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# RIVER POLLUTION AND RIVER POLLUTION CONTROL ACTS

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## Introduction

Food, clothing and shelter constitute a basic, indispensable element in our daily lives, and of these, food is indisputably the most important. Among the various items considered as food, drinking water is the most frequently and freely used and there is a tendency to forget its great importance. Man everywhere has always constructed his dwellings near places where springs well forth, and has constructed cities in areas rich in water supply. The wells of Greece and the aqueducts of Rome, cities whose culture and influence occupy an illustrious place in world history, are world famous and water was the mainstay of the prosperity and wealth of these peoples. Cities and villages which had no aqueducts or sewage systems soon fell victim to typhus, cholera, dysentery and enteritis. Soon the need was accutely felt for a water system and then a sewage system and at the present day, as a result of this keen awareness, hygiene engineering has reached its present widespread development. Infectious diseases, which at one time raged, finally were eradicated with the spread of water supply systems and disinfection treatment by chlorine and partially by ozone. However, now the very water supply systems which served to eliminate previous difficulties, have encountered a new, widespread and strong enemy in the form of pollution of water systems, which arose through the development of industry and the population explosion, and against which disinfection treatment is futile. Assuming the daily BOD of sewage disposed by a Japanese to be 45-55 g, this means 5,000 t per day throughout the country. In addition to this industrial pollution which is sometimes harmful, and more difficult to treat than human sewage, becomes mixed with the latter and, except for partial treatment, almost all of it flows freely into the rivers and harbors of our country. As every year passes, the degree of pollution is increasing steadily. The Yodo, Kamo and Sumida rivers, which at the end of the Meiji period were 2. to 10 times cleaner than two large rivers in Europe (the Irwell River in Manchester and

and the Seine River in Paris), now have met an opposite fate as they have become the source of pollution and foul odors. River pollution soon intrudes on water supply sources, is harmful to human livelihood, causes damage to downstream industries, (agriculture, fishing, laver, oysters and others) sometimes totally destroying them or finally producing water sources which are unsuitable even for industrial use.

Consequently, the dispute over these public nuisance problems has continued unabated. In 1958 alone, the number of public nuisance complaints due to factory and mine wastes reached 1,466[2]. Water quality standards for factory drainage and the like are thus a crying need in the light of current public opinion. Standards for discharge water from sewage systems and sewage treatment plants have already been established and water quality standards for factory and mine drainage are being expedited. Long ago, the Thames Conservatory was established in England in 1857, and beginning with the River Pollution Prevention Act of 1876 based on the report of the Royal Committee, the developed countries of the world have continually been establishing regulations. In view of this situation and present public nuisance problems, Japan in 1958 finally established specific basins and standards for the quality of the water in those basins on the basis of the "Law for Conservation of the Quality of Water in Basins used for Public Water Consumption." At the present time, 9 such basins have been designated (see Table 1) and altogether 121 basins are included in the plans of the Economic Planning Agency[11] and are at present either under consideration or soon to be discussed (see Table 2). These will be officially designated upon completion of surveys at the end of March 1971 and water regulations are to be established for almost all principal rivers and harbors. Inadequacies and defects in present controlled areas will be overcome. It will be a source of great joy if, by the end of 1972, we will have restored even to some small degree the former appearance of our rivers, which constitute the mainstay of our industries, our staff of life and the main source of recreation for fishing and boating, and if we succeed in reviving the beauty and the charm of their headwaters.

Table 1. River basins and river control acts in Japan.

| Name of river basin (prefecture) | Industries protected against pollution | Wastes | Application date of the acts |
|---|---|---|---|
| Edo (Chiba-Saitama-Tokyo) | fishery, city water | ind. wastes, mining wastes | October 1, 1962……working sewage or wastes treatment plants<br>Will be proclaimed later……sewage |
| Yodo (Kyoto-Osaka) | city water | ind. wastes, sewage | July 1, 1963…… factories<br>By March 31, 1966 at latest……sewage |
| Kiso (Gifu-Aichi-Mie) | city water, laver, fishery | ind. wastes | July 1, 1963 |
| Ishikari (Hokkaido) | | | |
| (A) upper reaches | agriculture, fishery, city water | ind. wastes, sewage | November 1, 1963<br>April 1,1965……sewage |
| (B) middle reaches | agriculture, fishery, city water | ind wastes<br>coal wastes | May 1, 1965<br>July 1, 1966……coal wasts |
| (C) lower reaches | fishery, city water | ind. wastes<br>sewage, coal wastes | October 15, 1965<br>By April 1, 1970 at latest……sewage |
| Tokoro (Hokkaido) | fishery | ind. wastes, sewage | July 1, 1965<br>April 1, 1965……sewage |
| Ara (B) or Sumida | enviromental hygiene | ind. wastes, sewage | Jan. 1, 1965 or April 1, 1967. tentative criteria in some cases |
| Saiden (Kagawa) | city water, laver, fishery | ind. wastes | August 1, 1965 |

