems prior to discharge to rivers.

Other states profited from the data generated at the Lawrence Experiment Station and began to pressure State Legislature for authority to take action requiring wastewater collection and treatment. Although the Kansas Board of Health recognized the problem, the State Legislature refused to take action. It was not until 1907 that the Kansas Legislature finally relented and allowed the State Board of Health to have the authority to license municipal water supplies and wastewater treatment facilities. One of the unique arrangements of the first water pollution legislation in Kansas was appointing a member of the Kansas University faculty as State Sanitary Engineer.

Research at the Lawrence Experiment Station and at MIT around 1900 helped set the stage for wastewater treatment and reduced stream pollution. As the treatment plants were constructed and placed into operation, typhold fever and other enteric diseases showed a steady decline until it was essentially eliminated by the 1930s. The Great Depression of the 1930s proved a boon for wastewater treatment as the Federal Government set up various public work programs designed to put people to work. Many water treatment plants and wastewater treatment plants were built or expanded with WPA funding. Although Federal funds were used for these constructions, control of water pollution remained at the State level under the State Health Departments.

MODERN DEVELOPMENTS

World War II disrupted the normal industrial development in the United States and created new industrial areas. Water pollution control facilities were neglected during the war except in the most critical areas. At the end of World War II the State Sanitary Engineers found they had a backlog of wastewater treatment facilities to be constructed. Part of that backlog was generated by the Federal war effort. Needless to say, the States felt that the Federal government should assist in helping pay for the new wastewater treatment improvements.

In 1948 the U.S. Congress passed the first water pollution legislation at the Federal level. Congress reaffirmed that water pollution control was basically a State problem and should be controlled at the State level. Congress also gave funds for university research and increased funding for the Environmental Health Center in Cincinnati, Ohio. The U.S. Public Health Service was charged with coordinating the Federal efforts with the States and to determine if the water pollution problems needed Federal assistance.

In 1953 Congress extended the act for an additional 3 years to develop new Federal legislation designed to meet the demands of the State Sanitary Engineers for Federal grants to stimulate local funding for wastewater treatment facilities. The State Sanitary Engineers felt that if the Federal government gave some grants for construction, the States could find it easier to obtain the remaining funds at the local level. President Eisenhower opposed the construction grant provision of the new legislation; but Congress passed the first permanent water pollution act in 1956 with a provision for $500 million dollars over the next 10 years.

Instead of stimulating construction, the initial funding simply resulted in a slowing of construction as every city wanted Federal funds. There simply was not enough money to meet the demand. In 1961 the Water Pollution Control Act was amended to increase the size of Federal grants and to increase Federal enforcement to all navigable waters as well as interstate waters.

Public dissatisfaction with the rate of progress in pollution control was recognized in Congress where it was proposed that water pollution control be removed from U.S. Public Health Service control and placed in a separate agency with the Department of Health, Education and Welfare (HEW). In 1965 the Water Quality Act established the Federal Water Pollution Control Administration with HEW and relieved the USPHS of responsibility for water pollution control. It was hoped that this administrative change would give greater emphasis to water pollution control. The amount of grant funds for a single project were doubled so that large treatment plants could receive the same percentage grant funds as the small projects. The Federal grants went from $600,000 to $1,200,000 for a single project with a limit of 30% of the total cost. The grant could be increased 10% if the treatment plant project was part of a comprehensive plan. More importantly, the Water Quality Act of 1965 required each State to develop water quality standards for all waterways. The water quality standards had to be approved by the Secretary of HEW. Unfortunately, the new Federal Water Pollution Control Administration was not prepared to assist all of the States in developing acceptable water quality criteria. Confusion and chaos resulted at the State levels as no one wanted to develop criteria that would not be acceptable.

To make matters worse, the Federal Water Pollution Control Administration was moved from HEW to the Department of Interior for greater emphasis on control of the environment rather than emphasis on health.

This change resulted in further loss of professional engineering leadership and greater control by lawyers and environmentalists without technical backgrounds. The States had been given a two year deadline to prepare the water quality criteria. The Dept. of Interior set the Guidelines for maintaining maximum water quality for all uses. Conflicts resulted in the Administration to try to develop River Basin criteria; but Senator Muskie felt the States that had started developing their criteria should not have to change directions and insisted that the original concepts be retained in the Water Quality Improvement Act of 1966. Federal grant funds were increased again. The FWPCA decided to produce a single set of guidelines and insisted that the States adopt them. Unfortunately, a single set of water quality criteria were not satisfactory for all 50 States. The FWPCA refused to adjust their criteria and it insisted that all States have approved criteria before the change in Administrations after the 1968 elections. This action created serious splits between the FWPCA and the State Sanitary Engineers. In an effort to change its image, the new Administration changed the name from FWPCA to Federal Water Quality Administration to put the emphasis on water quality rather than on water pollution. Image was more important than substance.

The most sweeping change in the Federal establishment came when the Environmental Protection Agency was established to replace the FWQA and to provide a single organization for all environmental pollution control. Because of the public sensitivity to environmental pollution in 1970, the EPA was placed directly in the Office of the President. In effect, water pollution control moved to the highest political level and has remained there for the past 16 years.

CURRENT CONDITIONS

PL 92-500 was passed by Congress in 1972 and set the stage for the current water pollution control regulations in the United States. PL 92-500 represented Senator Muskie's effort to produce a major change in water pollution control. It was not an easy piece of legislation to put together and to get passed. It covered far too many subjects that were difficult to understand and contained potential problems that have yet to be fully resolved. Young environmentalists attempted to have the legislation prevent the discharge of pollutants into rivers and streams. Instead, the legislation set prevention of the discharge of pollutants into natural bodies of water as a national goal. PL 92-500 set the mechanism for the NPDES permit system, requiring every municipality and every industry discharging wastewaters into natural bodies of water to obtain a permit for such discharge.

The NPDES permit required information of the complete chemical characteristics of the wastewaters and their volumes. Needless to say, the EPA was not prepared to handle the massive number of NPDES permit applications. For the most part, EPA supplied some funding for the State Water Pollution Control Programs and requested the States to process the NPDES permits. PL 92-500 required that each wastewater treatment plant meet the Best Practicable Technology (BPT) by 1977. For municipal wastewater treatment plants the initial goal was secondary treatment with BPT being 30 mg/L BOD 5 and 30 mg/L TSS with pH between 6.0 and 9.0. A fecal coliform standard was originally proposed at 200/100 ml; but no one had evaluated the amount of chlorine required to achieve the coliform level prior to its adoption as a standard. It did not take long to recognize that there was not sufficient chlorine available to meet the domands imposed by the proposed standard. Rather than admit that a mistake was made, the Administrator decreed that disinfection was a tertiary treatment process rather than a secondary treatment process. This chminated it from the NPDES effluent criteria except where fecal coliforms were found to be a health hazard.

Industrial wastes posed a greater problem for the NPDES permits than the municipalities. EPA found that it had to evaluate different basic industries to determine what BPT was at the present time. Contracts were given to a number of consultants to visit different industrial plants and to collect data on treatment plant operations. These data were evaluated and a report was submitted to EPA with recommendations for the proposed effluent quality. EPA published the reports and held public hearings to give all interested parties a chance to comment on the proposed effluent criteria before they were adopted. Afterreviewing the comments presented at the public hearings, EPA prepared the NPDES effluent criteria for each major industrial group and had it published in the Federal Register, making it official. The States then used the EPA effluent criteria to set specific limits on each industrial permit. Before the NPDES permit could be issued, the States were required to give public notice of the permit applications and request public comments by a specific date. If no comments were received, the NPDES permit was issued for a period of 5 years. The NPDES permit provided definite limitations for a daily average and a daily maximum for every major pollutant in the wastewaters as well as stating the frequency and type of sampling required by the industry. Each wastewater treatment plant was required to submit data on each of the specified pollutants every three months. Industries were given until 1977 to meet the effluent limitations of BPT and were required to meet the Best Available Technology Economically Achievable (BAT) by 1983.

To illustrate how the NPDES permit affected a small industry, I will use Royal Brand Roofing Company as an example. Royal Brand Roofing was a small industrial operation located in Phillipsburg, Kansas. Phillipsburg is located in northwest, Kansas, in a sparsely populated region. Its location was selected as it was about halfway between two major trade areas, Denver, colorado, and Kansas City, Missouri. Phillipsburg also had a small oil refinery that supplied the asphalt as a waste product which Royal Roofing used to make asphalt roofing singhles. The basic raw material for the asphalt shingles was waste paper which came from Kansas City or Denver. The waste paper was resuspended in water and converted into the paper felt for the shingles. The primary wastewater was produced in the felt mill and was discharged to a nearby stream. Because of a citizen complaint, the Kansas State Health Department requested that Royal Roofing treat their wastewaters prior to discharge. I was asked to design the wastewater treatment plant. Because the industry was quite small and did not have technically trained wastewater personnel, I designed a simple three state lagoon system to treat the wastewaters without complex operations. The treatment plant was actually constructed and placed into operations before PL 92-500 was passed. The EPA used data from this plant as part of its NPDES permit for felt paper industries.

The EPA NPDES permit criteria was published in the January 14, 1974, Federal Register. The criteria were for BOD5, TSS and pH. The BOD5 allowed for one day maximum was 3.75 kg/kkg product produced and the 30 day average was 2.5 kg/kkg product produced. The TSS were 3.9 kg/kkg product on a one day maximum and 2.5 kg/kkg product produced on a 30 day average. The pH had to be within 6.0 and 9.0

The State of Kansas requested public input regarding the proposed NPDES permit, allowing one month to submit information. Royal Brand Roofing received its NPDES permit effective November 14, 1974, for a five year period. All NPDES permits had to be re-evaluated and reissued every five years. The NPDES permit gave a definite pollutant discharge and indicated the desired data collection. Data were submitted quarterly.

It was January, 1981, before the NPDES permit renewal was requested; even though it was due in 1979. A fee of $30/yr was required to defray the cost of processing the permit. In January, 1981, the EPA published new regulations on the Best Conventional Pollutant Control Technology (BCT). The BOD5 allowed was lowered to 1.2 kg/kkg product for one day maximum and 0.74 kg/kkg for 30 maximum and 0.89 kg/kkg for 30 day average. Major improvements in treatment were expected of all plants.

Kansas prepared the new NPDES permit and requested public input in November, 1981. The new NPDES permit was issued December 23, 1981, for five years. The sampling frequency was increased to twice monthly; but no other major changes were made. The State Health Department staff visited the plant in 1984 and raised some questions about their NPDES permit. Several letters were required before the confusion was cleared and the State accepted the fact that there was only one discharge requiring an NPDES permit.

The NPDES permit system is in place and is working reasonably well even though the amount of paperwork and required reporting has increased significantly. Industries were required to meet the NPDES permits by 1977; but municipalities were given and extension to 1987 and now have been given a new extension to 1992. The problem lies with the Federal grant funds. Since no Federal grant funds were available to industrial waste treatment plants, the industries were forced to comply with the Congressional mandated time schedule even though it was not reasonable. Most industries have complied with the NPDES permit requirements. Municipalities resisted treatment plant construction until adequate Federal grants were available. Some municipalities are still resisting.

One of the important features of PL 92-500 was the increase of Federal grants to 75% of the project cost. The raise in the Federal grants was designed to insure compliance by 1977. Unfortunately, the Federal appropriations failed to meet the need for funds. Another set of factors also adversely affected the construction program. There were a limited number of qualified design engineers and construction companies with experience in constructing wastewater treatment plant. No one recognized that the mandated deadlines could not be met without a shift in resources from other areas. The increased funding attracted more design engineers and new construction companies. The new design engineers were not knowledgeable in wastewater treatment design and created some errors that limited the effectiveness of the treatment plants. The construcion companies also made some serious crrors. The increased paperwork overloaded the State agencies and the EPA. Improperly trained young people were hired and put into positions of responsibility without adequate training. As a net result more errors were made and many design errors passed unseen. The greatest error made by EPA was failure to recognize the lack of trained wastewater treatment plant operators. Limited funds were available for operator training. It was up to each municipality and each industry to train their own operators. At best, EPA required design engineers to develop design manuals to explain how to operate their systems. Unfortunately, design engineers did not know how to operate the wastewater treatment plants they designed. The design engineers hired other companies to write packaged operation manuals to meet EPA criteria and abdicated responsibility for operations. The net result is that many of the new treatment plants failed to meet EPA effluent criteria.

One of the problems that EPA and Congress perceived was that new technology was not being used fast enough. The 1977 Clean Water Act provided an additional 10% Federal grant above the 75% grant if the design used techniques that could be classified as Innovative and Alternative. The new designs could cost up to 115% of conventional systems and the EPA agreed to replace any systems that failed to meet effluent requirements. This concept resulted in disguising many conventional concepts as innovative and alternative to qualify for additional Federal grant funds. Equipment manufacturers also used this concept to propose untested concepts in the hopes that the new plants would supply the research data and save development costs. Unfortunately, little improvement in wastewater treatment plant design has resulted from I&A grants even though most of the grants were not failures.

A study by the General Accounting Office (GAO) of Congress found many municipal wastewater treatment plants were not meeting effluent criteria. By the end of 1979 there were approximately 18,000 municipal wastewater treatment plants in operation or under construction. The total Federal investment was estimated at $25 billion. A group of 242 plants were sampled randomly by reviewing the discharge reports submitted to EPA. In one year 87% of the 242 plants violated their permits with 31% of the violations classified as serious. In depth examinations were made of 15 seriously deficient plants. There 10 major design deficiencies and 9 operations and maintenance deficiencies. The basis problem was trying to do too much too quickly without adequately trained engineers, contractors and operators.

A change in political parties with the 1980 elections produced a major shift in water pollution control activites. The Republicans reduced funding for the construction grants programs and attempted to end all construction grants. Discussions between the Republicans and the Democrats prevented passage of amendments to the Clean Water Act. The operations continued on the basis of an annual extension of existing legislation. It was not unitl 1987 that the 1987 Amendments to the Clean Water Act were passed over President Reagan's veto.

The 1987 Water Quality Amendments provide for construction grants to continue through 1990 and then stop. In effect the Federal government hopes that the burden of providing wastewater treatment failities will return to the local level where the pollution is generated. A proposal has been made that States set up a revolving loan fund to assist communities needing to construct wastewater treatment facilities. Federal funds will be provided the states from 1989 through 1994 to establish loan funds. Communities will have to demonstrate that they have provided adequate user charge fees to cover the cost of operations and maintenance as well as for amortization of the wastewater treatment plant. Past efforts to force setablishment of suitable user fees have met with considerable resistance. As long as Federal funds were available, no one wanted to set up user fee structures that might penalize their users while other communities did not have adequate wastewater treatment plants or comparable user fee charges. It will be intersting to see what happens in 1990 and in 1994.

USER FEE CONCEPTS

Many cities have developed user fee concepts over the years; but they have not been universal. In 1978 California voters enacted proposition 13, cutting property taxes by 56% and reducing governmental expenditures at the State and Local levels. In order to survive, most wastewater treatment plant organizations were forced to develop user fees to cover their costs. Efforts have been made to develop user fees that reflect the actual costs of wastewater treatment operations, including future replacement costs. The user fees are established annually with adjustments in unit costs to reflect changes in the system. Annual changes are made so that adjustments are not too great and do not create sudden jumps in fees. Expansion of the sewerage system is done with a one time tap charge for connecting to the collector sewers. The tap charge is assessed against the properly since it serves a specific property and ramains a part of the property.

Financing wastewater treatment systems has provoked many different procedures. No one system has emerged as perfect or even as best. There are many different reasons for selecting a specific technique for a specific system. For the most part, the general concepts are similar, even if the specifics are different.

In order to produce a desired impact on the receiving waters, each wastewater treatment system is required to meet a specific effluent quality. While there are many different systems that can be employed, some system must be selected, constructed and operated. The wastewater treatment plant is designed for a specific capacity over a definite number of years. It is necessary that funds be raised to pay for the cost of initial construction, operations and maintenance and replacement costs. In the United States, Federal construction grants have paid a varying share of the initial construction costs. Local funds have paid for operations and maintenance. It is in the area of replacement costs that the problems have arisen and will continue to raised in future. It is important that replacement cost be considered as part of numal expenses so that funds are available for replacement at the end of the plant life.

The total annual cost of the treatment plant must be paid for by the users. Most communities use a single family residence as the basis of setting unit charges. User charges are on the basis of a single family living unit rather than the number of total inhabitants within the house. Since apartments have less people and less wastewater producing facilities, apartments are given a fraction of the single family residence. A single fraction is determinded for all apartments and used across the board. Commercial establishments are rated on their size and wastewater production with one value for size and one value for type of business conducted. Each commercial establishment has a single value based on the product of the two values. Industries are also classified on their size and their wastewater characteristics with each eatablishment having a single value factor related to their equivalent single family residence.

In the United States with wastewater treatment plants designed to handle a given volume of flow, a given amount of BOD5 and given amount of TSS costs are allocated to these three factors. If nutrient removal or disinfection is required, these factors are simple added on to the total cost function. The annual costs for treatment, based on flow, BOD5 and TSS, are prorated between the total number of equivalent single family residences served by the system to convenience of the users. Industries pay different levels of charges based on their specific wastewater characteristics. Industries are required to remove all toxic materials from their wastew prior to discharge into the sewerage system to prevent problems at the treatment plant. Industries which elect to pretreat their wastewaters prior to discharge to the sewer are given credit for that pretreatment by being charged only for what they discharge to the treatment sewer. Effective sewer service charges require the concept of equity and fairness for all parties. Public hearings are set each year on rates for the coming year so that the public can comment as well as be informed of th charges for the coming year. Everyone has the right to petition for a change in their charges if they feel the rates are unfair. Since the system serves a specific segment of the public, it is important that segment of the public is kept informed about "their" wastewater treatment plant. User service charges properly handled can create a greater public awareness of their own contribution to keeping the environment clean for everyone.

DISCUSSION

Considerable progress has been made in the United States in water pollution control since the first Federal legislation was passed in 1948. Unfortunately, the progress has not been as great as it could have been and the cost has been far greater than it should have been. This is the price that democratic societies pay for progress. Yet, we have learned some important lessons that can help developing nationas if they make an effort to learn from our successes and our failuures.

We thought that Federal grants could stimulate local activities. We found that Federal grants simply whetted the appetite for more Federal grants. The Federal grants came at a price. The Federal government demanded more control over the wastewater treatment plant design when they contributed more money. This was only natural. The Local government lost interest in the project as they contributed less monev. This, also, was only natural. The Federal government finally realized that no one at the Local level was willing to assume responsibility for the own pollution control unit they were financially responsible. This obvious lesson has taken over 35 years to be recognized. Federal grants have contributed much to the construction of wastewater treatment plants. Yet, if the Local government had faced its responsibility initially, better treatment plants would have been built at a lower cost. Water pollution is a local issue that must be resolved at the local level with pressure from the Federal government.

We found that problems are created when Congress set deadines without proper evaluation of available resources. It is essential to plan carefully and to adequately evaluate the task at hand and the resources available for reaching the desired goals. We used 5 year legislative mandates; but failed to work together before Congress passed the mandates. Environmentalists exerted undue pressure on Congress and the public with the development of unrealistic goals and timetables. PL 92-500 mandated municipal secondary treatment by 1977. We have not achieved that goal in 1987 and currently set 1990 as the next target. It is interesting that industries have come closer to achieving the desired wastewater treatment goals than municipalities. Industries were not given Federal construction grants to assist in building their wastewater treatment plants. They were simply given the mandated deadline. Municipalities waited for Federal grants before proceeding to build their wastewater treatment facilities. Since there were limits to the annual appropriations, progress was limited to the grant funding.

With limited funding it is important to plan carefully and construct the least costly facilities that will produce the greatest improvement first. It is impoortant to demonstrate that is is possible to produce improved water quality before trying to reach the highest degress of treatment. Collection sewers should be carefully planned to have adequate capacity for the area served without beging oversized. Good planning and sound engineering design take time. Hastily conceived projects tend to waste limited resources that cannot be wasted.

Operations of wastewater treatment plant requires trained personnel if the treatment plant is to produce the desired resuts. The Federal government failed to recognize that we lacked skilled operators for all the proposed wastewater treatment plants. A shortage of qualified operators was one of the major reasons why many wastewater treatment plants failed to meet their desired effluent quality. There is still a shortage of skilled wastewater treatment plant operators in the United States.

Improvement in wastewater technology lies in better eductiion and research. The progress in wastewater treatment in the United States can be attributed to recognition that basic sciences must be joined with engineering practice if better treatment plants are to be designed and constructed. Prior to 1948 wastewater treatment plant design was based on trial and error experimentation in the field. The Federal funding of university research in 1948 stimulated a shift from trial and error design towards development of fundamental scientific concepts which were blended with engineering to produce more efficient wastewater treatment plant designs.

With a better understanding of basic science has come simplicity of design as well as improved operational technology. Biological fundamentals predict exactly what reactions will occur and at what rate. Engineering showed how to go from the laboratory to field scale systems and how microcomputers could be used to make operations easier. In effect, better design and better operations makes the costs of operation and maintenance a minimum and maximizes the life of the equipment and the plant. The user costs are at their lowest level.

Wastewater treatment is the most critical service for society. Without wastewater treatment the pollutants from every person, every business and every industry are discharged into the environment where they must be stabilized or accumulate. As the population icnreases, the load on a given area of the environment exceeds the ability of the environment to assimilate the pollutants. Eventually, the pollutants will destroy the higher forms of life, leaving only the basic organisms to survice. It is not a choice of wastewater treatment or nothing. Wastewater treatment is a basic requirement for survival. We have the tools and the ability to construct and operate the wastewater treatment facilities. The question to be asked is whether we have the will to do the job. Those that face the callenge and build the treatment facilities will not only survive, they will prosper like never before. Those that chose not to face water pollution control will soon pass and be forgotten. The issues are simple. The future is ours to decide. It will be interesting to see which path we chose to follow.

CONCLUSIONS

The following conclusions can be drawn from a review of 39 years of experience in water pollution control in the United States.

1. Federal grants for wastewater treatment plants have assisted in the construction of a large number of treatment plants.

2. Federal grants shifted emphasis on wastewater treatment away from local responsibility.

3. Federal grants and Federal regulations appear to have slowed wastewater treatment progress in the United States.

4. Federal laws imposed unrealistic deadlines and provided massive funding that could not be properly handled, resulting in wasted efforts.

5. One must properly plan to handle the problems before passing legislation mandating specific changes.

6. Controlling water pollution requires accurate knowledge of all contributors, their loads and their points of discharge.

7. Construction of wastewater treatment plants requires careful design by competent engineers and construction by skilled personnel.

8. Operations of wastewater treatment plants requires skilled operators who understand how to achieve the maximum from their plants with a minimum of effort.

9. Education and research provided the basic concepts needed to improve wastewater treatment plant design and operations.

10. Water pollution control requires time and patience as well as resources to be successful.

11.. Water pollution control is essential not only for future development but also for simple survival.

OUTLINES FOR URBAN WATER RESOURCE ENVIRONMENTAL MANAGEMENT

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ABSTRACT

This article, from the actual conditions of Chinese present urban water resource environment, stresses that strenghening the management of urban water resource environment should be put in the first place in the following quite a long period and outlines the management of urban water resource environment from management system, legal system and scientific policy-making. It particularly introduces the scientific management and holds that water resource environment system is the combination of water resource system and water environmental system. Meanwhile, it points out that the availability and limitation of water resource environment systematic engineering should be solved in particular today on the basis of general research for systematic engineering of domestic water resource environment since 1970s.

I

At present, China's urban wastewater is directly discharg ed into medium- and small- sized rivers without treatment on the whole. A large amount of organic pollution and prominent heavy metal pollution have affected the quality of urban water environment and have polluted drinking-water resources, thus resulting in water resource shortage. In the meantime, overextracting undergroud waters have brought about water quality deterioration, water level drop and surface subsidence as well as underground water pollution. This is the major reason to exhaust water resources and deteriorate water quality in China's Northen cities.

According to the statistical data of 1985 in China's 324 cities, the total discharge of urban wastewater was 63 52 million tons per day, but we only had 51 sewage treatment plants with the capacity of 1.6 million tons per day, occupying 2.5 per cent of the total discharge of sewage, which slightly increased more than 1980 (discharge of sewage is 53.45 million tons per day, the capacity of sewage treatment is 2.1 per cent of the total), however it is still far from foreign countries who paied attention earlier to water resource environmental management. As sewage treatment plants need a huge sum of money (If the capital expenditure of sewage treatment is 350 yuan RMB per ton, a sewage treatment plant with the capacity of 50,000 tons per day should be invested 17 million yuan. Then the whole country shall invest 20 billion yuan.) and our existing financial ability and material resources are limited, it is impossible for our country to take a large sum of money to control water pollution and to improve environment. Therefor, we should put urban water resource environmental management in the first place.

Water resource environment is not a single technical problem, but a very complex system referring politics, economy, laws, aesthetics and other fields, subjects and different government departments. It is a powerfully comprehensive, regional, social and scientific system. We must strenghen water resource environmental management from management system, legal system and scientific policy making.

II

Urban environmental protection work in our country has begun to shift from single struggle and individual treatment by environmental protection departments to synchronous planning, total implementation and comprehensive realignment by those with urban construction departments under the unified leadership of municipal governments.

Cities, as big and relatively-centralized pollution sources and water-abstracting locations in the centre of whole riverbasins, should take into account not only the establishment of unified water resource environmental management organizations under the leadership of municipal governments, but also the relations with water resource environmental management organizations belonging to river basins.

Urban water resource environmental management organizations are responsible for organizing and coordinating every related-department in cities to work out the policy of "exploration of new water resources and conservation of the existing ones" and the planning of water pollution controls, to formulate the corresponding laws, regulations and standards, to implement water and wastewater control engineerings and to conduct urban water resource evaluations and the research work for water pollution control technology and other respects.

Urban water resource evaluations and its rational use, urban water pollution evaluations and its controls are a component part of riverbasin water resource environment under a city. Urban water resource environmental management organizations should be subordinate to the correspond -ing riverbasin management organizations. All water-qaulity plannings, laws, regulations and standards formulated by urban water resource environment management organizations should be restricted by those of the corresponding river basin management organizations.

III

Legal measures have more prominent position and more powerful function than technical and economic measures. The issue and implement of "the Environmental Protection Law of the People"s Republic of China"(Trail) and "the Water Pollution Law of the People's Republic of China" indicates that water resource management of our country has entered into a stage of legal system. Our existing laws, decrees, administrative regulations, standards, policies and etc. have begun to form law and regulation system. The problem now is how to take further steps to perfect and strenghen legal system from legislation and enforcement of laws.

As early as the year of 1885, Hungary had made the law to prohibit pollutants from being discharged into river courses. In 1917, France formulated "the Water Quality Law" making clear that sewage discharge must have the licences issued by governors of provinces. Australia laied down "the Clear Water Law" with 37 articles which made specific stipulations for penalty. Many countries in the world have made water laws before water environmental protection movements are flourishing. All this sufficiently shows that perfect legal system is of importance to water environmental protection. Compared with those of other countries, our existing "the Water Law" (including the rational use of water resources, overextracting underground water, drainage fees by consumers, pollution fees, water pollution prevention and controls, etc.) is not quite perfect. Some of the articles require to be revised. some need to be drew up, published and implemented.

Enforcement of laws is the guaranty of strengthening legal system. Unsevere enforcement of laws is the urgent problem to be solved at present. Besides its unperfect parts, our existing water law is unable to be implemented to a considerable extent. In some respects, so far we can not make clear the discharge of sewage for some major sources of pollution. In some places, we can not collect less than 50% pollution fees, to say nothing of restricting the discharge of sewage. Therefore, we must strenghen legal system management and strictly implement laws in the first place so as to guarantee the implementation of existing water laws and meanwhile progressively draw up new laws and revise existing laws and regulations.

IV

It is necessary to establish unitized urban water resource environmental management organizations to strenghen legal and economic measures and to carry out scientific management and scientific policy-making, i.e. systematically analyze water resource environmental system and build water resource environmental management models with systematology and system engineering methods.

System means the comprehensive system of independent and interdependent component parts (subsystem). It is the most complicated research object. Water resource environmental system can be regarded as the combination of water resource system and water environmental system. Water resource system includes water-circulating factors of riverbasins, i.e. rainfall, runoff, infiltration, evaporation and drainage, in which includes infiltration and drainage of underground water compensation. Water resource system analysis means the analysis for every essential factor of water circulation and mastering the relationship of water compensation and drainage, boundary conditions and varying laws of time and space. This is the hydrologic model including the hydrogeological model of underground water. Water environmental system covers water body, source of pollution, sewage discharge, water environmental pollution and water environmental calculation. Water pollution control system includes source of pollution, sewage transport and disposal, sewage treatment and quality of water body.

We should build water balance models for simulating, evaluating and calculating the variation of water capacity, water level, water quality and water temperature and build optimized models for planning, distribution and management on the basis of systematic analysis of water resource system and water environmental system. What is called scientific policy-making and scientific management is the coincidence of these two respects.

Around about 1960s, water resource environment systematic engineering had been attached great importance and widely used in the world-wide scale. Since 1970s, evaluation for underground water resources and research for comprehensive river pollution controls have been carried out successively in our country. Numerical value simulation methods and techniques have been popularized to some extent. In 1986, the three dimensional numerical value simulation of large area underground water (4,800 square kilometers in Huhhot Basin of Inner Mongolia) was accomplished for the first time in our country, with which Gen Bao water resource was discovened . The problem of water resource was solved in Huhhot city and a great breakthrough was made in this respect. From 1983 to 1985, the research for comprehensive water pollution controls of rivers or networks of waterways has been successively completed in our country and has been obtained gratifying achivements, such as the Yi Luo River(Henan), the Tuo River(Sichuan), the Xi River (Shenyang), the reach of canal in Hangzhou, the Huang Pu River, downstream of the Ya Lu River, the Xiangjiang River (a heavy metal polluted river in Hunan Province) and a network of inland rivers in Suzhou City, etc.(The two dimensional model was adopted by the Ya Lu River and the Xiangjiang River.The rest rivers used the one dimensional model.)

For the use of present water resource environment systematic engineering, the following two essential problems should been solved:

1. Availability: The planning of water resource environmental system should be based on urban overall planning and water and wastewater control engineering planning and be highlighted the availability of mathematic models in combination with the urgent need of urban construction and urban economic development so as to make it the scientific basis for water resource environmental management and policy-making. We may say that the method of water resource environmental system planning is ripe. Now the important problem is not to go on studying the method and

improving its accuracy, not to spend time in mathematic model itself, but to solve some concrete problems.

2. Limitation: Water resource environment is a extremely Complex dynamic system. Its mathematic model generalities, introduced assuming conditions and subjective factors of water environmental calculation cause a certain limitation for the planning of water pollution control system. Any model and systematic planning, whatever methods you use and however high the accuracy is, is a distance from objective things. Therefore, we must face the limitation of models, attach importance to the study of modelling generalities, introduced assuming conditions and water environmental calculation, and base ourselves upon short-term planning so as to make it reflet objective laws on the whole.

Water resource environmental protection work started later in our country. The present water pollution is rather serious and conditions of our work are limited. However, only by starting from the actual conditions of our country and grasping the management of water resource environment conscientiously from management system, legal system and scientific policy-making, can we completely control and progressively improve water resource environment.

Shanghai Shows How To Solve Its Water Pollution Problem

And What Problems It Has

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A. Historical review

Since 1980, Shanghai has been making major effort, expedited by tackling one of the key research projects listed in the Six*h Five-Year Plan (Water Pollution Control of Huangpu River) and by the work done by Sino-Australian cooperative team on water pollution control, and important successes have been gotten. These successes are closely connected with the changes in conception, progress in technology and science brought about by research and cooperation.

1. Changes in conception

1-1. Breaking the convention that the problems of control of pollution sources and treatment of municipal wastewater were solved separetely without taking the relation between them and comprehensive control of city's water pollution control into consideration.

1-2. Breaking the frame of taking Huangpu River as the receiving body of Shanghai's wastewater. Outlook was broadened and Yangzi River or Hangzhou Bay have been taken as receiving bodies of wastewater for Shanghai, since they have much large assimilation capacity than Huangpu. As a net result, the controversy over two options relating water pollution control for Shanghai was over. These two options took Huangpu River or larger water bodies such as Yangzi River or Hangzhou Bay respectively as the sink of wastewaster.

1-3. To discharge wastewater into Yangzi River or Hangzhou Bay is not impossible. They have much larger assimilation capacity than Huangpu has. Taking proper engineering measures makes it possible to integrate rational utilization of this assimilation capacity and environmental benefit together. Though domestic experts have suggested long ago, successes in foreign countries and the idea of foreign experts played important role in accepting these suggestions But to discharge wastewater into Yangzi River or Hangzhou Bay should be performed under certain conditions rather than random discharge.

1-4. Management is sometimes much more important than engineering measures. For comprehensive control, management and engineering measures are supplementing each other and depending on each other. Regulations on protection of upper stream of Huangpu River and issuing discharge permits are glaring examples of putting attention to management.

2. Progress in technology and science

2-1. Development and application of water quality models. Water quality models and physical models are tools for understanding the connection of hydrology, water quality of Huangpu River and the water pollution sources. By using water quality models, people can know the relation between the assimilation capacity under sertain water quality objective and the amount of pollutants that could be discharged. The use of water quality models makes it possible to know clearly that either the lower stream or the upper stream of Huangpu River will be overloaded even after secondary treatment of all wastewater if the treated wastewater is to be discharged into Huangpu River. Thus, the udnerstanding about the environmental features of Huangpu River is deepened which brings the controversy to an end and an unanimous option is obtained. This is very important and expedites the work of making the comprehensive control program for Huangpu River.

2-2. Development and application of functions of capital expenditure and cost of 0 & M
Introduction of economic consideration into the making process of water pollution control program is very important. Having had these functions, people can use computer to analyze and compare the economic aspects of options. Results show clearly the scale effect of treatment facilities: the larger the treatment facilities, the lower the capital expenditure and the cost of 0 & M for unit treatment capacity.

2-3. Optimization
The application of concepts of contemporary system analysis in tackling the keyresearch project of the Sixth Five-Year Plan, the combination of water quality models and functions of capital expenditure and cost of 0 & M make it possible to have the planning optimized on the basis of options developed each of these options is of multi-objective and provides solution to problems at different levels. What mentioned above has expedited the process of producing the water pollution control program.

2-4. The upgrading of means and the use of new techniques used in water quality analysis

For example, the use of AMES test makes it possible for people to get deepended understanding about the pollution situation of Huangpu River and the harmfulness which impels the government to make decision on water pollution control for Huangpu River. Owing to these means and new techniques, people get idea about the water quality objective and key problems in water pollution control for Huangpu River. The key problems are to upgrading the quality of water for drinking use and to upgrading the quality of water source. It is neccessary to move the water intake facility from where it is now to upper stream of Huangpu River, to prevent the water there from further pollution and to formulate laws and regulations such as the Regulation on Protection of Upper Stream of Huangpu River.

2-5. Theories and experiences in practice concernig ocean outfall have been introduced from foreign countries

With the theory and practice introduced from foreign countries, more and more knowledge has been obtained about dilution, dispersion, pollution field and assimilation capacity of larger water body. Tracing experiments have been made. The application of mathematical and physical models has brought light to objective laws governing dispersion pattern of wastewater discharged into ocean, cleaned people's mind of doubts about the discharge of wastewater into ocean. This is a breakthrough. As for the application of these theories, rather than the dilution ratio currently used as the critical parameter, the mixing zone cencept has been developed not only based on foreign experiences but also on the domestic conditions. This is pioneering work and could be useful to others who are working at the same area of environmental protection.

3. Cooperation

We are working on a particular problem making comprehensive planning for water pollution control. The problems concerning economy growth and development of the society, such as construction of harbors, transportation facilities, municipal works, public utilities, water conservancy and the problem of financing should be taking into consideration. This means that in order to do a great job on making comprehensive planning, cooperation of engineers and scientists of various disciplines is absolutely necessary, and the sincere cooperation between administrative and research units is especially important. If possible, international cooperation is also needed. This was a coordinated work of multidisciplines in wide area which made it possible to fulfil in the Sixth Five-Year Plan period the scientific research on water pollution control program for Shanghai. Universities, colleges and research institutions have contributed a lot. Cooperation between administrative and research units makes the application of the newest results of research to improving environmental management possible.

B. Existing problems

Though Shanghai does get important progress in water pollution control planning and in the implementation of this program, there is no boundary for progress, understanding should be deepened and there are still problems to be studied and solved.

1. It should be recognized that the progresses are of contemporary level, but another thing should also be recognized that for a long period of time, little attention has been paid to the accumulation of data and to statistical work, it was especially true for data needed in environmental protection. Water quality models, functions of cost or capital expenditure, linial planning theory and so on are tools only but nothing else. If there are not sufficient data, these tools can not help producing "good products" --- correct results which reflecting reality, and sometimes, the situation will even be worse --- people may be misled by incorrect results. The real difficulty is to get data without which the theory and the methodology imported can not be used in connection with the concrete situation in China. For example, water quality models developed on the basis of several times of investigation on hydrology and water quality might not be fully rational. To have some data is better than no data, but never be overoptimistic about this, otherwise mistake will be made. The important thing to do is to build monitoring network and system on the basis of careful consideration so that data can be collected and accumulated from day to day. This is a strategic task. As more and more newly collected data can be used for correcting and improving the existing water quality models, the longer the period of time in which the data are collected, the more correct the result from the water quality models. It is not true that the existing water quality models for Huangpu River are perfect and nothing is to be done with these models. On the other hand, if these models were perfect, they would not have reflected DO and BOD in Huangpu only but also other pollutants such as nonbiodegradable compounds. Peopel should be clear-headed.

2. Construction of the project of moving the water intake facility makes it possible to improve drinking water quality for people in Shanghai. But it is necessary to protect the water source. In order to protect the new water source, 40km of Huangpu (almost half of the length of Huangpu River) have been defined as protected zone or secondary protected zone. The area along this part of Huangpu River is not far from the heart of Shanghai and has convenient transportation facilities and energy supply, the problem with this area is that it is in the protected zone of water source, its development is strictly restrained. Economy development and environmental protection are in contradiction with each other, the solution to this problem is "to have the wastewater pretreated seperately in factories where wastewater is produced and to have the pretreated wastewater collected for dischar-

ging into Hangzhou Bay", as the research report stated. This means that each factory should be responsible for pretreatment before the wastewater is discharged into the collection system. This project and the project of moving water intake facility to upper stream of Huangpu River form a complete program for upper reaches of Huangpu River. The interceptor and outfall project should have been constructed soon after the project of moving water intake facility, but becourse of financing problem, it is not on the agenda of 7th Five-Year Plan, this is really a matter of regret. For Shanghai, there is another project --- the project of intercepting wastewater being discharged into Suzhou Creek. Though this is an event of practical significance, it costs Shanghai 1.7 billion Yuan of which only one fourth (about 100 million US dollars) is the loan from the World Bank. But the project of protection of upper stream of Huangpu River only costs some 500 million Yuan, which is a relatively small amount compared to that for Suzhou Creek project. At present time, Shanghai is short of money, the first thing to do is to improve the water quality for drinking use, so the project of protection of upper stream of Huangpu River should be given priority, and the construction of Suzhou Creek project should be postponed.

3. There is no doubt that the concept of comprehensive control of water pollution is correct, but the concept has not been accepted by municipal departments which have the view that they are responsible only for dealing with domestic wastewater, the city-owned sewer is for domestic wastewater, no industrial wastewater is allowed to discharged into this sewer. Following this principle, when they are going to build a pumping station or sewer, the discharge of industrial wastewater is not taking into consideration even the factory is near the sewer. Several years ago the Bureau of Environmental Protection and the Bureau of Municipal Engineering were under the jurisdiction of Shanghai Commission of Capital Construction, it was easier to have them coordinated. But now, the Bureau of Environmental Protection is under the jurisdiction of Shanghai Planning Commission, coordination of these two bureaus is not as easy as before. How the administrative system matches the needs of comprehensive control of water pollution is a problem to be studied.

