KANSAS PUBLIC WATER SUPPLIES — A CENTURY OF PROGRESS

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Introduction

The opportunity to share my experience and views with this body is a welcome one, for it gives me the pleasurable opportunity of acknowledging the leadership of many outstanding individuals past and present as well as visiting with many old friends.

Mr. Robinson, in extending the invitation to me last summer, asked for a historical review of public water supplies in Kansas during the last century, including the problems faced, the systems designed, and the people who have contributed to progress. My association with Kansas during the past 40 years has given me a great deal of respect for those early pioneers such as Dr. McClintock, Dr. Johnson, Colonel Tweeddale, Professors F.O. Marvin, EHS Bailey, Barber, W.C. Hoad, Earnest Boyce, Dr. Samuel Crumbine, and many others who contributed to the safe public water supplies which we enjoy today.

Any attempt to cover the history of public water supply in Kansas in a single speech must be sketchy at best, but, to help in organizing our thoughts I will discuss: 1. the early public health problems associated with drinking water, 2. the water men and women who were the leaders for change, 3. the evolution in water works practice, and 4. the attempts to deal with large variations in supply during flood and drought. I will not attempt to trace the history of the American Water Works Association in Kansas through the Missouri Valley Section and later the Kansas Section AWWA. I hope that someone will do so at later date.

While my comments are for the period 1880 to 1980, I am aware of water systems developed in Kansas much before that time. In the late 1600's a group of refugee Pueblo Indians from Mexico settled in Scott County near the Scott County State Lake. There they found springs from which they trapped water and conducted it in channels to supply their needs and that of the crops which they grew. Present day archaeologists have uncovered the remains of the irrigation ditches near the Scott County State Park.

Early Systems - Their threat to public health

In 1885 John Snow, in the Broad Street pump incident in London, identified polluted water as the cause of cholera. Two years later Louis Pasteur laid the foundation for the germ theory of disease with his work on wine fermentation and silk worm disease. In 1880 Pasteur was investigating cholera in chickens and followed up his germ findings in 1881. In 1882 Koch established a relationship between the tuberclebacillus and tuberculosis.

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Three years later, in 1885, the Kansas State Board of Health was formed with a large part of the Board's concern and activity directed toward improving sanitation practices. In the earliest years, however, Kansans and the world were influenced by the then popular concept of disease by miasma — the exundation of a mysterious nature from equally mysterious decaying organic matter in the oozes and slimes of swamps and low lands. At the first meeting of the Kansas State Board of Health in Topeka in 1885, Dr. Johnson of Atchison, the President of the Board remarked on "The Death Angel — Waste-Pipes." Dr. McClintock, President of the Topeka Board of Health, noted the polluted condition of the majority of wells in Topeka. He referred to a theory that two levels of groundwater existed in North Topeka, with the upper carrying away all polluted surface drainage and the lower, from which water supply was taken, as being free of organic impurities.

Upon investigation of those using the wells, Dr. McClintock found cases of dysentery and typhoid fever affecting at least 25 persons. In pointing out the results of chemical analysis (2) made of the well water, he stated, "a few specimens were good, a number usable, a larger number suspicious, and less number impure, which shows that the wells are truly in an alarming condition."

County Health Officers played an important part in improving the condition of Kansas public water supplies through their inspection of private supplies. For example, Dr. Simmons, Douglas County Health Officer, reported in 1885 that the poor conditions of private water supplies in Lawrence and Douglas County had lead to an outbreak of typhoid and typho-malarial fever.

In 1885, Topeka sewers drained directly to the Kansas River. In the winter, workmen harvested ice from the river within 25 feet of these outlets, leading one physician to draw the parallel with a passage from the Old Testament "Moab is my wash pot," with the modern version, which he said should be "The Kaw is our wash pot and our ice pond." Ice was also harvested from Soldier Creek north of Topeka which carried drainage from slaughterhouses and sewage from the State Reform School.