Table 2. River basins which effuent criteria are under consideration.

| | Name of river (prefecture) basin | Industries protected against pollution | Wastes |
|---|---|---|---|
| under consideration | Watarase (Tochigi-Gunma) | agriculture | mining wastes |
| | Tama (Tokyo-Kanagawa) | city water, fishery, agriculture | ind. wastes, sewage |
| | Yamato (Osaka) | city water | ind. wastes, sewage |
| | Neya (Osaka) | enviromental hygiene, agriculture | ind. wastes, sewage |
| | Onga (Fukuoka) | agriculture, city water | mining wastes |
| will be discussed soon | estuary of Kushiro (Hokkaido) | fishery | ind. wastes |
| | Shin-ara (Saitama-Tokyo) | environmental hygiene | ind. wastes, sewage |
| | seaside of Yokkaichi and Suzuka (Mie) | fishery, city water | ind. sewage |
| | Waka (Wakayama) | city water, environmental hygiene | ind. wastes, sewage |
| | seaside of Yatsushiro (Kumamoto) | fishery | ind. wastes |

Water Quality Regulations in Foreign Countries

1. Present State of Pollution Prevention Laws

In the same manner as water works were first constructed in the face of the threat to life from infectious diseases of the digestive system, the spread of cholera in 1831 was responsible for the development of a sewerage system in England. In 1848, the world's first public health law was established and sewage was routed into rivers through underground sewers. Later together with the development of cities and the rapid expansion of industry, the volume of sewage discharged into the rivers increased year by year and finally, pollution of the rivers itself oppressed water systems and downstream industries, the rivers began to emit a stench and caused major problems in environmental hygiene. For this reason, regulations for keeping rivers inside of municipal areas clean were drawn up in 1858 [12], and the Thames River Control Bureau was established in 1857. Following this, the River Pollution Prevention Control Act of 1876 based on the Royal Commission for Prevention of River Pollution was promulgated, followed by the salmon and fresh water fish laws of 1923, the regulation of surface oil slick from navigating ships in 1922, the sewage ordinance of 1930 and the industrial waste regulations of 1936 [12]. The English River Pollution Prevention Act in force in England at the present time [4] was established in 1951 and is a revision of the same acts of 1876 and 1893. Scotland has its own special prevention laws. The water standards for sewage discharge into rivers that was devised in 1912 at the present time is cited throughout the world and our sewerage discharge is in part based on this.

Control and administration of river pollution prevention laws is carried out by 45 hydrographic offices, 32 river bureaus, 53 basin control offices and 1,600 pollution prevention offices. In addition, there are river control bureaus established for those areas which do not belong to the river bureaus, such as the Thames River and the Lee River and in the metropolitan area, the provinces and certain cities themselves are responsible for control of rivers within their administrative districts as well as for pollution prevention. In addition to water control, the construction and operation of motorboats is licensed in order to protect the Thames River water system and recreation areas. The discharge of oil, rubbish [33] and sewage from motorboats [23] into the river is prohibited, and river pollution by motorboats is effectively and adequately counteracted [5] through the establishment of river bank incinerator areas and sewage drains.

The pollution prevention law of the Ruhr, which is a famous coal mining area, (Ruhr Reinhaltungs Gesetz, 1913) is especially worthy of attention in river pollution prevention in West Germany. The Ruhr coal mining area is formed from the basins of the Ruhr, Emscher and Lippe Rivers, each of which flows into the Rhine, Formerly, the main coal mining area was along the Ruhr River, whence the name Ruhr, but now the coal mining operations in the Ruhr are carried out principally along the Emscher and Lippe Rivers with only 7%

of the coal mining being done in the actual Ruhr area. Essen is the center of this area and each basin has its own pollution prevention association. The Emscher Pollution Prevention Association (Emscher Genossenschaft), which forms the mainstay, is in the city of Essen and is engaged in research and administration of pollution prevention. This organization is unique and famous in this area. This association is a civil body which carries out "purification of sewage and drainage and provision of drainage systems" without receiving any financial support from the government, on the basis of the "law for the establishment of treatment facilities in the Emscher basin", and includes cities, towns, villages, companies and factories. It has charge of 24 sewage and drainage treatment stations, and 19 facilities for the extraction of carbonic acid, and treats one million eight hundred thousand cubic meters per day of sewage and drainage. In 1926, the Rippe Association [7] was established, which has the function not only of treating sewage, but of conserving and utilizing the water resources in the area. In addition, Germany established the Prussian Water Law of 1913, the Fishing Law of 1916 which provides for purification of water when its quality deteriorates, and has also provided for compensation for damage.

