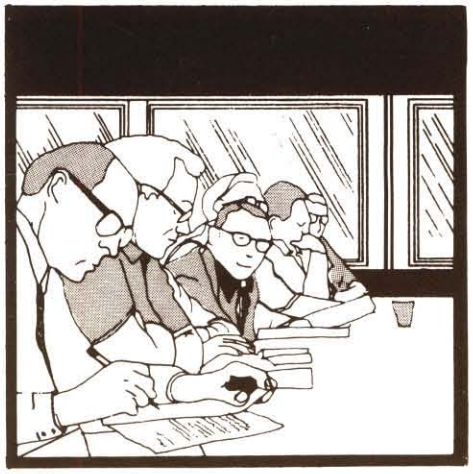
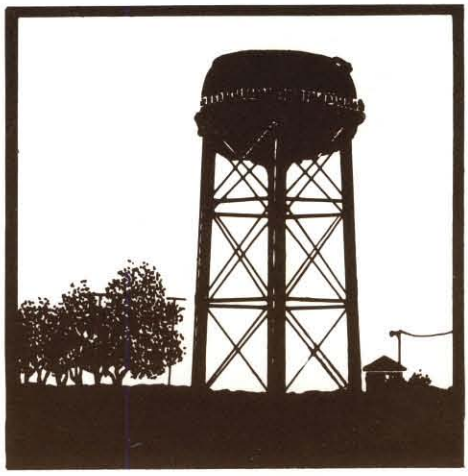
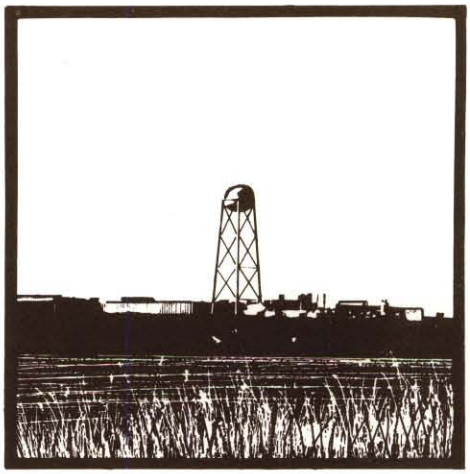




APPENDIX TO THE POLICY ISSUE STUDY ON

MUNICIPAL WATER NEEDS



State Water Planning and Review Process
Nebraska Natural Resources Commission

MARCH 1983

POLICY ISSUE STUDY
ON
MUNICIPAL WATER NEEDS

STATE WATER PLANNING AND REVIEW PROCESS

AN APPENDIX TO
THE MUNICIPAL WATER NEEDS
POLICY ISSUE STUDY
APPENDIX A THROUGH H

REPORT
OF THE
NATURAL RESOURCES COMMISSION
TO
GOVERNOR ROBERT KERREY
AND
THE MEMBERS OF THE NEBRASKA LEGISLATURE

MARCH 1983

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APPENDIX A

Summary of Statutory Authorities

STATUTORY AUTHORITIES OR CONSTRAINTS APPLIED TO MUNICIPAL OR PUBLIC WATER SYSTEMS - PURPOSE FOR WHICH SYSTEM MAY BE ACQUIRED OR CONSTRUCTED.

Subdivision Classification	Authority or Constraint	Source NEB R.R.S. 1943
Metropolitan District	Control of water supply for domestic, mechanical, public, and fire purposes, either by acquisition or franchise.	(14-1008)
Primary Class Cities	Creation districts and supply for domestic, industrial or fire purposes, or to enlarge existing mains.	(15-528)
First Class Cities	Power delegated to construct and operate water works, or may franchise such service to private enterprise, but under franchise may require service to any person along pipes or conduits without regard to purpose of use. (Note: Laws governing utility service in First Class Cities include gas, water, power, heat without separation of procedures or authority.)	(16-673) (16-678) (16-679) (16-681)
Second Class Cities and Villages	Provision of steam engines and a supply of water for fire protection, public use, and for the use of inhabitants. The system of water works must be located in whole or in part within each city or village.	(17-531)
Any Class City	Provide utility service and exercise police powers over airports, parks, or water works system outside corporate limits.	(18-1715)
Improvement Districts	Powers delegated or limited by the court in approval of Articles of Incorporation.	(31-727)
Rural Water Districts	Once organized, power and authority to provide water for all rural use, except irrigation, but including service to communities under 10,000 population with Federal grant and loan funds.	(46-1008)
Natural Resource Districts	Provision of water for domestic, agricultural, and industrial or any other beneficial use.	(2-3223)

STATUTORY AUTHORITY OR CONSTRAINTS APPLIED TO MUNICIPAL OR PUBLIC WATER SYSTEMS - MANAGEMENT

Subdivision Classification	Authority or Constraint	Source NEB R.R.S. 1943)
Metropolitan District	Managed by elected and bonded Board of Directors; most employ trained and bonded general manager; limited control on general personnel policy by statute; may tax for fire protection purposes after minimum protection; may issue rules and regulations and set rates; must operate services as separate utilities; and must repay 2% of income to the several political subdivisions served by the systems.	(14-1003) (14-1020) (14-1021) (14-1022) (14-1019) (14-1015) (14-1042)
Primary Class Cities	Little or no control unless addressed in home rule charter.	(15-228)
First Class Cities	Authority with mayor and council to operate system; may establish reserve fund for replacement, operation and maintenance; may by ordinance establish Board of Public Works; Board limited by requiring Council approval on rates and major expenditure.	(16-675) (16-864.01) (16-691)
Second Class Cities and Villages	Managed by elected council or village board; must delegate bonded water commissioner, not a member of council or board, to collect income from water system, report condition of system semi-annually, and approve any expenditure of funds for system operation, maintenance or expansion.	(17-541) (17-543)
Improvement Districts	Managed by elected and bonded board; may appoint and pay an engineer, must elect one board member to be clerk.	(31-706) (31-707)
Rural Water Districts	Managed by elected boards;	(46-1007)
Natural Resource Districts	Managed by elected boards;	(2-3213)

STATUTORY AUTHORITY OR CONSTRAINTS APPLIED TO MUNICIPAL OR PUBLIC WATER SYSTEMS FINANCING CAPITAL IMPROVEMENTS

Subdivision Classification	Authority or Constraint	Source NEB R.R.S. 1943)
Metropolitan District	May assess 1.5 mill tax on taxable property; may issue mortgage or revenue bonds; vote required on mortgage bonds. Must maintain separate water account for all water system income and may invest such funds within limits; may lend funds from one utility account to another when more than one utility is operated.	(14-1026) through (14-1029) (14-1104)
Primary Class Cities	Upon favorable vote of the people may issue bonds for a period not to exceed twenty years; or may issue bonds in accordance with the home rule charter of the City.	(15-228)
First Class Cities	May assess 2.0 mill tax on taxable property for lighting, heat, water, etc., but limited to one mill for any one of the respective services; may pledge city credit up to $250,000 for constructing, maintaining or operating water system after voter approval; funds for expansion limited to $125,000 per year not to exceed in aggregate the $250,000 limit; upon majority vote of the people, revenue bonds, in saleable amount, may be issued.	(16-675) (16-676) (16-6101)
Second Class Cities and Villages	May assess 2.1 cents on approval by petition vote for the purpose of maintaining and operating the water system; may make improvements costing up to $7,500 without bids; may issue general obligation bonds not exceed 12% of assessed valuation, upon voter approval; may place water works income into general fund; may assess 3/5 mill to maintain fire hydrants; may establish water service districts and assess property for cost or issue general obligation bonds payable within 10 years; may issue revenue bonds.	(17-545) (17-568.01) (17-534) (17-540) (17-545) (17-975) (17-976) (18-1803)
Improvement Districts	May issue general obligation bonds up to 5.3% assessed valuation for utility including water mains; may issue revenue bonds payable from earnings of the district to construct sources of supply and water treatment plants.	
Rural Water Districts	Financed by 40 year, 5% loans and grants from the federal government. Loan limit based on ability of consumers to pay with remainder of costs through direct grant. No taxing authority.	(46-1008)
Natural Resource Districts	May assess 1 mill tax and borrow money to be repayed from taxes on property within the district or may issue revenue bonds for a specific project.	(2-3226)

STATUTORY AUTHORITY AND CONSTRAINTS APPLIED TO MUNICIPAL OR PUBLIC WATER SYSTEMS FISCAL ACCOUNTABILITY

Subdivision Classification	Authority or Constraint	Source NEB R.R.S. 1943
Metropolitan District	All accounts audited by secretary and approval required from Committee on Accounts and Expenditures; records subject to public inspection; Directors may set rates for particular services; all payments and receipts paid daily to county treasurer; may contract for work or may accomplish work without bidding or contract; may transfer funds; must operate utilities separately, but may transfer funds from one operation to another, with interest, for a period not to exceed five years; may withdraw funds from Treasurer and maintain checking accounts for current expense.	(14-1013) (14-1014) (14-1016) (14-1027) (14-1102) (14-1104)
Primary Class Cities	As applied by home rule charter.	(15-228)
First Class Cities	Council establishes rates and shall require meters to determine consumption; may use reserve funds under construction contract or with employed labor; may establish a board of public work to manage system and use funds deposited with the city treasurer; First Class Cities subject to Municipal Accountability Act.	(16-681) (16-691) (19-2901 through 19-2909)
Second Class Cities and Villages	Council or village board establishes rates; surplus income may be used to retire bonds, for improvements, or may be transferred to the general fund, or invested in U.S. Bonds; water commissioner must account for water system income to the treasurer; subject to Municipal Accountability Act.	(17-538) (17-540) (17-543) (19-1901 through 19-1909)
Improvement Districts	Bonds must be certified by the Auditor of Public Accounts prior to issuance; County Treasurer ex-officio treasurer and responsible for all funds remitted monthly.	(31-759) (31-739)
Rural Water Districts	Annual audit required.	(46-1018)
Natural Resource Districts	Must provide NRC with copy of annual audit.	(2-3222) (2-3223)

APPENDIX B

NEBRASKA SAFE DRINKING WATER ACT
Article 53
NEBRASKA SAFE DRINKING WATER ACT §71-5301

Section.

71-5301. Terms, defined.

71-5302. Director; adopt drinking water standards; rules and regulations; purpose; harmful materials; how determined; applicability.

71-5303. Public water supply system; permit; director; inspect system; report; powers; denying or revoking permit; basis; appeal hearing.

71-5304. Director; rules and regulations; construction and operation of system; objectives, enumerated.

71-5305. Public water supply system; construction, extension, or alteration; written authorization required; exception; procedure.

71-5306. Director; powers and authority, enumerated.

71-5307. Operator of public water supply system; certificate of competency required.

71-5308. Certificate of competency; application; forms; contents; issuance; duration; investigation.

71-5309. Director; rules and regulations; qualifications of operators of public water supply system; considerations.

71-5310. Director; authorize variances or exemptions to standards; when; conditions.

71-5311. Advisory Council on Public Water Supply; established; duties; members; qualifications; terms; vacancy; meetings; officers; quorum; expenses.

71-5312. Violations; penalty; county attorney or Attorney General; take action to assure compliance with act.

71-5313. Act, how cited.