4. With the development and implementation of the principle of comprehensive control, the principle of "the designing, construction and putting into operation of environmental protection facilities should be carried out at the same time with the main project" is developed somewhat. That is, heavy metals, nonbiodegradable substances, if there is any, should be removed in factories where these pollutants are produced. As it has been done so far for new factories and workshops, the designing, construction and putting into operation of facilities removing all kinds of pollutants are carried out at the same time with the new factories or workshops. Our idea is that for the

new factories or workshops where the biodegradable substances are produced, the fund needed for building facilities removing these substances should be included in the budget for the new factories or workshops, the designing, construction and putting into operation of these facilities can be carried out together with those for municipal sewer and wastewater treatment plant, this means that the factories can discharge their biodegradable substances directly into municipal sewer system and WTP, the municipal WTP treats the wastewater from factories, but the factories should pay cost of construction and cost of O & M of their share. Also, for area where new factories or workshop are going to be built and where there is municipal wastewater treatment plant, the only thing for the new factories or workshops to do is to pay O & M cost as the cost of using the existing municipal facilities but not to build wastewater treatment plant of their own. This may simplify the procedure and to reduce the work for the factories to do. But for area where the new factories or workshops are going to be built and where there is municipal wastewater treatment plant, if the new factories will produce wastewater containing heavy metals, nonbiodegradable substances as well as biodegradable substances, what they will do is to pay O & M cost for their wastewater containing biodegradable substances and to build treatment facilities of their own for removing heavy metals and nonbiodegradable substances before discharging the pretreated wastewater into municipal sewer.

5. With the progress of environmental protection course and strengthening the environmental management, environmental protection is one of the problems to be seriously considered by factories and any institutions. Beginning from 1987, the regulation on environmental impact assessment for new project is put into practice to prevent the harmfulness from happening, this is very important. But to complete an EIA or to design treatment facility takes longer time than to design the main project, because the conditions (data and others) are worse than that for the main project. There will be difference in the length of time meeded for completing the design of the main project and environmental protection facilities. The leading members of factories or institutions would have the design of both main project and the environmental protection facilitied needed for the main project finished at the same time so that they can construct and put the project and treatment facilities into operation earlier for increasing the benefit and paying back the loan as earlier as possible. How to reduce the difference is also a problem worth studying carefully for environmental protection agencies at different levels. EPAs should take the responsibility of properly carrying out the environmental management work, at the same time EPAs should be eager to help solving problems which the new factories are eager to solve. This should be one of the features of socialist system. This means that people responsible for environmental management should

improve their art of management, to have the work better organized. In order to express this idea clearly we would like to introduce an example. We are preparing an EIA for a project using imported technology. The environmental protection agency demands to do three times of investigation on hydrology and water quality for the sector of Huangpu River where the wastewater which will be produced in the production process of the proposed project is to be discharged. The investigations are asked to do for low flow, average flow and high flow periods. This will take at least one year. But this project is a project using improted technology, the time for us to prepare the EIA draft is only two months, if the draft can not be finished in two months the EPA will not approve this project, and the agreement with foreign company will not be allowed to sign but the agreement should be signed by the end of two months. Three times of investigation covering one year and to finish the draft within two months are asked to do by the same agency. This makes the institution preparing the draft of the EIA very embarrassed. If the EPA and environmental monitoring organization had data accumulated and kept collecting data needed for EIAs, it would have made the preparation of EIA much easier. So the research institute and monitoring organization attached to EPA should do this kind of job well to meet the needs of better environmental management. Priority should be given to this kind of job.

6. Emphasis must be placed on the point that to avoid doing the same thing at the same level again and again. This is the phenomenon which can be seen in carrying out environmental monitoring and data collection. EPAs, water conservancy departments, waterworks, municipal engineering departments, departments responsible for planning, designing and construction of harbors and even some bureaus or companies responsible for management of industries, and also research institutes, have their staff responsible for environmental monitoring, they may do the same thing separetely, or may repeat some jobs the other organization has already done before but there is no reason to repeat. The problem is how to form a monitoring system consisting of the existing monitoring teams or institutions, how to share jobs among these monitoring teams according to an all-round plan or arrangement,so that to have this problem solved.If so,the benefit of investment for monitoring will be increased, manpower will be saved and good conditions for Shanghai's water pollution control will be provided. The data collected and accumulated should be published in the form of yearbook or monthly for people to use. The present situation is abnormal. Environmental monitoring done by different institutions even though they are attached to different bureaus or departments, is financially supported by government, this means the fund needed is included in budget of the nation, but the collected data are regarded as "private property", as goods to be sold at high price. This situation is harmful to the interest of the whole nation and makes it difficult for people to do scientific research and to improve environmental management. To our knowledge, this situation seems much worse than that in advanced countries. It is understood that this situation is temporary situation and is to be overcome in the process of reformation. We hope the concerning departments make regulation for data exchange as soon as possible.

STRENGTHEN THE NETWORK OF ENVIRONMENTAL PROTECTION, REINFORCE THE ENVIRONMENTAL MANAGEMENT AND CONTROL THE ENVIRONMENTAL POLLUTION IN THE RURAL AREAS

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Rural industry developed rapidly in the past few years. Up to the end of 1986, there were 13,000 factories, falling into 11 trades, it was an increase of 67% of the number of the factories of 1978. Its total industrial output value increased from 5.46 billion yuan in 1984 to 12.4 billion yuan in 1986. At the same time, the peasents' average per capita income also raised from 500 yuan in 1984 to 700 yuan in 1986. In a word, the development of rural industry has provided a profound material base for rural economic take-off and for theconstruction of villages and towns. It has played an active role in solving surplus rural labour force and raising the peasents' living standard. The masses say: "We lived in thatched cottages and ate coarse food grain (maize, sorghum, millet, etc.) in 1950s; in the 1960s, the thatched cottages were rebuilt into tile-roofed houses while eating wheat flour and rice; while building a house a corridor was added in the 1970s and started taking into consideration architectural styles; how we are constructing two or three-storied buildings in the 1980s and paying attention to nutrition in food." It fully reflects that the people enjoy the benefits brought by the rural industry. But new problems as how to enforce the rural environmental management and how to control environmental pollution in the rural areas emerged as the rural industry develops. In recent years, we tried to establish networks, by stressing management, and launched pollution protecting work in the rural industry and have made some results. Therefore, although the gross output value of rural industry doubled and the drainage amount of waste keeps increasing, the water quality of over 85% of water area in six counties or cities (at county level) under the jurisdiction of Suzhou municipality still mantains at the third grade of water standard. The following is our knowledge of dealing with environmental problem.

I. Strengthening the network of environmental protection is the basic guarantee of enhancing the environmental management in the rural areas

In the early stage of the development of rural industry, there existed blindness in designating developing orientation, productive structure and distribution of industry due to the lack of experience of running enterprises in the vast rural areas. Moreover, some willages and towns and townships were so eager to increase production output value and gain profit that they neglected environment protection in running industry. As a result, the environmental quality in the rural areas worsens constantly. According to the statistics, of all rural enterprises in Suzhou municipality, 30% are polluted ones and 5% are seriously polluted, and they discharge 200,000 tons of waste water daily. It is very common that one factory pollutes a river and a chimney pollutes a stretch of land, pollution accidents often occure and farmers and fishermen often lodge complaint against pollution with local authorities because of highly despersion of rural industry, low level of management and poor technology. For instance, a water source of adjacent county was contaminated by the waste water discharged by the Wool Dyeing Mill of Baó Ji Cun, Yangse Township, Shanzhou County, and hundred mu of farm land was polluted by hydrogen fluoride discharged by the two Factories of Cold-Producing Medium run by Fu Shan Township of Changshu and Dongchiao Township of Wuxian County, respectively. Reality impels government at different levels and institutions of environmental protection to place the rural environmental management on their agenda. Though each county (or at county level) established a bureau of environmental protection, they were small and weak, there were only five or six people in each bureau. Therefore it is even hard for them to manage the environmental protection in the county seat towns and state and collective owned enterpriese, let alone the vast rural areas. Usually the situation is that the instruction from higher authorities cannot be implemented promptly, information cannot be fed back immediately and polluted accident cannot be handled promptly. No one checks the construction of three simultaneous projects (facillities for treating waste must be designed, constructed and put into production simultaneously with the main project), no one supervises the operation of waste treatment facilities. With the swift development of rural industry, reality proves that there will be no specially-assigned people taking charge of environmental protection; even though there are more laws and regulations, and much better measures, it is still impossible to carry them out. The present situation makes us determined to change the state of rural environmental protecting organs that there is only an organ in county government but no regular people in charge of environmental protection in rural areas. A document was issued by Suzhou municipality in May 1984, demanding that every township should allocate regular people in charge of environmental protection By September 1984, regular people in charge of environmental protection were allocated in 174 townships and towns of Suzhou municipality. On this base, offices or leading groups of environmental protection have been established in the townships. In some counties, groups of environmental protection have been set up in villages. Waste control groups have been set up in the polluted enterprises in most counties.

There are 2,300 people who are full or part time workers in charge of environmental protection, a network of environmental protection at county, township and village (enterprise) levels have come into being. As far as the environmental management in the rural industry is concerned, it is basically realized that the instructions from higher authorities are properly carried out and there are particular people in charge of detail measures.

Looking at the practice we experienced in the past two years, one can see that the regular people of towns and townships in charge of environmental protection is a main force in the network of rural environmental protection. Therefore, how to allocate them and make them play their roles is a key link of making a good job for the management of towns and townships environment. In this respect, we pay attention to following things. Firstly, allocating the environment protectors to meet the real condition. Our city is located on a water country land of the southern part of Jiangsu Province with a developing rural industry. According to concrete conditions, we make a decision initially that if annual industrial output of a town or township is more than 10 million yuan, or its daily waste water more than one thousand tons, a full-time environment protector should be appointed for the town or township. If yearly industrial output is less than 10 million yuan, and daily waste water less than one thousand tons, then there will be a part-time environment protector. If a town or a township yearly output is more than 100 million yuan, or daily waste water is more than five thousand tons, or its a combination of town and township, there will be two full-time environment protectors appointed there. In this way, appointment according to the actual situation, we do not treat all things in one way. Our methods are not only easily accepted by personnel department but also welcome by towns and townships. Secondly, selecting and engaging talented people. At the beginning, most of the environment protectors were recommended. As a result, those people were over age, less experienced, and with lower education. Being not competent at the job, some of them were replaced. All the counties under jurisdiction of Suzhou municipality got their lessons from this. They listed the prerequisites for selecting environment protectors. The document published by the authorized size commission and personnel bureau of Wujiang County demands that the educational level of the environment protectors of town and township had to be above middle school, they should be under forty, experienced, and with certain organizing ability. They should be recommended by town or township and approved by the environment protection department of the county. By these, we can sustain the quality of the environment protectors. 28 environment protectors in Wujiang County have been in their positions for 2 years. They are working hard and actively. In our city 44 environment protectors were praised by the city government. Thirdly, making clear responsibility and giving full play to activity. In order to give full play to the role of the environment protectors, the environment protection bureau listed ten clauses of responsibilities for the environment protectors.

A. Conscientious implementation of the laws, regulations and stipulations regarding environment protection.

B. Taking vigorous action to publicize the general and specific policies towards environment protection and spread knowledge of it.

C. To work out long-term environmental protection programme and yearly plan for towns and townships.

D. To find out the pollution condition area under their jurisdiction, and set up the pollution sources file.

E. To assist the higher level environment pretection department to give first check up to the report on environment affected by items of rural enterprises and accept three simultaneous projects.

F. To supervise and check management of the pollution controlling devices' operation , and put forward suggestion for rewards and punishments.

G. To assist the agrotechnicians to spread methods to tackle the pollution problems in a comprehensive way and promote the healthy circle of the agricultural ecosystem.

H. To collect charges for dealing with discharge of wastes in township according to regulations, and supervise the rural enterprises in their using the fund for controlling pollution.

I. To assist the higher level environment protection department to answer the people's inquiries and letters in time, and settle disputes and accidents relating to pollution.

J. To report to the higher level environment pretection department timely, and fulfil the tasks assigned by them.

We publish the responsibilities of environment protectors of town and township to the rural enterprises, and each protector has a paper of "supervising environment protection" given by us. In the area under their own jurisdiction, they can supervise all enterprises on environment protection without any obstruction. Because environment protectors' duty are clear and definite, and they are in full powers while they are at their posts, they played an active part in environment protection for the rural enterprises. A healthy state appeared. For instance, the education on environment protection was further promoted, information fed back quickly, pollution controlling speeded up, environmental management strengthened, the disputes between enterprises and people handled in time. According to the approximate statistics, in propagating the environment protection in 1986, the environment protectors in all the towns and townships, organized broadcasting for 213 times, published 363 issues of blackboard news, showed 119 slides, organized enterprises to subscribe 4,900 copies of the newspapers China Environment Report, 1000 copies of Environment Report published by Jiangsu Province. We also have done something in pollution control and environment protection completed 293 pollution controlling projects. The total investment was 6.84 million yuan. We applied the policy of "three simultaneous projects" to the new construction, renovation and extension projects. We gave preliminary check up on 380 projects, 188 projects of them have carried on the policy of "three simultaneous projects", which account for 50%. Last year, the environment protectors of town and township handled 97 cases of the pollution accidents and gave answers to 640 letter. So that they were praised by people as "mediator helpful to people".

II. A breakthrough made by each trade is the important way to control the pollution by rural enterprises.

The network of environment protection of town and township has been amplified, the ranks of the full-time and part-time environment protectors are growing steadily. But we are facing the problem of how to control the pollution made by the rural enterprises. Through the practice we feel the rural enterprises are numerous, many pollution cases are waiting for treatment, while our technical level is low, and our finances are not enough for the treatment of all the pollution cases, we should not treat them all at once in all circles. If we issue orders and do not give concrete instructions, not only will we have an over-extended battle line, but also we make a gesture to give the people the impression of doing something on environment protection and actually we do nothing, as a result we'll waste manpower and material resources. Basing on this idea, we use the method of "making focal points stand out, making breakthrough by each trade" to control pollution. If we do some jobs, we'll do it well and we'll consolidate our achievements and clean away any "sequelae".

First of all, we started our work in electroplate industry. Because this industry is seriously polluting, the people have a lot of complaints about it. Some electroplate factories' waste water seept into the ground and polluted wells. The chronic acid fog exhausted by the factories endangered the crops in the nearby field. For this reason, the factories also feel pressured from the masses. On the other hand, the technology of treating the waste water of electronplate is fairly sophisticated. The factories owned both indigenous and foreign methods. So that, a decision of coordinate actions of our city was made to concentrate our energy to eliminate this pollution.

We divided the eliminating of the pollution in the electroplate industry into four steps. First, we reached a common understanding, shifted our mind from "I was asked to do something to control the pollution" to "I do want to do something to control the pollution."

When asked by the environmental departments to bring the pollution under control, people in electroplating industry have different reflections, which can be concluded as three points, First is to take the attitude of wait-and-see and none is willing to do it before another; Second is to rely on the environmental departments for everything; third is to seek investment and material from the higher organizations. Therefore, we held the special meeting called "Comprehensive Prevention and Treatment of Electroplating Waste Water" and all the leading members of the same factories joined in. At the meeting, we studied some documents concerned, presented the bare truth of the pollution, discussed its and clarified the responsibility, thus knowing very well that preventing and dealing with the pollution is the bounden duty of our enterprises. Most people said

"Now we fully realize the harm of the pollution to our society and we must control it rather than what we thought before as wastes from the production was unavoidable and its discharge reasonable". Some factory directors uttered that the enterprises at county or township level are the socialist ones as well. They said, "We can't concentrate ourselves only on money-seeking at the expense of our coming generations," thus building up a fairly good ideology of who makes pollution who has to solve it and bringing into full play the enthusiasm of the leading members of the enterprises in doing a good job in electroplating waste water treatment. The second step to be taken is to pay close attention to prototype, train the key members of the enterprises. It must be pointed out that it is the obligation for the environmental departments to give directions and act as an intermediary in the process of treatment just because the county-and-township-run enterprises are weak in technology and badly in need of the knowledge for prevention. In order to grasp the first-hand information to give better specific guidance, we selected two electroplating factories as experimental units, lay much stress on treating waste water with chromium and cyanagen content. In technical treatment, we adopted the measures of using less investment, easy management, simple equipment with reduction and oxidation. At the same time, we helped those two factories to set up the organizational system of the environmental management. So someone in factory leadership was assigned to the supervision work, someone taking a special care in management and there were records made for the running of the equipment. On this basis, we also sponsored the training class for the people in charge of treatment at the factory level and pass on the specific methods to them. The third step to be taken was to treat by stages, in batches and within a definite time. First of all, according to the requirements set by the City

Environmental Protection Bureau on the complete treatment of electroplating factories by three stages in a year, the environmental protection bureau in each county would make a list of factories which had to under go time-limit treatment then the city bureau would issue the documents to the factories for treatment and held a on-the-spot meeting for the factory leading members and other people on the list of the first-batch ones. During the meeting, the experimental factories or units introduced the treatment experience of suiting measures to local conditions, getting on the job with local methods and building the factories of their own, improving the work step by step and, in a specific way, introducing the methods of treating hexad-chromium and cyanide as well as the daily managerial measures so that everyone could not only learn the managerial methods but also build up confidence in treatment. The city bureau checked and accepted when the treatment period was over. If they failed to reach the standard they would be forced to stop production, For example, one electroplating factory in Wuxian county was found to still surpass the standard of hexad-chromium and was ordered stopped for treatment. It was not until when it was checked and approved by the county environmental protection office that it could start production again. What is more, we circulated a notice of it to all electroplating factories or units and it provoked a great shock. After more than a year of hardworking, about 130-odd factories had erected the devices for treatment with cyanagen and hexad-chromium up to the standard of discharge. The fourth step to be taken was to issue the certificates, draw up the rules and regulations to gradually develop achieved success. For consolidating the accomplishments of the treatment and improving the quality, we have formed up the system of check, awards and fines. At first, the people responsible for environmental protection both at county and township level, generally speaking, checked one another on a fixed area once in a month so they could learn from each other's strong points to off set their weaknesses and reach the aim of common development. Some practised the system of sample-sending. The factory sent a bottle of the discharged water monthly to the County Supervision Station for analysis. If it exceeded the standard, the station would inform the factory of this, request it to find out the reason and cope with it at once. Under normal circumstances, people at the county level were to go to spot to examine the work quarterly and people at the city level half a year without any notice in advance. On arriving at the factory, they first checked the treatment of equipment operation, saw the results of it and finally heard their report. In spot checking, any factory discharged the waste water which went beyond the standard or without treatment, they would be fined over 10-20% of the output value in previous month following the seriousness of the case. Only in this way, can we assure to play a good role in the normal operation of the factory equipment, Last month Kunshan Electroplating factory did not immediately repair the treatment equipment which was frozen and damaged and discharged the waste water directly into a pond. In the end it was fined 6000 yuan: When the county Party Committee got to know it, it lost no time in asking the factory director to make self-criticism and repairing the equipment within a certain time limit. After that, several following checks of the treated waste water are to be satisfactory. In the first half of past year, the city government spot checked about 60 electroplating factories. The working rate of the equipment came to 98% the rate of comformity to the standard 71% and about 3.69 million yuan was fined. In order to encourage the factories to do a better work, we appraised through comparisons annually among them and give spiritual encouragement to First, Second and Third Place winners. For the sake of improving the quality and doing well the environmental protection, we also issued formally the electroplating working certificates to those who did a good job, not to those who did not. To mediocre factories we just issued the temperary working certificates. The factories that have received the formal certificates by the approval of the City People's Government are free-of-tax for one year. So it greatly brings into play the enthusiasm for good environmental protection of all electroplating factories. Many factories have invested more than 100,000 yuan in paying the anti-leaking floor, solving the problem of acid mist recovery in electroplating workshops, installing the dust abstraction devices in the polishing workshops and making them green inside the factory area. Through issuing the certificates the factory has taken on a new look and its environmental protection has improved by a big margin, Starting from this year, we set about to solve the problem of nickle patron recovery so as to avoid the pollution of water by nickle. After that treatment, we have used the same measures to control the printing and dyeing industry. Up to now, about 200 printing and dyeing factories, which comes to 60%, have their treatment devices. In developing and strengthening the electroplating industry and concentrating our energy on treating the printing and dyeing factories at the same time, we are doing some experiments of tiny cement dust recovery this year and making some preparations for treating the pollution of cement dust within a set time limit in the years to come.

III. Doing a good job in supervision, guidance and help are the effective measures in strengthening the environmental management of the rural enterprises.

In the practice, we recognize that we should combine supervision, guidance and help together in the environmental management of the rural enterprises.

1 . Supervision. In accordance with the Document No,(1984) 135 of the State Council, we began our supervision work in four respects.

1-1 . Supervising from long-term planning. In the certain period of time of the past, the townships did not have clear and definite plans as the guide in the construction and the development of the economy. Factories were set up everywhere and waste water was drained off to the nearby rivers. To counter this situation, Suzhou and Changshu Municipal Environmental Protection Bureaus conducted the experiment of working out environmental protection plans of townships and towns in Bixi Townships and included the township's environmental protection work into the township's overall plan. The township government paid great attention to it, did construction in the light of the plan and achieved good results. We popularized this experience in the whole municipality. Now the environmental protection is included in the overall plans of most townships and towns and the attention also be paid to the national layout of industry according to the plans. For example, when an activated carbon regenerating factory and a steel rolling factory were going to be set up in Hengjing Township of Taicang County, the sites were not only selected to the leeward of the residential areas but also 1.1 and 2.2km away from the areas respectively. When the factories went into production, on the whole they did not bring problems to the residence.

1-2 . Doing a good job in supervision "three simultaneous projects".

The departments in charge of environmental pretection at the municipality, county and township levels take the provention of newly emerged pollution source as their important task. First, striving for the support by the leading members is the guarantee in implementing the principle of "three simultaneous projects" under any circumstances.

For example, in the second half of 1980, the departments in charge of economy transferred to the lower levels their powers of the approval of the construction projects. Township could approve the projects with the investment of 300,000 yuan, and township tax stations could grant the business licenses. At that time, the Municipal Party Committee explicitly pointed out in the document concerning the transferring powers to the lower levels, "All the high energy-consuming projects and the projects which will cause pollution should be examined and appoved without exception according to the former rules." The leading members of Kunshan and Wuxian Counties spoke at the mass meetings that the powers should be transferred to the lower levels, but the powers of family planning and environmental protection were excepted. That guaranteed the implementation of "three simultaneous projects". Secondly, we followed the No. (1984) 135 Document of the State Council and avoid the constructing of the projects which will cause serious pollution and in hand to be harnessed. For example, when Nangang Township of Shazhou County was going to set up a fluorescent lamp factory, they began the building of the workshops without getting the approval of the factory from the department concerned. When the county and municipal environmental department learned this, they resolutely stopped the building because the factory would produce mercury products. In the two years of 1984 and 1985, the six counties and municipalities under the jurisdiction of Suzhou altogether stopped the construction of 36 projects which were violating the No.135 Document of the State Council. Thirdly, we rigidly enforce the regulations concering examination and appovement. The Municipal Environmental Protection Bureau prints and distributes the "Form of Report on Environmental Effects of Construction Project". Each county also makes concrete demands in the light of the actual situation. For instance, Changshu Municipal Environmental Protection Bureau makes it a rule that four kinds of projects will be disapproved, i.e. the project whose sites are not appropriately selected, the projects whose technological process of the production are not clear, the projects whose conditions of "three wastes" are not clear and the facilities to harness the pollution are not provided with, and the projects which have not been examined by the environment protectors of the towns and townships will not be approved by the Municipal Bureau. By doing so, the ratio of implementing "three simultaneous projects" has been raised from 30% in 1980 to about 90% nowadays, Besides, we pay attention to the cooperation with other units and coordinate with the Rural Industry Bureau and Industrial and Commercial Administration Bureau and make checks on the projects together. The Safety and Environmental Protection Section was specially established in the Municipal Rural Industry Bureau while the Environmental Protection of Rural Industry Section was set up in the Municipal Environmental Bureau. The two sections keep close contact and exchange information with each other. The production Section of Rural Industry always invites staff members of Municipal Environmental Bureau on their own initiative to make joint examination on the projects which may cause pollution, thus to bring the new pollution sourses under control with joint efforts. The Changshu Municipal Environmental Protection Bureau and Industrial and Commercial Administration Bureau formulates a rule that they handle the official business together once a month. Every month, the Environmental Bureau sends staff members to Industrial and Commercial Administration Bureau, examined the application forms for business licenses together with the members there. If the forms fail to contain the environmental protection, the licenses are not going to be granted and at the same time the Environmental Protection Bureau will inform the enterprises concerned to complete the formalities of "three simultaneous projects". The Industrial and Commercial Administration Bureau of Wujiang and some other counties have refused all the applications for business licenses of the environment-polluting enterprises which have not been examined and approved by the environmental protection bureaus.

1-3 . Doing a good job in surpervising the key areas.

The key areas are the protection zones of water sourse and residential areas. Water is the lifeline of southern Jiangsu area in developing economy. Many rivers have multiple functions and undertake the mission in transportation, irrigation and drinking water supply. So the environmental protection bureaus of the different counties and municipalities take the protection of water sourses as the priority on the environmental protection of towns and townships. For example, Kunshan and Taicang Counties disignated Linhetong River, the main river running through the two counties, as the protection zone of water resource. They also formulated the protection rule that the construction of factories which may cause pollution to the water sourse was prohibited within the scope of 1 km along the river bank. Besides, to the enterprises which obviously violate the Water Sourse Protection Regulations, we enforce the rule strictly to warn others against following the bad example. In 1985, Xukou Township did not get the approval from the environmental protection department when they set up a glass fibre factory only several hundred meters away from Taihu Lake, and 1,000 meters below was the water intake of Suzhou No.3 Waterworks. It obviously ran counter to the Taihu Lake Water Sourse Protection Regulations and seriouly threatened the safety of the water works' intake. When the environmental protection department learned this, for keeping the seriousness of the regulations, it instructed the township to stop the construction of the factory though 400,000 yuan had already been invested in. To protect the water resourse, the municipal and counties environmental department also stopped the construction of Taiping Township's waste oil retrieving factory with investment of 200,000 yuan, which was situated by Yangchenghu Lake.

1-4. Doing a good job in supervision

All the organs and workers of the environmental protection from counties (or cities at the same level) and townships have regarded supervision as an important part of their work. The Environmental Protection of Mocheng Township of Changshu City (county level) has irregularly organized leading members of the rural industry to inspect environmental protection and operating conditions of the pollution control facilities, and to give marks to different items. Thus the sense of responsibility of doing a job in environmental protection has been deepened. The counties (or cities at the same level) have also made it a rule that environmental protection workers of each sub-area get together every month and examine the enterprises' environmental protection in their area. All these have helped the enterprises to promote environmental protection.

2. Guidence

Due to heavy task and urgent demand in production the enterprises of the rural industry sometimes tend to pay little attention to pollution problems when they choose to carry out whatever project is profitable. In such cases the environmental protection department has always handled the problems by reasoning things out instead of speaking in a bureauratic tone and adopting an attitude of negating everything. By so doing, the rural industry's leading members have been completely convinced. Take Diandong Township of Kunshan County for example. The township planned to build a paper mill by Dianshan Lake. In order to get approval, the township's leaders went to the County Environment Protection Bureau one after another to put in a word for the planned mill.

To help them to get perciptual knowledge, members in the county bureau repeatedly explained the consequence with patience and reason, and at the same time accompanied them to Suzhou and Shanghai to have a look of the existing pollution of the paper mill there. After making an on-the-spot investigation, they finally gave up the plan, and admitted frankly; "They are three major problems in running a paper mill: the technology of pollution control is not up to the standard; it's beyond the mill to invest the pollution control; the harm caused by the pollution is unexpected; so it's true that the disadvantage outweighs the advantage." Considering that the township is economically backward, the county bureau offered to help the township to acquire a non-pollution project from the county government. Another example is that Choushi Township intended to build a tannery, but through the joint efforts and explanation from the city and county bureau, the township changed its plan.

3. Assistance

The common problem with the enterprises of rural industry is that they are lack of technical strength and knowledge of environmental protection. Some enterprises wish to control pollution but do not know how, and some intend to install facilities but have no ides where to buy them. To help the enterprises of rural industry tackle these problems is an important prepequisite in accelerating the work of pollution control, and in keeping with the demand that environmental protection department should serve the grass-root units. In order to solve the above-mentioned problems, the six counties (or cities at the same level) have first of all set up their associations of environmental science or associations of water pollution control, which involved scientific and technological workers of the counties concered and which offered advisory services for the enterprises of rural industry on technology of pollution control. In the last two years since

Taicang County Association of Environmental Science was established, it has fulfilled eleven items of technological advisory. Sometimes the association would invite engineers and technicians from Shanghai to study and solve some difficult items of pollution control together. The enterprises of rural industry highly appreciated what the association has done for them. After the settlement of technology of pollution control, the equipment of pollution control are common problems to be solved. As the work of pollution control develops in depth, an equipment supply department that serves the work of pollution prevention and control in rural industry needs to be set up. For the need of rural industry's pollution prevention and control, the six counties (or cities at the same level) have all established Environmental Protection Service Companies, which help to purchase or process pollution control equipment according to the need of the rural enterprises. The Environmental Protection Service Company of Shazhou County has provided the enterprises of rural industry with eleven sets of facilities of sewage treatment in less than two years since the establishment of the company. A lot of leading members of the enterprises of rural industry commented: "With the support of the environmental service company, we can go ahead and handle items of pollution control without the slightest worries." The environmental protection service company of Wujiang County has combined the work of serving the enterprises with providing information for the Bureau of Environmental Protection, which helped the bureau in strengthening its supervision. For example, through its monthly sales of reducer and coagulant to the electroplating factory and the printing and dyeing factory, the service company would analize whether the facilities of pollution control are going on regularly. If the company finds that factory purchases less or does not purchase at all, it would report the matter to the bureau, which will then go to the factory for examination. If the facilities for pollution control are found in suspension, the factory concerned would be fined by the bureau according to regulations. All these have played a good role in supervising the enterprises of rural industry to manage the facilities of pollution control well.

Though we have achieved some results in prevention and treatment of pollution in rural industry, yet there is still a lot for future improvement. Especially, how to check the shift of pollution in the course of the horizontal combination among enterprises remains a problem, and we still have a great deal of work to do. We are determined, however, to do a better job in the prevention and control of pollution in the rural areas.

BETTER WATER RESOURCES MANAGEMENT

-----THE ONLY POSSIBLE SOLUTION TO QUENCH WATER CRISIS

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Abstract

To strengthen water resources management is only a possible solution to qnench regional water crisis. It is necessary to have a conceptual revolve on the opinion of water resources management. This paper briefly introduces the draft results of current research activities on the water resources management and policy study in Beijing Area and put its emphasis on the close relations between society, eonomy, resources and ecological environment for the purpose of seeking a possible solution to solve water shortage problem thoroughly. Following opinions were drawn from the authors' current research project: in water short region less water consumptive economic structure is a vitally important condition to develop social economy; the key link to reform the water using code is to strengthen water demand management. To reduce water demand did not only release the dependence on new water resource exploitation, but also decrease the environmental pollution and effects on natural ecological system. There are close interrelations between society, enonomy, resources and environment, which has to be handled proporly. In this sense, a centralized water authority has to be eastablished and technic policy must be issue to execute the effective water management.

I. Introduction.

Beijing-Tianjin Area is the national polictical and cultural centre with highest urban population density and large scale industrial base. For the past 30 years, the industrial and agricultural production and human's living level have been rapidly increased so that the water demand increased dramatically. Meantime, due to the fact that this region is located in the semihumid and semi-arid zone having limited water resources, and that there is no effective water authority, the imbalence between available water supply and unlimited water demand has greatly restricted the regional social economic development.

Leading comrades of the Central Government always pay great attention to the issue of water resources of Beijing-Tianjin region and have pointed out several times its severity and urgency. In order to implement the instruction of the leading comrades of the Central Government and strengthen management of water resources exploition and utilization in Beijing-Tianjin region, at the begining of 1986. State Science and Technology Commission assigned the soft scientific research project of "Study on Water Resources Forecast and Appraisal for Beijing-Tianjin and Adjacent Areas" to the Science and Technology Commissions of Beijing and Tianjin municipalities respectively. This study should be a systematic study in the sense of trans-discipline and combination of quantitive and qualitative analyses on the issue of water resources in Beijing--Tianjin region. By means of advanced techniques and methods, such as system analysis, decision-making theory as well as technical-economic evaluation, the study will make correct appraisal on the amount of water supply available and projection of water demand in this region. Furthermore, reasonable policies, feasible alternatives and institutional management measures will also be drawn out from the study. All of them will serve as a scientific base of decision-making and macroscopic management for the government. Based on the requirement of the above said soft study project, the Science and Technology Commissions of both Beijing and Tianjin Municipalities have jointly organized a collaborative research group in trans-department and trans-decipline manner to carry out the study work in depth. The Environmental and Policy Institute of the East-West Center, Hondulu, Hawaii, USA was invited to participated in the study collaboratively.

Over the pasing year the researchers and experts in both municipal research groups have done excellent work and obtainted the draft study results. In this paper the guideline of research and some preliminary opinions on water resources management and policy were drscussed.

II. The Background of Research Activities

2.1. The Origin and Objectives of Study.

A great amount of basic investigation on the issue of water resources of Beijing--Tianjin region were carried out by many research, design and administrative institutions in the region, which also raised some benificial suggestions. However, the engineering measures which have been adopted so far (for instance, the project of diverting water from the Luanhe River to Tianjin) can not meet the demand of long-term development in this region, various proposals raised were always lack of comprehensive analysis and inevitably bore the professional limitation of the researchers, and an overall scheme which can be accepted by various departments and organizations concerned has not been formed yet.

It is not difficult to understand that the issue of water resources itself only relates to water quantity, water quality, as well as time and spacial distribution, but in order to solve the problem of imbalance between water supply and water demand, it has to be linked with social-economical development, environmental ecologial function and mutual impacts between regions. Just because of the diversitied use of water. it will make no difference that whether in river basin or in a city. the competition between various water users is inevitable in the water shortage areas, such a contradiction is even protruding. As China is a socialist country with planning economy as her mainstay, regional economy and national economy have to be well integrated; and therefore, the rational use of water resources must be the following: on one hand, it can promote both national economy and regional economy developing in parallel, and along with the economic development, social welfare such as housing level, comfort lives etc. should be relevantly raised; on the other hand, the use of water resources at least will neither deteriorate the necessary conditions for social reproduction nor worsen environmental ecology. Our goal is to build both Beijing and Tianjin into municipalities with prosperous economy, developed culture, advanced technology and sound ecological function. That means we should use the point of view in integrating economy, resources and environment to analyse and to plan the water resource issue in Beijing--Tianjin region. The goal of decisionmaking on water resources in this region should be linked with :

1 the goal of national economic development;

2 the goal of regional economic development;

3 the goal of social welfare; and

4 the goal of environmental-ecological quality.

These four goals are inter-related but also contradicted with each other. If regional economy was over stressed, the national economy might be harmed and vice versa. It is almost impossible to optimize both environmental goal and economic goal simultaneously. The difficulties in decision-making on multi-objective lie in lack of generally acknowledged measurement, their measurability is always different, it is also impossible to find out a common measurement to weight the four goals in order to decide whether accept a project or reject it. Some of the factors are greatly related to the decisionmakers' desires, indeed. Thus, the current study must be based on the point of view that economy-resource-environment is a intragated body and the solution should coincide with available water resources, reasonable environmental impacts and national or regional economic strength. The study should emphasize the methods of upgrading the efficiency of water use to make up the gap between water supply and water demand. The reason is that the potential for further expanding water supply within this region is very limited, moreover, it is beyond the financial capability of the nation to build trans-basin water diversion facilities. Since the complex nature of decisionmaking on multipurpose use of water resources has been recognized, one may not unilaterally seek after the mathematical model which has a rigorous theory, but instead, should focus on depicting the dynamics of water resources system and make a combination of researchers' analysis and decision-makers' experiences so as to arrange an order of priority for the feasible alternatives and measures which should be available for the leading departments' reference in their decision-makingprocesses. Owing to the fact that besides the identity on water resources issue in Beijing and Tianjin Municipalities, there are still some differences on natural, social and economic conditions, the content priority of some study topics will not be the same, such an oriented policy and measures will bear even clearer aim and feasibility.

2.2. The Current Water Supply and Demand in Beijing Area.

The water resources in Beijing consist of two main parts -- groundwater deposited under plain area and surface water delieved from reservoirs. Fig. 1 shows the water balance in Beijing based on 1962-1984 hydrolic series.

The Beijing surface water resources consist of local runoff and inflow from upstream region. According to statistical hydrological series from 1941 to 1984, the average annual precipitation in the area is 595 mm, and total rainfall is 10 billion M^3 /yr. When surface water groundwater interactions are iccounfed for the average annual runoff is 0.69 billion M^3 /yr.. In theabove runoff, it includes the base flow of the river spilled over from the aquifer during the dry season.

The surface inflow is an important part of water resources in Beijing. The Juma River passes through southwestern boundary of Beijing, proposed Zhangfan Reservoir is on the river. According to statistical data from 1961 to 1984, the average annual inflow from outside of Beijing approximates 1.75 billion m^3 /yr, 0.68 billion of that is from the Chaobai River, 0.99 billion from the Yongding River and small portion (about 0.08 billion m^3 /yr) from Jiyun River. The 55% of the inflow comes in flood seasons, from June to September, and most of inflow is controlled by the reservoirs. The local surface runoff is another important part of water resources in Beijing. The some runoff from the mountainous area and almost all runoff produced in the plain can not be controlled and they flow towards downstream region of Beijing. According to the hydrological series from 1961 to 1984, the average annual outflow through main river is about 1.367 billion m^3 /yr (0.998 billion m^3 /yr flows out from plain areas, 0.369 billion m^3 /yr from mountainous areas). About 71% of outflow occurs in flood season and 0.738 billion m^3 /yr of total outflow is concentrated in July and August.

The local groundwater resources in mainly distributed in the upper middle part of alluvial prolluvial (al-pl) fan of the five major rivers, the al-pl fans in the Yingding River and the Chaobai River are the richest areas of groundwater. According to the estimation, the average annual groundwater replenishment in Beijing is about 4 billion M^3 , in which around 3 billion M^3 /yr. is in the plain area.

Besides rainfall in plain area, the percolation supplement

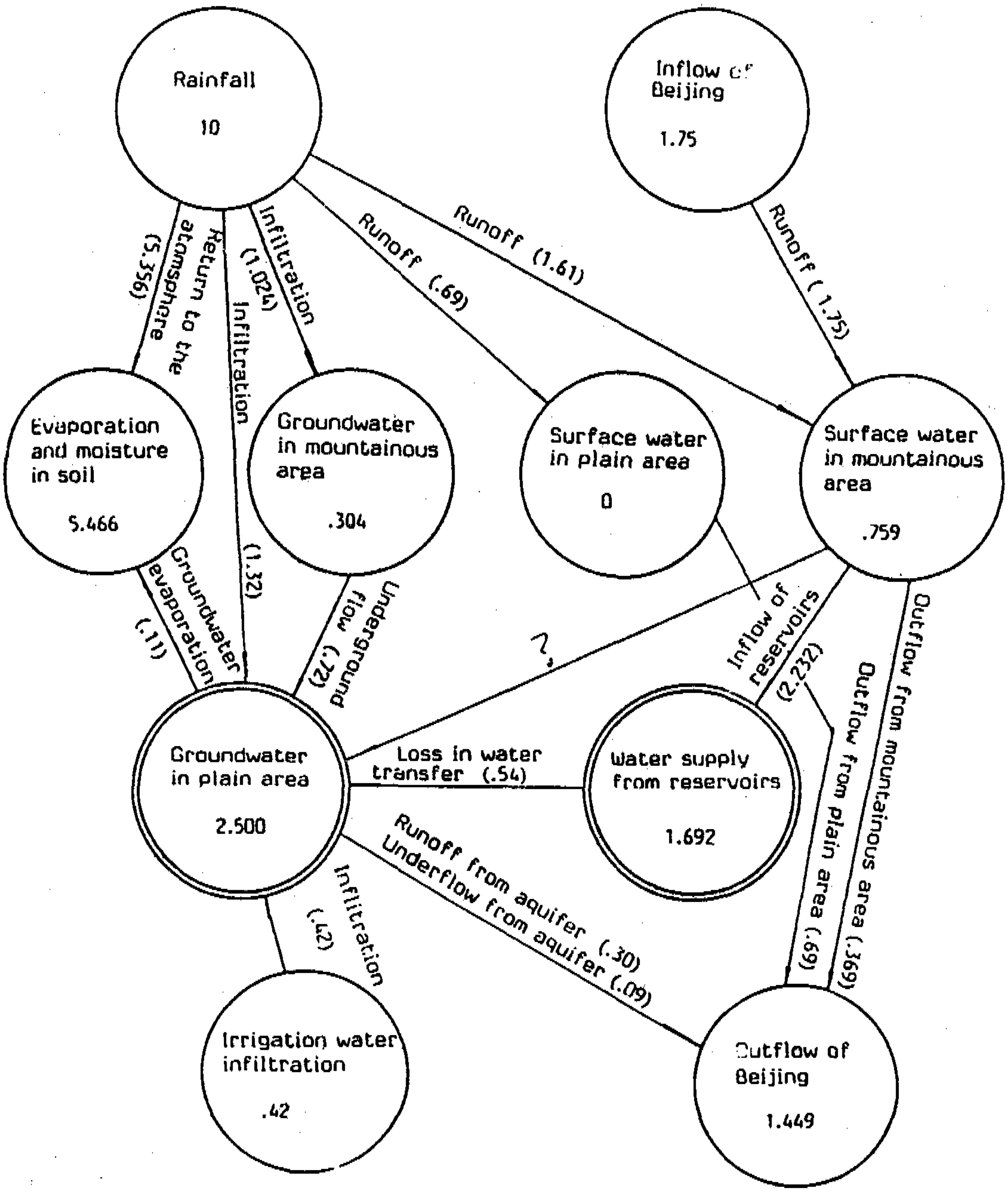


Fig. 1 Water Resources and Balance in Beijing

(The data are based on hydrological series from 1961--84, unit is 10^9 M^3/yr.)

from river bed and irrigation areas, the replenishment of groundwater in plain area comes partly from versant to pediment. Apart from phreatic water evaporation. Outflow and spring losses, groundwater resources in Beijing is 2.5 billion m.^{3}/yr approximately. In recent years. because of consecutive dry years and reduction of inflow, the groundwater supply has already reached 2/3 of the total water supply, and becom the main water source in Beijing.