The United States has one overall act, the Federal Water Pollution Control Act of 1956 which delegates the responsibility and authority for pollution control to the individual states. Forty six of the forty eight states have prevention laws, some of which date back to 1913. Most of them are based on the Suggested State Water Pollution Control Act of 1950. There are slight differences from state to state, but generally the control methods can be divided into three. A) Basins are classified according to use and standards for running water established. Final effluent standards are established to meet these standards. As for example, the New York state water basin classification includes water which is provided to the water supply for drinking purposes after merely being disinfected, drinking water supply of water that has been treated and disinfected, bathing water, fish breeding water, agricultural and industrial water, fish conservation water, water for motorboat navigation and discharge of sewage and wastes, and in addition includes four classes of sea water standards. B) Either running water standards or final effluent standards are established. An example of this category is the state of Pennsylvania [30] whose regulations were established first in 1905, and revised again in 1937 and 1945. This state does not make a classification into water basins, but makes three broad categories according to the degree of treatment of the final effluent: partial treatment with 35% elimination of BOD, intermediate treatment with 50% elimination BOD, and full treatment with 85% elimination of BOD and the public water supply is classified according to this. There are also some cases in which the degree of treatment of the upper reaches and the lower reaches of the same river differ. C) Treatment is carried out after decisions are made on a case by case basis by committee [12]. An example of this is the system of the state of Illinois which was first established in 1929 and revised in 1951. The pollution prevention committees determine each individual source of pollution and indicate the degree of elimination required. Our country follows this system of water conservation law. In other countries [12] the years in which pollution prevention laws were promulgated are as follows: France - fishing, 1829, resources, 1898 - hygiene, 1902 - industry, 1917;

Austria - 1934, Spain - 1944, Denmark - 1949, Belgium - 1950.

2. Pollution Inspection Plans[8]

Now I shall introduce the ocean area inspection plans and the water standards for the state of California which includes an ocean area. The total number of effluent systems in California at present (November 1961) is 135 (river mouths, rivers, waterways), 30% of which (41 systems) are under inspection. This inspection plan requires inspection of final effluent, receiving water, or both. A final effluent inspection system has been adopted for inspection cost reasons, in the case of small effluent. The drainage BOD, suspended matter, sedimentary matter, and pH and grease is measured in one particular season or in four seasons, and the sedimentary matter and salts are determined weekly or daily. In areas in which factory drainage becomes mixed, the water contains heavy metals and poisonous elements and radiation is sometimes detected. River estuary seawater must be analyzed for colitis germs, floatage and sometimes coloration tests must be made. The DO sulfides and pH are also determined. Detailed inspection plans have been developed for the case of large volume effluence and preliminary surveys are conducted with new effluent systems in order to standardize the physical, chemical and biological conditions. The factory drainage differs according to type, and biological tests are required pursuant to the "Fish Death Law". The California state standards require that the average number of colitis germs in coastal and inland waters be 10/ml and that no sample exceed 100/ml. The standards establish that the "sick disk" (transparency) must show that of the total measured values of the main effluent, 50% should be above 20 feet and 10% of the continually measured effluent must be above 15 feet. The minimum DO in sea water is 5.0-6.0 ppm, and 0.5-5.0 ppm in special water. The pH is determined according to use. It is established that grease and oil should be 5-50 ppm in factory drainage, that it be 2 ppm in shellfish beds, 5 ppm in boating and fishing areas, 5 ppm in fishery areas and 10 ppm in resorts.

### Water Regulation in Japan

In order to establish water standards and designate basins on the basis of the "Law for Conservation of the Quality of Water in Basins Used for Public Water Consumption" of 1958, our country began surveys of the most urgent basins, receiving the cooperation of the provincial agencies concerned, centering around the Economic Planning Agency. Local universities, test and research agencies took the responsibility for surveys of water and flow rates and measured the flow rate of the basins, the water quality, pollution load, and rate of purification. The standards for final effluent are decided upon from the relationship of the flow volume and the volume of pollution, considering the water quality requirements in terms of the industry being protected and environmental hygiene considerations, and the rate of elimination of drainage that the industry is economically and technically capable of handling. Special committees of the Water Inquiry Commission are responsible for inquiries. They learn about actual conditions in their area on the basis of results of the above-mentioned surveys and consider the reports and the opinions of the local people concerned. Their findings are reported to the

Economic Planning Agency, and are issued after serious deliberations. The objective is not to follow the slogan "the stricter the water quality standards, the better", but to reduce public nuisances to a tolerable limit through the spirit of cooperation among the upstream and downstream industries. Table 3 presents the approximate composition of industrial wastes and BOD population equivalent from Moore's[9] table for 1 day, with the daily BOD discharge for 1 Japanese being 45 g.

That is, the coke sulphite cooker waste for one ton of coke corresponds to 2700-7600 people, the sulphur dye waste for 100 pounds of dyed goods corresponds to 422-3040 people, the waste for making one ton of canned raw material corresponds to 64-2700 people, and the waste for 100 pounds of leather corresponds to 253-3400 people; the waste for making one barrel of beer corresponds to 57-90 people (101-126 people per 120 liters, the alcohol distillate is equal to 1 bushel of grain (35.30) and the amount of waste from making one ton of beet sugar corresponds to 114-152 people. Consequently, the table is convincing evidence of the fact that industrial wastes, beginning with coke and beet sugar wastes, are becoming a greater source of pollution than the sewage systems in surrounding cities.

