4 Water Quality

The quality of water can not be measured in isolation. Only when the intended use of the water is considered, can water quality be defined.

Water containing a high level of bacteria may be suitable for certain types of industrial use, but it may be totally inappropriate for municipal or recreational use. Quality of water, then, is relative to its intended use and can have many characteristics.

There is no such thing as "pure" water. Its quality is affected by numerous natural and man-made factors. Water in the atmosphere picks up dust, pollen, chemicals, and a variety of other materials. After reaching the earth, water percolates through organic materials such as roots and leaves, reacts with living things such as plankton or algae, and dissolves minerals from the earth's crust.

The quality of groundwater in several parts of the state is unsuitable for many uses because of naturally occurring high concentrations of nitrates and dissolved solids. Surface waters are naturally contaminated by the sediment and nutrients contained in surface runoff. Man, however, has greatly accelerated this process by current land use practices.

Although a multitude of uncontrollable natural factors contribute to degradation of clean water, control of pollution from municipal, industrial, and agricultural point sources and from urban and rural nonpoint sources can be accomplished. This is the objective of the state water quality management program.

The Resource

There is an increasing demand for high quality water by many user groups. Quality of water can be seen as being of equal importance to quantity, because the quality determines the suitability of water in a particular location.

Municipalities must treat water to make it suitable for human consumption, and thus, the existing water quality has a direct bearing on the economics of providing a safe water supply. Many industries also require high quality water and have to be concerned with treatment costs.

In addition, many instream water users require a high level of water quality. The maintenance of desirable fish and wildlife populations and the preservation of natural beauty require good quality water, as do boating, swimming, and other forms of outdoor recreation.

Unfortunately, using water to receive and assimilate wastes can seriously impair the quality of the water. The decomposition of organic wastes from municipal and industrial wastewater treatment plants or livestock feeding operations can deplete the dissolved oxygen supply of the receiving waters. Chemicals and toxic compounds that did not exist 20 to 30 years ago, are now common constituents of industrial wastes that can enter waterways from discharge pipes and improper land disposal.

Heat from electric generation or other industrial cooling processes can adversely affect the aquatic habitat. Sediment from agricultural or urban runoff affects turbidity of the water, destroys aquatic habitats, and silts in lakes and reservoirs. Fertilizers and pesticides also enter waterways as either agricultural runoff or industrial wastes.

Surface water is a valuable resource for assimilating and carrying away wastes, but unlimited use of this resource for waste disposal will limit its use by other beneficial users. Groundwater, furthermore, does not have the assimilative capacity of surface water and must be provided with a high degree of protection from contamination.

The information presented in this chapter is based on the comprehensive "Task Force Report on Water Quality," prepared in conjunction with the Department of Environmental Quality and filed with the Iowa Natural Resources Council.

Present Situation and Future Trends

Statutory Authority

The Department of Environmental Quality (DEQ) is the state agency responsible for water quality management, under Chapter 455B of the **Code of Iowa.** Iowa water pollution control activities date back to the enactment of the Iowa Stream and Lake Pollution Law in 1923. That act established the first enforcement authority, which was assigned to the State Department of Health.

It has been amended several times, the first major addition being a 1949 amendment expanding the definition of pollution beyond public health matters to include all legitimate beneficial uses of water. The 1949 amendment also provided authority for water pollution control regulation through permits for construction or expansion of wastewater treatment facilities.

In 1965, new legislation repealed the Stream and Lake Pollution Law and created the Iowa Water Pollution Control Commission, as an agency within the State Department of Health, to administer water pollution control programs. Many of the provisions of the old law were carried forward to the new law, and others, including authority for water quality standards, were added.

The Water Quality Commission within the DEQ establishes program policy for implementation of plans, programs, and water quality standards. The DEQ has the authority to grant construction and operation permits for wastewater treatment works, to conduct investigations and hearings, to order the management of wastewaters

and receiving waters, and to disperse state and federal construction grant appropriations to municipalities.

The Federal Water Pollution Control Act was first passed in 1948. It gave the U. S. Public Health Service, in cooperation with other federal and state agencies, responsibility for cleaning up contaminated rivers and lakes. It established a statutory advisory board on water pollution control matters and provided limited loans and grants for research, planning, and construction.

It was amended in 1956 (P.L. 84-660) to provide the first comprehensive federal water pollution control legislation. The 1956 amendments increased technical and financial assistance to states and authorized construction grants to municipalities.

The Federal Water Pollution Control Act was again amended in 1961 strengthening the federal role in water pollution control (WPC), in 1965 providing for water quality standards and implementation and enforcement authority for standards, and in 1966 further increasing the scope of WPC activities and levels of funding.

The Act, as amended in 1972 (P.L. 92-500) is the basis for current water pollution control programs. The 1972 amendments set goals of attainment of fishable, swimmable waters by July, 1983, and elimination of the discharge of pollutants into the nation's waters by 1985. This act greatly expanded the role of the U. S. Environmental Protection Agency in WPC and increased the level of funding for state programs and construction of publicly owned wastewater treatment plants. It also gave new significance to uniform standards, public participation, and planning.

In December, 1977, the Act was again amended (The Clean Water Act of 1977). These amendments do not substantially alter the thrust of the Act, and the regulatory approach to water pollution control will remain essentially the same.

Sources of Water Pollution

Pollution sources are often described as point or nonpoint. Point source pollution implies a wastewater discharge from a pipe or some identifiable confined and distinct conveyance. Nonpoint source pollution refers to a diffuse flow of pollutants which cannot be easily identified as to source, and which are usually attributable to pickup and conveyance by precipitation and runoff.

Point sources include effluents from municipal sewage systems and industrial plants and runoff from concentrated animal feeding operations. These major types of point sources can have significant impacts on water quality. Furthermore, the processes used in treatment plants to treat the liquid portion of wastewaters accumulate large volumes of residual solids (sludges). If not properly stabilized, and disposed of, such residual waste can cause pollution by running off to surface waters or leaching through the soil to groundwater. In addition, minor point sources, such as rural cluster housing, isolated restaurants, service stations, mobile home parks, quarries, and campgrounds, are numerous. Distributed statewide, these in total pose significant problems to water quality.

Nonpoint source pollution results from runoff from both urban and rural land. Because of the large percentage of agricultural land in Iowa, sediment, pesticides, and nutrients from farmland runoff are the major nonpoint pollutants. The amount of these types of pollutants reaching Iowa's waters has increased significantly during the last two decades. This increase is attributable to use of agricultural chemicals, decreased crop rotation practices, conversion of marginal land to annual crop production, and use of larger farm machinery that discourages the adoption of soil erosion control structures and conservation practices. Motor vehicle residues, industrial air pollution fallout, and any number of chemicals from city streets, roofs, parking lots, and lawns can also have significant impact on water quality when carried to streams by precipitation runoff.

The Department of Environmental Quality's basin plan studies have identified more than 600 municipal wastewater systems, nearly 600 industrial wastewater discharges, and more than 500 minor point sources in Iowa. In addition, nearly 2,500 livestock feeding operations have been identified as needing to come under permit application requirements. Water pollution problems associated with livestock feeding operations have generally been localized in impact. Although localized, that impact can be very significant.

Of the major point sources, municipal sewage systems have received the most regulatory attention and have the best treatment record. Nearly every Iowa municipality with a sewer system has some form of primary and secondary treatment. Nearly half of those are served by waste stabilization ponds, and of the remainder, most are served by trickling filter plants. With the advent of more stringent water quality and effluent standards, a large percentage of the trickling filters will be replaced by some form of the activated sludge process.

High quantity and high strength industrial waste sources have, through the years, had some form of treatment. Under the current permit system, the treatment facilities for these large sources are becoming more effective, and the smaller industrial waste dischargers are also being brought into compliance with effluent standards.

Lake McBride State Park
Iowa Development Commission

Animal waste control, for the most part, consists of waste retention and application of the wastes on land. The DEQ has adopted rules requiring certain livestock operations having significant water pollution potential (because of operation size, distance to stream, or type of waste handling system) to obtain state permits. Although these rules require an estimated 2,500 livestock operations to obtain permits, less than 600 have presently been issued permits. In addition, the DEQ rules exempt from permit requirements a number of livestock operations which may cause minor water pollution problems.

Present Water Quality

Rivers and Streams

In general, water uses of Iowa streams and lakes are not seriously restricted by gross pollution. However, in nearly all areas of the state, there are waters in which pollutants affect aquatic life, recreational uses, cost of treatment for potable and industrial water supply use, and aesthetic values. Since water quality varies widely from stream to stream and even from reach to reach on many streams, a detailed description of existing water quality would be lengthy. The Department of Environmental Quality has published a comprehensive report on water quality (305 (b) report) and a synopsis is contained in Chapter II, Surface Water, Section A, "Existing Water Quality". The 305 (b) report is being updated, and it is planned that it will be revised yearly to serve as a water quality management tool and as a progress reporting mechanism.

It is difficult to draw concise conclusions about the quality of specific bodies of water because water quality is so strongly affected by variations in seasonal and hydrologic factors. Point source problems are more wide spread and pronounced during dry years and dry seasons, when streamflows are low. On the other hand, when precipitation is more abundant, good streamflow dilution reduces point source impacts, but nonpoint sources become more evident because of runoff.

Therefore, it is difficult to classify water quality as good or bad; such judgment must be qualified. One of the goals of the DEQ's reporting process is to identify water quality in terms of seasonal variations in order to determine trends and to define cause and effect relationships of water quality and wastewater management.

Waters in nearly all areas of the state are adversely affected to some extent by nonpoint source pollutant loads. These effects are most clearly evidenced by turbidity caused by silt and by algal growths stimulated by nitrogen and phosphorus nutrients washed away from farm land. Pesticides, heavy metals, and other toxic chemicals are routinely detected at some level in most streams, and hazardous levels have been found. Dieldrin in Coralville Reservoir, for instance, has resulted in limitation of commercial fishing, and pesticide finds in the West Nishnabotna and the Des Moines Rivers have raised concern about the buildup of pesticide residues in fish flesh.

Concentrations of the traditional indicators of point source pollution (dissolved oxygen, biochemical oxygen demand, and organic and ammonia nitrogen) have shown improvement in recent years, which coincides with improvement in industrial and municipal wastewater treatment. Even so, improvement in treatment efficiency is often offset by increase in development.

There are some rivers receiving large waste loads

Sewage lagoon, Iowa Beef, Mason City
Soil Conservation Service

such as the South Skunk, the North Raccoon, the Des Moines, and smaller streams also, where low dissolved oxygen levels are common during low flow or ice cover periods. The river basin planning and permit programs, however, are designed to permit attainment of minimum water quality standards during those critical periods.

The Department of Environmental Quality basin plans identified two categories of stream conditions, based on volume of waste discharges in relationship to flow volume of the receiving streams:

1. Effluent quality limited—Those streams or reaches of stream where standard secondary treatment will be sufficient to maintain stream quality standards.
2. Water quality limited—Those streams or reaches of stream where advanced waste treatment will be required to attain water quality standards.

The most critical of the second category are shown on Figures 4-1 through 4-6. These are the streams for which attainment of water quality standards will be most difficult, and which must have the highest priority for water quality management programs. Although standards can be met by achieving stringent treatment requirements, industrial and municipal expansion must be closely monitored to ensure that water quality improvements keep pace with development.

Lakes

Gross point source pollution of Iowa lakes has not been a serious problem. Direct wastewater discharge to lakes was prohibited by early water pollution control legislation, and that prohibition is still in effect. Lake problems are usually attributed to nonpoint source pollutants, as evidenced by siltation, turbidity, algae, and other undesirable aquatic plant life. Nonpoint related sedimentation decreases water volume, and increases nutrient levels. Few lakes have not had algal problems at one time or another, and winter fish kills are common. However, recreational, fishing, and water supply uses are usually not seriously restricted in those lakes with good water inflow and depth.

Groundwater

Approximately 75 percent of the water used in Iowa for private and municipal supply comes from underground sources. In the past, when the quality of ground-

FIGURE 4-1 Stream Reaches Where Advanced Waste Treatment Will be Required: Iowa-Cedar River Basin

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FIGURE 4-1 Stream Reaches Where Advanced Waste Treatment Will be Required: Iowa-Cedar River Basin

water has been evaluated for use as a public supply, the primary parameters of concern have been total solids, hardness, iron, and manganese. Because of new public awareness and revised drinking water quality standards, emphasis is now being placed on additional contaminants including nitrates, fluorides, heavy metals, and radionuclides. Groundwater quality throughout the state is dependent on many factors, both physical and man-made. In general, alluvial aquifers occupying the valleys of the major streams yield water of good quality. A natural increase in the total mineral content of the water including high concentrations of hardness, sulfate, chloride, and other ions is a problem especially in western and southern Iowa. The higher quality water is generally found in the northeastern quarter of Iowa and in small areas in the western and northwestern parts of the state.

Much of the Iowa land surface functions as a recharge area for groundwater. All recharge areas are potential areas of entry for groundwater pollutants; however, through most of the state, percolating waters must penetrate a considerable thickness of naturally filtering soils before they reach aquifers. Thus, many potential pollutants are fixed, absorbed, and attenuated before they create serious water quality problems. However, there are limits to this natural filtering capability. Solid waste disposal, confinement livestock feeding, and spills of harmful or toxic material all have the potential to degrade groundwater quality. This is a problem, especially in the "Karst" region in the northeastern corner of the state. Sinkholes are a common feature in this terrain and provide direct recharge to the groundwater flow system.

Wells also provide direct lines of communication for pollution to enter groundwater sources. Improper well construction and maintenance can cause serious pollution problems. Presently, the state lacks a comprehensive well monitoring or regulation program.

Program Management

Planning

Planning is an essential and prominent tool of water quality management. The high water quality standards envisioned by the goals of the Federal Water Pollution Control Act amendments of 1972 and the monumental cost forecast for meeting those goals dictated that the level of state planning be greatly increased. The Iowa water quality management program is based on basin planning required by Section 303 of the Act. The first phase, which consisted of taking inventory of pollution sources and assigning permissible waste load limits to meet water quality standards goals, serves as the basis for current second phase planning, which is a continuing planning process that will include program implementation and facilities development.

Water Quality Standards

These standards are the state's goals for river and lake water quality. The standards consist of an inventory of water uses and specific definition of the character of water quality needed to protect and support those uses. Streams and lakes are classified by name and by reach to define the uses made of the water. The classifications then dictate the physical, bacteriological, biological, and chemical criteria which the water must meet in order to assure protection of the uses. The Phase I basin plans were based on water quality standards adopted in 1973, but, under the continuing planning process, the standards are reviewed and revised every three years to keep pace with current scientific opinion, technology, and current water uses.

Effluent Standards

Effluent standards are technology based minimum standards for acceptable wastewater quality. Where

FIGURE 4-2 Stream Reaches Where Advanced Waste Treatment Will be Required: Southern Iowa River Basins

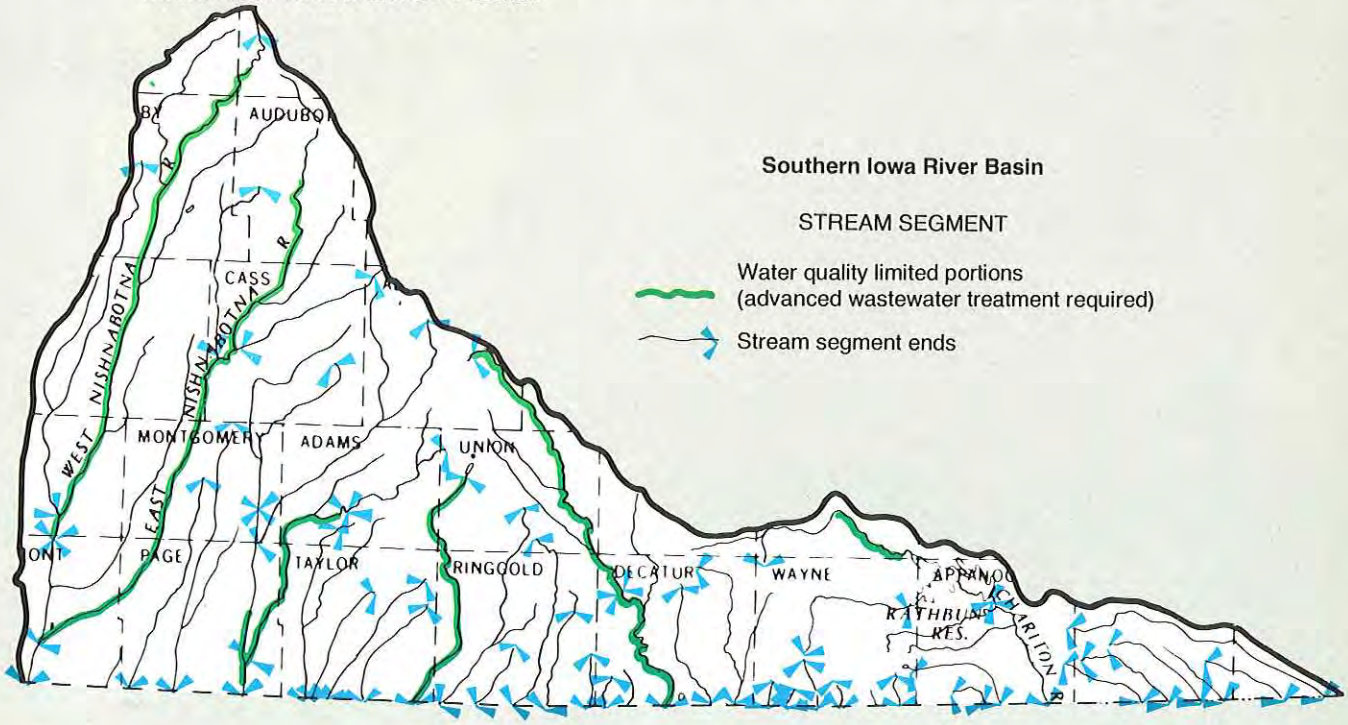


FIGURE 4-3 Stream Reaches Where Advanced Waste Treatment Will be Required: Northeast Iowa River Basins

maintenance of stream water quality is not a controlling factor, existing discharges are limited to a level that can be achieved by use of best practicable waste treatment technology (BPT). New source industrial discharges must meet levels which can be achieved by use of best available treatment technology (BAT). Water quality stream standards are minimum acceptable standards, and the intent of effluent standards is to utilize available treatment technology to obtain better than minimum stream water quality wherever practical.

Wasteload Allocation

Wasteload allocation is the method of determining the amount of waste a river system can assimilate and dividing that assimilative capacity between the various discharges within the basin. On streams with more than one discharge, the discharges can have overlapping and even basinwide effects on water quality, making wasteload allocation a complex process. Water quality computer modeling techniques were developed and used in the Phase I planning to take into account all the discharges within a basin. They are used to determine the largest individual waste loads that can be permitted and still meet water quality standards basin wide, even at low stream flows. The process results in some discharge limitations requiring more stringent than secondary treatment, but where sufficient assimilative capacity is available, the dischargers are limited to BPT or BAT effluent standards.

Statewide 208 Planning

This statewide planning (Phase II, the "Continuing Planning Process") is focused on the solution of nonpoint source pollution problems. The current planning effort (July, 1976 to November, 1978) features a Department of Environmental Quality/Department of Soil Conservation (DSC) inter-departmental study. DSC has been delegated the responsibility for evaluating the extent and magnitude of nonpoint source pollution, and developing a management strategy to deal with the problem. A prominent part of the planning process involves broad based public participation in the decision-making process.

Advisory committees have been formed. These consist of locally elected officials, representatives of areawide planning agencies and conservancy district advisory committees, and the public at large. These committees provide input to all phases of the planning process. The DEQ is also, as part of Phase II, conducting a statewide comprehensive assessment of water quality, evaluating and refining the wasteload allocation procedures, evaluating a regional concept for wastewater treatment plant operation and maintenance, and developing a residual waste management program.

Areawide 208 Planning

Such planning is being conducted by planning agencies in the Des Moines metropolitan area and the four-county area around Lake Rathbun. Officially designated and federally funded under Section 208 of the Federal Act, the planning process is structured to the particular needs of each of these areas. It is intended to produce a water quality management program based on areawide as well as local considerations, and to economically meet Statewide 208 goals and plans at minimum cost.

Construction Grants

Construction grants management is an integral part of the DEQ planning effort. The federal legislative amendments in 1972 greatly increased the grants for financial assistance in construction of publicly owned treatment works. The Federal Act provides grants of 75 percent of project costs, which are currently matched by five percent state appropriated money, leaving 20 percent of costs to the municipalities. Although the terms of the Act would allow grants for construction of both collection sewer projects and treatment works, appropriations are insufficient to satisfy all the needs. Therefore, collection sewers have been given low priority and are not funded. This places a heavy financial burden on small cities that are trying to replace individual septic tank systems. In addition, the per unit cost of a treatment plant is higher for a small community.

The Phase I basin plans identified needs for more than 700 municipal construction projects with estimated costs of more than $500 million. The cost and limitation on grant funding dictate that construction starts must be spread over several years. This, along with the complexity of the grant application process, grant requirements for local planning, and other limiting factors, suggests that meeting the Federal Act's goals will be delayed.

It was, therefore, recognized in Phase I planning that projects would have to be given priorities and scheduled accordingly. The priorities were assigned, and federal funds are awarded according to a formula that takes into account existing treatment efficiency and impact on receiving water quality. The priorities and schedules are updated annually under the Continuing Planning Process.

Permits

Operation Permits

These permits are the principal tool for enforcing point source water pollution control. Discharging wastes without a permit or in noncompliance with a permit is unlawful. Iowa operation permits feature:

1. Effluent limitations determined by basinwide waste load allocations. (Plants with deficiencies which prevent maintenance of final effluent limits are given reasonable interim effluent limits along with the compliance schedule.

Center Street Dam, Des Moines
Iowa State Historical Museum

2. Compliance schedules which specify needs for upgrading treatment efficiency or effectiveness, collection sewer improvements to reduce flow of effectiveness, collection sewer improvements to reduce flow of extraneous water to the plant, or improved operation and maintenance. These schedules include a time table of events leading to compliance with final effluent limits.
3. Self monitoring requirements which include flow measurement, specified chemical and bacteriological testing of the effluent, and reports of the records of operation to the DEQ.
4. Reports that assess progress in meeting schedules.

Despite the important and unique value of operation permits, a significant percentage of the 4,200 identified discharges have not been placed under permit. DEQ manpower shortages have dictated that permits be processed first for municipal and major industrial and agricultural discharges. This prevents action in regulation of minor sources. These minor sources of wastes include marinas, boats, small commercial establishments, rural cluster housing, recreational areas, and quarries. It is reasonable to assume that problems from such minor sources will increase in the future and in the meantime, lack of regulatory controls and services by a local unit of government, severely limits pollution control in unincorporated areas.

Construction Permits

Construction permits are issued to ensure that wastewater treatment works meet minimum recognized design standards. It is unlawful to construct or change a sewerage system without obtaining a permit. An application for a permit must be accompanied by plans and specifications prepared by a registered professional engineer. The plans and specifications are then reviewed by DEQ engineers and, if approved, a permit is issued. The design/review process enables the DEQ to judge whether a proposed project is capable of meeting effluent limitations.

Surveillance and Compliance

The features of the operation permit allow for efficient monitoring of progress in controlling pollution. The DEQ field staff also conducts periodic inspections of treatment works. The purpose of these inspections is to sample and test the effluent as well as to evaluate operation and maintenance practices, self monitoring testing procedures, record keeping, and planning and construction progress. The permit is a descriptive and enforceable guide to the discharger, and a document which allows easy measurement of compliance or progress toward compliance.

In cases of noncompliance, the authorizing statute and the terms of the permit allow for negotiations between the discharger and the DEQ for corrective action. When immediate corrective action is impractical and when the noncompliance has good cause, the negotiations usually result in a revised compliance schedule or raising of interim effluent limitations. When negotiations fail or when the noncompliance cannot be justified, compliance with the permit is pursued through the courts by the Attorney General.

Stream water quality monitoring is conducted by the State Hygienic Laboratory (SHL), under contract to the DEQ. SHL maintains a network of fixed stream monitoring stations which are sampled periodically through the year, and also conducts intensive surveys of selected stream reaches. Currently, extensive data is available for some water bodies, but many streams, lakes, and aquifers have limited or no data available. In addition, there is a need for more data on pesticides and many industrial pollutants unknown a few years ago.

Stream sampling resources are directed toward determining water quality trends. Stream sampling data is also used to support permit enforcement and to aid in planning activities. Continued strong emphasis must be placed on water quality surveillance in order to monitor progress toward meeting water quality standards.

Operator Training and Certification

The best designed and constructed treatment works can be entirely ineffective if not adequately operated or maintained. Iowa was a pioneer in operator certification, and in the past, through the support of the Iowa Water Pollution Control Association (IWPCA), the state universities, and the state health and environmental quality departments, has maintained a program of voluntary training and certification by examination. Mandatory operator certification is now required by statute, and a certification board within the DEQ conducts a regulatory program to assure that municipal waste treatment works are under supervision of certified operators. Current rules classify plants according to size and complexity of operation. Operators must have a certification level consistent with the plant classification. The program requirements now apply only to municipal plants, but may apply to the industrial sector also as the number and complexity of industrial plants increases.

Operator training sessions are still conducted through a coalition of IWPCA, the State University of Iowa, and Iowa State University. New training programs are also available through Iowa area community colleges. Certified operators, however, are in short supply and the number and size of treatment plants are increasing. In addition, more complex and effective activated sludge treatment processes are replacing the existing, more easily operated, trickling filter plants. Emphasis must, therefore, be given to funding and expansion of operator training programs.

Spring fed stream, Backbone State Park
Iowa Conservation Commission

FIGURE 4-4 Stream Reaches Where Advanced Waste Treatment Will be Required: Skunk River Basin

FIGURE 4-5 Stream Reaches Where Advanced Waste Treatment Will be Required: Des Moines River Basin

FIGURE 4-6 Stream Reaches Where Advanced Waste Treatment Will be Required: Western Iowa River Basins

Conclusions and Recommendations

Municipal and Industrial Point Sources of Pollutants

Conclusions

Despite the progress made in recent years in controlling water pollution from point sources, a significant percentage of the 4,200 identified discharges have not been placed under permit. DEQ manpower shortages have dictated that permits be processed first for municipal and major industrial and agricultural discharges. The increasing number, size, and complexity of the treatment plants being built dictate that training programs be available for operators.

Treatment plants are expensive to build, and the higher unit construction costs for treatment facilities in small cities is a particular problem. In addition, the cost of sewer construction often exceeds the cost of the treatment facility. This places a heavy financial burden on small cities attempting to improve environmental conditions by replacing individual septic tank systems.

The flow of a receiving stream can have a significant effect in pollution problems. Streams with low flows have less assimilative capacity, and consequently, industries and communities discharging to small streams must provide a high degree of treatment before discharge.

Recommendations

The DEQ should continue to employ river basin planning as a water quality management mechanism. In order to assure optimum levels of water quality throughout a basin, all the sources and their basinwide cumulative effects must be considered in assigning individual discharge effluent limitations and in setting enforcement and construction priorities.

The DEQ should continue to use discharge permits as the principle enforcement mechanism to assure compliance by each discharger.

More effort should be expended on improvement of treatment plant operation and maintenance. Multiple plant sharing of qualified operators and laboratory facilities should be encouraged, and more technical assistance should be provided, possibly through university extension services.

State financial assistance should be provided to small cities where needed to offset the higher per capita costs of community environmental improvements. Consideration should be given to such alternatives as loans, grants, and revolving funds.

Municipalities should practice strict enforcement of local ordinances on sewer, housing construction,

Clean waters, an indispensable resource — *J. D. Leonard*

inspection, industrial in-house waste recovery, and pretreatment in order to minimize costs for treatment of clear water infiltration and excessive industrial waste flows.

Industrial development efforts should encourage location of high volume dischargers on streams with adequate waste assimilative capacity, so as not to restrict future development. Local governments should consider water quality impacts in planning for domestic and industrial development. Where the assimilative capacity of a stream has been reached, future development must be offset by more stringent waste treatment requirements.

In the design of industrial and commercial facilities, careful consideration should be given to minimizing the amount of waste products that will be generated within the facility.

Where soil conditions, character of the waste, and other conditions permit, land disposal of wastewater and residual sludges should be encouraged, because of economies that can be realized in solving treatment and disposal problems and values that can be attributed to use of organic waste as a fertilizer supplement and soil conditioner.

Future policies on consumptive water withdrawal should give consideration to their impact on assimilative capacity of Iowa's streams.

Minor Point Sources of Pollutants

Conclusion

Little or no effort is presently being made to regulate or control minor point sources of pollution. Such sources of pollution presently have minimal impact on overall water quality in the state, but the localized impacts are of considerable importance. The DEQ and state and local health departments receive many complaints regarding pollution, nuisance conditions, health hazards, and aesthetics degradation attributable to such minor sources. Such complaints are increasing as the public becomes less tolerant of those conditions.

It is reasonable to assume that the problems from such minor sources will increase in the future. The trend toward random rural housing will likely continue until such time as land use plans or zoning restrictions control such developments. In the meantime, lack of regulatory controls and services by a local unit of government severely limits pollution control from random housing in unincorporated areas. There also appears to be an increasing trend to locate commercial facilities, such as truck stops, locker plants and food establishments in rural areas.

Recommendations

Additional resources should be provided to allow for regulation and control of the minor point sources of pollution in cooperation with regional and local governments.

The General Assembly should adopt legislation that would mandate the formation of sanitary districts (or a comparable mechanism) around lakes and rural cluster developments to assure the proper treatment and disposal of wastes from homes and businesses where septic tank systems pose a threat to water quality.

More active participation by county health departments should be required, or district health units should be established through a cooperative institutional mechanism, in order to adopt and enforce rules governing the installation and operation of individual home waste disposal systems.

The legislature should adopt some means of providing assistance or other incentives to local health departments to adopt effective programs to control pollution from individual home systems.

Government agencies responsible for regulation or operation of public and private recreation facilities should require adequate treatment and disposal of all wastes at all appropriate facilities.

Nonpoint Sources of Pollutants

Conclusion

Nonpoint sources are known to be significant contributors of pollutants to Iowa's waters. The principal nonpoint source in Iowa is runoff from agricultural land, although runoff from urban areas also has a significant impact on water quality.

Very little effort has been made to control water pollution from these sources. Iowa has had an active soil conservation program for many years, but the emphasis has been almost exclusively to protect the soil and little or no consideration has been given to promoting these practices for the purpose of protecting water quality. However, Iowa is now in the initial phases of a 208 study which should result in the development and implementation of a management program which emphasizes water quality protection.

Recommendations

The state should implement nonpoint source control programs directed toward solving rural and urban nonpoint source pollution. Existing soil conservation programs and proposed nonpoint source control programs should give high priority to projects that will provide the most protection or improvement to the state's waters, with highest priority being given to those waters with the highest value to the state.

The state's executive and legislative leadership should evaluate the alternatives available for using state and local funds to finance land management practices necessary to protect water quality.

The state should work closely with Iowa's Congressional delegation and with federal officials to obtain increased federal funding for implementation of nonpoint source control measures. Any federal assistance programs enacted should give major responsibility for determining funding priorities, eligibility for funding, etc., to the states.

Agricultural Point Sources of Pollutants

Conclusions

Although progress has been made in controlling water pollution from livestock operations through the DEQ livestock waste control rules, much work remains. A majority of the operations covered by the permit requirements of DEQ rules have not complied with permit application requirements, even though the rules required permit application by April 1, 1977. The state program to control water pollution from livestock operations is hampered by a lack of adequate staffing, which has forced the program to focus on new facility construction, and precluded significant progress in controlling pollution from existing operations.

Recommendations

DEQ's livestock waste control program should be

supported at a level adequate to carry out a comprehensive program for controlling water pollution from both existing and new livestock and poultry operations.

Water Quality Monitoring and Surveillance

Conclusion

The present monitoring network for water quality is inadequate. Currently, extensive data is available for some water bodies, but many streams, lakes, and aquifers have limited or no data available. The need for extensive data on trace elements, pesticides, organics, chlorinated organics, and many industrial pollutants, unknown a few years ago, is becoming more evident. This is especially true of groundwater quality which can be affected by increased use of agricultural chemicals, landfill disposal of solid wastes, and land application of wastes.