Typhoid fever, much of it water borne, was a common occurrence throughout the remainder of the 19th century and the early 20th century. It contributed to high rates of morbidity and mortality. Water systems continued to be a source of this disease in the period 1900 to 1910, when, under the prodding of the State Health Officer, Dr. Samuel Crumbine, cities began to use the chemical treatment of water along with sedimentation. In 1911, Atchison, Leavenworth, and Kansas City, Kansas had many cases of typhoid fever. Dr. Crumbine guided Kansas Governor W.R. Stubbs to address the governors of Missouri, Iowa, Nebraska, and South Dakota requesting that they appoint representatives of the health departments of those states to meet with representatives from Kansas to determine some commonly agreed upon action which might preserve the purity of the Missouri River.

The Missouri River Sanitary Conference was established as a result. A three-person Kansas commission was appointed with Dr. Crumbine as Chairman. The other states took similar actions, with the commissions directed to work together to find a means by which legislative actions could be taken to restore the purity of the Missouri River.

Dr. Crumbine was a leader in the new State and Territorial Health Officers Association and one of a very few state health officers who traveled to the meeting with "his engineer," Mr. Charles Haskins. In 1911 they requested the U.S. Public Health Service to make an investigation of the Missouri River.

(2) Possibly ammonia, chloride, nitrate, nitrite, and oxygen consumed and this was done in 1912. The investigation demonstrated that upstream sewage was carried into the public water systems. It was this sewage, contaminated with typhoid organisms, which contributed to the high typhoid rate in the Missouri River cities. Once cities using surface water installed chlorination, coagulation, and sedimentation facilities, typhoid fever was virtually wiped out as a waterborne disease. Filters were not provided at Atchison until after World War II.

The improved water quality was brought about to a considerable extent by state government including staff at Kansas University and by pioneer local health officers.

The early actions of the Kansas State Board of Health indicated that Kansas was not isolated from the main stream of public health. The board members quickly understood the new germ theory of disease and applied it. Highlights related to health included:

- 1833: Wichita was pumping water directly from the Little Arkansas River without sedimentation or filtration.

- 1886: The State Board of Health required that all ice taken from streams be a safe distance above contamination and more than five miles below it.

- 1887: The Board required cities constructing a water works system to submit water samples for chemical analysis before starting construction.

- 1887: The Board recommended that the Topeka Water Treatment Plant be moved upstream from pollution sources or that much deeper wells be constructed, commenting that the cost of construction should not be a deterrent to this improvement since "the welfare of the water works company is not to be weighed against the public health, the lives of company is not to be weighed against the public health, the lives of our people, and their right to enjoy pure water."

- Late 1880’s: The cities of Lawrence and Paola were using aerated sedimentation basins to provide treatment.

- 1901: Professor Marvin reported that he had met with Messrs. Burns and McDonnell to discuss proposed improvements to the Osawatomie public water supply. He called attention to the unique provision in the specifications that certain tests of the sanitary efficiency of the filter plant were to be approved by the sanitary engineer and the bacteriologist of the State Board of Health before construction was to proceed.

- 1907: The Kansas Water and Sewage Law was passed, through the efforts of Dr. Crumbine and Professor Hoad, requiring anyone supplying water to submit a

certified copy of the plans and surveys for water treatment and distribution. It also required that the source of supply be approved, and provided that no new source of supply could be used without a written permit in advance. This was the direct result of Dr. Crumbine's concern about the high incidence of typhoid fever.

- 1909: The use of the common drinking cup was prohibited in Kansas after an extensive public education campaign, directed by Dr. Crumbine, which captured the interest of the nation. Incidentally, this action led to the entire single service paper industry. Railroad officials, concerned about serving water to their passengers where the common cup was banned, called upon Dr. Crumbine to modify the order. He suggested single service containers. They inquired how this might be done, and he picked up a sheet of letterhead and rolled it into a cone to form a cup.

- 1913: The Board first began to certify the purity of drinking water used on interstate carriers.

- 1914: First U.S.P.H.S. Treasury Drinking Water Standards issued. Dr. Crumbine was a member of the Commission that produced these standards.