71-5301. Terms, defined. As used in sections 71-5301 to 71-5313, unless the context otherwise requires:

(1) Council shall mean the Advisory Countil on Public Water Supply;

(2) Director shall mean the Director of Health or his authorized representative;

(3) Designated agent shall mean any political subdivision or corporate entity having the demonstrated capability and authority to carry out in whole or in part the provisions of sections 71-5301 to 71-5313 and with whom the director has consummated a legal and binding contract covering specifically delegated responsibilities;

(4) Major construction, extension, or alteration shall mean those structural changes that affect the source of supply, treatment processes, or transmission of water to service areas, but shall not include the extension of service mains within established service areas;

(5) Operator shall mean the individual or individuals responsible for the continued performance of the water supply system, or any part of such system, during assigned duty hours;

(6) Owner shall mean any person owning or operating a public water supply system;

(7) Person shall mean any individual, firm, partnership, association, company, corporation, political subdivision, or other entity;

(8) Water supply system shall mean all sources of water and their surroundings under the control of one owner, and shall include all structures, conduits, and appurtenances by means of which such water is collected, treated, stored, or delivered, except service pipes between street mains and buildings and the plumbing within or in connection with the buildings served;

(9) Public water supply system shall mean a water supply system designed to provide the public piped water fit for human consumption, if such system has at least fifteen service connections or regularly serves at least twenty-five individuals. This definition shall include (a) any collection, treatment, storage, or distribution facilities under control of the operator of such system and used primarily in connection with such system, and (b) any collection or pretreat-

ment storage facilities not under such control which are used primarily in connection with such system; and

(10) Drinking water standards shall mean rules and regulations adopted pursuant to section 71-5302, and which (2) establish maximum levels for harmful materials which, in the judgment of the director, may have an adverse effect on the health of persons, and (b) which apply only to public water supply systems.

Source: Laws 1976, LB 821, §1.

71-5302. Director; adopt drinking water standards; rules and regulations; purpose; harmful materials; how determined; applicability. (1) The director shall adopt and promulgate necessary minimum drinking water standards, in the form of rules and regulations, to insure that drinking water, supplied to consumers through all public water supply systems, shall not contain amounts of chemical, radiological, physical, or bacteriological material which are determined by the director to be harmful to human health.

(2) In determining what materials are harmful to human health, and in setting maximum levels for such harmful materials, the director shall be guided by:

(a) General knowledge of the medical procession as to materials and substances which are harmful to humans if ingested through drinking water; and

(b) General knowledge of the medical profession and related scientific fields as to the maximum amounts of such harmful materials which may be ingested by human beings, over varying lengths of time, without resultant adverse effects on health.

(3) Subject to section 71-5310, state drinking water standards shall apply to each public water supply system in the state, except that such standards shall not apply to a public water supply system:

(a) Which consists only of distribution and storage facilities and does not have any collection and treatment facilities;

(b) Which obtains all of its water from, but is not owned or operated by, a public water supply system to which such standards apply;

(c) Which does not sell water to any person; and

(d) Which is not a carrier which conveys passengers in interstate commerce.

Source: Laws 1976, LB 821, §2.

71-5303. Public water supply system; permit; director; inspect system; report; powers; denying or revoking permit; basis; appeal hearing. (1) Commencing January 1, 1978, no person shall operate or maintain a public water supply system without first obtaining a permit to operate such system from the director.

(2) To aid in accomplishing the purposes of sections 71-5301 to 71-5313, the director shall inspect public water supply systems and report findings to the owner, publish a list of those systems in compliance, and promote the training of and certify the capability of operators, and may seek a temporary or permanent injunction or such other legal process as is deemed necessary to obtain compliance with the provisions of sections 71-5301 to 71-5313.

(3) The basis for denying or revoking a permit to operate a public water supply system shall be noncompliance with the provisions of sections 71-5301 to 71-5313 or the rules and regulations adopted thereunder.

(4) Any person shall be granted, upon request, an opportunity for a hearing before the department under the provisions of Chapter 84, article 9, prior to the denial or revocation of a permit. Judicial review of such denial or revocation may be obtained as provided by such chapter and article.

Source: Laws 1976, LB 821, §3.

71-5304. Director; rules and regulations; construction and operation of system; objectives, enumerated. (1) The director shall adopt and promulgate necessary minimum rules and regulations governing the siting, design, construction, alteration, and operation of public water supply systems to insure that such public water systems shall not contain amounts of chemical, radiological, physical, or bacteriological materials which are determined by the director, pursuant to section 71-5302, to be harmful to the physical health of human beings. In adopting such rules and regulations, the director shall attempt to meet the following objectives:

(a) Insure that facilities are physically separated, to the greatest extent possible, from water or land areas which contain high levels of materials which are harmful to humans;

(b) Insure that such facilities, and all parts thereof, are physically sealed so that leakage of harmful materials into the water system itself from sources outside the system shall not occur;

(c) Insure that all materials which are used in the construction of a system shall not place harmful materials into the water system;

(d) Insure that all chemicals or other substances used to treat and purify water are free from harmful materials; and

(e) Insure, to the greatest extent possible, that such rules and regulations will allow uninterrupted and efficient operation of public water systems.

(2) The rules and regulations may contain differences and distinctions based on the physical size of the facilities and number of persons served, so long as the objectives of this section are met.

Source: Laws 1976, LB 821, §4.

71-5305. Public water supply system; construction, extension, or alteration; written authorization required; exception; procedure. (1) No major construction, extension, or alteration of a public water supply system shall be commenced after July 10, 1976 without written authorization from the director. No such authorization shall be needed in the case of minor repairs and matters of maintenance. No such authorization shall be granted unless plans and specifications, prepared by a registered professional engineer, and any additional information required by the department have been submitted to the department or its designated agent for review.

(2) Upon a finding that there has been compliance with the minimum sanitary requirements adopted pursuant to section 71-5304, authorization to proceed with construction shall be granted by the director or his designated agent. In issuing authorization for the development of new public water supply sources, consideration shall be given to the location and effects of other water supply systems and the location of points of discharge or disposal for solid and liquid wastes.

Source: Laws 1976, LB 821, §5.

71-5306. Director; powers and authority, enumerated. To carry out the provisions and purposes of sections 71-5301 to 71-5313, the director may:

(1) Enter into agreements, contracts, or cooperative arrangements, under such terms as are deemed appropriate, with other state, federal, or interstate agencies or with municipalities, educational institutions, local health departments, or other organizations, entities, or individuals;

(2) Require all laboratory analyses to be performed at the Department of Health Laboratory, or at any other laboratory which has entered into an agreement with the Department of Health therefor, and establish and collect fees for making laboratory analyses of water samples pursuant to sections 71-2613 to 71-2621, except that the provisions of subsection (4) of section 71-2619, shall not apply for purposes of sections 71-5301 to 71-5313;

(3) Receive financial and technical assistance from an agency of the federal government or from any other public or private agency;

(4) Enter the premises of a public water supply system at any time for the purpose of conducting monitoring, making inspections, or collecting water samples for analysis;

(5) Delegate those responsibilities and duties as deemed appropriate for the purpose of administering the requirements of sections 71-5301 to 71-5313, including entering into agreements with designated agents which shall perform specifically delegated responsibilities and possess specifically delegated powers; and

(6) Require the owner and operator of a public water supply system to establish and maintain records, make reports, and provide information as the department may reasonably require by regulation to enable it to determine whether such owner or operator has acted or is acting in compliance with the provisions of sections 71-5301 to 71-5313 and rules and regulations adopted pursuant thereto. The department or its designated agent shall have access at all times to such records and reports.

Source: Laws 1976, LB 821, §6.

71-5307. Operator of public water supply system; certificate of competency required. Commencing January 1, 1979, no public water supply system shall be issued or otherwise hold a permit to operate a public water supply system, granted by the department, unless its operator possesses a certificate of competency issued by the department.

Source: Laws 1976, LB 821, §7.

71-5308. Certificate of competency; application; forms; contents; issuance; duration; investigation. (1) Application for a certificate of competency to act as a certified operator of a public water supply system shall be made upon forms prepared by the director and shall contain such information as the director, by regulation, shall deem necessary.

(2) Certificates of competency to act as certified operators of public water supply systems shall be issued by the department for the calendar years applied for and shall expire at midnight on December 31 of the third year. Certificates of competency may be renewed triennially upon application. The department shall notify each certificate holder at least ninety days before the expiration of the certificate by a letter addressed to him at his last place of residence as noted upon its records.

(3) The department shall, within thirty days after receipt of an application, make an investigation and, if found in compliance with regulations adopted pursuant to section 71-5309, shall issue a certificate of competency, valid until midnight of December 31 of the third year.

Source: Laws 1976, LB 821, §8.

71-5309. Director; rules and regulations; qualifications of operators of public water supply system; considerations. The director shall adopt and promulgate minimum necessary rules and regulations governing the qualifications of operators of public water supply systems. In adopting such rules and regulations, the director shall give consideration to the level of training and experience which are required, in the opinion of the director, to insure to the greatest extent possible that the public water supply systems shall be operated in such a manner that (1) maximum efficiency can be attained, (2) interruptions in service will not occur, (3) chemical treatment of the water will be adequate to maintain purity and safety; and (4) harmful materials will not enter the public water supply system. The director may require, by regulation, that the applicant for a certificate of competency successfully pass an examination on the subject of operation of a public water supply system. The rules and regulations, and any tests so administered, may set out different requirements for different sizes of public water supply systems, so long as the criteria set forth in this section are followed.

Source: Laws 1976, LB 821, §9.

71-5310. Director; authorize variances or exemptions to standards; when; conditions. The director, with the approval of the council, may authorize variances or exemptions from the drinking water standards issued pursuant to section 71-5302 under conditions and in such manner as they deem necessary and desirable; Provided, that such variances or exemptions be permitted under conditions and in a manner which are not less stringent than the conditions under, and the manner in which, variances and exemptions may be granted under the Federal Safe Drinking Water Act, Public Law 93-523, 93rd Congress.

Source: Laws 1976, LB 821, §10.

71-5311. Advisory Council on Public Water Supply; established; duties; members; qualifications; terms; vacancy; meetings; officers; quorum; expenses. (1) There is hereby established the Advisory Council on Public Water Supply which shall advise and assist the department in administering the provisions of sections 71-5301 to 71-5313.

(2) The council shall be composed of seven members appointed by the Governor, three of whom shall be owners or operators of public water supply systems, one of whom shall be a registered professional engineer, one of whom shall be a licensed physician, and two of whom shall be consumers of a public water supply system. Each operator of a public water supply system appointed to the council after January 1, 1979, shall be an operator certified by the director.

(3) The Governor shall make the initial appointments to the council within sixty days after July 10, 1976. In the making of initial appointments, one owner or operator and one consumer shall be appointed to serve for terms of one year each, one owner or operator, one consumer, and the physician shall be appointed to serve for terms of two years each, and one owner or operator and the registered professional engineer shall be appointed to serve for terms of three years each. Thereafter, all members shall be appointed for three-year terms. No member shall serve more than three consecutive three-year terms. Each member shall hold office until the expiration of his term or until a successor has been appointed. Any vacancy occurring in council membership, other than by expiration of term, shall be filled within sixty days by the Governor, by appointment from the appropriate category for the unexpired term.