Complete data is essential in measuring trends in the quality and quantity of the state's water resources. Our highly industrialized society creates increasing volumes of an ever increasing number of pollutants which are introduced into our environment. The water resources of the state cannot be assured adequate protection unless we are able to detect changes in water quality promptly and can establish future regulatory programs from a sound data base.

Recommendation

The various water resources agencies of the state should be appropriated sufficient funds to develop a comprehensive data collection program, and annual funds to maintain and update the data base for quality and quantity of Iowa's waters.

Groundwater Quality

Conclusion

Groundwater pollution is a serious concern, especially when one considers that approximately 75 percent of the water used in Iowa for private and municipal supply comes from underground sources. Although many potential pollutants are absorbed and attenuated as they percolate through the soil down to an aquifer, there is a limit to this natural filtering capacity. Thus, solid waste disposal, confinement livestock feeding, and spills of harmful or toxic chemicals all have the potential to degrade groundwater quality.

Across the state, there are several areas where the transition from surface to underground water and back occurs over comparatively short distances and in brief spans of time. Among the more sensitive of these areas is the "Karst" region in the northeastern corner of the state. Sinkholes are a common feature in the terrain of northeastern Iowa and provide direct recharge to the groundwater flow system.

Poor well construction techniques, improper well location, and inadequate well maintenance have caused a considerable number of rural water supply systems to deliver inferior quality water. All wells, although certainly not intended, are direct lines of communication for pollution to enter the groundwater environment.

There is a need to have more conclusive information on the subject of irrigation and nitrate leaching. There is a need to know to what extent irrigation increases or decreases nitrate leaching, under what conditions nitrate leaching occurs, and what soils can accommodate the spreading of feedlot wastes.

Groundwater protection is urgently needed and imperative to the protection of the state's underground resources.

Recommendations

A mandatory licensing program for well drillers needs to be established to ensure proper well location, construction, and maintenance. Guidelines for proper well construction and abandonment have been developed by the Iowa Geological Survey, but there is no means of enforcement.

The Department of Environmental Quality's authority to regulate solid waste disposal should be extended to include disposal of industrial waste on land owned or leased by the industry.

A study evaluating the impacts of irrigation uses of water should be conducted for each basin and subbasin before water resources are allocated to that use.

An educational program is needed to eliminate the use of sinkholes by individuals for private dumps. Technical and monetary assistance should be provided for plugging or diking these areas where feasible. There is a need for improved inventory and monitoring of groundwater uses, particularly in northeast Iowa. Development of a well regulation program for users exempt from the water rights permit system would supplement the existing monitoring system.

Future Water Use Considerations

Conclusions

It is reasonable to assume that increasing amounts of water will be required for potable and industrial uses in the future. The large water requirements and associated thermal pollution problems of steam electric plants are areas of growing concern. Any increase in irrigated agriculture will have both water quantity and water quality complications. Development of Iowa's coal resources through strip mining has the potential to degrade water quality in the mined area. It is vital that the quality of Iowa's water resources be maintained as more and more demands are placed on it.

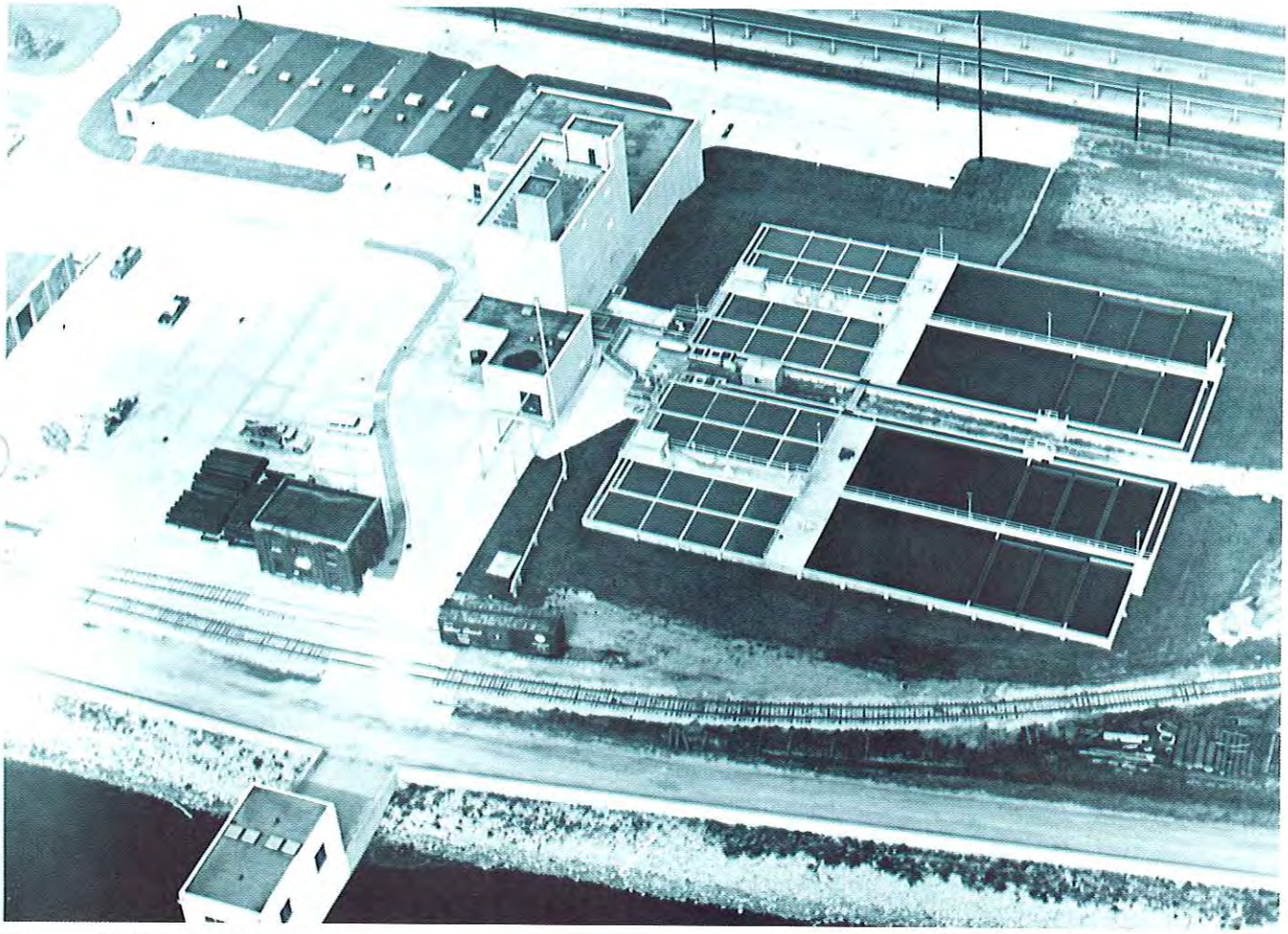
Recommendations

State agencies responsible for water resources management should develop programs that promote water recycling in industrial applications and use of treated wastewaters that have suitable quality for irrigation.

Plans for future electric generating plants should fully consider state water quality standards for thermal discharge in their site selection process.

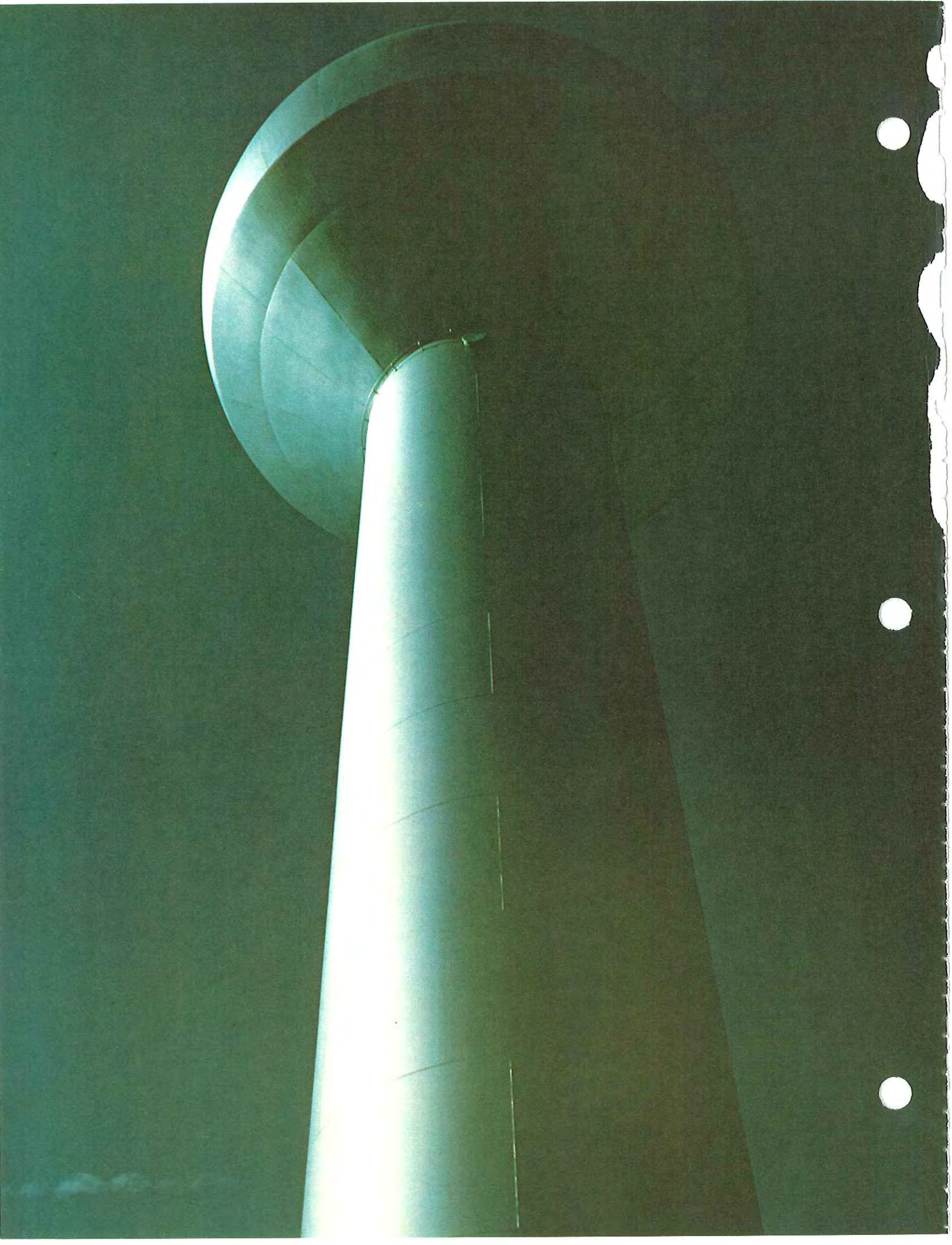
On interior streams of the state, closed-cycle cooling should be encouraged to eliminate any adverse impact on the aquatic habitat.

The state should fund a thorough study to determine the effect on water quality that would result from increased strip mining. Such a study should also include the development of guidelines and recommendations for the DEQ to use in adopting rules, standards, policies, and criteria necessary to protect water quality.



Water purification plant, Ottumwa

Ottumwa Waterworks



5 Water Supply and Use Problems

Current and Future Trends in Water Use in Iowa

In 1975, it is estimated that over 1.3 trillion gallons (3,990,000 acre-feet) were withdrawn from groundwater and streams in Iowa for various types of uses. This amount is equal to a withdrawal rate of 3.6 billion gallons per day (bgd), or 1,400 gallons per day per person. An estimated 460 million gallons per day (mgd) of that use were considered consumptive, meaning the water is no longer available because it has been either evaporated, transpired, incorporated into products consumed by living beings, or otherwise removed from the immediate environment.

For this study, water use was broken down into three major categories: those uses served by public water systems, agricultural uses, and industrial uses.

Public Water Systems

It is estimated that currently, 73 percent of the population of Iowa is served by public water systems. Public water systems include municipal and rural water systems, of which 73 percent utilize groundwater. The total annual withdrawal of these water systems is 296 mgd with an estimated consumptive use of 45 mgd (15 percent). Approximately 29 percent of the usage is for municipally supplied industrial and commercial use. Rural water systems comprise 1 to 2 percent of that use; a use that normally is considered to be from 75 to 100 percent consumptive due to the loss of the water to the immediate withdrawal vicinity.

Per capita use on public systems has increased from 106 gallons per capita per day in 1960 to 145 in 1975. Table 5-1 illustrates estimated water use trends in public supplies from 1960 through 1975.

Agricultural Water Use

Agricultural water use can be broken into three distinct categories: self-supplied domestic, livestock, and irrigation.

Except for the very limited areas supplied by Rural Water Districts, almost all rural domestic and livestock needs are supplied by wells or farm ponds. Due to the costs of production and limited low-cost water availability to these individual systems, per capita use in most rural areas is considerably lower than in urban areas. The estimated domestic use in rural or unincorporated areas in 1975 was 40 gallons per capita per day as compared to 145 in the urban areas.

In 1975, total rural domestic use in Iowa was estimated to be only 50 mgd of which 20.5 mgd (41 percent) was considered consumptive. Approximately 99.8 percent of this water was taken from groundwater sources.

Livestock water use in 1975 was estimated to be 116 mgd, with about 81 percent from groundwater sources. This use has been declining steadily since 1960 when it was estimated to have been 140 million gallons per day.

Table 5-2 illustrates rural domestic and livestock trends from 1960 through 1975.

Irrigation is by far the largest agricultural use of water in Iowa, both in terms of withdrawal and consumption. All but a very miniscule portion of irrigation in the state is supplemental and is totally utilized by growing plants. Therefore, irrigation is considered a 100 percent consumptive use.

As of May 31, 1977, the Water Commissioner's Office of the INRC had issued 1,105 irrigation permits for 185,000 acres at an authorized use rate of 225,000 acre-feet per year (73.4 billion gallons per year). In addition, there was a backlog of more than 700 irrigation applications to be processed. Sixty percent of the authorized withdrawals for irrigation are from groundwater.

Of the current INRC permitted withdrawals, irrigation comprises 17 percent of the total withdrawal and 61 percent of the total annual consumptive use in the state.

Industrial Use

Industrial water uses in this study were placed in two basic categories: water for power generation and water for manufacturing and processing.

Water for energy production has the greatest withdrawal rate of all uses in the state, comprising 74 percent of the total withdrawal in 1975. Power generation that year withdrew 2.7 billion gallons a day (bgd) with a consumptive use of 14.8 mgd. All but 2 mgd of that withdrawal was from surface water sources. It should be noted that most of these massive withdrawals are taken from the border rivers and only about 25 percent of the current withdrawals are in the interior of Iowa.

The information presented in this chapter is based on the comprehensive "Task Force Report on Water Supply and Use," prepared by and filed with the Iowa Natural Resources Council.

Water tower at Indianola / W. E. Akin

The predominant use of this water is for cooling. The United States Geological Survey (USGS) water use estimates show a doubling of water withdrawal from 1970 to 1975. A more definitive discussion of the water use in power generation is included in the chapter on water for energy. It is estimated that other industrial withdrawals in Iowa amounted to 315 mgd with a consumption rate of 63.1 mgd in 1975. Fifty-eight percent of these withdrawals were from groundwater sources.

Table 5-3 illustrates the trends in industrial water withdrawals from 1960 through 1975.

Projected Future Trends

As shown in Table 5-4, water withdrawal in Iowa is projected to increase from 3.6 bgd in 1975 to 27.5 bgd in 2020. Much of this will be water withdrawals for electric energy production and considerable recycling and reuse will be involved. The consumptive use portion is expected to increase a corresponding 7.5-fold during the same period.

Only three use categories have any major effect on that increase: power generation, manufacturing, and agriculture (primarily irrigation). These three categories accounted for 92 percent of the total water withdrawal in 1975 and are projected to utilize 93 percent of the state total by 2020.

Other self-supplied industrial uses (primarily manufacturing and processing) are projected to triple by 2020 to almost a billion gallons per day withdrawal and a consumptive use rate of around 190 million gallons per day. At this projected rate, the manufacturing and processing industry would maintain its status as the second greatest water user in the state.

There are many variables to consider in projecting future irrigation use, the main one being the cost of energy. However, we did try to develop a reasonable projection of possible irrigation rates by the year 2000. It was projected that irrigation water usage could quadruple, increasing by 740,000 acre-feet per year (241.2 billion gallons). All of this withdrawal would be considered consumptive, particularly during drought periods when utilization would be expected to equal the permitted amounts.

The other use categories are projected to have only minor increases in use rates, and although there should be a major increase in the number of rural water districts, the high costs of production should keep the rural rates around current levels.

Figures 5-1 and 5-2 show current withdrawal and consumptive use rates and those projected by 2020.

Allocation Problems

Although the gross figures of stream runoff and groundwater availability contained in the Water Availability chapter of this study indicate that Iowa is a water rich state overall, the water is not spread evenly over the state. If a majority of the surface water at high flow stage were impounded, there would be a surplus, but this has not been accomplished. The gross average annual stream flow figures also are misleading, indicating more than adequate quantities of water on a yearly basis for almost any major withdrawal; however, these averages hide the fact that during the summer-fall flow period, flows in the major Iowa streams are extremely low and are insufficient to handle any major consumptive use.

There are vast amounts of groundwater under Iowa, but quality, depth, and areal location limit its use in much of the state. Major aquifers such as the Jordan and Dakota systems are extremely slow to recharge (most of the recharge occurs out of state) and massive withdrawals would result in mining; that is, using the water at a rate exceeding replenishment of the aquifers. Water quality in the major deep aquifers of the state is a major problem in some areas. Depth causes the cost of obtaining water from some portions of these aquifers to be prohibitive. Now federal regulations concerning drinking water standards also will affect or limit the use of these sources. Yield from some of the shallow surficial aquifers is variable, limiting withdrawals during drought periods in certain areas.

Three major regions in Iowa have severe shortages of surface and groundwater of good quality; namely, the Northwest, Southwest, and South Central (Figure 3-18). In these areas, for the most part, the quantities of quality groundwater and surface flow are such that even under non-drought conditions there are water supply problems. Realistically, unless additional storage, desalinization of deep aquifers, or diversion from the border streams is provided, there is not enough quality water to support any substantial increase in water use in these three regions of the state.

Although the rest of the interior portions of the state, with some exceptions, have a more favorable situation with respect to surface and groundwater, these systems are not sufficient to support massive withdrawals and, even more critically important, massive consumptive uses.

The 1977 spring and summer drought highlighted the fact that Iowa does have serious water problems among competing uses. Scores of public water systems were in

TABLE 5-1 Estimated Water Use in Iowa, Water Used for Public Supplies*

Year	Water Withdrawn (MGD)				Water Delivered (MGD)				Water Consumed (MGD)
					Industrial & Commercial Use			Domestic Use & Loss	
	Ground Water	Surface Water	All Water	Per Capita (gpcd)	Air Cond.	Other	All Uses		
1960	91	68	160	106	5.1	67	72	88	16
1965	150	47	200	104	1.2	56	57	140	19
1970	180	73	250	123	NA	NA	60	190	37
1975	216	80	296	145	NA	NA	86	210	45

*Based on estimates made by the U.S.G.S.
NA - Not available.

TABLE 5-2 Estimated Livestock Water Use (1970)*

Livestock Category	Number (1000's)	Annual Production (1000 lbs)	Drinking MGD	Other MGD	Per Head (gal/head)	Total (MGD)
Beef and Cattle	7,181	2,948,500	42.68	13.57	7.8	56.25
Sheep and Lambs	797	50,854	0.50	0.	0.8	0.65
Hogs and Pigs	16,322	5,081,960	30.19	11.03	2.6	41.23
Milk Cows	486	4,716 (milk)	7.26	6.32	27.9	13.58
Chicken, Broilers and Turkeys	20,228	179,970	0.68	0.14	—	0.81
Hens and Pullets	13,506	3,034[1]	0.88	0.28	—	1.16

*Source: Second National Assessment of Water and Related Land Resources (19).

[1] Million Eggs.

critical condition and programs of conservation and rationing were imposed in many cases. Thousands of farm wells went dry under the drought stress. Releases from major reservoirs were cut back to assure a critical minimum flow for essential uses. Many smaller reservoirs and farm ponds went dry. Irrigation from streams was halted by May when flows fell under the INRC protected level.

Iowans must face up to the fact that we do not have unlimited water resources during these frequently-experienced drought periods. Excluding the Border Rivers and their alluvial systems, any major high consumptive use or diversion from its original system can have catastrophic effects on the state's surface and groundwater systems. The competition for the limited supply of water is growing exponentially and some difficult water allocation decisions will have to be made in the very near future.

The Iowa Natural Resources Council, which currently handles the water allocation system for the state, has already started limiting major consumptive uses from the Jordan and Dakota aquifers. During the summer of 1977, the Council held public hearings on these aquifers and formulated very restrictive rules on water use from these systems. These sandstone aquifers are very slow to recharge (except where the Dakota system is interconnected directly to a stream valley), are extremely fragile, and are the primary source for many public systems. Due to a lack of data to substantiate the total quantity of water available, the Council banned all heavy industrial and irrigation uses from these systems until 1980, when the current Iowa Geological Survey recharge and availability studies are scheduled for completion.

The shallow alluvial aquifers of the streams in the Northwest were also placed under severe restrictions. The Council plans a similar review on the major limestone aquifers in 1978-79.

Along the same lines, the Council is concerned about the pressure for increased municipal and industrial withdrawals from Iowa's natural lakes. These lakes provide a fragile, unique ecological environment and other substantial recreation benefits to the state. These withdrawals into municipal systems eventually go into the sewer systems, are treated and discharged downstream of the lake outlet. These totally consumptive withdrawals have a serious impact on these lakes for both purposes during drought periods, and any future increase in withdrawal by current users, and any new withdrawal use must be limited, or even prohibited. Alternate sources of supply must be found to meet these increasing demands.

Under current laws, the only water uses which are given a priority are domestic and livestock water uses and other uses of less than 5,000 gallons per day. There have been suggestions that a statewide priority system be developed. Such an approach is not practical since each aquifer and stream system has different capabilities. The Council's current approach, which sets priorities by individual source systems, is a far more realistic solution to regional allocation problems. It recognizes regional differences in supply and demand, and is a better long-range planning mechanism.

The legal intricacies and needed changes in water allocation law are discussed in greater depth in the Law and Government chapter.

Water Management Problems

As stated earlier, the greatest withdrawal use of water by a wide margin, now and in the future, will be power generation. Frankly, there is not enough available supply from the interior streams, the alluvial systems, or the deep groundwater aquifers to support this massive demand, particularly during annual low flow or periodic drought stress. Such withdrawals from groundwater sources, with no return flow considered practical, are totally consumptive for that aquifer. Otherwise, condenser cooling is about two percent consumptive, the other 98 percent being recirculated (with blowdown), or returned to the surface stream system. Power utilities must realize they have four available options, namely: (1) locate on the border rivers (Missouri and Mississippi); (2) purchase storage in existing reservoirs in the interior; (3) develop their own storage capability or (4) cooperate in obtaining storage in new state and

federal reservoirs on the interior streams. Iowa cannot jeopardize the other vital user demands for the benefit of such a high withdrawal and partially consumptive use industry.

As previously stated, Northwest, Southwest, and South Central Iowa have a critical scarcity of developable groundwater now. Natural stream flows are not substantial enough during low-flow periods to support any further major developmental use. Storage reservoirs are the only viable solution to assure water supplies for any reasonable economic growth in these areas. Unfortunately, the Northwest region is not overly blessed with potential reservoir sites; the other two regions offer more opportunities. Those sites presently available are disappearing rapidly due to other developmental uses. There is a dire need to preserve adequate prime reservoir sites to ensure stable economic growth in these regions and in other critical regions of the state. To forestall losing this option, the state should initiate a program of prime reservoir site preservation. Even if these sites are never utilized, they would have significant ecological preservation and recreational benefit spinoffs to the state.

Currently, there are four major Corps of Engineers reservoirs in the state. Only Rathbun Reservoir has any provision for water supply storage and according to federal statutes this storage must be paid for by the user. The state can act as a wholesaler of this storage for multipurpose uses. Saylorville, Red Rock, and Coralville reservoirs have no direct allocation for water supply storage. Over 80 percent of the total justification of the reservoirs is for flood control benefits for which the benefactors do not reimburse the state or federal governments. Flood plain occupancy for uses more intense than agriculture is the poorest form of land use, and such a free benefit tends to promote such action. On the other hand, water supply storage, which is far more essential to economic and demographic growth, is placed by the state and federal governments on a 100-percent reimbursable basis.

During the severe drought of 1977, although there were grave indications of serious water supply problems, water was released from Coralville Reservoir in the early spring to provide storage for flood control. Later in the year, flows from this reservoir, and others, were cut to try to keep the reservoirs from going completely dry had the drought continued.

Iowa must exert pressure on the United States Congress to give water storage at least equal footing with flood control. At the same time, all reservoirs in the state should be examined to see if water supply storage can be a compatible use with the reservoirs' design purpose.

Along the same lines, there is increasing pressure to divert major portions of the Missouri River, both above Iowa and downstream, to other basins for such uses as irrigation, industry, coal beneficiation, and coal slurry pipelines. Iowa has a major stake in its border rivers and must protect its right to an equitable share of those flows. The state must forcefully oppose, through the Title II Basin Commissions and its Congressional delegation any major adverse diversion of the natural flow of the border streams and, if necessary, be prepared to take appropriate legal action to assure its just share of those flows.

Another very serious problem is the degradation of the Missouri River stream channel in northwest Iowa, as a result of the U.S. Army Corps of Engineers Missouri River Stabilization and Navigation project. The bottom of the river channel has dropped at least 7 feet at Sioux City. This causes problems not only on the main channel, but also creates problems of degradation on all the major tributaries and their alluvial groundwater systems. Immediate action is imperative, first to halt the degradation, and then to restore it to its previous state.

Corning reservoir during drought, 1956 *W. E. Akin*

TABLE 5-3 Estimated Water Use in Iowa Self-Supplied Industrial Water Use* (MGD)

Year	Electric Utility Uses (MGD)			Water Consumed	Other Industrial Uses (MGD)			Water Consumed	All Industiral Uses (MGD)			Water Consumed
	Surface Water	Ground Water	All Water		Surface Water	Ground Water	All Water		Surface Water	Ground Water	All Water	
1960	1500	0	1500	2	37	74	110	11	1537	74	1610	13
1965	1500	2	1502	21	55	130	185	19	1555	132	1687	40
1970	1400	0	1400	20	130	150	280	5.3	1530	130	1660	25.3
1975	2716	2.0	2718	14.8	132	183	315	63.1	2848	185	3033	78

*Based on estimates made by the U.S.G.S.

TABLE 5-4 Summary of Water Use Projections in Iowa 1975-2020* (Billion Gallons Per Day)

	1975	1980	1990	2000	2010	2020	Average Annual Growth Rate (%)
Intake	3.615	4.907	7.359	11.189	17.038	27.532	4.51
Gross Use	4.445	6.630	11.378	20.315	37.047	72.910	6.21
Discharge	3.351	4.616	6.978	10.644	16.274	26.433	4.59
Consumption	0.263	0.299	0.425	0.827	1.112	1.973	4.48

*Adopted from the IER Projections (3).

The State of Iowa must work together with the U.S. Army Corps of Engineers and Congress to solve the problem without delay, before further irreparable harm is done.

The Iowa Water Rights Law is one of the best of its kind in the nation. It was spawned after the drought of the mid-fifties and functioned well in the period of plentiful water supplies of the sixties through mid-seventies. However, the drought stress of 1976-1977 pointed out areas of deficiency. Competition for water increased astronomically. More irrigation permit applications were received in one year than had been received in the previous twenty years. Communities that had not planned for the ever-recurring drought cycle, ran out of water or were forced to instigate strict rationing procedures. Power brownouts became a distinct possibility. These and other situations arising from the drought highlighted the need for some specific legislative changes.

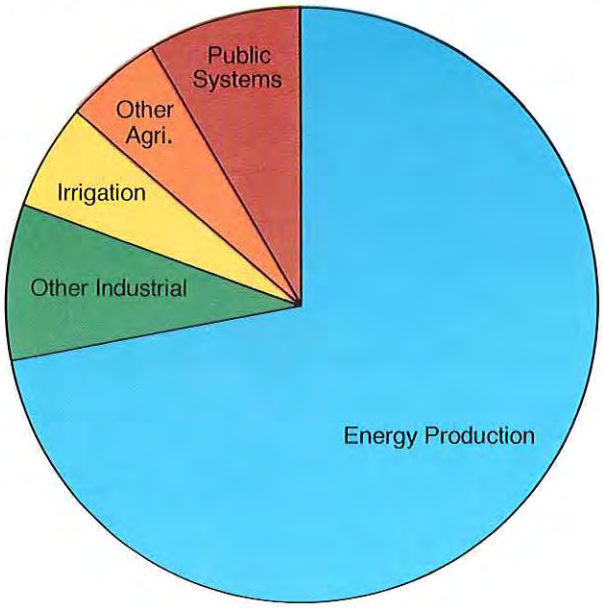
Prior to the 1977 drought, the Iowa Natural Resources Council had never been forced to take anyone to court for unauthorized water use. During 1977, the Council had four court cases for unauthorized water use for irrigation. In all instances, the irrigator had been warned repeatedly not to pump without a permit or they would be prosecuted. However, the $100 fine was no deterrent to the violator. Some said it was worth $100 to save their crop. The maximum fine levied to date upon conviction of this offense was $49.50 per offense. It is felt that a civil penalty of $1,000 would be a more effective deterrent, and that a conviction for unauthorized water use should preclude the violator from obtaining a valid permit for at least five years.

The 1957 water law exempted an estimated 3,000 industries and 500 communities from the water permit system. This means the Council has no exact figures on just how much water is being used by these individual users. It is extremely difficult to set up a reasonable allocation system for an aquifer or other water source with such a major component missing. Adequate data is an absolute necessity. The Council feels that all of these uses should be brought under the water permit system. Rather than go directly into the standard permit system, it is recommended that a 5-year registration approach, similar to that used on the border rivers irrigation permit under HF 277, (67th General Assembly), be initiated. During this 5-year period, water use reports would be required just as they are from regular permittees. At the end of 5 years, all of these exempted uses would fall under standard permit procedures.