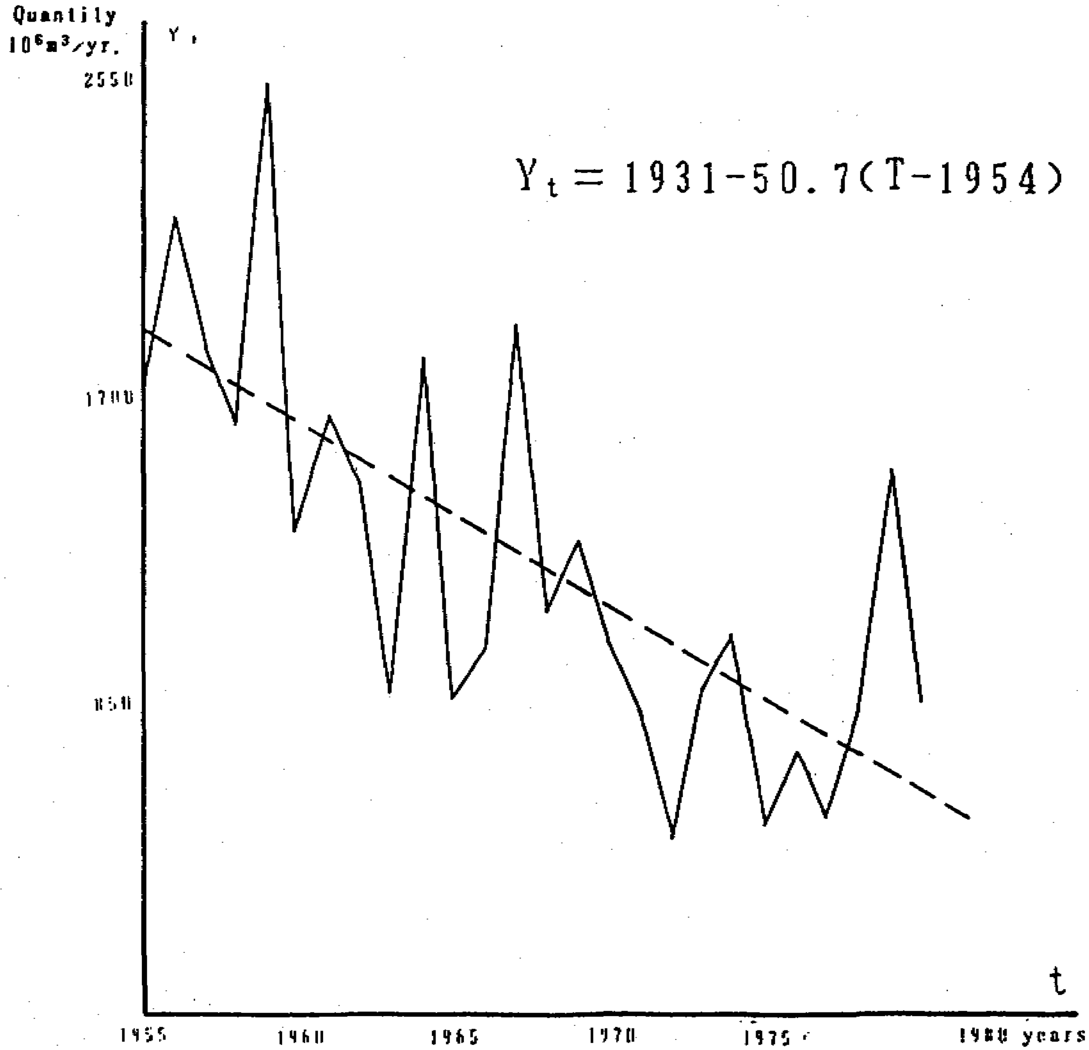
The characteristics of water resources in Beijing can be summarized as follows: uneven distribution in time and space, and low stability caused by sustained reduction of inflow from upstream.

1) The precipitation varies sharply among the twelve months in Beijing region. From June to September the rainfall reaches close to 60-70% of yearly precipitation and in the flood season the monthly rainfall can take up 1/3 of yearly rainfall, moreover in the most dry month, only 2-4% of whole yearly precipitation happens. It is too difficult to control such violently changed rainfall and runoff. In addition to monthly precipitation variation, the Beijing region commonly experience persistent wet and dry cycle of approximately four years duration. In every four years, two of them are ordinary years, one is wet, and one is dry, but eight consecutive dry years occurred from 1956-72 and the first five years of 80's also have been dry.

2) There is also a strong spacial distrivution of water resources. In term of regional distribution. runoff in the mountain is more than that in the plain. they take 70% and 30% of the whole runoff in the area respectively. In term of river systems, the Chaobai River with the largest amount of runoff takes up 40.3%. Secondly, the Beiyun Riverm, takes up 22.4%. The Yongding River, the Daqing River and the Jiyun River take up 12.6%, 14.8%, 9.6% respectively.

3) The problem is that the spacial distribution of water resources does not coincide with social and economic distribution. Because Beijing's surface water supply system depends largely on the upstream flow of the two reservoirs, the decreasing trend of upstream inflow, which was attributed to the increasing use of water in upstream regions and recently prolonged drought as shows in Fig. 2, has become a serious threat on the supply system.

The actual water uses in Beijing during the year of 1984 are listed in Table 1. It is easy to be seen that the total water use was 4.005 billion M.^{3}, which closed to the average annual available water supply. (4,200 billion M.^{3} /yr.) Under the condition of that the storage capacity of reservoirs had been fully used, used the balance between water supply and demand could have been maintained. But the extremely emergent water short issues have been perplexing the citizen of Beijing because of a series of dru years and vulnerable water management, the water delieved to the farmers was strictedly controlled; the water quota were set for every factory and enterprise and the pressure of water supply



inflow to Guantin Reservoir

Table 1 Actual Water Uses in 1984

Unit:million M^3

Items	Water Demand	Water Sources			
		Guanting Reservoir	Miyun Reservoir	Other Reservoirs and Baseflow	Groundwater
1. Urban and Suburbs	1,808	407	246	6	1,149
Domestic Water Use	487	3	11	6	467
Famers' Domestic Use	18				18
Industrial Water Use	893	390	131		372
Lakes and Vegetable Crops	410	14	104		292
2. Rural Area	2,197	83	356	227	1,531
Farmers' and Animals' Water Use	187			11	176
Industrial Water Use	236	18	45	6	167
Crops, Orchard and Fish Farming	1,774	65	311	210	1,188
Summary	4,005	490	602	233	2,680

system was constrained within a low level.

The agricultural water uses was the largest water use sector, among which the irrigation water took 75.5%. Metallourgic industry, chemical industry, coal and tar industry, timber industry and pulp & paper industry were large water use sectors, the total quantity of water use in five sectors took 61% of general industrial water use. Water use in power plants was about 0.29 billion M which approximated 1/3 of total industrial water use (power plant plus general industries.)

The domestic water demand is defined to include two categories: residents' water use and water use in public facilities. The purpose of residents' water use covers cooking, drinking, washing, bathing, toilet flushing and other, miscellaneous usage. The water use in public facilities includes commercial water use. non-commercial water use, domestic construction water use, as well as water use for environmental sanitation. In 1984, the public water use was about 73.2% of whole domestic water use.

The average water use rate for public facilities was 156 l/c.d., 65 l/c.d., for residents' indoor use, and 18 l/c.d., for other miscellenous uses. So the total domestic water use rate was 239 l/c.d., in 1984,

2.3. The Prediction of Available Water Supply and the Projection of Water Demand

At present, the Beijing area is still in the dry period in term of long dry-humid circle. From Fig. 3 it can be seen that the precipitation in this region is decreasing at the rate of 7.44 mm./yr. continuously. The inflow from adjacent upper reach area is also declining due to the economic development and climate. It is impossible to withdraw more groundwater from the plain area because of over-exploitation of groundwater and fewer replenishment from rainfall. So it can be predicted the available water resources will decrease in the coming 10-20 years, compared with the current level. Although the water delieved for agricultural uses will be strictly controlled and water saving measures will be adopted in industrial uses, the absolute industrial output increase and human living standard raising will definitely cause the water demand even greater. If no any engineering projects in water saving were adopted the balance of water resources would be worse than present, and huge gaps between water supply and demand would have to occur (shown in Table 2).

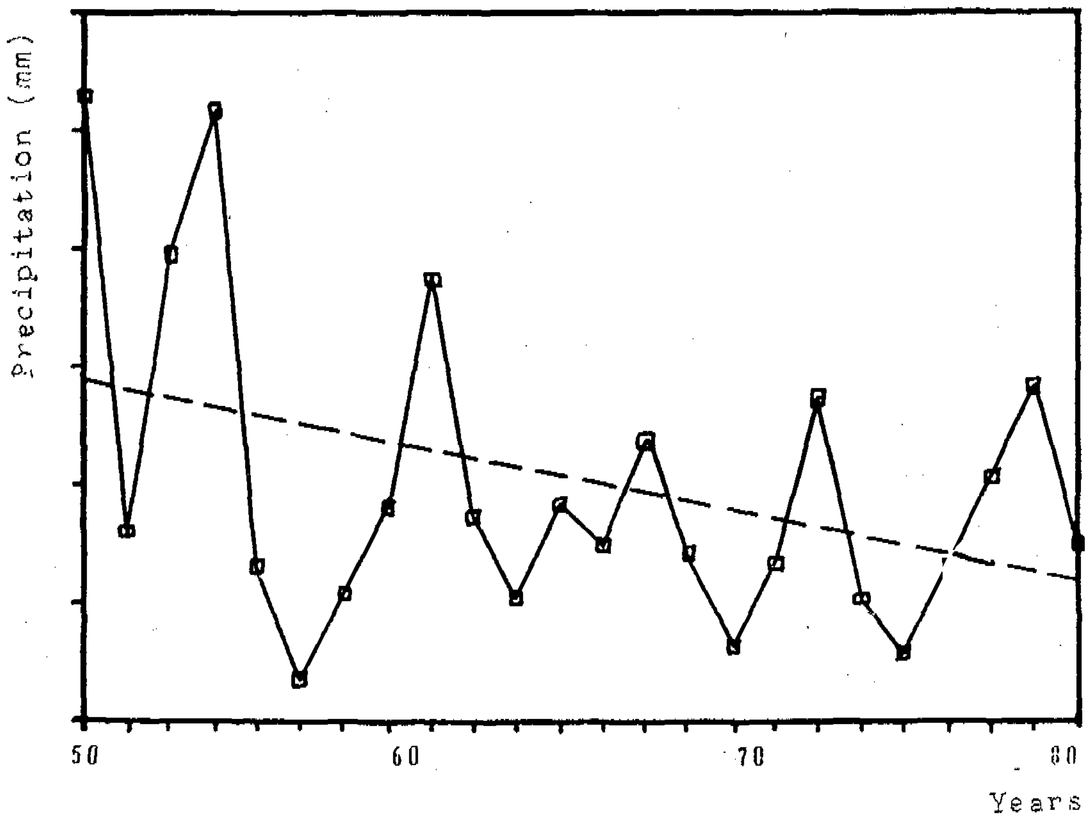
The problem is evident: there is no enough water to support the regional social and economic structure that will be larger and larger ----- What is the solution?.

Table 2 The Results of Base Balancing between Water Supply and Demand

	Areas	Whole Region			Urban and Suburbs			Rural Areas		
	Frequence	50%	75%	95%	50%	75%	95%	50%	75%	95%
1990	Supply	4,220	3,740	3,380	2,080	1,770	1,560	2.140	1,970	1,820
	Demand	4,670	5,190	5,190	2,130	2,180	2,180	2,540	3,010	3,010
	Gap	-450	-1,450	-1,810	-50	-410	-620	-400	-1,040	-1,190
2000	Supply	4.130	3,690	3,340	1,990	1,820	1,520	2.140	1,940	1,820
	Demand	5,350	5,760	5,760	2,610	2,680	2,680	2,740	3,080	3,080
	Gap	-1,220	-2,070	-2,420	-620	-860	-1,160	-600	-1,110	-1,240

Unit: 10^6 M^3/yr.

* Projected agricultural water demand in 95% dry year is calculated as same as that in 75% dry year.



Precipitation in Beijing Area

III. Better Water Supply and Demand Management
------the Only a Possible Solution.

Through the balancing results of water resources as shown in Table 2, it is obvious that the gap between available water supply and projected water demand will be widened in 1990 and 2000 as compared to the present. No matter whether in urban and suburbs or in rural area, the water shortage crisis will be more serious. In the light of water shortage, Beijing Municipality is facing three choices, they are:

1). Don't pay any attention to the water shortage problem until the through destruction of Beijing Water Resource System.

2). To stop development, and keep both the water shortage and production value output at present level.

3). Based on economic development the vigorous policy and measures have to be adopted in order to cease the water shortage problem thoroughly and to build Beijing into the national political, economic and cultural center with elegant environment and sound ecological function.

It is possible to make Beijing into a water-saving city and the agricultural and industrial practices into water-saving ones. For the objective, the following principles should be adopted:

A. To strengthen management first and to expand new water supply capacity secondly:

Except a small portion of the Juma River which passes through the southern boundary of Beijing and a small quantity of groundwater in rural areas of Beijing which can be exploited further, there is almost no local water resources that could be developed in the future. Indeed sewage can be regarded as a kind of resources that may be reused after primary, secondary or postsecondary treatment corrosponding to different reuse purpose. However, there are no secondary treatment plants in Beijing now, which means that the sewage can not be reused by industry or domestic users until municipal secondary sewage treatment plants are built.

Relatively speaking, there are many problems that have to be solved urgently in water management. So there really exists great potential to reduce water demand and to raise water use efficiency through strengthening water management in both water supply system and water use processes. In this sense, to strengthen water resource management should be given priority over the new water resource exploitation.

B. In term of region, imbalance of water supply and demand in urban and suburbs have to be changed first. In the meantime, more attention should be paid to the imbalance in rural areas.

The essential problem of water shortage is imbalance of water supply and demand in core region of Beijing especially for deomestic use. Needless to say, water supply to the core region should have higher reliability than any other regions. On the one hand, all water resources that can be collected and allocated to urban and suburban uses should be supplied to the city at a top priority. In the processes of water rights transferring, the compensation should be considered. On the other hand, the centre of water use in urban area should be decentralized. The speed of economic construction in downtown area should be slowed down, and the construction of industrial zone and satellite town in rural areas should be encouraged and sped up. Thus, the rate of increase in water demand will be reduced in the urban area. In order to carry out the scheme, the rational economic distribution will be plannd based on the results of subdivision balancing of water resources.

C. In term of schedule of possible alternatives in water resource management, in the near future before 1990, the water demand management should be focused on water-saving project, because of its instant effects. The agricultural, industrial and domestic water demands have to be cut down to the upmost extent and remarkable success will have to be pledged through the implementation of water saving scheme every year.

It will be crucial period from 1990 through 1995 to solve water shortage problem in Beijing areas thoroughly, and it will be given the first place to strengthen water supply management. All the bussiness or activities that are related to water supply management, from water resource exploitation, allocation and operation, wastewater disposal to water pricing policies, water right and water law, etc. will have to be subjected to a complete scientific institutional system of water resources, which will be able to provide a sound base to quench water crisis in this area. Because a long preparing period is needed to establish the institutional system, from now on the preparing work must be done promptly.

Beyond 1995, the water management will mainly rely on the ajustment of water use structure, which includes to change the agricultural crop mix, to reform the industrial production structure and to improve the domestic water using code. Only when water using structure were changed, Beijing could become a watersaving city.

D. The management of water resources will be aimed at the drought year. The results of first balance between available supply and projection of water demand in 1990 and 2000 show that the gap between supply and demand will be -1.81 billion M^3 /yr. by 1990 and -2.42 billion M^3 /yr. by 2000 respectively, corresponding to dry year at 95% frequency.

In the past several decades, long-period operation of water reservoirs was not carried out in Beijing area. In order to keep dry year in mind, the rainfall and runoff in wet years have to be stored in the reserviors and delivered during the dry seasons. Following alternatives are proposed espacially.

1) The optimal operation of two major reservoirs (possibly including Zhangfang reservoir after it is completed).

2) Carrying out the west suburban groundwater reservoir management scheme in order to increase water supply in the dry years.

3) Conjunctive use of surface and groundwater. In wet years groundwater withdrawals should be reduced by increasing surface water supply for groundwater conservation, so that groundwater can be over withdrawin in the dry years to remedy the gap between water supply and demand.

The essence of above principles is to strengthen water resource management both on demand side and on supply side. The following projects and options can be adopted to mitigate the water shortage in Beijing Municipality.

3.1. To strengthen the water management on demand side.

1). Domestic Water-saving Measures: The water abusing and leaking in domestic demand side are serious at present, so the domestic water saving measures should have definite target with detailed implementation plan, which include water-saving sanitary facilities and bath facilities. The recycle and reuse rate for cooling or air conditioning water should be increased to above 90% in 2000.

The potential of water saving in public facilities, especially in university and office building, is considerable. The sewage reused for miscellanous non-contacting uses should be increased under feasible condition.

2). Industrial Water-saving Measures: relatively speaking, industrial water use is more centralized so water-saving measures are easier to be implemented. The following options are considered as internal factors because its effect in water-saving and/or inverstment requried are estimative.

a. Adjusting the proportion of production value among different sectors. Under the prerequisite of the industrial products being basically satisfied with demand in human life within in the region, the production value of low water consumption industries should be raised, such as mechanic industry, Meantime, the high water consumptive industries should be restrained.

b. The recycle rate of cooling water systems should be raised so that makeup water can be reduced. For the purpose, cooling water treatment technology will be popularized and once-through cooling systems must be changed to recycle ones within the given time.

C. The reuse rate of wastewater within factories should be raised. It is economically feasible to resuse the effluent of water-water treatment plants that have been installed in some factories. Before 1990, the option should be implemented through the institutional policy if necessary.

3). Agricultural Water-Saving Measures:

The agricultural water demand is the biggest sector in Beijing with low irrigation technical level. From now on, surface water in two big reservoirs will not be allocated to the agricultural users. the gap between water supply and demand in rural area will be even larger. By means of reducing irrigation losses, changing the irrigation methods and planting more low water consuming paddyrice, the water use rates have to be limited within the reasonable range. The agricultural water use must be metered strictly in order to realize the rational irrigartion. To level farmland is a good way for water-saving, so the measure should be highly suggested to farmers.

3.2. To Strengthen Water Resource Management on the Supply Side.

The west suburb is one of important industrial zone in Beijing where most of water users were supplied by Guanting Reservoir over the past years. Because inflow of Guanting Reservoir has been declining continuously, there is the possibility no water will be delivered from Guanting Reservoir in the future. In order toguarantee water supply in the area, the water transfer main from Kunming lake to Gaojing plant was proposed as the second water source, which can also be used to transfer water from Miyun Reservoir system to Guanting Reservoir system. Even though the facility will only be used when the emergency happens, it is keyproject in water rescurce management in Beijing. The covered canal from Huaiyou Reservoir to Kunming lake was planned to overcome the difficulty in water transfer during the winter season, in the meantime, the losses in water transfering process will also be reduced. Because the losses of water transfering was regarded as a replenish source of groundwater in the rural area, in this sense, the project may play a role to collect the scattered groundwater in rural areas and to transport it to central district. Water Works No.9 is another key project to transport water from Miyun Reservoir to urban area. More attention must be paid to the west suburben groundwater reservoir management. In essence, the water sources for replenishmen should be determined. Before the optimal operation of surface reservoir and conjunctive use of groundwater and surface water are realized, the water about 0.18 billion m^3 /yr that has been alocated to domestic use through the second phase engineering of Water Works No. 9n can be recharged to west suburbs soon. If do so, the required injecting well and recharging facilities should be constructed primarily. The wastewater or sewage treated (about 0.06 billion M^3/yr.) could be used as water sources for recharging during the non-irrigation seasons.

Table 3-1 The Second Water Balancee in 1990 Unit: 10^6 M^3/yr.

Items \ Region / Frequency	Whole Region			Urban and Suburbs			Rural Areas		
	50%	75%	95%	50%	75%	95%	50%	75%	95%
Available Water Supply	4,220	3,740	3,380	2,080	1,770	1,560	2,140	1,970	1,820
Projected Water Demand	4,672	5,190	5,190	2,133	2,181	2,181	2,539	3,009	3,009
Water Supply Expanded	344	334	334	161	151	151	183	183	183
Zhangfang Reservoir	70	60	60	70	60	60			
Sewage Reusing	274	274	274	91	91	91	183	183	183
Water Demand Decreased	523	420.75 ≑		380			143		
General Industries	181	119.70 ≑		118			63		
Power Plants	188	184.00 ≑		188					
Agriculture	80	83.00 ≑					80		
Demestic	74	34.05 ≑		74					
Losses in Transfering	232	232	232	232	232	232			
the Gap of second Balance	183	-825	-1,185	256	-112	-322	-73	-713	-863
The Gap of first Balance	-452	-1,450	-1,810	-53	-411	-621	-398	-1,039	-1,189

≑ Unit is 10^6 yuan in term of investment of water saving measures.

Table 3-2 The Second Water Balancee in 2000 Unit: 10^6 M^3/yr.

Items \ Region / Frequence	Whole Region			Urban and Suburbs			Rural Areas		
	50%	75%	95%	50%	75%	95%	50%	75%	95%
Available Water Supply	4,130	3,690	3,340	1,990	1,720	1,520	2,140	1,970	1,820
Projected Water Demand	5,350	5,760	5,760	2,610	2,680	2,680	2,740	3,080	3,080
Water Supply Expanded	646	646	646	323	323	463	323	323	183
Zhangfang Divesion	280	280	280	140	140	280	140	140	
Sewage Reusing	366	366	366	183	183	183	183	183	183
Water Demand Decreased	1,219	890.90 *		753			466		
General Industries	509	287.60 *		310			199		
Power Plants	296	197.90 *		296					
Agriculture	267	323.20 *					267		
Demestic	147	82.20 *		147					
Losses in Transfering	268	266	268	266	268	266			
The Gap of Second Balance	379	-471	-821	190	-150	-210	189	-321	-611
The Gap of first Balance	-1,220	-2,066	-2,416	-624	-855	-1,155	-596	-1,111	-1,240

* Unit is 10^6 yuan in term of investment of water saving measures.

3.3. New Water Resource Development

In order to make up the decline of inflow to Guanting Reservoir the Zhangfang Reservoir is solely proposed. The diversion canal has to be built before 1990, otherwise the gap between water supply and demand in Guanting water supply system will not be remedied easily.

In some rural areas where groundwater spilling over to form the baseflow of river because of high groundwater table, there is potential to increase the groundwater withdrawal. With groundwater withdrawal increasing, groundwater table will drop down so that the percolation of rainfall will be increased and outflow in Beijing area can be reduced. It is need to do further feasibility study on how to utilize this potential.

Sewage and wastewater treated will be reclaimed as a new water resources that may play a vitally important role in water balancing. But, the investment for reusing effluent of treatment plants would be a limited factor. If all investment is attributed to exploitation of water resources the unit investment (RMB Yuan/M^3.yr.) will be higher than that of inter-basin water transfer project. Moroever if the investment for secondary wastewater treatment is regarded as that for environmental protection, the sewage reuse scheme will probably be constrained by the limited budget for environmental protection.

If all these proposed water supply projects and water demand options can be applied due schedule, the situation of water supply will be imporoved greatly. But from Table 3 it can be seen all water demand alternatives and water demand options with many technic difficulties cost dearly in term of both time and finance. Even though every target will be reached. In the dry years with frequence of 75% and 95%, the gap of water balance still exists, even though the proposed demand options and supply projects can be carried out. Obviously it is too difficult in finance to divert water from the Yellow River or the Yangze River, therefore the solution in balancing water demand and apply must be based on the water resources in Beijing areas. The further possible supply projects and demand options are as following.

1. Optimal operation of surface reservoirs to expand water supply capacity.

2. To store the outflow in wet years, industrial effluent and purified sewage in no irrigation seasons in order to overwithdraw groundwater in the dry years.

3. Expoitation of groundwater in rural area under the guidance of plan.

4. To speed up the exploitation of sewage and wastewater resources and to increase the quantity reused.

5. To work out the further water-saving scheme and set the higher level of implementation of proposed water demand options.

6. To reduce water demand by strict water quota, water pricing policy, scientific management and mass media, etc.

IV. Some Opinions about "Water Resources" and "Water Resources Management".

As stated above how to handle water shortage problem is a stratetic challenge in social and economic development. There are sufficient evidences show that the direct reason of water shortage is rapid increase of water demand and inadequate natural water resources, but the basic reason in due to the vulnerable water management system and the antiquated water using code. The crucial issue is to reform and strengthen water resources management, the rational technic policy is the necessary condition to execuate effective water management, In the paper the term of "water resources management" has appeared hundreds times so far, so it is needed to have a more destinct concept on water resources management.

4.1 The Extension of the Concent of Water Resources Management.

1) "Water resources"

In the past when we talk about "water resources" it only means the natural resources which is available for human's activities. For example. It is regarded that water resources in Beijing is about 4.2 billion M^3/yr. which includes the surface water delieved from reservoirs or other hydrologic facilities, and groundwater distributed broadly under the plain area. It is important to reassess regional water resources based on the natural water cycle, in order to augment the field of vision to find out more water. Generally speaking, the natural water resources are equal to the precipitation plus inflow (the incom of water) minus evaporation and transpiration (output of water), finally, multiply the reuse coefficient. The reuse coefficient is the ratio of water intaken minus consumptive water use. v.s. water intaken. In practical the large portion of water intaken is disposed to the environment as wastewater or sewage after it is used. although the water quality is polluted in the water using processes by human's activities sewage can be purified in the artificial treatment plant, so that it may be reclaimed and reused. In the sense sewage should be taken as a special water resources for the special usage.

Furthermore the water resources hould be diveded into different sectors according to the sources, quality and reliability. The natural water resources could not be sufficiently used in most cases because of limitation in space and time. The available water resources is such kind of water which have been exploited by means of the arrificial hydrolic facilities. Even for the available water resources, they still can be labeled based on the different exploitation degree. The water delievered from reservoirs can be used in agricultural production, While the water in the resources must be diverted to the urban and industrial sites through long-distance deversion mains, and properly treated in the water supply facililies for industrial and domestic uses, it is needed to develop fruther, the higher of development level is, the more the water costs and the higher its using value is. The using value (the economic benefit get from water using processes) is a sole standerd to classify water resources. The purpose of classification is to reconfirm the regional water resource clearly, to determine the potential for furhter development, and to estimate the mvestmentand cost in the new water supply capacity expansion.

Any activity to develop water resources, need ficacial input, labor inputect. meantime the using value of water will be raisen. What the planner is interested is how much input is necessary and how much output will be obtained in these water resources development.

2) "Water Resources Management"

In the traditional concept the water resources management is only the management of water supply system. So all efforts to remedy the imbalence between water supply and demand is to exploit new water resources and to augment water supply capacity when water crisis occur, over the part three decabes or more about 2000 reservoirs with total storage capacity of 28.4 billion M^3 were constructed which govern the 80% runoff in the mountain area besides that, there were 92.7 thousand pumping wells. The total water supply capacity was over 42.5 billion M^3 /yr. which approximated 84% or regional natural water resources. There is little potential to get more fresh water in the North China Plain. The trans-basin water diversion projects were proposed under these background.

We think the connotation of water resource management has to be enlarged Water resources management is by no means only a water supply management, it should include water demand management. In the water supply management, the rational allocation of available water resources is more important than the new water resources development. Ten years ago, more attention were pain on the construction of larg-scade hydrolic engineering project to meet the increasely water demand while a few water saving measures were adopted to reduce the water demand. As a result, the bas water using code and water crisis have formed gradually. How much water can be diverted to Beijing-Tianjin area through the proposed trans-basin canals. Based on the preliminary it will not be more than 2.0 billion M^3/yr. while the balancing result in our current project shows that the gap between water supply and demand will be more than 2.0 billion M^3./yr. In Beijing by the year of 2000 except the proposed transbasin water transferring project from the Yangze River to North China

Plain, it will be almost impossible to find any other water sources to remedy the water shortage. Needless to say water resources cannot be rationally allocated without water supply authority; and water demand will not be met if water can be increased without any limits. From this point of view, the optimal operation of water supply facilities for water resources reallocation and optimal management of water demand for increasing water use efficiency shluld be the most important objectives, and will be the essential contents of water resources management.

4.2. Three New Issues in Water Resources Management

1. Economic Efficienvy of water supply and Uses

Because the social-economic structure and water using code were formed when there were abundant water in Beijing area water uses were not limited in 1960s and 1970s, the industrial water use rate was 0.0714 M^3/yuan(RMB) and domestic water uses was quite high, which led to a serious water crisis in the beginning of 1980s. No matter what supply projects or demand opions were adopted, it is desirable to use the smallest input and obtained the most output and best effects. With the development of new water resources, the water transferring distance became longer and longer so that the unit investeaent required rose sharply. In 1950s unit investment to construct the Guantin Reservoir was 0.116 yuan/M^3 yr., while in 1980s the investment required for the proposed Zhangfang Reservoir increased to 2.32 yuan/m^3 /yr., about 20 times more than that in 1950s. The cost of water supply was also raised from 0.035 yuan/M^3 to 0.236 yuan/M^3 . Because water economy has changed greatly some projects and opions that were regarded uneconomic at low water supply cost in the past are acceptable at high marginal cost of water supply. In the past wastewater reclamation was regarded uneconomic due to the high cost of wastewater treatment and low cost of water resources development. But now, the opinion has charged. Although the unit investment of wastewater treatment plant is about 1.64 yuan/M^3 /yr. it still lower than that of the proposed Zhangfang Reservoir, the by-effects of wastewater reclamation is the environmental improvement. There is about 0.7 billion M^3 /yr. sewage collected in Beijing, the challenge is which project will be the better, transbasin diversion canals or water recolamation factories.

Due to the critical situation in water shortage, the water resources must be reallocated in order to supply the social-economic activeties with the limited regional water resources. In the passing few years. Some interesting topics such as "transport food or divert water?", "what if to limit economic development for reducingater demand " or "what if to transfer more water to maintain high developing speed of regional economy." were under arguing. The essence of these topics is what objective will be set for social, economic development accordance to the available regeonal resources. Although the restricted role of water resources in the economic development have been recognized, it has not be considered suffeciently in the planning so far. As one of vitally important part of water resources management, the relations between society economy, resources and environment must be handled perly. A very interesting fact is the agricultural water use in rural area of Beijing and Hebei Province. The water used in farming irrigation will reach 45.65 billion M^3 by the year of 2000, about 75% total natural water resources. If the agricultural water demand could be saved 10%, the quantity of 4.5 billion M^3/yr. water would be used for other purposes, which eguals to 1/2 of total quantity of water diverted form the Yangze River. The question is if the investment (cost) to save water is lower than investment to expand water supply capacity.

Concerned with water using efficiency, in the North China Plain, the increase of grains mainly depended on the high input of energy, water and fertilizers etc. so that the ratio of input to ouptput has been decreasing. Taking nine rural counties of Beijing Municipolity, from the investigation data collected during four periods, 1965-66, 1973-74, 1979-79 and 1983-84, it can be seen that in the 27 years the output of grains increased by 90%, output of eggs, meat and fish by 100%, but in the same period, the input of nitrate fertilizer increased by 343%, the input commercial energy was 337% more than that in years prior to 1965, pump wells by 441%, the capacity of irrigation and drainage were augmented by 367%. In these case, the transform rate of nutrition has dropped 51% and that of energy has dropped 223%. The question is that whether the better econonomic efficiency could be obtained whenwater supply capacity was enlarged through trans-basin diversion project. From the point of view in micro- and macro-economics the economic efficiency is a important standard in water resources management. In order to increase the econonomic efficiency the economic structure has to be charged into less water consuming one, water supply system and water using code into high effective ones.

2. Environment and Ecology.

The environmental and ecological issues were hardly considered in the water resources planning. The over-exploitation of water resources and bad management in both water supply and demand have caused aquatic and terrestrial ecological system retrogradation.

1) Water environmental pollution.

Because of over-exploitation of water resources the aquatic ecological system was heavily affected, first of all, water quality has been becoming worse and worse. Almost every river was polluted at different degree. The total quantity of sewage collected was over 0.7 billion M^3 in 1984 and most of it was not treated properly, so that there were almot no high level aquatic eaimal in the outflow rivers.

Secondly, the quantity of river water has been decreasing since

1960s. Only in the flood seasons there was floodwater flowing through the rivers where water flow during whole year in 1950s or 1960s. The decrease of water discharged into the sea affected not only the fresh-water aquatic ecosystem. but also the marine aquatic ecosystem, the fishery resources degenerated due to salt content increasing. and short of fresh water during oceanic fishery spawning from April to June

The water pollution affects the using value of water resources, and reduces the quantity of available clean water which make the water crisis even more serious.

2) The environmental issues in the terrestical ecosystem.

The over-exploitation and abuses of fresh water resources caused the violent change in the terrestical ecosystem. River water was stored in resources so that the surface of water body decreased and river dried; the over withdrawal of groundwater made water table drop down. As the result of terrestical ecosystem change, the farmland tend to sandy, the vegetation declined and the load capacity of farmland become small

A large amount of hydrolic facilities and the complex water using processes prolonged the detention time of water so that the quantity of evoperation enlarge. In Beijing area, the average annual rainfall was 10.0 billion M^3 /yr. and inflow from adjacent area was about 1.75 billion, while the average annual outflow (sewage plus flood) was no more than 2.5 billion M^3/yr. About 9.2 billion M^3 /yr. water disappeared through evaporation, transpiration and in human's using processes, which is 78.6% of total water obtained every year. The enlarged quantity of evoperation destrbed the natural water cycle, which is one of the most important affects on the terrestic ecosystem and may cause a series of bad results.

3) The Aridity of Climate

The essence of maintainence of natural water cycle is rational utilization of water resources. In the process of natural water cycle, if imbalance between water supplement and water consumption occurs, drought will happen. Therefore drought is not only caused by low precipitation, but also affected by the activities of human being. In the natural ecology, the ecological effects of water are collaborately interferred by both temperature and precipitation. For example, there are two place where the precipitation are the same, but in ecological sence, the warmer the place is, he drier it will be.

If the degree of aridity or arid index is defined as A==Eo/p, where Eo is the average annual quantity of evaporation potential (equals to pan evaporation) and p is annual precipitation. Then, the index in Beijing area is between 1.5-2.0. This figure shows that the climate in Beijing is quite dry. If the monthly or seasonal average data were used in the equation, the index would be much higher in spring, autumn or winter, in most cases, it would be greater than two, which means that in these three seasons the climate is much drier than summer.

In the Haihe-Luanhe River Basin catchment a lot of rivers have become dry in the most downstream region since a large number of reserviors were completed to expand water supply capacity. The losses of water and erosion of soil in mountainous area that were caused mainly by the bad vegetation on the earth's surface led to the supplement of groundwater decreasing sharply. In plain area the groundwater table declined rapidly and the moisture in the surface layer of soil was reduced because of the excessive exploitation of groundwater. The construction of reservoirs and diversion canals also cause an additional loss through the water surface evaporation. The decrease of moisture and precipitation brought about the invasion of the sand blown by the wind. The vegetation in mounatinous area decayed, and the forest ecologic system with high biomass production evolved into thick growth of grass with few species and low biomass production. This sign shows that the climate in Beijing area has shifted in the direction of aridity since 1960's compared with that in 1950's.

Since late 1950's the groundwater in eastern suburbs of Beijing has been heavily overpumped which causes sustained decline of groundwater table, and compression of the spongy deposition of quaternary-system. So the earth's surface subsidence appeared. The sufficient evidences showed that the speed of earth subsidence has been increasing. Prior to 1966, the speed was about 2-5 mm/yr., in the core region of subsidence area, and it increased to 10 mm/yr after 1970. At the beginning of 1980's, the speed reached 81 mm/yr. The total area of earth's surface subsidence in eastern suburbs reached 600 Km^2. The area where the height of the subsidence was greater than 100mm. approximated to 200 Km^2, which has led to the sustained expansion and depression of groundwater funnel underlying the urban area of Beijing. In order to stop the earth's surface subsidence in the near future, groundwater table must be maintained at a stable level, which means that the exploitation of groundwater will have to be controlled strictly.

3. Institutional Issues.

The third issue in the concept extension of water resources management is that the old institutional system was not suitable to the new requirements. The issue can be stated as how to unite many separated institutional organization into a water authority at river shed level or regional level, and how to coordinate the relation between the current separated institutional organization. There are five councils and six to eight bureaus in Beijing Municipality in change of water management in the field of water supply, water demand, dewage desposal. They challenged to water rights, investment of water engineering, etc..

Another issue related to institutional system was the research work was disjointed with planning, decision-making and production practice. The new water authority should have the responsobility to undertake these coordinative work and other legestrasive and excuative work.

Water pricing policy is another aspect of management, water pricing system must be reformed the current water price did not express the real composition of water supply cost so that it can not play a role to adjust water supply and demand. Low price was not in favor of water saving measures and options

These three issues stated above related to both water supply and demand, the main idea can be summarized as following:

----The objective of water supply and demand management is to form a low water consumptive economic structure and raise the economic efficiency of water using. If the objectove can be reached, it is desirable to develop regional social economy within the limitation of scarce water resources.

----Water resources management should include the water exploitation supply, reallocation utilization and disposal. Institutional work of water authority covers the planning, reasearch, organization decision-making, legistration, excuation, as well as surpervision, etc.

-----Water resources management should correspond with natural water cycle, the by-effects on ecosystem and environment should be seriously considered in every step of water resources management especially in the field of terrestical ecosystem that was almost nelected in the past.

Many problems in water resources management have been emerged. Some important ones are as follows:

1) The existing water resource system does not meet the demand of city development anymore. The urban water resources system is a complex one composed of many subsystems. Every subeyeterm should have a rational structure and be developed co-ordinately with each other. But the existing system of water resources is different from an ideal one. The urban scale has been over the bearing capacity of regional water resources. The indusstrial location is not geared to the water resources distribution'; the water works and networks are not suited to the practical demand' the construction of wastewater treatment systems falls behind water supply systems; groundwater reservoirs and surface water reservoirs are not conjunctively used; and also in some places (for example in the western suburbs) water supply system can not be separated from wastewater disposal system.