Regulations for the Protection of Waterworks

The basins which have been appointed as the basic objectives of waterworks conservation are the Yodo River running from Kyoto to Osaka, the Kiso River which flows through Aichi, Gifu and Mie prefectures and in addition, other objectives of conservation together with industry are the Edo River, the upper, middle and lower reaches of the Ishikari River and the Obata River, thus totaling five basins. Now I shall describe the background to the regulations for the Yodo River[10].

1. Required Water Quality for Reservoir Water (for Waterworks).

The desired water quality from the Ministry of Health and Welfare was as follows with respect to an analysis of the compilation of the water quality standards. In other words, the following figures must not be exceeded in the area of Makigata Ohashi

| | Monthly average | Maximum |
|---|---|---|
| BOD ppm | 2.5 ppm | 4.0 ppm |
| Colitis germ (MPN/100 cc) | 5,000 | 15,000 |
| Phenols, ppm | | 0.005 |
| pH | 5-8-8.6 | |

where the phenols do not exceed 0.005 even in the area of Torikaiohashi.

Table 3. Approximate composition of industrial wastes[9] and B.O.D. population equivalent.

| Waste | Production Unit | Gallons per Unit | Suspended Solids, mg/l | BOD, mg/l | BOD Japanese Population Equivalent/Production Unit | Special Characteristics |
|---|---|---|---|---|---|---|
| Beet sugar * | 1 ton beets | 3,000-4,000 | 800 | 450 | 114-152 | Without Steffens' waste |
| Brewery | 1 bbl beer | 300-1,000 | 250-650 | 500-1,200 | 101-126 | — |
| Cannery | 1 ton stock | 2,500-8,000 | 200-3,000 | 300-4,000 | 53.5-2,702 | — |
| Coal washing | 1 ton coal | 600-2,400 | 3,000-150,000 | — | — | Fine coal |
| Distillery | 1 bu grain | 45-55 | 20,000-40,000 | — | 87-90.1 | Starchy |
| | 100 gal molasses | 200-300 | — | 20,000-30,000 | — | High in potash |
| Gas and coke | 1 ton coal | 200-400 | 200-3,000 | 1,000-6,000 | 16.6-203 | Phenols 1,000-5,000 mg/l in untreated liquor |
| Laundry | 100 lb clothes | 1,500 | 400-1,000 | 300-1,000 | 36.6-126 | Alkaline |
| Malthouse * | 100 bu barley | 800 | — | 400 | — | — |
| Milk plant | 1,000 lb milk | 100-225 | — | 300-2,000 | 25.4-388 | Lactose, sours readily |
| Packing house | | | | | | |
| Small | 1 hog' | 1,000-1,500 | 500-1,500 | 600-2,000 | 50.6-253 | High in fats, proteins |
| Large | 1 hog' | 500-800 | 400-1,000 | 350-1,000 | 12.6-63 | — |
| Paper making | 1 ton paper | 5,000-100,000 | 150-1,000 | 20-100 | 8.3-830 | Fiber, clay |
| Paper pulp | | | | | | |
| Groundwood | 1 ton pulp | 0-12,000 | 500 | 20 | 0-20.2 | — |
| Sulfite | 1 ton pulp | 30,000-100,000 | 100-150 | — | 1,010-3,371 | — |
| Sulfite cooker-liquor | 1 ton pulp | 2,000-3,600 | — | 16,000-25,000 | 2,702-7,600 | Lignin, sulfites |
| Tannery | 100 lb hides | 600-700 | 1,000-5,000 | 500-5,000 | 253-3,400 | High in lime |
| Textile | | | | | | |
| Cotton kier | 100 lb goods | 120-250 | — | 1,000-1,600 | — | High in caustic alkali |
| (kier-liquor only) | 100 lb goods | 30 | — | 4,000-8,000 | — | — |
| Cotton kier and bleach | 100 lb goods | 1,000-1,600 | — | 100-200 | 8.4-27 | High in oxidizing agents |
| Flax retting * | 1 ton straw | 5,300 | — | 1,800-2,800 | 805-1,253 | — |
| Silk boiling * | 100 lb silk | 850 | 100-500 | 700-1,000 | 50.2-71.7 | — |
| Sulfur dye | 100 lb goods | 500-1,800 | — | 1,000-2,000 | 422-3,040 | Sulfides |
| Wool-scouring batch | 100 lb wool | 160-500 | 1,000-170,000 | 200-10,000 | 2.7-420 | Wool grease |
| countercurrent | 100 lb wool | 40-100 | 1,000-170,000 | 200-10,000 | 0.7-54 | Wool grease |

* Data from one source only.