- 1915: The State Board of Health officially established the Water and Sewage Laboratory, although a small group had been doing laboratory work at the University since 1890.

- 1915: The Board required that an annual analysis of each public water supply be performed.

- 1923: The State Board of Health, at Earnest Boyce's suggestion, developed a procedure and began rating public water supplies.

- 1926: Drinking water suspected of being related to mottled enamel of teeth. Mr. Boyce surveyed all dentists and mapped areas of Kansas where mottling was reported.

- 1928: Cross-connections were the second cause of all waterborne outbreaks in the United States. State program started to identify and remove cross-connections.

- 1930: As part of an effort to publicize safe drinking water, 289 municipalities posted roadside signs stating that the drinking water was "Approved Kansas State Board of Health."

- 1930: A study made in Chetopa by Mr. Boyce showed that mottled tooth enamel in Chetopa was caused by the city's water supply. An investigation continued in 1932 with the examination of 69 school children who had mottled enamel and who had been using the city water during childhood. One hundred thirteen other students and normal teeth and these were demonstrated to have not used the city water during early childhood.

This study was indeed a pioneering one. In 1931, research studies in Arizona and Arkansas identified the link between fluoride and mottling. It was at this time that the direct relationship between the 8 and 9 mg/l fluoride in the city's water and mottled enamel was demonstrated. Not only did Chetopa change its source of water supply as a result of the findings, and by order of the Board, but other studies were initiated across the country linking mottled enamel with fluoride.

It should be noted that Chetopa voters were little different a century ago than voters today. They resisted the recommendation, and refused to approve the bonds in two elections. Finally in July of 1934, the Board urged the city to yet another effort. That effort was aided by a lawsuit against the city by the parents of a child who suffered the loss of her teeth from mottling. The threat to their pocketbooks was more convincing than the demonstrated threat to health.

- 1933: The board required any company or individual selling water in Kansas to display warning labels if the fluoride was sufficient to produce mottling in the teeth of children.

- 1934: Oil field brine disposal legislation passed in Kansas. Research program with U.S. Bureau of Mines initiated.

- 1942: The largest waterborne outbreak in Kansas occurred in Newton when 3,000 cases of bacillary dysentery were counted in the city. Proud of its Equus beds water, the city advertised that the water was 99.999 percent pure. The other one thousandth of one percent came from the sewage of Mexican laborers. The sewage drained into the city's main supply line while repairs were being made. The diluted sewage was quickly flushed throughout the distribution system and 30 percent of the population became ill. Thousands of troop train passengers who also received the water were affected. This experience led to widespread efforts to chlorinate public water supplies in Kansas even when source of supply was thought to be beyond reproach.

- 1966: Galena was the last city to chlorinate its water supply. It did so only after losing an appeal from the Board's order in the Kansas Supreme Court. This was strange in light of the progressive attitude when it started using liquid chlorine in 1919.

- 1945: Dr. Comley, an Iowa physician, discovered that high nitrate water contributed to nitrate cyanosis in some infants. Shortly thereafter an extensive program was undertaken in Kansas to evaluate the possible hazard posed in public water supplies. Several cases of cyanosis due to water from shallow private wells were investigated with the conclusion that water containing more than 20 milligrams per liter of nitrate as nitrogen posed a possible hazard. Programs were worked out with those supplies which exceeded this concentration, warning against its use by infants under six months of age. The State Board of Health also made it a reportable disease. No cases have occurred from public water supplies.

- 1955: Studies of organics in Missouri River water were started by Kansas, Missouri, and Nebraska using carbon columns as collectors.

In 1981, at the end of the century, concerns about the quality of drinking water continue. The Congress adopted Public Law 93-523 and Kansas followed with its modification of drinking water regulations to bring them into compliance with the Federal Drinking Water Regulations. These became effective in June 1977. Much of today's concern deals with the organic compounds which are released from chemical manufacture, and the application of herbicides, pesticides and fertilizers. In addition, some concern exists about the interaction between chlorine and organic compounds which causes the formation of trihalomethanes.