2) The traditional using water code can not meet the requirement of a modern society, In the past, the traditional way of water using was once-through use in industries, overflow irrigation in agriculture, and centralized water supply with high quality in domestic water uses. These ways can reduce the cost of water supply. So it is acceptable in the places having plenty of rainfall, but unreasonable in arid areas, such as Beijing area. The water using manner should be linked with micro-economic

efficiency under the prerequisite of having good macroeconomic efficiency. According to the requirement, the water using efficiency has to be raised by conjunctive exploitation and utilization of water resources, and the water with different water quality should supported to different water uses.

3) Through decentralized water management system, the water resourbces could not be rationally used. For example, groundwater conservation in the core area of Beijing is urgent, although it is agreed by the experts in different departments, the west suburban groundwater reservoir management project could not be get off the ground because nobody has responsibility to pay water bill for recharging water. So the groudnwater table in the region has been falling down, which led to the capacity of Water Works No.3 and No.4 declining continuously.

4) Bad water pricing poicy disencourages the water users to use water rationally. There are two mistakes in current water pricing policy. One of them is low water price that makes the proportion of expense for water consumption much lower in the totasl cost of products for both industrial and agricultural users. The other one is that the differences among water prices are so unreasonable that enterprises and residents are not able to get benefit throught water saving.

5) The capital investment is scattered among the different sectors, so that the effectiveness in investment can not be optimized.

4.3 How to Strengthen Water Resources Management

Water resources system is a complex system consisted of many subsystem, it also has close relations with other systems such as society, economy, environment, Among all subsystem the instituttional subsystem is only one that can coordinate the relations between inner or outer elements.

The way to strengthen water resources management is to form a water authority and to set a packet of teehnic policy.

What kind of water resources insitution should be selected and set up, will have to be determined based on the existing system and background of water resources management in Beijing. No correct model can be copied from abroad directly. It may be a better choice to set up a high level authoritatively, and comprehensively institution body with the definite objectives. The main responsibility of the Municipal Water Resources Council is to make all activities in water resources exploitation, allocation, utilization and conservation under control of the council, the responsbility includes:

1) Drawing up long-term and short-term planning and implement program based on the regional social and economic development objectives.

2) Rationing water resources, working out and approving the yearly water use scheme.

3) Drawing up law and regulations for water management.

4) Promoting water saving projects.

5) Adopting necessary measures to handle vital problems in water resources exploitation, utilization and conservation.

6) Organizaing scientific research and exchanging information.

The council should have its working body in charge of daily routine.

Based on background of regional water resources, the suitable institutions and rational management policies supplement with each other. It is needed to issue and consummate the institutional policies. The following policies are proposed:

1) The policies for water resource development
This set of policies includes to ensure the water supply in core areas; to supply water for satellite towns; to build new water resources engineering; to control groundwater withdrawall in urban and suburbs; as well as to manage surface and groundwater conjunctively.

2) The policies for water rationing
This set of policies covers to set water quota and to draw out water supply scheme, and to supply water with different qualities to appropriate water users.

3) Water pricing policy
To set rational water price system is for balancing water demand and supply.

4) Water Saving Policies
Water saving policies are used for promoting the reform of economic structure of water saving and popularization of water saving measures and facilities.

5) The policy for wastewater reuse
The policy is issued for encourage wastewater reclamation and reuse and dual water supply system construction.

6) The policy for water resource conservation
In order to prevent of loss of water and erosion of soil, to control water quality in term of subdivision, as well as to protect drinking water sources and groundwater replenishment zone. The policy has to be issued.

7) The policy for rewards and punishments
The policy is applied to reware those people who makes contribution to water saving or water resource conservation, and to punish

those people who abuse water, damage water facilities and pollute water sources.

8) The investment policy

The policy implies to collect and allocate investment interb-gratively for seeking the best investment efficiency, and to determine the priority order of differnet alternatives based on the cost-benefit analysis.

Water crisis has be becoming more and more series in the glode scope. In 1970s, the oil crisis occurred which affected the economic growth in most developed countries, but soon it was released. It is evident that water crisis problem is even more difficult to be solved because it is too expensive to transfer water from this continent to an other, and there were almost no substitutes of water for human being. So to strengthen water resources management in both supply side and demand side will be only a possible solution to quench water crisis thoroughly.

IMPORTANCE OF ENVIRONMENT MONITORING AND MANAGEMENT

IN WATER POLLUTION CONTROL IN FUJIAN

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Fujian Province, with the sea on the east and uplands in the other sides, has an area of mountain land of 90% of the total area in the province. The coverage rate of woodland in the province is 39.5% and is the highest value in China except that in Taiwan Province. Fujian has coast line over 3,300 km long, which is the second in all the coastal provinces. Rainfall is rich and the average annual precipitation is over 1,400 mm. The total length of all the rivers in this province is 12,850 km and it is about 0.11 km per square kilometer in average. Generally speaking, the environmental capacity for purification should be great. Moreover, industry is not very developed and economic is still backward in this province. As a result, one may calculate that environmental quality in Fujian should be fairly good. But there are still some serious problems of water pollution are ecological destruction. And it has been found to be very important to study in detail the major features of natural and social environments in Fujian Province.

1. Major Features of Natural Environment in Fujian Province

1) The coast line in Fujian is winding with a curvature of 6:1, which makes to be easily retained. The river mouths along the coast are mostly in the form of deltaic bays and are good for building harbours. With small environmental capacity, water exchange between the inner water and the outer water is poor, which induces water pollution. Further more, the major pollutants in the province are organic pollutants and oils, being over 90% of the total load of pollution, and rich nitrogen and phosphorous and high water temperature provide the conditions for the outburst of red tides. Undoubtly, the prevention of the potential danger of red tide outburst in bays and harbours is one of the strategy in water pollution control.

2) The distribution of rainfall is uneven. In every year, the rainfall from March to June is about 50-60% and from October to March of the next year it is only 10% of the total amount of rainfall in a year. Some rivers which rely on rainfall for water supply have lower runoff in dry seasons. But the sewage discharge often exceeds runoff of the rivers. The river water becomes black and stinking, and no fish nor shrimp could survive in it. The conditions have produced serious impact on the local

people for drinking and irrigation. For example, the Mulanxi river has very low runoff in dry seasons, and at the same time three large sugar refinery factories begin operation and discharge a great amount of sewage containing high concentration of BOD and COD which turn the water black and stinky. The life of than 300 thousand people along the river is seriously harmed. The same problem exists in Baguagou river in Zhangzhou, Longjinhe River in Lonyan and inner rivers in many cities.

3) The average cultivated land per capita in Fujian is amll. According to the statistic data, the cultivated land is 0.76 mu per person in this province and is only 0.3 - 0.4 mu per person in the counties along the coast. It is estimated that in the year of 2000, the average cultivated land for each person will be only 0.6 mu in this province. In order to enlarge the area of cultivable land, measures such as recreation of land from sea, woodland and waste land have been taken, which induce the loss of water and soil and destruction of ecosystems. In order to increase the agricultural production, chemical fertilizer has been used in over due amount which induces soil pollution. Further more, the development in large scale of neighbourhood enterprices has also added burden to the environment. Pollution has developed very quickly. The agricultural ecology environment has been started to be destructed, and the suspension load in waters and pollutants of chemical fertilizer and pesticides in the environments are being increased.

2. Major Features of Social Environment in Fujian Province

1) The industry in Fujian Province is dominated by small enterprises. According to statistical data, the output value of small enterprices is about 72.3% of the total and the number of small enterprices is 70,7% of the total number in this province. Small enterprices are featured by backward technology, old equipment, higher demand on raw material and energy, large amount of waste water, waste gas and solids, weak power of technology and economic and lower ability for pollution control. The discharge of waste water, gas and solid from factories, accounting for the output value of 10 yuan higherthan the average level in China. But the control rate is lower than that in average in the country. In comparison with the discharge amount in 1981, it has increased 32% - 78% in 1985, of which, paper mills play an important role. In 1983, the total number was 508, of which 412 paper mills are township or neighbourhood enterprises. Most of the paper mill do not have any dewing for waste treatment and consequently have brought great haar to water environment. It is estimated that in 1990, the discharge of waste water, gas and sludge from industries will increase 1-2 times, which is considered as the major cause of under development of industry and quite serious pollution in local areas in Fujian Province.

2) In Fujian Province, economic and basic construction are not fairly developed, and municipal environmental quality is low. Cities, with high density of industry and population, require a large amount of materials and energy, and discharge in large scale waste water, gas and sludge. Consequently, ecology can not be self-equalibrated in cities and artificial ecosystem should be intensified, by construction of sewage treatment plants, gasworks and garbage treatment mills etc. In all the cities of the province, only Xiamen City is building sewage treatment plants while Fuzhou City has only one experimental plant which treats 5,000 tons of sewage per day. It is estimated that no sewage treatment plant is able to be built in recent years in all the other cities. In many cities, even the sewage system are not complete, so the intensification of basic construction in cities should be put on the agenda.

Based on the above analysis of the major features of the natural and social environment, organic pollution in waters is a common problem in this province. There also exist two pairs of sharp contradictions, i.e. the contradiction between water pollution and aquaculture, the contradiction between water pollution and water use for irrigation and drinking. There exist three potential harmfulness, namely potential danger of red tide outburst in estuaries and bays, spreading and worsening of acid rain, and the destruction of agricultural ecosystem. Thus, water pollution control is an important long term strategy.

With personal view point the strengthening of environmental mornitoring and management is the base for water pollution control, and it is a suitable way for environmental protection in China.

First, it is the idealogical basic to heighten the environmental consciousness of all the people, especially the environmental consciousness of leader in various level and departments on water pollution control. We understand that the purpose of protection is to protect natural resources and human health and finally to protect productivity. In the past, people were not aware of the importance of environmental protection. They scrifice the productivity of the environment to pursue one-sidely transient productivity, which has brought forth the pollution of the environment and destruction of natural resources and harmfulness to human health, and has in turn hindered the development of productivity.

To protect water environment is the life water resources development. "The resolution on the guiding policy in the building of spiritual civilization" adopted in the sixth Section of the 12th Congress of the Central Committee of Chinese Communist Party points out clearly that: It is essential to encourage everybody to love public property, protect the environments and resources and to do his duty consciously for the country and society." Therefore, to protect the environment is not only a criteria of material civilization but also a criteria of spiritual civilization and the level of socialist morals, and it is also the obligation to which every civilian must do his duty. We must take "Environmental Protection Law", "Marine Environmental Protection Law" and "Water Pollution Control Law" as our guidance of action and the theoretical basis for the unification of our realization. We should rely on law once there is a law, and enforce the law strictly and punish those who violate the law.

Secondly, overall planning and rational arrangement are the most essential tasks in water pollution control. Planning is the concrete arrangement of decision-making in time and space. The comprehensive development of water resources in Fujian Province is to bring forth a harmonious atmosphere and mutual promotion among industrial construction, harbour and pier construction, urban and countryside construction,aqnaculture, agriculture, forestry, husbandary, planting, tourism and various resources in the ocean environments. The most important thing is making overall plan in long term, combining with the short term benefits from all the aspects. The shortterm arrangement should be based on the full consideration of the features of natural environments in this province. In the process of planning, two tendencies should be opposed, namely the tendency of developing aquaculture in areas wherever there is water and the tendency of discharging sewage wherever there is water. The different function of water bodies should be determined rationally, and the targets of water environment control should be determined based on its function. The water quality should be mornitored based on its targets to enter the realization of the targets and to meet the requirements to the function of water bodies.

Thirdly, we must strictly implement "the regulation of environmental protection and management for the construction terms" and insist on carrying out the system of environmental impact assessment and transformation construction terms. This system should be taken as the basis for the approval of a term, selection of site and designing. The system of designing, construction and operation of a factory should be simultaneously enforces, so that the new pollution sources can meet the discharge requirements stipulated by the state and local governments. The old pollution sources should be control by incorporation with technical transformation and using new technology which turns resource and energy into products to the highest extend and decreases the discharge amount of pollution to a less degree. New equipment which produces no pollutant or less pollutant and low noise and saves resources and energy should be adopted. Raw materials withouttoxin or harmfulness or with less toxin or harmfulness should be used. Purification and treatment equipment with advanced technology, high efficiency and low cost, and economic and rational principles should be adopted. The old pollution sources should be put on the plan for technical transformation in a planned way. Especially, the old pollution sources which have great effects on water environments such as paper mills, sugar refineries, chemical works, printing factories and foodstuff manufacturers, should be put on the plan as early as possible. The environmental management of township or neighbourhood industries should be strengthened. The industry and commercial management departments should release the license to the township or neighbourhood industries which have not obtained the approval from the environmental protection departments. Waste discharg, which exceeds the standard, from the township and neighbourhood industries should be charged so as to control pollution by using of economic lever.

Fourthly, to attach great importance to the work of survey, research, assessment and mornitoring of water environments is the prelude of pollution control in a scientific way. At the present, efforts in Fujian province should be concentrated on the investigation and study of the present condition of water environment, transformation of pollutants, the self-purification capacity of major pollutants, and the environmental capacity in South Fujian Golden Triangels, including, Xiamen, Zhangzhou and Quanzhou, and the economic development zone of Meizhou Bay, Mawei, Fuzhou and the valley areas of the Minjiang River and Shaxi River. In these areas, the ecological theories should be taken as the guidlines in the regional environment planning. How to use the rainy and dry seasons in this province, How to adjust rationally the discharge of organic pollutants, How to use the self-purification capacity of the ocean environments and rationally design the sea outfall works, How to study the sea outfall plans in ebb tide period by using of the adjustment pools, How could the acid waste water from the sugar refineries transform the salinized soil along the beach, How to eliminate the effects of foam of waste water from paper mills and how to adopt the measures of deep-layer discharge, How to utilize oxidation ponds to treat municipal sewage from people living after from the city, How to rationally design the network of mornitoring and determination for pollution spources and how to deal with pollution accidents, All these should be investigated and studied. In general, environmental research and mornitoring should be carried out by fully considering the concrete state of art in this province.

Fifthly, it has been necessary to strengthen environmental protection units with technical personnels, to strengthen environmental mornitoring and management, to complete the system of environmental laws, policies and standards, and to strengthen training and education for environmental management. To strengthen environmental monitoring and management is a policy with the least cost and the highest efficiency and it is the Chinese-type way for environmental protection. Under the circumstances of less funds for environmental protection work in Fujian Province, water pollution can only be fundamentally controlled through the strengthening of environmental mornitoring and management.

DISCUSSION ON THE REALIZATION OF CONTROL OVER TOTAL QUANTITY OF POLLUTANT DISCHARGE IN WATER SOURCE PROTECTION AREA IN UPSTREAM HUANG-PU RIVER

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ABSTRACT

This article illustrates the necessity of implementation of control over total quantity of pollutant discharge in the water resource protection area in upstream of Huangpu River. Combining their working experience, the authors put forward the concrete methods with enacting the discharge license to carry out the policy of control over total quantity of pollutant discharge and demonstrate the imperative conditions of implementation of discharge license. Meanwhile, they discuss the physical issues and take part in the valuable test in order to strengthen the environmental administration.

Upstream section in the Huang Pu River is the intermediate area where pollutants from the upper stream will be received and then discharged downstream, that is, by this area not only the waste water discharged from the pollution source in the same area must be received, but also it will be influenced by polluted water from the upstream and those from the city center downstream owing to tide-being in. After the water-intake section of Shanghai municipal water supply has been removed upward to the place in vicinity of the Huang Pu River Bridge, upstream section of the Huang Pu River will become the main water source of Shanghai. Recent years, in order to protect the upstream water source, we follow the concerned regulations of "Articles for protecting the upstream water source in the Huang Pu River of Shanghai"(1) and management method of controlling total quantity of pollutant discharge in combination with the control of discharge concentration has been executed. Index for controlling total quantity of pollutant discharge has been assigned to each major units for pollutant discharge in the form of pollutant discharge permission license. In this paper, authors attempt to make some discussion and exploration about the problem of controlling total quantity of pollutant discharge in connection with the practices in our work.

1. The necessity of implementing the control of total quantity:

With the continuous development of production and the population growth in Shanghai, water quality in the Huang Pu River is deteriorated gradually. According to the analysis based on water quality monitoring data in 1985 (2), if measured in terms of the 3rd grade of national standard for surface environmental quality, non-polluted section of the Huang Pu River (in conformity with the 3rd grade water standard) is only 32.6 KM long, amounting to 28.7 % of 113.4 KM -- the whole length of the Huang Pu River, it means that the polluted section of the Huang Pu River (not in conformity with the 3rd grade water standard) is 80.8 KM long, amounting to 71.3 %. But 80 % of water supply for Shanghai City is taken from the river section along Shanghai City where more than 80 % of pollutant discharge of the city concentrates, thus, causing an extremely unreasonable jagged interlocking pattern of water supply intake ports mixed with polluted water discharge ports. It is not in conformity with requirements of sanitation to take water body in the river along section of Shanghai City as the source of drinking water. Therefore, a decision has been made by Shanghai Municipal Government to remove the intake port of water supply upward to the upstream of the Huang Pu River near the Huang Pu River Bridge. This construction started formally in 1985, and it is expected that the first stage of construction to connect the new water source will be finished on July 1, 1987. Besides, this construction is believed to be the biggest scale civic substructure since the liberation. According to data analysis (3), the water quality in the river section near the Huang Pu River Bridge for the time being is approximately equivalent to that in the river section along Shanghai City in the middle of Nineteen-Fifties, basically in conformity with the second grade of national standard for surface water environmental quality. "Basically" is meant that at a certain period of the year, some separate index of water quality is still not in conformity with the second grade water standard. The reason is that the Huang Pu River being one with tide, polluted water in downstream section may reach the river section near the Huang Pu River Bridge with the tide being in. Probabilities of polluted water in river sections along Wu Jing and Min Hang flowing upward to the section near the bridge are 64 % and 95 % respectively (4). In upstream area of Huang Pu River along river section from Long Hua to Mi Shi Tu with a length of 45 KM, there are located four industrial areas, i.e. Gang Kou, Wu Jing, Min Hang and Song Jiang, which are industrial areas for paper-making, building materials, chemical industry, as well as machinery and electrical machine-building developed gradually after liberation (1949). The above areas are listed as one of the priority areas of investment and construction in the period of the Seventh Five-Year Plan because of their favorable conditions for further development, such as, vicinity to city center, plenty of land available and relative perfection and convenience in power supply, traffic and public utilities, etc. Hence, there exists great cotradiction and conflict between economic development and water source protection in these areas. On the one hand, the river section along these areas will become main source of drinking water supply for Shanghai and substantial measures must be taken to greatly reduce the quantity of pollutant discharge, so that water quality in the water source can be assured to reach the specified national standard; while on the other hand, important constructions will be undergone in these areas, and consequently, threatening of new pollution will certainly be produced here. How to handle well the conflict between water source protection and economical development becomes the practical but difficult task for every worker on environmental protection to accomplish. Our aim is to find an approach to scientific management, and to coordinate correctly the relationship between economic development and water source protection, in order that on the premise of protecting the water source without any being polluted, economic construction in upstream areas of Huang Pu River can be developed normally and continuously.

In the past, we adopted the management method of controlling concentration of discharge for point-pollution, that is, we demanded that the concentration of pollutant discharged to the environment should be in conformity with the specified national standard, and the unit of discharge should pay fine for above-standard discharge. This method played an active role in controlling environmental pollution, but owing to lack of low legality conception and practising fraud by some units in addition to the inadequacy of monitoring forces, a huge quantity of cooling water or water supply is added to dilute the pollutant discharge for the purpose of paying less or no discharge fee, thus, the concentration of pollutant was kept within the limit of standard, but the absolute quantity of pollutant discharge was still multiplied. Therefore, the goal of controlling pollution could never be achieved. At present, the management method of controlling total quantity of pollutant discharge in combination with the control of concentration in the upstream area of Huang Pu River — the protected area of water source of Shanghai and has assigned licenses of pollutant discharge to the units concerned.

The so-called "the control of total quantity of pollutant discharge" is exactly the management method to control the total quantity of pollutant discharge into the upstream waters within a certain limit in terms of a consolidated effective measure and to lower gradually the total quantity of pollution load discharged into waters, thus, enabling the water quality to be in conformity with the standard of drinking water source. As regards the starting points ascertained by the total quantity of pollutant discharge, the first one is to utilize the purification capacity of water body to its fullest extent (that is, the self-purification) while the second one is to consider the conditions of pollution as far as possible and the existing status of technique for treating the pollution and economic tolerance capacity. According to the above two requirements, the permissible maximum pollutant discharge (i.e. the environmental capacity) to meet the requirements of environmental target in the waters may be calculated by using the water quality mode. Based on the preliminary calculation, thepermissible maximum COD discharges in upstream sections along the Huang Pu River (take COD as an example) are listed as follows:

Upstream section of the Huang Pu River	Permissible maximum COD discharge Tons/day
Gang Kou, Wu Jing	15.15 , 27.75
Min Hang, Song Jiang	5.65 , 5.91

Then, the above index should be broken down, allocated and assigned to each enterprise or institution in the form of license of pollutant discharge as the legal index of discharge. Each unit should shoulder the legal responsibility to obey the specified quantity of pollutant discharge and the correct mode of discharge for the purpose of assuring the target of local waters environment.

In short, there are advantages of implementing the management method of controlling total quantity of pollutant discharge in combination with the controlling of discharge concentration. Firstly, the total quantity of pollutant discharge is directly associated with the environmental capacity, therefore, promoting the realization of environmental target; secondly, lawful means is reinforced. The unit by which, pollutants discharged exceed the specified discharge index or the requirements of environmental protection can not be met overdue, should be accused of violating the law, thus, the realization of environmental target is guaranteed by means of law, and thirdly, the pollutant discharge index is allocated and assigned to each unit. It is clear in legal responsibility for each unit and thus, promoting the initiative of each unit to treat the pollution.

2. Concrete approaches to executing total quantity control:

According to the experiments made in some units these two years on execution of management method in controlling pollutant discharge total quantity in combination with control of discharge concentration which is realized mainly via implementing the system of pollutant discharge license. The concrete approaches are as follows:

1) Enforcement of application for pollutant for discharge:

Application for pollutant discharge is the basis of executing the system of "pollutant discharge license", which is also the important symbol in appraising the level of management and conception of law for any unit. Therefore, we designed an investigation form on industrial waste water discharge in upstream areas of the Huang Pu River in Shanghai and asked each unit of pollutant discharge to fill out the form seriously about pollutant discharge quantity in 1982, and the detailed situation about pollutant discharge in 1985, the quantity of polluted water to each pollutant discharge port and the concentration as well as the quantity of discharge for each pollutant factor, etc. Besides, the detailed report concerning the concrete measures to reduce the pollutant, the quantity of reduction, the year to achieve the target etc. were required. Each unit made repeated investigations on conditions of pollutant discharge in its own factory, calculated the quantity seriously and reported exactly. When submitting application for the pollutant discharge, a lot of units of pollutant discharge put into effect the plan of pollution treatment. For example, after the completion of the two items in Wu Jing Chemical Factory: dimethyl sulfate dilute ammonia spirit and copper pickling waste liquid ammonia and nitrogen, quantity of ammonia and nitrogen discharged may be reduced by 3 tons every day, amounting to 30% of the quantity of ammonia and nitrogen discharge in the factory. A set of bio-chemical treatment facility for polluted water has been expanded in size in Wu Jing Coke-Chemical Factory by which the quantity of phenol discharged daily can be reduced by some 80 KG. After the completion of items for treating the waste alkline liquid of benezene flush residues, and coumarone waste water, COD discharge may be reduced by 4 tons each day, approximately amounting to 30% of total ammonia and nitrogen discharge in the factory. In addition to the urgent treatment of waste water and promotion of treatment effect, these factories further strengthen their forces on environmental protection and management with a view minimizing the quantity of pollution.

2) Enforcement of verification of total quantity:

The index for controlling the total quantity of pollutant discharge in principle is worked out on a fair basis in accordance with the environmental capacity, existing conditions of pollutant discharge, technical and economic feasibilities in the local area. According to the research and analysis by Tongji University (5), if the requirement specified in the "Articles", that is, the surface water environmental quality in protection area of water source being promoted to the second grade of standard, while that in the subprotection area of water source being promoted to the third grade of standard, would be met, all the units of pollutant discharge should reduce 60% of pollutant discharge based on the discharge quantity in 1982. The permissible quantity of pollutant discharge will be allocated in the form of pollutant discharge license to the units of pollutant discharge along the river. Every unit must control the pollutant discharge effectively according to the requirements of license in combination with the measures, such as, technical transformation, modification in technology, installation of pollution treatment facilities, and strengthening pollution administration.

Method of two grade administration is adopted in verifying total quantity. Fourteen big factories with 80% of the total discharge quantity in upstream area of the Huang Pu River will be directly verified by Shanghai Municipal Bureau of Environmental Protection, while other units of pollutant discharge in the respective areas under their supervision will be verified by the environmental protection departments of each district and county. We regard the sum of permissible pollutant discharge quantity allocated to each unit in the supervision area of district or county as the permissible total quantity of pollutant discharge in the area of that district or county. In consideration of more serious situation of pollution by COD, BOD_5, ammonium and nitrogen, oil, phenol, copper, mercury, etc. in water body in upstream areas, requirements for reducing the pollution factors mentioned above must be met and guaranteed, while method of "elastic administration" can be adopted for other pollution factors. We don't mean that every pollution factor must be reduced by 60%, but the specified reduction of total quantity must be satisfied.

After having made efforts for several years and having attained the standard of discharge for every pollution factor, such unit will not be assigned further requirements of reduction generally. In some units, if a part of pollution factors have really attained the standard of pollutant discharge, while other part have nearly attained the standard, but even all factors have attained the standard, the quantity of reduction is still below 60%, such units may be approved on the condition that all factors have attained the standard to discharge. For those units with large quantity of pollutant discharge, although, concentration of discharge at the discharge port can attain the standard owing to the pollutant being diluted with large amount of cooling water, strict requirements for further reduction will be assigned too.

According to the above principle, we verify the application and report from each unit one by one, including repeated verifications on the source of data, reliability, feasibility, etc. and make the necessary discussion.

During verification, we adopt a combined index — "pollutant over standard equivalent"(6) to make a comprehensive analysis on situation of pollutant discharge and degree of environmental pollution in every unit. Based on this, we formally verify and approve the control index of total quantity for each factory. Mathematical formula for calculating "pollutant over standard equivalent":

$$I = \sum_{i=1}^{n} I_i$$

$$I_i = \frac{C_i - S_i}{S_i} \cdot Q \cdot \delta \cdot 10^{-4}$$

Where:

- I — pollutant over standard equivalent, the sum of pollutant over standard equivalent for every pollution factor. 10000 M^3/day.
- I_i — pollutant over standard equivalent for a certain pollution factor. 10000 M^3/day.
- C_i — average value for times of over standard actually measured for a certain over standard pollution factor. mg/l.
- S_i — national or local standard for discharge for a certain over standard pollution factor. mg/l.
- Q — quantity of waste water discharged daily at a certain pollutant discharge port M^3/day.
- δ — over standard ratio
  over standard times/monitoring times.

Definition of pollutant over standard equivalent:

Over standard times of a certain over standard pollution factor multiplied by quantity of polluted water discharge and further by over standard ratio. If there are n pollution factors m pollutant discharge ports, we should make calculation separately and then add to make a total quantity. Physical implication of pollutant over standard equivalent:

Be equivalent to the quantity of fresh water consumed for enabling each over standard pollution factors in polluted water discharge to attain separately the discharge standard. It has a unified dimension and clear physical meaning, and can be used to measure the degree of pollution on environmental imposed by the unit of pollutant discharge which has advantages of better comprehensiveness and comparison

The detailed situations of pollutant discharge and the permissible verified and approved discharge index in 1985 for the fourteen units of pollutant discharge verified directly by Shanghai Municipal Bureau of Environmental Protection can be seen in Table 1 and Table 2.

In Table 1 and 2, the important pollution source and pollution factor are shown sharply, therefore, it is clear to find the target of management and easy to manage. If the discharge quantity of polluted water is not increased, only we verify the index of "pollutant over standard equivalent", can the total quantity of pollutant discharge be controlled effectively. Under the special condition, requirements of additional control over individual important pollution factor may be made too, which is simple, convenient and flexible in application.

3) Assignment of pollutant discharge license:

Pollutant discharge licenses may be divided into two kinds: the formal one and the temporary one.

To any unit its pollutant discharge quantity was reduced by 60% at the end of 1985 as compared with that in 1982 or all of its pollution factor in the discharge had really attained the limit of standard, the formal license of pollutant discharge may be assigned and discharge quantity of every pollution factor or the allowable discharge quantity should be clearly recorded in the form. Discharge quantity of every pollution factor is basically in agreement with the allowable one. But there are a few units, every pollution factor of which is much lower than its standard discharge quantity, therefore, in verification, the allowable discharge quantity may be permitted slightly greater than that in 1985. By such a practice, the enterprise concerned may be encouraged for providing with some tolerance in pollutant discharge.

To any unit, its pollutant discharge quantity was not reduced by 60% at the end of 1985 as compared with that in 1982, only temporary license of pollutant discharge can be assigned. In addition to the actual and allowable discharge quantity of every pollution factor in 1985 filled in the recording form, the year when the unit should accomplish the target will be specified. The schedule of the year being dependent on the degree of pollution, quantity of pollution treatment and the technical complexity will be limited to one or two years at least, or three to four years at most, but within the end of 1990.

The recording form becomes effective immediately after two of it have been signed and stamped by the leader of the unit of pollutant discharge and head of environmental protection department. Both parties keep one copy. Every year, an irregular inspection and appraisal of the environmental protection work will be held and organized and results of inspection and appraisal should be recorded in the form.

There are totally more than 300 units of pollutant discharge in the protection area of upstream water source. Up to now, there are 108 units which have completed the work of verification and approval for the licenses of pollutant discharge and the pollutant discharge quantity of which amounts to approximately 95% of the total quantity of the pollutant discharged by all the units in upstream section. Among the 108 units, 18 units have been assigned the formal license and 90 units the temporary license. Hereafter, any unit which has been assigned the formal license must discharge the pollutant only in accordance with the permissible quantity. If quantity of discharge is found to exceed the permissible limit, it will be regarded as an unlawful unit and should be responsible for the act and will be prosecuted.

3. The necessary conditions for executing the system of pollutant discharge license.

The execution of the system of pollutant discharge license is a new trial on strengthening the enforcement of environmental administration. In foreign countries, this system has been proved to be an effective method. However, in China, this system is just being executed for the first time, no matured experience can be made use of. According to the enforcement of this system in some chosen units for two years in Shanghai, we think that if the system pollutant discharge license should play truely the effective function in environmental administration, then, attentions must be paid to the following points:

1) All the units discharging waste water must obey the regulation of administration, which is the key point in the execution of the system of pollutant discharge license. Assignment of pollutant discharge license is a means of administration, the aim of which

is to bring the situation of pollutant discharge of the enterprise and institution into line with the environment target administration. To speak in popular terms, it is just the planned distribution of "environmental protection ticket" similar to that of food coupon. In other words, the aim of this sys tem is to control the quantities of pollutants discharged from each enterprise and institution within the permissible limit required to make the water quality in the area of water source protection attain the second grade or third grade, and to adopt a planned pollutant discharge. Assignment of license is the first step in the execution of target administration. If overlooking the concept of law, taking it lightly and being negligent in treatment of pollution and environmental administration, the unit, to which even the license has been assigned, may still discharge pollutant above the specified index, and violate the law. As regards the units, to which, temporary licenses have been assigned, they have no reason to lower the requirement imposed on them, and must take every kinds of measure to meet the requirements of reducing pollutant discharge as quickly as possible.

2) Strengthening supervision and inspection and strict law enforcement:

The execution of license system is specified by "Article", therefore, it is valid in law. However, whether it can be really enforced depends on the strengthening of supervision and inspection by environmental department in addition to the strict law-abiding by all the units. During these two years, we have imposed some measures, such as, warning, notice of criticism, compulsory correction within a specified period and fine on some unit violating the law according to the regulations in the "Article". It is very necessary for such measures to enforce the license system. Last year, in order to strengthen supervision and inspection, environmental departments headed by Shanghai Monitoring Center made sampling monitoring on three major units of pollutant discharge in Wu Jing area separately. Hereafter, such monitoring should be formed into a system. Sampling inspection of the situation about the execution of license system will be made irregularly on all the units of pollutant discharge in the areas of water source protection for the purpose of assuring the successful execution of license system.

3) Stressing on the treatment of pollution source:

In order to fulfil the environmental target in upstream areas, it is necessary to arrange the appropriate pollution treatment facilities. According to the preliminary analysis, it is advisable for some major units of pollutant discharge to spend investment of more than sixty million yuan (based on price in 1982) in the construction of some fifty items of pollution treatment, and it is also feasible for those units to reduce the quantity of pollutant discharge by 60% or more after four or five years. At present, the key weak link is the fund of investment. In addition to actively raising funds by factory and enterprise according to the principle of "who polluts, who treats", the authoritative departments should also give the affiliated units support, including some financial favor (premium).

4) Strict control of new pollution:

After the execution of the license system for discharge, the control index in the total quantity may be comprehensively balanced and adjusted within the scope of district and county. As regards the water environmental capacity of upstream sections of the Huang Pu River, only the reduction of quantity of pollutant discharge is allowed, while increase in quantity is forbidden. However, when the quantity of pollutant discharge by a certain area is smaller than the index assigned to that area, owing to the efficient environmental administration and the timely construction of pollution treatment facilities, then, some items of construction with a little pollution and high economic effectiveness will be permitted to develop in that area. Some units with a lot of pollution and low economic effectiveness may also be shut down, stop operating or removed to other places according to the plan, hence, the control index of pollutant discharge they curbed will be assigned to the new enterprises with a little pollution, but high economic effectiveness. In our practice, there has been an instance as follows: Fei Da Feature Clothing Company is an enterprise for developing export products which is high in economic effectiveness but without any control index of pollutant discharge assigned. Under the support and coordination of county and town governments, an oil barrel factory with big quantity of pollution and inferior economic effectiveness was removed. Index of pollutant discharge left by oil barrel factory was transferred to Fei Da Feature Company, while the latter gave some proper economic compensation for the former one to remove. By such a method of transferring index of pollutant discharge, pollution is under control and economic development promoted too.

4. Some problems necessary to be investigated:

1) The area of upstream water source protection where two districts and six counties cross, covering a total area of 830 square KM and located are some 300 units of pollutant discharge. The task of water source protection there is characterized by its huge quantity, big area, heavy duty, strict policy execution and highly diversified specialties. But at present, the force engaged in protection of water source is very weak at levels of city, district and county, unable to undertake such a complicated task. Hence, the organization for protection of water source in upstream areas with power and authority must be established and cadres specialized

in environmental administration assigned to be fully responsible for the protection of water source in upstream areas.

2) *Enforcement of controlling* the total quantity of pollutant discharge:
Quantity of polluted water discharge and the concentration of pollutant discharge are two basic elements. Now, we lack the means of metering for polluted water discharge and the measurement of waste water is inaccurate owing to the rough estimate by experience and water flow from upstream, thus, giving rise to a lot of difficulties for control of total quantity of pollutant discharge. Besides, there are few technical staffs in the monitoring of concentration of pollutant is not a few units, resulting in the scarcity of scientific basic data for control the total quantity of pollutant discharge. Therefore, the instrument for automatically monitoring the waste water flow suitable for application in various conditions must be developed, data base be established, and metering system, as well as system for monitoring water quality be set up in every unit of pollutant discharge; while a full systematic and long term monitoring and analysis must be made on the conditions of pollutant discharge of every unit (including quantity and quality of water) by environmental monitoring department and data obtained input to database.

3) For the time being, "license of pollutant discharge" is only executed on trial in enterprises, but these non-point pollution sources both huge in quantity and big in area, (mainly concerning the pollution caused by agriculture and living in town and city) are still not under control and administered owing to the absence of monitoring means. This is a weak link in environmental administration which can not be overlooked, otherwise, the protection of water source in upstream areas certainly will be greatly influenced.

4) Source origin of the Huang Pu River is situated in Zhejiang province and Jiangsu province. In order to carry out the protection of water source in upstream areas perfectly, we must ask support and coordination from the two provinces. Therefore, cooperation, coordination and regular discussion about the protection of water source should be strengthened.

Table 1. Relationship of pollutant above-index equivalent and permissible pollutant above-index equivalent of 14 major units of pollutant discharge in 1985

Units	Discharge in 1985 m^3/d	Permissible discharge m^3/d	Rate of reduction %
Hong Wen Paper Mill	216935	70000	67.7
Synthetic Detergent Factory	14880	9717	34.7
Wu Jing Chemical Factory	838428	278673	66.8
Shanghai Coke Factory	837065	244790	70.8
Shanghai Electro-Chemical Factory	141490	61998	56.2
Dyestuff Chemical Factory	145825	86952	40.4
Shanghai Electric Machine Factory	0	0	0
Song Jiang Pulp Factory	69461	0	100
Red Flag Medical Cotton Factory	13900	3000	78.4
No. 2 Metallurgical Plant	28308	280	99.0
No. 2 Copper Tube Factory	3120	1500	51.9
Dian San Lake Brewery	30471	0	100
Water-Sport Gymnasium	0	0	0
Grand View Garden	0	0	0
Total	2339883	756910	67.7

Table 2. Relationship of total quantity of pollution element discharge and permissible total quantity of discharge in 14 major units of discharge in 1985

Pollution element	Discharge in 1985 Quantity of Pollutant		Permissible discharge Quantity of Pollutant		Reduction rate of equivalent
	pollutant kg/d	equivalent m^3/d	pollutant kg/d	equivalent m^3/d	%
COD	86914	506115	33221	146453	71.1
NH_3-N	14810	785105	6651	237225	69.8
Oil	4435.5	153014	2963	64750	57.7
SS	52415	33926	29824	1073	96.8
Phenol	439.2	410864	157.5	124984	69.5
Cu	38.17	18028	15.35	1500	91.7
F	768.1	39568	833.4	39568	0
S^{--}	180	134746	77	31746	76.4
CN^-	101.2	80921	71.9	39921	50.7
Benezene	16	822	16	0	100
Zn	1.98	0	9.25	0	100
Ni	15.96	63	20.96	0	100
Cd	2	4378	2	0	100
Cr^{6+}	4.07	7537	10.43	0	100
Mn	6	117	12	0	100
As	23	0	25	0	100
Nitra-benezene	16	1919	7	0	100
Antimony	68	13653	7	0	100
PH, color etc,	—	149107	—	69690	53.3
Total	—	2339883	—	756910	67.7

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Some Problems on Water Environment Management

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Water is an unreplaceable natural resource, and is an important component part of natural environment. It occupies an important position in economic construction, social development, and human livelihood. Rational development and utilization of water resource, prevention of pollution and damage to water environment is an important national policy.

China's fresh water resource is not abundant, and because of its uneven distribution in time and space, water resource in certian parts of our country is very limited. Geographically, water resource is ample in the three river basins(Changjiang river, Zhujiang river, Song Huajiang river) but very limited in the other river basins (Huanghe river, Huaihe river, Haihe river, Liaohe river). The main water shortage districts are: the plains of Huanghe river, Huaihe river, Haihe river, the power source district with Shan Xi as its center, the central and southern parts of Liao, and the Jiao dong peninsula. The water shortage problem is even more acute in the following cities, Beijing, Tian Jin, Shen Yang, Da Liang, Tai Yuan, Shijia Shuang, Qindau. With the development of economic construction and urban construction and population increase, quantity of water consumption is steadily increasing, the contradiction between supply and demand of water is becoming very acute. At the same time, large quantity of industrial waste water and domestic sewage is discharging to water bodies, polluting surface water and ground wafer, which leads to further reduction of water resource and deterioration of water environment quality, and this has made the question of water resource the control point of economic construction and urban and rural development, this question of water resource will also do damage to ecological environment, and influence human livelihood and health of people.

This paper will discuss some problems from the viewpoint of water environment management.