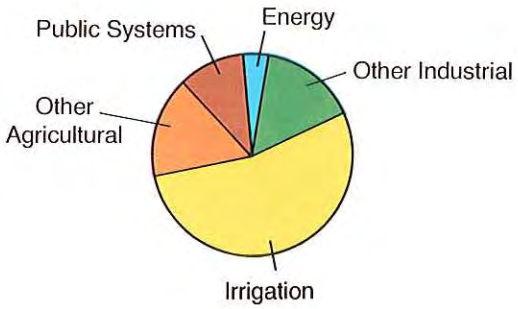
Irrigating crops near Missouri Valley

Soil Conservation Service

FIGURE 5-1 Water Withdrawals and Consumption by Use Categories, 1975

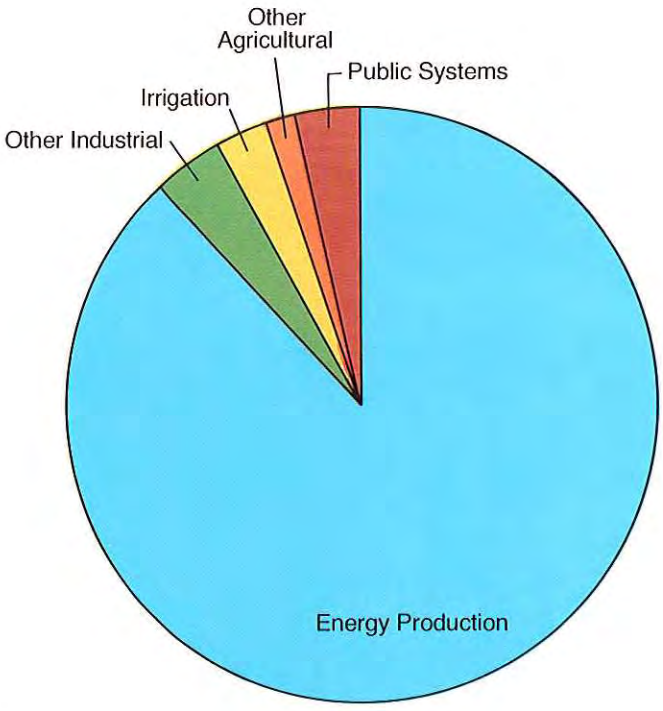


WATER WITHDRAWALS 1975
(3,678 mgd)

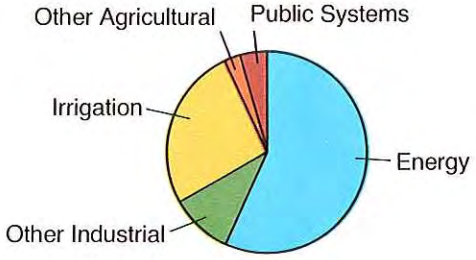


COMSUMPTIVE USE 1975
(393 mgd)

FIGURE 5-2 Estimated Water Withdrawals and Consumptive Use, 2020



ESTIMATED WATER WITHDRAWALS 2020
(27,531 mgd)



ESTIMATED CONSUMPTIVE USE 2020
(2,886 mgd)

A great deal of public water system problems arising in the 1977 drought could have been avoided if adequate long-range planning had been initiated. Unfortunately, after the crisis period is over, the potential for another severe drought in 20 years is soon forgotten. Public water utilities must program for the possibility of disaster or the consequences could be grave. One of the requirements for a withdrawal permit on any public water system should be a fully developed disaster contingency plan for alternative sources, conservation practices, rationing procedures, etc. Legislation should be adopted requiring this procedure.

Research and Data Needs

Adequate stream flow and aquifer capacity data are essential in any water allocation scheme. Unfortunately, Iowa has numerous voids in its hydrologic data base. Data acquisition historically has been a low priority funding item. The increasing pressure for greater withdrawal from the ground and surface water makes it imperative that data systems be maintained and improved.

In the area of stream flow data, rising costs with no increased appropriations have caused several U.S. Geological Survey stream and lake gages to be abandoned. These gages are critical to the practical regulation of low flows by the Water Commissioner's office. There is only one lake level gage operating in the state and it is supported by local government. The state must support the stream and lake gaging program with increased funding and pressure the federal government to do the same for this 50-50 cost-sharing USGS program.

Another data area which is essential to good water resource management and allocation is that of groundwater availability and yield capacity. Again, this field of research and data collection has carried a very low funding priority in the past. Because of this lack of emphasis, there are many uncertainties as to the capabilities of most of our major state aquifers to withstand varying rates of withdrawal. Of particular importance is the aquisition of data on the Dakota aquifer. The State of Iowa must accelerate its groundwater research if we are to allocate water in a nondetrimental manner.

Conclusions and Recommendations

Groundwater Allocation and Use Priorities

Conclusions

The increasing competition for groundwater for the major use categories, coupled with the limited capability of most aquifer systems, makes establishment of user priorities imperative. It has been suggested that use priorities be established statewide. Since each aquifer varies in the amount of sustained yield available, a statewide use priority system would not be practical. An aquifer-by-aquifer designation and regional surface water limitations by basin or sub-basin, is a better solution.

Recommendation

The INRC should continue the policy they initiated in 1977 on the Dakota and Jordan aquifer systems after public hearings, to establish through the rule-making procedure, use priorities, and allocation criteria on the Mississippian, Silurian, alluvial, and buried channel aquifers. Appropriate application of use priorities and allocation criteria to the surface stream systems on regional, conservancy district, or sub-basin basis, would be a second phase.

Low water level at Lake Binder, Corning, 1956 *Des Moines Register and Tribune*

Water for Power Generation and Other Major Withdrawal Uses

Conclusions

Power generation and other major industrial processes circulate vast quantities of water through cooling towers with substantial consumption of that water through evaporation. Approximately 85 percent of municipal water supply systems utilize groundwater sources. Some of these aquifers, such as the Jordan and Dakota, achieve very limited recharge locally and are susceptible to collapsing under heavy withdrawal pressure. Therefore, they could be lost to any future use. Most of the other aquifers, though recharged locally, do not have the capability of sustaining massive withdrawals. Stream flows on the major interior streams during low flow periods are simply not sufficient to sustain major consumptive withdrawals without endangering other uses and the environmental integrity of the stream.

Irrigation and large rural water districts are also major consumptive users of water and often compete with municipal and other domestic uses for limited water sources.

Recommendation

No increases in power or other comparably heavy industrial use can be allowed to withdraw groundwater in Iowa other than from the alluvial aquifers along border streams, and there only after careful evaluation has been made of the impacts on the available supplies. Any surface withdrawals for these uses on the interior streams of Iowa must be predicated on providing adequate storage.

In setting priorities for groundwater use from interior aquifers, irrigation and industrial uses must carry a lower priority than municipal, rural water districts, and domestic uses. There should be additional state agency coordination for industrial site selection to assure that plant siting, water needs, and water availability are meshed together. The state should encourage power interests to locate major generation facilities on the border streams, or consider interior storage along with cooling tower units.

Natural Lakes

Conclusions

Iowa has 67 natural lakes ranging from Spirit Lake, with a surface area of 5,684 acres, to Whitfield Lake, with a surface area of less than 10 acres. These lakes have a unique fragile ecological character and are extremely popular for water-based recreational pursuits. Most natural lakes are located in the north central part of the state. Substantial withdrawals could seriously damage the ecological viability and recreational capability of these lakes. Currently, there are major municipal and other use withdrawals on some of these lakes and there is continuing pressure for more allocation of water from these sources.

Recommendation

Iowa's natural lakes must be protected. No new allocations of water from these lakes should be allowed and current users should not be allowed to make any substantial increases in the current withdrawal rate. Therefore, the INRC, by the rule making procedure, should prohibit any new withdrawals from these lakes and deny any requests for substantial, increased withdrawals from current users.

Municipal water supply, Fort Dodge
City of Fort Dodge

Disaster Contingency Plans

Conclusions

During the 1977 drought, several communities experienced severe water supply problems. At times, some communities approached the crisis stage in their efforts to provide adequate water to their constituents. Although droughts follow a fairly predictable cycle, and these communities had experienced similar problems in the past, they were totally unprepared for the emergency. An adequate evaluation of source potential and disaster contingency plans would have considerably lessened the hardships experienced. Unfortunately, when the emergency is over, many communities will quickly forget the problem and no thought will be given to the next drought or other water supply emergencies until they happen again.

Recommendation

All municipalities and rural water districts should be required to furnish proof that they are developing a water supply disaster contingency plan prior to being granted a water withdrawal permit by the INRC. Both normal conservation practices and emergency rationing plans should be included.

Legislation: Exempted Use

Conclusions

The water rights law (455A.25) exempted all beneficial uses within corporate limits that had been initiated prior to May 16, 1957, from the permit process unless it could be demonstrated that there had been an increase in withdrawal of over 100,000 gallons per day or 3 percent, whichever was greater. It is estimated that over 3,000 industries and 500 communities fall under this exemption. This presents problems in determining the total water withdrawals from a particular source of water. All permitted withdrawals require annual pumpage reports. Exempted uses are not required to provide this information. To properly allocate water from each system, this data is essential.

Recommendation

Chapter 455A should be amended to eliminate the current exemptions. It is recommended that legislation be

enacted providing a 5-year registration system similar to the irrigation processing of House File 277 (1977). All the currently exempted uses would then be required to report pumpage. After the 5-year grace period, these uses would fall under normal permit procedures.

Legislation: Penalty Provisions

Conclusions

During the 1977 drought period there were four cases sent to prosecution by the INRC where individuals, despite repeated warnings by the Water Commissioner's Office, defied the law and withdrew water for irrigation without a permit. Their logic was simple: a $100 fine for illegal withdrawal was not a deterrent when they were threatened with loss of a crop. The current penalty requirements are simply not sufficient to deter a serious water user from making withdrawals illegally.

Recommendation

Legislation should be enacted providing for a penalty of one thousand dollars ($1000) per each offense on willful violation of the water law. In addition, the legislation should have provisions for denying the offender a water withdrawal permit for a 5-year period.

Groundwater Supplies

Conclusions

With rare exceptions, the Northwest, Southwest, and South Central sections of the state have insufficient amounts of quality groundwater and stream flow to sustain any major increase in water use demand. In most cases, supplies for current use are extremely marginal. The only viable solution that allows any degree of economic or demographic expansion in these regions is reservoir construction or Missouri River Basin diversion. Urban growth in central Iowa also is placing a heavy demand on low flows in the streams and from limited groundwater resources. Prime reservoir sites are constantly being lost to various types of land utilization and development.

Recommendation

The state should be empowered and funded to develop a program for identification and preservation of prime major reservoir sites, particularly in the water short areas in the Northwest, Southwest, and South Central regions of the state.

The INRC must continue to be firm in requiring storage on any major development in these regions. These regions must carry first priority on any multipurpose reservoir development.

Research Needs

Conclusions

The Dakota and Jordan aquifers are of extreme importance in meeting the water supply uses of a vast majority of municipalities in Iowa. Information is lacking to provide adequate withdrawal management decisions on these aquifers. Funding for data acquisition on these aquifers has been woefully inadequate in the past.

Recommendation

Priority should be given to adequate funding of data acquisition programs on the Dakota and Jordan aquifers. These should be followed by data programs on the other bedrock aquifer systems, and detailed studies of selected alluvial and buried channel aquifers in water-short regions of the state.

Conclusion

The stream and lake gaging systems, which are essential to the surface water management program of the INRC, are continuing to lose critical gages due to the increasing federal costs of maintaining them. Iowa's current allocation for state matching funds for these projects is not sufficient to keep the current network intact, let alone reestablish several critical gages which have been lost to increasing operation costs.

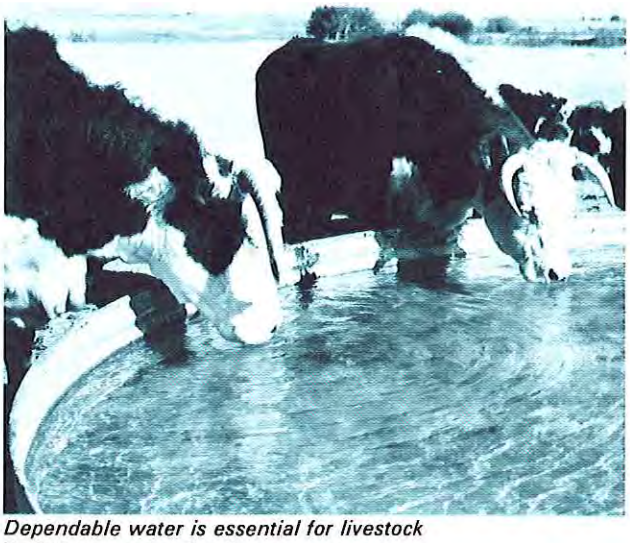
Recommendation

Iowa must provide increased funding to maintain the current level of stream and lake gaging systems and also reestablish critical gages already discontinued. The state should also put pressure on the Federal Government to provide adequate funding to the USGS to keep the federal share equal to the state's willingness to invest in these critical gages.

Federal Reservoirs

Conclusions

There are four major Corps of Engineers' reservoirs in Iowa. Although they all have considerable water supply storage capability, only Rathbun Reservoir has any storage provided specifically for that purpose. Saylorville, Red Rock, and Coralville Reservoirs were justified primarily on Mississippi River flood control benefits, most of which water is downstream of Iowa. Storage for water supply must be paid for; flood control storage is free. It seems totally illogical to almost completely subsidize unwise land use practices such as flood plain occupancy and then charge the full cost of storage for water supply. Surface water availability is limited in the general vicinities of these reservoirs, especially during the summer low flow period. Additional water supply storage would be advantageous, not only to municipal and domestic uses, but also for power generation and industrial development.



Dependable water is essential for livestock
Soil Conservation Service

Recommendation

The State of Iowa should establish a goal to achieve optimum development of water supply capability in all federal reservoirs. The state should encourage and insist that the Federal Government give water supply storage an equal status to flood control, recreational development, and other beneficial uses, with a corresponding cost allocation equalization.

Interstate Groundwater Management

Conclusions

Most major deep aquifers, such as the Dakota and Jordan sandstone aquifers, are not located solely in one state, and groundwater management programs vary from state to state. Iowa is deeply concerned about wise use and restriction of mining of its deep aquifers. Some other states are actually encouraging intensive use on the same aquifers, which could have serious consequences on Iowa's portion of these deep aquifers. Although we have Title II Basin Commissions (Upper Mississippi and Missouri) to coordinate management of major surface water systems, there is no current effective coordination mechanism for management of interstate aquifer systems. Such a mechanism is sorely needed.

Recommendation

Iowa should assist in establishing an interstate coordination mechanism for management of major interstate groundwater systems. This could be accomplished by either a compact commission or under aegis of the current Title II Missouri and Upper Mississippi River Basin Commissions. It is imperative that such action be initiated promptly, particularly for the Jordan aquifer.

Interstate Surface Water Management

Conclusions

The border streams of Iowa provide massive amounts of water for all uses and currently, water quantities are more than sufficient for our state's needs. However, there have been a number of proposals for massive diversions by states upstream of Iowa, primarily on the Missouri River. A great deal of this diversion is for irrigation which causes not only a consumptive use problem, but also an irrigation return flow quality problem.

Recommendation

The State of Iowa must adamantly defend its right to a reasonable portion of the flow of the border rivers. Any major diversions upstream of Iowa must be carefully evaluated to assure our just share of these critical flows.

Missouri River Degradation

Conclusion

The U.S. Army Corps of Engineers Missouri River Stabilization and Navigation project has given rise to a serious channel degradation problem in northwest Iowa. The bottom of the channel has dropped approximately seven feet at Sioux City. This not only causes serious problems on the main channel but has also created severe problems on major tributaries such as the Floyd, Little Sioux River, etc. In addition, there is a potentially serious problem of a major alluvial groundwater level subsidence on the mainstem and tributaries. So far, no major effort has been initiated to remedy the situation other than long-range perennial studies.

Recommendation

The State of Iowa must insist on immediate action by the Federal Government to remedy the current situation. It should be made quite plain that Iowa does not want to prolong the study of the problem for several years. Remedial action must be underway within a two-year period.

Irrigating crops with center pivot equipment *Valmont Industries*

Mississippi River flood at Sabula, 1965

Iowa Natural Resources Council

Rural flooding, Mississippi River, 1965

Iowa Natural Resources Council

6 Flood Plain Management

The concept of flood plain management is based on the public policy that seeks the minimization of flood water damages. Some of Iowa's flood plains, which comprise about 8 percent of the total area of the state or about 2.7 million acres, are presently occupied by uses much more intensive than agriculture or open-space uses—industrial, commercial, transportation, and residential uses. These latter uses are not compatible with the goal of reducing flood damages. Recognizing that continued use for agricultural crop production (pasture, hay, and row crops) may be economically justified, the other uses more compatible with the goal of reducing flood damages are open spaces, woodlands, wildlife habitat, recreation, and sand and gravel quarry operations. Floods constitute an immeasurable threat to human life, particularly from flash floods occurring in small area watersheds. These problems make it imperative that Iowa continue to strengthen its flood plain management program.

Resource Overview

The Code of Iowa defines a flood plain as "the area adjoining the river or stream which has been or may be hereafter covered by flood water." In many valleys with steep side slopes, the flood plain may extend from bluff to bluff.

Flood plains, found in every county of the state, are located along more than 6,000 miles of interior streams, and over 600 miles of border streams.

Flood Damages in Iowa

Iowa incurs an average of over $43 million in flood damages each year. Table 6-1 shows the breakdown of average annual flood damages by hydrologic subarea. The Iowa-Cedar subarea suffers 35 percent of all total state damages and 36 percent of all non-agricultural damages. The Western Iowa subarea incurs 18 percent of the total damages and 24 percent of the non-agricultural damages.

Combined, these two areas sustain well over half the total non-agricultural damages in the state. Based strictly on the subarea percentages, they should carry a high priority in flood plain management programming.

Table 6-2 indicates cities in Iowa currently sustaining average annual damages of over $500,000. West Des Moines, Davenport, and Marengo have structural projects proposed which should greatly reduce their annual damage rate, and construction is underway on a part of Sioux City's structural works that will give partial protection. Clinton and Waterloo, both of which exceed over $1 million a year in average annual damages, were not included in the table because structural protection works are currently under construction that will substantially eliminate current flood damages.

Realistically, Iowa, with the completion of those projects under construction and currently proposed, has expended all its viable structural alternatives to flood damage reduction from major river flooding in its larger urban areas. Non-structural alternatives will be needed to substantially reduce flood damages in the future, particularly in flash-flood areas along smaller tributary streams.

The information presented in this chapter is based on the comprehensive "Task Force Report on Flood Plain Management," prepared by and filed with the Iowa Natural Resource Council.

Resource Considerations and Problems

Flood Plain Management in Iowa

There are flood plain management programs at both the federal and state levels. Federal efforts include: (1) the U.S. Department of Agriculture's watershed program for soil and water conservation and flood prevention, (2) the Corps of Engineer's flood control projects and other flood-related programs, (3) the U.S. Geological Survey's stream data collection program, (4) the National Flood Insurance Program administered by the Federal Insurance Administration, and (5) the disaster assistance program of the Federal Disaster Assistance Administration.

The state flood plain management program has been carried out primarily by the Iowa Natural Resources Council. The Council reviews proposals relating to flood control and water resources development by federal agencies. This includes coordination of flood plain information studies, usually conducted by the U.S. Army Corps of Engineers and flood insurance programs of the Federal Insurance Administration. The Council is also charged with flood plain regulation as it relates to any development and construction in the flood plain. All construction projects in flood plains are reviewed by the staff and the Council and must meet its criteria.

The Council currently regulates any construction, excavation, etc., in the 100-year flood plain. (See Figure 6-1) and prohibits any construction in the 100-year floodway (that area needed to convey the floodwater at a 100-year flood discharge). Almost all state or federal government flood plain management programs rely on this 100-year flood criterion which basically means that, statistically, in any given year there is a one percent chance of exceeding a flow of that magnitude.

Unfortunately, while the 100-year flood statistic gives the public a sense of security, nature does not always follow probability curves. Iowa is sufficiently large in size compared to the area covered by severe local

thunderstorm activity, that almost every year some area of the state experiences a flood having a 200-year to 500-year frequency. Rainfalls of up to 12 inches in 6 hours or less, and 16 inches in 24 hours, have caused most of these floods. This is the real concern in evaluating the flash flood potential and hazard to human activities in the many small tributaries in urban areas.

The Council participates in flood plain management by providing assistance to local communities in developing local flood plain regulations and ordinances that are acceptable to the INRC. Implementing adequate flood plain management regulations by communities is a condition for eligibility for admittance into the federal flood insurance program. The INRC supports this program as an incentive for developing good flood plain management within cities and counties.

Several other state agencies have flood plain management or data gathering responsibilities. The Iowa Department of Soil Conservation works with the U.S. Soil Conservation Service in administering the watershed program. The Iowa Geological Survey and the U.S. Geological Survey are responsible for the collection and dissemination of basic water resources data including information relating to floods and flood plains. The Iowa Conservation Commission has jurisdiction over the bed and banks of meandered streams and administers statutes and programs relating to the state waters, forests, preserves, and stream access areas under its jurisdiction.

Flood Damage Reduction Alternatives

There are two major approaches to reduction of flood damages, namely structural and nonstructural methods.

Structural methods include reservoirs, channel modifications, levees, and floodwalls, etc. Over the past 50 years, the federal government has spent over $1.5 billion nationally to reduce flood damages, but damages are still increasing rather than decreasing.

Current damages exceed over a half a billion dollars a year and are projected to exceed $1 billion by the turn of the century unless stringent flood plain zoning and regulation are employed. In too many situations, structural projects have instilled a sense of false security within the public and actually intensified flood plain occupancy with resultant increased flood damages.

The nonstructural approach utilizes techniques such as land use planning, zoning and regulation, and flood plain acquisition. Flood plain occupancy for any uses other than recreation, fish and wildlife habitat, or agricultural purposes is the poorest form of land use. With only eight percent of the total state land in the flood plain, it is both ridiculous and unwise to allow any new major development in those areas.

If proper land management techniques were employed, there would be few flood damage problems. Unfortunately, in the past, major flood plain development occurred in our large urban centers. It would be extremely difficult and costly to evacuate the flood plain in those areas, but the use of a viable flood plain management program could preclude any future development in the flood plain with its resultant potential loss of life and property.

Structural Problems

Channel Modification

Very few of Iowa's flood plain lands or streams have been left in a natural state. Channelization alone has affected about half of the state's stream miles. The reason for a majority of the channel changes is to gain more cropland and to increase efficiency in farming. Meandering streams often take up much of a farmer's potentially tillable land in the flood plain, or prevent him from planting an area in straight rows.

There are many problems which result from changing the natural meander of a river, including flooding upstream if pilot cutoff channels are utilized, channel degradation and flooding downstream from the accelerated flow if effective channel capacity is provided, and the loss of the storage capacity of the meander bends.

The effect of channelization on the fish and wildlife habitat of the stream is devastating. The most obvious impact is the actual elimination of natural habitat caused by reducing the stream's length. The gradient and speed of the straightened stream increases, scouring the waterbed and increasing the movement of streambed material. This eliminates the diversity needed for fish

TABLE 6-1 Average Annual Flood Damages in Iowa

River Basin	(1000 Acres)	Total Annual Damage Per Acre ($)	Average Annual Flood Damages[1] ($1000)		
			Crop & Pasture	Other[2]	Total
Western Iowa	1,120	6.88	2,700	5,000	7,700
Southern Iowa	610	8.69	4,300	1,000	5,300
Des Moines	640	8.28	3,000	2,300	5,300
Skunk	330	12.42	2,500	1,600	4,100
Iowa-Cedar	740	19.73	6,500	8,100	14,600
Northeast Iowa	350	17.43	2,300	3,800	6,100
TOTAL	**3,790**	**11.37**	**21,300**	**21,800**	**43,100**

[1]Estimated 1977 price level by INRC.

[2]Includes other agricultural land, urban, transportation, and indirect floodwater damages.

Sources: Missouri River Comprehensive Framework Study and Upper Mississippi River Comprehensive Basin Study (Updated to 1977 prices).

TABLE 6-2 Average Annual Damages for Major Flood Prone Cities in Iowa in Excess of $500,000 by River Basins*

River Basin	
Western Iowa	
Council Bluffs	$1,590,000
Sioux City	2,780,000
Southern Iowa	
None	
Des Moines	
Des Moines	570,000
West Des Moines	910,000
Skunk	
None	
Iowa-Cedar	
Cedar Rapids	2,560,000
Iowa City	500,000
Marengo	1,610,000
Northeast	
Davenport	990,000
Bettendorf	690,000

*Estimated 1977 price level by INRC.

habitat and destroys many of the aquatic organisms on which the fish feed.

At any rate, most channel alterations made in Iowa do not provide a high degree of flood protection, but rather are designed to reclaim flood plain lands and improve local drainage for farming.

The stringent new rules adopted by the Council in May, and effective in July, 1978, will help alleviate major channel modification problems in Iowa.

Dam Regulation

Several recent major dam disasters in the United States have accentuated the need for a substantial nationwide dam inspection and regulation program.

In Iowa, the dam regulation authority has been assigned to the Iowa Natural Resources Council. Since 1957, all structures impounding over 18 acre-feet of permanent storage, having a total storage of more than 25 acre-feet, or having a drainage area of 5,000 acres or more have required approval. In urban areas, any water-retention structure over 6 feet in height requires Council approval under Chapter 455A. Under Chapter 469, milldams are also regulated by the Council.

In January, 1978, the U.S. Army Corps of Engineers initiated a cooperative dam safety inspection program with the Council on the 27 structures in the state that have the highest damage potential. The program also included verification and updating of the statewide inventory of all major dams.

Although the Council has reviewed the design of all dams constructed after 1957, there is a considerable number of prestatutory structures upon which engineering analysis has not been performed.

Currently, the only recourse in enforcing proper maintenance and construction on prestatutory structures is to demonstrate public nuisance (major danger to life and property). Preventative maintenance is precluded on structures, other than milldams covered by Chapter 469.

There is a dire need to totally rewrite the statute concerning dam construction and safety. Not only is clarification needed of abatement procedures on high-hazard structures, but statutory provisions for required preventative maintenance also is necessary.

A major rewriting of all dam safety statutes should be a priority item in the next General Assembly. Logically, provisions in Chapter 455A and 469 should be incorporated into a new single section of 455A.

Levees

The use of levees to protect flood plain lands from flood flows is an ancient technique which is quite common today. However, levees frequently create obstructions to the passage of flood flows, diverting flows and increasing flood depths to the point where additional flood damages are incurred on other flood plain lands. The uncontrolled proliferation of levees, especially agricultural levees, can increase, rather than lessen, flooding and damages.

All flood plain construction projects must be reviewed and approved by the Iowa Natural Resources Council prior to construction. This regulation includes

Stream meandering in straightened channel
Iowa Geological Survey

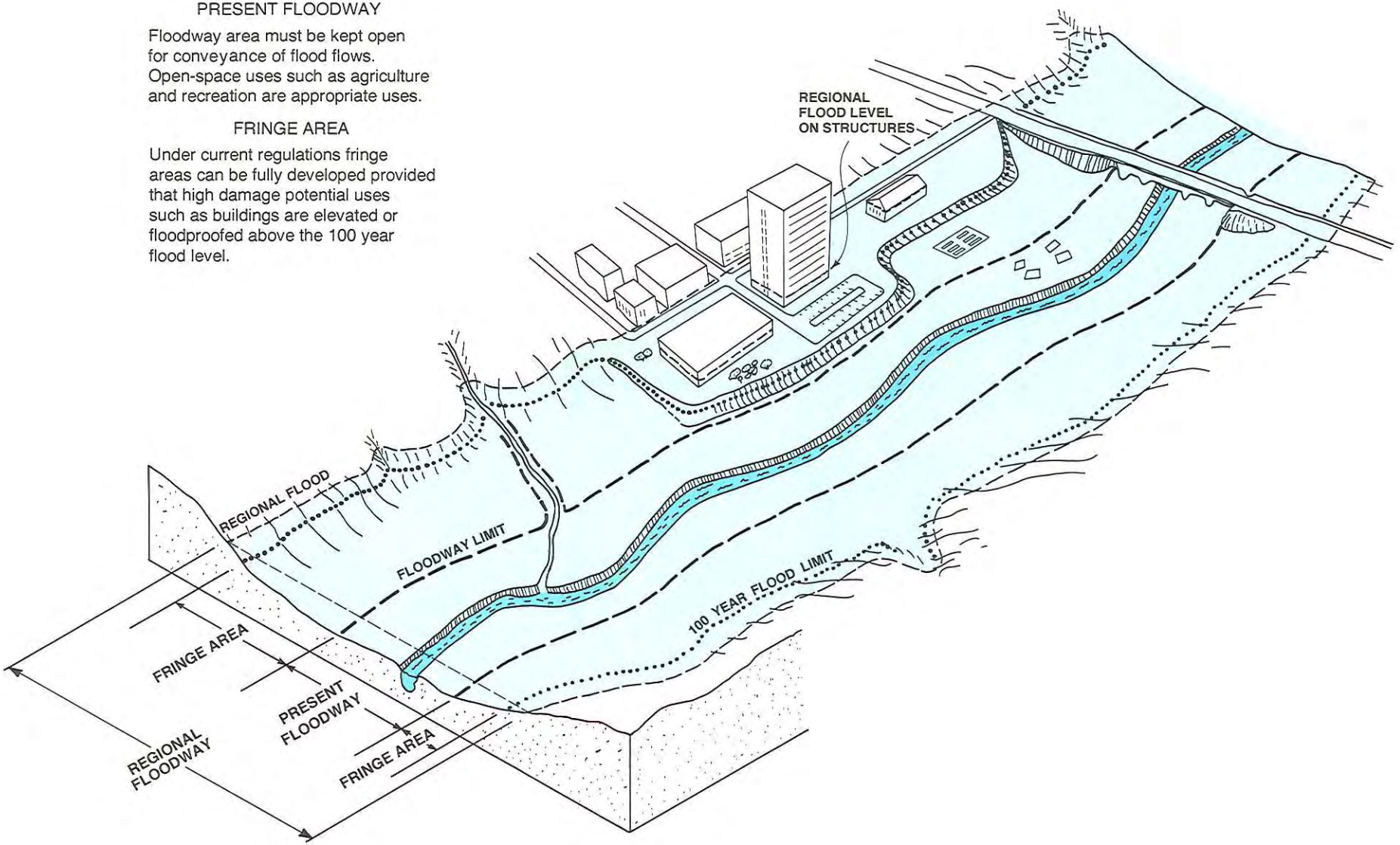
FIGURE 6-1 Floodway, Floodway Fringe, and Regional Flood Concept

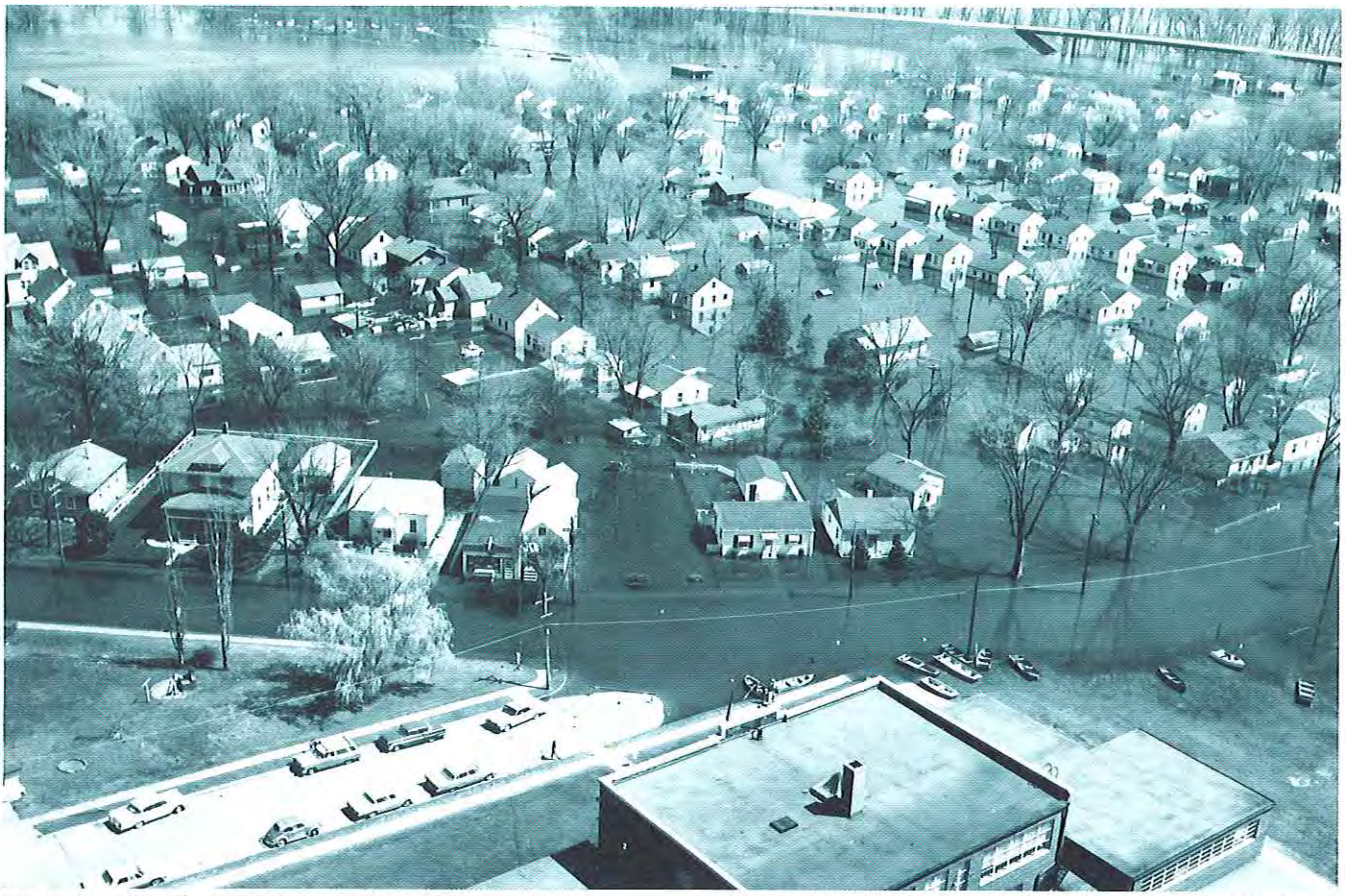
PRESENT FLOODWAY

Floodway area must be kept open for conveyance of flood flows. Open-space uses such as agriculture and recreation are appropriate uses.