The Early Leaders

The early leaders who contributed toward safe drinking water were physicians, civil engineers, chemists, microbiologists, and faculty members from the University of Kansas. Colonel Tweeddale of Topeka was one of the first engineers to provide guidance to the infant Board of Health in the field of water supply and treatment. At the first meeting of the Board, the Colonel gave a report on the "State of the Art of Water Treatment." In the report he discussed sedimentation, chemical processes, distillation, and filtration — the latter method of purification used commonly in Europe but to a very limited extent in the United States.

Dr. Samuel Crumbine undoubtedly was a great leader. He became the state health officer in 1904 when the entire budget of the State Board of Health was $3,000 a year. It was Dr. Crumbine who convinced the legislature to pass the Water and Sewage Law in 1907 and to fund the water and sewage laboratory. He laid the basis for these laws through a program of field investigation and research. For two years, he and W.C. Hoad, Professor of Civil Engineering at KU, made repeated and extensive investigations of the conditions of public water supplies through the discharge of untreated sewage by the municipalities. They were aided in this by Professor E.H.S. Bailey, head of the Department of Chemistry, who made many of the analyses.

Dr. Crumbine believed in action. Shortly after his appointment as State Health Officer, he and Professor Barber of KU traveled by boat down the Kansas River from Topeka taking water samples every half mile to measure the effect of Topeka's untreated sewage. They proved that the Topeka sewage had not been entirely purified in the 28-mile journey to Lawrence. Incidentally, the trip took two days. The first night was spent at Lecompton. Dr. Crumbine, being the smaller of the pair remained in the boat while Professor Barber frequently debarked to push the boat over sandbars. Dr. Crumbine's special interest in public water supplies continued until he left Kansas in 1923 and included his work with the national commission that produced the first U.S. Drinking Water Standards (1914).

In addition to the early physicians already mentioned as serving on the State Board of Health, Dr. Earle Brown gave strong support to the pollution abatement efforts of Earnest

Boyce, Chief Engineer. Dr. Thomas R. Hood had a major impact on the quality of Kansas water supplies. He served as State health Officer during the drought of the 1950's and also supported the first attempt in the United States to clean up an entire river basin from sewage pollution. This led to frequent confrontations, with one at Marysville ending late at night and Dr. Hood and the author slipping safely out of town in a dense fog, while local residents played with a hangman's noose.

Civil engineers had an important part in the progress of public water supplies. I have already mentioned Colonel Tweeddale's advice to the first meeting of the Kansas State Board of Health. A civil engineering professor at the University of Kansas, W.C. Hoad was giving the Board advice at the turn of the century. He reviewed plans for the proposed construction of supplies and aided in the investigation of complaints and special problems. For example, he and Professor Bailey investigated a complaint about Parsons' city water supply. Professor Hoad reported that several decayed cattle carcasses had been found in the stream. They were removed.

Professor Marvin and Professor Hoad contributed to the public education which led to the passage of the 1907 Water and Sewage Law. Professor Hoad advised the Board on the use of Chlorine which began to be applied to public water supplies in Kansas in 1908. Other engineers playing an important role were Charles Haskins, F.M. Veatch, N.T. Veatch, and Albert Jewell. No doubt many others whose names have been omitted also made important contributions.

Professor Earnest Boyce, returning from World War I, came to Kansas in 1920 as Assistant Sanitary Engineer and became Chief Sanitary Engineer for the Board in 1924. He and Albert Jewell started operator training. He visited offices of consultants to give advice on design, and helped solve many problems through his field investigations. His contributions to understanding the role of fluoride have already been mentioned. He attacked the problems of salt-water pollution from oil production and was responsible for perhaps the earliest state program for the control of oil field brine, well ahead of neighbors in Oklahoma, Texas, and Louisiana.