1. Rational development, utilization and protection of water resources.

For a long time, the utilization of water, management of water, and control of water are all under different administration, each organisation looks after its own interest, and there lacks unified planning, thus affected the efficiency of water control. As a matter of fact, the quantity of water that can be utilized from a water resource is not only governed by its uneven distribution in time and space, but also is affected by the quality of water. Quantity of water and quality of water, utilization of water and protection of water are problems that cannot be divided. They should be placed under a unified plan, and with unified management. The traditional hydraulic engineering planning of river basins, and the development and planning of underground water should be properly combined together with modern water quality management, make full use of hydraulic engineering works and groundwater development in industrial and agricultural production, and in improvement of water quality, in beautification of environment, in coordination of ecology, etc. The structure of existing water resource systems, the principle of water allocation and ways of utilization of water should be studied and improved.

For those districts whose water resources are irrationally developed, necessary reorganization must be carried out. According to the principles of "multiple development, rational utilization, proper protection, and scientific management", unified consideration must be given to surface water and ground water, thus rationally allocate the water used.

For water reservoir built on the upstream of river, its design and operation must satisfy the needs of flood prevention, power development, irrigation, aquaculture, tourism etc, necessary reservoir volume must also be given to protect the needs of ecological environment, to guarantee the minimum flow below the dam which will be beneficial in improving water quality and in coordinating ecological environment. The environmental impact assessment for every single engineering project must be well carried out, so that the development and utilization of water resources will be on a sound scientific base.

As to lakes, based upon their different functions, eutrophication should be prevented, In districts where conditions permit, exchange of water in drainage basins may be utilized, accelerate the exchange of wastewater and lake water, thereby raising the ratio of clear water to wastewater of the lake, so as to attain the aim of controlling lake pollution, and preventing eutrophication of lakes.

For districts with limited ground water resources, ground water should be used for human domestic consumption only, other usages should be restricted. The drilling of wells and tapping of ground water is strictly prohibited. For district whose ground water table has already been lowered to a state that will be difficult to recover, especially for deep ground water and for districts with sea water intrusion, for districts with land settlement, for districts of Subsiding of karst, and for districts of tapping of ground water should be prohibited and strictly limited. For districts where ground water is excessively tapped, recharge of water is encouraged, using surface water or reused water that meets recharge standard, thus regulate and store up ground water resources. For industrial districts with potential danger of polluting ground water, the ground water quality must be monitored by setting up long term moniter system, so that the condition of contamination can be monitored in time, and those factors that causing deterioration of ground water quality can be eliminated in time.

Using of water according to plan and thrift use of water should be practised. Gradually put into practice the supply of water according to different quality, good quality water is sent to places where high quality water is required, multiple use of water should be encouraged.

There should be a quota for quantity of water consumed by different industries, quantity of wastewater disposed should be measured, and there should be an index for water reused. For those whose quantity consumed is beyond the allocation, cost of water will be increased, and for those who use less they will be rewarded with a bonus. Engineering items that use less water and produce less wastewater will be given priority.

Agricultural consumption of water is a big item, it occupies about 88% of the year total. Consumption must be according to plan, and fee collected according to quantity used. Study the use of new material, new techniques, develop drop irrigation underground irrigation, flexible pipe irrigation techniques which are of low cost and consume less energy. also develop other techniques which prevent seepage and leakage, thus raise utilization rate of water used for irrigation. Arid and semi-arid districts should carry out crop agriculture and not irrigation agriculture. For metropolis in the north where water is short, agricultural structure should be adjusted, one ton of rice consumes 3600 tons of water. "Shall we transport water or transport crops" is a question to be considered. For those districts field crops should be reduced, and instead, develop dry fruits, animal husbandry, forestry etc. In the vast water-shortage districts in the north, the question of sewage irrigation should be given serious consideration, the sewage and wastewater, besides given necessary treatment to prevent contamination and pollution, should be effectively utilized the whole year round.

For domestic water consumption, fixed rate system and all kinds of subsidies must be abolished. Use water thriftly, scientificaly and and according to plan. Water leakage in pipelines should be prevented, toilet flushing facilities should be improved. In cities where water is short, domestic sewage after treatment should be utilized in sprinkling, flushing of streets, car washing, replenishing cooling water, thus reducing fresh water consumption as well as reducing wastewater discharged.

2. Prevention and treatment of water pollution must be considered from the view point of a district and as a system.

From the production of sewage and wastewater, contorl of water quantity and quality, transportation of sewage, the setting up of sewage treatment plants, the treatment methods used, the disposal and reuse of sewage after treatment, natural purification and self assimilation of water bodies and of soil used for elimination of pollution, all these must be given comprehensive consideration and under a unified plan.

At present, in our country, there exist the following problems in the management of water pollution control:

(1) A unified plan and arrangement based on the technical and economic feasibility study of pollution control is lacking. In the setting up and carrying out of certain policies their aims are not clear and are not definite, there exists blindness to a certain degree.

(2) The idea of comprehensive prevention and treatment of wastewater in a district, and the guidance by the principle of system engineering is lacking. Instead, emphasis is given to disperse treatment, a high treatment ratio of industrial wastewater, no consideration was given to the cities basic engineering condition and city sewerage system, as a result, investment benefit is low.

(3) Policies and regulations that suit special profession, department and district are lacking. Some are only general proposals and are not specially suitable to certain districts and thus limit the benefit of existing policies.

The movement and circulation of water forms a natural drainage basin geographically and through different kinds and forms, natural and artificial, surface and underground, urban and rural are all combined into a water system as a whole. The production and control of water pollution is not an isolated problem, as a matter of fact, it reflects the non-synchronous development of economic construction, urban construction and environment construction. It means the loss of equilibrium between disposal of pollutants and environment capacity, recovery and utilization of wastewater, artificial treatment and natural treatment, and other multiple treatment processes. If these interconnected factors which made the water environment problem as a whole are neglected, the environment aim as well as investment will lose control. To treat these problems as an isolated matter will never solve the problem.

In order to control effectively water pollution and to develop rationally water resources, water quality control plan for cities must be carried out step by step, based on hydrology, geography, economy, sewage collection of cities, at present and possible future change, water used in industries, agriculture, municipal, surface water and ground water, and wastewater reused after treatment must be considered as a whole. The district is then divided according to water quality, rationally paln the water resources in the district and the development, and utilization of water resources, rationally arrange every item on water resources. development the control and treatment of river systems and sewerage systems, rationally arrange the site for treatment and utilization of waste water, thus provided the basis for planning and designing water treatment and control works in cities.

Water quality management planning must include quantity and components of wastewater in the district, direction of flow, environment requirement, ecological specialities, combined with population, economic development, sites of wastewater disposal are rationally chosen. According to the environment aim of planning using principles of system engineering, the control, collection, treatment, utilization of dispersed pollutants, their disposal system, and purification of environment are organically connected together, using mathematical models, finally the optimum disposal site, the number, size, and degree of treatment of sewage treatment plants and the sewerage system are fixed, thus a complete pollution control and prevention system of the district is formed. A system controlling the total pollutants should be put into practice, as to the cities and districts within the drainage basin, considering the components of the pollutants, the functions of water body, the class of water quality, the permissible load of pollutants, the total amount of main pollutants controlled are all finally determined. The total amount of pollutants to be reduced is then allocated to every city and district, this must be controlled, so that not only the environment requirement is satisfied, but the cost is reduced to a minimum, or through modification of environment requirements so as to reduce the required cost, thus a most rational policy is made.

In the control and preventional of river pollution, some countries abroad studied the interrelation of the following three factors: the self assimilating power of water bodies, amount of wastewater transported, the removal ratio of pollutants after treatment, a most economical plan is then proposed with distinct efficiency. This means that this is more economical, more rational than the traditional way of treatment at disposal site. This work can also be carried out for a single part known as plan for multiple control and prevention of water pollution of a district.

For districts where water is short, facing the problem of shortage of water resource, and the intensification of water pollution, serious consideration must be given to strategic protection of water resources. For the water resources of any drainage basin (or district), the question of water quantity and water quality must be given consideration at the same time, the rational utilization of water resource and prevention and control of pollution are problems that cannot be divided. The problem of water not only affedts ecology in water but also affects ecology on land. A single item of water consumption will affect the whole situation. Throughout the use and consumption of water, the reduction and solution of water pollution must always be kept in mind, that prevention and control of pollution is a long term job is also an idea to be kept in mind. For industrial wastewater, emphasis must be put on the thrifty use of water and reduction of pollutants, while for city sewage, the degree of treatment should be based on its utilization, also for industrial wastewater closed alcycle-system and harmless treatment techniques should be considered seriously. For treatment of city sewage, emphasis should be placed on land treatment system and utilization of sewage, establish different kinds of reuse water system:

3. Protect urban water sources, control water environment

Firstly, for urban water resources, a unified plan for development, utilization and protection must be established. Protection zone for urban water sources must be established. Within the protection zone, all engineering items that may pollute the source are strictly prohibited, and no tourism point will be permitted. Such restriction is necessary. At present, many cities have turned the reservoir and lakes which are the sources of city water supply into scenic spots for tourist, and scenic spots with amusement items were set up, some have even built convalescent hospital, and allowed the establishment of industries with pollution, thus endangered the urban water source, if such are not prohibited promptly, the result will be very serious. The water source of a city's water supply is the city's lifeline, we must protect the water source as we protect our eyes.

Secondly, disposal standards must be set up. Requirements will be different for new factories or old factories, for the disposal of wastewater into rivers or into pipes, and to water bodies receiving the wastewater with different functions. For factories, the principle must be::who pollute it must bear the responsibility," the heavy metals in the industrial wastewater must be controlled (such as electroplating wastewater), for those organic matter in wastewater (such as pulp wastewater or pesticide wastewater) that is difficult to degrade biologically must be controlled, and industries with highly concentrated wastewater (such as alcoholic wastewater and pharmaceutical wastewater) must be controlled. For those above mentioned industries, the wastewater must be pretreated and useful matters recovered before leaving the factory. For those wastewater with large quantity of organic matter, the total quantity must be controlled, and a certain amount of fee be charged, then allow it to discharge to the municipal sewer systems and be treated together with the city's domestic sewage.

Thirdly, the sewerage system in a city and the treatment plants and recovery facilities are important component parts of a city's basic engineering items and environment facilities of a district. According to the principle of combination of single item treatment and multiple treatment, disperse treatment and centralized treatment, the construction of city treatment plant is accelerated. As regards to municipal sewage treatment plants, there are many points that do not reach the required standard, national and local investment must maintain a definite proportion, and material and facilities and power and running expenses must be guaranteed. At present, the fees collected from industrial wastewater disposed a large proportion should be spent on district pollution control. In order to do well wastewater treatment, the city's sewerage system must be improved and popularized. At the same time, the treatment plants at present functioning in factories must be properly managed, so that they will do their job well.

The treament technique of municipal treatment plants depends on whether the sewerage is utilized and how it is discharged and the requirements of environment, there is diference between metropolis and medium and small cities, also difference between key cities and cities for tourists and ordinary cities, all these must be taken into consideration, and feasibility studies made for the money invested. For water lacking districts, the setting of wastewater treatment plants must also consider the utilization of sewage. Sludge disposal must also be considered in the treatment plant.

In the prevention and control of water pollution, the general rule adopted is that disposal standard and the degree of treatment should be governed by the economic condition. According to the financial condition and power supply of our country at present, for sewage treatment, it is imperative that key cities should use biological treatment, but for most of the cities, emphasis should be placed on primary treatment and natural biological purification by effectively utilize the assimilating power of river, lake and sea in the technique of disposal by dilution. In this way, large amount of pollution load is first reduced, and then gradually raise the degree of treatment. Feasibility tests must be carried out before municipal sewage and sludge are disposed to river and se shore, and to choose the most suitible site, and the most suitable way of disposal.

Fourthly, the industrial wastewater of food industries located within the city or suburban districts, ecological engineering system should be considered using the waste water and refuse of the industries to develop poultry, breeding of animals and fisheries. The highly concentrated organic wasteater and refuse produced by food industries located in the city as well as those by other light industries, chemical industries, "anaerobic fermentation-methane-sludge fertilizer" system should be developed, thus developing industrial methane and recovery of useful material. As to municipal sewage, if condition permits, ecological treatment system of "anaerobic pondfacultative pond - aerobic pond - fishery pond - irrigation farming" may be developed. The aeration pond is an ecological system with bacteria, algae, aquatic plants, aquaculture, and poultry living together, forming many food links which can effectively purify and utilize the organic pollution and also a definite amount of poisonous and harmful material in the sewage. By using the solar energy to heat sludge, the solar energy is converted into biological energy, this raises the convertion rate of energy, and the self-sufficiency rate of energy consumed in sewage treatment. Recently, a sewage treatment technique using hydrolysis (acidification) combined with aerobic biological treatment to treat municipal sewage is a breakthrough item, for this not only treated the sewage, but also treted sludge to a certain degree, and this has brought attention to many people. In some places, municipal sewage, after proper treatment, can pass through a series of water - soil - biological system to complete the deep treatment.

Fifthly, the river and lakes in a city must go through reformation and regulation under planning. Citizens, enterprises and organisations must be persuaded to take part in this work, and to complete their own share, thus rapidly change the black and smelly conditions of river and lake in the city.

4. The water price system is an important problem in management of water economy.

In the development, supply, utilization and pollutant disposal of water resources, the four items mentioned above must all go through the water price factor to attain the aim of rational development, rational management, rational utilization and rational disposal and raise the utilization value of water resources, make good use of the conomic benefit of water resources and reduces the quantity of wastewater. Experience told us that if the price of water is too low thus deviates too much from the value of water resource, water is not occupying an important part in production, then the condition of wasteful use of water resources cannot be thoroughly stopped, and the condition of insufficient supply of water and the deterioration of water environment cannot be improved, the burden of the water supply system and the treatment and disposal system is getting heavier and heavier.

In the question of water resource utilization, on one hand, water source is insufficient, many places are short of water, but on the other hand, because the price of water is too low, many water users are unwilling to carry out water saving devices, water consumption quota are very high rate of repeated use and rate of recirculation use are very low, there exists large waste in water consumption. As the price of water is too low, the macroscopic economic benefit, social benefit, and environment benefit of water resource have all turned to water users, thus covered up the very acute wasteful condition of water users.

Since 1981, the municipality of Beijing has practised a series of actions to strenghten the economic management of water resource. Since 1981, fee is collected according to amount used from private wells, in 1983 the price of surface water used is adjusted, in 1984, price of running water supply is revised, that is, the price is fixed according to different grades, and water is supplied according to quota. Since 1986, a way of collecting more fee for consumption in excess of the alloted quota is adopted, if the comsumption of water is 10% in excess of the alloted quota, 100% extra is added to the price of water. The 97 enterprises that consume large amount of water were investigated, and the investigation shows that if we increase the price of water, enterprises will effectively take steps to cut down their consumption, the cooling water system will be improved, water will be recirculated, and industrial wastewater will be reused. Under the present condition of production and with the facilities as it is now, water used by industries which was 340 million cubic meters can be reduced to 150 million cubic meters, i.e. a reduction of 60% or 190 million cubic meters can be saved. The above shows there is great potentiality in reducing water consumption in industries, it also shows the significance of raising price of water.

How is the price of water to be fixed? We consider that the following principles must be followed:

Firstly, the principle that water resource must be commercialized. Under conditions of planned commodity economy, products are commodities. At present, the water that can be directly supplied to every water user is produced and supplied by the water producing unit, (such kind of production is of special nature,) the water producing unit must take back their investment with profit, they cannot supply water without renumeration. Therefore in fixing the water price, the first principle is that the water resoruce is a commodity, and cost of water must be calculated from that.

Secondly, the principle that water resource must be used with renumeration. Based on this, the fee of utilizing water resource or resource tax must be rationally fixed. Because the price of water is too low, this causes great waste of the water resources, quantity of wastewater disposed is greatly increased, which pollutes and damages the environment. In order to correct these economic problems during the process of using water resources, the water users must pay enough fee to the nation. That is the cost of using the water resource or the resource tax must first cover the cost necessary to protect the environment that has been polluted and damaged, and secondly to cover at least the cost of reproduction of water resources.

Thirdly, the principle of supply and demand. The price of water like the price of other commodities is governed by the principle of supply and demand. Therefore, when fixing the price of water, due consideration must be given to its supply and demand relationship, as a matter of fact, this means that the price of water should be regulated by the supply and demand relationship of water resources. We cannot ignore the change of supply and demand relationship and leave the price of water unchanged, if so, price will lose its lever function and its significance.

Fonrthly, the principle of time value and difference in location. In fixing the price of water resources, due consideration should be given to the time factor of hydraulic engineering investment, so that the investment is fully utilized and money taken back in time. Because of this, the money invested on development of water resources must be evaluated with compound interest. In order to straighten the value of water resources, the fact that a same price level is carried out throughout the nation must be changed, price of water resource must be divided into different districts. While fixing up the price of water resources of different districts, do not follow the administrative boundary, instead, the boundary must be the possible shere of utilization of water resources. This requires that the direction of flow be first decided, and the market boundary be roughly fixed, and the price level be determined by the worst market condition of the district.

Some points about adjustment of water price. Firstly, the economic management of water resources must be improved. At present, investment on water saving devices, progressive way of collecting fee for excess consumption over quota allowed, deduction they all lack a series of complete management devices, this is disadvantegeous to both water suppliers and water users. We propose that besides revise water price, rational water consumption quota should be fixed on the basis of scientific investigation, thus straighten the devices for collecting fees in a progressive way for excess use over the alloted quota, set up devices, for use of the excess fee collected and the amount left over, and subsidiary for investment in water saving devices, and other management devices for borrowing money without interest from bank and other auditing devices.

Secondly, strenghten the study of elastic index of water price so as to provide a scientific foundation for fixing water price. Even today, there are still many people who do not realize the important function of water price in promoting rational development and thrifty use of water resources, they do not realize that increase of water price will lead to thrifty use of water and increase of quantity of water supplied. As a matter of fact, whether from strict theoretical analysis or from economic statistics of actual data, they both showed that price will guide change in expenditure and production. Raising of price will reduce demand and lowering of price will increase demand. When price of water is low, consumption of water will increase, and when price of water is raised, consumption of water will decrease. When the price of water is raised 1%, the reduction in percentage of water demand is known as the elastic index of water price. According to American Statistics, the elastic index is generally 0.4, and the elastic index for domestic consumption is 0.23. In our country, investigation on water saved due to increase of water price showed that elastic index is only 0.05-0.1, because the price of water is too low. Beijing lacks 20% of water every year, if according to the elastic index, the price of water should be raised 2-3fold, the question of water shortage can be greatly eased. Therefore, the study of elastic index of water will provide an important reference of rationally fixing the price of water.

Thirdly, the adjustment of water price should be carried out step by step. Water price is one part of national price system, its change will have great influence on national economy and people's lifelihood, the change of water price must be carried out with great care.

THE MANAGEMENT OF WATER AND WASTEWATER IN BEIJING

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ABSTRACT

Beijing is a city of serious water shortage. Both the groundwater and surface water resources are inadequate to meet the increasing demands of the city. The water is also seriously polluted. More than 90% of the wastewater discharge into the natural water courses without any treatment. It is not possible to consider "transporting water from the South" at present. Therefore, it is important to depend on the area of Beijing itself to develop and reuse the water and wastewater. The recharge of groundwater and the storage of surface water must be given better management. The structure of industries should be readjusted. Industries should reform their equipments to save water. Agriculture should also save water. Flood irrigation may be substituted by spray irrigation where it is possible. The latrines and sewerage systems of the city should be better managed. Wastewater should be treated for reuse. The saving of domestic water should also be given attention. Beijing being the Capital of the Country, should take the lead in the management of water and wastewater.

Main points of the paper:

1) Introduction -- Beijing is a city of serious water shortage. The best evidence is that there were fountains of artisean water with head of more than 3 M, but now due to the over-usage the groundwater table is greatly lowered that we have now an area of about 1000 KM^2 with lowering funnel of groundwater table with average depth of lowering of 3-4 M, and a maximum lowering of groundwater table of about 20 M.

2) The water resource in Beijing is seriously polluted. According to Beijing Municipal Engineering Bereau, we have now about 62 "Long Xu Gou" in the city.

3) Self-dependence of area of Beijing to rationally develop, reuse and manage the water resources. "Transporting water from the South" is not possible at present.

4) Comprehensive planning and developing the groundwater and surface water of Beijing. Storing all surface water in reservoirs & recharging groundwater should be carefully planned.

5) Readjust the structure and plan of industries. Reform the equipments of industries so as to save water. Cooling water must be circulated for reuse. City government should see that the industries manage the treatment of their water and wastewater properly.

6) Readjust the agricultural plan. Reduce the area of rice plantation to wheat, cotton, etc. to save water. Improve the system of irrigation to save water. Flood irrigation should be changed to spray irrigation where it is possible. The agriculture department of the city must take immediate action to reform the agricultural structure for the management of saving water and reducing pollution.

7) Improve the management of latrines and sewerage system. Wastewater should be treated for reuse and pollution control. Industries should share the expenses of sewer construction and wastewater treatment. "Three Same Time" should be strictly enforced. Saving of domestic water should receive more attention. A dual system for water used for spray streets, fire protection, flushing toilets, and fountains, planting trees and flowers, etc. may be considered.

8) Improving the leadership of the municipality and the cooperation of various departments involved. Beijing being the Capital of the Country should take the lead in the management of water and wastewater.

DISCUSSION ON THE CRISIS OF THE FRESH WATER RESOURCES AND THE PREVENTION AND CONTROL POLICY

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ABSTRACT

Beijing has entered the crisis stage of the water supply in 1970. It proved that China would enter the stage in 2000, and the whole globe would do in 2030. It is concluded that there are three contradictions, three patterns and three stages in the water supply problem. The probability of relieving the crisis of the water resources is put forward by the writer, several suggestions of countermeasures and the protection approaches are made.

I. Men face the bad thread of the crisis of the water resources.

It is more and more clearly learnt by men that the crisis of fresh water resources is not only in a city, a local area or a individual country, it becomes one of the policy problems of the whole globe. It takes a great part, and occupies a special position in the various policy problems in the world, it is also one of the basis for the policymaker to make a decision in every country.

The importance of the problem is repeatly emphasized at the session about "the human environment" in 1972, at the session about "the human residence" in 1976, at the session about "the desert spread" in 1977 of UNGA. Especial at the session about "water" in the March, 1977, it was discussed that there is a shortage of water resources of the globe, the environmental pollution is widespread, the countermeasures must be taken. A series of international meetings about the fresh water resources problems were held around that time.

As a matter of fact, several cities and districts in the north area of China have entered the water crisis stage in 1970's, and 1980's. It was well known that there was the worst drought disaster in Africa continent in early 1980's. In this disaster, there were 150 million refugees lacking of food and water, more than 10 million people ran away from home, thousands refugees died of hunger and thirst. It was called the worst human disaster in Africa in recent history.

It is predicted by the scientists that more than 1 billion people can not get the cheap and up to standard water in 1990's. The decade of 1990's is named as "The years of the drinking water supply sanitation" by U.N. The intention of it is to draw the whole globe attention to improving the supply and sanitation of water, and sound the alarm lasting ten years.

It was commented by the Environment Quality Committee of U.S. that the amount of water supply per capita would decrease one third than that of today only due to the population growth in 2000. Dr. Robert P. Ambroggi said that there would be more than 30 countries badly lacking of water. In fact, it is hard to collect 200 billion U.S. dollars aid to solve the problem of the water resources sanitation in the developing countries. Even taking some simple measures for the problem, it still needs 30 billion dollars at least.

After the writer studying the problem of water resources of Beijing, of China and of the whole world, it was supposed that:

i. Beijing has entered the primary stage of the water resources crisis since 1970;

ii. Most area of China would begin to enter the crisis stage of water resources in 2000;

iii. Most countries in the world would get into the crisis stage of water resources in 2030.

II. The problem of water resources emerges and develops

It is very complicated that the problem of water resources emerging and developing, this problem is affected by both aspects of nature and society in exploiting, utilizing, draining and protecting process. Although there are many factors interfere the problem randomly. According to the comprehensive survey, a conclusion could be made there are three contradictions, three patterns and three stages included in this problem, all these make up nine items of this problem. Each items needs its special countermeasures.

i. Three contradictions are as follows:

a. the contradiction of supply and requirement of water;

b. the contradiction of pollution and purification of water;

c. the contradiction of the cost and effect of protection.

ii. The patterns are as follows:

a. water lacked,
b. water polluted,
c. both features combined.

iii. Three stages are as follows:

a. the primary stage,
b. the balance stage,
c. the crisis stage.

The symbols of the water crisis stage are as follows:

a. the amount of water requirement in one time is more than that of the natural water supply from all the available water resources;

b. it becomes the regional problem that the water level under ground decreases continuously;

c. the years in the intervals between the drought disasters are getting fewer and fewer;

d. most or all of water resources are polluted;

e. there is no guarantee for the measures of economy, technique and management in controlling the quality and amount of water.

III. The countermeasures against the crisis of water resources

i. There are three different attitudes as follows:

a. it is thought by the unrealistical optimist that water is the endless resources, there is always more water in the natural world than that being needed, and water can be always renewed, there never is the water crisis problem.

b. it is thought by pessimist that the water crisis is never averted, it can be only done to slow down the developing speed of production and raising speed of the living lever for saving water.

It is considered by us that there really are various probabilities of water crisis emerging, in some cities, rural villages, regions and countries, the probability has turned to the reality, because the people do not have a clear idea of how the things are going, let things drift. If we study and handle the features of the water resources seriously, control the three contradictions, three patterns and the regularity of the three stages emerging and developing, take the feasible and effective countermeasures in time, the water crisis can be averted thoroughly, the place where the water pollution has reached the crisis stage can restore back the balance stage, the water for production and living can be guaranteed.

ii. Several ways of relieving the water crisis:

a. exploit new resources,
b. economize the resources,
c. control by time and space,
d. guarantee the investment ratio,
e. take unified ways and measures of protection.

It is learnt that the problem of preventing from the water resources crisis is actually a problem of analysing the regional water environment systems and controlling in system. It is the problem of balancing the relation of regional water supply with amount of water requirement, water quality and water economy, it is an optimizing policy problem based on the policy, economy, technology and management. It only can be solved by the unified protecting and controlling ways and measures.

iii. Analyse the probability of relieving the water crisis.

a. The water resource is of a kind of resource that can be renewed in some range, for instance, the ensuring rate of the plan on utilizing water is limited in 95%, the regional water crisis will not come out.

b. The ratio of the water usage to the total amount of water resource is reasonably assigned, and rule that water supply should be in some definite amount is made.

c. Two ranks of the ratio of the usage to the total amount of water mentioned above is assigned for raising the efficiency of water utilizing.

d. Unified administration put the rules and regulations of licenses of exploiting,utilizing and draining water into effect.

e. Perfect the law, policy, economy, technique and management systems, formulate the water quota systems for the special field, the product, the apparatus, men, and cattle respectly, set the measurement system and collect the fees for the utility above quota, impose a fine on the overspending and give awards to the thrifty.

f. Encourage the processing technique and utilizing manner without water or with less water instead of those needing a lot of water, prevent from vaporizing of water used in agriculture.

g. Take advantage of the feature of water that it can be renewed make use of water in every possible way, and make use of water repeatly in circulation, make one ton of water serves the purpose of several ton, ten ton even dozens ton of water;

a) It is tried that the rate of water used in circulation to the total amount of water is above 70% monthly in the factory, the recovery of cooling water in circulation should be above 95%.

b) The medium water way is built in cities, through it water is renewed and used repeatly in circulation, the recovery of water in circulation is to be above 50%.

c) Water can be used repeatly in a region, flood and drain are to be decreased, the recovery of water is tried to get more than 30%.

h. Ensure the water underground or on the surface of earth against pollution, eliminate various causes and channels of pollution, water supply should be built in the watershed protected area.

i. Study various methods of utilization and purification of waste water. Passing sanitary test, the purified water is restored back underground.

j. Build reservoir which can be controlled by time on the earth surface.

k. Transfer water crossing valleys, and control the process by space.

l. Study the economical and practical technology for recovering the waste water.

m. Make the valley green by planting and afforesting, so as to conserve watershed and soil, as well as improve the climate.

n. Take advantage of iceberge and snow to make artificial rain, it is an inportant way to get fresh water in some area where ice and snow are available.

o. Make use of seawater is the basic way to solve the water supply problem, this way includes desalination of seawater, transportation of fresh water in a long distance, especial a cheap energy cost.

The energy resources also faces a crisis problem, energy supply would enter a hard historical period called "an irritating blank gap", after this time, the energy supply would get to stabilize, but it would be still a problem whether the energy supply could meet the requirement of utilization and transportation of water, so that it can be learnt that the crisis period of water supply would be longer than the period of the energy crisis.

iv. Policy, technology and management

It usually depends on the policy, technology and management to solve any a big problem related the nature and society. Technology and management would lose direction without policy, policy and management would lose pillar without technology, policy and technology would never be implemented well without management. All these three parts make up one body, none of them can be neglected, the same principle in the problem of water supply.

It is extremely important to make policy of water supply in scientific way. Many countries have pay attention to the energy supply problem, but they have not taken the water supply problem as an important policy problem on the agenda, much less talk about the scientific way.

Technic approach is the key, without science and technique, all the matters can not develop, especial in the developing countries, the situation different from the advanced countries, matters are limited by the economic base, the economical and feasible way must be approached.

It is really urgent to make administration efficient, in fact, the water resources are badly wasted now, 1/3 - 2/3 of the reason is due to lacking of administration. For the developing countries, the consolidated approaches on law, administration, economy, technique and education are needed, but intensifying administration is the most economical, feasible and effective way to solve the problem of water supply.

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DISCUSSION ON THE FEASIBILITY OF APPLYING STORAGE TANKS ON INTERCEPTING SEWER IN THE SUZHOU CREEK DISTRICTS

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ABSTRACT

Suzhou Creek is a river of small net flow with a small self-purification capacity. In order to maintain the river at a certain DO level after the storm overflows, larger intercepting factors should be adopted at a higher engineering cost. After reviewing the designing papers of the intercepting sewers in the Suzhou Creek districts the author proposes that by utilizing a nearby small creek as a natural storage tank, by maintaing the main sewer and other fascilities after the intermediate pumping station at the original designing intercepting factor of 2, and by adjusting sewers before it to an intercepting factor of 3, with the storage capacity of 2 DWF, thus the engineering effect can be raised by 60% only at an increasing of the engineering cost by 5%. The conclusion is: It is feasible to apply the principles of storage tanks on intercepting sewers in the Suzhou Creek districts.

1. The basic conditions of the Suzhou Creek districts

The sewer system in the old built-up areas of Shanghai is mainly a combined system, and today in the master sewerage plan of Shanghai, the combined system is still maintained in those areas. The intercepted wastewater after the treatment to a certain degree are going to be discharged with outfall diffusers into the deep water of Chang-Jiang estuary.

Suzhou Creek flows through the central part of the city. There are more than 30 outlets which are generally the concentrated outlets of each drainage area through the pumping stations, with the total drainage areas of about 40 km^2, and with a population of more than 2 million. The designed DWF for the year 2000 is 1.2 million m^3/d. The average population of each drainage area is about 60,000 persons, and a maximum of 160,000 persons.

More than half of the combined wastewater are industrial wastewaters which undergo incomplete treatment. About 60% of the human excreta stored in the nightstools are transported to the nearby countrysides or neighbouring counties to be used as fertilizers. This latter part of the excreta will be discharged into the combined sewer along with the renovation of the old built-up districts as well as the installment of water closets will be used instead. The BOD_5 concentration of DWF during the summer time is about 150 mg/l, and in winter, 200 mg/l or even higher. The tendency of the BOD_5 concentration in recent years is increasing.

It rains often in Shanghai. According to the record of a long period the average rainy days are more than 130 annually. Except being effected by typhoons,the rainfall intensity is, however, not very high, especially in the monsoon season, it drizzles intermittently for many days. The rainfall intensity mostly is less than 5.2 mm/h in most rainy days by records of year 1981-1983 (Table 1).

Table 1. Rainfall intensity in years 1981-1983

rainfall intensity (mm/h)	<1.8	1.9-3.6	3.7-5.4	5.5-7.2	7.3-9.0	>9.0	total
average rainy hours per year	298	80	23	12	10	21	444
% of the total rainfall hours	67.1	18.0	5.2	2.7	2.3	4.7	100.

Suzhou Creek is a tidal river, and the net flow is very small. The yearly average is about 10 m^3/s. For example, although it was a wet year in 1954, there were still 36.2% of the days in the year with net flow less than 10 m^3/s, and besides, 10% of the days were with negative flow. In the following year, the percentage of net flow less than 10 m^3/s increased to 71.2% with a 16.1% of negative flow. In the lower reach of the creek, the flow in Spring tide is about 120 m^3/s and the flow in the neap tide is 75 m^3/s. Once sewage is discharged into the creek, it will oscillate for many days before it flows into the Wang-Pu River.

In 1926, the concentration of BOD_5 in the middle reach of the creek during the ebb tide was already as high as 27.6 mg/l. In 1950, it was 41.9 mg/l, whereas the total water consumption of the city (including deep wells) was only 0.74 million m^3/d. It was estimated that about 0.3 million m^3/d were discharged into the Suzhou Creek. This signifies that the self-purification capacity of the creek is very small. During summer days in recent years, the value of dissolved oxygen (DO) in the most urban part of the creek is zero or near zero.

2. Discussions about the intercepting factors to be used for the combined sewers in the Suzhou Creek districts

The adoption of the value of intercepting factors depend on the different requirement of the water quality of the river into which the wet weather flow (WWF) overflows. The Environmental Protection Bureau of Shanghai sets the goal of year 2000 for Suzhou Creek is that it should be a water body of grade III, i.e., the minimum DO should not be less than 4 mg/l.

The Chinese designing specification of sewerage and sewage treatment stipulates that intercepting factors of 1-5 should be used according to many factors such as: the different requirements and hydrological conditions of the water bodies; the quantity and quality of the storm overflows, etc. At the very beginning of 1950, the combined sewer system was tentatively used with intercepting factor of one in some newly built residential districts of the city. But after many years of usage, they were proved to be unsatisfactory. The Hai River in Tianjin is a river quite similar to the Suzhou Creek but the intercepting factors adopted for the intercepting sewers along that river were about 5, and the environmental aspects of the river after storm water overflows have proved to be satisfactory.

A paper(1) prepared by a joint committee of ASCE and WPCF in 1979 stated that. "It may be concluded that no satisfactory reduction in the pollution carried by storm water overflow can be accomplished by any reasonable increase in intercepter capacity above that required for the peak dry weather flow".

The explanation of the Japanese sewerage specification in 1982 provides that the interceptor capacity of 3 times that of the peak flow should be used.

The report(2) of a Government Technical Committee on Storm Overflows and the Disposal of Storm Sewage of the UK in 1970 stated that: Among 10,000 and 12,000 storm overflows surveyed in England and Waues, of those overflows set at 6 DWF or higher, only 18% were classed as unsatisfactory.

The USSR specification of 1976 provides that for river flow less than 10 m^3/s, intercepting factors of 3-5 should be used.

Some surveys(3) made by Shanghai Municipal Research Institute in 1984 about the variations of the concentrations of the wet weather flow in some combined sewer pumping stations revealed that, owing to effect of the first flush, the BOD_5 values in the initial stage of rainfall were increased to 150% - 200% of that of DWF, while the values of SS were increased as high as 500 - 600%. Shanghai Sewerage

Institute also made some surveys about the variations of flows in dry weather at all the pumping stations for 3 consecutive days and nights and found that the hour variation factor within a day was 1.5, and this, combined with the seasonal variation factor of 1.3 from Shanghai Water Works, made the average peak flow factor of 1.95 for a drainage area with a population of about 60,000 persons. This means, during summer days, when the value of the peak flow is already equal to 2 DWF, if an intercepting factor of 2 is used, the virtual intercepting factor will be only one.

In the report(4) made by Shanghai City Planning and Designing Institute, numbers of overflow and durations of storm overflow for different intercepting factors in the Suzhou Creek districts according to the equivalent rainfall intensity of the designed wastewater flow were calculated by using the following formula:

$$H = \frac{1000\,Q}{24 \times A \times \phi \times 10^6} = \frac{Q}{A\phi \times 24 \times 10^3}$$

where, H — the equivalent rainfall intensity of the designed DWF in mm/h;

Q — the designed DWF in m^3/d;

A — drainage area in km^2

ϕ — coefficient of surface run-off.

In more than 30 drainage areas of the Suzhou Creek districts, the value of ϕ are ranging from 0.4 to 0.8; A, from 0.15 to 2.75 km^2; the calculated H, from 0.9 to 4.26 mm/h with an average value of 1.8 mm/h for the whole district. Rainfall data of 10 years (1974-1983) were used and the computed results are listed in Table 2 and Table 3.

Table 2. Number of overflow (m), duration (t) and quantity (h) of storm overflows for various intercepting factors

Intercepting factors (n_0)	0.5	1.0	1.5	2.0	3.0	4.0	5.0
Average yearly rainfall (mm) for ten years	1142.5	1142.5	1142.5	1142.5	1142.5	1142.5	1142.5
Number of overflow (times)	116.7	71.9	54.1	41.1	28.4	21.1	14.7
Total duration of overflow (hours)	258.1	137.9	87.9	59.9	37.6	25.7	17.5
Quantity of overflow (mm)	675.3	498.0	392.4	322.9	232.4	180.6	145.2

Table 3. Percentage of overflow duration for various intercepting factors

Intercepting factors (n_0)	0.5	1.0	1.5	2.0	3.0	4.0	5.0
Total yearly duration of overflow (hours)	258.1	137.5	87.9	59.9	37.6	25.7	17.5
Overflow <1 hour, (%)	49.6	57.3	63.8	70.6	77.5	83.9	85.6
Overflow 1-2 hours (%)	23.2	22.8	22.2	20.1	16.5	12.8	10.3
Overflow 2-3 hours (%)	9.8	8.0	7.8	6.0	3.9	2.4	4.1
Overflow 3-4 hours (%)	8.2	5.9	3.1	2.9	2.1	0.9	-
Overflow > 4 hours (%)	7.2	6.2	3.1	0.4	-	-	-
The max. duration of one overflow (hours)	15	13	8	7	4	4	3

The water quality of the Suzhou Creek in the preliminary designing papers of the Shanghai Combined Sewerage Implementation Project[5] was forecasted with the help of a water quality model. In the calculation, the DO of the supposed clean water from the upper reach of the Suzhou Creek and the tidal inflow from the Wangpu River were all assumed to be 4 mg/l. The result of the average value of DO in the Creek after storm overflows for a length of 20 km is listed in Table 4.

According to the experience in Shanghai, if the DO level is equal to or less than 1.5 mg/l a river will become black and smelly. From the result in Table 4, one can see that with intercepting factors of 2, 3, 4 respectively, the yearly probability of DO level equal to or less than 1.5 mg/l may occur 8, 5 and 4 times respectively. Thus, we can draw the conclusion that the self-purification capacity of the Suzhou Creek is rather small.

Table 4. Water quality of the Suzhou Creek forecasted after storm overflows

Intercepting factor (n_o)	Average yearly overflow (times) *	Average DO of the Suzhou Creek (24 km in length)			
		≤0 mg/l	≤1 mg/l	≤2 mg/l	≤3 mg/l
1.5	47	2	5	12	26
2.0	38	2	5	9	21
3.0	25	1	4	6	16
4.0	20	1	3	5	10

* Based on the rainfall data from 1981-1983

3. Discussions about the feasibility of applying storage tanks on intercepting sewers in the Suzhou Creek districts

From the data given above, we can summarize as follows:

i. The net flow of the Suzhou Creek is very small and the fact that there are many days of negative flow makes the condition very unfavorable.

ii. Of the total duration of rainfalls, the rainfall intensity of less than 5.4 mm/h occupies 90.3%.

iii. A great percentage of the storm overflow lasts within 2 hours.

iv. After the storm overflow, the content of DO in the Suzhou Creek drops to a considerable extent.