(4) The council shall meet within sixty days after the appointment of its members and not less than once each year thereafter. Special meetings of the council may be called by the director or upon the written request of any two members of the council explaining the reason for such meeting. The place of the meeting shall be set by the director. At the first meeting of the council, such officers as the council deems necessary shall be elected. A majority of the members of the council shall constitute a quorum for the transaction of business. Representatives of the department shall attend each meeting. Every act of the majority of the members of the council shall be deemed to be the act of the council.

(5) No member of the council shall receive any compensation but shall be entitled, while serving on the business of the council, to receive his travel and other necessary expenses while so serving away from his place of residence, on the same basis and subject to the same conditions as those of full-time state employees.

Source: Laws 1976, LB 821, §11.

71-5312. Violations; penalty; county attorney or Attorney General; take action to assure compliance with act. Any person who shall violate any of the provisions of sections 71-5301 to 71-5313 shall be guilty of a misdemeanor and shall, upon conviction thereof, be fined not less than one hundred dollars nor more than five thousand dollars and a further fine of fifty dollars per day plus costs for each day of continued violation. It shall be the duty of the county at-

torney or the Attorney General, to whom the director reports a violation, to cause appropriate proceedings to be instituted without delay to assure compliance with sections 71-5301 to 71-5313.

Source: Laws 1976, LB 821, §12.

71-5313. Act. how cited. Sections 71-5301 to 71-5313 shall be known and may be cited as the Nebraska Safe Drinking Water Act.

Source: Laws 1976, LB 821, §13.

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APPENDIX C

RULE 5

REGULATIONS GOVERNING PUBLIC WATER SUPPLY SYSTEMS

(1) GENERAL

(a) **DEFINITIONS.** As used in these regulations, unless the context to be intelligible or prevent absurdity otherwise requires;

i. **COUNCIL** means the Advisory Council on Public Water Supply.

ii. **DIRECTOR** means the Director of Health or his authorized representative.

iii. **DESIGNATED AGENT** means any political subdivision or corporate entity having the demonstrated capability and authority to carry out in whole or in part the provisions of the Nebraska Safe Drinking Water Act and with whom the Director has consummated a legal and binding contract covering specifically delegated responsibilities.

iv. **MAJOR CONSTRUCTION, EXTENSION, OR ALTERATION** means those structural changes that affect the source of supply, treatment processes, or transmission of water to service areas, but shall not include the extension of service mains within established service areas.

v. **SERVICE AREA** means the land area over which the owner of a public water supply system has legal franchise or authority to remain the sole distributor of piped drinking water.

vi. **OPERATOR** means the individual or individuals responsible for the continued performance of the water supply system, or any part of such system, during assigned duty hours.

vii. **OWNER** means any person owning or operating a public water supply system.

viii. **PERSON** means any individual, firm, partnership, association, company, corporation, political subdivision, or other entity.

ix. **WATER SUPPLY SYSTEM** means all sources of water and their surroundings under the control of one owner, and shall include all structures, conduits, and appurtenances by means of which such water is collected, treated, stored, or delivered, except service pipes between street mains and buildings and the plumbing within or in connection with the buildings served.

x. **PUBLIC WATER SUPPLY SYSTEM** means a water supply system designed to provide the public piped water fit for human consumption, if such system has at least fifteen service connections or regularly serves at least twenty-five individuals. This definition shall include:

A. any collection, treatment, storage, or distribution facilities under control of the operator of such system and used primarily in connection with such system, and

B. any collection or pretreatment storage facilities not under such control which are used primarily in connection with such system.

xi. **COMMUNITY WATER SUPPLY SYSTEM** means a public water supply system which serves at least fifteen service connections used by year round residents or regularly serves twenty-five year round residents.

xii. **NON-COMMUNITY WATER SUPPLY SYSTEM** means any public water supply system that is not a community water supply system.

xiii. **DRINKING WATER STANDARDS** means the rules and regulations adopted pursuant to Section 71-5302, which establish maximum levels for harmful materials which, in the judgment of the Director, may have an adverse effect on the health of persons and which apply only to public water supply systems.

xiv. **SAMPLING SCHEDULE** means the frequency required for submitting drinking water samples to the laboratory for examination.

xv. **SAMPLING PERIOD** means that time span over which several individual samples are evaluated to determine compliance with drinking water standards.

xvi. **MAXIMUM CONTAMINANT LEVEL** means the maximum permissible level of a contaminant in water as measured at the point of entry to the distribution system or at the free flowing outlet of the ultimate user of the public water supply system. Contaminants added to the water under circumstances controlled by the user, except those resulting from corrosion of piping and plumbing caused by water quality, are excluded from this definition.

xvii. **CONTAMINANT** means any physical, chemical, biological, or radiological substance or matter in water.

xviii. **PICOCURIE** (pCi) means that quantity of radioactive material producing 2.22 nuclear transformations per minute.

xix. **GROSS BETA PARTICLE ACTIVITY** means the total radioactivity due to beta particle emission as inferred from measurements on a dry sample.

xx. **DOSE EQUIVALENT** means the product of the absorbed dose from ionizing radiation and such factors as account for differences in biological effectiveness due to the type of radiation and its distribution in the body as specified by the International Commission on Radiological Units and Measurements (ICRU).

xxi. **REM** means the unit of dose equivalent from ionizing radiation to the total body or any internal organ or organ system. A "millirem (mrem)" is 1/1000 of a rem.

xxii. **MAN-MADE BETA PARTICLE AND PHOTON EMITTERS** means all radionuclides emitting beta particles and/or photons listed in Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure, NBS Handbook 69, except the daughter products of Thorium-232, Uranium-235, and Uranium-238.

xxiii. **GROSS ALPHA PARTICLE ACTIVITY** means the total radioactivity due to alpha particle emission as inferred from measurements on a dry sample.

xxiv. **SANITARY SURVEY** means an on-site review of the water source, facilities, equipment, operation and maintenance of a public water system for the purpose of evaluating the adequacy of such source, facilities, equipment, operation and maintenance for producing and distributing safe drinking water.

(b) **COVERAGE. Subject to the granting of a variance or exemption, state drinking water standards and, therefore, these implementing regulations, shall apply to each public water supply system in the state, except that such standards and regulations shall not apply to a public water supply system:**

i. Which consists only of distribution and storage facilities and does not have any collection and treatment facilities;

ii. Which obtains all of its water from, but is not owned or operated by, a public water supply system to which such standards apply;

iii. Which does not sell water to any person; and

iv. Which is not a carrier which conveys passengers in interstate commerce.

(c) **RESPONSIBILITY.** The owner of each public water supply, as defined in these regulations, shall designate an individual, or individuals, who shall be responsible for contact and communications with the Director in matters relating to system alteration and construction, monitoring and sampling, maintenance, operation, record keeping, and reporting, as required by law and these regulations. Any change in assigned responsibilities or designated individuals shall be promptly reported to the Director.

(2) DRINKING WATER STANDARDS

(a) **INORGANIC CHEMICALS.** The maximum contaminant level for nitrate is applicable to both community and non-community water supply systems. The levels for other inorganic chemicals apply only to community water supply systems. The maximum contaminant levels for inorganic chemical contaminants are as follows:

CONTAMINANT	LEVEL MILLIGRAMS PER LITER
Arsenic	0.05
Barium	1.
Cadmium	0.010
Chronium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.
Selenium	0.01
Silver	0.05
Fluoride*	1.8

*Maximum permissible contaminant levels for Fluoride may be increased to 2.4 mg/l in increments determined from recorded annual average maximum daily air temperatures at the location of the community system.

(b) **ORGANIC CHEMICALS.** The maximum contaminant levels for organic chemical contaminants, applicable only to community water supply systems, are as follows:

CONTAMINANT	LEVEL MILLIGRAMS PER LITER
Chlorinated Hydrocarbons:	
Endrin (1,2,3,4,10, 10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8, 8a-octa-hydro-1,4-endo, endo-5, 8 -dimenthano naphthalene).	**0.0002**
Lindane (1,2,3,4,5,6-hexachloro-cyclohexane, gamma isomer).	**0.004**
Methozychlor (1,1,1-Trichloro-2, 2-bis, p-methoxyphenyl ethane).	**0.1**
Toxaphene ($C_{10}H_{10}C1_8$-Technical chlorinated camphene, 67-69 percent chlorine).	**0.005**
Chlorophenoxys:	
2,4-D. (2,4-Dichlorophenoxyacetic acid).	**0.1**
2.4.5-TP Silvex (2,4,5-Tri-chlorophenoxypropionic acid).	**0.01**

(c) **TURBIDITY.** The maximum contaminant levels for turbidity are applicable to all public water supply systems using surface water, in whole or in part, as a source of supply. The maximum permissible levels for turbidity are as follows:

i. One turbidity unit (TU), as determined by the monthly average of daily examinations, except that up to five turbidity units, may be allowed if the owner can demonstrate that the higher turbidity does not interfere with disinfection, will not prevent maintenance of the disinfectant agent throughout the system, or will not interfere with microbiological examinations of the water; and

ii. when the exceptions listed under the preceding paragraph cannot be demonstrated by the owner, the average of two samples taken on consecutive days does not exceed five turbidity units.

(d) **MICROBIOLOGICAL.** The maximum permissible contaminant levels for coliform bacteria, applicable to all public water supply systems, are as follows:

i. When the membrane filter techniques are used the number of coliform bacteria shall not exceed one per one hundred milliliters of sample examined per sampling period; or four per one hundred milliliters in more than one sample when less than twenty are examined per month; of four per one hundred milliliters in more than five percent of the samples when twenty or more are examined per month; or

ii. When the fermentation tube method and ten milliliter standard portions are used, coliform bacteria shall not be present in more than ten percent of the portions examined during any sampling period; or in three or more portions of any one sample when less than twenty samples are examined during the sampling period; or in three or more portions in more than five percent of the samples

when twenty or more samples are examined per sample period.

iii. When the coliform bacteria in a single sample exceed four per 100 milliliters, at least two consecutive daily check samples shall be collected and examined from the same sampling point. Additional check samples shall be collected on a schedule established by the Director, until the results from at least two consecutive check samples show less than one coliform bacterium per 100 milliliters.

iv. When coliform bacteria occur in three or more 10 ml portions of a single sample, at least two consecutive daily check samples shall be collected and examined from the same sampling point. Additional check samples will be collected daily, or more or less frequently as necsssity requires to insure fresh samples or to properly ascertain the source of contamination, until the results obtained from at least two consecutive check samples show no positive tubes.

v. The location at which check samples were taken shall not be eliminated from future sampling without the approval of the Director.

vi. The results from all coliform bacterial analysis, except those obtained from check samples and special purpose samples, shall be used to determine compliance with the maximum contaminant levels established for coliform bacteria. Check samples shall not be included in determining compliance with monitoring requirements.

vii. The sampling period for systems serving more than 4,000 persons, shall be one month and for systems serving 3,999 or fewer persons, shall be 3 months.