Webster Kehr, Ray E. Lawrence, Selma Gottlieb, Paul D. Haney, Ben L. Williamson, Lewis A. Young, Robert Hess, Sr., Cassandra Ritter, Howard Stoltenberg, Russell Culp, Major Hagar, Frank Willey, Bob Mounsey, and Dan Rupp are but a few of the many who have made major contributions to improved water systems in Kansas in the last half century. Ray Lawrence carried out early investigations on cross-connection problems and sewage chlorination. Selma Gottlieb conducted early research on detection of low concentrations of fluoride in water. Miss Ritter helped the Public Health Service develop media for use with the milapore filter and perfected methods for using fecal strep as a measure of pollution. Dan Rupp, the highest paid official in Topeka, was an authority on lime softening.

This paper could deal entirely with the personalities who have helped shape Kansas' water works practice, but I must hurry on to the discussion of the state's evolution in water treatment and the impact of floods and droughts. Before I do, however, let me pay tribute to Dr. Erasmus Haworth, Dean of Geology at KU, who discovered the Equus beds. He was employed by the City of Newton to find a water supply. He charged the

city $13.50 for his services and expenses of travel. Little did he dream when he died in 1932 that he had discovered a groundwater system so abundant in supply that it would become the main source of the state's largest public system. An interesting sidelight to early Kansas water history is that two pioneer Kansas State Sanitary Engineers would become distinguished professors of the University of Michigan. They were W.C. Hoad and Earnest Boyce.

Evolution in Water Treatment

The purpose today is not to trace in detail the development of water purification practice. Kansas practices parallel water purification methods elsewhere in the nation and abroad in terms of chemical treatment, filtration, iron and manganese removal, softening, chlorination and disinfection. However, in the hope that you will find a few of these facts interesting, let me call attention to a few of the more easily found "firsts":

- 1829: Part of London's water supply was filtered through slow sand units.
- 1866: St. Louis sent James B. Kirkwood to Europe to study filtration practices in England and Germany.
- 1873-1875: Cities along the Hudson River began to install slow sand filtration units.
- 1880: Atchison constructed water treatment works consisting of sedimentation basins.
- 1881: Abilene constructed water treatment works with wells, a distribution system, and standpipe.
- 1883: Kansas City, Kansas constructed facilities including sedimentation basins and six-1 mgd Jewell, wooden tub, mechanical gravity filters.
- 1897: Council Grove built a "New York" type pressure filter.
- 1899-1901: New Orleans and Washington, D.C. installed filtration units.
- 1908: The first use of hypochlorite solutions for disinfection.
- 1915: Chanute and Osawatomie built rapid sand filters, among the first I have been able to find.
- 1917: Valley Falls and Coffeyville were "'among the first communities" in the
- 1921: Topeka constructed aerators, grit chambers, mixing chamber, settling basins, pre-filters, coagulating basin final filters, and sterilizing apparatus.

- 1938: Very high turbidities from the Kansas River at Lawrence, approximately 50,000 turbidity units. The use of carbon filtration for odor control was begun at Lawrence.

- 1939: The Kansas City Star published a photograph of KU's Chancellor Malott walking away from the water laboratory at Marvin Hall with a jug of carbon filtered water.

- 1945: Chlorine dioxide was first used in the elimination of tastes and odor in Lawrence.

- 1946: The first fluoridation equipment was installed at Ottawa. It utilized a homemade feeder costing less than $100,000, was built by "Dad" Meyers, and continued in use through the 1970's.

- 1956-7: The first intentional water reuse was practiced at Chanute and Lyndon.

Floods and Drought

Kansas water supplies have suffered from both an overabundance and a scarcity of rain. The most damaging flood occurred in July 1951, and the most damaging drought followed immediately from 1952 to 1957. A brief historical review of floods and droughts follows:

- June 1844: Greatest flood of record on Kansas River.

- 1859-1868: Drought caused 40,000 eastern Kansas settlers to leave.

- 1881: Drought caused settlement boom to collapse, bank and businesses to fail.
- 1893-4: Drought. Farmers hit hard.

- 1903: Most damaging flood to date on Kansas River inundating private and public water supplies.