Therefore, in order to obtain a fairly satisfactory engineering effect, the value of the intercepting factors should not be less than 3 to 4. But, as a consequence, the larger the intercepting factors adopted, the higher will be the engineering cost and the power load required. This is beyond the present local financial ability. After a comparison made by Shanghai City Planning and Designing Institute on different engineering cost and power required for various intercepting factors, it was found that 94 ∿ 96.7% of the storm overflows were with overflow duration less than 2 hours when the intercepting factors were 3 ∿ 4 [4]. Thus, by the aid of storage tanks, smaller intercepting factors may be used for interceptors and the related facilities after the storage tank. The capacity of the storage tank may be taken as the product of 2 DWF and the difference of intercepting factors before and after the storage tank. This results a better effect and less engineering cost as well as less power load required. In Table 5, it shows that the option with intercepting factor of 4 before the storage tank and with 2 after the storage tank has the same effect as that of the option without storage tanks but with intercepting factor of 4 while the cost and power requirement of the former is only equivalent to that with intercepting factor of 2.5. The capacity of the storage tank is (4-2) DWF x 2 = 4 DWF. Furthermore, it can be pointed out that the nearer the site of the storage tank (or tanks) to the overflow outlets, or the longer the trunk sewer after the storage tank, it wull be benefited more economically. Either natural water bodies of lower environmental requirement or artificial underground structures may be used as storage tanks.

Table 5. Comparison of the options with or without storage tank

	Intercepting factors (n_0)	Engineering cost %	power load %	annual power expense %
Options without storage tank	1	89.4	79.8	98
	2	100.0	100.0	100
	3	111.8	120.2	101
	4	122.4	139.5	102
Option with storage tank	before storage tank 4	108.2	117.6	102
	after storage tank 2			

In the preliminary design of the Shanghai Combined Sewerage Implementation Project, the intercepting factors adopted when converted to the values according to the definition of the Chinese Sewerage designing specification are as follows: the branch intercepting factors of the upper reach of the Suzhou Creek are 3 or more than 3, that of the lower reach, 2 ∿ 3; for the main interceptors before the intermediate pumping station are 2 to 3, and that of the main conduit of 24 km long and other facilities such as treatment plant, outfall pumping station and diffuser pipes after the intermediate pumping station is 2. Therefore, the intercepting factor of 2 is the controlling factor for the whole project, and the whole engineering effect of the project is that of intercepting factor of 2. Now, near the intermediate pumping station, there is a small creek with a total available water surface of 160,000 m^2 of lower environmental requirement at the time being and this small creek can be used as a natural storage tank. As the intercepting factors along this creek in the Project is 0.95, and most probably this small creek will be displaced by large conduits in the future, the temporary pollution will not cause significant problems. Now if the intercepting factors before the storage tank are adjusted to 3 and after the storage tank, the origional designed intercepting factor of 2 maintains unchanged, then the storage capacity will be $(3-2) \times 2$ DWF = 2 DWF and the whole project will function as if it adopts the intercepting factor of 3. Thus, the number of occurance of DO level equal to or less than 1.5 mg/l will decrease from 8 times to 5 times, and this means the engineering effect is increased by 60% while the additional cost is only 5%.

The storm overflows stored in the small near-by creek together with its existing dirty water can be drawn by means of the intermediate pumping station into the main conduit and is finally discharged into the large water body of the Chang-Jiang estuary. Besides, by opening the gate at the south end of the small creek, the cleaner water from the Wang-Pu River may displace the existing black and smelly water, and the environmental condition of that small creek will also be improved.

From the above analysis, it may be concluded that it is feasible to apply the principles of storage tank on intercepting sewers in the Suzhou Creek districts.

4. Conclusion

1) By applying the principles of storage tanks (either utilizing natural water bodies or constructing artificial underground structures) on intercepting sewers in the districts of combined sewer system, the engineering cost can be lowered while the engineering effect can be increased.

2) Under the specific conditions of the Suzhou Creek districts, a nearby small creek of lower environmental requirement can be used as a storage tank with storage capacity of 2 hours of DWF.

3) By maintaining the origional designing intercepting factor of 2 for the main conduit and other fascilities after the intermediate pumping station, and by adjusting the intercepting factors to 3 for the intercepting sewers before the intermediate pumping station, the whole project will develop the same engineering effect with the intercepting factor of 3 while the additional engineering cost is only increased by 5%.

4) It is, therefore, feasible to apply the principles of storage tanks on intercepting sewers in the Suzhou Creek districts.

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CHAPTER I

Discussions

I **Jeremy Warford on Recent World Bank Policy Initiatives on Environment**

1. - Description of evolution of World Bank Policy on Environment will be in general but will apply to all countries and various aspects of environment.

   - Recommended that audience think about the general statement made and see how they apply to the Chinese situation.

2. - In World Bank we define environment broadly

   - First, 20 years ago, primarily water and air pollution. Now, desertification, deforestation, threats to indigenous people.

   - A variety of different circumstances and country priorities but broad generic principles are common to all.

   - The Stockholm Conference alerted people to problems of environment. At that time big differences between developed and developing countries was noted.

   - Developing countries tended to agree that environment was luxury but now almost all recognize its importance. Especially those who depend on a declining natural resource base find that, compounded by population growth, environmental degradation threatens economic development and health.

Environmental degradation is both a cause and consequence of poverty.

Good economics and good environmental protection often go hand in hand.

We have found that there are complex physical and behavioral linkages between natural reosurce-using activities, which have often had unexpected consequences. For example, livestock projects have led to deforestation, soil erosion, sedimentation, and loss in agricultural productivity.

Most important lessons of all: even if we are successful in making sure that our individual projects are environmentally sound, we still do not make impact on environmental problems, which are primarily caused, not by large projects, but a majority by countless small scale activities which cannot be controlled on a case-by-case basis.

More important than projects are sets of policies which induce people to behave in ways that are environmentally sound. Government policies are critically important even sometimes when they are at first sight quite unrelated to observed environmental degradation.

For example, in many countries, government provide subsidies for irrigation, which causes excessive use of pesticides and fertilizers. These subsidizes encourage overuses, with diminished impact on insects, and result in pollution of waterand land. Other examples are:

- Forestry is often subsidized and there is no incentive to reforest and replant. This causes soil erosion and loss of agricultural land.

- energy is subsidized: coal is sold at less than cost resulting too much coal consumption and creating air pollution problems.

- exchange rates are often overvalued: this encourages imports and discourages recycling and resource recovery, sometimes leading to pollution.

Conclusion:

A country will have much more success on environmental action if it addresses these fundamental issues. Since environmental degradation is so important, we have to elevate environmental concerns to highest level of country planning, and not simply concentrate on individual projects.

Those concerned with environmental problems need to address areas which in the past were left outside of the scope of environment professionals.

Regarding the new World Bank program, we will do environmental assessments in about 30 countries. We will have to be selective in topics, region and countries.

General procedure consists of three steps:

1. Make assessment of natural resource degradation in the country, identify trends, projections into future under various scenarios of economic growth and resource utilization. Use this to judge priorities. *They will vary from country-to-country, and could be, for example, air* pollution, desertification, or upland watershed management.

2. Look at direct and indirect, or underlying causes of environmental degradation. May be far away in time and space from environment problem we see. Many problems are caused by incorrect economic incentives such as prices and subsidies. But it is not just economics, cultural, institutional constraints, political and legal obstacles may be present. One example: the system of property rights, insecurity of land tenure may mean that people have no incentive to preserve land for the future, thus causes soil erosion. Therefore one of the most important areas to protect water may be to change land tenure arrangement.

3. After understanding the forces at work which explain natural resource uses and abuses,devise a set of polciies which address them. These might include reduction of subsidies to pesticides, and land reform; indeed a whole range of incentives, direct and indurect, which impact on resource use, with consequent impact on environment should be addressed.

Questions, Answers and Discussions

Q. Zhang CH: What are the Chinese issues?

A. Warford: One of the important issues is the subsidization of coal, which encourages air pollution, land degradation, and, by acid rain or when stock gasses are scrubbed, even water pollution.

Q. Okun: We enter scene when damage has already been done. How can we undo damage?

A. Warford: There are many countries in the world where things are bad and getting worse. The poorer countries will continue to be dependent on foreign aid. There is a continuing need to promote economic growth, to stimulate efficient ways to use resources. For example, it has been suggested by some people that in Brazil in order to take pressure off rain forests, use tax policy, industrial location, property rights policies, to encourage people to move to environmentally less fragile parts of the country.

Q. Kinnersley: I welcome What Warford says. Has it been difficult to get this accepted in Bank? How to get it accepted in the countries?

A. Warford: The new policy is a major change. It has so far been well accepted in the Bank, mainly because it integrates environmental economics with economic policy. We already are planning an environmental policy loan to Brazil. In Indonesia, we are analysing extent of resource degradation and identifying policies to address the problem. We have made a structural adjustment loan to Haiti, a condition of which was that Haiti eliminates the export tax on coffee. The argument is that soil erosion threatens economic growth, and coffee has good soil retention characteristics. Hence ending the discrimination against coffee would have an environmental benefit.

Comment by Mr. Gu: In our experience policy is essential. Our energy policy is wrong. World Bank has reported waste of energy and resultant air pollution.

II Hugh Fish on Water Conservation

Subjects:

1. Water resources quality
2. Water resources quantity
3. Reference to Thames

1) Fundamentals of Water Conservation

- o control extractions

- o levy charges (dependant on nature of use and return flow)

- o development of water resources according to integrated plan which has regard to environmental needs and reuse possibilities.

Use these as a checklist to evaluate existing management system.

Emphasis on need of skilled team and analytical capabilities to develop integrated plan. How to get that?

2) Requirements for water pollution control

- o pollution to be made illegal
- o discharge control by licensing

- o realistic water quality objectives for various types of water bodies and uses

- o set realistic limits of quality and quantity of discharges in order to meet water quality objectives

- o control and sanctioning system

Again, use this as a checklist

3) Thames

Map of Thames catchment with main cities, and waterworks intakes

Example Swindon

Charges for intakes (or abstractions)

Charges for discharge (treatment)

In dry time, 70% of (upstream) Thames flow is Swindon discharge.

Next is Oxford: purifies, uses and discharges; and so on for subsequent cities along Thames.

Overviews of water reuse in Thames

Total sewage effluent	1470 m^3/d X 10^3
% reuse	48
Volume of reuse	662 m^3/d X 10^3
Annual cost of purifying and disposing of sewage effluent discharged	Pounds 41.7 million
Annual cost of supplying 662 m3 X 103 water	Pounds 41.2 million

The conclusion is that the cleaning of the river is achieved at essentially zero cost. The above system also performed well in drought of 1976 (one in two hundred dry year).

Example was presented of quality objectives Thames tideway (similarity with Huang Pu River)

Questions, Answers and Discussions

Q. Bruestle: What are Fish's suggestions to Chinese on how to move ahead?

A. : Impressed with progress regarding broad water management since last 5 years. Lack of arrangements, administrative and systems institutions with respect to "What" to do. Administrative system not expected to change but more coordination anticipated. Ensure big increase of training of water managers. Also perform scientific and economic analysis for optimisation of development. Seek support from other countries. Basic engineering and scientific skills seem to be all right.

III David Kinnersley on Institutions for Water Management and Pollution Control

The situation in Europe has one similarity with the present position in China described by the leading Chinese officials yesterday. The individual nations of the European Economic Community (The EEC or Common Market) have agreed a list of Water Directives setting out policies and standards of pollution prevention for them to achieve. But the real struggle is to find the institutions and the methods to achieve those results reliably and efficiently. To illustrate, the subjects of the Directives are:

Detergents 1973

Surface Water for Drinking 1975 and sampling of it 1979

Drinking Water (at the tap) 1980

Standards for Freshwater Fish Waters

Standards for Shellfish Waters

Bathing Water Standards

Dangerous Substances List I very dangerous
Lists II dangerous

Ground Water

Mercury

Titanium Oxide

Together these Directives set good objectives but this does not mean Europe has its water pollution problems fully solved or even under full control. The gap is in getting good results achieved through the insitutions in each country. A book just published shows how different in detail the approach in each nation has to be to fit with political structures and funding methods at provincial and municipal levels.

So most important institutional problem: water manageeent work has to be coordinated through institutions which are not suited to water tasks. This is because most communities are land based, and have many tasks besides water management.

Here are examples: In Government it is rare to find a Ministry of Water and nothing else. NEPA has to deal with other environmental problems. Ministry of Water Resources has to deal with electric power.

MURCEP deals with sewage treatment and many other aspects of urban development. CPHCC has to deal with many other health aspects in addition to water related disease. In UK water issues are under Ministry of Environment and Ministry of Agriculture, and they often fight. In Germany, water is managed by Ministry of Interior, Health and Agriculture, but there are also 11 provinces - water is a provincial responsibility. In Netherlands, some water agencies are under Ministry of Transport, others are under local control. This cannot be altered because water is the basis for agriculture, industry, health - hence one agency cannot hope to control everything about water. Water runs through the whole country, therefore we need the whole country to manage it better.

Sometimes you hear about integrated river basin authority in UK. This is okay in the UK because no irrigation and little hydro power are involved making it easier for the authority.

Let us leave the Government, and go to the river bank. What institutions are involved? Mr. Wu said 83% of the wastes are from industry and 17% from municipal sources. Policy is to get more industry wastes in to municipal systems. That policy is right, but municipalities are not water management institutions, they have many other concerns, and too little money.

Example: In UK, in 1970 we had Water Pollution Laws in effect for 20 years. We had a study to see what is happening, half of municipal sewage plants were not meeting permit rules because of other priorities.

In USA central government took city of Detroit to court for repeated violation and the court took over the running of the sewage works.

In UK Manchester built great aqueducts at large cost. The result, Manchester had more dirty water than it could handle, and not enough money for treatment plants with the result that the receiving water became the dirtiest in the UK.

Water is different from everything else. People and industries do not consume water, they borrow it and put it back. That is the institutional problem, how to get people to put it back better.

<u>Tools for Better Water Management</u>

1. Laws and permits

They have to be obeyed. But they also allocate resources. If a municipality on industry is behaving poorly, how could we get them to change their ways? We obviously cannot send them to prison. They need to be motivated. For example, if there is clean waterbody nearby, there is no need to go far for a fresh safe source. Good water promotes fisheries, tourism, etc. In China I am impressed by respect for soil, well cultivated with excellent crops. Say to industries that they must respect the water as the farmers respect soil.

Two reasons of importance to motivate:

1. Sewerage works have to be operated for the long term future. When a project is completed the real work just begins. Operation and maintenance is tremendously important. People should be encouraged to respect O & M. Among engineers construction *provides prestige* but O & M needs to be honored more.

2. Caring for water costs money. People and industry have to pay; therefore need to motivate them, and explain how their payments are used. Long term cost of caring for water is less than cost of damaging environment. That is why environmental protection is everyone's job and we must educate people to care.

In caring for environment we are trying to do three things:

- Protect environment
- Achieve economic efficiency
- Achieve fairness

These may look in conflict because we look at costs instead of long term impacts. We also want fairness between industries, and between rural and urban. Rules do not have to be uniform but variations must be rational. NEPA should be aware of special cases. In UK the coal mines were excluded from controls, but later a great struggle ensued to get them in. In the Chinese countryside where there are many plating plants and paper plants, do not let them say it's a small plant and hence a small problem.

Europe has not found one best way. Europe has learned three lessons:

1. Build environmental protection in accordance with your own political system and culture. Each separate European country is wrestling with the problem of putting the agreed rules into its own culture and structure.

2. Europe has learned that it takes a long time, therefore start early.

3. Government departments must work well together to get integrated balanced, sensible action by municipalities and factories. In UK, when government departments fight, the municipalities continue to pollute.

More points

1. River Systems are complex. Institutions need guidance. NEPA must not be seen as a policeman. Use EIA to help factories develop good performance.

2. Second: all I have said is about man-made and point source. But need to allow for silt load and agrochemicals.

3. It is good to hear from China about the emphasis on water conservation. In UK we found when we charged heavily for waste volume and concentration, factories discovered that using less water saves money in two ways: for water and for waste discharge. It motivated them to save water in both stages.

When we must manage water with institutions that are not specialized, it means that water people need to educate, guide, motivate and get laws obeyed.

Finally, get people to enjoy water in order to get people to care for it.

Questions, Answers and Discussions

Q. Mr. Chen of Shanghai:
What to do if 50% of municipalities do not comply.

A. We changed the institutions (created river basin authorities) and increased the charges for water and wastes.

Q. Okun: If a city does not meet its obligations, prohibit them from putting more connections on sewers. Most cities want to grow, and this obstacle to growth usually prompts action.

Bruestle: But what to do if the city is responsible for both development and environment.

Okun: As Dr. Warford says economic growth and environment must be done together.

Kinnersley: I have been emphasising motivation and constructive attitudes, but in the background there has to be the threat to overrule the municipality. NEPA should be slow to use it, but not let anyone imagine it does not have this power.

IV Daniel Okun on Financing for Water Supply, Wastewater and Pollution Control

I have prepared a paper on rural water supply and hope it gets into file. Yesterday Mr. Huang of CPHCC told about the successful rural water supply program in the PRC. The core of that success is that the community pays for most of the capital and all the operation and maintenance costs.

In Africa most water supply is financed from the top, from the donor or ministry, then down to the community, which is expected to provide the operation and maintenance. The funds required for O & M are often not programmed and the facilities quickly disintegrated. So I cite PRC as a good example of how to do rural water supply.

I also brought some slides from water reuse, and appropriate technology for.water supply. But I did not guess right as I am asked to talked about financing for water supply.

Financing water supply should be based on the fact that water has the capacity to recover the costs at least for O & M, and often the capital costs as well. If a community has the willingness and ability to pay, it usually can obtain a water system. But too often someone else is asked to provide the money and the community must wait in line to get a grant or subsidy.

The US has a long history of subsidies. I will describe the good and the harm to the US of subsidies. US was initially settled in the east where water is plentiful. But the government wanted to settle the west, to occupy the land. But the west is dry. So the Bureau of Reclamation was created (Land Reclamation) to provide funds for large irrigation projects in the west. It was successful. People moved west, grew crops and prospered. That was 150 years ago. But we are still growing crops with high cost water that the government subsidizes. The government has to buy and store the crops (because no one else wants them) and the government is still paying the Bureau of Reclamation to provide free water. Lesson: Once a subsidy is started, politically it virtually is impossible to stop. In the eastern part of the U.S., people pay high taxes to provide water.to grow crops in the west that no one wants.

Another example is the Corps of Engineers, a branch of the army. congress decided the C of E should protect people from heavy floods. So C of E is authorized to build dams to prevent floods. C of E has to show that its projects have positive benefit/cost ratio. After the flood aleviation effective they started doing multi-purpose projects. The value of these projects are largely for recreation and less for water supply in cities. These are mostly in the east where little is used for irrigation. The money for these projects come from central government. Local governments have been asked to pay but the refuse. For some projects local people objected to the reservoir being filled after the dam was built.

A third subsidy is for sewage treatment, where local communities get 75% federal grants plus 10% additional grants if they use innovative technologies plus 10% from the state, thereby requiring the 75% federal grants and 10% for communities opted innovative practices and 10% from communities to pay only 5% even for costly projects. Among the many immediate disadvantages of subsidies are the follow:

1. If money comes from somewhere else, sometimes the project may not be a local priority.

2. The project becomes capital intensive because the grant is for capital cost, not O & M cost. Hence this may not be the most economic project.

3. Because the focus during planning is on capital costs, the fact that a community may be burdened in the future with high O & M costs is often overlooked.

4. If there is an opportunity to get a grant, projects are delayed because Mayors wait for grants before commencing with a project.

A major disadvantage is that subsidies are addictive. It is hard to end a subsidy program once it is started. Some communities decided to use their own funds instead of federal grants, and they moved ahead more quickly and at lower cost but in general the subsidies are pervasive and if anything delay progress.

Our water supply in the US is almost entirely financed by local govenments.

Water supply is more than health and life. In China the consumer believes "running water is happy water". It greatly enhances the quality of life.

Water supply has the capacity to be initiated and sustained locally. There is no need to wait in line for someone else to decide if you are next for a grant. Therefore a good system is where a local community expresses its ned and puts up the money. In China the community pays 70% of capital cost and 100% of O & M. In Africa, there is strong resistance against this type of cost recovery. The most African leaders would yield to is that the community pays for O & M. If the capital has to be provided from outside it means fewer people can be served. Although the World Bank China RWS loan is big (over six million people are served), the need is for 600 million people. There is not enough money outside to finance local needs entirely.

In the US we realize our water pollution control programs were financially ineffective. Now there is a new policy: loans are made to banks for revolving funds, and these are used to cover a group of communities.

Myths: (1) "Water is a necessity of life therefore it should be free". But food is also a necessity and that is not free. Water is not free, because we need to pay for pipes and pumps and labor.

(2) "Many people are to poor to pay".

Many studies challange the myths. We studied two poor areas, and found people who bought water from vendors who carried water to their houses paid 40 times more per liter than richer persons with piped house connections. If their expenditures were capitalized poor people would get a better service at lower cost. That is the role of government; government can set up revolving funds to provide the seed capital for piped water construction

Another point is conservation. If someone gets something for free, they are less careful as to how it is used. They waste water and do not take care of the facilities. That is why water projects should include metering. In RWS in China, the meter sometimes costs 10% of project. The value of water saved may be less than 10%, but meters are valuable because they also let people know water is a valuable resource.

Similarly, those who abstract water from underground or from a river should be required to be licenced, and possibly to pay. When we abstract water, or discharge wastes to water, we profit from its beneficial use. Therefore such uses should require a licence, and (I suggest) a charge.

Initially charges were established to cover the administrative cost of licensing, not the cost of the resource. But now we collect for abstraction and resources to pay for facilities, and to cover the damage costs.

A suggestion for consideration in China is borrowing money for banks. The central government may sometimes be a "donor" if it gives a grant. An alternative is to borrow money in the open market. A community can do a good business with water. they can borrow and build. With good O & M the institutions will be strong and borrowing costs will be lower enough to be all.

Questions, Answers and Discussion

Q. Bruestle: How to charge for abstraction and wastewater discharge?

A. Okun: In U.S. it is becoming common to require licensing at points of abstraction. In Florida, if industry wants to get ground or surface water, they must get a consumptive use permit. The applicant for the permit most state the proposed use. If it is wanted for cooling, the permit will not be given if it can be shown that lower quantity and quality will suffice. In eastern US, generally no one pays for abstractionor pays for discharge of waste water.

Wu: In 20 cities of China factories are required to pay for ground water abstraction.

Zeper: I have two comments. To raise funds for waste water, the community should pay. But in urban areas it is more difficult to charge individuals. Therefore in the Netherlands, we devised a system for any discharge, industrial or domestic, there is a "population equivalent" charge. We introduced it slowly, initially RMB 5/yr, for example. But it goes up each year, second year RMB 8, then 15. Also if one community puts wastes into a river that crosses a boundary, it has to pay for the load that crosses the boundary. These funds were used for revolving funds to subsidize treatment plants which had to be constructed. The central government made a plan, and then gave 60% subsidy. Now we no longer have subsidy, each water authority charges as necessary to cover costs.

Fish: On subsidies. In 1944 UK enacted a rural water supply and sewage law which provides a 30% grant for all capital costs.

Lim: In Los Angeles there is a charge for water abstraction.

Okun: There is a major new activity in US for reclaming waste water for non-potable uses. This is used for covering the costs of waste water and for replacing high-quality water for low quality needs with reclaimed water. The high quality water is thereby saved for potable use.

V Ross McKinney on Water Pollution Control in the USA

Remark: Important to realize that each country developed its own criteria within its own system. In general these are country-specific and cannot be copied by other countries as an integrated package.

An Overview of Events in USA

USA pollution control started in 1887 in Massachusetts with founding of Lawrence Experiment Station in Merrimack River.

Hence it was detected that typhoid epidemic was caused by wastewater contamination with typhoid bacteria. Wastewater treatment was identified as the solution.

The first water pollution-control legislation was enacted in Kansas in 1907.

Enteric dealth rate dropped to zero from 1900 to 1940 with implementation of simple wastewater treatment and source protection facilities.

Then, attention shifted to other issues than health.

The first federal law on water pollution control was enacted in 1948.

A second law was passed in 1956. It included construction grants to states for treatment plants but did not provide for an adequate source of funds.

The Water Pollution Control Act of 1961 provided more funding and more control.

The 1968 Water Quality Act established the Federal Water Pollution Control Agency (FWPCA) within the Department of Health, Education and Welfare. It provides still more funding and controol, but objectives were ill-formulated.

In 1968 FWPCA became Federal Water Quality Administration within Department of the Interior.

The EPA was established by law in 1970 and placed in the Office of the President. Environmental issues brought to attention of younger generation (to distract attention from war in Vietnam). This led to the following regulations in 1972, PL 92-500:

- o Zero discharge adopted as a goal.
- o Permit system introduced which provided registration of all municipal and industrial discharges to environment.
- o Set 1977 as deadline for secondary treatment compliance (but this is still not realized).
- o General effluent criteria defined:
  - 30 mg/l BOD5
  - 30 mg/l TSS
  - PH 6 to 9
  - 200/100 ml coliforms

Most of the above is either nonsense or infeasible; the latter because:
Federal share 75% (in building plants), but;

- o not enough money available
- o not enough design engineers
- o not enough contractors
- o incompetence
- o not enough trained personnel of EPA
- o not enough trained operators

In 1979 the General Accounting Office performed a study concerning 18,000 municipal wastewater treatment plants (WWTP) and federal funding of 25 billion dollars. It reviewed 242 WWTP and found:

- o 87% were under permit violations
- o 31% were in serious violations
- o 15% seriously deficient WWTP were looked into more closely, and it found:
  - 10 design deficiencies
  - 9 operator deficiencies

Regulations for Industrial WWTP's provide for:

- o 5 years permit
- o effluent limitations

- o quarterly reports required
- o best practical treatment required by 1977
- o best available technology required by 1988

Conclusion

The following conclusions can be drawn from a review of 39 years of experience in water pollution control in the United States.

1. Federal grants for wastewater treatment plants have assisted in the construction of a large number of treatment plants.

2. Federal grants shifted emphasis on wastewater treatment away from local responsibility.

3. Federal grants and Federal regulations appear to have slowed wastewater treatment progress in the United States.

4. Federal laws imposed unrealistic deadlines and provided massive funding that cound not be properly handled, resulting in wasted efforts.

5. One must properly plan to handle the problems before passing legislation mandating specific changes.

6. Controlling water pollution requires accurate knowledge of all contributors, their loads and their points of discharge.

7. Construction of wastewater treatment plants requires careful design by competent engineers and construction by skilled personnel.

8. Operations of wastewater treatment plants requires skilled operators who understand how to achieve the maximum from their plants with a minimum of effort.

9. Education and research provided the basic concepts to improve wastewater treatment plant design and operations.

10. Water pollution control requires time and patience as well as resources to be successful.

11. Water pollution control is essential not only for future development but also for simple survival.

<u>1987 Clean Water Act Amendments</u>

- o phase out federal grants by 1990 (municipal grants)
- o federal loans by 1994

Questions, Answers, Discussion

Mr. Lin asked about the implications of moving various responsibilities to the Office of President in 1970.

Mr. McKinney: This meant a shift from technical to political people with great risks of incompetence.

Prof. Okun: The Executive part of the Government (the President and agencies under him) and the Congress are very different. Congress is elected but the Executive spends the money. Congress tends to be very strict in defining their wishes, which may then become infeasible to implement.

Mr. Kinnersley: Great Britain moved responsibility for waste treatment away from municipalities to separate new authorities, who obtained limited funds. Therefore hard thinking required about which plants to be built first. This led to priority setting and classification of waters. Still some low priority waters are dirty, but at least no money was wasted.

VI Ross McKinney on Key Issues

The legal base has to originate at the central level. Once responsibilities have been set, then one can do the planning to develop the policy and institutions. Important that at national level the planning not get too involved in details. Central should do only overall planning, set broad planning guidelines, with provinces doing their plans, and the cities their plans. So the policies work from the top down rather than bottom up. For China, water pollution control is of high priority. They must launch a national campaign of water pollution control for national survival of China. People at all levels must build the institutions.

China is correct when it says the polluter is responsible. Each is a polluter with responsibility . By joining together we can do a better job than doing it alone. No doubt money is in short supply, but the rest of the world cannot build your systems because it's your pollution. you will need to do it over time and with a lot of work. If the State decides to put an amount for pollution control, and this is gradually increased then progress can be made. Government has the capacity to collect costs from industry. Build up on what you have in your current facilities. Do not abandon your present infrastructure. Whyen an old industrial plant wears out, build new plants or phase them out with a single wastewater collection system. At local levels, they want central funds, at central, they expect local agency to finance. The ultimate responsibility will rest at the local level.

Sequence of legal, policy and planning:

- Start with a legal base. The law should be written with eventual policies in mind. China's system of trail laws is a good way to start.

- National planning and policies must come before the laws are finalized.
- All the steps can go forward simultaneously.

- Then everyone throughout the system can start to do their policies and planning.

There can be a law, but the central government should have the flexibility to decide in which areas the law applies first. The central government should have the law, the guidelines for implementation, and the funds for grants or loans.

VII Professor Fu on Training and Manpower

Manpower is associated with education and training. Also how a person is used and the management system. We should look into problem along with changing mangement system.

In China at all management levels require greater awareness of environmental protection. Especially in the economic and industrial sectors and from central to local governments and to plant director because decisions taken by these agencies and people are crucial to impacts on the environment. How to enhance environment awareness at all levels of government. We must let them know the laws, regulations and economic aspects. I believe EPA should have responsibility for this and help to prepare coure seminars.

Decision makers must be able to fully utilize the technical people to make best use of scarce resource. In order to compensate for scarce manpower there are several channels, such as setting up consulting teams.

At all levels of education: primary, secondary and higher: environmental protection shold be in the eduational program. Everyone is a polluter, so everyone is responsible, so they must understand about environment. In some schools every student is required to take a basic course in environment principal.

Regional planning by systems techniques are essential. It is closely related to law and economic policies. On this we must set up a program at higher education levels and get support from abroad.

Finally, on grass roots levels, we are short of operators of, for example, waste water treatment plants. I understand we mainly rely on local level to train them, but this may not be enough.

VIII Gerrit Baarse on Water Resources Management and Pollution Control in the Netherlands

In the Netherlands, legislation, planning and finance regarding water resources management and pollution control is embodied in an integrated Water Managment Act (WMA). The WMA is not yet fully operational but important parts of it have already come into effect, like the Pollution of Surface Water Act (1970) and the Groundwater Act (1982). The WMA pays very explicit attention to planning procedures. Main characteristics of these planning procedures are:

- o Distinction of different levels: national, regional (provincial), local (waterboards).

- o Integrated "water system" approval on each level, meaning that all relevant aspects of the water systems are taken into account simultaneously (quantity and quality, surface water and groundwater, supply and demand) and explicit attention is given to the costs and effects to various users and the impact on the natural environment.

- o Top-down appraoch: national and regional polans must be drawn up, while the national plan sets the boundary conditions for the regional (provincial) plans. This approach leads to need of iteration to develop a consistent set of plans. Within its boundary conditions (in terms of quantities and qualities available for region and quantities/qualities coming from region), the province can draw its own plan. Provincial planners are expected to involve the water boards in a way similar to what is done at the national and regional levels.

IX Lohani on Environmental Impact Assessment

A brief presentation will be made on the experiences in South East Asian Countries, especially in integrating environmental issues in development planning, and observing problems and issues of past practice, and what is coming in the future. The presentation will focus on the countries in the region which have achieved successes.

Dr. Warford outlined the integration of natural resources in macro economic policies, whereas in Asia the emphasis to integrate environmental protection in development planning.

Here is what is happening in South East Asia.
Fig. 1

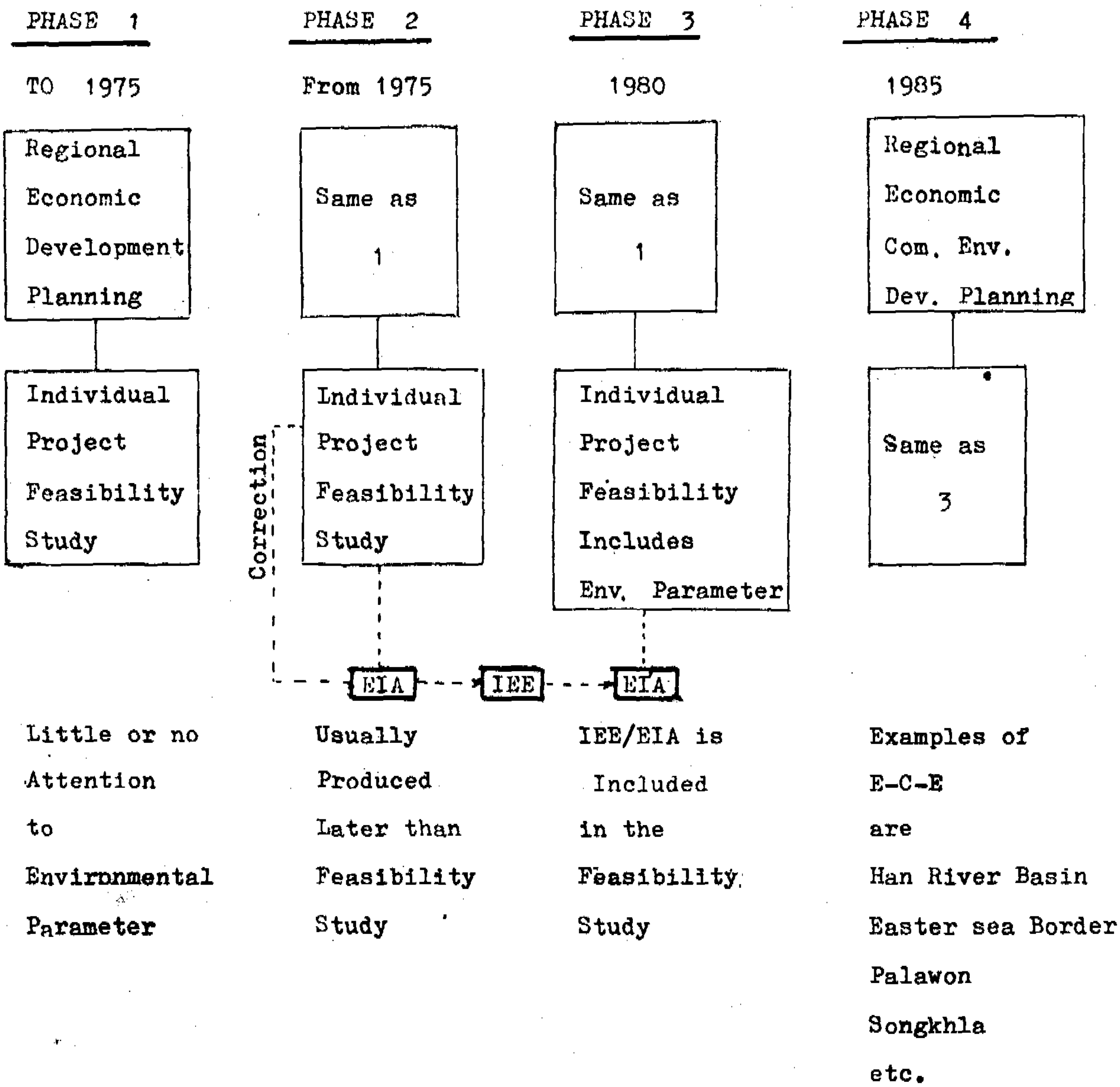
Up to 1975 the region had individual feasibility studies and regional plans. In 1970's region got carried away by EIA and the developments in USA. Like in the United States environmentalists and conservationists tried to get project people to integrate environment consideration in designs. Engineers did not pay much attention to this. Consequently pressure groups for environmental protection developed. Environmental conservationists played a great role to make EIA a requirement for the projects.

The impact is that EIA's were conducted after feasibility studies, when it was too late to make changes. It was not popular among project personnel.

They also borrowed and developed guidelines along the US EIS requirement. Soon they found that it was too detailed and too costly, and not enough manpower was available to carry out the work.

A less comprehensive and better integration through the EIA process was sought. An IEE (initial environmental examination) was introduced. This assisted in screeningenvironmental issues which were not important to project and helped to focus on a few issues which would have to be taken into account in design and constructions. Another disadvantage of EIA was the practice to produce as a separate document, which often duplicated information in feasibility studies.

Final lesson: was to build environmental concerns in feasibility studies. It became a required part of feasibility studies. This approach seems to work well in most countries.



History of Use of Env. Parameter in Develobment Plnning in Asia

Some countries felt planning at regional level were not adequate to take into account environmental aspects related to sectoral development and to establish such linkages.

Economic cum environmental planning approach is being found to be useful. Some successful projects are noted in Korea, Philippines and Thailand. This approach seems to be more cost-effective than preparing environment planning later to adjust the economic development plan.

IEE followed by EIA seems to be effective for project planning. Economic cum environmental planning is good approach for regional planning. It may however be realized that the EIA is a piecemeal approach and hence the importance of environmental planning on a regional and national level should not be overlooked.

Manpower Development

Fig. 2

When EIA was required it was difficult to find the right people. Therefore most works were done by foreign consultants; there was hardly any technology transferred. At least one country, I know, decided to do the work with local expertise only, but that did not work because local expertise was not adequate. Therefore now foreign consultants and advisors are brought in at several stages, but local people do the most work.

This was a good way to get technology transfer and yet keep the cost low. Now Indonesia, which is starting mandatory EIA, is training people first.

EIA cost initially was high because requirements were too stringent; hence needed to modify the extent of EIA to meet local financing.

ASEAN countries found IEE as a cost-effective prerequisite for EIA which dealt detailed studies for selected environmental components only.

Fig. 3

IEE/EIA costs in ASEAN Region is in the range 0.1 to 0.4% of project cost.

For large water resources projects, the time required was up to 12 months, at cost of 100 - 200 m/m. This is much cheaper than the cost when a detailed study was conducted without an IEE or preliminary EIA. There were shortcomings: in most countries the EIA report was reviewed by on

Manpower Derelopment

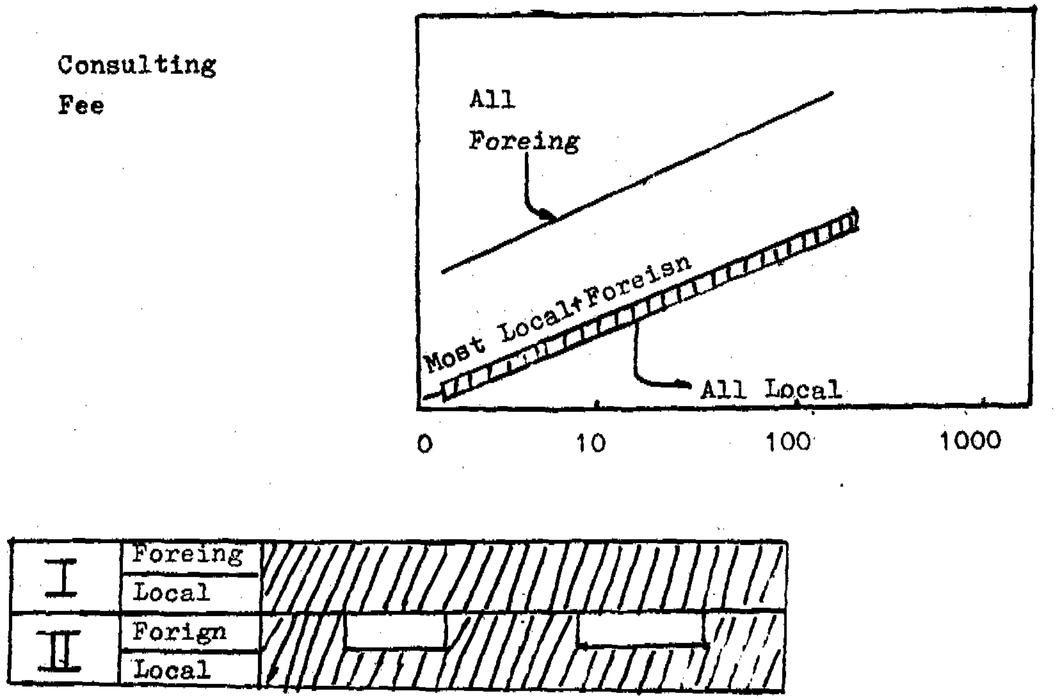


Fig 2

Resources Required

Later Resources Projects	Type of Study	IEE/EIA Cost % of Project Cost	Time Spent	Total m/m
Multipurpose Dam Pallani	EIA	0.20	10	150
Kwa Nai River Basin	Partical EIA	0.04	-	150
Khem Lam Multipurpose Dam	EIA	0.03	12	180
Quae Yai Multipurpose	EIA	0.12	12	-
Loei water dev.	IEE	0.28	5	180
Lang svan Multipurpose		0.15	-	80

Large Projects (water Resources)

Cost : 0.1 — 0.4 % Total Project cost

Time : 6 - 12 Months

Tolal : 100 — 200 m/m

$\frac{1}{4}$ of Cost in IC

Fig. 3

individual. He had right to accept or reject the report. This was unsatisfactory. The credibility of the individual was challenged. Now EIA reports are beginning to be reviewed by a group including industry, government, etc.