(e) **RADIUM-226, RADIUM-228, AND GROSS ALPHA PARTICLE ACTIVITY.** The maximum contaminant levels for Radium-226, Radium-228, and gross alpha particle radioactivity, applicable to community water supply systems only, are:

i. Combined Radium-226 and Radium-228-5 pCi/liter.

ii. Gross alpha particle activity including Radium-226 but excluding radon and uranium - 15 pCi/liter.

(f) **BETA PARTICLE AND PHOTON RADIOACTIVITY FROM MAN-MADE RADIONUCLIDES.** The maximum contaminant levels for beta particle and photon radioactivity from man-made radionuclides, applicable to community water supply systems only, are:

i. The average annual concentration of beta particle and photon radioactivity from man-made radionuclides shall not produce an annual does equivalent to the total body or any internal organ greater than 4 millirem/year.

ii. Except for the radionuclides listed in Table A, the concentration of man-made radionuclides causing 4 mrem total body or organ does equivalents shall be calculated on the basis of a 2 liter per day drinking water intake using the 168 hour data listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure," NBS Handbook 69, as amended August, 1963, U.S. Department of Commerce. If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or any organ shall not exceed 4 millirem/year.

TABLE A - Average annual concentrations assumed to produce a total body or organ dose of 4 millirem/year.

Radionuclide	Critical Organ	pCi Per Liter
Tritium	Total Body	20,000
Strontium-90	Bone Marrow	8

(g) **MONITORING REQUIREMENTS.** The owners of public water supply systems shall be responsible for accomplishing monitoring requirements as demonstrated by possession of an official copy of laboratory results. The Director will establish schedules for sampling, and will

assist in the collection of chemical and radiological samples. Samples will be examined at timed intervals and on schedules designed to meet monitoring requirements and maintain a uniform Laboratory work load. The owner of each public water supply system will be informed of this schedule and, if for any reason the schedule is not met, will be responsible for initiating arrangements for an alternate date to effect compliance with established monitoring requirements. These arrangements shall be timed to provide the required number of samples within the designated sample period used to determine compliance with these regulations. All samples will be examined by a State Health Department Laboratory or a laboratory which has entered into an agreement with the Department of Health.

i. **MICROBIOLOGICAL MONITORING REQUIREMENTS.** The owner of a community water supply system shall take coliform density samples at regular time intervals established by the Director and shall submit them to the State Health Department Laboratory in containers provided by the Laboratory. The number of samples required shall be determined by the population served by the system and in no instance shall the frequency be less than as set forth below:

Population Served	Minimum Number of Samples Per Month
25 - 1,000	1
1,001 - 2,500	2
2,501 - 4,100	4
4,101 - 7,600	8
7,601 - 11,100	12
11,101 - 14,600	16
14,601 - 18,100	20
18,101 - 21,500	24
21,501 - 28,000	32
28,001 - 37,000	40
130,000 - 190,000	130
360,000 - 500,000	210

The owner of a non-community water supply system shall submit samples for coliform bacteria examination in each calendar quarter for which the system is in operation. The Director shall provide sample kits at times meeting the required schedule for each system. Sampling shall begin January 1, 1978. All biological samples shall be mailed to the assigned laboratory through the U.S. Postal Service, with the owner paying the postage, unless the Director authorizes other means of transmittal.

ii. **TURBIDITY.** Samples shall be taken by owners of both community and non-community surface water supply systems at a representative point of entry to the distribution system at least once a day for the purpose of making turbidity measurements. When the results of a turbidity analysis indicates that the maximum allowable level has been exceeded, the sampling and measurement shall be repeated as soon as practicable and preferably within one hour. The repeat sample shall be the one used in computing the monthly average.

iii. **INORGANIC CHEMICALS.** The State Health Department will collect and analyze samples from each community water supply for inorganic chemical contamination by July 1, 1978, when surface water is used as a source and by July 1, 1979, when ground water is used as a source. These analyses will be repeated at one-year and three-year intervals respectively unless the concentration of inorganic chemicals approach the maximum permissible levels, in which case the frequency of sampling and examination will be at the discretion of the Director. When any maximum contaminant level is exceeded by a community water supply, the owner of the supply shall be responsible for collecting, preserving, and transporting samples to the State Health Department Laboratory in accordance with the following schedule: three additional samples from the same sampling point within one month of notification of the original violation and with the average of the original and the three confirming samples, rounded to the same number of significant figures as the maximum contaminant level of the substance in question, demonstrating a value

below the maximum permitted contaminant level; and, when the average of the four samples exceeds the maximum permitted contaminant level, samples shall be submitted at time intervals determined by the Director until such time as a variance, exemption, or enforcement action takes effect. The owner of the community water supply shall pay the laboratory the actual costs for examination of samples beyond the first sample showing contamination and until the contamination is removed or otherwise eliminated.

iv. **ORGANIC CHEMICALS.** The State Health Department will collect and analyze samples from each community water supply for organic chemical contamination by July 1, 1978, when surface water is used as a source, and by July 1, 1980, when groundwater is the sole source of supply. These analyses will be repeated at three-year intervals unless land use practices or other potential for contamination of groundwater indicates the need for more frequent sampling at the discretion of the Director. When any maximum contaminant level is exceeded, the owner of the supply shall be responsible for collecting, preserving, and transporting samples to the State Health Department Laboratory in accordance with the following schedule: three additional samples from the same sampling point within 1 month of notification of the original violation and with the average of the original and the three confirming samples rounded to the same number of significant figures as the maximum contaminant level of the substance in question, demonstrating a value below the maximum permitted contaminant level; and, when the average of the four samples exceeds the maximum permitted contaminant level, samples shall be submitted at time intervals determined by the Director until such time as a variance, exemption, or enforcement action takes effect, or until the average concentration no longer exceeds the maximum contaminant level. The owner of the community water supply shall pay the actual costs for examination of samples beyond the first sample showing contamination and until the contamination is removed or otherwise eliminated.

v. **RADIONUCLIDES.** The State Health Department will collect and analyze samples from each community water supply for radioactivity by July 1, 1979, when surface water is used as a source, and by July 1, 1980, when ground water is the sole source of supply. These analyses will be repeated at four-year intervals, except analysis for beta activity in groundwater sources may be less frequent at the discretion of the Director.

vi. **SPECIAL MONITORING-RADIONUCLIDES.** Within two years of the effective date of these regulations, the owner of any community water system designated by the Director as utilizing waters receiving effluents from nuclear facilities shall initiate quarterly monitoring for gross beta particle and Iodine-131 radioactivity and annual monitoring for Strontium-90 and Tritium.

A. Quarterly monitoring for gross beta particle activity shall be based on the analysis of monthly samples or the analysis of a composite of three monthly samples. The former is recommended. If the gross beta particle activity in a sample exceeds 15 pCi/l, the same or an equivalent sample shall be analyzed for Strontium-89 and Cesium-134. If the gross beta particle activity exceeds 50 pCi/l, an analysis of the sample must be performed to identify the major radioactive constitutes present and the appropriate organ and total body doses shall be calculated to determine compliance with Section (2)(e) of these rules.

B. For Iodine-131, a composite of five consecutive daily samples shall be analyzed once each quarter. As ordered by the Director, more frequent monitoring shall be conducted when Iodine-131 is identified in the finished water.

C. Annual monitoring for Strontium-90 and Tritium shall be conducted by means of the analysis of a

composite of four consecutive quarterly samples or analysis of four quarterly samples. The latter procedure is recommended.

vii. **APPROVED LABORATORIES.** The owner of a public water supply system may utilize the services of any laboratory which has entered into an agreement with the Department of Health therefor. The Department of Health shall enter into an agreement with any laboratory demonstrating a continuing capability to perform required analyses, to conduct each specific analysis in an acceptable manner, to participate in quality control activities, and to comply with all requirements of these regulations relative to maintaining records and reports.

viii. **CONSECUTIVE SYSTEMS.** When a public water supply system provides water to one or more other public water supply systems, the Director may modify the monitoring imposed by this Part (2) to the extent that the inter-connection of the systems justifies treating them as one system for monitoring purposes.

ix. **TREATMENT TECHNIQUES.** Treatment techniques and processes for removing or reducing the levels of any of the contaminants listed in this Part shall be approved by the Director prior to application and shall conform with tested and proven engineering practices. The Director shall include recommended criteria for acceptance of such techniques and processes in the "Guidelines for Water System Design," herein incorporated by reference as Attachment 1, required by Part (6) of these rules.

(3) PUBLIC NOTIFICATION AS CONDITION OF OPERATING A PUBLIC WATER SUPPLY SYSTEM

(a) **WHEN REQUIRED.** The owner of any community water supply system found to be delivering water containing contaminants exceeding those levels prescribed in Part (2) of these rules, or who fails to submit samples on schedule as required by that Part shall notify the public that are or who may be consumers of the failure to comply with the rules or standards.

(b) **METHOD OF NOTIFICATION.** Notification to resident consumers shall accompany the first set of water bills of the system issued after the failure and in any event by written notice within three months. Such notice shall be repeated at least once every three months as long as the failure continues. In addition, the notice shall be published for three consecutive days in a newspaper or newspapers of general circulation in the area served by the system and a copy of the notice shall be provided to the radio and television stations serving the area.

(c) **CONTENTS OF NOTICE.** Notices given pursuant to this Part shall be written in a manner reasonably designed to inform fully the users of the system. The notice shall be conspicuous and shall not use unduly technical language, unduly small print or other methods which would frustrate the purpose of the notice. The notice shall disclose all material facts regarding the subject including the nature of the problem and, when appropriate, a clear statement that a primary drinking water regulation has been violated and any preventive measures that should be taken by the public. Notices may include a balanced explanation of the significance or seriousness to the public health of the subject of the notice, a fair explanation of the steps taken to correct any problem, and the results of any additional sampling.

(d) Notice to consumers of non-community water systems shall be given in a manner appropriate to the situation as prescribed by the Director.

(e) Public notification as required by this Part shall be given whenever a variance or exemption is granted or whenever a compliance schedule contained in a variance or exemption is violated.

(4) REPORTING AND RECORD KEEPING

(a) **REQUIRED REPORTS.** The owner of a community water supply system shall report to the Director within the time prescribed on each of the following occurrences which influence or alter the reliability of the system or the safety of drinking water delivered to the consumer:

i. Any disruption in service that results in a likelihood for the entrance of contaminants into the system, including reduced pressures due to fire fighting operations or breakdown, should be recorded by the owner of the system. Any loss of

pressure or disruption of service for reasons beyond normal repair or replacement should be reported to the Director when more than 10% of the consumers are affected.

ii. Any proposed change in source of supply or treatment processes, or any expansion of storage or of the distribution service area shall be reported to the Director before entering into any financial commitment for implementing a change.

iii. All reports, studies, and investigations pertinent to the operation and management of a community water supply system shall be made available to the Director on request.

iv. Any change in personnel, elected or appointed, having primary responsibility for the operation of a community water supply system, shall be promptly reported to the Director by the owner or a representative of the owner.

v. Any change in ownership of a public water supply system shall be reported to the Director by the prior owner, and the prior owner shall be responsible for informing the new owner of the general provisions of the Nebraska Safe Drinking Water Act and the regulations implementing it.