' 1 steer = 2.5 hogs ; 1 sheep or calf = 1 hog.

Table 4. Total B.O.D. loading at the main points of Yodo river[10].

| | | Present state | (A) March 31, 1965 | (B) March 31, 1966 |
|---|---|---|---|---|
| Kyoto city | domestic sewage | 28.4 t/day | 28.4 t/day | 50.0 t/day |
| | ind. waste | 33.1 | 33.1 | 33.1 |
| | total | 61.5 | 61.5 | 83.1 |
| | removal by sewage treat. plant | 14.6 | 48.6 | 48.6 |
| | total load from Kyoto city | 46.9 | 12.9 | 34.5 |
| the junction of 3 rivers* & one drainage | | 39.1 | 10.8 | 28.8 |
| the junction of Ai river & Kuroda river | | 68.1 | 43.3 | 58.4 |
| the junction of Akuta river | | 67.3 | 43.3 | 57.8 |
| Torikaiohashi | | 60.7 | 39.5 | 52.2 |

* Kizu river, Uzi river and Obata river
(A) The quantity of domestic sewage was calculated as 200 l/head/day
(B) 〃 〃 300 l/head/day

In the above desired water qualities, the pH has been disregarded since it has no interference with present conditions; and since the phenol reacts with the chlorine used for killing germs in the water to form chlorophenol which produces an extremely foul odor in drinking water, it is included in the regulation items.

2. Rate of Improvement (Elimination) of BOD Loading Before and After Establishment of Regulations.

Table 4 gives the BOD loading at the main points of the Yodo River.

At the present time the total pollution water (in BOD) from Kyoto city is 46.9 t/day subtracting the amount purified by treatment plant, and is 39.1 t/day due to self-purification at the junction of the Kizu and Uji Rivers, but at the junction of the Ai and Kuroda Rivers, the BOD becomes 68.1 t owing to mixing with polluted matter and is 60.7 t/day at Torikai Ohashi. (A) in table 4 refers to the case of 200 l per capita domestic sewage, and the rate of removal at the treatment plant in this case is 34.9%, (B) is the case for 300 l of domestic sewage and the rate of removal in this case is 14.1%. Now, we take the actual results of measurement of the flow rate and the BOD for 21 months beginning April 1958 at Maigata Ohashi as a base point, plot the correlations of both of them, read off the volume of flow with respect to the desired water quality BOD of 2.5 ppm, compare this with the volume of flow in actual measurements taken after that and compute the number of months in which the water quality exceeded 2.5 ppm in the past 96 months. We see that when the rate of removal of pollution in Kyoto City, is 14.1%, the number of months in which it exceeds 2.5 ppm will be 20 by the end of 1965, and exceeding this only during five months, at 34.9, will be somewhat improved over the present state of 32 months.

At the present time the number of months in which 4 ppm have been exceeded at the Shibashima intake point is 54, 40 at a removal rate of 14.1% and 17 months at a removal rate of 34.9%. The item required by the Ministry of Health and Welfare is the $KMnO_4$ consumption rate, whereas the Fisheries Agency required the C.O.D. Both items were then recognized as being the same and now (the water) is regulated by the C.O.D. equation.

Equation (1) expresses the water quality at the base point, focusing on the water supply and laver, in the winter dry season (December through March) when there are many problems, using the Asahi intake point as the base point, the equation was obtained by depicting the relationship of the C.O.D. of this point to the rate of discharge

$$C = 0.7 + 698/qr \quad \text{.......} \quad (1)$$

C : The quality of the running water at this point (COD), ppm
0.7 : Water quality which is naturally preserved (COD), ppm
698/qr: Artificial water quality generated by pollution, ppm
qr : Discharge rate, t/sec.

Now, making C the water quality at the base point, i.e. the water standard, a decrease of 698g/sec should be made in order to improve the water quality. Moreover, purification of running water involves both dilution and self-purification and both of these are reflected in the figure 698/qr.

After considering the curves of the past discharge rates and the frequencies of generation of the water quality (the number of days exceeding the required water quality) and the relationship of the number of days exceeded to the "reaching water load" [literal translation] (the load in g/sec when the pollution, after being discharged, has been purified in the running water and has reached the base point), the Planning Agency inquired concerning the demands of the water supply people, the capabilities of the companies concerned for investment in treatment facilities, and the opinions of the supervising ministries. The agency established the number of excess days, i.e. the number of days in which the discharge is small and the required water quality cannot be satisfied, and adjudged the "reaching water load" at 524g/sec. In this manner the C.O.D. computed for factory drainage becomes the water standard for drainage, but in the fall of 1962, due to the increase in factory construction, the "reaching water load" reached 769g/sec, so the number of days exceeded reached 54. When this is regulated to 524g/sec a 32% improvement is attained. A 20% improvement is considered for laver, so the 32% for the water supply system also is satisfactory for the laver.