Another problem: the EIA was approved by national EPA, but implementation is always left to the sector agency. The EPA's could not supervise what was said in the report. Often the EIA statements were not implemented. so the EPA's started talking to the line agencies but this was not enough. So EPA's had to strengthen the sector agencies as well. EPA's undertake activities such as sectoral guidelines and trained sector agencies to do environmental planning for strengthening of line agencies.

In some cases they looked at engineering design codes and rewrote to reflect environmental concerns.

Another useful area was economic evaluation of environmental impacts. Costs were quantified where possible and put to decision makers in project planning.

There are some lessons learned by the countries who have done good works. It does not reflect a general situation in all the countries but highlights bits and pieces from many countries in the region.

Questions, Answers and Discussion

H. Fish: UK does not use EIA.

J. Zeper: In Netherlands, EIA is mandatory.

H. Fish: EEC will soon require EIA.

D. Okun: In USA when act was passed in 1979, it created a new industry and created a new group of professional. It only applied to federal projects..

In USA we have many environmental groups who may insist that before project go ahead, there be an EIA. They are voluntary agencies, and engineers fell they cause great problems. But on balance the roles of these groups are useful, because they do what government has let slip, and they have become true representatives of the people. One of the most important laws in the USA, the safe water acts, was because of research done by a voluntary agency.

Zhang Chong-Hua: In PRC the greatest complaints from the people are on environmental issues.

Mr. Ling: In USA, EIA have caused many delays and raised costs in USA. Question: What size projects are subjected to EIA's in Asia?

B. Lohani: Most countries which have EIA define the project size and the type requiring EIA. When integrated with feasibility study it does not cause delay; feasibility studies will have a section on environmental impact. Hence the project planner sees all related issues, even social issues, and takes them into account. rather than bring in a variety of agencies, the EIA allows the integration. The objective is to have all related issues dealt with at the planning stages. For example, ADB has guidelines for each sectoral projects, and these guidelines, include environmental concerns in project planning and implementation. The guidelines are prepared for use by the project staff in the bank and may not be of direct use for other agencies but it provides a lot of information useful to all environment.

Mr. Lin: In USA we do EIS which we subject it to public hearing.

B. Lohani: No country is Asia has a public hearing system in the US way.

Mr Fu: Tsinghua University re EIA in China. If we only work on individual projects, we are not able to handle issues which deal with different sectors. Therefore we need integrated planning. In certain areas in China, were we do planning from top, we do a better job. But that is not universal. How is it handled in Asia?

B. Lohani: As I mentioned in my presentation, countries are beginning to prepare integrated plan and considering economic and environmental aspects. This is a beginning trend which helps to integrate environmental aspects at the early stage and also assists in identifying projects needing environmental assessment. Examples which showed in the transparency re the Han River Study in Korea, Songkhla Lake Basin Planning in Thailand; Integrated National Development in the Philippines, etc.

H. Fish: When it comes to environmental conservation, it will not be done properly until the environmental process that create ecological problems are understood. I do not believe that the majority of EIA's do the job they are supposed to.

D. Kinnersley: The existing environment is not the work of nature alone. I was once in charge of a reservoir which people thought important because of nesting birds. We were told not to disturb the birds. The reservoir was built 80 years ago; where did the birds live then? In banning, industry and water management, people constantly change the environment. EIA is a way of discussing what changes we make next.

Another point: I was trained in economics. It is not a path to perfections.

X Questions to Dr. Lin (after he presented his paper on Maximum Contaminants Levels and Water Management)

Q. Fish: In your paper you refer to standards for THM. As for as I know, no one has been able to show impact on health. Why have the standard?

A. Lin: We do not want to wait until it is too late.

A. Okun: 1) THMs particularly chloroform, have been shown to cause cancer in animals, and that makes them suspect. 2) Latest epidemiological studies comparing population using chlorinated and non-chlorinated waters show health impacts on those using chlorinated water.

XI David Kinnersley presented the views of Group A on the main issues of law, planning and money.

On law, the group agreed that law must be put in place at national level. The commitment of central government is crucial and all polluters -- the public, industry, agriculture -- must be made aware of and recognize the law and the government's commitment to reduce and prevent the pollution of water resources. Law is the prerequisit for a permit system to manage water quality as described below.

But law is not enough on its own. The Central Government must have guidance ready for the provinces and municipalities to follow.

The approach must be flexible. Municipality efforts to provide treatment of domestic and industrial wastes must not encourage the neglect of industrial treatment plants which are in good working order. The factories must still treat their own toxics and wastes which are not biodegradable or will damage sewers and wastewater processes. Improvements must be built on what is already there and still capable of being used.

Also, the law must provide for some cities and provinces to be selected as priority clean up areas, where progress is most urgently required.

This lead to Planning which should include some classification of river lengths by water quality standards to be achieved and pass to their neighbours downstream. This helps each area to plan its own treatment program. The standards should reflect the use to which the water will be put, and must be realistically achievable in terms of technology and cost

It is vital that the National Government - when it indicates the standard to be achieved on classified lengths of river - not get into detail. This must be left to the agencies in each area, probably in groups so progress is made together. When Shanghai provides only primary treatment, it is of concern that other upstream communities will do the same, with severe impact on the Yangtze. A coordinated appraoch between jurisdictions will be necessary.

The links between water quantity and water quality must also be recognized - in Netherlands there are many disputes between agencies until that was recognized.

Government planning will set standards and guidelines for river classifictions under the law and priorities for certain areas and then local communities and industries should achieve the result according to their own plans and circumstances.

There will need to be suitable approaches for the growing amount of industry in rural areas. Much worry aboout these rural industries as a rapidly increasing source of pollution including non-point pollution. They may be doing more damage than they recognize but they cannot be dealt with in same way as cities.

On money, the Group recognized that central government funds for pollution control are limited and weak, so most of money must be gathered in provinces and municipalities. The group was told of three main ways money is gathered at present.

It was urged that there be critical review of all these methods as charges are bound to play a major role in providing money for improvements. The best charges to increase will be those which give industries incentives to reduce water consumption and effluent discharges. The concept of variable charges at different seasons of high or low flow may also be relevant.

The principle that the polluter must be responsible for his pollution may need more understanding - there are different ways of applying it but either way those who make pollution must not escape costs which this creates.

External financial assistance from central government or abroad should be repayable by the beneficiary as loans to provide for revolving funds.

Finally, on economics, the group recalled Mr. Warford's paper and the recognition that environmental protection and the prevention of environmental damage will usually be the most economical way to address environmental problems. Present damage to environmentaal resources may prove to be very costly in the future.

This led chairman to emphasize again the role of motivation and persuading central government to give continuing strong leadership to stimulate and guide local action in cities and rural areas, to prevent pollution before it occurs.

XII Discussion on Presentation of Group A

D. Okun: You mentioned national standards for ambient water quality, but not of drinking water quality. Ambient standards are important. Ambient standards depend on use. However since drinking water is for health only, that should be done by Central Government. The Central Government should examine the contaminants of concern and establish standards based on health, based on research in China and elsewhere.

B. Lohani: WHO had standards for the whole World, but it was not sensible to have one set of standards for all. Now the WHO "standards" are called guidelines. A country may have a manimum/maximum standard, rather than a common standard, and standards may vary from place to place, and for rural versus urban. For example, if there is a high natural fluoride content in locally grown grains, the concentration of fluoride in water must be set lower than for other areas. China should consider introducing drinking water quality guidelines.

H. Fish: As a consequence of who should do what, if municipalities are to take general guidance from government, then decide for themselves how to apply that guidance, this will require trained managers who are different than those used now. They must know more about the technical fields.

D. Kinnersley: The group recognized the need for good planners and designers, and operators.

H. Fish: I am refering to the multidecipline manager, he needs to know water resources and water supply. His background should include training in of water resource schemes.

Prof. Qian Yi: We recognize that environmental standards are important, but how to set them up? We face conflicts: if we follow water quality objectives, the standards would be strict, but this is costly and exceeds avaiatble finance. We should not set standards we cannot achieve. But if we do that we cannot protect our water resources. We conclude that we have to start with lower standards, and gradually improve.

H. Fish: The secret of bringing pollution under control while industrial growth take place, is to hold pollution at the present level. Then select certain rivers and gradually improve them. Then gradually raise the standards.

Mr. Qu: As far as standards are concerned we must clarify a point. The pollution discharge standard and ambient standards are two different concepts. Ambient is based on water quality objective of water body. In China, we have not set the ambient water quality standard based on ambient conditions. Japan has seven different water quality objectives. The basic standard is for discharge. But it will take us time. So discharge standard should not be set too high at the outset.

D. Okun: A subject not covered so far but which should be included in the final report. No mention has been made of importance of ground water for China. Some ground water not adequately exploited, and some ground water resources are contaminated. In other countries ground water is very important.

Mr. Wang, Nanjing: Ground Water very important and in short supply in Western, North Western and Northern China. Groundwater is important for irrigation as well. Groundwater is critical where high population and where used for agriculture. In Beijing groundwater is a great problem. In 1966 land subsidence of 2-5 mm/yr in 1970, 10 mm/yr, in 1980, 81 mm/yr. Upper aquifers are badly polluted. Hardness is increasing at a cost to industry of Y 50 million/yr. In Southern China we use surface water.

Mr. Cheng: Groundwater overuse causes land subsidence, lowering of water table, and decrease of water quality. Our groundwater assessments began in 1970's. We have standard on planning of water resource. We have a lot on paper, but little action because of institution, legal and management problems.

D. Okun: What actions are under consideration to stop decline of groundwater?

Mr. Wang: Use surface water.

Mr. Song For Shanghai, since 1973 we use surface water more because of subsidence. In winter we recharge the aquifers with tap water. In summer we abstract.

Mr. Zhou - Shanghai: There are different types of reuse. If water is not concentrated in one place then used for resue, that is expensive. One would need a costly redistribution system. It is better to put it into river. It is better to use in factory itself, it is cheaper. If one wants to reuse from waste water treatment plant, need to log out plants rapidly. But probably better to concentrate, because larger is more cost effective.

Mr. XX of Beijing Groundwater: Regarding how to control land subsidence:
1. increase recharge by artificial means. But its technically and economically difficult, though meaningful for control of subsidence.
2. Use surface water instead of groundwater.
3. Strong enforcement method to control abstraction of groundwater. Use better groundwater for domestic purposes. We will use this in Mongolia and Beijing. Problem of water resources and environment has two aspects. Groundwater and surface water are not two aspects, but one. Water resource and water environment are also the same.

D. Okun: In US there is a large facility for water reuse. Surface water situation in Western US is similar to Nothern China, both are water scarce. Phoenix, Arizona sell all of their waste water to a power plant for cooking. It was sued by citizens because the resale price was too low and there were high value uses within the city. Waste water will become as attractive as water source as a new groundwater well.

D. Kinnersley: Water from river should be made as expensive as water from a pipe so factories are encouraged to recycle.

H. Fish: The biggest reuse of water is for agriculture and industry, because they can use lower quality water. Once through cooling water is okay, but recycled cooling water builds up dissovled solids.

XIII J. Zeper Presented the views of Group B on Water Resource and Water Quality

With respect to water resources the problem in North China is mainly on quantity and in South China mainly on water quality.

In Northern China the concern is not limited to water based ecosystems, but also land based ecosystems appear to be threatened. There is still very limited knowledge in China how to deal with land based ecological studies.

For Northern China instead of water resources policy the empahsize appears to be on water exploitation policy. This will inclulde pricing of water, conservation of water, allocation of water, etc.

Water use - especially in South China - appears to be characterized by a great interrelation between river intakes for water supply and discharges of wastewater.

This phenomenon was clearly demonstrated by the situation in the Tai Lake delta area. Here the quality of the Grand Canal water is rather bad due to high pollution loads from the four towns along its course. It was recognized that the Lake Tai as well as the lower Yangtze River had to be studied by an integrated approach.

It appears that this need for coordination has resulted in the creation of a leading group as well as in the designation of the Lake Tai Management Burau as the agency in the field.

Recent developments in the Grand Canal Area such as the increased use of fertilizers and rising labor costs have had an adverse effect on the quality of the water of this Canal. This reflects the views as mentioned by Mr. Warford ofthe World Bank. As a result of this the sludge from the bottom of the Grand Canal and the human manure from the urban areas is less in demand in the agricultural area and as such the deoxygenation of the Grand Canal is substantially increased.

The Yangtze River is, so large - 2X Mississippi and 300 X 10^6 inhabitants - that is influences a substantial part of China. Given the interrelation with the Grand Canal situation, water pollution control measures of the Yangtze River as a whole may influence the Tai Lake Delta area.

It was mentioned by a number of participants that the reuse of effluent of wastewater treatment is a very important issue, especially in the northern part of China. So reclaimed wastewater is to be considered as a water resource.

With respect to standards for classification of surface waters, the conventional system appears to be inadequate when the long term impact on public health are taken into consideration. This calls for a new approach with new up-to-date standards.

Non-point sources of pollution, that is through urban, industrial and agricultural run-off are not collected in sewers and therefore not subject to possible treatment in centralized wastewater treatment plants. To avoid pollution of sensitive waterbodies - such as Lake Tai - careful planning of activities through land-use will be required.

Uniform effluent standards for industry - irrespective of local circumstances - has resulted in unnecessary high investments for the treatment of industrial waste waters. Care should be taken that too high standards on water pollution do not result in escape routes leading to air pollution by incineration or soil pollution by land disposal of wastes.

The question of low cost investment types of treatment plants was raised as an intermediate measure, especially in those instances where no municipal sewers are yet available to discharge industrial and/or domestic wastewaters.

As a general recommendation it was stated that lagoons, land treatment and other extensive treatment methods require much land and are therefore only applicable for relatively small-scale plants.

Another observation was that the first steps should be aimed at the construction of sewers - or interceptors of existing drains - and the construction of primary treatment plants. In a second phase it can be decided whether the effluent will be used as a water resource, or that a secondary treatment will be added.

XIV D. Okun Summary of the Technical Discussions

I am very much impressed by the bredth and depth of discussion on water quality management. Given the time limits, and diversity of interests, it is remarkable that a concensus is developing.

The conferees heard presentations and held informal discussions which led to the following general conclusions:

I. The PRC Government's role in environmental protection is crucial. Government officials, industrial managers and workers, peasants, teachers and students and people generally must perceive that their government is committed to environmental protection. The government can show its concern in many ways.

1. Establish national standards and guidelines for ambient, effluent, and drinking water quality, recognizing that they need to be adapted to varying situations and that methods for achieving the standards should be developed locally.

2. Provide funds, prefearbly through loans, to assist local authorities with the provision of the necessary facilities, with the understanding that these loans would be rapaid by those who benefit from the services so that the funds can be used elsewhere.

3. Set priorities among provincial and local authorities for such government assistance.

4. Develop programs for issuing permits for water abstractions and wastewater discharges along with suggested charging systems that would permit local authorities and provincial offices to recover costs of these services and resources.

5. Provide for and help in the development of the wide range of professional personnel required for water quality management, with emphasis of needs at the local level.

6. Stimulate cooperation among local authorities the various ministries and other agencies that need to work together to optimize the management of the water resources.

7. Help organize and standardize the collection of all water-related data that are accumulated around the country.

II. Provincial and local authorities are equally essential with government to effect sounmd water quality management. In a country as large and advance as the PRC, programs have to be implemented in full recognition of local circumstances. Their roles are also extensive:

1. Public education on environmental issues and the value of water.

2. Implement systems of permits for abstraction of groundwaters and high quality surface waters together with systems of charges for such water to encourage conservation and to provide financial resources to permit further development of water resources.

3. Also implement a system of discharge charges for wastewater effluents based on volume and strength both to surface waters and to sewerage systems to reduce wastewater volumes and strengths and to provide funds for treatment and management.

4. Provide incentives, through charging and restrictions on abstractions of high quality water for stimulating reclamation of wastewaters for non potable reuse.

5. Prepare land-use plans that protect the high quality water resources of a region and optimize their use. Land use plans together with permit systems and charging practices should help protect high quality water resources.

III. Many factors were presented that identify critical water issues in the PRC. These include:

1. The greatest threats to water resources result from the nature and intensity of development construction on a groundwater recharge area restricts infiltration increases flooding, and thereby reduces the yield of the water source. Furthermore, the intensity of development impacts on water quality to the extent that conventional water treatment technology can no longer assure a healthful supply.

2. Water quantity and water quality issues need to be considered together. In Northern China, the major concern is with quantity, but water quality cannot be ignored. In Southern Chnina, water quantity is generally ample, but its quality has been seriously compromised by heavy urban, industrial and agricultural development. Adequate resources of high quality are limited almost everywhere in China so that a high priority must be given to their identification and protection.

3. Where water resources are intended for drinking, they can no longer be adequately characterized by the conventional parameters. China is exhibiting the patterns of health typical of industrial countries, with high cancer and heart disease death rates. Accordingly, the safety of drinking water must be characterized by the presence of potential for carcinogenic compounds, many of which are not easily measured and are not

easily diminished during flow in a river. The current status of treatment technology is far less certain of producing a safe water than choosing a source of high quality in the first place. Boiling wate is also no longer a guarantee of safety.

4. In deltaic areas, water resources tend to be part of a single system and need to be considered together. A good example is the system that includes Tai Lake, the Grand Canal, the Yangtze River, and groundwaters in the region.

5. The Yangtze River is large, having 2X the flow of the Mississippi River in the U.S. However, the population on its watershed is about 3X as great. The lower Mississippi has been found to be rich in synthetic organce chemicals: can the Yangtze River be used as major disposal site for wastewaters while serving as an important source of drinking water?

6. Changing economic and political circumstances can have a significant, if unintended, impact on water. For example, the new economic policy in the PRC, and the improved economic status of farmers, has made the use of night soil less attractive than commercial ferlitizers. As a result, the night soil has been piled up on the land, causing considerable pollution and nuisance. Also, farmers used to dredge canals for the fertilizer value of the sediment. Now they do not dredge the canals, and the sediment creates a noxious situation because it deoxygenates the water.

7. Another element in the changing scene is the increasing use of flush toilets, which is much preferred to night soil collection and disposal but which creates other problems.

8. With increased use of sewers, and to facility for treatment, a useful interim measure is land disposal or pond treatment which require large areas of land. However, these are only suitable for small installations and will need to be abandoned with increasing urbanization.

9. Runoff from urban, industrial and agricultural areas is difficult to monitor. However, such runoff may contribute more pollution to water that point sources. Research to characterize the quantity and quality of runoff from various types of land use should permit estimates to be made of such runoff as a precursor to preparing programs for controlling such pollution.

10. Effluent or discharge standards should not be rigid or uniform. They should reflect the use to which the receiving body of water is put. For waters used for drinking, preferably no discharge or a very high standard is required to maintain safety. If the objective is to prevent odor and black septic conditions, the effluent standard can be relaxed.

with a considerable saving in cost. Restrictive standards should not force industries to discharge their wastes to the soil or the air, with perhaps greater consequences.

11. In watershort areas of China, reclamation of wastewater for nonpotable reuse offers considerable promise for meeting resource needs while reducing pollution, both at lower cost. Urban reuse for watering of parks, for construction, for industrial process water and cooling, for fountains replaces high quality drinking water formerly use forsuch purposes. It has been use successfully for toilet flushing in large housing blocks. Such reclaimed water must be clear, colorless, free of odor, and disinfected, to eliminate any hazard from accidental ingestion. Such dual systems are becoming widely used in the U. S.

XV Discussion on D. Okun Summary of technical Discussions

D. Okun: I wish to comment on the Yangtze River: same cities plan to put wastes in the Yangtze, others want to use it as a source. There is need for overall coordination. In Southern China water quality is most important, and even the Yangtze is not a limitless resource. I am concerned that other ciites will do as Shanghai is doing, that is, putting their wastes in the Yangtze with primary treatment only. That may be okay, but I wonder if any agency is looking at the total loadging into the river now and in the future, and what the impact will be.

In Northern China, water quantity is more important and ground water is very important . There is great diversity of problems, therefore also need diversity of policy and approach.

D. Kinnersley: In UK we pass new laws regarding water pollution in 1974, but only parts are operation in 1986. That may seem slow, but for the community as a whole it is good progress. So we must keep pushing ahead at the national government level to get other communities to follow.

A. Bruestle: Now that the issues are focussed, China needs to involve in future workshop and discussions the Ministries of Agriculture, Industry, and Finance, and the State Planning Commission.

D. Okun: I believe the Chinese know what to do. They need to decide how to do it. There is less need for foreigners at future workshops.

D. Okun: Are the waterways people important?

Zhang CH: (reply not recorded)

Mr. XX: What is the first next steps?

Mr._____MURCEP: Most important is to develop our institutions. Factories are reluctant to give money for pollution control because they must give it to Finance Bureau. Mayors also have many demands on the limited funds they have. Industrial plants never go bankrupt. Waht can they do when budget is cut? Reduce the size of the wastewater plant, or reduce the degree of treatment. The main thing in our country is to raise awareness.

XVI Mr. Wang Of EPA: Final conclusion

This day we talked about regulations, legal, water management, reuse, institution. Based on our countries sitution, here is my personal opinion. First, our legal situation has moved quickly recently. In 1983 we passed the environmental law, in 1984, the Marine pollution control law, in 1985 the water pollution control policy. But once a law is passed we used guidelines and detailed regulations. Also detailed rules and regulations must be prepared by local governments, and in some cases this still must be done. Also we require two standards, ambient and discharge. Both are in process of development, by September 1987, both will be finalized. Regarding charging: we only charge those which cannot meet the standard. It is far from satisfactory. Regarding issue of permits, we are using it on a trial basis. Also we do not recognize yet that the variety of uses require varying quantities and qualities of water. Also we do not know how to penalize those who violate the laws and regulations. And we do not have strong enforcement. We have the law,, but we do not adequately enforce it.

Regarding water pollution control planning. Shall we have centralized treatment system, or regional? Based on foreign experience, it is better to have industrial pretreatment. But we cannot collectively use funds from factories, and it seemed easier to do it factory by factory, we used that approach in the 70's. After 1985 Conference of cities on integrated treatment, did we raise awareness of importance of centralized treatment.

For densely populated regions we need a regional program. Regardless of its integrated by city orregion, it is more difficult because financing is more complicated.

Regarding financing of treatment, economic development is a priority. Especially because the State has said that by 2000 we will triple output. But Wastewater Treatment Plants do not have a direct productive effect. On May 14 the State announced that the total cost of 12.5 billion m3 of water will be used in the 7th plan. Based on statistic of other countries, we will have to spend about 0.3% of GDP to protect water quality.

Another policy we have been looking at is to have the people pay for discharge, but it is difficult to implement. We are short of trained manpower. People's awareness of environmental protection must be raised and that is the key point. Today more than 40 institutes have environmental program and there are about 5000 students. But it is far short of need. Most of students are concerned with environmental engineering and monitoring, not management and planning.

Regarding water resources, in first day Mr. Wu gave a comprehensive report. In total we are rich in water resources but because of population only 2700 cu m/person/year. But in northern and northeast China, only 300 cu m/person/year.

The five dragons fight for water: water Conservancy, Agriculture, Domestic, Transportation, and Industry. Although we have water resource commission, seven basins and Lake Tai, how much they can control is in question. They must be strengthened.

Water abstraction is not charged and this results in waste of water.

Regarding water reuse, we irrigate about 20 million mu with reused water. But treatment was not enough, so there were side effects and land an crops were contaminated.

XVII Closing Remarks of Mr. Qu: Mr. Wang has given a comprehensive report. Regarding Mr. Ling Zhen of Fujian Province EPB question: there are two priorities:

First: The legislation. Now we have water pollution control laws. The next is to fullfil that in provincial and rural areas. Based on workshop discussion, we must fullfil the laws and regulations, and issue standards.

Second: There are seven dragons. In mythodology dragons are responsible for bringing rainfall. Hence dragons are often on the roofs. If you want good rainfall you need many dragons. One dragon to bring water is fine, with two it is still okay but with three the situation gets worse. Toom any dragons they battle each other. Sometimes drought, sometimes flood. We do need an authority to be responsible for water. In central government we are discussing the possibility of centralizing the responsibility of water. It would be like we have drive out energy. Once we have this we will start new era for water.

Chapter II
WATER POLLUTION CHARGES

INTRODUCTION

Water management is the source yielding the greatest wealth of data on the use of pollution charges. Management of water resources has been practised through the ages and a large number of regulatory and institutional systems have been adopted including every kind of financial incentive. The case-studies undertaken by the Water Management Group(1) cover a rich and varied range of experience, from policies based essentially on pollution charges (France, the Netherlands) to other forms of intervention relying mainly on direct control (United States, Japan). Intermediate situations are also to be found in which economic incentives assume some degree of importance in a few regions or municipalities (Canada, USA) whereas Germany, rich in significant experiences (Ruhr), is to extend the use of water pollution charges throughout the country (in 1981).

In this connection, a number of definitions ought to be clarified. In water pollution the general term <u>pollution charge</u> (redevance de pollution) covers two separate concepts: <u>effluent charges</u> (redevances de déversement) paid for direct discharges into an aquatic environment (rivers, lakes, etc.) and <u>user charges</u> (redevances pour service rendu) for discharges into community sewer systems. In both cases, the basis used for assessing the charge is the quantity of pollution discharged, but the methods for calculating the rates and collecting the charges may vary.

Countries where <u>effluent charges</u> are widely used, such as France and the Netherlands, generally apply principles shared by both types of charge (effluent charge and user charge) so that the general term <u>pollution charge</u> can be applied in either case. On the other hand, <u>user charges</u> are much more widespread. All countries use them to some extent, especially at local level, where users have to pay in proportion to the amount of waste discharged into the local sewer systems. Sometimes the link with pollution is fairly remote or even entirely lacking, as in the case of uniform taxes.

This chapter mainly deals with pollution charges in the wide sense, i.e. insofar as they cover both effluent charges and user charges, thus providing the main instrument of water management pol-

1) See <u>Water Management Policies and Instruments</u>, OECD, 1977, and <u>Water Management in Industrialised River Basins</u>, OECD, 1980. See also R.W. Johnson and G.M. Brown Jr., <u>Cleaning up Europe's waters</u>, Praeger, New York, 1976.

icy. In other words, the various types of municipal charges and taxes(1) intended to cover the operating costs of municipal sewer systems will not be described, apart from a few examples where these charges have a direct link with effluent and have a real or potential incentive function.

In the case of economic incentives, it should also be noted that direct or indirect financial assistance to polluters is found everywhere, although levels of aid vary widely. Examples of these forms of action will be mentioned only in cases where they are combined with pollution charges (France, the Netherlands).(2)

Lastly, in no case are charges applied exclusively, without any other form of intervention. They are combined with direct control and with other financial instruments such as local taxes and financial assistance.

The basis of charges, their rates and methods of application will be dealt with in turn.

1. FIXING THE BASIS OF CHARGES

1.1 Water quality parameters

Water quality depends on a very large number of factors, and dozens of pollutants are ordinarily discharged in water. Moreover, water quality is difficult to define, insofar as it relates to different uses (industry, drinking, recreation) and is partly dependent upon more or less subjective interpretation, mainly as regards such parameters as appearance or odour (however, measurement methods are becoming more and more precise).

A basis for pollution charges, i.e. the selection and measurement of discharges subject to charge, must therefore be determined by selecting the most significant parameters to be given priority: a mean must be found between exhaustive but unduly complicated measurement of the different parameters and oversimplification. Experience has shown that a basis for charges should satisfy the two essential conditions of simplicity and acceptability.

Simplicity requires the selection of a limited number of significant parameters which are easy to measure with minimum accuracy and reproductibility and combined in a simple formula that can be

1) In this connection see the report entitled Improving the management of urban public services with special reference to environmental services, OECD, 1980.

2) A detailed analysis of the whole range of instruments is to be found in the various case studies published by OECD (see bibliography). Reference may also be made to: "An Examination of the Polluter-Pays Principle Based on Case Studies" in The Polluter-Pays Principle: Definition, Analysis, Implementation, OECD, Paris, 1975.

understood by all the parties concerned. Such simplicity moreover not only facilitates application but also minimises any disputes upon payment of the charges.

Acceptability by the parties concerned and the general public depends first on simplicity, which promotes better understanding, and secondly on the participation by the payees in selecting the basis. In France, bases of assessment are therefore fixed after consultation with the "Comités de Bassin" which are composed of an equal number of representatives of water users, local and government authorities.(1) It is much easier to run systems of charges when responsibility is shared in this way. The following are the parameters most often used:

- Biochemical oxygen demand (BOD);
- Chemical oxygen demand (COD);
- Organic matter (N);
- Suspended matter (SM);
- Salinity;
- Toxicity;
- Temperature.

It should be noted that these different parameters are not all independent. For example, temperature affects the assimilation of oxidisable substances, while pH and resistivity are two correlated measurements of salinity. An accurate measurement of effluents should theoretically take account of synergies. But here again undue complexity must be avoided. It will be seen, moreover, that fairly simple combinations in calculating the basis (addition, multiplication, ratios) are used.

Parameters must also be expressed in absolute value, i.e. they must depend on a single measurement (pollution flow) rather than relative values such as concentrations which may be conducive to some degree of tax avoidance if, for example, polluting discharges are diluted.(2)

The leading examples of assessment bases for charges are as follows:(3)

1) See Water Management in France, OECD, 1976 and Water Management Policies and Instruments, OECD, op.cit.
2) In cases of sewer charges, concentration is often used as a basis when non residential discharges are expressed in terms of "concentration in excess of normal concentration" (the normal concentration being found in residential discharges).
3) For France and the Netherlands, the two main river basins concerned are the Seine-Normandy Basin (France) and the Dommel-Aa Basin (Netherlands). In a particular country, methods of calculating charges as between basins may vary slightly. The examples chosen, however, may be regarded as representative.

FRANCE

In France (Seine-Normandy Basin) the basis for assessing pollution charges is the flow discharged (in kg/day).

In calculating the assessment basis physical, chemical and biochemical factors are included as follows:

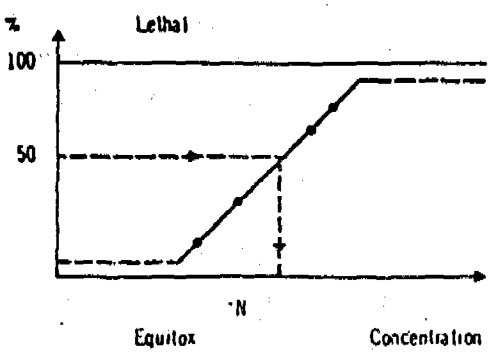
- suspended solids (SS) in g or kg per day
- oxidisable matter (OM) expressed by a weighted average of chemical oxygen demand and biochemical oxygen demand over five days in g or kg per day:

$$OM = \frac{COD + 2BOD_5}{3}$$

- soluble salts, expressed by conductivity multiplied by the volume of water discharged (mho/cm) x m^3
- inhibiting and toxic substances, evaluated by means of a biological test (based on the reactions of a small shellfish, Daphnia). The measuring unit is the equitox-gramme/day or equitox-kilogramme/day.

The measurement of inhibiting and toxic substances consists in assessing the effects these produce on a population of daphnias. The proportion of deaths is a nearly linear function of the concentration of the toxic solution. By gradually diluting the latter a concentration in which 50 per cent of the daphnias die is obtained, is regarded as normal. The number of times the initial sample has had to be diluted indicates the equitox number for the solution (Figure 2-1).

Figure 2-1



Nitrogen compounds are not taken into account as in the Netherlands, but this is being seriously considered. Bacterial and viral pollution should also be included. Nor is the problem of thermal pollution yet resolved: thus rises in water temperature should be a further factor in choosing the basis for charges, and might be measured in terms of the number of kilo-calories discharged or increase in temperature. A number of difficulties still have to be solved in this connection, as damage caused by over-heating is not an independent variable but already depends on the existing amount of pollution, i.e. the heavier the pollution, the greater the oxygen deficiency due to heat. Thus, a rise of degrees will entail reduced assimilative capacity f (x) and additional residual pollution.

Different rates are applied to the four parameters chosen, with the result that the charges are given by a linear combination of the type:

$$\underset{\text{(francs)}}{R} = \underset{\text{(fr/kg/day)}}{t_{SS}} \times \underset{\text{(kg/day)}}{SS} + \underset{\text{(Fr/kg/day)}}{t_{OM}} \times \underset{\text{(kg/day)}}{OM}$$

$$+ \underset{\text{(Fr/mho/om x m}^3)}{t_{Salt}} \times \underset{\text{(mho/om x m}^3)}{Salt} + \underset{\text{(Fr/equitox/g/day)}}{t_{IS}}$$

$$\times \underset{\text{(equitox/g/day)}}{IS}$$

where t = charge rate

SS = suspended solids

OM = oxidisable matter

IS = inhibiting substances.

By taking only the first two terms (SS and OM), which are valid for household wastes and non-toxic and non-saline industrial wastes, the assessment basis for the charges can also be expressed in population equivalent;(1) this is also the case in the Netherlands.

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1) Up to 1976 the financial rates for suspended solids and oxidisable matter were the same. A town dweller was assumed to discharge 90 grammes per day of SS and 57 grammes per day of OM, so that:

$$\underset{\text{(p.e.)}}{A} = \underset{\text{(g/day)}}{\frac{SS + OM}{147}}$$

After that it was decided to allow for the higher cost of destroying oxidisable matter discharged by industrialists by applying twice the rate for oxidisable matter in the Seine-Normandy Basin (tripling the rate is even now being discussed):

$$\underset{\text{(Fr/g/day)}}{t_{OM} = 2\, t_{SS}}$$

In terms of population-equivalents the assessment basis A thus becomes in this case:

$$\underset{\text{(p.e.)}}{A} = \underset{\text{(g/day)}}{\frac{OM + \frac{SS}{2}}{102}}$$

OM and SS being expressed in grammes per day (giving $57 + \frac{90}{2} = 102$ for a town dweller).

NETHERLANDS

In the Netherlands (Dommel-Aa Basins), the basis for assessing the charges depends on two factors:

- pollution load
- a volume correction factor taking the volume of discharges into account.

The pollution load (W) includes several parameters expressed as population-equivalents:

i) oxidisable matter (BOD and COD) (1 p.e. = 180 g/day)(1)

or

$$W = \frac{Q}{180} \quad (COD + 4.57\ N)$$

If the effluent comes from a biological treatment plant, the formula becomes:

$$W = \frac{Q}{180} \quad (2.5\ BOD_5 + 4.57\ N)$$

ii) suspended solids (1 p.e. = 120 g/day)

$$W = \frac{D - 60\ W_x}{120}$$

iii) toxic substances (1 p.e. = 1 kg/year)

$$W = A$$

where:

W = pollution load expressed in population-equivalents (in weight units)

Q = rate of discharge in 24 hours (m^3)

COD = chemical oxygen demand in mg/l

BOD_5 = biochemical oxygen demand in mg/l

N = nitrogen

A = weight of toxic substances discharged (kg/year)

D = weight

W_x = pollution load in terms of oxidisable matter.

1) Broken down as follows: 135 g of COD and 4.57 x 10 g of organic matter.

A volume correction factor (Vc) is used to take into account the polluter's actual level of activity (expressed in working days per year). On the basis of 250 working days/year, the population-equivalent in terms of volume has been estimated at 50 m^3/year. Therefore

$$Vc = \frac{Q - Qs}{50}$$

where

Vc is the volume correction factor

Q is the total volume discharged per year (m^3/year)

Qs is the standard annual volume estimated at 25 m^3 (250 days x 100 litres)

If at least 45 per cent of discharges take place by night, in other words if discharges are more or less evenly distributed round the clock, a coefficient of 0.8 is applied. Thus the fact that regular discharge helps treatment plants to operate more smoothly is taken into account. The volume correction factor then becomes:

$$Vc = \frac{0.8\,Q - Qs}{50}$$

It should be noted that Vc can be negative or positive.

Total pollution discharge is calculated by adding all the pollution loads defined above. A single rate is applied to this overall basis (unlike the Seine-Normandy Basin, where rates differ according to type of pollutant).

1.2 Measurement of discharges

As indicated in the previous paragraph, the assessment basis of charges should as far as possible include parameters that are easy to measure. The parameters mentioned can be measured by tested manual techniques (sampling), and in some cases by automatic equipment. Measurement of discharges calls for measurement of both the concentration and volume, the product of the two giving the quantity of pollution per unit of time. The measurement can be done by the polluters themselves, by the authorities concerned or by both. Generally polluters carry out the measurements, which are checked at regular intervals by the administrative authority.

Measurement always entails a cost, even if a fairly low one in some cases, but an extension of measurement to all polluters can lead to substantial expenditure. One approach is therefore actually to measure pollution for major polluters only, and simply estimate it (see below) for "minor" polluters. This policy is followed in France where discharges are generally estimated on a flat-rate basis (coefficients of discharge), while leaving open the possibility of specific measurement when considered necessary by the "Agence de Bassin" or at the request of any users who feel that the estimated rate discriminates against them. In the latter case the cost of measurement is borne by the user if the pollution is found to be lower than the presumptive or flat-rate assessment and by the agency when the opposite is true.

As a general rule, flat-rate estimates of emissions seem to be a satisfactory and widely used method. The following are a few examples drawn from France and the Netherlands.

In the Netherlands, discharges by small industries (i.e. less than 1,000 population-equivalents/year) are estimated by means of coefficients expressed as population equivalents (p.e.) per employee, per tonne of output, per tonne of intermediate consumption, per m^3 of water used, etc. For example, in the chemical industry discharges are estimated at 20 population equivalents per year per employee; in the paper pulp industry the figure is 1.4 p.e./tonne of paper (for wood and cellulose) and 7 p.e./tonne of paper (for the other raw materials). Above 1,000 p.e./year, the polluter himself must continuously measure the volume discharged and monitor the concentration of pollutants by sampling at regular intervals. The greater the volume discharged, the greater the sampling frequency required.

Households, residential premises and small firms discharging less than 20 p.e. are charged on the basis of 3.5 p.e. per unit, the average size of households being 3.5 persons. People living alone are charged on the basis of 1 p.e. on request.

In France, estimates based on combined emission factors and set out in "flat-rate schedules" are very widely used. They are, moreover, fixed after consultation among the parties represented on the "Comités de Bassin". Emission factors are calculated according to a method quite similar to that used in the Netherlands, although no specific pollution thresholds are used in order to determine whether or not to apply the coefficients. Actual measurements are made for the largest sources as required, depending on the measurement cost involved.(1)

In local communities, oxidisable matter discharges are assessed in relation to the number of urban inhabitants (on the basis of 147 g/day/p.e. - see above).

In view of the fact that the amount of pollution discharged does not vary in direct proportion to the size of the community (for example, pollution in rural communities is on a small-scale compared with that in large towns), community coefficients are applied to actual population figures or to basic rates charged per p.e. (Table 2-1.)

Table 2-1

COMMUNITY COEFFICIENTS FOR THE CALCULATION OF POLLUTION CHARGES (FRANCE)

Class	Population of community plus any seasonal residents of the municipality or municipalities making up the community	Community coefficient
Class I	Up to 500	0.5
Class II	From 501 to 2,000	0.75
Class III	From 2,001 to 10,000	1.00
Class IV	From 10,001 to 50,000	1.1
Class V	Above 50,000	1.2
Class VI	Communities with no water supply system	0
	Paris area	1.4

1) For example, in the Seine-Normandy Basin classification of pollution sources according to size shows that the 200 largest industrial polluters account for 80 per cent of the total pollution, the next 1,400 only accounting for the remaining 20 per cent.

In order to allow for municipal water treatment in cases where pollution is not directly masured, "treatment premium coefficients" are applied to the basic gross charge (see Table 2-2).

Table 2-2

TREATMENT PREMIUM COEFFICIENTS (FRANCE)

Type of plant	Coefficient applicable to S.M.	Coefficient applicable to O.S.	Coefficient applicable to population
Settling tank	0.5	0	0.3
Complete biological treatment	0.7	0.6	0.7
Sewage farm	1	0.8	0.9

This is not applicable to industries where net pollution discharged is calculated (either by direct measurement or by applying coefficients).