FRINGE AREA

Under current regulations fringe areas can be fully developed provided that high damage potential uses such as buildings are elevated or floodproofed above the 100 year flood level.





Mississippi River flood at Davenport, May, 1965 *Corps of Engineers*

levees, floodwalls, and similar or related structures for the protection of flood plain lands from flooding. By following the levee design guidelines established by the Council, individual levee projects should fit together to form a uniform system and not cause undue additional flood damage on other properties.

The rapid growth in numbers of agricultural levees has caused problems in coordination among levees in a common reach of a river. A comprehensive study to identify the nature and extent of agricultural levees in Iowa would provide the information needed to develop an orderly approach to controlling flood plain lands by levees, and determine their effects on the rights of other landowners.

One problem area currently of concern to the Council is the Skunk River basin. A pilot study on the South Skunk River which provides information of this sort could help the INRC evaluate the costs, benefits, and public acceptance of the studies, and determine whether studies should be expanded to other Iowa streams.

Management Problems

Stormwater Detention

Construction projects in municipalities aggravate flood problems by covering land with impervious materials, increasing stormwater runoff. Some cities are developing or have adopted stormwater detention ordinances that require a developer or landowner to develop stormwater detention basins or systems that will ensure that runoff after construction is no greater than before construction. This detention system can consist of ponding areas in parking lots, effective grading, and seeding within the development. Cities should be required to adopt such ordinances to help reduce flood impact on others by new developments, and to control floodwaters in large storms. The INRC should develop model ordinances and perform basic engineering for a uniform statewide approach to stormwater detention.

Identification of Flood Plain Property

Numerous individuals have purchased property that is subject to flooding without being aware of the problem. There is no requirement to "tag" a piece of property located on a flood plain as being "flood prone". Only after a sad flood experience do the owners realize the folly of their purchase.

A solution to this would be to tag the contract of sale, and all instruments for conveying flood plain property, with notice that the property is in the flood plain and may be subject to flooding.

Authorization of Construction

One nonstructural approach to flood plain management is the currently legislated regulation of construction in the flood plain by the INRC. This control is hampered by inadequate enforcement mechanisms. Even when a flood plain violation is successfully prosecuted, Chapter 455A provides for a maximum fine of $100 for unauthorized construction. This doesn't provide much of an incentive for compliance. Raising the fine for unauthorized construction to $1,000 may provide this incentive.

Another approach to restricting development in the flood plains could be to make building contractors, as well as landowners, liable for construction in the flood plain. This could curtail construction projects, as contractors would not want to be liable for building a nonconforming structure in the flood plain.

House File 2212, passed in the 67th General Assembly, originally contained provisions for a $1,000 civil penalty for water rights and flood plain violations, along with contractor liability for unauthorized construction in the flood plain. Unfortunately, these provisions were deleted in final passage. Such legislation is imperative to the effective operation of the Flood Plain Regulation Program.

Flood Plain Information Studies

Part of the problem in determining proper management for Iowa's flood plains is the lack of information about each river basin and about the economic, social, and environmental impact of flooding on the urban area. Before effective flood plain planning and management can be undertaken, comprehensive flood plain information studies must be completed.

The traditional flood plain information studies identify Iowa's flood hazards by computing flood levels along streams, and have not attempted to collect other information that cities and counties must consider in making flood plain land use decisions. Expanded flood plain information studies would identify existing land use, wildlife, social, economic, and environmental conditions of the entire basin, providing cities with a data base for analyzing the impact of development and changing uses in the basin. These studies are needed most in basins with large urban areas where there is significant potential for development or change. Section 206 of Public Law 86-645, Flood Control Act of 1960, authorizes the U.S. Army Corps of Engineers to initiate these expanded flood studies. Two such studies are presently in progress in the state, and more emphasis should be placed in this area. A definite time schedule and priority listing should be key elements of a positive flood information program.

Land Acquisition

Another alternative available in flood plain management is the acquisition of flood plain lands by some unit of government—local, county, state, or federal. Such purchases make possible the prohibition of uses that are not compatible with the flood plain environs.

Since 1966, an excess of $7.7 million has been spent by the U.S. Bureau of Outdoor Recreation for the acquisition of some 46,000 acres in Iowa through their Recreation Land and Water Conservation Fund. In the past five years, the State Conservation Commission has acquired some 10,000 acres of open space land through its Open Space Acquisition Program. In both cases, substantial amounts of flood plain land were acquired, primarily in rural areas.

A flood plain land acquisition program could be an alternative to the construction of reservoirs, levees, etc. Additional federal and state funds could be allocated to accelerate such acquisition programs.

Urban flood plains might be acquired in redevelopment phases. Redevelopment and renewal programs are available through the U.S. Department of Housing and Urban Development (HUD) grants; in addition, permanent evacuation of flood plains can be achieved through HUD programs and certain authorities of the U.S. Army Corps of Engineers.

An alternative to actual acquisition would be to provide owners of flood plain lands with certain tax incentives for use of their land for woodland or open space areas, or for continuing selected agricultural uses in urban areas. These incentives could include revocation of part or all of the tax assessment or a greatly reduced land valuation procedure.

Flood Warning System

Where construction has placed life and property in

TABLE 6-3 Iowa Communities of over 25,000 population with High Potential for Flash Flooding

City	Streams	Included in Iowa Flash Flood Warning Network
Ames	Squaw Creek and Skunk River	Yes
Cedar Rapids	Prairie, Indian, and Dry Creeks	Yes
Council Bluffs	Indian and Mosquito Creeks	No
Davenport	Duck and Goose Creeks	No
Des Moines	4-Mile and Walnut Creeks	Yes
Fort Dodge	Lizard and Soldier Creeks	Yes
Iowa City	Ralston Creek	No
Marshalltown	Anson Creek and Iowa River	Yes
Mason City	Willow Creek and Winnebago River	Yes
Ottumwa	Jefferson Park Watershed	No
Sioux City	Perry Creek	No
Waterloo-Cedar Falls	Black Hawk and Dry Run Creeks	Yes

Streambank erosion on Soldier River, Monona County, 1950 *Soil Conservation Service*

the flood plain, and where there is inadequate structural protection, the final management recourse is provision of flood warning systems. These systems must continue thereafter unless and until a less intensive use is achieved.

At present, nine areas in Iowa participate in a Flash Flood Warning Network operated by the U.S. Weather Service, and many areas which have severe flooding potentials have no such protection. The warning system, coupled with extensive flood monitoring, should be expanded to cover all major flood prone urban areas of the state, and to non-urban areas where floods threaten life and property. Table 6-3 lists those urban areas with populations in excess of 25,000 that have a recognized high potential for flash flooding.

Conclusions and Recommendations

Flood Plain Occupancy

Conclusion

Flood plain occupancy for purposes other than agriculture, woodlands, open space, recreation, and fish and wildlife habitat is extremely poor land use. Experience has shown that loss of life and property far overshadows the benefits of the profit incentive. Only eight percent of the total land area in the state is in the flood plain, but there is an inordinate amount of pressure toward development for other than the aforementioned best uses. Any use more intensive than those listed above must be prohibited. The 100-year flood criterion currently utilized by the INRC and the federal government remains inadequate as a standard for the long-range protection of life and property.

Recommendations

Legislation must be drafted banning any new development in the INRC regional flood plain for residential, commercial, and industrial uses. The regional flood plain is the area that would be inundated by the INRC regional flood, defined as a large flood representative of floods which have been observed on streams and rivers located in Iowa, excluding extremely rare events. Such a flood would exceed the 100-year flood in magnitude.

Legislation should be drafted requiring the formal notification of any prospective buyer of existing flood

Flash flood damage at Audubon, July, 1958
Soil Conservation Service

Big Sioux River flood at Akron, April, 1969
Corps of Engineers

Sandbag reinforcement for levee, Clinton, 1965
Corps of Engineers

plain development that said property is in the flood plain and is subject to flooding. Such legislation should place liability squarely on the seller and realtor for any damages incurred from sale of flood plain property without formal notification of the buyer.

Legislation should be adopted giving tax incentives to owners of INRC regional flood plain properties for maintaining those properties in their natural state (open space, wildlife habitat, woodlands, etc.).

Flood Control Structures: Interior Streams

Conclusion

For 50 years, the country has been attempting to reduce flood damages by structural measures. Such measures have been sorely inadequate in reducing flood damages. In fact, annual flood damages from improper development of flood plains are increasing each year, despite the expenditures for flood protection. Much of this damage is encouraged by a false sense of security incurred from these structural measures since they actually encourage unwise use of flood plain areas. Flood plain zoning and flood plain acquisition are alternative solutions to reduction of flood damages in areas already developed, or almost so. In new areas, just urbanizing, they are far better solutions than structural measures. Managing a community's or county's flood plain and stream networks should be as equally important as the maintenance of its transportation, water, and sewage systems.

Recommendations

The State of Iowa should initiate a policy that structural methods of flood control should be undertaken only after nonstructural methods (zoning, acquisition, etc.) have been demonstrated as unfeasible or impractical solutions to flood damage reduction.

The state should only condone structural flood control measures if rigid mandatory local flood plain zoning is assured on the project.

All counties and major urban areas should be required by legislation to adopt strict flood plain zoning and subsequent enforcement, subject to approval by the INRC.

Flood Control Structures: Border Rivers

Conclusions

In the past, the U.S. Army Corps of Engineers has had a tendency to construct projects in a piecemeal manner, particularly on the Mississippi and Missouri Rivers; thus, they provide varying degrees of protection from project to project without taking into consideration the entire flood flow regime of the river. Increased flood stages, increased velocity of flow, and increased damages at points not protected from flooding, as well as environmental and water quality considerations should be addressed. In some areas, 50-year protecton is provided; in other areas they are protected to the 200-year level. Any structural solution must be weighed against its effect on the total river flood flow regime.

Recommendation

The State of Iowa must insist that any major federal structural flood control project must be viewed in its total effect on flood flow alteration throughout the entire river basin. Our major streams must be studied in total as to effects of any structural flood control measures. The state

should require that the border rivers in particular be studied and proper flood flow modeling developed to ascertain adverse effects from individual structural projects. Iowa connot tolerate the current federal practice of piecemealing structural projects.

Fish and Wildlife Habitat

Conclusion

Recreation, fish and wildlife habitat preservation, and related open space uses, are the best land uses for many flood plain areas. Most of the remaining timber and wildlife habitat is found in the river valleys and their flood plains. These resources are constantly being diminished; therefore, acquisition of flood plains for their protection and preservation is critical.

Recommendation

The Iowa Conservation Commission should place acquisition of flood plain lands as the number one priority in its Heritage, Conservation, and Recreation Service land acquisition program. An alternative is to create a floodway acquisition program as an additional responsibility for the INRC.

Acquisition of flood plain lands should be weighed as a viable alternative to any structural flood damage reduction measure.

Urban Flood Problems

Conclusion

Urban flooding problems are aggravated by increased runoff from new developments resulting from covering of large land areas with impervious surfaces. As more and more shopping centers, apartment house complexes, parking lots, streets and highways, etc. are being developed yearly, the problem is intensifying. A stormwater management program in major urban areas is imperative. Other areas of the nation have been quite successful in reducing stormwater damages in this manner.

Recommendation

Legislation should be adopted requiring all municipalities over 5,000 population to adopt stormwater management ordinances which limit stormwater discharges and runoff after development to the level prior to said development. Such ordinances should be subject to approval by the INRC, and would require onsite retention of the increased amount of runoff. The INRC should be responsible for establishing uniform, statewide criteria to manage the program. Financial assistance to accomplish the required studies should be considered by the General Assembly.

Flash Flood Warning Network

Conclusion

At present, only nine areas of the state participate in the Flash Flood Warning Network of the U.S. National Weather Service. Many other areas of the state have serious potential for dangerous flash flooding. In some instances, the communities are unaware that the threat exists.

Recommendation

A concerted effort must be made to incorporate into the Flash Flood Warning Network every major flash flood prone urban area, or any other area where lack of warning would create serious hazards to life and property. Additional coordination with the National Weather Service is recommended.

Federal Flood Insurance

Conclusion

The Federal Flood Insurance program has been extremely helpful in promotion of flood plain studies and local ordinances. This program plus the U.S. Army Corps of Engineers' flood plain studies have made a major dent in problems of identifying flood hazard areas. However, Iowa still has a long way to go in accomplishing studies of major flood prone areas. The flood plain study program

Floyd River flood protection project, Sioux City *Corps of Engineers*

Mississippi River flood at Dubuque, April, 1965 *Corps of Engineers*

must be intensified to accomplish identification of all major urban flood prone areas as soon as practically possible.

The Federal Flood Insurance program still utilizes the 100-year flood as its primary criteria. As stated previously, the INRC does not feel this criteria is rigid enough and it should be broadened to the INRC regional flood level of protection.

Recommendation

The State of Iowa should press for an acceleration of flood plain information studies in all major urban areas not yet investigated.

The state should also demand that all federal agencies hear their programs to discourage any development in the INRC regional flood plain.

Agricultural Levees and Channel Modification

Conclusion

Any agricultural levee or stream channel modification has an impact on the entire stream flood flow regime. Heretofore, all such projects have been reviewed on the basis of their localized effects to immediate surrounding properties. The cumulative effect of such individual projects on the entire stream system have not been studied. It is almost certain that a piecemealing of structural projects throughout a basin will intensify damages as flows progress downstream. A basinwide flood plain model would assure better and more equitable regulation of structural projects by enabling the INRC to assess the basinwide effects of any structural proposal.

Recommendation

The INRC should be funded to conduct a pilot study of the cumulative effects of structural alteration of stream flows, with the ultimate goal being development of a computer modeling system that could be applied to all major streams under intensive pressure for structural measures for crop protection. Due to the extensive amount of levee work on the Skunk River, it would be a prime study candidate. It is recommended that this be a high priority item in the INRC flood plain management program in the next biennium.

Penalties for Violations

Conclusion

Flood plain enforcement is currently hampered by the very low maximum fine of $100 for flood plain construction violations. A penalty of this magnitude is hardly a deterrent to a prospective violator. In some cases, contractors have reportedly encouraged or misled landowners to violate flood plain restrictions. To adequately regulate the flood plain, the INRC needs penalties of enough magnitude to deter prospective flood plain violators.

The House version of H.F. 2212, which passed the 67th session of the General Assembly, contained provisions for a civil penalty of $1,000 and $100 per day thereafter for violations of flood plain regulations, and made contractors, builders, and tenants, etc., equally liable for unauthorized flood plain construction. Unfortunately, these provisions were deleted in final passage.

Recommendation

The legislation previously contained in H. F. 2212 pertaining to instituting a $1,000 civil penalty and contractor liability should be a priority legislation for the next session of the General Assembly.

Dam Safety

Conclusion

Although the Iowa Natural Resources Council has regulated all major structures (other than milldams covered by Chapter 469) since 1957, there are numerous prestatutory dams on which little or no information is known. Remedial action on these prestatutory structures is possible only under public nuisance provisions when eminent danger can be demonstrated. Recent major dam failures nationwide, with their resultant loss of life and property, accentuate the imperative need for adequate legislative controls on all phases of dam construction, maintenance, and hazardous structure abatement.

Recommendation

Legislation should be enacted combining the dam regulation provisions of Chapters 455A and 469 into a single dam safety section of 455A. This clarifying legislation should contain provisions for Council authority to:

(1) Order the immediate draining or breaching of any impoundment or dam found to be unsafe.
(2) Order the owner to conduct engineering studies where the safety of a dam is questionable or design modifications where the existing structure is inadequate, and to construct those modifications.
(3) Order preparation of or changes in the operation, management, or maintenance plans or practices of the dam.

In addition, Council rules concerning dams should be strengthened to provide more stringent engineering design criteria, thus assuring more adequate protection of life and property.

Expanded Flood Plain Information

Conclusion

Expanded flood plain information studies, which identify the existing uses and conditions of the entire river basin, would provide a tool for local governments for analyzing the impacts of flood plain management decisions and provide data for state agencies for developing adequate and effective flood plain management policies.

Recommendation

Iowa should encourage acceleration of expanded flood plain information studies by the Corps of Engineers in those basins with significant potential for development or change. State support of the U.S.G.S. streamflow monitoring program should be strengthened.

Flooded farmland from break in levee, Mississippi River flood, Louisa County, 1965 *Corps of Engineers*


SET

7 Water-oriented Recreation, Fish and Wildlife

Outdoor recreation has become an important element to a quality life style in Iowa, and water plays a vital role in providing or enhancing the outdoor recreation experience. Iowans are participating more often than ever before, looking to outdoor recreation for a source of healthful exercise, goal achievement, and peace of mind. The outdoor recreation experience benefits a person emotionally, physically, and intellectually. Also, outdoor recreation is a growing industry and as such, is important to Iowa's economy.

Fish and wildlife resources are integral segments of Iowa's many outdoor recreation pursuits. These resources are vital elements of our total ecosystem and are tied directly or indirectly to the state's water resource base. The more diverse Iowa's ecosystem is, the healthier and more resistant to adverse change it will be. Too often, our outdoor recreation, fish and wildlife resources have been adversely affected and diminished through habitat change brought about by man's short-term economic endeavors. Iowans must work harder to ensure the protection of these natural resources for present and future generations.

Iowa should not forsake the remaining water-oriented fish and wildlife resource base in the name of economic development. Long-term public values must be weighed against short-term private gains. Iowans must remember that what is "good" for Iowa's agriculture, industry, or residential growth is many times the very use pressure that desecrates Iowa's remaining natural and scenic areas suitable for recreation, fish and wildlife habitat. At the heart of this issue, is the identification of private gains compared to the cost of public losses. Who are those that benefit from a project and who are those that bear the cost? Iowa must manage its resources to provide for both the recreational and economic needs of the people without diminishing the resource or the options and opportunities for future generations.

Iowa cannot afford to rely on one solution to solve its water-oriented outdoor recreation, fish and wildlife problems. But the single most important method of protecting Iowa's water-oriented recreation, fish and wildlife resources would be to maintain those remaining undeveloped river and stream corridors, lakeshores, and wetlands in open space uses. This proposal would include that the natural vegetation adjacent to the water's edge be maintained or enhanced to halt erosion and that man's activities leading to degradation of the environment, such as channel straightening and diking, be severely restricted. Iowans must learn to live with a compassion for nature and its resources.

The information presented in this chapter is based on the comprehensive "Task Force Report on Water-Oriented Outdoor Recreation, Fish and Wildlife," prepared in conjunction with the Conservation Commission and filed with the Iowa Natural Resources Council.

Sailing on Iowa's Great Lakes / Iowa Conservation Commission

The Resource

Many outdoor recreation activities require a natural resource base. Two of the most important natural resources for outdoor recreation are vegetation and bodies of waters: lakes, streams, rivers, and wetlands. Iowa contains a variety of landscape patterns lending themselves to a multitude of recreation uses and habitat types. The undulating to sharply rolling landscape of Iowa is dissected by stream and river channels. Within these stream and river channels lie a majority of Iowa's most important resources remaining today for recreation and fish and wildlife habitat.

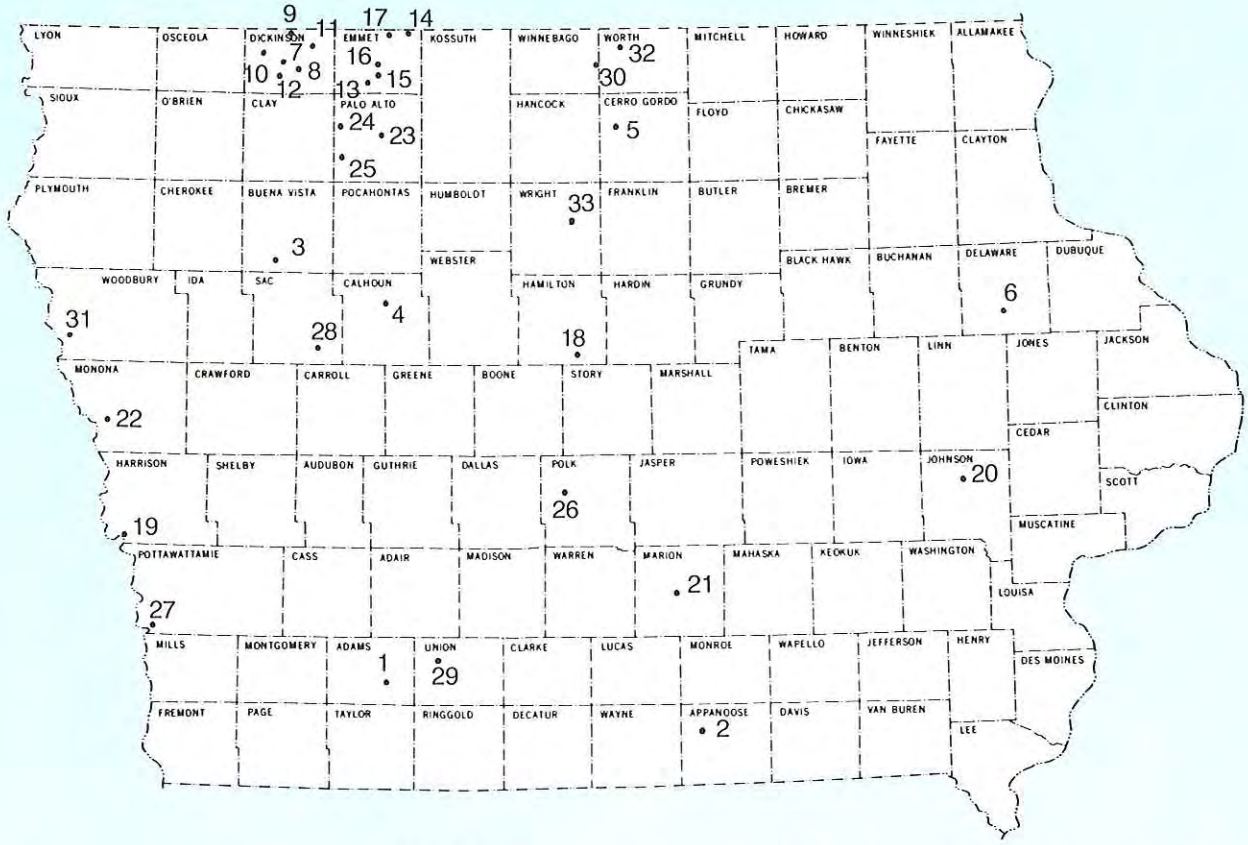
Iowa natural lake country is situated in the north central portion of the state, with the largest concentration being located in Dickinson County (Figure 7-1). The Mississippi River and the Missouri River and its oxbow lakes also serve as important elements of Iowa's water resource base. The remaining portion of the state depends upon constructed impoundments, both public and private, to supply flat water recreation needs. (Figures 7-2 and 7-3).

Iowa contains over 1,600 miles of meandered rivers, designated at the time of the original government survey and on which the state owns the riverbed up to the normal high water mark (Figure 7-4). Jurisdiction over all meandered streams and lakes within Iowa is the responsibility of the Conservation Commission. This jurisdiction is subject to approval of the Natural Resources Council in matters regarding flood control.

Iowa's natural resource base provides the framework in which the human resource base lives and makes decisions. Conservation-minded decisions are needed to wisely use the resources that remain. If our resources are continually exploited, then future recreation, fish and wildlife opportunities will steadily decline in number and quality. With a balanced conservation program, Iowa will be able to increase the number of opportunities available for quality outdoor recreation experiences and for optimum propagation of fish and wildlife species.

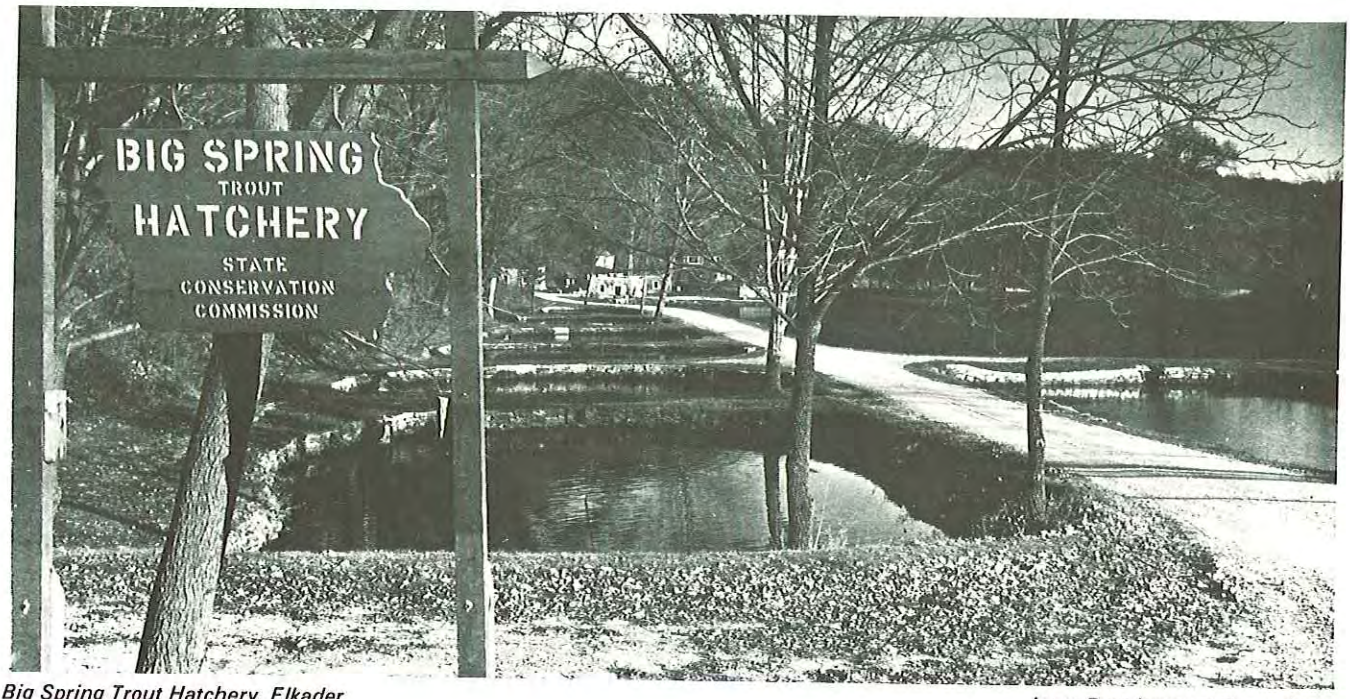
Historic loss in quantity and quality of our natural water heritage only means a higher cost to future

FIGURE 7-1 Iowa's Principal Public Power Boating Lakes (over 200 acres, over 6 hp capability)



MAP NUMBER	NAME OF LAKE	COUNTY LOCATION
1	Lake Icaria	Adams
2	Rathbun	Appanoose
3	Storm Lake	Buena Vista
4	North Twin	Calhoun
5	Clear Lake	Cerro Gordo
6	Lake Delhi	Delaware
7	Center	Dickinson
8	East Okoboji	Dickinson
9	Little Spirit	Dickinson
10	Silver	Dickinson
11	Spirit	Dickinson
12	West Okoboji	Dickinson
13	High	Emmet
14	Iowa	Emmet
15	Ingham	Emmet
16	Swan	Emmet
17	Tuttle	Emmet
18	Little Wall	Hamilton
19	Desoto Bend	Harrison
20	Coralville	Johnson
21	Red Rock	Marion
22	Blue	Monona
23	Five Island	Palo Alto
24	Lost Island	Palo Alto
25	Silver	Palo Alto
26	Saylorville	Polk
27	Manawa	Pottawattamie
28	Black Hawk	Sac
29	Green Valley	Union
30	Rice	Winnebago
31	Browns	Woodbury
32	Silver	Worth
33	Cornelia	Wright

*Natural and Artificial Lakes—200 Acres Plus, Excludes Mississippi River Navigation Pools.



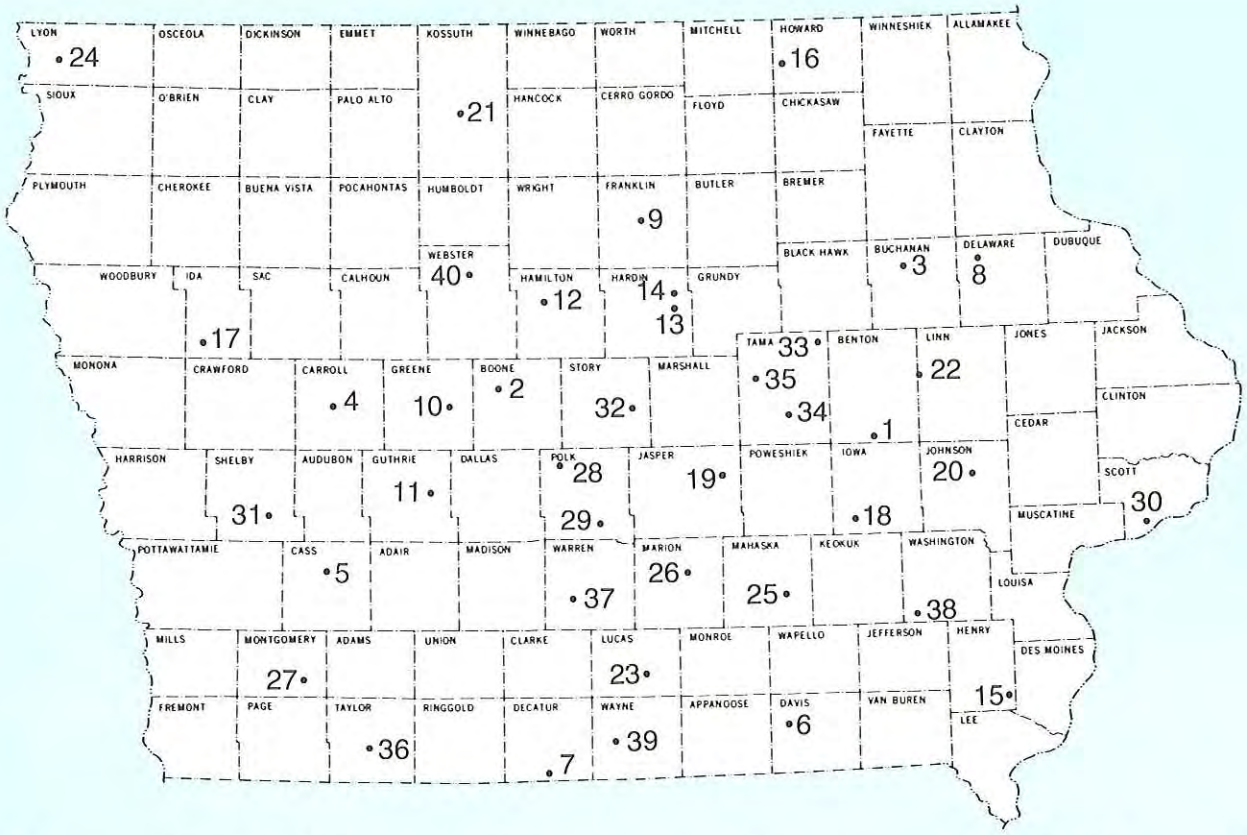
Big Spring Trout Hatchery, Elkader

Iowa Development Commission

Spring migration of Canada Geese

K. Formanek

FIGURE 7-2 Public Artificial Recreational Lakes (over 40 acres, 6 hp limit)



MAP NUMBER	NAME OF LAKE	AREA (in acres)
1	☆ Hannen Park	45
2	☆ Don Williams	160
3	☆ Fontana Park	60
4	○ Swan Lake	130
5	□ Lake Anita	171
6	□ Lake Wapello	287
7	□ Nine Eagles	56
8	□ Backbone	125
9	□ Beeds Lake	130
10	○ Spring Lake	49
11	□ Bay's Branch	287
12	☆ Briggs woods	80
13	□ Pine Lake	63
14	□ Upper Pine Lake	101
15	□ Geode	205
16	☆ Lake Hendricks	52
17	☆ Crawford Creek	80
18	☆ Iowa County Park	92
19	□ Rock Creek	640
20	□ Lake Macbride	950
21	☆ Lake Smith	53
22	□ Pleasant Creek	410
23	□ Red Haw	72
24	☆ Lake Pahoja	70
25	□ Lake Keomah	82
26	◇ Roberts Creek	300
27	□ Viking Lake	150
28	△ Big Creek	890
29	☆ Easter Lake	220
30	☆ Lake of the Hills	70
31	□ Prairie Rose	218
32	☆ Hickory Grove	110
33	☆ Hickory Hills	72
34	☆ Tama County Lake	69
35	□ Union Grove	110
36	□ Lake of Three Fires	125
37	□ Lake Ahquabi	130
38	□ Lake Darling	302
39	□ Bob White	115
40	☆ Kennedy Park	55

☆ County owned, county managed
○ State owned, county managed
□ State owned, state managed
△ Federally owned, state managed
◇ Federally owned, county managed

Note: Artificial lakes over 100 acres are allowed a maximum of 6 Hp. unless special authorization specifies higher limits. Artificial lakes under 100 acres are limited to a maximum of 1.5 Hp. electric motors.

generations for the construction of new lakes or renovation of existing bodies of water. Good stewardship is less expensive than replacement of lost or abused resources.