3. Water Quality Standards

In the Yodo River [10, 14], the B.O.D. and phenol in factory drainage are regulated [10,14], in the public sewerage the B.O.D. and colitis bacteria and in the city sewer system the B.O.D. and phenol are regulated. In the Kiso River the pH, C.O.D. and suspended matter are regulated [13, 14]. For details see the above references. In the Obata River [21, 22] the water supply is the chief objective.

Regulations for the Protection of Fishing

The protection of parent trout and salmon moving upstream, and of their fry moving downstream to the sea in the Ishikari River (entire area) and the Tokoro River is unique in the protection of the fishing industry. The average amount of harmed fish in the Ishikari Fishermen's Cooperative Association in the 9 years up to 1950 was 2,000,000 kg, and the 200,000,000 yen catch has recently dropped to 20,000,000 or 20% of that figure. This is only 12% higher than the catch at the turn of this century. The general prohibition of fishing and the government-run conservation, hatching and stocking projects notwithstanding, the situation remains serious. Consequently, water control extends to the headwaters (A), the central waters (B) and downstream (C) Ishikari, encompassing the river in its entirety [See note]. I will describe the downstream basin (C) which is most strongly influenced.

[Note: (A), (B), (C) are designated by ~~the Japanese~~ ordinal system Ko, Otsu, Hei in the Kampo (Official Gazette)]

1. Sources of Pollution and Required Water Quality

The chief source of pollution in area (C) is the organic drainage from the paper pulp factory in Ebetsu, the distilleries and the city sewerage in Sapporo. These drainages accumulate on the river bottom together with the inorganic and organic drainage coming from upstream and midstream, consume the dissolved oxygen and cause decomposition. At the same time they impede the growth of food plants and hinder the upstream migration of parent salmon and trout and the upbringing of fry.

As for the water supply source which is simultaneously being protected, the Fe, Zn, and Mn--especially the Mn in the mine drainage in the Shirai River, have become the cause of foul odor and black water in the water supply. The pH requirement by the fishing industry here is 6.5 to 7.5 in the mainstream of the stocked river, since a decrease in the pH would strengthen the toxicity from sulfur compounds. The dissolved oxygen was 5 ppm or less, the B.O.D. was enough to prevent the formation of slime or sludge on the river bed (3 ppm or less) and the volume of suspended matter was less than 50 ppm in the mainstream of the stocked river.

The water supply system required that the Mn not exceed 0.05 ppm, which is the U.S. limit at the intake point. The Zn should be less than 1.0 ppm at the intake point and the pH should be above 5.8 since a total Fe of 100 ppm is the maximum desirable at the mine drainage discharge outlet.

2. Analysis of Water Quality and Rate of Improvement

Adult salmon and trout move upstream to lay eggs from September to

November. As a state-run project these are caught, the eggs gathered and inseminated and artifically spawned. In the following April to June they are released into the Ishikari River to swim downstream to the sea. The problem months, therefore, are the two periods mentioned above. The month with the smallest rate of flow is November, which is also the month in which pollution has the greatest effect on salmon and trout. The average discharge for November is slightly higher than the ordinary water discharge, so from the safety standpoint the ordinary water discharge was regarded as the standard discharge for salmon and trout. That is, the objective is to remove pollution to the degree that it does not influence the upstream or downstream migration of salmon and trout. The percentage B.O.D. pollution load of the main source of pollution, keeping the future in mind, is 91% for the drainage of the paper pulp plants in the main part of the Ishikari River and the Ebetsu River, 45% for the distillery drainage in the Toyohira River, 49% in the city sewerage, and is [the same as] for the city sewerage in the old Ishikari River.

The quality of the river water in the mainstream of Ishikari River, even with consideration of self purification and dilution, has a B.O.D. of 3.1 ppm, and is 3.3 ppm in the Toyohira River. Making the allowable limit in the desired water quality 3 ppm.

$$M = \frac{E\alpha + n\alpha}{1 + n} \quad \cdots\cdots (2)$$

M: Measured water quality (B.O.D. 3 ppm in terms of desired water quality)
E: B.O.D. of water polluted by humans 170 ppm.
$\alpha$: Rate of control
n: Multiple of dilution (discharge'drainage of human pollution) where $\alpha = 0.79$, 20% of the factory drainage should be eliminated.

Likewise, in the Toyohira River factory area $\alpha = 0.71$. It can be seen from this that the sewage treatment plants should carry out high grade treatment, and 30% of factory drainage should be eliminated.

3. Water Quality Standards

Please refer to the references [16] and bulletins [15] for water quality standards. In the downstream section (C) of the Ishikari River of the pH, B.O.D., and suspended matter are regulated for factory drainage, the pH, Zn and Mn are regulated for mine drainage and the pH, B.O.D. and suspended matter are regulated in the sewer systems. In addition, the basins which are the targets of fish conservation include the Edo [17, 18], Tokoro [19, 20], Obata [21, 22] Rivers and (B) and (C) in the Ishikari River. (B) and (C) will be described later.