- 1910-1917: Drought.

- 1933-1938: Drought — driest on record. Governor Landon organized an emergency water conservation program in 1934. He secured the loan of several hundred gas and motor driven pumping units from oil producing companies to pump from rivers, creeks, and ponds into storage tanks from which farmers and stockmen could haul water for livestock.

- 1951: On July 13, 37 Kansas municipal water supplies were knocked out along the Smoky Hill, Solomon, Saline, Blue, Kansas, Cottonwood, Marais des Cygnes, and Neosho Rivers. The flood was caused when a rainstorm centered on the divide

between the Kansas and Neosho Rivers between Junction City and Salina. It caused flows of one million cubic feet per second in the Kansas River at Kansas City and 500 thousand cubic feet per second in the Neosho River at the Oklahoma line.

Customers were notified to boil all water used for drinking. Several portable water purifiers owned by the Board, two truck-mounted purifiers owned by the U.S. Public Health Service and other units owned by the Corps of Engineers were employed. Plants that remained in service found the normal stocks of chemicals insufficient. Damage to electrical-switch gear and motors was extensive. Portable and stationary motor-drying equipment was at a premium. Mud had to be removed from settling basins, clear wells, filters, and other parts of the plants. Only a few wells had to be replaced, however. The condition of water distribution systems varied considerably. The breakage of fire hydrants by bulldozers removing debris and silt from the streets caused much of the damage. The State Board of Health Engineers made daily visits to each of the cities to guide rehabilitation.

- 1952-1957: Drought — this was the most devastating. Rural areas were the hardest hit and the drought stimulated the start of rural water development. Two hundred and fifty-eight of 426 public water supplies and shortages. Eighty-three had critical or near critical shortages. Sixty had to find emergency sources. A total of 172 supplies required either voluntary or compulsory water use restrictions. Lake supplies were exhausted for two years or more at Osage City, August, and El Dorado.

  Normal well-water supplies at Valley Falls and Oskaloosa failed and emergency treatment equipment owned by the Board was used to treat surface water. Portable chlorination equipment and pumping facilities were set up in Lyndon to reclaim water from pools in the creek bed below the city. Although this water had been stored in these pools for 30 to 60 days, special treatment was needed because part of it originated from the effluent of the sewage treatment plant. This emergency measure supplied Lyndon with safe water for about 3 months, until the end of the drought.

  In the summer of 1956 the Neosho River ceased to flow, threatening Chanute's water supply. City officials considered several alternative sources. They decided to recirculate the treated sewage, and on October 14,1956, without fanfare, the city opened the valve which permitted mixing of treated sewage with water stored in the river channel behind the water works dam. Further precautions were required, including chlorination of the sewage treatment plant effluent, re-chlorination of raw water, installation of a continuous chlorine residual recorder at the softening plant, and more frequent sampling.

  The treated water had a pale yellow color and an unpleasant musty taste and odor. Initial public acceptance was good but gradually changed when stories appeared in the local papers. There were no known cases of waterborne disease or other adverse health effects.

- 1963-1967: Drought. One hundred and thirty systems of 514 experienced shortages. Six required emergency supplies. Thirty cities which had shortage problems also had problems in the drought of the 1950's but did nothing to develop adequate reserve supplies.

- 1971-1974: Drought. Forty-five public water supplies had shortages. One system hauled water and five others used civil defense emergency filter systems to treat surface water to supplement supplies from regular sources.

- 1976-7: The same systems which had previously run out of water repeated.

- 1980: The drought was especially intense in June and July. Records for low precipitation were set along with records for high temperatures. In eastern Kansas fifty-two systems were unable to supply their customers continuously.

In summary, Kansas has faced a wide variety of water supply problems in the last century. That many of these were solved for the benefit of Kansas was due in large part to the innovativeness and leadership of waterworks and public health officials for whom Kansas has provided a fertile and supportive environment. As one of those who has benefited from this support, I express my appreciation to you and to your fellow citizens.