Resource Considerations and Problems

Water has been and continues to be the focal point for recreation, either as a resource in which to boat, swim, and fish, or as an aesthetic backdrop for other outdoor recreation activities. Participation in water-oriented recreation is expected to increase steadily in the coming decades. Iowans are spending more time in recreation due to physical and mental needs present in current life-styles: increased urbanization, a shorter work week, more discretionary income, and increased mobility. Unfortunately the provision of additional water-oriented outdoor recreation opportunities, or access to those opportunities, has not kept pace with growing demands. Several county conservation boards have tried to step into the void created by the lack of state development by constructing new lakes. The expense incurred has led to financial burden or the postponement of design and construction of these facilities.

Deficiencies are evident for some water-oriented recreation activities in certain regions of the state and will increase in the future. Overcrowding, safety problems, and resource degradation will become more severe if deficiencies are not corrected.

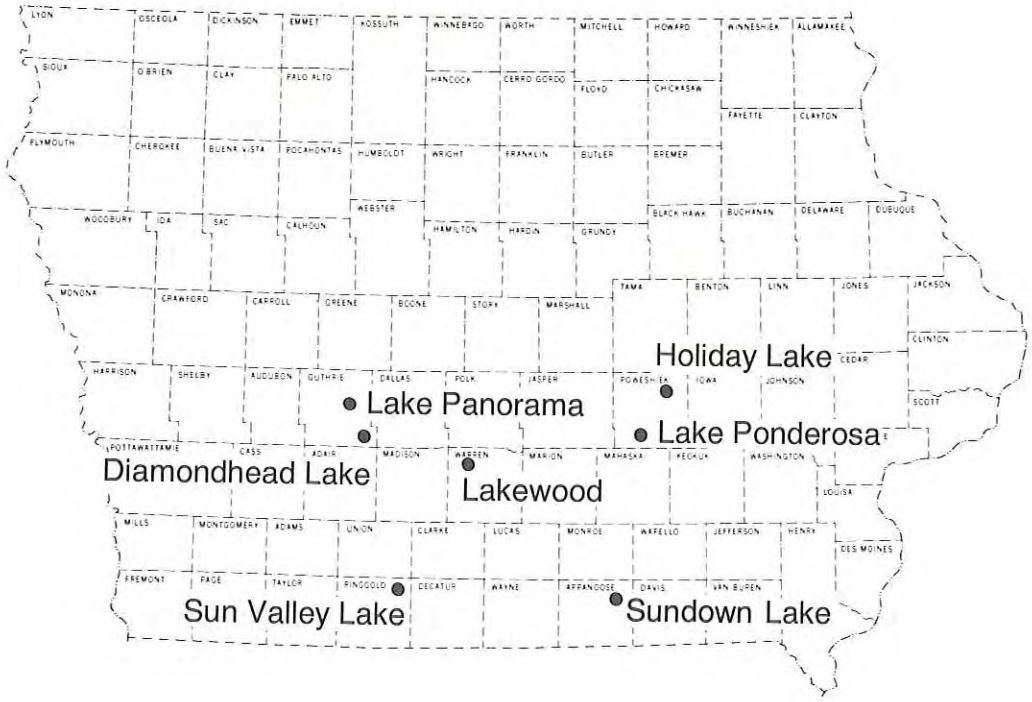
On a statewide basis, the 1975 population of 2.89 million is expected to increase to 2.97 million in 1985 and 3.22 million by 2020. The average annual rate of projected growth is 0.24 percent. In general, urban areas of the state have been growing and are expected to continue to increase in population while rural and small town regions of the state have stable or declining population densities. Only in the more urban counties do small communities experience a strong growth. Rural participation in outdoor recreation may increase if farm income remains strong, as in the 1972-1976 period. These trends will increase future demands for outdoor recreation.

Increased world population and the growth of agricultural exports will put more pressures on Iowa's natural resource base. Iowa has experienced the demand for increased crop production for distribution around the world. This has prompted the agricultural community to expand or improve farming operations by land clearing, stream channel straightening, and wetland drainage. Increased Iowa population and the quest for a more aggressive economy are pressuring the development of residential, commercial, industrial, and transportation complexes. Rural residential growth has been significant in the more urban counties. These developments have, in many cases, been at the expense of valuable natural habitat or prime agricultural land. As prime agricultural soils are developed, there are greater pressures to convert the undeveloped land to row crop production. The state has minimal powers to protect these resources in a comprehensive manner, and it is just beginning to study statewide land use policy needs.

River Corridor Preservation

The future stewardship of the land should be considered along with economics in striking a balance so we can pass on to future generations the kind of world that will provide a quality life in Iowa. Because Iowa has such rich agricultural soils, there are only a few land areas that remain in their "natural" state. The largest portion of such areas lie in our river and stream corridors. The vegetation within these corridors provides invaluable wildlife production areas and helps to reduce soil erosion. Within these corridors lie the most significant areas of natural scenic diversity still remaining in the state.

FIGURE 7-3 Iowa's Large Private Development Lakes



Iowa can protect the remaining natural corridors, lake shorelines, and wetlands by funding and implementing a protected area water system. The primary objectives of this system would be to preserve scenic and wetland areas, minimize erosion and channel degradation, reduce flood damages by reducing flood plain occupancy, and prevent destructive changes to the flood plain and watercourse. The state must identify water areas of statewide critical concern and assist and cooperate with local units of government in preparation of plans and regulations for the wise use of these critical areas. If city and county entities fail to develop and administer the local responsibilities, the state must have the authority to protect and manage these areas of statewide significance.

Scenic Rivers

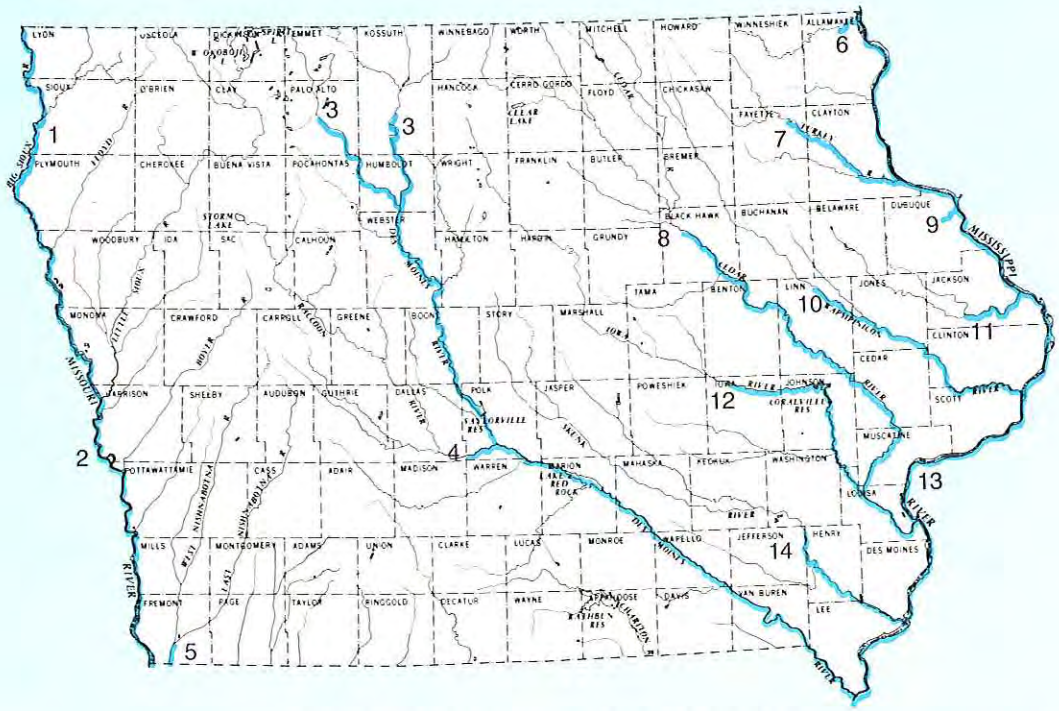
The protected water area system could serve as the foundation for an Iowa scenic river system. A "Protected Area Water Act" could protect Iowa's high quality, scenic, and recreational rivers, and adjacent lands from destructive changes. The Iowa Conservation Commission has never had enough funding or staff to initiate an action program under Iowa's Scenic Rivers Legislation (Chapter 108A of the **Iowa Code**). To effectively protect and manage the shoreline and river, the state and local governments must be authorized to use a variety of methods such as fee title acquisition, tax incentives, easements, management agreements, condemnation powers in special circumstances, and land use regulations.

In general, improved zoning ordinances would apply to new construction and future land use changes. Existing land uses and structures would be allowed to remain as they are. As a compensating measure to local governments, the taxes on land purchased in fee title, generally, should be paid by the state and not taken off the tax roles. Some states, such as Minnesota and Michigan, have authority to zone areas of statewide importance if a local entity fails to do so. This authority increases local compliance with a state program.

Public Access

Increased pressure for water-oriented outdoor recreation has led to a need to increase water recreation opportunities. Increased recreational opportunities can be provided by: (1) acquiring public access to existing

FIGURE 7-4 Meandered Rivers of Iowa



TOTAL MILES ON EACH MEANDERED RIVER

		MILES
1	Big Sioux River	128
2	Missouri River	179
3	Des Moines River	389
4	Raccoon River	16
5	Nishnabotna River	5
6	Upper Iowa River	2
7	Turkey River	62
8	Cedar River	163
9	Little Maquoketa River	1
10	Wapsipinicon River	147
11	Maquoketa River	28
12	Iowa River	143
13	Mississippi River	312
14	Skunk River	62
	TOTAL	1637

bodies of water, (2) constructing new wetlands along with boating and fishing lakes, and (3) delineating public and private rights to streambed use. The first two means for increasing recreational opportunities require manpower and funding to plan, design, acquire, construct, and maintain the public access areas and the new impoundments. These additional opportunities could be provided through a constant source of funding for a state resource program, for direct aid to county resource programs, or on a case-by-case problem solving basis.

The third method to increase outdoor recreation opportunities is the delineation of the public's right to float and walk the streambed of any flowing stream with recreation potential, regardless of the ownership or navigability. The public's right may be determined in two ways: First, legislatively, by redefining Iowa's test for navigability and the public's right to use those navigable waters, and second, judicially, by the courts adjudicating the public's right to utilize Iowa's waters. A judicial solution will only fashion a decree enforceable against the litigating parties, while a legislative solution will apply statewide.

To permit public use on selected or designated nonmeandered rivers, the Conservation Commission should be authorized and funded to negotiate fencing agreements for regulating fences strung across streams, and to provide technical and financial assistance to landowners for the construction of facilities, canoe gates, or other passage facilities. People have noted that this delineation of the public's right is not a critical problem today, but the predictions for increased future recreational use makes this program emphasis one of action rather than reaction.

Water Quality

Iowa's water suffers the greatest adverse impact from material carried in agricultural and urban runoff (nonpoint source pollution) and, secondarily, from industrial and municipal discharges from water pollution control facilities (point source pollution). Unchecked runoff carries silt loads which settle out and fill reservoirs. It also fills pools in rivers and streams needed for aquatic life. In conjunction with these silt particles, herbicides, pesticides, and fertilizers are carried to rivers, lakes, and streams. For example, commercial fishing has been banned in Coralville Reservoir as a result of high concentrations of dieldrin found in fish flesh. Nutrients such as nitrogen and phosphorus, cause excessive algal blooms which reduce the aesthetics of a recreation experience. Also, certain point discharges prove to be toxic or harmful to fish and wildlife by reducing the dissolved oxygen, creating temperature stress, or poisoning from chemicals. Iowa's primary effort in stream and lake protection should be directed toward restricting pollutant inputs into its waters with priorities placed on lakes, rivers, and streams with high natural, scenic, recreational, and cultural value.

Iowa Conservation Commission

Water Withdrawals

Surface water and groundwater withdrawals for agricultural irrigation, industry, and municipal use are increasing yearly. During drought conditions, the conflicts between water withdrawals and in-stream recreation and fish and wildlife needs become the most serious. In these types of situations, the state should expand its conservation program to assure that only essential water uses are permitted so the impact on recreation and fish and wildlife can be minimized. A more adequate state network of gaging stations would give the state needed information on when to cut off nonessential users and protect recreation and fish and wildlife interest. On streams offering exceptional recreational opportunities, the protected low flows of streams, as established by the Iowa Natural Resources Council, should be reexamined for possible greater protection. To date, the Conservation Commission has not assessed or designated Iowa's streams with exceptional value, other than those important to the state's fishery.

Border Rivers

Iowa's two border rivers provide untold wealth to the people of Iowa. The Mississippi River is probably Iowa's greatest asset for recreation and fish and wildlife. Currently, two Great River Environmental Action Teams (GREAT I and II) are developing dredge material management plans to be completed in 1979 and 1980 respectively. Iowa's other major border stream, the Missouri River, has become less desirable for recreation and fish and wildlife as a result of the navigation and stabilization project. Since channelization, the streambed has been degrading above Council Bluffs, and the river environment itself has become less diversified. Degradation affects access to oxbow cutoffs and also lowers water levels within these oxbows. The swift current makes pleasure boating and water contact recreation dangerous and has limited the types and amounts of fish and wildlife that exist. Iowa has a great deal at stake in the management of the Missouri River; Iowa must take positive steps to gather information on degradation, land and water, recreation, and fish and wildlife losses in order that sound management and mitigation decisions may be made in the future. Meanwhile, continued management of the oxbow lakes in the Missouri River Valley is warranted.

Recreational Deficiencies

The primary objective of a statewide outdoor recreation program is to provide a wide range of activities for

Iowans to enjoy in their increasing leisure time. From the economic standpoint, reducing the outflow of Iowa recreationists will lead to increased tourism dollars for Iowa. To provide suitable areas for recreational outlets, the state of Minnesota appropriated $20 million for the 1975-1977 biennium and $23 million for the 1977-1979 biennium for land acquisition. Correspondingly, since 1955, Iowa has spent approximately $1 to $1.5 million per year for land acquisition.

Both free time, and the diversity of choices for the use of free time, are greatest near urban centers; therefore, demands may be concentrated in or around large cities. Recreational studies have shown that urban populations participate in outdoor recreation activities more frequently than rural populations. There is a need to develop adequate water-oriented recreation facilities within a reasonable distance of these population centers. Ideally, travel time should not exceed 1 to 1-1/2 hours for day use, regional, non-urban sites.

Within a recreation region, the urban center is not always located close to the recreational resource. Consequently, the urban center may be deficient of water-based recreation facilities while the region in total may not. Iowa has three large urban areas that consistently do not rate highly in the regional analysis as being of top priority for providing new opportunities in water-oriented recreation. Due to the lack of usable recreation water, it would appear that these areas should receive special attention. These urban areas are Sioux City, Council Bluffs, and the Waterloo/Cedar Falls area. The demand for recreational facilities near urban areas may increase in the future in view of growing energy shortages. Less fuel at higher prices may cause Iowans to travel less often, and for shorter distances, for selected purposes.

In order to anticipate future demands for outdoor recreation, the Iowa Conservation Commission has conducted three surveys on recreational use by Iowans and has related these use patterns to available recreation resources. The original survey was based on personal interviews conducted in 1966. It was updated in 1970 and 1975. The 1975 participation survey, combined with the two previous surveys, provides the best available picture of Iowans' changing pattern of recreational use.

The water-oriented outdoor recreation and fish and wildlife report is concerned with six main water-oriented or water-enhanced recreation activities: camping, boating, fishing, picnicking, natural environment swimming, and waterfowl hunting. Participation data were tabulated on a regional basis (Figure 7-5). Differences in regional patterns and pressures in seven regions relate to each region's population, socio-economic makeup, and more importantly, to the natural and recreational resources present. Regional needs and priorities are derived through analysis of each region's supply/demand situation. A priority system for recreational needs was developed for each recreational activity, based on each region's rank relative to other regions. It must be remembered that these are regional priorities and that each region is composed of a number of counties and cities, each of which may have local needs different from the region as a whole.

Boating

Boating has grown tremendously in popularity during the last decade. Figure 7-6 reveals that boating participation from 1966 to 1975 increased 55 percent, due to the creation of additional impounded water. The same rate of increase is expected from 1975 to 1985. Boating is projected to become the second most participated in activity, surpassing picnicking, during the 1980s. During 1975, 44.8 percent of Iowans participated in boating an average of 11.5 days.

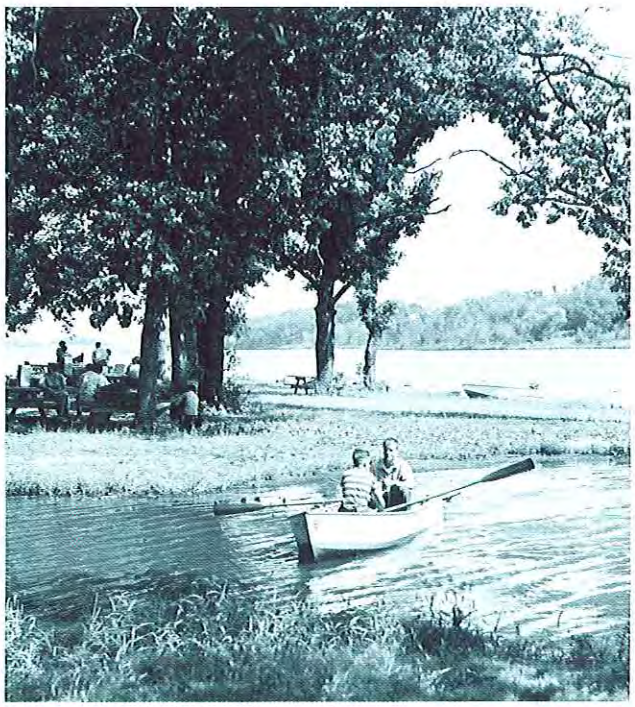
Figure 7-6 shows that Region 6 attracts the largest number of boaters from other regions, and it is also projected that it will have the smallest number of acres available per boating party by 1985. Region 6 will probably experience an inflow of boaters for many years to come because most of the natural lakes in Iowa are located in this region. This trend may be slowed somewhat if more surface water acres are provided in other water-deficient regions. This region may not need additional water acres, but rather more accessibility and more comprehensive management of the resource and the recreationist.

Regions 1 and 7 both show the highest outflow of boaters to other regions. In Region 7, this outflow should slow somewhat because Saylorville Reservoir is now in operation. In Region 1, the problem is that the major boating resource, the Mississippi River, is distant from the heaviest urban concentration in that region. This outflow could be decreased by providing additional surface water acres around the Waterloo/Cedar Falls area.

In Region 4, the inclusion of the Missouri River provides more area than water safety would justify. The interior counties, in addition to the Council Bluffs urban area, are deficient in flat-area water bodies. The same trend, in general, occurs in Region 5, west-central Iowa, and including Sioux City.

Fishing

Iowa's streams and lakes offer a variety of fishing opportunities. A 1975 survey of Iowans indicated 51.1 percent of the population fished an average of 14.4 times per year. Figure 7-7 shows that in the early 1970s, fishing



Boating and picnicking, Viking Lake
Iowa Conservation Commission

Fishing on Spirit Lake *K. Formanek*

popularity surpassed picnicking, becoming Iowa's favorite water-oriented activity in terms of total number of activity days. Because of the impact of drought conditions on water bodies in the mid to late 1970s, sales of fishing licenses have suffered over the last couple of years. Considering this decline, fishing activity is projected to increase only 22 percent between 1975 and 1985.

From Figure 7-8, it is seen that available fishing acres appear adequate for every region. This analysis does not take into account that much of this water frontage is in private ownership and lacks public access. Therefore, much of the existing potential for fishing cannot be realized. In some areas, there are conflicts with other water uses. Through proper management techniques, the Iowa Conservation Commission can ensure a safe and enjoyable experience for the greatest number and variety of users.

Figure 7-8 shows that only region 3 has more fishermen coming into their region than leaving. Approximately 25 percent of Iowan's fishing days are spent out-of-state. Regions 5, 6, and 7 have the smallest number of acres (supply) per 1975 fishing party (demand). A program to provide public access may be concentrated in these three regions, and in local problem areas in all regions. The greatest success in improving access can be achieved by those municipalities adjacent to fishing waters. All recreation agencies should give high priority to improving fish habitat to meet increased fishing demand. The state hatcheries system provides needed fish to help maintain fish populations in Iowa's lakes, rivers, and streams.

Natural Environment Swimming

Traditionally, swimming has been a popular activity for all age groups, especially the young. In 1975, surveys showed 38 percent of the population swam at beach facilities an average of 9.2 times. Figure 7-9 shows that participation by Iowans is projected to increase 56 percent by 1985. Seventy-nine percent of this participation occurs between Memorial Day and Labor Day, with 60 percent occurring during peak periods on weekends and holidays.

Figure 7-9 shows that Region 2 is the only region where demands exceeded supply in 1975. By 1985, Region 2 is projected to have the smallest supply of beach per person of all regions. Regions 1, 4, and 7 have large outflows of swimmers to other regions. Saylorville and Big Creek beaches will provide Region 7 with expanded opportunities. Additional beach development around

FIGURE 7-5 Outdoor Recreation Regions

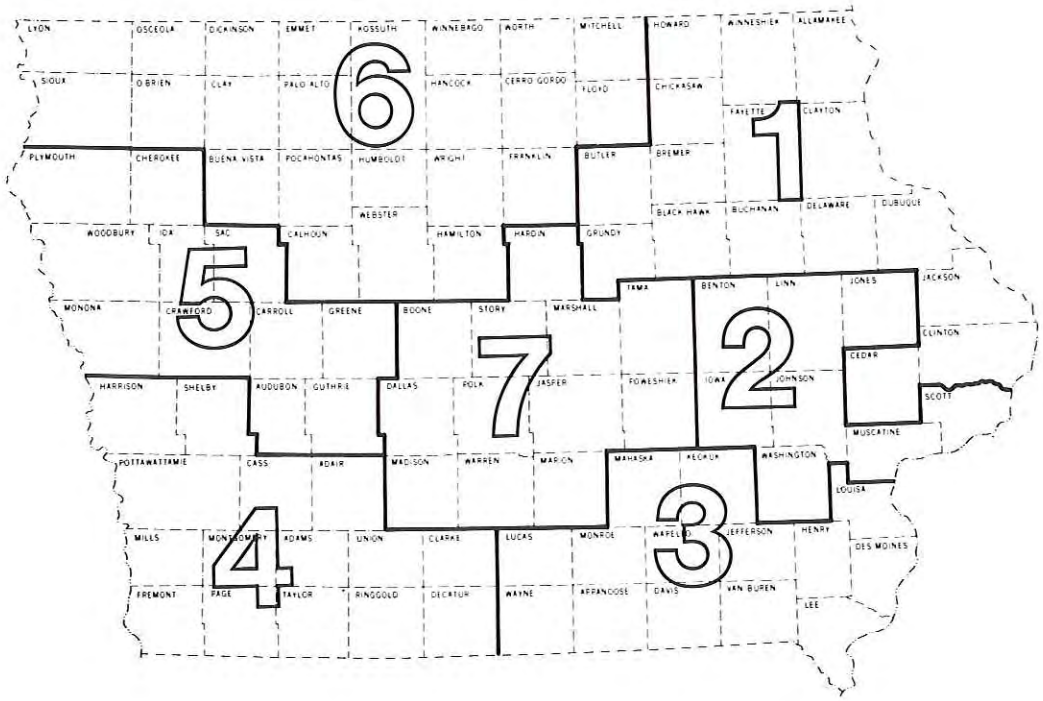
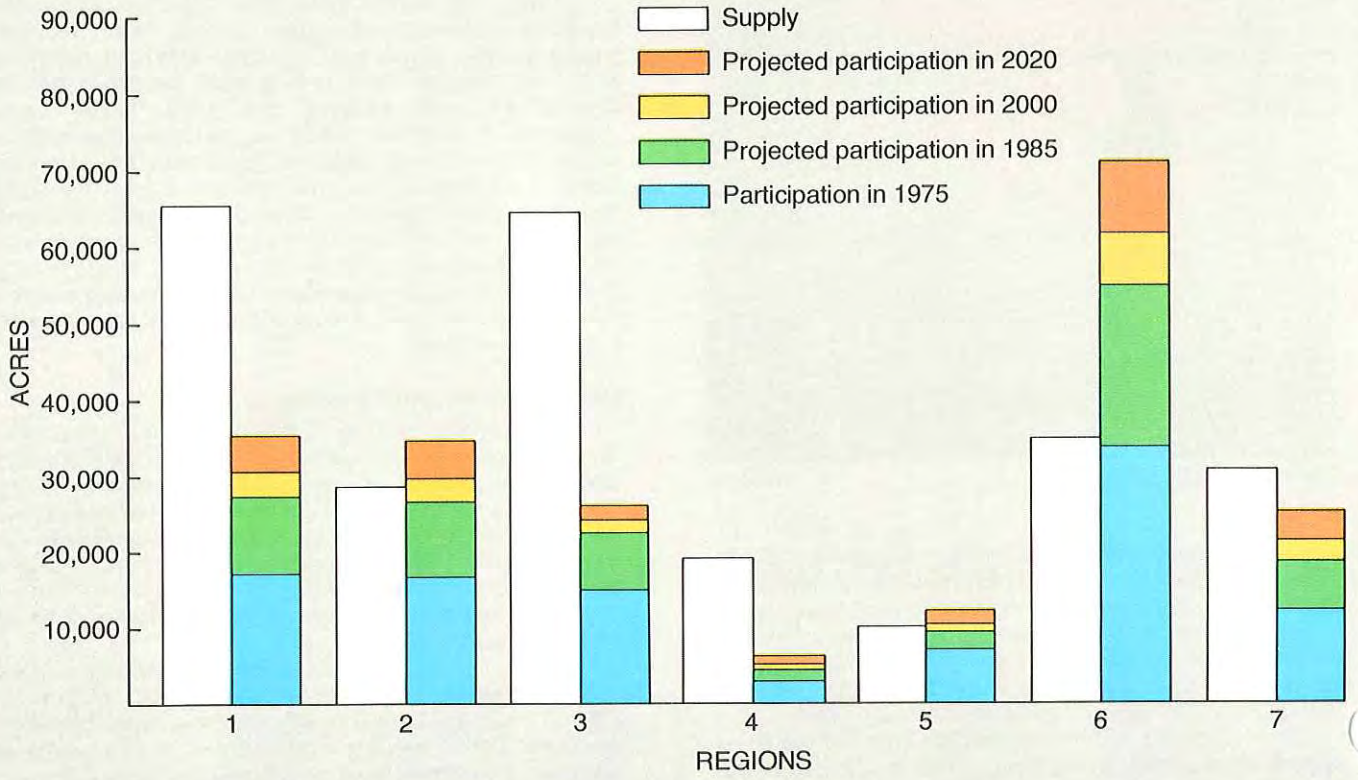


FIGURE 7-6 Present Availability of Boating Facilities and Projected Demands



Region	Present Supply (acres)	1975 Projected Demand (acres)	Net Exchange Outflow (−) or Inflow (+) (parties)	Present supply / 1985 Projected Demand (parties)	Regional Priority
1	65,467	17,188	−2,137	12.0*	5 (Low)
2	28,741	16,710	−2,029	5.4	3 (High)
3	64,556	15,105	+225	14.3	7 (Low)
4	19,114	3,313	−883	20.5	6 (Low)
5	10,020	7,040	−413	5.3	2 (High)
6	34,500	33,396	+1,612	3.2	1 (High)
7	30,384	12,105	−5,858	8.2	4 (Med.)

*Acres per 1985 boating party

Council Bluffs in Region 4, and Waterloo/Cedar Falls in Region 1, would help curtail outflows to other regions.

The deficiencies of natural beaches may be accommodated first, by facilitating access to and the development of existing natural beaches; and secondly, by the development of new beaches in conjunction with existing water-oriented recreation areas, and third, by providing for beaches at new or proposed water areas. Also, these beaches should be located near urban areas for convenience and energy conservation.

This analysis has dealt specifically with the demand for natural environment swimming. Some of this demand may be met by providing swimming pools; in fact, water quality and cost factors may deem the construction of pools a necessity in the future. Another alternative is to modify beach areas to simulate a swimming pool environment, particularly where clay suspended sediments have been detrimental to beach preservation and maintenance. Continued interest and additional support of public pools should be part of the outdoor recreation program in this state.

Picnicking

Picnicking is not necessarily linked to water but is enchanced by its presence. It is the most popular of the six activities covered in this study in terms of percentage of participating population: over 78.3 percent of the sampled population picnicked in 1975. Figure 7-10 shows that picnicking from 1975 to 1985 is projected to increase 18.2 percent. This rate of growth is the lowest of the activities studied, primarily because picnicking is the most established activity in Iowa for all age groups. Increased income, mobility, and leisure time have little effect on increasing the participation in this activity.

In 1975, only Regions 3 and 7 were deficient in meeting demand. Figure 7-10 indicates that Region 7 will have the largest outflow and the smallest number of tables per picnicking party in 1985. New picnicking facilities at the Big Creek State Recreation Area and Saylorville Reservoir near Des Moines and Ames may help stem some of the outflow from Region 7. By 1985, all regions except Regions 4, 5, and 6 will have picnic facility deficiencies, but again, this may not hold true for isolated areas within the region. Deficiencies in facilities for picnicking may be met by all levels of government involved in recreation. Such facilities should be an integral part of future recreation developments.