## Regulations Protecting Agriculture

The basins which have become regulated in order primarily to protect agriculture are the Ishikari River basins (A) [23] and (B) [24]. Regulations for both also include protection of fishing and water works. Below is a description of area (A).

1. Pollution Source and Desired Water Quality

The "sludge" that flows down and accumulates during the irrigation period causes chemical damage to crops by decomposing, especially in the late summer growing period. Nitrogen is given off in excessive quantities causing late crops and increasing the amount of cold weather damage. The amount of nitrogen is four times greater than in other rice fields. As for mechanical damage, the young sprouts are carried off by the incoming sludge or are buried in it. Seeds rot in the seedbeds. The tillers are suppressed and the roots develop in two stages. The ground temperature does not rise. "Sludge" sticks to the water pumps and troughs and lowers their efficiency. The area of arable land is reduced due to the necessity of constructing precipitation beds (ponds). As for harm to the fishing industry, "sludge" and slime are the chief cause of death to natural food vegetation, as they cover the river bed. The number of fry are reduced due to harmful components such as sodium sulfide and foul odors and there is a rapid decrease in the amount of fish caught. One may also cite the fact that fishing gear is damaged and that the price of fish is lowered due to foul odor. The principal source of pollution is the 79.5% load percentage of the B.O.D. and the 78.3% load of suspended matter from the pulp factories. The B.O.D. load from the distilleries is 11.0%, suspended matter 8.2%; in the chemical plants the B.O.D. is 4.9%, the suspended matter 6.0%. The B.O.D. load in the sewerage is 4.3%, and the suspended matter is 7.4%. Ino was selected as the irrigation point and Osamunai was selected as the base point for irrigation water and as the point at which trout and salmon are removed from the water, and the relationship of water quality to discharge was sought. The B.O.D. at Ino was 10.3 ppm and 7.0 ppm at Osamunai. The water reaching period was 5.7 hours. The self purification coefficient found from the equation below was K = 0.72 and we can say that between Ino and Osamunai 30% purification with respect to B.O.D. occurs.

$$Qa = Qb \times 10^{-KT} \qquad (3)$$

Qa: B.O.D. in ppm at Osamunai
Qb: B.O.D. in ppm at Ino
K : Self purification coefficient
T : Reaching time, days
$\therefore$ K = 0.72

This self purification coefficient includes both precipitation and dilution. Please refer to reference 23 for the names of the constituent bacteria and growth elements in "sludge."

2. Desired Water Quality for Agriculture and Fisheries.

The water quality at which irrigation water will not suffer severe damage should be characterized at the intake point by a pH of 6.5-7.0, then should be 1/4 of the present amount of suspended matter, or 16 ppm and the B.O.D. should be 3 ppm which is the level at which aquatic bacteria will not grow after the water has entered the paddies. The desired water quality for fishing at the point (area) used should be characterized by a dissolved $O_2$ content of more than 5 ppm, a pH of 6.5 to 8.5, a constant B.O.D. of 3 ppm, and as for solid suspended matter, no substances should precipitate and cover the river bed. As for coloration and turbidity, no substances should be permitted which will severely impede the entry of sunlight into the water. Offensive odor should not be perceptible. The CN should be below 0.025 ppm and phenol below 0.02 ppm.

The B.O.D. was set at 3 ppm on the basis of the fact that a 4 ppm there is considerable accumulation of sludge on the river bed and that it does not accumulate at 2 ppm.

3. Water Quality Standards

Water quality standards have been established for areas (basins) B/24/ and A/23, 25/. At present the pH and phenol present no problems in area A but the drainage is regulated in order to maintain an average and the B.O.D. and suspended matter are regulated in order to minimize the generation of sludge.

Regulations for Improving Environmental Hygiene

As river pollution becomes more pronounced, injury in the form of headaches, dizziness, ailments of the nose and respiratory organs from foul odor occurs and for this reas[illegible] ter quality standards were established in order to improve environmental hygiene. The Arakawa basin (B) /See Note/, i.e. only the Sumida River pertains to this. The Neya River (Osaka) is currently being discussed and the Shin Arakawa tail-race is soon to be discussed.