Lastly, account must also be taken of peaks of pollution when measuring discharge flows. It may be necessary to take several samples during the year for this purpose. In France the charge is calculated on the basis of an average day during the month of heaviest pollution for each industry. For example, if an industry discharges 3,600 kg in September and 2,400 kg in the other months, the average daily discharge will be estimated to be $\frac{3,600}{30}$ = 120 kg/day.

2. RATES OF CHARGES

2.1 General principle

Rates of charges are calculated according to the amount of expenditure under the programmes to be implemented, whether for river basins (France, Netherlands) or municipalities in the case of user charges (e.g. a sewage treatment charge). The rate is therefore fixed so as to cover all or part of the cost of implementing such annual or multiannual programmes. The break-even rate for distributing proceeds is therefore defined as follows:

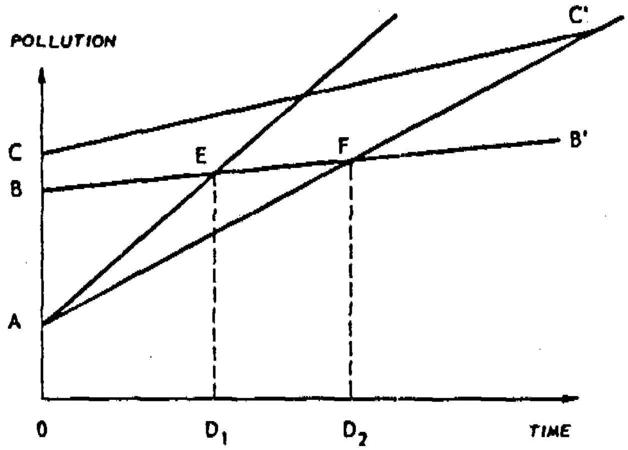
$$t_r = \frac{\text{cost of programme}}{\text{pollution discharged (in units of assessment basis)}}$$

The scale of programmes is extremely varied. In municipalities applying user charges these are intended to cover the cost of investment in municipal sewage plants and/or running costs. In the Netherlands, charges levied by Water Boards (Waterschappen) are intended to cover the working expenses of municipal sewage plants (including capital cost), while the charges levied by the Government on discharges in "State waters" are redistributed as financial aids to pre-existing factories (existing before implementation of the Water Act of 1st December, 1970). In France, charges are redistributed in the particular river basin as aids to industries and municipalities.

It should be noted that break-even rates for the redistribution of proceeds are usually very closely associated with the idea of catching up with accumulated pollution; relevant programmes are therefore based on a treatment technology, a budgetary appropriation and a timetable for carrying out the work.

Line CC' in Figure 2-2, represents the estimated trend of pollution after allowing for treatment carried out (OA); the time lag to be made up is therefore represented by AC = OC - OA. Aside from the total elimination of pollution, the objective may be to make up part of this time lag, i.e. AB. The available technology allows for efficiency of treatment represented by the line BB', which is the technically feasible objective. The lines AE and AF represent two possibilities of making up time lags according to budgetary appropriations, and durations D1 and D2 correspond to these two possibilities. Programme AE covering the period D1 represents maximum financing, with a corresponding high charge rate. Programme AF covering the period D2 represents a lower rate of financing, hence lower charge rates.

Figure 2-2



2.2 Practical examples

In the Netherlands, waterboard rates are calculated in relation to annual installments of investment programmes. For instance, the Aa waterboard estimate of the charge for 1978 was as follows:
Annual expenditure (in million Dfl.)

- Trunk sewers	2.6
- Treatment stations	10.8
- Collecting expenses	0.7
- General expenses	0.7
Total	14.8

Total population load = 0.63 million p.e.

$$\text{Charge per p.e.} = \frac{14.8 \times 10^6}{0.63 \times 10^6} = \text{Dfl.23.40(1)}$$

For discharges into waters under direct central government control ("State waters"), the rates are fixed by the central government according to the amount of expenditure needed for protecting these waters, as in the form of aid to local bodies that incur expenditure

1) Source: Water Management in Industrialised River Basins, OECD, 1980, Chapter III.

for protecting "State waters" or aid to industries that were set up prior to the Surface Water Protection Act of 1st December, 1970. The subsidy must not exceed 60 per cent of the investment cost. This system of charges may in fact be regarded as specifically designed to finance a "catching-up" programme for the period 1971-1985.

Rates of charges for discharges into "State waters" show the following trend (Table 2-3).

Table 2-3

Year	Rates of pollution charges ("State Waters") in Dfl./p.e.	
	Fresh water	Saline water
1975	13.00	7.00
1976	15.00	9.00
1977	17.00	11.00
1978	21.00	15.00
1979	25.00	19.00
1980	29.00	23.00
1981	33.00	27.00
1982	37.00	31.00
1983	41.00	35.00
1984	45.00	39.00
1985	49.00	43.00

In France, rates are calculated on the basis of a multiannual programme of activities drawn up by the Agence Financière de Bassin.

As the value of M in the programme and its duration (in years) are known, we have:

$$M = t_{ss}\sum_{1}^{n}(SS)_i + t_{OM}\sum_{1}^{n}(OM)_i + t_{salt} \times \sum_{i}^{n}(salt)_i + t_{is}\sum_{1}^{n}(IS)_i$$

$$\text{with } t_{SS} = \frac{t_{OM}}{2}$$

As a general rule there are "salinity" and "toxicity" sub-programmes which make it possible to select t_{salt} and t_{IS}

For the Seine-Normandy Basin, the 1978 rates were as follows:

Population-equivalent	Fr.10 per year ($2)
SS (kg/day)	Fr.48 per year ($9.65)
OM (kg/day)	Fr.96 per year ($19.30)
Inhibiting substances (equitox-gramme)	Fr.1 per year or Frs.1,000 ($201.20) per equitox-kg
Soluble salts ($\frac{mho}{cm} \times m^3$/day)	Frs.1,350 per year ($271.60)

According to forecasts for the 1977-1981 programme, the rates should rise as follows in 1979:

p.e.	Frs.11.55	($2.30)
SS	Frs.56.62	($11.40)
OM	Frs.113.24	($22.80)
IS	Frs.1,150.00	($231.40)
Salts	Frs.1,350.00	($271.60)

The Agencies' action programmes consist mainly of loans and subsidies to industries and municipalities in the basins. The revenue from charges is therefore redistributed among polluters in order to help implement the programme. Table 2-4 summarises the action programmes of the six French basin agencies for the period from 1977 to 1981.

2.3 Geographical distribution of rates of charges

Setting different rates according to conditions and objectives peculiar to each area can strengthen the incentive effect of charges.

In the Netherlands, there are appreciable differences in rates as among areas (which varied by a factor of 1 to 3 in 1979 - see Table 2-5), actually reflecting differences in the waterboards' programmes and expenditure. On the other hand, rates do not vary within a particular basin, while a standard rate is also applied for discharges into "State waters".

In France, rates vary according to area within some individual basins.(1)

1) The geographical context should, however be taken into account: France only has six river basins (divided into sub basins), whereas the Netherlands have 40 "Vaterschappen" (waterboards) which collect pollution charges, and the rates therefore vary considerably.

Table 2-4

SUMMARY OF THIRD PROGRAMMES OF THE
FRENCH RIVER BASIN AGENCIES (1977-1981)

	Ardour Garonne	Artois-Picardy	Loire-Brittany	Rhine-Meuse	Rhône-Mediterranean Corsica	Seine Normandy	Total Frs '000,000
EXPENDITURE Resource development aid							
- Dams	48.00		210.40	36.20	77.30	95.00	
- Protection of water resources	22.00	127.00	22.70	9.00	22.80	120.00	1,150.36
- Other action	19.00		35.96	-		305.00	
TOTAL RESOURCES	89.00	127.00	269.06	45.20	100.10	520.00	1,150.36
EXPENDITURE Pollution measures							
- Local municipal plants	95.00	88.00	192.00	113.00	176.70	241.60	906.30
- Sewer systems	22.00	141.00	9.00	25.00	78.00	250.10	525.10
- Industrial plant	96.00	215.00	174.00	241.00	-	388.60	1,456.80
- Waste treatment centre	5.00	-	6.00	-	297.50	33.70	-
- Aid for processing and transporting waste	5.00	30.00	2.50	3.10	16.50	102.20	159.30
- Technical assistance	11.00	3.00	25.00	7.00	18.20	37.50	101.70
- Other	-	25.00	23.00	-	31.90	96.50	176.40
- Local treatment facilities	84.00	187.00	503.20	59.00	228.00	929.92	1,991.12
- Maintenance	-	(1)	-	11.40	32.70	226.90	271.00
TOTAL POLLUTION	318.00	689.00	934.70	459.50	879.50	2,307.02	5,587.72
- Studies	6.00	80.00	108.50	10.00	63.10	47.00	738.15
- Operation	88.50			64.50	125.00	145.55	
- Internal programmes carried over	46.00	132.00	93.90	74.40	457.70	584.17	1,388.17
TOTAL EXPENDITURE	547.50	1,028.00	1,406.16	653.60	1,625.40	3,603.74	8,864.40
REVENUE							
- Pollution charges	380.00	625.00	935.50	454.60	1,366.10	2,454.73	6,215.96
- Abstraction charges	96.00	321.00	110.46	86.70	164.30	726.00	1,504.49
- Repayment of loans and advances	75.00	82.00	297.90	112.30	103.00	423.01	1,093.21
- Other	-	-	219.21	-	-	-	219.21
TOTAL REVENUE	551.00	1,028.00	1,563.07	653.60	1,633.40	3,603.74	9,032.87

1) Included under "Other".

2) Five-year instalment of long-term 1975-1995 programme in terms of expenditure guaranteed by charges collected over a seven-year period.

2.4 Incentives and redistribution

- Redistributive role of charges

The examples studied show that water pollution charges mainly play a redistributive role, in other words their chief purpose is to collect financial resources in order to cover the cost of implementing the management programmes of basin or municipal authoritie

Redistribution can be achieved in two different ways:

- by financing sewer systems and community treatment facilities (e.g. waterboards in the Netherlands and many municipalities in most countries). The charge is then essentially a user charge,
- by redistributing the proceeds among the various polluters (industries and municipalities) in order to finance part of the investment and/or operating costs of the treatment facilities they set up. This is how the French system mainly works and how "State waters" are managed in the Netherlands. According to the definition given in the introduction to this Chapter, these are effluent charges on direct disposal into surface waters.

In fact both types of redistribution may be closely combined, as in France, where the proceeds are used for financing community treatment plants, and sometimes individual ones.

- <u>Incentive charge</u>

According to economic theory, a charge does not have a redistributive but an incentive role (see Introduction). An effective rate level is therefore one at which polluters will be induced to treat their waste up to the point where the marginal cost of treatment equals the rate of the charge. A specific objective must match this level of treatment. The incentive rate t_i may therefore be expressed as:

$$t_i = \frac{\text{depreciation + maintenance cost + running cost}}{\text{technical efficiency of treatment}}$$

The break-even rate for redistributing proceeds (t_r) - defined in section 2-1 - and the incentive rate (t_i) will therefore be determined according to different criteria. Although their objectives are different, this does not mean that they are divergent, since the end will always be to achieve a given level of treatment. In the case of (t_r) the charge is primarily a method of financing, while in that of (t_i) it is an incentive. The two functions are not incompatible, as t_i can also serve as a method of financing and t_r may have incentive effects. The sole case in which only one of the functions can be fulfilled is when $t_r < t_i$.

As theoretically shown in the Introduction, the sums redistributed among the polluters may bridge the gap between t_i and t_r (where $t_i > t_r$) in order to meet a specific objective when the incentive level has not been reached.

Does the fact that current charges turn out to be essentially redistributive mean that any reference to the incentive role has been abandoned? To answer this question, current rates and their future trend must both be taken into account.(1)

In some cases current rates of charges may act as an incentive. This is especially true for the Netherlands, where rates per population-equivalent are several times higher than in France (by a factor of 6 to 15 in 1979 - see Tables 2-6 and 2-7).

As rates can vary widely from one waterboard to the next it is difficult to generalise. Nevertheless, an example is the trend in rates of the Dommel and Aa Waterboards compared with the trend in treatment costs per unit (Table 2-5).

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1) Regardless of the rate, the fact that a charge closely linked to the pollution discharged is paid may act as an incentive to control pollution.

Table 2-5

RATES OF CHARGES (PER P.E. PER YEAR) COMPARED TO TREATMENT UNIT COSTS (PER P.E. PER YEAR) FOR THE DOMMEL AND AA WATERBOARDS

(in Dfl.) (a)

		1975	1976	1977	1978	1979	1980
Dommel	Treatment cost (b)	13.45	17.34	23.46	27.19	28.72	29.60
	Rate of charge	13.00	18.00	23.04	25.92	29.00	32.00
Aa	Treatment cost (b)	13.54	20.70	25.71	28.22	29.31	30.27
	Rate of charge	10.68	17.04	22.32	25.25	25	24.75

Source: Water Management in Industrialised River Basins, OECD, 1980. Case studies on the Dommel and Aa Basins, OECD, 1980.

a) Estimates.
b) Treatment costs are stated in discounted terms, and include investment, operational and administrative costs.

Table 2-6

WATER POLLUTION CHARGES IN THE VARIOUS DISTRICTS OF THE NETHERLANDS (FIGURES FOR 1975-1980 ARE ESTIMATES)

District	Unite Charge Dfl./p.e.									
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Groningen			8.00	11.00	15.00	19.50	20.90	22.00	17.14	53.17
Friesland		6.00	8.00	10.00	15.00	18.00	19.20	24.00	29.00	31.00
Drenthe			6.00	12.00	18.00	21.36	26.64	27.15	32.85	37.10
West-Overijssel				12.96	18.96	25.44	30.72	38.28	42.11	56.37
Regge en Dinkel	8.60	11.75	11.75	15.60	15.60	19.44	23.04	25.68	29.04	31.49
Oost-Gelderland		10.50	12.75	16.00	21.00	26.00	31.35	34.15	35.15	37.73
Veluwe		10.50	14.00	16.80	20.40	24.00	28.80	30.80	32.85	34.25
Rivierenland		10.50	13.80	17.43	22.80	26.80	30.96	34.50	39.00	47.00
Utrecht			18.24	18.24	21.72	27.00	31.00	35.00	38.58	40.85
Aostel en Gooiland					18.00	25.00	29.60	32.12	34.85	37.81
Uitvaterende Sluizen	7.12	9.65	12.20	15.10	18.25	27.65	37.30	43.75	50.50	57.10
Rijnland	7.98	9.40	11.00	13.50	17.90	23.50	28.00	30.00	32.00	39.00
Voerden				18.24	22.80	31.44	36.32	40.25	40.85	40.10
Delfland					16.00	19.50	27.50	29.15	34.10	32.50
Schieland					20.00	26.00	35.00	38.00	37.00	40.00
Kritpenerwaard					18.60	23.00	30.60	28.00	40.00	40.00
IJsselnonde					16.00	21.00	28.00	23.00	27.00	27.00
Nederwaard					12.00	17.00	28.00	40.00	42.00	42.00
Overwaard					21.00	28.00	32.00	32.50	32.50	32.50
Vijfheerenlanden					16.00	25.00	32.50	37.50	39.50	?
Prielse Dijaring	2.00	5.00	8.00	11.00	20.00	28.00	39.00	45.00	48.00	58.00
Hoeksche Waard					17.50	25.00	35.00	38.00	39.50	41.50
Goerse		6.00	8.00	10.00	13.00	15.00	24.00	38.00	38.00	38.00
Plakkee					17.00	25.00	27.00	27.00	45.00	67.00
Schouven-Duiveland					26.00	28.00	38.00	51.60	51.27	71.94
Tholen					26.00	36.00	37.00	38.00	60.00	60.00
Koord-Bevelard					34.00	39.00	40.00	42.00	75.79	71.97
Walcheren					18.00	22.00	28.00	28.00	39.00	42.00
Brede Watering					22.00	34.00	35.00	42.00	43.00	42.00
Eet Vrije van Sluis					34.00	39.00	39.00	50.00	50.00	59.00
Axeler Ambacht o.a.					15.00	15.00	15.00	22.50	23.50	25.00
								27.69	28.93	30.43
Bulster Ambacht					9.00	10.00	12.58	12.52	45.10	61.65
Vest-Brabant		7.00	10.00	16.00	20.00	24.00	26.00	29.00	32.00	35.00
De Ala		11.00	14.00	16.80	20.00	22.50	26.00	-	-	-
De Doncel	5.20	7.00	9.00	11.00	13.00	18.00	23.04	25.92	29.00	32.00
De Aa	3.00	3.50	5.60	8.60	10.68	17.04	22.32	25.25	25.00	24.75
Kaaskant						22.56	23.52	26.88	28.21	38.43
Lizburg				11.00	14.50	23.00	26.65	30.26	34.02	37.50
Aosterdas			10.83	14.40	16.80	19.60	21.00	22.36	not yet known	

Abatement plan still to be fixed.

Table 2-7

TREND IN BASIC RATES OF POLLUTION CHARGES DURING THE THIRD PROGRAMME OF THE AGENCES FINANCIERES DE BASSIN

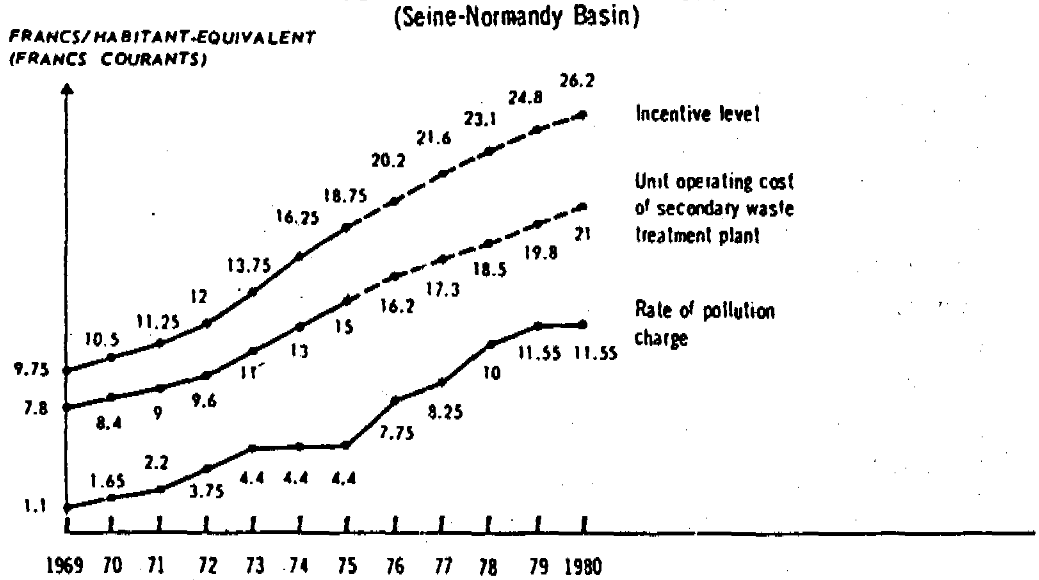
Agency	Parameter(1)	1977	1978	1979	1980	1981	1982	1983
Adour-Garonne	Population	5.32	5.68	6.31	6.31	7.14	7.14	-
	IS	640.00	650.00	700.00	700.00	800.00	800.00	-
Artois-Picardy	Population	4.17	6.12	7.34	8.57	8.57	8.57	8.57
	IS	612.00	770.00	847.00	932.00	1,025.00	1,127.00	1,240.00
Loire-Brittany	Population	6.22	7.70	8.77	10.09	10.09	10.09	10.09
	IS	765.00	875.00	1,080.00	1,080.00	1,080.00	1,080.00	1,080.00
Rhine-Meuse	Population	7.65	7.65	7.65	7.65	7.65	7.65	7.65
	IS	680.00	1,000.00	1,000.00	1,200.00	1,200.00	1,200.00	1,200.00
Rhone Mediterranean Corsical	Population	7.45	9.00	9.50	9.50	9.50	9.50	9.50
	IS	596.00	720.00	760.00	760.00	760.00	760.00	760.00
Seine-Normandy	Population	8.25	10.00	11.55	11.55	11.55	11.55	11.55
	IS	852.00	1,000.00	1,150.00	1,150.00	1,150.00	1,150.00	1,150.00

Therefore, as a rule, charges in the Dommel basin have incentive value. Although the figure is a very general one, it may be noted that the treatment cost per unit for the 39 waterboards averaged Dfl.41 per p.e. in 1978, while the average rate of charges was Dfl.33.

Hence, on average the actual rates are not far removed from the incentive level.

In <u>France</u>, rates of charges are much lower. Table 2-8 shows the trend from 1977 to 1983.(1) Figure 2-3 shows rates of charges as related to treatment plan operating costs for the Seine-Normandy Basin Agency. On average, rates of charges per p.e. will be seen to account for only one-third of the unit cost for treatment plants. As charges are not indexed, the erosion of money must also be taken into account, since it reduces the incentive effect of charges, as shown in Table 2-8 (Seine-Normandy Basin).

Figure 2-3
INCENTIVE EFFECT OF CHARGES
(Seine-Normandy Basin)



Note : The upper curve («incentive level») shows that the average yield of treatment plants is 80 per cent, so that the incentive level is equal to the average unit cost of treatment multiplied by 1.25.

1) Any comparison with the Netherlands must be based on population-equivalent figures only, since inhibiting substances are not subject to charges in the Netherlands. The exchange rate (approximately Frs.2 for Dfl.1) must also be taken into account.

Table 2-8
EFFECT OF INFLATION ON RATES OF CHARGE
(SEINE-NORMANDY BASIN)

	Rate of charge in francs at current prices	Rate of charge corrected for building and contracting price index
1969	1.12	1.12
1970	1.69	1.54
1971	2.25	1.87
1972	3.75	2.81
1973	4.41	2.82
1974	4.41	2.30
1975	4.41	2.04

Generally speaking, it should be noted that the incentive concept is a relative one for several reasons:

- the incentive effect is not enough to promote the use of an available technology that is more advanced and therefore more costly (more efficient treatment of suspended solids and oxidisable matter, removal of organic matter and phosphorus, suppression of toxic elements and heavy metals, and disinfection of residual wastes);
- non-point pollution sources have not been taken into consideration in the above figures. When the number of point sources declines the effects of non-point pollution are felt more strongly;
- the economic reference base chosen (operating costs are related entirely to technology) does not take account of damage caused by pollution to the natural environment, especially biological and ecological damage.

Finally, rates of charges ought to rise steadily (in terms of constant value) and thus approach or even reach the incentive effect level. At all events this is an objective in both France and the Netherlands.

In fact, the concept of a redistributive charge at a non-incentive rate is closely connected with that of a <u>transitional period</u> of policy implementation, during which the primary aim is to make up for the cumulative time lag (see above) while avoiding any serious economic difficulties which the sudden introduction of some heavy incentive charge might cause for industry and municipalities. This explains why the charge rates in France and the Netherlands are initially fairly low but are progressively rising.

3. STRUCTURES FOR IMPLEMENTING CHARGES

Without going into details, a few brief comments concerning structures for implementing water pollution charges may be in order.

3.1 Different levels of action

The studies on the water management policies of OECD countries show that three complementary approaches to water management have been adopted in the following chronological order:

- a legislative approach (legal and regulatory constraints, penalties);
- an economic approach (financial incentives);
- a comprehensive or integrated approach, which combine and integrate the two previous approaches through the planning objectives and programming of resources.

Action can be implemented at three levels:

- at central government level;
- at intermediate regional level;
- at local user level.

On the basis of these categories, it can be noted that the implementation of systems of charges in the strict sense is:

- always combined with legal instruments and usually as part of comprehensive action;
- generally found either at intermediate regional level or at local user level, while rarely at national level.

If these various characteristics are combined, two leading methods of implementing systems of charges can be distinguished:

- integrated management by river basin;
- management at local community level.

3.1.1 Integrated management by basin

The very concept of the hydrographic basin is intended to reflect the physical solidarity of all water users located in a basin, where any change in the water system or quality affects users as a whole. This physical interdependence can be expressed in economic terms by pollution (and abstraction) charges. Moreover, implementation of an action programme confers maximum consistency on such management, which is why systems of charges usually come under the heading of integrated management on a river basin basis. Water management methods in France and the Netherlands provide the most cogent examples of such action.

At institutional level, decentralisation and financial independence are the essential characteristics. In France, each of the six river basins is run by a "Comité de Bassin", and especially by an "Agence financière", which formulates and implements multi-year action programmes, levies charges and redistributes the proceeds as different forms of aid to ensure that the programme is carried out. In the Netherlands, the provinces - or water boards by delegation - levy charges and implement action programmes but with varying degrees of decentralisation, some boards running fairly large river basins and others managing local systems.

Financial autonomy, while not precluding some degree of supervision or essential co-ordination by the central government, provides for maximum flexibility and efficiency in carrying out action programmes, since the river basin board is free to use its funds as it sees fit. Financial autonomy also offers the best guarantee of security with respect to revenue; by eliminating the constant risk, associated with central decision-making, of seeing resources withheld or reduced.

Charges can be combined with direct control in different ways and with different degrees of integration. In France, regulatory and economic action is taken separately: the Prefects issue licences and the "Agences financières" provide only technical and economic management. In the Netherlands, however, responsibility for both types of action whether at province or water board level - is held by a single body. This broader responsibility borne by Netherlands boards primarily means that they themselves own and run communal treatment plants.(1) The French Agences financières de Bassin, on the other hand, neither own nor run any type of equipment. In this sense the Dutch water boards are closer to the concept of integrated management than the French River Basin Agencies.

1) The investment is financed by calling on the money market, while running costs (including depreciation) are financed by charges.

In the case of the Netherlands, it should be recalled that the central government collects and redistributes aid to pre-existing industries all charges on discharges into what are known as "State waters" (the Rhine, Meuse, main canals, the Ijesselmeer and surrounding lakes, the North Sea, Waddensee and estuaries).

3.1.2 Management at local community level

In some countries, charges are not an essential instrument of water management as they are in France and the Netherlands, but are used occasionally by some local communities. In this case they must be regarded as an economic instrument at local user level (user charge).

This form of intervention is therefore quite different from that at river basin level, as it is dispersed, confined to a small number of communities, and is not part of integrated management on the broader scale of a river basin or region.

3.2 Political acceptability of systems of charges

Very little information is available on this subject, but a few brief comments may be formulated on the basis of the monographs.

Systems of charges cannot be said to be implemented without difficulty.

In the Netherlands, some pressure groups and owners have refused to pay charges.

In France, the chief resistance came from municipalities. A mayor regards a pollution charge as an additional tax and as therefore meaning fewer votes. Local authorities moreover consider that charges may be a disincentive to setting up new industries in the community and accordingly curb its expansion. In order to get around these difficulties, a new procedure for collecting charges was introduced in 1976, under which charges are no longer collected by the municipal authorities but by (private or public) undertakings supplying water, which then pay the equivalent to the Agences de Bassin. The charge thus no longer appears as a tax but is included in the water rates.

While industries seem to accept the system more easily, primarily owing to the financial aid distributed by the agencies, some complain that charges can threaten their competitive position, while others have found an element of inequity in the geographical differentiation of charges. It may in fact be that particular attention will have to be paid to ensuring equity of the systems. In this connection, it may be noted that it is extremely difficult to tax non-point forms of pollution; hence no charges are levied on agricultural activities, thus detracting both from the system's efficiency and equity.

The following observations are therefore in order:

- the political acceptability of charges is considerably increased when they are redistributed among users. At river basin scale, such redistribution creates a genuine feeling of mutual responsibility among users and gives concrete expression to their interdependence. From this central idea, moreover, sprang the first associations in the Ruhr at the beginning of the century, which have served as a model for the French system. In any event, the mere fact that the use made of the funds is known promotes user acceptance of the system;
- public participation (managers, users, public opinion in general) is a decisive factor in ensuring the success of water policies. The fact that users are involved in determining the bases for assessing charges and fixing the rates makes it possible to take everyone's interest into account and accordingly to gain maximum support for the system. One role of the "Comités de Bassin" in France, as we know, is to discuss the action programmes of agencies and the charges required to implement them. In the Netherlands, the various parties concerned (businessmen, farmers, land-owners, local authorities) are represented on the board's council. A task of this council, which meets several times a year, is to fix the level of charges.

4. FINAL COMMENTS

Although it is in water management that by far the greatest amount of experience on the use of pollution charges has been gained, there are still few examples where such systems have been resorted to. True, in most countries a number of municipalities levy charges on users of collective treatment plants, but France and the Netherlands are almost alone in applying charges on any widespread systematic basis, and now Germany, which already has the benefit of the longest experience, provided by its associations in the Ruhr, is to extend the system at federal scale in 1981.

In France and the Netherlands, moreover, it should be noted that charges are still in an early phase, and that as the rates are still apt to be too low, the redistributive effect has a greater impact than the incentive effect. But as rates increase, the incentive effect should become greater. The high inflation rates now prevailing in most countries, however, will hardly promote such a trend.

Charges are calculated (basis and rates) according to well-tried procedures and rapid improvements are being made, such as extension of the basis in France to include toxic substances. In this connection, therefore, there seems to be no major difficulty of implementation, unlike in other environmental fields even if the number of parameters currently adopted still falls short of requirements for fully monitoring the main pollutants. Nor does the application of charges appear particularly complex or costly from an administrative standpoint. For example, the running costs of the "Agence financière de Bassin" for Seine-Normandy in France come to little more than 5 per cent of its resources for a staff of about 160.

Integrated management at basin scale, which seems to be the most promising scheme of water management, proves particularly well-suited to economic intervention through the bias of charges.

Lastly, three essential factors of success for the policies under review are decentralisation, financial autonomy and public participation.

Annex(1)

EXAMPLES IN COMPUTING CHARGES

Industrial effluents must be distinguished from household effluents.

Industrial effluents

Generally speaking it would be too expensive to take direct measurements for calculating the assessment basis of charges, because too many would be required. Use might of course be made of a decentralised system of controlled individual measurements (such systems are found in the United States and Sweden). In the Seine-Normandy and Dommel-Aa Basins, however, flat-rate assessment (pollution coefficients), enabling simpler indicators for calculating the basis to be used, is preferred.

In the Seine-Normandy Basin an estimate is made from a scale which depends on the industry, the process and the type of product. For each unit of output (e.g. one tonne of steel, one tonne of tanned hides or one livestock unit) the scale gives the quantity of pollutants produced theoretically, expressed in SS, OM, inhibiting substances and salinity.

Taking the case of a tannery (making leather from cattle hides) with an output of 9,400 tonnes of hides in 1976 and 41 tonnes/day in the month of peak activity (the appropriate period for calculating the charges), the calculation gives the following figures:

Table 2-9

EXTRACT FROM DISCHARGE ESTIMATES:

TANNERIES IN THE SEINE-NORMANDY BASIN

Indicator	SS (kg/d)	MO (kg/d)	I.S. Equitox-gramme	Salinity Mho
1 tonne of hides	70	50	2,500	0
For the selected example (41 tonnes/day of pollution discharged):				
SS	2870 kg/d x	Frs.38 =	Frs.109,060	
OM	2050 kg/d x	Frs.78 =	Frs.155,800	
IS	102500 E_{qx} x	Frs.0.8 =	Frs. 82,000	
Salts	0 x	Frs.1350=	0	
			Frs.346,860	

1) Taken from Water Management in Industrialised Water Basins, op.cit.

For purposes of illustration (and comparison) the pollution produced by this tannery was in fact measured in 1976 with the following results:

SS	7739 kg x	Frs.38 =	Frs.294,082
OM	3767 kg x	Frs.76 =	Frs.286,292
IS	22933 E_{q_x} x	Frs.0.8 =	Frs. 18,346
Salinity	42590 Mhp	the salinity was not counted(1)	
			Frs.598,720

1) The reason salinity was not counted is because the discharge occurs in an area where no charge is levied on salinity.

This is an example of the often considerable difference which there may be between applying a "rule-of-thumb" scale which is lenient towards polluters and a much more rigorous and therefore stricter measurement of actual discharges.

Such a scale is used mainly for calculating the charges payable by small point sources of pollution, while the measurement procedure is kept for the few sources of major pollution where the cost of measurement is covered by the difference found between the two estimates of pollution (in the preceding example over Frs.250,000, i.e. almost ten times the cost of measurement).

The scales for industrial pollution are drawn up at national level in agreement with the trade associations. Both the polluters and the public authorities have the right to request non-application of these scales if they agree to pay for direct measurement, in which case the charges will of course be calculated according to the results of the latter (even if they give lower figures than the scale, which rarely happens).

In the Dommel-Aa Basin it is also worthwhile to note the result of pollution estimates for a tannery handling 6,000 hides per day.

Suspended solids have been omitted, since they are considered to account for a fairly negligible amount of pollution.

Organic pollution load:

For computing the magnitude of pollution use is made of the formula:

$$W = q \left(\frac{COD + 4.57\ N}{180} \right)$$

where

W = pollution load (p.e.)

COD = chemical oxygen demand (mg/l)

N = org. N + (NH_4) N-content (mg/l)

Q = rate of discharge (m^3/day).

The input data make no reference to the N_{kj} content. It is therefore assumed that for a tannery the relationship N/COD = 1/9. Substitution of the relevant data results in:

$$W = 306\left(\frac{2,500 + 4.57 \times 2,500/9}{180}\right)$$

$$= \underline{6,408 \text{ p.e.}}$$

Heavy Metals:

For the discharge of heavy metals a pollution load of 1 p.e. needs to be added for every kilogramme of metal discharged per year.

The quality of chromium contained in the waste-water - assuming 250 working days each year - amounts to:

$250 \times 306\ (m^3/day) \times 200\ (g/m^3) = \underline{15,300\ kg\ Cr/annum}$.

The total pollution load is therefore:

$6,408 + 15,300 = \underline{21,708\ p.e.}$

Volume Correction:

If the waste-water is conveyed directly to a treatment plant belonging to one of the Waterboards a volume correction - based on 250 working days/year - is applied according to the formula:

$$V_c = \frac{Q - Q_s}{50}$$

where V_c = volume correction (p.e.)
Q = discharge (m^3/annum)
Q_s = standard discharge (m^3/annum)
= 250 (days) x 0.1 (m^3/p.e.) x W (p.e.)

However the application of this formula is restricted to effluents with a water content equal to or exceeding 50 l/p.e. per day. For discharges below this threshold, the (negative) volume correction corresponding to this limit will be applicable.

For the tannery considered, the daily water content per p.e. amounts to 306 (m^3/day)/21,708 p.e. = 14 l/p.e. per day.

Hence, in this case the volume correction will be subject to the restriction referred to above and therefore be based on a (nominal) effluent discharge of:

50 (l/p.e. per day) x 21,708 (p.e.) = $\underline{1,085.4\ m^3/day}$.

Substitution in the formula gives:

$$V_c = \frac{250 \times 1,085.4 - 25 \times 21,708}{50} = 5,427\ p.e.$$

Total Pollution Load:

The pollution charge will therefore be based on a load of:

Pollution load	W =	21,708 p.e.
Volume correction	V_c =	(-) 5,427 p.e.
Total		16,281 p.e.

For the year 1977 the annual charge for discharging the effluent directly into a treatment plant would have been:

i) in the region controlled by the River Aa Waterboard
16,281 p.e. at Dfl.22.32/p.e. = Dfl.363,391.92

ii) in the region controlled by the River Dommel Waterboard
16,281 p.e. at Dfl.23.04/p.e. = Dfl.375,114.24.

For discharge of the effluent directly into surface water the corresponding 1977 annual pollution charge would have been:

i) River Aa Waterboard
21,708 p.e. at Dfl.22.32/p.e. = Dfl.484,522.56

ii) River Dommel Waterboard
21,708 p.e. at Dfl.23.04/p.e. = Dfl.500,152.32

A comparison of such two evaluations is not easy to make, as the definitions of units vary between systems.

In the Seine-Normandy basin, application of the scale results in an annual charge of Frs.350,000 for 41 tonnes of hides per day (i.e. Frs.8,500 per daily tonne of hides). Hence, the rate per population equivalent was (in 1976) Frs.7.72.

In the case of the Dommel-Aa Basin, the charge amounts to Dfl.500,000 for 6,000 hides per day, but the charge is six times higher (Dfl.23 per p.e.).

If a hide is assumed to weigh 30 kg, the charge per tonne of hide amounts to Dfl.2,800 (Frs.5,600). If account is taken of the variation between the rates of charge (in a ratio of some 1 to 6), the pollution load as estimated according to the French scale would seem much greater (some 9 times) compared with the Netherlands scale. This point should be checked and more thoroughly investigated.

Another example of calculation may be given for an oil refinery (located in the lower valley of the Seine).

Application of the rule of thumb leads to the following operation:

The characteristic magnitude is the labour force: 1,850 staff in 1978.
The specific coefficients are respectively SS = 3, OM = 3.
The gross assessment basis is therefore: SS = 5,550 kg, OM = 5,550 kg.
Hence the gross 1978 charge would be put at Frs.754,743.

Pollution measurements were in fact carried out in 1974. The characteristic magnitude is the tonne of oil refined per day, one easy to measure and monitor. In 1978 the average figure for a month of maximum activity is 53,425 tonnes per day.

The specific coefficients based on a measurement carried out in 1974 were respectively: SS per tonne produced: 63.87 g; OM per tonne: 144,486 g; Equitox per tonne: 5 g.

The gross assessment basis is therefore:

SS = 3,412 kg per average day during a month of maximum activity; OM = 7,719 kg; Equitox = 267,125.

Hence the rate of the 1978 charge being: SS/kg = Frs.45.33; OM/kg = Frs.90.66; Equitox/kg = Frs.0.954, the net amount of the charge is Frs.1,109,229 for 1978.

A similar calculation has been carried out for a petro-chemical facility in the Dommel-Aa Basin.

By applying the formula

$$W = Q \frac{COD + 4.57\ N}{180}$$ for the pollution load,

we obtain:

$$W = 24 \times 975\ \left(\frac{2,127 + 0}{180}\right) = 276,510 \text{ p.e.}$$

Hence for levying purposes, the pollution load resulting from the discharge of raw (untreated) waste water amounts to 276,510 p.e.

Volume correction:

If this waste-load is conveyed directly (e.g. by means of a trunk-sewer or such like) to a waste-water treatment plant belonging to one of the Waterboards referred to, a volume correction is applied to the pollution load computed above. For a plant discharging 365 days per year the following formula applies:

$$V_c = \frac{Q - Q_s}{(50 \times 365)/250}$$

where V_c = volume correction (p.e.)
Q = discharge (m^3/year)
Q_s = standard discharge (m^3/year).

For this case:

Q_s = 365 (days) x 0.1 (m^3/sec) x W (p.e.)

As in addition the rate of discharge of effluent is rather uniformly spread over a day (more than 45 per cent of the volume is discharged at night between 7 p.m. 7 a.m.) the discharge Q may be multiplied by a conversion factor 0.8.

Substitution of the data supplied results in:

$$V_c = \frac{0.8 \times 8{,}545{,}340 - 365 \times 0.1 \times 276{,}510}{73}$$

$$= \underline{44{,}607 \text{ p.e.}}$$

Total Pollution Load:

For levying purposes the total pollution load amounts to:

Pollution load	W =	276,510 p.e.
Volume correction	V_c =	(-) 44,607 p.e.
Total		231,903 p.e.

If the effluent of the petrochemical facility is discharged directly into surface water, no volume correction is applicable and the pollution charge will be based on a load of 276,510 p.e.

Annual Pollution Charges:

For the year 1977 the annual levy for discharging the effluent directly into a treatment plant would have been:

i) in the region of the River Aa Waterboard
231,903 (p.e.) at 22.32 (Dfl./p.e.) = Dfl.5,176,074

ii) in the region of the River Dommel Waterboard
231,903 (p.e.) at 23.04 (Dfl./p.e.) = Dfl.5,343,045

For effluents discharged directly into surface water, the corresponding 1977 annual charges would have been:

i) River Aa Waterboard
276,510 (p.e.) at 22.32 (Dfl./p.e.) = Dfl.6,171,703

ii) River Dommel Waterboard
276,510 (p.e.) at 23.04 (Dfl./p.e.) = Dfl.6,370,790

These similar industries might be compared if a few production features of the latter example were known.

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