Dam at Beeds Lake State Park, Hampton
Iowa Conservation Commission

FIGURE 7-7 Projected Growth of Iowa's Water-Oriented Recreation Activities

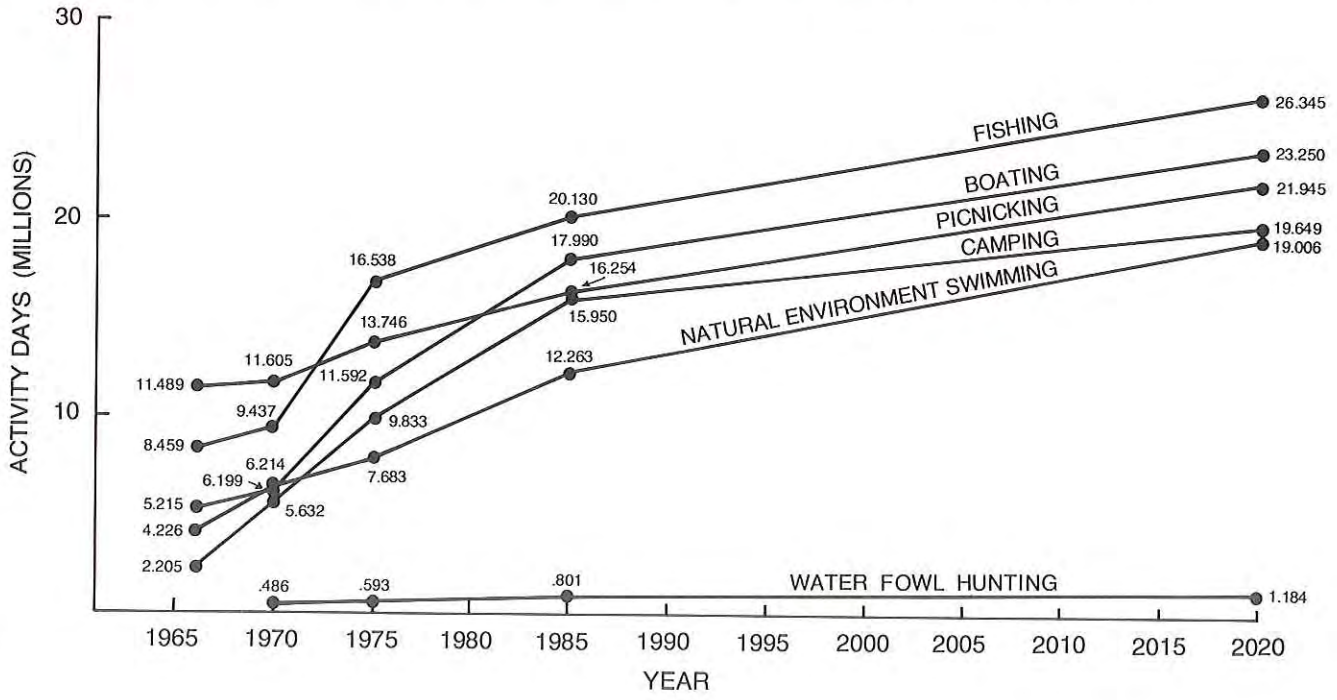
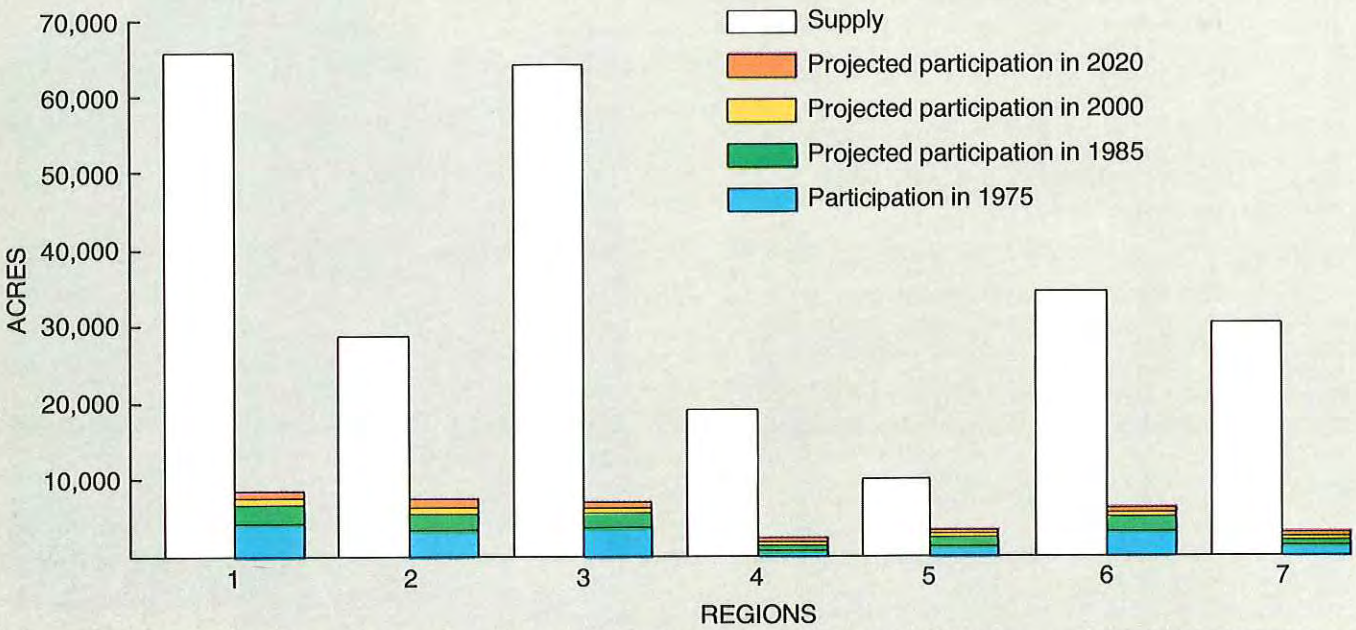


FIGURE 7-8 Projected Growth of Recreational Fishing in Iowa

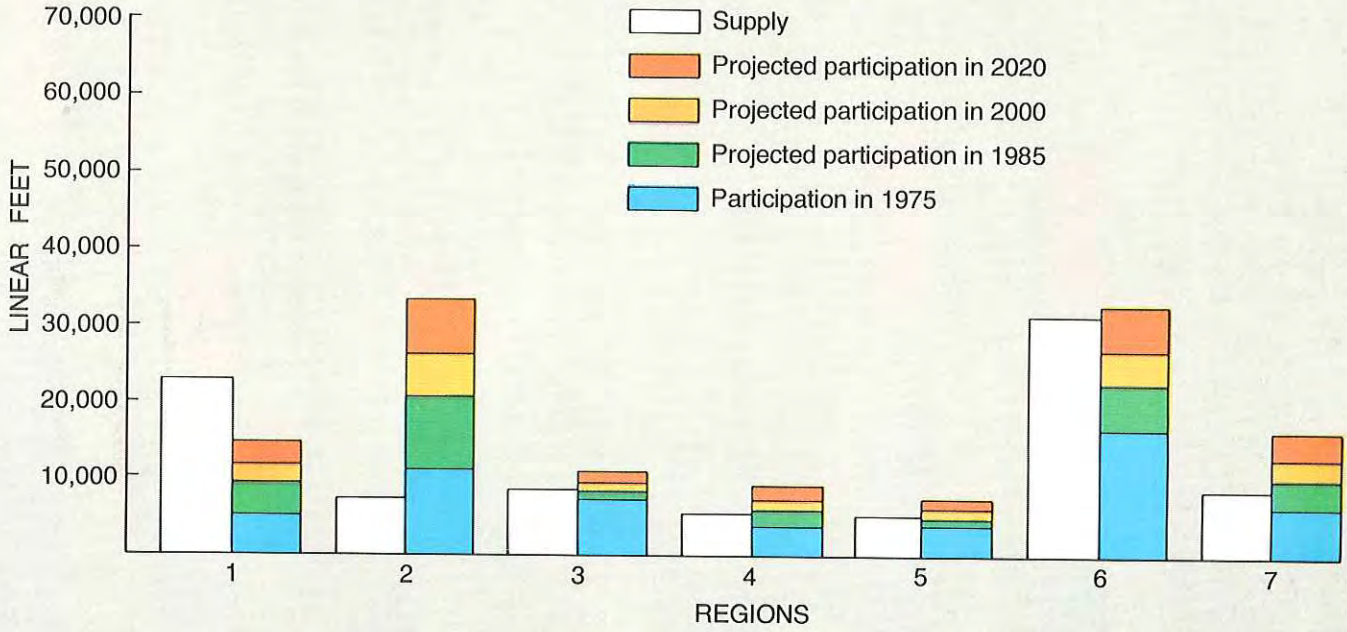


This graph may be misleading because it implies that unlimited and equal access to all fishing acreage is available to the public, which is not the case.

Region	Present supply (acres)	1975 Projected Demand (acres)	Net Exchange Outflow (−) or Inflow (+) (parties)	Present supply / 1985 Projected Demand (parties)	Regional Priority
1	65,467	4,242	−2,621	9.6*	6 (Low)
2	28,741	3,462	−2,601	5.2	4 (Med.)
3	64,556	3,954	+398	10.8	7 (Low)
4	19,114	942	−965	6.0	5 (Low)
5	10,020	1,482	−917	3.2	1 (High)
6	34,500	3,438	−48	4.5	3 (Med.)
7	30,384	1,532	−4,459	4.0	2 (High)

*Acres per 1985 fishing party

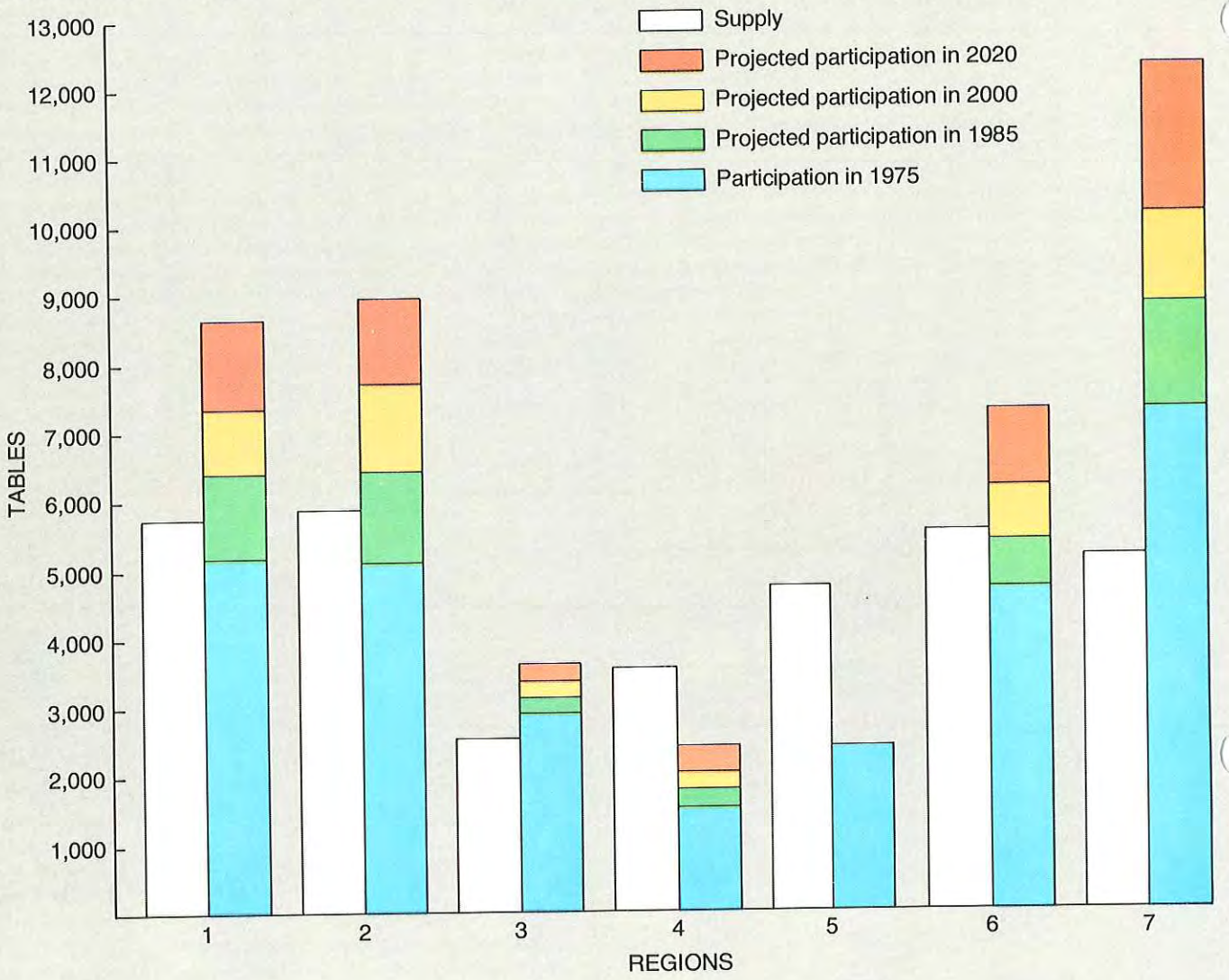
FIGURE 7-9 Projected Growth of Natural Environment Swimming



Region	Present Supply (lineal feet)	1975 Projected Demand (lineal feet)	Net Exchange Outflow (−) or Inflow (+) (Persons)	Present supply / 1985 Projected Demand (Persons)	Regional Priority
1	23,050	5,122	−3,834	2.39*	7 (Low)
2	7,500	11,344	−2,011	.36	1 (High)
3	8,400	7,389	+537	1.02	4 (Med.)
4	5,400	3,778	−3,155	.93	3 (Med.)
5	5,100	3,956	+123	1.09	5 (Med.)
6	31,300	16,833	+3,311	1.38	6 (Low)
7	8,450	6,300	−8,922	.85	2 (High)

*Linear feet per person

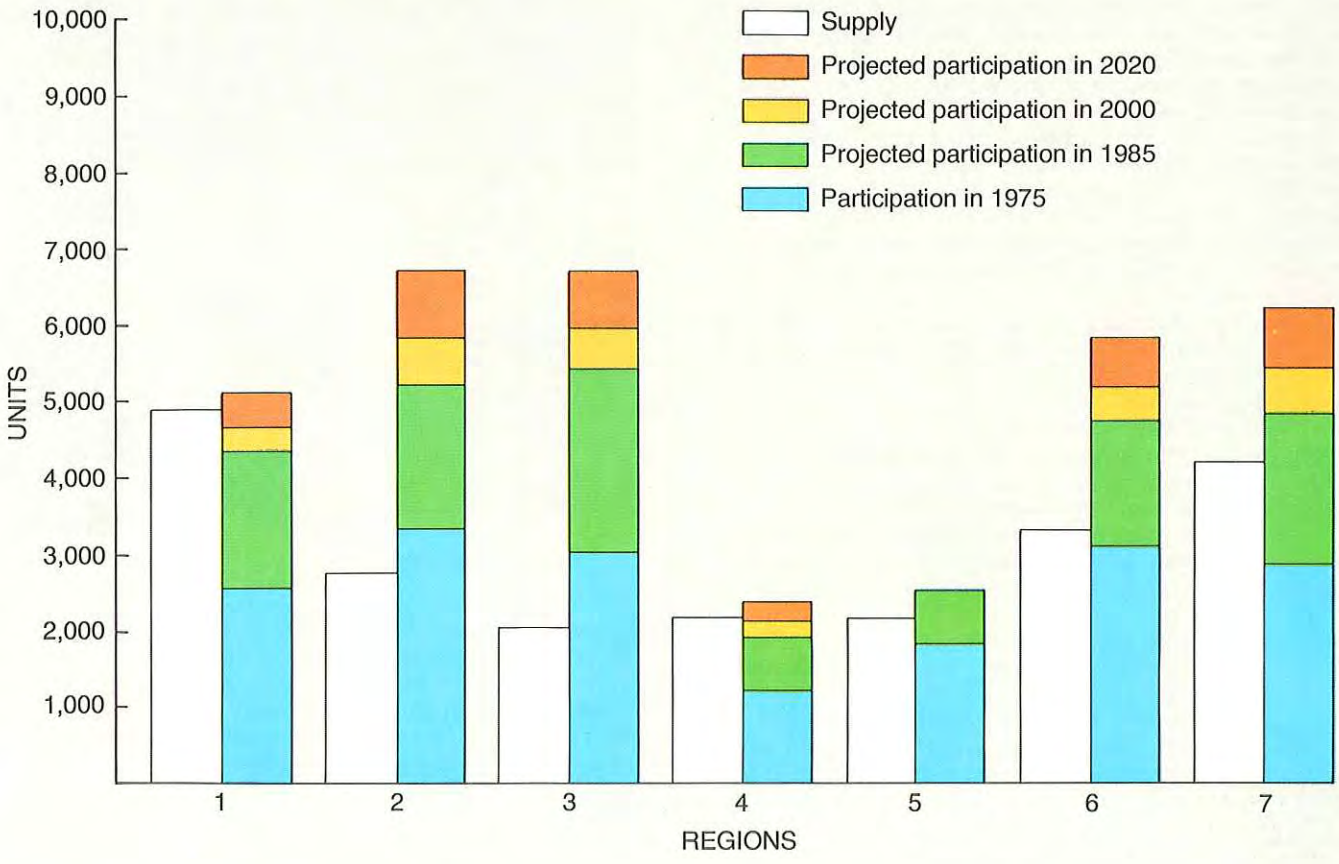
FIGURE 7-10 Projected Growth of Picnicking



Region	Present Supply (tables)	1975 Projected Demand (tables)	Net Exchange Outflow (−) or Inflow (+) (parties)	Present supply / 1985 Projected Demand (parties)	Regional Priority
1	5,707	5,194	−2,405	.89*	2 (Med.)
2	5,988	5,117	−1,530	.92	4 (Med.)
3	2,552	2,957	+304	.80	3 (Med.)
4	3,514	1,547	−540	1.96	6 (Low)
5	4,722	2,426	+103	2.32	7 (Low)
6	5,546	4,736	−287	1.03	5 (Low)
7	5,170	7,303	−4,063	.59	1 (High)

*Tables per 1985 picnicking party

FIGURE 7-11 Projected Growth of Camping



Region	Present Supply (units)	1975 Projected Demand (units)	Net Exchange Outflow (-) or Inflow (+) (parties)	Present supply / 1985 Projected Demand (parties)	Regional Priority
1	4,917	2,571	−4,592	1.13*	6 (Low)
2	2,768	3,352	−2,362	.53	2 (High)
3	2,035	3,015	−41	.37	1 (High)
4	2,190	1,245	−781	1.14	7 (Low)
5	2,172	1,832	−245	.86	4 (Med.)
6	3,311	3,122	−990	.70	3 (Med.)
7	4,207	2,878	−3,903	.87	5 (Med.)

*Camping units per 1985 camping party

Camping

Camping is another activity enhanced by water. Water serves as a scenic backdrop and provides a diverse range of water activities associated with a camping outing. The 1975 survey of Iowa residents indicates that 35.8 percent of the population camped an average of 10.4 days per year. Figure 7-7 shows that participation in camping has grown rapidly from 1966 to 1975. Camping is projected to increase 62 percent from 1975 to 1985.

Figure 7-11 shows that Regions 2 and 3 are the only regions where demand for facilities exceeds supply in 1975. Table 7-11 also reveals that these two regions will have the smallest number of camping units (supply) per camping party (demand) in 1985. Before 1985, Regions 5, 6, and 7 will also need additional camping units to meet projected demands.

All regions have more people driving to other regions than using facilities within their own region. Typical camper use patterns reveal that 42 percent of the total annual camping takes place out of state. This figure represents an average of five days of camping for each person in Iowa. The remaining five days of camping are spent closer to home, probably at the nearest quality site that a family can reach for weekend or overnight use. Again, for convenience and energy considerations, Iowa should provide new camping units within a one to one-and-one-half hour drive of urban population concentrations.

The deficiencies may be met primarily at the federal, state, county, and private levels, with municipalities assuming a secondary role. Iowa could look to the private sector for the provision of highly developed and energy intensive types of camping. This includes camping for motor homes requiring such facilities as water, sewer, and electrical hook-ups.

Waterfowl Hunting

Waterfowl hunting is a very specific activity in that it requires specialized knowledge of preferred habitats and specific traits of individual waterfowl species. Waterfowl hunting has been and will continue to be an activity in which a small percentage (3.6 percent) of the population participates. Figure 7-7 shows that waterfowl hunting should increase 35 percent by 1985.

At the present time, it is not possible to calculate the supply of waterfowl areas by regions; consequently, no regional deficiencies have been developed. Table 7-1 shows that Regions 3, 4, and 5 are the favored waterfowl hunting regions because of the inflow of waterfowl hunters encountered. Regions 1 and 2 have the largest relative outflow of waterfowl hunters. This is an indication that these regions do not have waterfowl hunting habitats close to regional population centers.

TABLE 7-1 Waterfowl Hunting

Region	Total Days by Residents (millions)		Net Exchange Outflow (−) or Inflow (+) (Millions of Hunters)
	Originating from Region	Using the Region	
1	.128	.104	−.024
2	.062	.043	−.019
3	.158	.162	+.004
4	.047	.072	+.025
5	.066	.077	+.011
6	.046	.035	−.011
7	.086	.069	−.017

Sailboating on Iowa Great Lakes
Iowa Conservation Commission

Preservation of Iowa's remaining wetlands are important as habitat, feeding, and nesting areas for waterfowl. To increase the number of waterfowl in this state, a program to preserve the remaining wetlands and the reclaiming of some of those lost must be actively pursued.

Statewide Summary of Regional Activity Priorities

Based on the priorities delineated in Table 7-2, Regions 2, 5, and 7 have the greatest need for providing more opportunities for water dependent activities while Region 6 has a medium priority. In both Regions 1 and 6, the provision of additional boating facilities has the highest priority. The problem in Region 1 is lack of adequate water surface acreage near the principal urban center, while the problem in Region 6 is one of inadequate public access. Regions 1, 3, and 4 are ranked as the low priority regions. For the water enhanced activities (camping and picnicking), Regions 2, 3, and 7 should receive the highest priority in providing opportunities for these activities. Each community, county, and regional agency, in analyzing its specific needs and/or opportunities, may use this summary as a starting point in identifying whether a certain water-oriented activity is deficient in their region. However, unique situations can override the regional priorities listed here, and may result in a higher priority for alternative activities. For example, the urban area of Waterloo/Cedar Falls in Region 1 has a low priority but it is also deficient in water-related recreation opportunities, the reason being that the available supply of water in this region is located along the Mississippi River which is two to three hours away from this urban center. Similarly, the Council Bluffs and Sioux City areas are along the Missouri River, but are deficient in safe flat water recreation sites.

Conclusions and Recommendations

Critical Water Resource Protection

Conclusion

Critical water-oriented natural resources such as river and stream corridors, lake areas (natural and artificial), and wetlands are in short supply in Iowa. These resources are continually being encroached upon, diminished in value as natural resources, and reduced in size by man. The major land use changes adversely impacting upon outdoor recreation and fish and wildlife resources include vegetation clearing along lake shores and within river corridors, stream channelization, and wetland drainage.

Iowa's water resources and their adjacent lands provide a major portion of the valuable open space, recreational opportunities, and fish and wildlife habitat currently remaining within Iowa. Also, the most significant areas of natural scenic beauty are associated with these resources.

Presently, Iowa lacks a statewide inventory of, and a comprehensive future management program for, Iowa's remaining natural areas. Also, Iowa has no comprehensive method to protect valuable resources with statewide significance other than through fee, or less than fee, title acquisition. The primary objectives of this protection would be to curtail alteration of critical resource habitat, to minimize channel erosion and degradation, to reduce flood plain occupancy, to preserve scenic and wetland areas, and to provide for public use where compatible.

Recommendations

1. The State must fund and implement a "protected water area system". A resource inventory identifying those critical river and stream corridors, lake shorelines, and wetlands must be the first

TABLE 7-2 Regional Recreational Priorities

Region	Water Dependent Activities			Water Enhanced Activities		Statewide Priority for Water Dependent Activities
	Boating	Fishing	N.E. Swimming	Picnicking	Camping	
1	L	L	L	M	L	Low
2	H	M	H	M	H	High
3	L	L	M	M	H	Low
4	L	L	M	L	L	Low
5	H	H	M	L	M	High
6	H	M	L	L	M	Med.
7	M	H	H	H	M	High

Region	Each Regions Highest Priority for Water Dependent Activities
1	Boating (acreage)[1]
2	Swimming
3	Swimming
4	Swimming
5	Fishing
6	Boating (access)[2]
7	Fishing and Swimming

[1] Region 1 needs more water surface acreage close to its urban center to meet additional demands.

[2] Region 6 has an abundant supply of natural lakes but needs more public access sights to meet additional demands.

step. A general plan must be prepared that outlines statewide goals and objectives, establishes criteria of interim protection and analysis, establishes priorities, and recommends potential areas for protection. Following the preparation of the general plan, an in-depth plan for those areas recommended for permanent designation must then be prepared. This plan should include specific land use regulations, acquisition recommendations, and management and funding needs.

2. The State must be given the authority to zone "protected water areas" of statewide significance if local jurisdictions in which the protected area is located fail to adopt and enforce regulations necessary for their protection. Currently, only 59 out of 99 counties have adopted land use zoning regulations.

Increased Recreation Demands

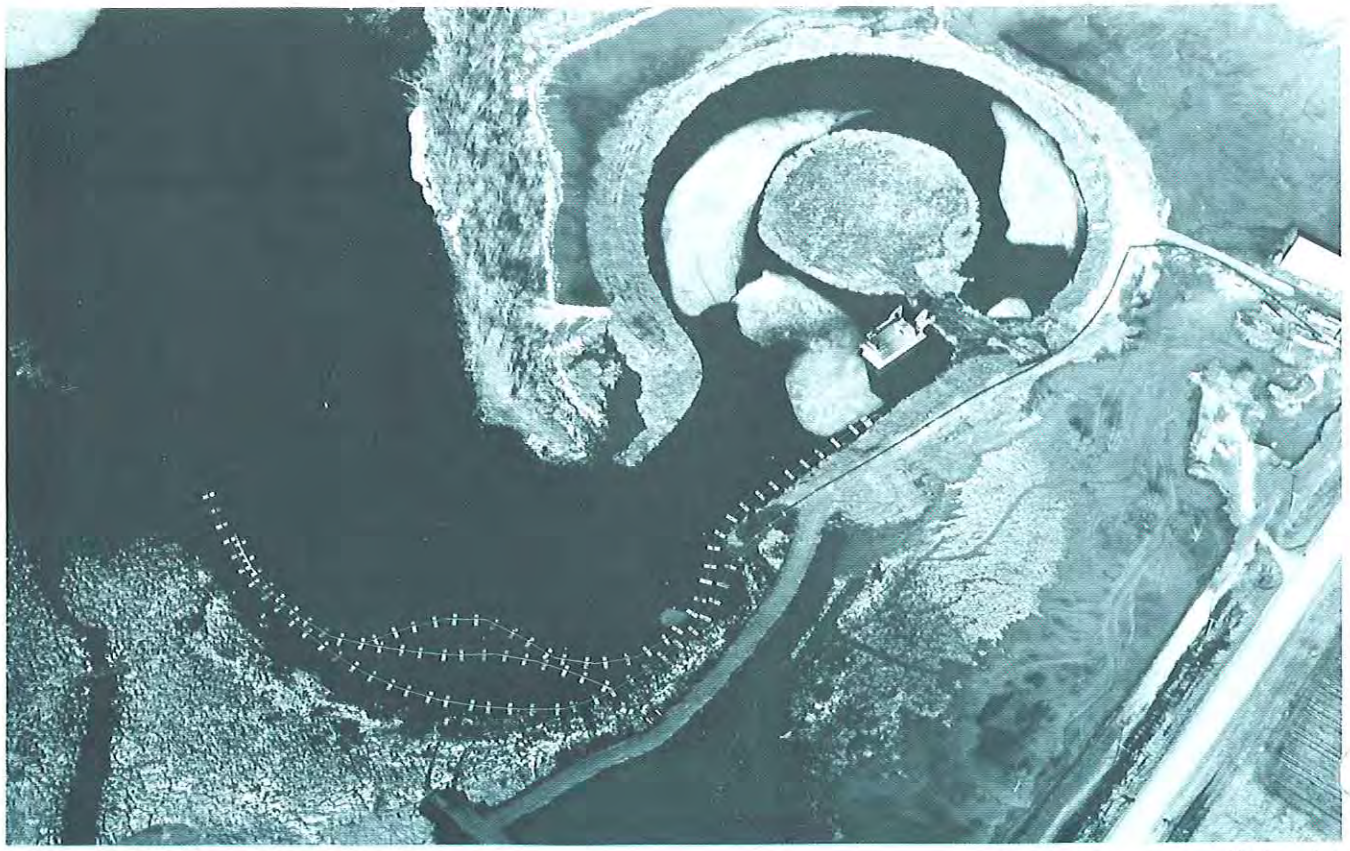
Conclusion

Participation in water dependent and water enhanced forms of outdoor recreation is projected to increase through the year 2020 (Figure 7-7). Increased participation on a limited resource base will lead to overcrowding and degradation of today's recreation resources. In turn, decreased user satisfaction and safety problems may result.

Increased demands may be met through a variety of measures such as the construction of renovation of access and recreation facilities on existing water areas, the construction of new impoundments, renovation and rehabilitation of water bodies, pumping or water diversion to increase surface acreage, improvement of water management techniques, upgrading of enforcement techniques, and defining the public's right to use flowing water. There are problems or drawbacks associated with each alternative including manpower, funding, or the change of riverine recreation and habitat to flat water recreation and habitat. Outdoor recreation resource managers and planners must have a variety of measures available to lessen the impact of future demand on Iowa's limited resources. Iowa's resources must be managed wisely so that all Iowans have the opportunity to enjoy a quality outdoor recreation experience while protecting the resource's integrity.

Recommendations

1. Iowa should expand the acquisition and development of additional public access facilities to existing flat and flowing recreation waters. Access provisions for the public should take precedence over private landowner access where needs, demands, and public investment so indicate.
2. Iowa should expand the rehabilitation and redevelopment of existing water-oriented recreation access facilities.
3. Iowa should carefully study the need and suitable locations for new recreational impoundments. Iowa should lend technical assistance to electric utilities and water supply proponents for potential use of their proposed impoundments for public recreation. Potential impoundment sites, regardless of proposed use, should be considered for protection by the state from development. Future



Dredging at Storm Lake *W. Lonning*

water supplies and management may depend upon these sites.

4. The public's right to use flowing water should be redefined either legislatively or judicially to include the right to float and walk the streambed for recreation purposes.
5. Iowa should expand its investigation and analysis of the water-oriented recreationist and the water-oriented recreation base. The impact of the energy situation should also be considered. The information will be used to determine user needs and resource capabilities, and to formulate management and enforcement techniques.
6. The legislature should investigate the establishment of local water area restoration districts to fund needed remedial projects that are local in nature, and which should not be placed on the general state tax burden, or should only be shared in part by the state. County Conservation Boards could serve or participate in water area restoration if given additional authority and funding opportunities.

Scenic Rivers System

Conclusion

Chapter 108A of the **Iowa Code** established a "scenic river system" but a comprehensive program to guide or administer the system has not been funded, formulated, nor implemented. As a result, the shorelines of the state's scenic rivers are being developed in a random fashion and the state is losing an opportunity to protect these areas and to meet present and future recreation demands. Iowa has many river and stream segments of natural, scenic, recreational, historic, and/or cultural importance.

Neighboring states have successfully implemented scenic rivers programs. A variety of tools must be available to carry out this program in Iowa including the authority to zone if local entities fail to do so. Without overall program direction, funding, staff, and a variety of administrative tools, the result, at best, would be the piecemeal achievement of a system that has no direction. The "protected water area" legislation as discussed earlier could provide the basis for a scenic river system.

Recommendations

1. A "scenic rivers program" should be established, staffed, and funded within the Iowa Conservation Commission to carry out Section 108A of the **Code** for the planning, administration, and maintenance of an Iowa Scenic Rivers System. Criteria for selection of the scenic river segments must be developed in order to analyze Iowa's rivers, identify segments for inclusion, and establish priorities for the segments for detailed planning.
2. The development of a "scenic rivers program" demands that a higher funding and staffing priority be established for it by both the Legislature and the Conservation Commission. The program must also be assigned to an existing or new operating section within the Conservation Commission for administration and management.
3. Supporting legislation to make the scenic rivers program viable must be enacted:
   (a) Protected water area legislation.
   (b) County and municipal zoning meeting minimum state guidelines along designated river segments.
   (c) Empower the Conservation Commission to condemn for less than fee title those areas having outstanding scenic or natural characteristics to ensure equitable treatment of all landowners along a designated river segment and to protect the public values possessed by such river reaches.
   (d) Empower and provide funds for the State to reimburse local governments' taxes lost as a result of public acquisition for the scenic rivers program in fee or less than fee title.
   (e) Require county assessors to adjust property to reflect changes in values resulting from perpetual conservation easements acquired by governmental units for public benefit.
   (f) Continue the Open Space's funding program.