(b) **REQUIRED RECORDS.** Any owner or operator of a public water supply system subject to the provisions of this Part shall retain on the premises of the public water supply system or at a convenient location near such premises, the following records:

i. Records of bacteriological analyses made pursuant to this rule shall be kept for not less than five years. Records of chemical analyses made pursuant to this rule shall be kept for not less than ten years. Actual laboratory reports may be kept or data may be transferred to tabular summaries, provided that the following information is included:

A. The date, place, and time of sampling, and the name of the person who collected the sample.

B. Identification of the sample as to whether it was a routine distribution system sample, a check sample, a raw or processed water sample, or any other special purpose sample.

C. Dates of analyses.

D. Laboratory and person responsible for performing analysis.

E. The analytical technique or method used; and

F. The results of the analysis.

ii. Records of action taken by the owner of the system to correct violations of primary drinking water regulations shall be kept for a period of not less than three years after the last action taken with respect to the particular violation involved.

iii. Copies of any written reports, summaries, or communications relating to sanitary surveys of the system conducted by the owner of the system, by a private consultant, or by any local, State or Federal Agency including the Department of Health, shall be kept for a period of not less than ten (10) years after completion of the sanitary survey involved.

iv. Records concerning a variance or exemption granted to the system shall be kept for a period ending not less than five years following the expiration of such variance or exemption.

(c) **AVAILABILITY OF RECORDS.** All records required by this Part shall be available for public inspection at any reasonable hour and will be reviewed periodically for completeness by the Director. In addition, the Director shall publish at least annually, a listing of all public water supply systems together with violations of maximum contaminant levels, monitoring requirements, and record keeping requirements as prescribed in Parts (2) and (4) of these regulations.

(5) VARIANCES AND EXEMPTIONS

(a) **VARIANCE.** The Director, with the concurrence of the Advisory Council on Public Water Supply, may authorize a variance from a maximum contaminant level adopted in Part (2) of this rule when:

i. The raw water sources which are reasonably available to the system cannot meet the maximum contaminant levels specified in these regulations despite application of the best technology, treatment techniques, or other means, which the Di-

rector finds are generally available (taking costs into consideration);

ii. the concentration of the contaminant, or contaminants, for which the maximum contaminant level is exceeded by granting such variance, will not result in unreasonable risk to health; and

iii. within one year of the date the variance is granted, a schedule for compliance, or increments of compliance, is issued and the owner of the supply agrees to implement such schedule.

(b) **EXEMPTION.** The Director, with the concurrence of the Advisory Council on Public Water Supply, may exempt any public water supply system from any requirement respecting a maximum contaminant level or treatment technique, or from both, as adopted in Part (2) of this rule upon finding that:

i. Due to compelling factors, which may include economic factors, the public water system is unable to comply with such contaminant level or treatment technique;

ii. the public water system was in operation on the effective date of such contaminant level or treatment technique regulation;

iii. the granting of the exemption will not result in an unreasonable risk to health; and

iv. within one year of the date the exemption is granted, a schedule for compliance, or increments of compliance, is issued and the owner of the supply agrees to implement such schedule.

(c) **PROCEDURE.** Action to consider a variance or exemption from the requirements contained in Part (2) of this rule may be initiated by the Director or by the owner of the supply through a formal request submitted to the Director. Before a variance or exemption proposed to be granted by the Director may take effect, the Director shall provide notice and opportunity for public hearing on the proposal; inform the Advisory Council on Public Water Supply of all facts and findings relative to the proposed action; and obtain Council approval of the proposed action; provided:

i. The conditions for issuing the variance or exemption are no less stringent than conditions under which variances and exemptions may be granted under the provisions of the Federal Safe Drinking Water Act, P.L. 93-523, 93rd Congress; and further provides that,

ii. the procedures for notification and public hearing are in conformance with the requirements of Chapter 84, Article 9, Reissue Revised Statutes of Nebraska, 1943. The same procedures shall be carried out prior to prescribing a compliance schedule for conforming to the requirements of Part (2) of these rules. In no case shall an exemption schedule extend beyond January 1, 1981, unless the public water supply system has entered into an enforceable agreement to become a part of a regional water system, in which case the exemption may be extended for two additional years.

(6) SITING, DESIGN, AND CONSTRUCTION OF PUBLIC WATER SUPPLY SYSTEMS

(a) **SITING.** All wells, treatment and storage facilities, and other appurtenances necessary to the continued operation of a community water supply system shall be located so as to:

i. Assure against damage or breakdown as a result of floods, fire, earthquakes, or other natural disasters;

ii. prevent contamination of the drinking water by existing sources of pollution;

iii. permit control, by the owner, over the location of future potential sources of contamination within the proximity of the system in order to prevent or minimize any hazard to the safety of the drinking water; and

iv. provide a sufficient property interest for the owner of the public water supply system in order to operate, maintain, and replace the system components.

(b) **DESIGN.** Plans and specifications for all major construction, extension, or alteration to community water supply systems shall be prepared by a registered professional engineer, preferably commissioned by the owner, and shall be submitted to the Director for review and written approval prior to entering into a

financial commitment for construction, the awarding of a contract, or the beginning of construction.

i. Plans and specifications shall be submitted for the following types of projects:
   A. all components of new water supply systems;
   B. new wells and intake structures;
   C. alterations that influence the capacity of existing wells or intake structures;
   D. new treatment plants and modifications to existing treatment plants;
   E. installation of chemical feed equipment beyond replacement of existing equipment;
   F. storage facilities and repair to existing storage facilities;
   G. pump stations;
   H. transmission mains from the source of supply to the service area; and
   I. replacement of mains within a service area for the purpose of balancing pressure or improving the efficiency of the distribution system.

   Submission of plans and specifications is not required for extension of water mains within an established service area.

ii. Plans and specifications shall be reviewed for general conformance with "Guidelines for Water System Design," herein incorporated by reference as Attachment 1, published and distributed by the Director to reflect current technology in the design of public water supply systems and their components, and shall be:
   A. presented in legible form and of sufficient scale to establish construction requirements and facilitate effective review;
   B. submitted by the engineer in triplicate and in sufficient time to permit a two week period for review and comment or approval and with time for the incorporation of changes if required;
   C. amended in a manner that will alter the function or efficiency of components which may affect the chemical quality of the water only after change order directing such amendment are approved by the Director;
   D. replaced by "as built" plans when change orders reflect relocations or affect the operation or replacement of the improvement, and supplemented by information relative to the location of other utilities, basis of design, performance of proprietary materials or products and similar information, as may be requested by the Director.

(c) **CONSTRUCTION.** All major construction, extensions or alterations shall be completed in accordance with approved plans and specifications or approved change orders and shall comply with the following requirements:

i. No part of a community water supply system falling within the definition of major construction shall be placed in service prior to final inspection and issuance of approval by the Director.

ii. any part of community water supply system falling within the definition of major construction found not to be constructed in accordance with approved plans and specifications or change orders, or for which plans and specifications were not approved, shall not be placed in service until such time as the Director determines the construction to be in conformance with current published guidelines.

iii. construction of water distribution mains within an established service area and not requiring prior approval, shall be located above and at least ten (10) feet horizontally from any sewer line, with the joints of the water line located at least ten (10) feet from any intersection with a sewer line.

(d) **DISTINCTIONS APPLIED TO NON-COMMUNITY WATER SUPPLY SYSTEMS.** The owner of a non-community water supply system may:

i. accomplish construction, extension or alteration to the system in the same manner applicable to the siting, design and construction of community water supply systems, or

ii. report to the Director any intention to locate, construct, extend or alter a public water supply system and

complete the work in accordance with a design or designs prepared by a registered professional engineer and distributed by the Director.

(7) OPERATION AND MAINTENANCE OF PUBLIC WATER SUPPLY SYSTEMS

(a) **OPERATION.** All public water supply systems shall be operated and supervised by competent personnel and after January 1, 1979, such personnel must possess a certificate of competency issued by the Director. In addition, all community water supply systems shall:

i. Provide service on a twenty-four hour a day basis with a certified operator on call at all times unless the Director allows the community water supply system to establish an electronic or otherwise dependable means for mitigating disruption of service or which assures an adequate supply of safe water on a continuous basis;

ii. notify the Director of any situation with the water system which presents or may present an imminent and substantial hazard to health;

iii. within one year of the effective date of these regulations prepare an emergency operations plan for safeguarding the water supply and alerting the public in event of natural or man made disasters;

iv. flush and disinfect all newly constructed or repaired water mains and storage facilities in accordance with methods acceptable to the Director before placing the new or repaired portion of the system into service;

v. conduct a regular program for the effective detection and elimination of cross-connections and the prevention of backflow or backsiphonage;

vi. provide sufficient personnel, tools, spare parts, work areas, chemicals, and other essentials necessary to accomplish continuous operation of the system without undue or unnecessary interruption of service.

(b) **MAINTENANCE.** All public water supply systems shall adopt and carry out a preventive maintenance program incorporating the following elements:

i. Neat and orderly premises used solely for the purpose of producing, treating, storing, or distributing safe drinking water, with emphasis on easy access to those system components requiring periodic attention:

ii. routine inspection and servicing of all mechanical equipment in accordance with manufacturers' recommendations for such maintenance;

iii. timely replacement of worn or deteriorated system components and equipment parts as identified by routine inspection;

iv. elimination of rust and corrosion by application of paint, protective coatings, or cathodic protection or other treatment capable of prolonging the useful life of the system;

v. annual review of the capability of the source of supply, treatment, storage, and distribution facilities to provide for future service demands;

vi. action as necessary to protect the system and its components from encroachments that are likely hazards to the safety of the drinking water delivered by the system.

(8) PERMIT FOR OPERATING A PUBLIC WATER SUPPLY SYSTEM

(a) Prior to July 1, 1977, each person operating or maintaining a public water supply system within the State shall apply to the Director for a permit to continue the operation of such system beyond the date of January 1, 1978. The application shall be submitted on a form provided by the Director (Attachment 2).

(b) The Director shall, as promptly as is possible, inspect and survey the system, report findings to the owner of the system, and issue or deny a permit based on compliance with the requirements of the Nebraska Safe Drinking Water Act and of these rules and regulations.

(c) Any person constructing, or otherwise acquiring a public water supply system subsequent to July 1, 1977, shall provide the information required in Section (a) of this Part with the submission of plans and specifications as required in Part (6) of these rules. An operating permit will be issued upon confirmation that the completed works were constructed in accordance with approved plans and specifications and upon demonstration that

the system will be maintained and operated as prescribed by these rules and regulations.

(d) Any person operating a public water supply system after January 1, 1978, and prior to the issuance of a permit in the manner prescribed in Section (b) or (c) of this Part, and found to be in violation of any provisions of these rules or the provisions of the Nebraska Safe Drinking Water Act, shall be subject to enforcement action as provided by law.

(e) Permits shall be issued for an indefinite period of time, subject only to continued compliance with the Nebraska Safe Drinking Water Act and rules and regulations promulgated thereunder.

(f) Any person shall be granted, upon request, an opportunity for a hearing before the Department under the provisions of Chapter 84, Article 9, Reissue Revised Statutes of Nebraska, 1943, and amendments thereto, prior to the denial or revocation of a permit. Judicial review of such denial or revocation may be obtained as provided by such Chapter and Article.