/Note: The Arakawa basin is classified as "A" (Japanese: Kō ) in the Kanpo (Official Gazette)/

1. Pollution Source and Desired Water Quality

The Sumida River is the name attached to the downstream section of the Arakawa River. It includes the section of river where the Arakawa is separated from the Arakawa tail race at the Iwabuchi sluice. It flows a distance of 20 km to Tokyo Bay with widths varying from 90 to 187 m and an average of 117 m. This is a tidal river, in which observations of the flow (discharge) rate are difficult due to sinking of the ground owing to upwelling of underground water. The current is reversed at high tide and while considerable discharge is visible, the actual discharge is slight, about $30 m^3/sec$. Most of the principal factories of the more than 50,000 in the metropolitan area are concentrated in a strip along this river. At the present time fish and shellfish have been totally destroyed and even mosquitoes reportedly will not breed here. For estimation of the degree of pollution from house sewers a daily per capita sewage volume of 290 $l$/day in the overall river (drainage) basin and a per capita volume of 310 $l$/day for special districts in Tokyo were employed. The total population living in the basin is 5,260,000. The basin population was found from the following equation. Multiplying the population of the river basin area by the per capita sewage volume, the household sewage volume generation was computed to be about 1,500,000 $M^3$.

$$\text{Basin population} = \frac{[\text{Population within administrative districts}] \times [\text{basin area}]}{\text{Area of administrative districts}} \quad (4)$$

The sewage B.O.D. from public sewerage not connected to sewage treatment plants and areas without sewerage was assumed to be 80 on the average. The B.O.D. was set at 80 as a result of totaling the pollution load from the 200 major factories (since the drainage from the factories other than the 200 is small and is mixed with sewage). The total load of pollution released into the Sumida River was computed to be 2.26 kg/sec (100%) with the following breakdown: B.O.D. load from household sewage 0.72 kg/sec (32%), from the 200 factories 1.19 kg/sec (53%) and 0.35 kg/sec (15%) from other factories.

In the long term plan to 1970, the amount of sanitary sewage in $m^3$ that will be released into the Sumida River, including from the factories, will show a 65% increase over 1961 and the increase in the pollution load will be 54% or 3.5 kg/sec. The objective water quality with respect to this has experimentally been set at a B.O.D. of less than 10 ppm [26, 27, 28] and a dissolved oxygen content of more than 1 [26] with the condition that no foul odor be emitted from the river. August, in which generation of odor is most likely to occur, and which also is a month of low discharge, was examined as the target month. If all drainage water is set at a B.O.D. of 10 ppm, the river B.O.D. will become 10 ppm, but if discharged into the river with a B.O.D. of 30 ppm it will be impossible to keep river BOD below 10 ppm even with the present drainage. If drainage with 20 ppm is allowed, in the future the running water for about five days in August will have a B.O.D. above 10 ppm. Consequently the sewer drainage B.O.D. was set at 20 ppm, and since at 20 ppm the sewage can only be treated at a sewage treatment plant, the policy that was established was to divide the water standard into those areas with sewerage and those without.

2. Water Quality Standards

For details on standards see references 26 and 29. The regulations concern pH, B.O.D. and suspended matter, and based on the premise that sewerage is utilized and the pollution load is high, the water quality of each factory is rather strictly regulated in comparison with regulations elsewhere.

## Conclusions

River pollution and water pollution control laws in foreign countries have been surveyed above. They all share in the policy of striving to eliminate public nuisance to the greatest possible degree through consideration of the discharge of each basin and the total volume of pollution and promotion of cooperation between upstream and downstream industries, while maintaining that strict regulations are not necessarily the only answer to water quality, and also striving to tolerate those instances when the desired water quality is sometimes exceeded. It can be seen from the fact that the desired water quality (running water standard) B.O.D. is 2.3 to 3 ppm for the base points in water works, fishing and agriculture, that the pollution concentration of the drainage causing public nuisance is rather strictly controlled.

As for the final effluent standards for drainage water established on the basis of desired water quality, the fact that from the standpoint of environmental hygiene requirements, the final effluent standard of B.O.D. 20 ppm, in which the running water BOD is 10 ppm (degree at which odor is not strong), is more severe than the final effluent standard of B.O.D. 130-750 ppm (Case C in Ishikari River) in the strict desired water quality requirements (running water B.O.D. 2.5-3 ppm) for protection of water works, and upstream and downstream migration of fish (trout, salmon), is due to the policy of guidance and improvement on a case-by-case basis which is based on the overall view of total pollution volume and discharge and the utilization of sewerage. Anway, since the number of basins to be designated and regulated, are to be expanded to 121 over the present 9 designated basins, there of course will be rapid construction of treatment facilities to handle household sewage and the upstream industries will have to direct their efforts at improving their manufacturing methods in order to reduce their drainage to a minimum, as has already been accomplished in some factories, They will also have to consider methods of production which will include drainage treatment, and recognize that even the present rather low drainage concentration (several ppm in running water) is posing a public nuisance. I deeply hope that we can resolve our present regrets and impatience in being unable to keep up with the rapid increase in pollution and that we may enjoy living in a bountiful, civilized world in which the water supply that is our mainstay, the agriculture and fishing which are our staff of life, and the streams and rivers which are our enjoyment, have recovered some of their past beauty.

This paper is a compilation of materials on the pollution prevention laws whose objective is the protection of industry of all types, taken from the special publication of the symposium held by this society last autumn entitled "Regulation of River Water, as Seen from the Standpoint of Environmental Hygiene".

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