Muskrat dens in marsh, Clay County
Soil Conservation Service

State Fish Hatchery
Iowa Conservation Commission

Water-Oriented Recreation Deficiencies

Conclusion

The statewide summary of water-oriented activities in Table 7-2 will help determine whether a certain water-oriented activity is deficient in a specific region relative to the other regions. The state agency or others may use this prior system as a starting point in deciding in which regions of the state to put their effort in expanding water-oriented opportunities. However, it must be remembered that these are regional priorities and that a local area may be deficient although the region as a whole is not.

Besides the high priority regions, there are three urban areas in Iowa in need of additional water-oriented recreation facilities. They are the metropolitan areas of Council Bluffs, Sioux City, and Waterloo/Cedar Falls. The problem of meeting the recreation needs of large urban areas will intensify as both population and participation rates in water-oriented recreation activities increase.

Future energy implications on recreation may become substantial. One can reason that given two like facilities with similar visitation figures, the facility closest to the population would cause less energy use. This is very hypothetical because another may counter that the closer the facility is to an urban situation, the greater appeal and drawing power among those who might not otherwise attend a recreation area. It is the role of the public and private recreation sectors' role to satisfy those public recreation needs with respect to the costs to society, and energy is but one of these costs.

Recommendations

1. Iowa should plan to meet water recreation deficiencies in the planning regions and the major urban areas that indicate a need for increased water-oriented recreation opportunities and improved fish and wildlife habitat through increased natural resources funding. The metropolitan regions of Council Bluffs, Sioux City, and Waterloo/Cedar Falls should receive the first priority.
2. The future energy implications for recreation should be assessed, analyzed, and incorporated into future recreation planning. Emphasis on providing at least minimum water-oriented recreation facilities in each region should be considered in this assessment.

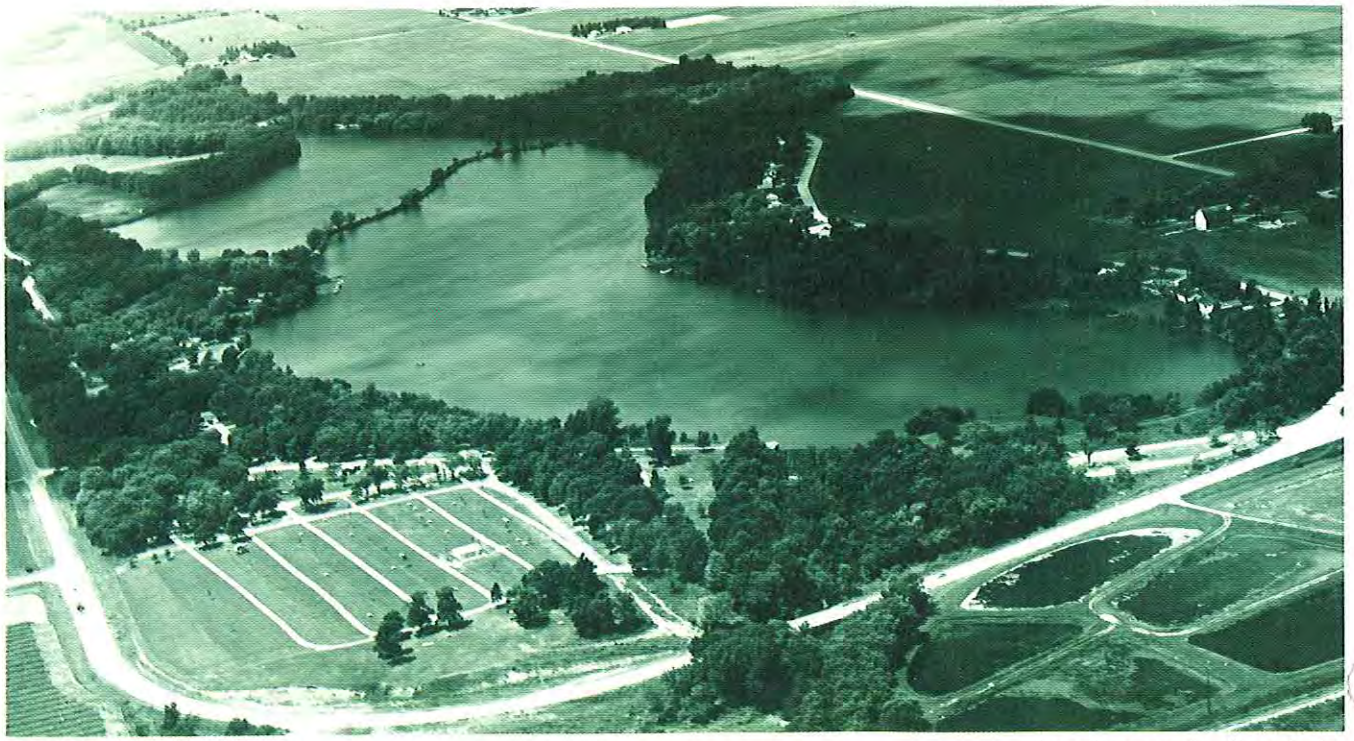
Mississippi River

Conclusion

The Mississippi River provides a vast resource base for recreation, fish and wildlife interests. The present resource is capable of meeting most of the projected increases in recreation demand; but as other use pressures and development increase, greater conflicts will arise. The adverse effects of dredging, sedimentation, and development of the flood plain on recreation, fish and wildlife resources have been major problems identified in the Mississippi River. A legal suit against the Corps of Engineers spurred the formation of the Great River Environmental Action Team (GREAT). GREAT involves participation of state, federal, and local governments and the public to study methods to minimize the impacts of navigation channel maintenance and other developments on the resources of the Mississippi River.

Recommendations

1. The Mississippi River Basin Commission Level B study and the GREAT study efforts should receive continued funding and personnel support from the State.
2. Upon formulation, a Mississippi River development plan should be implemented. The plan



Beeds Lake State Park, Hampton *Iowa Conservation Commission*

should provide for multi-purpose use of the river while protecting it from further degradation. It should also recommend areas to preserve, to upgrade, and where additional access should be provided.
3. The Corps of Engineers should assume responsibility for acquiring access to, development, and maintenance of dredge spoil recreation areas.

Missouri River Degradation

Conclusion

The Missouri River Bank Stabilization and Navigation Project has caused direct and indirect loss or degradation of recreation, fish and wildlife resources. Studies have been and are being conducted to determine base line effects of the project as well as probable future effects. Future resolution of the multiplicity of the problem will affect many Iowans and many interests.

Recommendation

1. Iowa should continue to determine the past, present, and future effects of the Missouri River Project through hydrological modeling studies of the entire river, recreation and fish and wildlife habitat evaluations, groundwater studies, etc. through an organization patterned after the GREAT study effort on the Mississippi River. This information is needed to ensure that future mitigation and problem solving efforts are not premature or misdirected.

Water Pollution

Conclusion

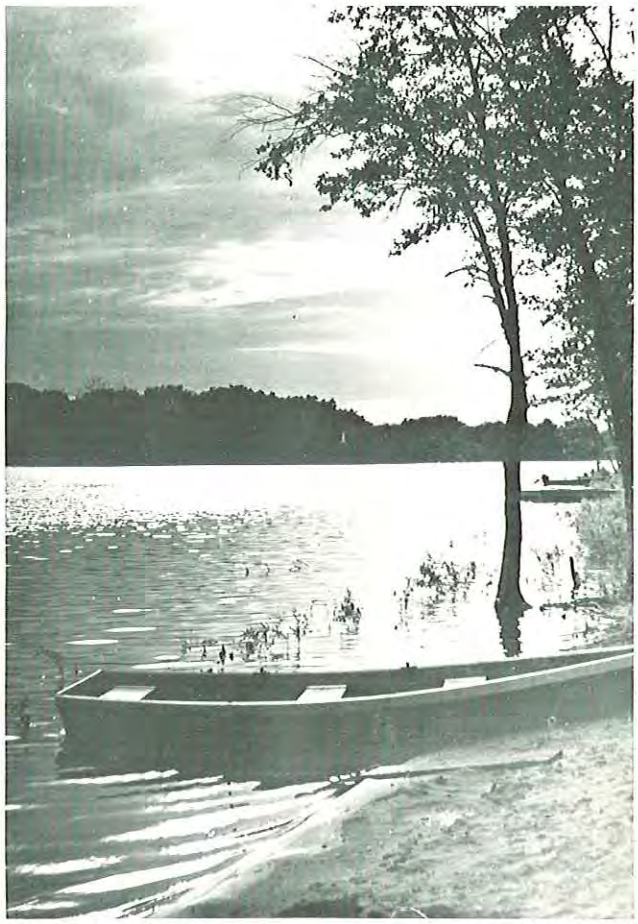
To differing degrees, most Iowa waters have water quality problems. These problems include contamination, sedimentation, and eutrophication. Point and nonpoint sources of pollution deteriorate the quality of Iowa's water and, therefore, adversely affect the quality of aquatic life and the desirability for recreational uses.

Properly treated point source pollutants do not harm aquatic life or reduce recreational appeal. Properly managed shorelands can help preserve water quality. Natural vegetation buffers trap nutrients and retard erosion while providing a scenic break between water and land.

The U.S. Environmental Protection Agency and the Iowa Department of Environmental Quality are guided by the goals outlined most recently in Public Law 92-500, the 1972 Federal Water Pollution Control Act amendments. Iowa is continuing its research in and regulation of point and nonpoint sources of pollution.

Recommendations

1. Iowa should continue to provide funds along with the Federal Government for the implementation of point and nonpoint source pollution control. A priority should be placed on abatement of pollution in watersheds that impact public lakes, rivers, and streams with high natural, scenic, recreation and/or cultural value. Iowa should institute a 75 percent state/25 percent landowner cost-share funding for erosion control measures above state lakes.
2. Iowa's primary effort on pollution abatement should be directed toward restricting pollutant inputs into its waters through such methods as:
   (a) Land use regulation
   (b) Watershed treatment
   (c) Improved effluent modification
   (d) Diversion
   (e) Shoreline stabilization
   (f) Construction of sanitary dump stations for marine holding tanks.



Mississippi River near Dubuque *B. A. Vogel*

Water Withdrawal

Conclusion

Drought conditions during the 1976 and 1977 growing seasons have greatly increased the demand for water withdrawal permits. Surface and groundwater withdrawals may have an adverse impact on Iowa's water-oriented recreation, fish and wildlife resources if not carefully regulated, monitored, and enforced. Protected low flows have been established for Iowa's streams below which no regulated consumptive withdrawals are permitted. Concern over potential adverse impacts of surface and groundwater withdrawals upon lake levels and stream flows increases as rainfall decreases. Even though abundant rainfall may diminish concern over water utilization, the state must take steps to ensure that overutilization of the resource does not occur during the next dry cycle.

Recommendations

1. Iowa should improve and expand the current network of gaging stations to assist in determining in-stream flow requirements for recreation and fish and wildlife uses.
2. The Iowa Conservation Commission should designate those streams having exceptional recreation and fish and wildlife uses. The Iowa Natural Resources Council should, if needed, place a higher degree of protection on these designated streams by raising protected low flows and stricter regulation of water withdrawals and channel changes. These designated streams should also be used by the Iowa Department of Environmental Quality to assign priorities for nonpoint and point source pollution abatement.
3. The water withdrawal permit applicant or the Iowa Natural Resources Council should adequately ensure that any surface or groundwater withdrawal permit has no significant adverse impact on stream flows or wetland and lake levels to the detriment of recreation, fish and wildlife habitat, or other public values.
4. Municipalities, rural water associations, and other water users should be required to adopt water conservation measures prior to the point when streams reach the protected low flow or, in the case of lake sources, when water levels reach a specific level below the established lake elevation.
5. Enforcement of water withdrawal permit regulations should be strengthened through hiring or contracting for a permanent enforcement staff and obtaining cooperative programs with existing county or regional agencies.

Canoeing on the Upper Iowa River *Iowa Conservation Commission*

Keokuk Hydroelectric Power Dam and Lock No. 19 *Iowa Development Commission*

8 Water For Energy Production

Energy production is one of the many competing uses for the water resource. Withdrawals of water for condenser cooling in thermal-electric plants are by far the largest use of water in the energy industry. Water is used in mining and reclamation of mined lands, processing and refining of fuels, conversion of a solid fuel into gaseous or liquid state, disposal of waste products and in other aspects of energy production. Water is also the prime mover in hydroelectric plants.

Iowa is not in a region where water supplies are expected to be critically short. However, there will still be water resource problems and conflicts involved with meeting the total water needs of the expanding energy industry and other beneficial users. This is particularly true for the interior portions of the state.

The Resource

Energy Resources

Almost all of Iowa's energy comes from fuels imported from out of state. Imports account for 98 percent of the fuel resources consumed. All the petroleum and natural gas used in Iowa comes from out-of-state, and only 7 percent of the coal used in Iowa is mined locally.

Petroleum

Iowa has little petroleum potential. Only one well has ever produced oil in the history of the state, and furthermore, there are no petroleum refineries in the state. Thus, it is unlikely that Iowa's water resources will ever be burdened by the demands of petroleum extraction or refining.

Coal

Although the coal industry in Iowa is small, the state has 21 billion tons of potential coal resources, 3.5 billion tons of which are measured and indicated reserves. However, Iowa coal has a high sulfer content and current air quality standards restrict its use.

It would be to Iowa's economic advantage to increase the mining of native coal, since the state's electric utilities expect to double their use of coal for power generation by 1985. To import the necessary coal would require an annual cash outflow of $300 to $500 million.

The information presented in this chapter is based on the comprehensive "Task Force Report on Water for Energy Production," prepared by and filed with the Iowa Natural Resources Council.

Hydroelectricity

Hydroelectric power accounts for less than six percent of Iowa sales of electricity. The largest portion of hydroelectric power used in Iowa is supplied from plants on the Missouri River and its tributaries in North and South Dakota. This electricity is sold primarily to rural electric cooperatives and municipalities in northwest Iowa. The potential for developing additional hydroelectric facilities in Iowa is very small. Full development of all potential hydroelectric plant sites in Iowa would provide only 2,500 million kilowatt hours per year, less than one percent of Iowa's current energy consumption. The largest run of the river plant in Iowa is on the Mississippi River at Keokuk.

Alternative Energy Sources

Alternative energy sources such as the sun and the wind are not expected to make a significant contribution in this century. It is expected that only 3.5 percent of total U.S. energy demands in the year 2000 will be met by these sources. Increased attention is being given to these potential sources in the National Energy Program.

Energy Use

Currently, Iowans are dependent on natural gas as the primary fuel for home, business, and industrial uses. Industries supplement natural gas with fuel oils and coal. Coal and nuclear fuels supplemented by hydropower are the primary fuels used to generate electrical energy. (See Figures 8-1 and 8-2).

Natural gas supplies to Iowa have diminished every year since 1974, but are expected to hold steady at current levels of consumption, with household use being of highest priority. For business and industrial expansion, oil, coal, or electricity must be used. Most industries currently use oil as a substitute for gas during winter months and will continue to do so unless federal restrictions limit petroleum availability. Conversion to coal or electricity would entail major equipment retrofit, and would necessitate the installation of emission-control equipment.

It is expected that electricity will be substituted for gas and oil when supplies of those fuels diminish since coal, nuclear fuels, gas, and oil can all be converted into

FIGURE 8-1 Fuel Use by Fuel Type in Iowa, 1976

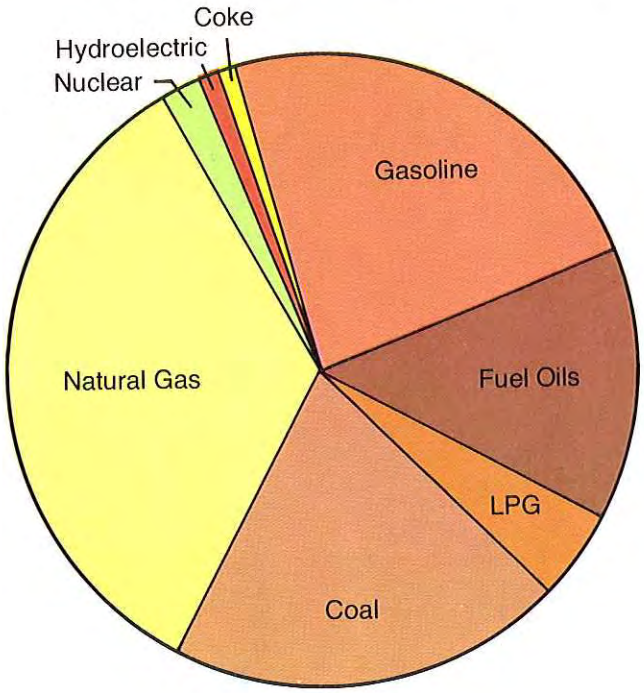
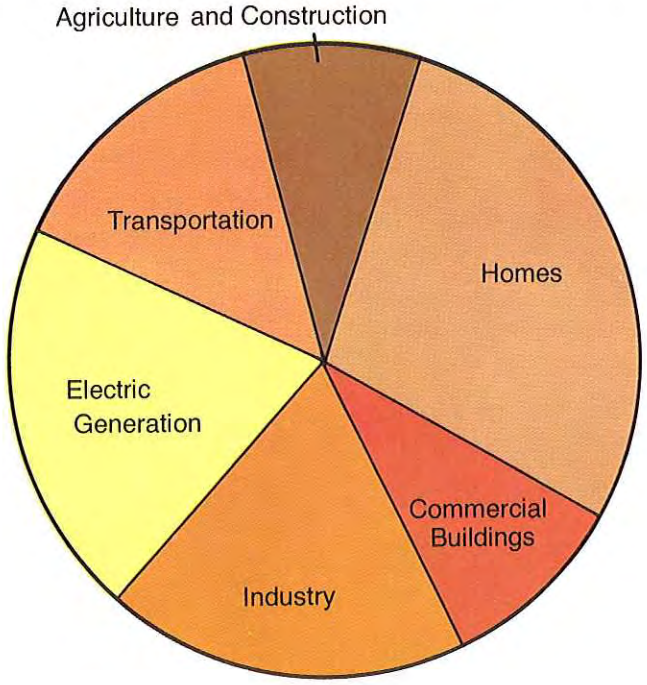


FIGURE 8-2 Energy Use by Consumers in Iowa, 1975



electricity. To meet the expected demands, Iowa utilities plan to build an additional 4,914 megawatts (Mw) capacity in new power plants, almost doubling existing capacity. As the demand for electric power grows, more stress will be put on Iowa's water resources for use in power plant cooling.

Coal will continue to be the source of most of the electric power used in Iowa. To meet increasing fuel requirements, Iowa utilities plan to increase their coal use by 111 percent between 1975 and 1980. Most of this increase will be low-sulfur coal imported from the western states.

Present Situations and Future Trends

Coal

Development of Iowa's coal resources could have a significant impact on the state's water resources. By 1985, it is expected that coal-fired electric generators will account for 69 percent of Iowa's installed generating capacity. Another more speculative use of coal will be gasification, or converting coal into a gas; this has large water requirements.

Water is consumed in mining to wet coal surface areas and access roads in order to reduce levels of coal dust pollution. However, these requirements are small; at the most, four gallons per ton in surface mining or 15 gallons per ton in underground mining. For example, the estimated amount of water used to produce the 644,000 tons of coal mined in Iowa in 1976 was 6.1 million gallons, only a fraction of 1 percent of Iowa's total annual water withdrawal requirements.

Larger quantities of water are used to remove sulfur and other impurities from coal. The water requirements for coal beneficiation, or preparation, vary according to the amount of waste which must be removed. The pilot coal preparation plant at Iowa State University processes 70 tons per hour and requires about 600 gallons per minute (gpm) for operation; however, due to recycling, the consumptive water loss is only about 35 gpm or about 5 percent of the circulating water requirement. Coal mining, reclamation, and washing are not expected to pose any serious water supply problems; however, there are some significant water quality problems associated with mining. Runoff or leachate from mined sites often is extremely acidic, thus, seriously impairing the productivity of the aquatic habitat. In addition, erosion from strip-mined lands causes sedimentation of streams and lakes and impairs the productivity of the land. Strip-mining would not be practical in many areas of southwestern Iowa where the coal deposits are deep beneath the surface. Deep shaft mining or in-situ gasification would be required in these areas.

Gasification

Through physical and chemical processes, coal can be converted to a variety of other fuels. High- and low-BTU gasification processes are now close to commercial development and may affect Iowa's fuel situation. Water is used in gasification in processing and cooling. Estimates of water requirements for a high-BTU plant range from 5,100 to 22,000 gpm and for a low-BTU plant from 2,400 to 3,200 gpm. The variations in water requirements are primarily the result of the priority given to water conservation and recycling in the process.

The greatest quantities of water in the state lie outside the coal-bearing areas, which will make supplying water for a gasification facility difficult. (Figure 8-3, 8-4, 8-5, and 8-6 show water supplies in the southern part of the state.) The low flows of the Des Moines River which runs through the part of Iowa in which the surface-recoverable coal deposits lie are not sufficient to satisfy gasification demands. Moreover, many water users compete for the Des Moines River water, so it is unrealistic to consider its entire flow as available for use in coal gasification.

Streams with lower potential yields flow in areas where coal is located farther beneath the surface. The potential yield of a well in the Jordan aquifer in this same area exceeds 500 gpm. However, much of this surface and groundwater is already allocated to other beneficial uses. Water demands for a gasification facility in this area could be met by constructing a storage impoundment, by piping water from the Mississippi or Missouri River, or by shipping the coal to a facility located on one of these border streams. In addition, a low-BTU facility must be sited where the gas is going to be used, because low-BTU gas, unlike high-BTU gas, cannot be transported by pipeline.

A gasification plant could have a significant impact on water quality. Many potential water pollutants, including tars, oils, cyanides, ammonia, and sulfur compounds are produced and like a steam electric plant, a gasification facility will have to deal with the problem of dissipating the waste heat from the cooling water.

Major expansion of Iowa's coal industry will be necessary to produce the five to eight million tons per year required by a high-BTU gasification plant (Iowa's coal industry only produces 644,000 tons in 1975. However, a low-BTU plant requires only 1.1 to 1.8 million tons per year. Coal gasification may never be profitable in Iowa due to the lack of thick coal deposits, lack of water unless storage is provided, and lack of substantial population or industrial centers in the coal regions to use the low-BTU gas.

Currently, this synthetic gas is not economically competitive with other energy sources. However, as improved processes for conversion at lower costs are developed, as natural gas and petroleum supplies tighten, and air quality standards continue to restrict the potential for burning coal, the demand for any clean, gaseous fuel may be less restricted by price factors. Since gasification offers an alternate means of using Iowa's high sulfur coal, the potential for gasification may eventually gain importance even though the economic and natural resource requirements are large. Low-BTU gasification, in particular, should be investigated because it has lower coal, land, water, and money resource requirements.

Electricity

Withdrawal of water for dissipating waste heat from thermal-electric power plants is the largest category of water use in Iowa. (Figure 8-7 shows the location of existing and proposed power plants in Iowa.) About 68 percent of all ground and surface water withdrawal in Iowa is used to cool the condensers of steam-electric power plants. However, less than two percent of this gross water use is actually consumed; that is, lost by evaporation to the atmosphere.

Our use of electricity increases every year. Since 1969, Iowa has experienced more than a 7 percent annual increase in the use of electricity. It is unclear if this growth rate will continue until the year 2020, but if it does, electric power production will remain the largest non-consumptive user of Iowa's water resources.

FIGURE 8-3 Surface Water Availability Based on Average Flow—Iowa Coal-Bearing Areas