(9) OPERATOR CERTIFICATION

(a) Commencing January 1, 1979, no public water supply system shall be issued or otherwise hold a permit to operate a public water supply system, granted by the department, unless its operator possesses a certificate of competency issued by the department. Application for a certificate of competency to act as a certified operator of a public water supply system shall be made upon a form prepared by the Director (Attachment 3). In determining the degree of competency required for proper operation of a system the following classification will be applied to public water supply systems:

Class I - All community water supply systems using conventional processes of filtration or other treatment processes requiring chemical and bacteriological control of operation and designed to serve a population in excess of 15,000 persons; and, all other community water supply systems designed to serve a population in excess of 50,000 persons.

Class II - All community water supply systems using conventional filtration processes or other treatment processes requiring chemical control of operation and designed to service between 2,000 and 15,000 persons; and, all other community water supply systems serving a population between 15,000 and 50,000 persons; and, all distribution systems serving in excess of 50,000 persons.

Class III - All community water supply systems using conventional filtration processes or other treatment requiring chemical control and designed to serve less than 2,000 persons; and all community water supply systems which do not treat the water or which do not apply chemicals for purposes of conditioning, disinfecting, or adjustment and, which are designed to serve between 2,000 and 15,000 persons; and, all distribution systems serving between 15,000 and 50,000 persons.

Class IV - All community water supply systems which do not treat the water or which apply chemicals for purposes of conditioning, disinfecting, or adjustment and which are designed to serve between 100 and 2,000 persons; and, all distribution systems serving between 100 and 15,000 persons.

Class V - All other public water supply systems.

The individual or individuals placed in responsible charge of each system, or system operation, shall hold a valid Certificate of Competency comparable in Grade to the Class within which the public water supply system is described.

(b) Certificates of Competency will be issued by the Director, in behalf of the Department, to those operators applying for such Certificates and meeting the following requirements:

i. in adequate physical condition;
ii. able to read and write the English language;
iii. produces evidence of satisfactory attendance at operators' training meetings or short courses, or completion of education courses available that are consistent with the Grade applied for;
iv. able to maintain logs and records of operation and maintenance consistent with the requirements for the Class system to be operated;

v. produces evidence of good moral character, integrity, ability to cooperate with others, industry, reliability, initiative, and judgment to the degree necessary to secure satisfactory operating results; and

vi. compliance with the requirements of paragraph (d) of this Part in regard to the appropriate grade.

(c) Five grades of certification shall be made available to operating personnel in accordance with the criteria described in paragraph (d) of this Part. Operators possessing Grade I Certificate of Competency are qualified to operate a Class I community water supply system; those possessing a Grade II certification are qualified to operate a Class II public water supply system, with the grades following having similar relationships with the other public water supply systems respectively. Operators working under the supervision of a certified operator, but in responsible charge while on duty, shall be required to hold a certificate of at least Grade IV.

(d) All applicants for a Certificate of Competency shall meet the following education and experience requirements for the appropriate Grade requested:

i. Grade I Certification -

A. successful completion of an examination on the subject of operation of a public water supply system recommended by the Advisory Council on Public Water Supply and approved by the Director, and

B. a degree of Bachelor of Science (with special courses or two years experience in sanitary sciences) and two years in responsible charge or operation of a public water supply system, or

C. four years of college and three years of responsible charge or operation of a public water supply system, or

D. high school education or equivalent and six years responsible charge of a Class I or II public water supply system or eight years operation of a system under the supervision of a person possessing the qualifications of a Grade I operator.

ii. Grade II Certification -

A. successful completion of an examination recommended by the Advisory Council on Public Water Supply and approved by the Director, and

B. two years of college, plus three years responsible charge or operation of a public water supply system, or

C. high school education or equivalent and six years responsible charge of a Class III, II, or I public water supply system or six years operation of a system under the supervision of a person possessing the qualifications of a Grade I or Grade II operator.

iii. Grade III Certification -

A. successful completion of an examination recommended by the Advisory Council on Public Water Supply and approved by the Director, and

B. high school education or equivalent and two years responsible charge or operation of a public water supply system, and

C. two years of high school or equivalent, and six years responsible charge of operation of a public water supply system.

iv. Grade IV Certification -

A. two years high school or equivalent and one year responsible charge or operation of a public water supply system, and

B. successful completion of a basic training course for water system operators recommended by the Advisory Council on Public Water Supply and approved by the Director.

v. Grade V Certification -

A. demonstrated ability in the collection of water samples, interpretation of results of biological examination, and the maintenance of required records.

vi. The following substitution or equivalents for required experience or training will be accepted by the Department:

A. two years experience in actual operation of a water utility may be substituted for one year of high school or grammar school education and does not apply to requirements for college education.

B. satisfactory completion of short courses recommended by the Advisory Council on Public Water Supply and the Director may be

considered as equivalent to:
two years of grade school, or
two years of experience, or
one year of high school, or
one-half year of college.

(e) Certificate of Competency to act as operators of public water supply systems shall be issued by the Department for the calendar years applied for and shall expire at midnight on December 31 of the third year. Certificates of competency shall be renewed trienially upon application. The Department shall notify each certificate holder at least ninety days before the expiration of the certificate by a letter addressed to him at his last place of residence as noted upon its records.

SOURCE: Sections 71-5302, 71-5304, 71-5305, 71-5306(6), 71-5308(1), and 71-5309

APPENDIX D

NEBRASKA PUBLIC WATER SUPPLY INFORMATION - 1982

Sources of Supply ■ Chemical Analyses ■ Treatment Plants

STATE HEALTH DEPARTMENT
Division of Environmental Engineering
P.O. BOX 95007
LINCOLN, NE 68509

INTRODUCTION

The data contained in this publication on source of water supply, chemical quality, treatment plants, and personnel have been assembled to satisfy the requests for this information by industries, public agencies, engineers, water works personnel, and others.

Compilation of these data was made by the Division of Environmental Engineering. The analyses were determined by the State Department of Health Laboratories.

It should be noted that some municipalities have several sources of supplies, either from different wells, springs, streams, impoundments, or a combination of these. The analyses of the "distribution" samples would, therefore, be representative only of the particular source in service and the type of treatment performed at the time the samples were collected.

The Division of Environmental Engineering is attempting to standardize the well numbering system by indicating the year in which the well was constructed followed by the sequence of construction during that year. (Ex: 64-2 is the second well constructed for the system in 1964.) The old well number is shown in parenthesis.

Bacteriological surveillance is accomplished by the Health Department. Information on compliance records may be obtained for any system on request.

Henry D. Smith, M.D., M.P.H.
Director, Department of Health

Charles Thone, Governor
State of Nebraska

NEBRASKA
PUBLIC WATER SUPPLY INFORMATION

KEY TO ABBREVIATIONS

The abbreviation used as column headings are the following standard chemical abbreviations and symbols.

pH	- Hydrogen Ion Concentration	**Hard**	- Total Hardness
TS	- Total Solids	**Ca**	- Calcium
Fe	- Total Iron	**NO_3**	- Nitrates
Mn	- Manganese	**Cl**	- Total Chlorides
F	- Fluoride	**SO_4**	- Total Sulfates
Alk	- Total Alkalinity	**Na**	- Sodium

All results are expressed in parts per million (milligrams per liter), with the following exceptions:

1. pH is the logarithm of the reciprocal of the hydrogen ion concentration in moles per liter.
2. Total Hardness and total alkalinity are expressed as mg/l of calcium carbonate.
3. Nitrates are expressed as mg/l of nitrate-nitrogen.

The following abbreviations are used to describe the source of the sample:

W - Well
S - Spring
IF - Infiltration Gallery
SR - Storage Reservoir
R - River or Creek
F - Finished Water @ Plant
D - Distribution
C - Composite

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Abie													
64-1 (3)	9-74	7.6	1108	0.6	0.0	0.83	312	352	99	0.6	216	201	270
Adams													
56-1 (2)	6-74	6.7	464	0.0	0.0	0.32	164	208	69	7.9	10	35	20
64-1 (3)	6-74	6.6	412	0.0	0.0	0.28	192	276	80	9.8	18	53	25
70-1 (1)	6-74	7.6	464	0.0	0.0	0.32	256	312	99	12.0	16	60	36
Ainsworth													
40-1 (2)	6-80	6.7	138	0.0	0.0	0.20	88	100	22	3.2	2	0	6
65-1 (4)	6-80	6.6	230	0.0	0.0	0.21	128	140	50	8.2	6	15	8
70-1 (1)	6-80	6.7	142	0.0	0.0	0.18	92	108	34	6.2	4	0	5
Albion													
60-1 (2)	5-74	7.2	362	0.1	0.0	0.35	224	196	67	0.4	0	0	9
65-1 (1)	5-74	7.4	394	0.0	0.0	0.35	236	212	69	0.4	8	2	15
66-1 (3)	5-74	7.2	364	0.0	0.0	0.33	220	228	66	0.8	0	0	9
Alda													
69-1 (1)	7-78	7.4	488	0.1	0.6	0.23	264	312	96	0.2	12	96	16
Alexandria													
37-1 (1)	11-76	7.4	184	0.0	0.0	0.28	120	112	34	2.8	8	20	15
76-1	5-79	6.5	188	1.5	0.0	0.19	128	120	34	2.8	0	19	10
Allen													
60-1 (5)	6-74	7.2	508	0.1	0.0	0.41	336	416	114	1.8	2	99	23
73-1 (3)	6-74	7.3	498	0.2	0.0	0.41	332	420	114	2.0	4	97	23

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Alliance													
36-1 (3)	5-76	7.6	462	0.0	0.0	0.79	248	284	78	2.1	18	106	28
38-2 (4)	5-73	8.4	388	0.0	0.0	1.12	216	256	67	1.6	16	76	
48-1 (5)	5-76	8.4	822	0.0	0.4	0.99	360	368	101	2.1	60	255	106
53-1 (6)	5-76	8.1	532	0.0	0.0	0.91	276	288	90	2.8	28	131	35
68-1 (7)	5-76	8.5	710	0.8	0.0	0.90	324	296	91	2.3	44	195	72
73-1 (12)	5-76	8.3	370	0.0	0.0	0.75	224	244	66	1.9	10	95	26
73-2 (13)	7-76	8.1	472	0.3	0.0	0.80	296	316	86	3.9	26	93	18
Alma													
75-1 (1)	5-76	8.1	302	0.0	0.0	0.31	272	232	70	1.4	4	19	7
Alvo													
36-1 (1)	12-76	7.6	344	0.0	0.0	0.36	268	272	78	0.4	4	15	34
Amherst													
76-1	10-77	7.9	368	0.0	0.0	0.21	272	272	85	1.0	2	25	16
77-1	5-77	7.1	308	0.0	0.0	0.32	276	272	85	1.4	0	23	12
Anoka													
63-1, 70-1 C	2-76	7.1	1616	0.5	5.0	0.45	320	1040	280	0.0	2	915	34
Anselmo													
39-1 (2)	3-76	7.4	202	0.9	0.0	0.18	148	132	40	0.0	0	0	3
64-1 (3)	3-76	7.4	250	0.0	0.1	0.32	172	148	50	0.0	0	0	4

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Ansley													
(1)	7-74	7.5	304	0.0	0.0	0.35	192	208	64	1.0	2	8	7
(2)	7-74	7.4	290	0.0	0.0	0.33	192	200	35	1.0	2	10	9
(3)	7-74	7.4	288	0.0	0.0	0.33	196	200	64	1.0	2	8	7
(4)	7-74	7.4	300	0.0	0.0	0.35	200	212	64	1.0	2	8	9
Arapahoe													
48-1 (1)	7-76	7.5	1014	0.0	0.2	0.61	380	650	181	6.4	82	400	61
62-1 (4)	7-76	7.6	1044	0.9	0.0	0.60	380	630	194	6.4	84	400	60
63-1 (3)	7-76	7.7	618	0.0	0.0	0.71	304	392	109	1.8	34	148	32
Arcadia													
35-1 (1)	7-74	7.3	290	0.0	0.1	0.41	160	184	58	0.0	14	20	15
57-1 (2)	7-74	7.2	342	0.0	0.0	0.35	228	264	70	0.0	8	20	16
Arlington													
F	6-74	7.5	612	0.2	0.1	0.46	320	412	128	0.2	18	193	52
39-1 (2)	6-74	7.3	681	1.3	0.6	0.46	328	146	128	0.0	18	164	50
65-1 (3)	6-74	7.5	500	0.7	0.1	0.50	324	340	96	0.0	8	98	44
Arnold													
53-1 (3)	5-76	7.2	196	0.0	0.0	0.23	124	124	35	1.0	0	0	3
56-1 (4)	3-76	7.4	200	0.1	0.0	0.26	124	128	37	1.4	0	8	3
69-1 (5)	3-76	7.2	206	1.2	0.0	0.25	136	132	24	0.8	0	8	5
Ashland													
31-1(1)	10-75	7.2	418	0.0	0.0	0.29	172	224	67	9.3	14	63	11
54-1 (2)	10-75	7.2	376	0.0	0.1	0.28	156	208	62	4.4	14	62	9
63-1 (3)	10-75	7.6	385	1.1	0.0	0.29	160	172	53	2.2	8	54	11
78-1	8-78	7.6	352	1.7	0.0	0.23	232	208	64	1.0	10	43	19

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Ashton													
56-1 (1)	8-75	7.0	438	0.2	0.0	0.32	276	308	94	1.4	16	17	4
75-1 (2)	8-75	7.1	372	0.0	0.0	0.28	244	248	82	0.8	4	11	3
Atkinson													
55-1 (1)	10-77	7.1	114	0.0	0.0	0.24	92	80	27	0.6	2	10	9
74-1 (3)	10-77	7.7	198	0.2	0.0	0.33	168	120	37	0.6	2	7	16
76-1	10-77	7.6	196	0.0	0.0	0.34	164	116	35	0.4	0	7	19
Atlanta													
03-1 (1) } C 68-1 (2) } C	10-74	7.3	348	0.0	0.0	0.46	244	272	75	2.6	4	12	12
Auburn													
D	5-76	7.3	480	0.0	0.0	1.10	232	352	102	7.3	32	108	15
41-1 (9)	5-76	7.3	710	0.0	0.0	0.28	278	600	155	7.0	66	52	22
43-1 (10)	5-76	7.5	510	0.0	0.0	0.26	296	408	131	8.2	20	94	11
46-1 (11)	5-76	7.5	502	0.0	0.0	0.26	280	408	166	7.7	19	96	9
63-1 (13A)	5-76	7.3	296	0.2	0.0	0.20	188	220	69	0.0	12	83	12
55-1 (16)	5-76	7.1	298	0.2	0.0	0.16	192	232	107	2.3	10	70	10
57-2 (18)	5-76	7.1	396	7.7	0.2	0.15	256	288	56	0.0	12	96	12
66-1 (20)	5-76	7.4	338	0.9	0.1	0.15	192	268	94	0.0	16	81	14
76-1 (2A)	5-76	7.6	604	0.3	0.0	0.20	268	452	142	8.0	78	101	15
Aurora													
56-1 (3)	7-77	7.3	306	0.1	0.0	0.40	200	220	67	2.3	10	38	19
65-1 (4)	7-77	7.4	298	0.0	0.6	0.43	208	212	67	1.7	14	41	22
71-1 (5)	7-77	7.3	256	0.0	0.0	0.51	168	188	58	1.2	12	49	18
Avoca													
54-1	5-76	7.9	550	0.0	0.0	0.46	292	400	120	0.0	32	113	12
67-1	4-76	8.2	392	0.0	0.0	0.27	288	308	96	7.1	10	32	5

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Axtell													
36-1 (1)	12-76	7.4	592	0.0	0.0	0.42	228	360	114	2.6	32	184	40
50-1 (2)	12-76	7.5	474	0.0	0.0	0.47	244	288	98	1.2	82	161	39
75-1	12-76	7.4	620	0.2	0.0	0.41	296	404	126	3.3	22	190	32
Bancroft													
30-1 (1)	10-74	6.9	456	0.0	0.0	0.43	360	392	109	6.7	6	22	23
56-1 (2)	10-74	7.0	422	0.0	0.0	0.46	352	368	104	6.0	4	20	23
69-1 (3)	10-74	7.1	376	0.0	0.0	0.43	324	332	98	3.0	0	16	21
Bartlett													
45-1	10-74	6.3	100	0.0	0.0	0.33	72	68	18	0.4	0	0	4
78-1	9-78	7.4	122	0.0	0.0	0.14	72	80	18	0.4	0	0	6
Bartley													
68-1	12-74	7.9	530	0.0	0.0	0.85	288	308	83	2.2	12	72	38
76-1	4-76	7.2	368	0.0	0.0	----	250	300	82	2.3	18	44	7
Battle Creek													
56-1 (1)	9-75	7.6	404	0.0	0.0	0.26	248	268	85	0.6	2	25	6
48-1 (2)	9-75	7.5	334	0.9	0.0	0.28	188	220	64	2.6	0	17	7
70-1 (3)	9-75	8.0	366	0.0	0.0	0.28	160	244	80	1.0	0	13	6
Bayard													
(1)	8-80	7.5	746	0.0	0.0	0.45	300	360	107	3.7	24	250	68
(2)	8-80	7.3	756	0.0	0.0	0.57	284	392	118	5.6	22	245	47
(3)	8-80	7.6	792	0.0	0.0	0.60	316	420	123	5.2	24	270	54
Bazile Mills													
59-1 (1)	12-74	7.6	296	0.4	0.0	0.34	212	240	77	6.3	4	14	9

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Beatrice													
31-1 (1)	7-76	7.6	264	0.0	0.0	0.28	164	204	59	2.1	12	51	14
31-2 (2)	6-76	7.9	304	0.0	0.0	0.23	167	204	74	3.5	10	60	14
31-3 (3)	6-76	7.8	252	0.1	0.0	0.22	164	172	54	1.8	8	36	12
31-4 (4)	6-76	7.4	288	0.0	0.0	0.23	164	180	61	1.9	12	46	13
65-1 (7)	6-76	8.1	324	0.0	0.0	0.23	164	204	66	3.2	16	65	14
65-2 (6)	6-76	7.9	410	0.1	0.0	0.26	168	248	80	5.6	16	106	17
65-3 (5)	7-76	7.9	222	0.0	0.0	0.26	164	176	53	1.5	12	27	10
67-1 (1A)	6-76	7.8	320	0.0	0.0	0.24	196	216	67	2.6	10	38	14
Beaver City													
37-1 (2)	7-76	7.6	364	0.0	0.0	0.45	288	296	91	1.2	4	29	5
48-1 (4)	7-76	7.6	526	0.0	0.2	0.47	336	412	123	3.2	10	93	12
48-2 (5)	7-76	7.8	466	0.0	0.0	0.50	300	516	109	1.4	22	73	11
Beaver Crossing													
37-1 (1), 57-1 (2) } C	7-76	7.6	364	0.5	0.1	0.23	256	256	88	0.0	8	29	11
Bee													
63-1 (1)	9-74	7.3	698	0.0	0.0	0.37	380	464	139	3.0	4	171	70
Beemer													
04-1 (1)	11-76	7.7	460	0.3	0.0	0.32	280	320	96	9.8	24	38	23
67-1 (2)	11-76	7.5	394	0.0	0.0	0.33	308	288	83	3.2	8	29	23
76-1	11-76	7.3	464	0.0	0.0	0.39	296	324	94	9.2	10	38	31
Belden													
49-1 (1)	7-74	7.4	426	0.6	0.0	0.43	288	344	118	8.1	6	54	16
70-1 (2)	7-74	7.4	450	0.0	0.0	0.43	288	332	104	8.7	8	52	16

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Belgrade													
64-1 (1)	8-73	7.5	494	0.0	0.0	0.32	296	400	123	9.2	26	37	
Bellevue													
F	11-77	8.2	490	0.0	0.1	0.90	328	312	77	0.6	2	80	26
D	5-75	8.7	298	0.0	0.0	1.14	208	192	34	0.2	12	44	17
58-1 (3)	6-73	7.7	632	15.0	1.4	0.33	516	556	197	1.2	8	63	30
62-1 (4)	6-73	7.5	694	11.5	1.0	0.33	500	572	120	0.0	10	100	38
62-2 (5)	6-73	7.5	552	6.5	0.4	0.33	496	480	115	0.8	8	53	39
65-1 (6)	6-73	7.8	430	8.0	0.2	0.35	388	296	106	0.8	8	33	23
67-1 (1)	6-73	7.6	476	10.0	0.2	0.32	408	428	107	0.4	6	45	20
67-2 (2)	6-73	7.8	456	11.0	0.4	0.35	356	376	91	0.8	8	35	20
Bellwood													
68-1 (2)	7-76	7.8	424	0.3	0.1	0.26	264	320	96	1.2	8	97	14
76-1	7-76	7.9	520	0.5	0.7	0.24	292	384	122	0.0	8	128	12
Belvidere													
36-1	6-75	6.9	360	0.0	0.0	0.35	264	260	80	1.6	6	34	23
Benedict													
15-1	6-75	7.1	378	0.0	0.0	0.37	264	272	80	1.8	8	32	24
Benkelman													
52-1 (8)	6-75	7.2	392	0.0	0.0	1.8	444	412	109	4.2	58	156	95
51-1 (10)	6-75	7.3	536	0.0	0.0	1.4	304	300	83	1.6	32	71	34
63-1 (11)	6-75	7.5	502	0.0	0.0	.82	192	268	82	3.0	52	71	20
66-1 (12)	6-75	7.5	458	0.0	0.0	.83	196	244	74	2.8	34	57	18
72-1 (13)	6-75	7.3	778	0.0	0.0	1.86	416	384	106	4.2	42	131	68