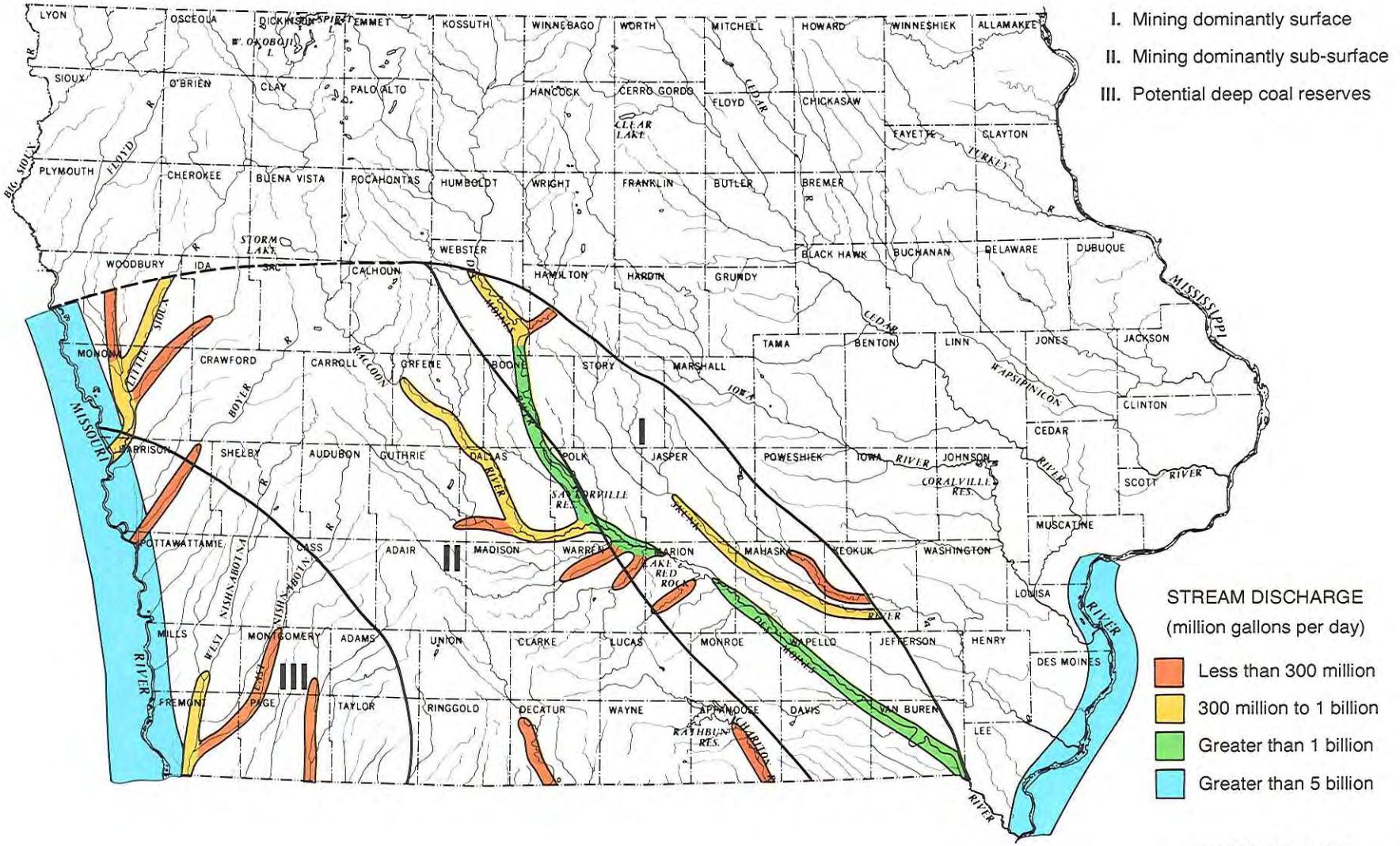


FIGURE 8-4 Surface Water Availability Based on Low Flow—Iowa Coal-Bearing Areas

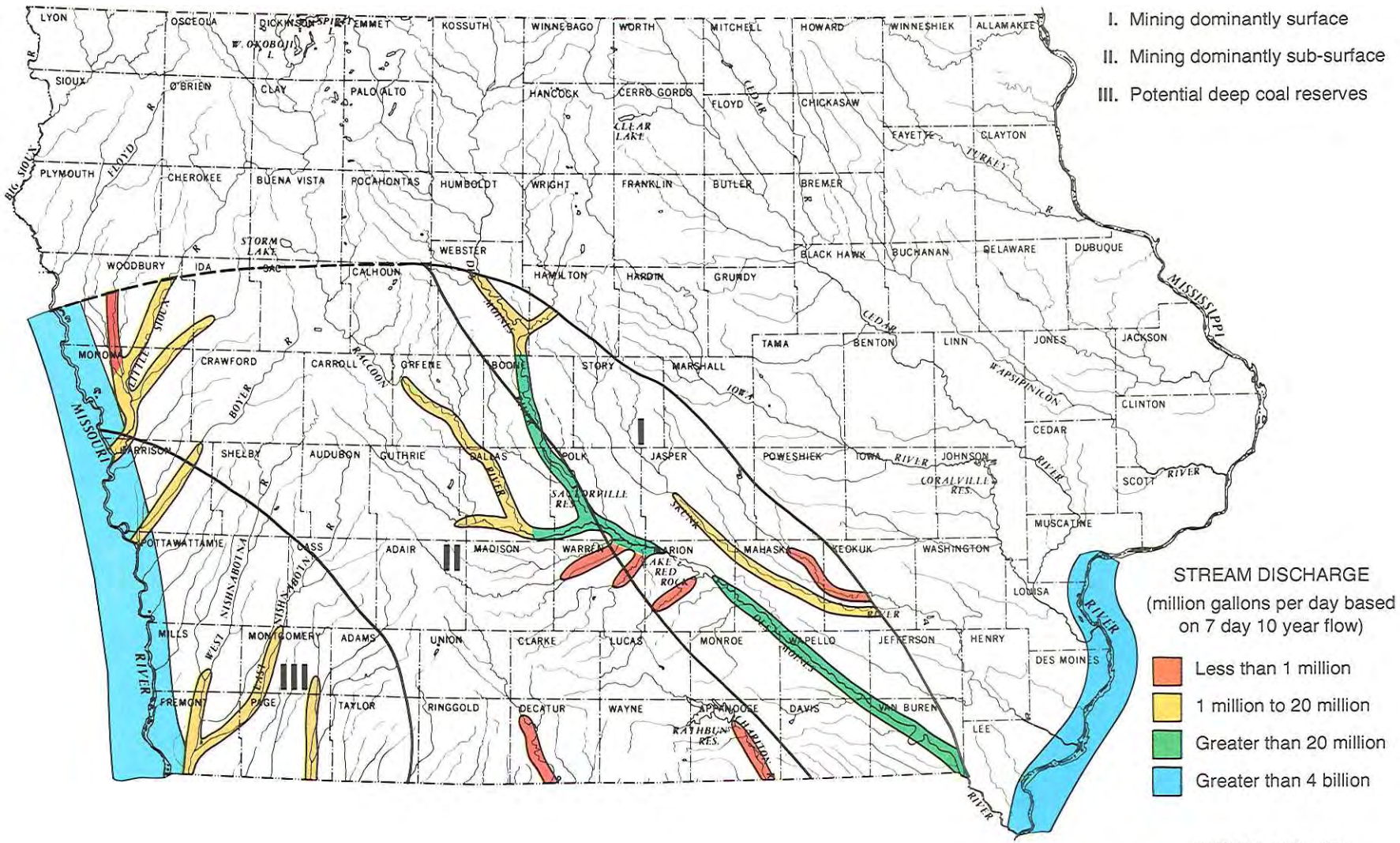


FIGURE 8-5 Bedrock Water Quality and Potential Yield—Iowa Coal-Bearing Areas

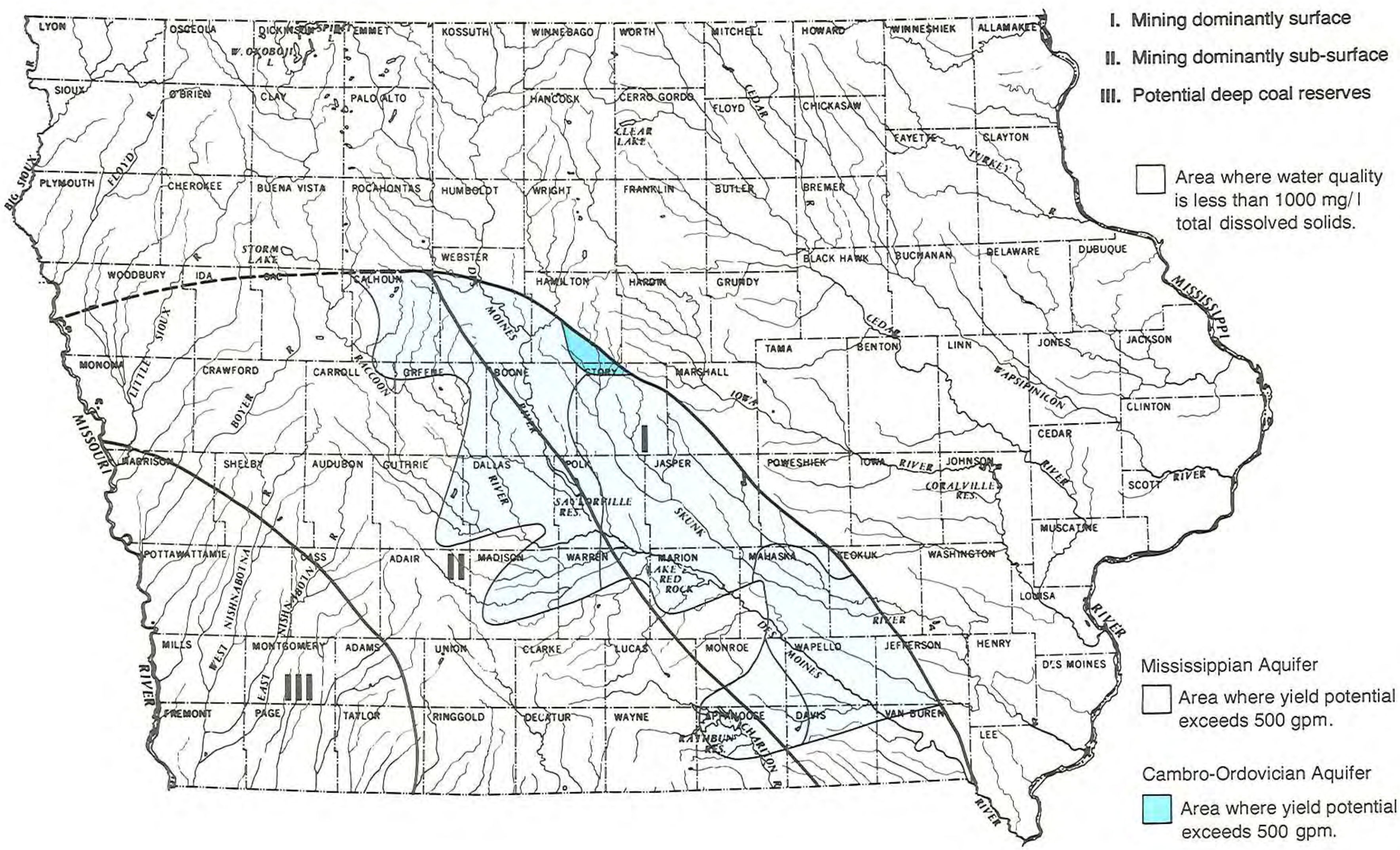
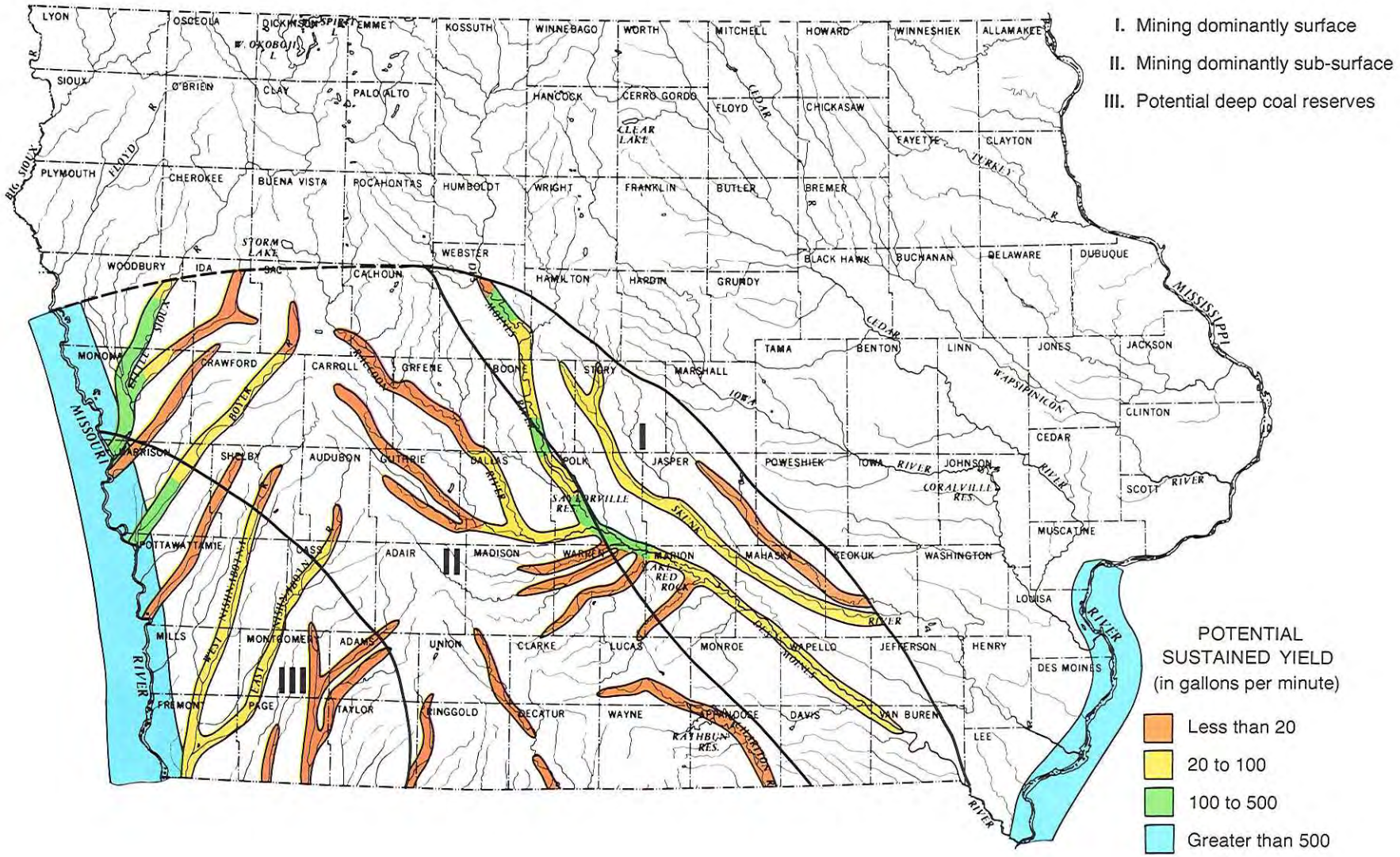


FIGURE 8-6 Potential Sustained Yield from Alluvial Aquifers—Iowa Coal-Bearing Areas



If our use of electricity increases at this same annual rate, in 2020, we will need to withdraw 54.9 million acre-feet of water for power plant condenser cooling, as compared to the 2.9 million acre-feet withdrawn for this purpose in 1976. Tables 8-1, 8-2, and 8-3 depict the three most likely trends in electrical use in Iowa and the effects on water needs. With low growth of 4 percent per year, 20.3 million acre-feet would be required for cooling in 2020; with high growth of 7 percent per year, 54.9 million acre-feet would be needed; and with the high growth of 9 percent per year until 1985 and leveling off at 4 percent thereafter, 32.5 million acre-feet would be required.

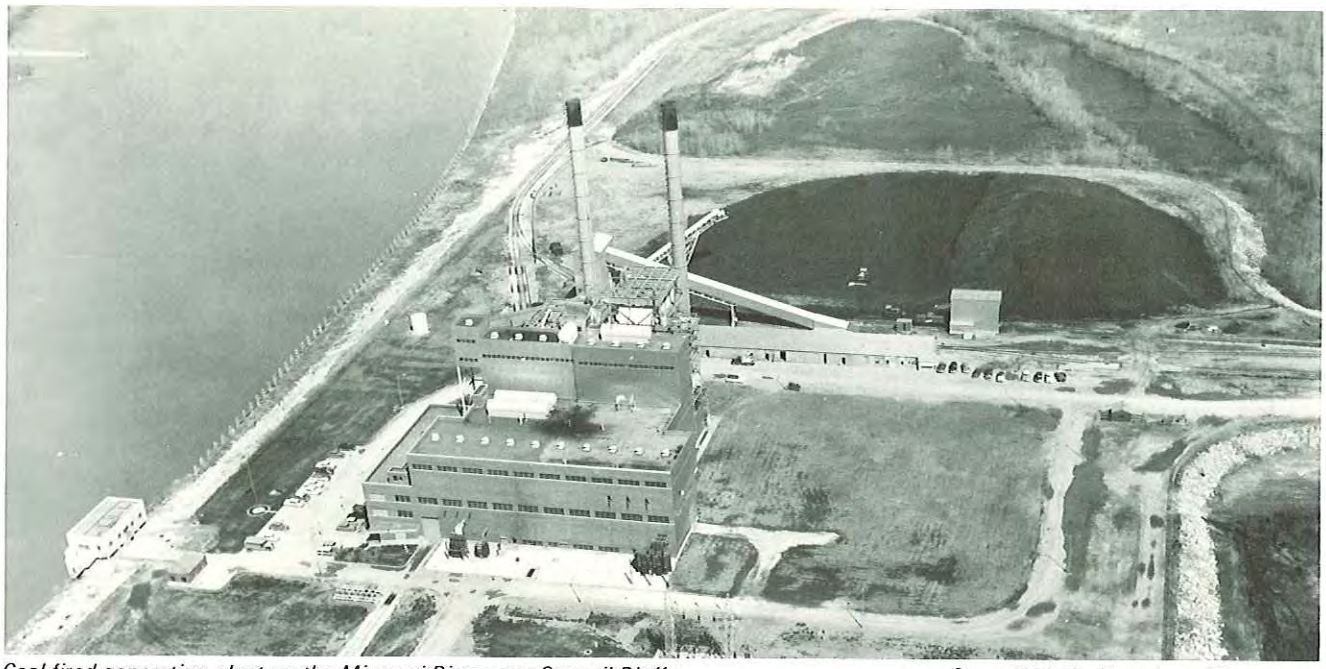
Although new technological developments in power generation such as magnetohydrodynamics (MHD) and nuclear fusion have the potential for making a significant impact on water requirements, they are many years in the future. Estimates indicate that nearly two-thirds of the nation's generating capacity in the year 2000 will be comprised of systems presently in widespread use. This means that water requirements for power generation will not be significantly reduced.

Although the largest category of water use is for cooling purposes, emission control systems on coal-fired plants can have significant water demands. These systems control emissions of particulates and sulfur

Windpower for pumping water
Iowa State Historical Museum

TABLE 8-1 Electric Power Use and Water Demands — 4% Growth

Year	Power Sales (million kWh)	Base-load Capacity (Mw)		Water Requirement (million acre feet)	
		fossil	nuclear	cooling	consumptive
1975	21,730	3,273	1,382	2.6	.026
1976	22,599	3,793	1,382	2.9	.026
1977	23,503	4,053	1,382	3.1	.028
1978	24,443	4,053	1,382	3.1	.029
1979	25,421	5,278	1,382	3.7	.029
1980	26,438	5,278	1,382	3.7	.030
1981	27,496	5,953	1,382	4.1	.034
1982	28,596	6,103	1,382	4.2	.036
1983	29,740	6,103	1,382	4.2	.037
1984	30,930	6,103	1,382	4.2	.039
1985	32,167	6,703	2,498	5.2	.048
1990	39,136	8,155	3,039	6.2	.059
1995	47,615	9,922	3,697	7.6	.072
2000	57,931	12,072	4,498	9.2	.087
2005	70,482	14,687	5,473	11.2	.106
2010	85,752	17,869	6,659	13.7	.129
2015	104,330	21,740	8,102	16.7	.157
2020	126,933	26,450	9,857	20.3	.191



Coal fired generating plant on the Missouri River near Council Bluffs *Council Bluffs Chamber of Commerce*

TABLE 8-2 Electric Power Use and Water Demands — 7% Growth

Year	Power Sales (million kWh)	Base-load Capacity (Mw)		Water Requirement (million acre feet)	
		fossil	nuclear	cooling	consumptive
1975	21,730	3,273	1,382	2.6	.026
1976	22,151	3,797	1,382	2.9	.027
1977	24,879	4,053	1,382	3.1	.029
1978	26,620	4,053	1,382	3.1	.031
1979	28,483	5,278	1,382	3.7	.033
1980	30,477	5,278	1,382	3.7	.035
1981	32,610	5,953	1,382	4.1	.040
1982	34,892	6,103	1,382	4.2	.044
1983	37,334	6,103	1,382	4.2	.047
1984	39,947	6,103	1,382	4.2	.050
1985	42,743	6,703	2,498	5.2	.064
1990	59,949	9,401	3,504	7.2	.090
1995	84,082	13,185	4,914	9.6	.127
2000	117,929	18,493	6,892	13.6	.177
2005	165,402	25,937	9,666	19.9	.249
2010	231,985	36,378	13,557	27.9	.349
2015	325,371	51,022	19,014	39.2	.490
2020	456,350	71,561	26,668	54.9	.687

Hydroelectric power plant and dam, Ottumwa *City of Ottumwa*

TABLE 8-3 Electric Power Use and Water Demands — 9%/5% Growth

Year	Power Sales (million kWh)	Base-load Capacity (Mw)		Water Requirement (million acre feet)	
		fossil	nuclear	cooling	consumptive
1975	21,730	3,273	1,382	2.6	.026
1976	23,686	3,793	1,382	2.9	.028
1977	25,818	4,053	1,382	3.1	.030
1978	28,142	4,053	1,382	3.1	.033
1979	30,675	5,278	1,382	3.7	.035
1980	33,436	5,278	1,382	3.7	.039
1981	36,445	5,953	1,382	4.1	.045
1982	39,725	6,103	1,382	4.2	.050
1983	43,300	6,103	1,382	4.2	.054
1984	47,197	6,103	1,382	4.2	.059
1985	51,445	6,703	2,498	5.2	.077
1990	65,658	8,555	3,188	6.6	.099
1995	83,798	10,919	4,069	8.4	.126
2000	106,950	13,936	5,193	10.7	.161
2005	136,498	17,786	6,628	13.7	.205
2010	174,210	22,700	8,459	18.0	.262
2015	222,341	28,972	10,796	22.2	.335
2020	283,770	36,976	13,779	28.4	.427

dioxide in order to meet air quality standards. Control of particulates by electrostatic precipitators requires only 0.8 percent of cooling water requirements; however, this can jump to 16 percent if water from the settling pond is not reused. Particulates can be removed by wet scrubbers; but this system consumes water by evaporation; consequently, water requirements for scrubbers are higher, accounting for about 10 percent of the cooling water requirements. Several processes have been developed for the removal of sulfur dioxide from gases emmitted from a coal-fired plant. Each system has about the same water requirement due to evaporation—about 10 percent of the cooling water requirement.

Cooling Systems

Steam-electric plants use water for a variety of purposes, the most significant being for condenser cooling. Several designs of cooling systems are used either alone or in combination; the system most suited for a plant being dependent on a multitude of factors. Each system varies in cost and requires a different amount of energy, land, and water as shown in Tables 8-4 and 8-5.

Once-through Cooling

Once-through cooling systems consume the least water, with water loss at least 25 percent less than that of a closed cycle system. A once-through system is also the least costly to install and maintain and the most energy efficient to operate. However, the water is pumped directly in and out of the condenser without any form of processing, resulting in discharge of heated water to the receiving stream. This "thermal pollution" is a cause of environmental concern, the present water quality standards limit the amount the temperature of a stream can be raised; for example, 5° F along the Mississippi and Missouri Rivers.

Although consumptive losses with a once-through system are small, withdrawal requirements are high—about 1 cubic foot per second per megawatt (cfs per Mw) for fossil fired plants, and 1.5 cfs per Mw for nuclear plants. Only Iowa's border streams have the heated discharge from the large power plants being built today. A recent study indicates that the Mississippi and Missouri Rivers could accommodate plants using once-through cooling if they are properly sited and use well-designed discharge structures.

TABLE 8-4 Energy, Water and Land Requirements for Alternative Cooling Systems

System	Land (acre/Mw)	Energy (% of installed capacity)	Water Consumption (gal/kWh produced)
Once-through	none	0.13	0.32
Cooling Ponds	3-4	0.15	0.52
Spray Ponds & Canals	.1-.2	1.9-3.8 (Quad Cities design)	1.1
Wet Towers	0.5	1.75-5.89	0.94
Dry Towers	0.8	2.0-8.0	none

Source: Adapted from:
U.S. EPA **Development Document**, p. 629
U.S. FPC 1970 **National Power Survey**, part I, p. I-10-17.
Drew, G. W. **Water Management in the Electric Utility Industry**, p. 154.

TABLE 8-5 Relative Costs of Alternative Cooling Systems

	Capital costs - $/kW	Operating Costs - $/kW-yr	Maintenance Cost - $/kW-yr	Additional costs to the Consumer per kWh	Total unit cost - mills per kWh
Once-through	5.24	0.50	0.50	—	0.168
Cooling Pond	7.50	0.62	1.62	0.26	0.219
Spray Pond	8.10	1.00	1.50	0.43	0.255
Nd Wet Tower	11.50	1.00	1.00	1.49	0.466
MD Wet Tower	9.40	1.33	1.33	1.56	0.480
MD Dry Tower	15.00	1.33	1.33	2.26	0.618

(Based on requirements of a nuclear plant with a 20°F. temperature rise across the condensers.)
Source: Drew, G. W., ed. **Water Management by the Electric Power Industry**, p. 152
(Based on 1969 costs and on the requirements of a nuclear plant.)

Cooling Ponds

There are several alternatives to the use of once-through cooling. A man-made or natural cooling pond may be used. These ponds serve a dual purpose: they provide a dispersion mechanism for the waste heat, and they provide water storage for plant operation. Water loss is less than that for wet cooling towers and energy utilization is about as low as that of a once-through system. On the average, installation and maintenance costs of a pond are lower than those of cooling towers; however, the land requirements are higher. There is a great deal of environmental concern about the construction of a large reservoir and about the inundation of valuable farmland. Utilization of one of the state's existing four major reservoirs (Red Rock, Rathbun, Saylorville, and Coralville) as cooling ponds is unlikely because they were authorized for other purposes. To utilize these impoundments for once-through cooling for steam-electric plants might create severe conflicts of interest.

Wet Cooling Towers

A wet cooling tower is another alternative to once-through cooling. Although water withdrawal needs are lower, consumptive water loss is usually about twice the loss from a once-through system. Towers also consume more energy than a once-through system. From 2 to 6 percent of the Mw capacity is needed to run a tower in warm months compared to between 1 and 2 percent for a once-through system. Despite high costs and consumptive losses by the system, the EPA considers the tower to be the best control technology. Towers discharge only "blowdown" and recirculate all other waters. Blowdown is water which must be eliminated to get rid of dissolved solids and which contains very little heat. Water withdrawal requirements are much less because water is recirculated, and new withdrawals are needed only to replace water lost through evaporation and blowdown. However, due to the variability of stream flow, a plant located in the interior of the state would still need some type of water storage facility to guarantee a water supply in times of low flow. Existing Army Corps of Engineers' reservoirs might be used for this purpose if reallocation of storage was considered. At the present time, supplies are earmarked for uses other than water supply augmentation for energy production, but studies on storage reallocation are currently being undertaken. Privately owned reservoirs are another alternative. Central Iowa Power Corporation recently purchased Lake Panorama, a real estate lake. On the border streams, supplemental storage would not be necessary; and thus, they are the preferred sites for power plants in terms of water supply.

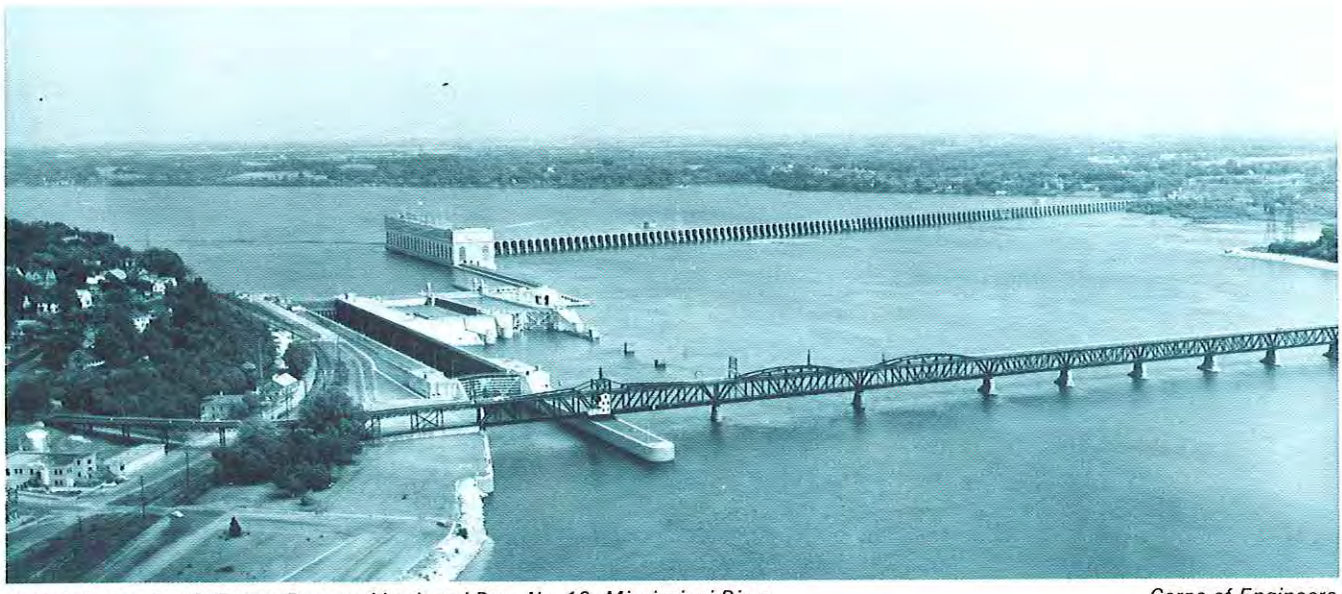
Spray Ponds and Canals

Spray ponds and canals combine the features of cooling ponds and towers to eliminate the inherent problem of the large land requirements for cooling ponds. Only .1 to .2 acre per megawatt (ac/Mw) are needed compared to 2 ac/Mw for ponds. However, disadvantages of this method include initial capital costs, high energy use, increased consumptive water loss, and technological unfeasibility in some situations. The Quad-Cities nuclear plant along Iowa's eastern border utilizes a spray canal.

Dry Towers

Dry towers have minimal water requirements because they remove heat by conduction and convection rather than evaporation. They operate like an automobile or truck radiator. This makes them most attractive in areas that are critically short of water. However, they are the most expensive to construct and operate of all cooling methods.

With the exception of dry towers, the alternative cooling systems have significant water requirements. Thus, the requirements of a power plant or any other large individual user can best be met by utilizing surface water, which is more easily renewable than groundwater.



Keokuk Hydroelectric Power Dam and Lock and Dam No. 19, Mississippi River *Corps of Engineers*

Conclusions and Recommendations

Plant Sites

Conclusion

Iowa has an impressive supply of surface water; however, the actual developable supply is much smaller due to the variability of stream flow. On the average, every other year, a peak flow is reached that is 30 or more times the average flow. During 10 percent of the time, however, low flows occur amounting to only about three percent of the annual flow. Due to this, Iowa's interior streams are able to provide makeup water for a large power plant only if additional storage is provided so that water is available in times of low flow. Even with additional storage, Iowa's interior streams do not have the capacity to accommodate once-through cooling for a large power plant. Storage is a means of making water available for energy production. There are several alternatives regarding storage for water supply purposes. Physical and geological factors limit the number of potential reservoir sites throughout the state. Even when a suitable site is found, there are numerous social, environmental, and land use factors that must be taken into consideration. There is a great deal of concern over flooding scenic areas, or large areas of valuable farmland.

Recommendation

A power plant siting program should be developed and implemented.

The possibility of reallocation of storage in existing reservoirs, for the purpose of providing water for energy development, needs to be investigated.

A study should be undertaken to identify reservoir sites suitable for energy development, throughout the state. A reservoir site preservation program is needed to reserve sites for future use.

In view of the physical limitations, environmental concern, and other conflicts, priority should be given to the development of multiple-use reservoirs in power plant siting.

The potential use of existing reservoirs as cooling ponds should be investigated as the need arises. The assimilative capacities of the reservoirs, the environmental affects of discharging heated water, the legal and institutional constraints of such a use should be assessed in such investigations.

Groundwater Withdrawal

Conclusion

The best yielding water wells in the state produce only between 500 and 2,000 gallons per minute (or between 1 and 4 cfs). It is easily recognized that this range of yield could not meet the 1.5 cfs/Mw (675 gpm/Mw) requirements of a once-through cooling system. The makeup water requirement for a plant with a closed cycle cooling system could potentially be met at a limited number of locations. However, the long-term effects on the aquifer and on existing and potential users would have to be determined. There is concern that the volume and rate of water withdrawal needed for cooling purposes would cause the mining of groundwater—that is, the rate of withdrawal would exceed the rate of recharge. Large withdrawals could have material adverse impacts on existing groundwater uses.

Recommendation

Energy development in the state should depend on the surface water resource, because of the high rate and large quantity of water required for a power plant cooling system. Smaller plant requirements might still be met by groundwater as well as tower makeup demands for plants with 100 Mw capacity or less.

Thermal Pollution

Conclusion

Once-through cooling is the least water consumptive, is cheapest to install and operate, has the least land requirements, and, is the most energy efficient to operate. Concern over the environmental effects of thermal pollution have prohibited its use on most streams. Iowa is fortunate in being bordered by two major rivers, the Mississippi and Missouri, which have the flow to satisfy the water requirements and the assimilative capacity to accommodate once-through cooling.

Recommendation

Because energy facility siting and development must consider optimal use of all natural resources, including land, water, and energy, as well as capital costs, once-through cooling on the border streams should carry the highest priority when it can be shown that no significant harm to the environment will occur.

There needs to be some flexibility in the implementation of temperature standards. There should be a mechanism whereby a variance from the five-degree temperature limit could be obtained, based on seasonal differences, hydrological differences, and on the diversity of the ecological system involved.

Gasification

Conclusion

The natural and economic resource requirements of a high-BTU gasification facility are large. It would require a tremendous increase in coal production which could create some serious land-use problems. The water requirements and water pollution potential for such a facility are significant. However, the land, coal, and water resource requirements for a low-BTU facility are considerably less.

Recommendations

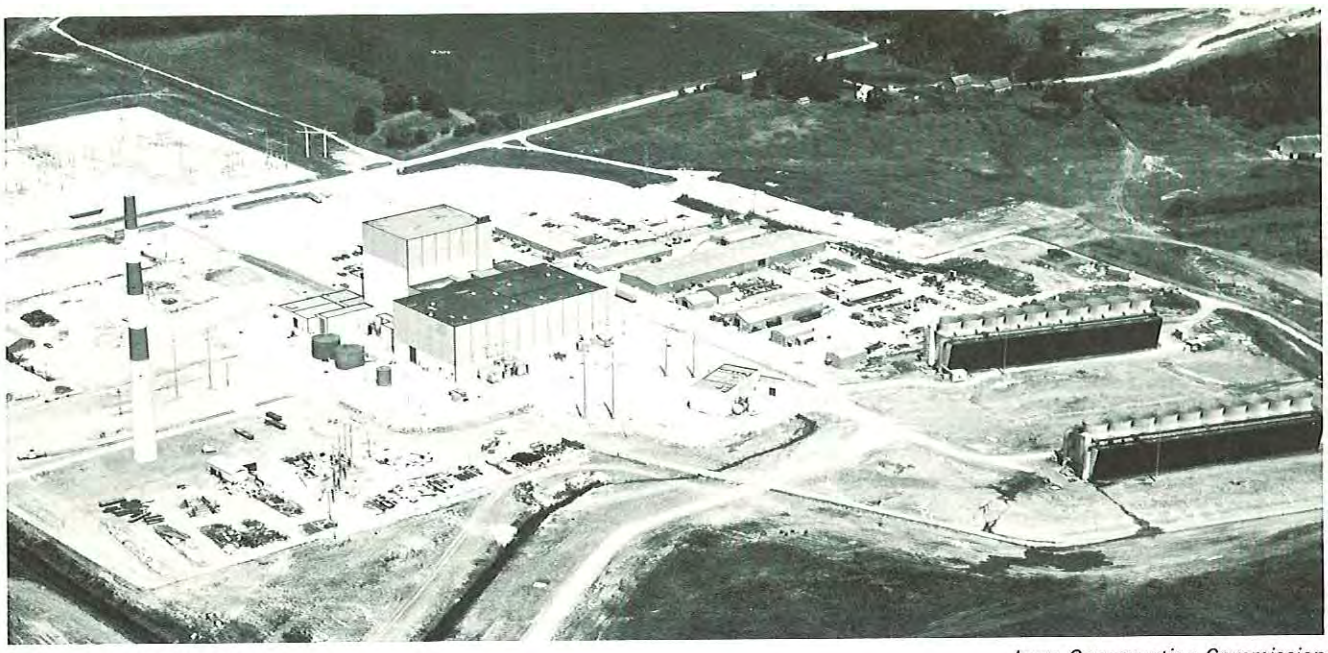
Energy studies should include evaluation of the low-BTU gasification potential as a means of using Iowa coal in an environmentally acceptable fashion.

Before a large scale, high-BTU gasification facility is considered in Iowa, a careful study should be made in order to assess the associated water and land resource problems.

Energy Conservation

Conclusion

Electrical energy demands will continue to grow even if not at the present high rates, and new sites will be needed for electric generating facilities. Not only will there be an increasing number of power plants, but there



Nuclear power plant, Palo *Iowa Conservation Commission*

will be an increase in the size of these plants. Although these plants will be generally more efficient than the older, smaller plants, they will create larger, more concentrated sources of waste heat.

There are both water quantity and quality problems associated with providing water for energy development. Although energy conservation cannot solve all of these problems, it can lessen the impact on the state's water resources. Also, additional benefits to be gained from energy conservation include conservation of fuel resources and reduction in air pollution.

Recommendation

Continued support of EPC's energy conservation program is recommended as an aid in controlling the amount of water which must be withdrawn and used for energy production.

Data Collection

Conclusion

Current methods of water use data collection by Iowa regulatory agencies are not adequate. Reports do not separate consumptive from non-consumptive use or individual uses such as condenser cooling, ash control, boiler feed, and blowdown. A more adequate data base will allow the planners to make better decisions regarding these competing water uses.

Recommendations

The data collection system should be updated and improved, with more emphasis placed on the quality (accuracy) of data received. The large water uses within a plant, such as condenser cooling flow rates, tower makeup, and ash control should be reported along with the gross water usage, regardless of the cooling system used. A more reasonable time base should be used, such as monthly, with the data reports submitted semi-annually or annually. Accuracy of the data submitted should be assured by requiring annual calibration of all instrumentation.

Acid Mine Drainage

Conclusion

The water requirements for mining and cleaning coal are modest, but there are some significant water quality problems associated with surface coal mining. Acid mine drainage problems occur when water contacts the mined surfaces of the earth and becomes contaminated from reactions with iron pyrite (or other sulfurous materials) and oxygen, resulting in the formation of sulfuric acid. This can result in runoff or leachate with an extremely low pH, which will seriously impair the productivity of the aquatic habitat. Erosion from strip mined lands is another serious water and land quality problem. Erosion impairs the future productivity of the land and causes sedimentation in streams and lakes.

Recommendations

In view of the serious environmental consequences of strip mining, Iowa's current mining and reclamation regulations should be strengthened and thereafter strictly enforced in order to prevent any significant degradation of land and water quality.