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Bennet													
56-1 (1)	2-77	7.6	412	0.1	nil	0.41	336	300	77	4.3	4	34	44
56-1 (1)	7-82	-	-	-	-	-	-	-	-	26.0	-	-	-
59-1 (2)	2-77	7.3	700	nil	nil	0.33	380	524	141	12.3	60	100	38
59-1 (2)	7-82	-	-	-	-	-	-	-	-	36.7	-	-	-
70-1 (3)	2-77	7.4	508	nil	nil	0.38	336	408	107	2.4	12	96	20
Bennington													
53-1 (2)	5-74	7.5	426	2.9	0.0	0.35	312	328	88	0.0	4	31	19
68-1 (3)	5-74	7.4	432	0.7	0.2	0.37	320	312	90	0.2	2	31	20
70-1 (4)	5-74	7.3	422	0.4	0.2	0.41	321	308	90	0.0	6	33	19
Bertrand													
54-1 (3)	9-76	8.0	524	0.2	0.0	0.29	220	348	115	5.1	26	131	9
76-1	6-76	8.2	592	0.0	0.0	0.34	216	360	112	2.4	22	165	18
Big Springs													
46-1 (1)	6-74	7.8	268	0.1	0.0	0.85	140	140	46	1.6	4	18	13
59-1 (2)	6-74	7.5	298	0.0	0.0	0.73	148	144	46	2.2	6	23	19
70-1 (3)	6-74	7.6	332	0.0	0.0	0.85	168	196	62	1.6	4	51	19
72-1 (4)	6-74	7.7	204	0.0	0.0	0.46	112	124	42	2.6	6	2	4
Bladen													
56-1 (2), 68-1 (1) C	10-74	7.1	444	0.1	0.0	0.35	248	328	110	1.4	36	31	13
Blair													
D	1-77	8.1	684	2.2	0.1	1.10	308	396	62	0.2	12	260	72
56-2 (7)	1-77	7.8	1294	12.0	0.6	0.46	640	800	179	0.0	2	480	122
56-3 (8)	5-77	7.1	1902	23.0	0.7	0.50	680	960	215	0.0	4	865	144
59-1 (3)	1-77	7.3	494	2.0	0.8	0.43	404	400	108	0.0	18	31	18
66-1 (13)	5-77	6.9	400	6.5	0.7	0.41	384	320	94	0.0	0	7	12
66-2 (9)	1-77	7.4	704	36.0	1.2	0.42	632	548	160	0.2	6	11	27
66-3 (10)	1-77	7.5	376	3.7	1.0	0.44	276	324	84	0.0	14	50	11
67-1 (11)	1-77	7.7	314	3.0	1.1	0.41	324	280	61	0.0	0	0	14

Continued...

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Blair - cont.													
67-2 (12)	5-77	7.1	416	2.1	1.0	0.48	340	348	93	0.0	18	38	9
68-1 (4)	5-77	6.9	544	5.4	1.6	0.41	412	464	120	0.0	26	58	6
75-1	1-77	7.8	556	8.5	2.2	0.69	276	412	90	0.0	56	102	21
77-1	10-77	7.8	410	0.2	1.6	0.40	360	332	88	0.4	0	17	18
Bloomfield													
65-1	4-79	8.0	374	0.4	0.0	1.02	272	312	90	1.2	4	84	13
75-1	4-79	7.8	642	0.2	0.0	.24	332	424	115	8.8	10	106	23
79-1	4-79	8.0	374	0.4	0.0	1.02	272	312	90	1.2	4	84	13
Bloomington													
09-2 (2), 55-1 (3) } C	12-74	7.8	290	0.0	0.0	0.28	244	288	94	2.2	20	20	14
Blue Hill													
69-1 (2)	10-74	6.9	382	0.2	0.0	0.46	260	300	98	0.8	24	20	13
73-1 (3)	6-76	8.1	406	0.0	0.0	0.37	260	308	102	2.5	22	23	8
Blue Springs - Water from Wymore													
Boelus													
35-1 (1), 61-1 (2) } C	12-75	7.3	402	0.0	0.0	0.23	216	268	90	8.5	10	32	8
76-1	8-76	7.9	326	0.0	0.0	0.29	232	256	78	0.6	6	15	8
Bradshaw													
64-1 (3)	7-76	7.6	388	0.0	0.0	0.30	268	268	86	11.2	16	32	24
71-1 (4)	7-76	7.7	438	0.2	0.0	0.31	280	280	91	10.1	18	38	29

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Brady													
46-1 (1)	7-76	8.1	180	0.0	0.0	0.38	128	120	40	0.0	0	0	4
67-1 (2)	7-76	8.1	172	0.0	0.0	0.37	128	112	38	1.2	0	0	3
Brainard													
47-1 (2)	1-75	7.5	652	0.0	0.5	0.41	344	484	139	1.2	0	163	14
66-1 (4)	1-75	7.5	680	0.0	0.1	0.41	320	500	141	2.0	6	179	14
77-1	6-77	7.3	578	0.0	0.4	0.32	336	440	125	0.8	2	146	20
Bridgeport													
2, 3 C	7-72	7.4	1140	0.1	0.0	0.35	372	344	102	1.0	32	196	133
Bristow													
66-1	10-75	7.8	282	0.0	0.0	0.32	132	188	67	1.4	0	41	9
Broadwater													
55-1 (2)	7-72	7.2	1080	0.1	0.0	0.73	316	396	123	1.0	34	195	85
75-1	6-76	8.2	692	0.0	0.0	0.88	384	376	114	1.2	24	201	41
Brock													
67-1 (5)	8-74	7.6	506	1.2	0.5	0.43	304	372	107	0.2	22	99	31
67-2 (6)	8-74	7.6	504	6.2	6.2	0.50	284	352	104	0.2	20	92	36
74-1 (8)	8-74	7.8	338	0.1	0.0	0.35	160	176	61	7.5	12	33	14
Broken Bow													
29-1 (3)	6-74	7.5	258	0.0	0.0	0.19	188	184	61	1.2	4	8	8
42-1 (4)	6-74	8.3	274	0.0	0.0	0.23	196	200	69	1.2	4	10	7
50-1 (5)	6-74	7.8	278	0.0	0.0	0.28	224	236	72	0.6	6	8	13
56-1 (6)	6-74	7.7	272	0.0	0.0	0.28	224	208	67	0.8	4	4	12

Continued...

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Broken Bow - cont.													
61-1 (7)	6-74	8.2	284	0.6	0.0	0.35	240	212	72	0.0	4	2	16
67-1 (8)	6-74	7.8	266	0.6	0.0	0.28	248	232	78	0.6	2	14	13
74-1 (9)	6-79	7.4	356	0.2	0.0	0.18	248	248	83	0.8	8	29	8
Brownville													
D	4-77	7.9	708	0.8	0.4	0.36	524	600	138	0.8	56	65	22
71-1	4-77	7.6	728	25.5	2.6	0.38	560	600	142	0.0	44	65	25
Brule													
50-1 (1)	5-74	8.4	356	0.0	0.0	0.62	184	216	64	1.2	8	78	31
62-1 (2)	5-74	8.2	696	0.0	0.0	0.53	248	396	123	3.6	20	196	70
Bruning													
61-1 (2)	6-74	7.5	314	0.0	0.0	0.43	184	208	69	5.6	16	47	29
74-1	2-77	7.1	232	0.3	0.0	0.37	180	192	61	1.4	12	35	12
Bruno													
36-1 (1)	9-74	7.3	358	0.0	0.0	0.32	144	264	75	4.2	22	96	13
65-1 (2)	9-74	7.5	298	0.0	0.0	0.37	208	236	64	4.4	4	6	14
Brunswick													
40-1	9-75	7.4	262	0.0	0.0	0.30	120	180	50	5.0	0	8	6
75-1	11-75	7.6	232	0.0	0.0	0.29	156	168	53	2.2	0	0	6
Burchard - Water from Pawnee County R.W.D.													
Burr													
50-1 (1)	8-75	7.4	362	4.3	0.1	0.24	252	248	85	7.7	10	23	22
68-1 (2)	8-75	7.5	308	0.0	0.0	0.24	236	228	74	3.6	2	23	21

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Burwell													
63-1 (1)	3-76	6.8	452	0.0	0.0	0.31	216	280	80	13.8	20	61	10
63-2 (2)	3-76	6.9	444	0.0	0.0	0.26	212	276	88	12.1	16	27	5
63-3 (3)	3-76	7.1	348	0.0	0.0	0.24	208	224	74	5.2	6	15	4
Bushnell													
35-1 (1)	10-75	8.0	340	0.0	0.0	0.78	216	236	70	1.0	20	36	11
62-1 (2)	9-77	7.0	376	0.0	0.0	0.70	200	264	67	0.8	20	34	18
Butte													
D	2-76	7.5	296	0.0	0.7	0.53	208	192	67	0.0	2	25	8
60-1 (1)	2-76	7.4	286	4.1	1.6	0.52	208	180	59	0.0	0	2	8
Byron													
62-1	3-76	7.5	320	0.0	0.0	0.24	200	220	75	3.7	22	17	6
Cairo													
59-1 (4)	10-74	7.1	420	0.3	0.5	0.37	328	332	112	0.6	10	33	23
60-1 (2)	10-74	7.3	382	0.3	0.5	0.48	280	296	91	0.2	10	35	22
63-1 (5)	10-74	7.3	268	0.3	0.2	0.43	180	204	64	0.4	8	43	9
Callaway													
03-1 (1)	10-74	7.5	216	0.0	0.0	0.35	164	140	53	1.2	0	2	10
54-1 (2)	10-74	7.4	218	0.0	0.0	0.37	164	168	48	1.4	0	2	10
55-1 (3)	10-74	7.4	220	0.0	0.0	0.35	152	132	43	1.6	0	0	10
75-1	9-76	8.0	230	0.0	0.0	0.24	160	164	51	1.8	2	11	5
Cambridge													
32-1 (2)	7-76	7.8	362	0.0	0.0	0.63	260	276	80	1.2	10	32	11
39-1 (3)	7-76	7.6	376	0.0	0.0	0.58	260	292	82	4.9	8	31	9
53-1 (5)	7-76	7.5	594	0.0	0.5	0.84	324	352	96	0.0	22	154	45

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Campbell													
10-1 (1)	11-70	7.0	438	9.5	0.0	0.3	254	292	86	1.4	10	38	17
54-1 (4)	10-74	7.4	408	0.0	0.0	0.37	228	272	86	0.4	8	57	14
69-1 (5)	11-74	7.7	410	0.0	0.0	0.37	224	268	86	0.6	10	51	13
Carleton													
30-1 (1)	4-70	7.4	250	0.0	0.1	0.23	162	140	42	2.0	10	4	39
39-1 (2)	8-74	7.6	274	0.0	0.0	0.37	112	140	45	4.0	8	12	14
Carroll													
08-1 (1), 25-1 (2) C	7-75	7.1	566	0.0	0.0	0.24	300	416	101	2.6	2	129	11
Cedar Bluffs													
57-1 (3)	5-74	7.3	524	0.9	0.2	0.52	268	344	101	1.4	2	101	24
69-1 (4)	5-74	7.4	486	0.5	0.4	0.35	276	312	96	2.2	4	60	19
Cedar Rapids													
55-2 (1)	6-76	7.3	330	0.0	0.0	0.22	272	276	92	0.8	8	11	8
Center													
62-1 (2)	12-75	7.3	468	0.9	0.8	0.30	240	324	99	0.0	0	97	14
74-1 (3)	12-75	7.4	698	3.3	1.8	0.31	344	484	158	0.0	4	220	15
77-1	5-77	7.4	374	1.2	0.7	0.36	232	300	93	0.4	2	98	10

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Central City													
26-1 (1)	9-76	7.5	638	0.1	0.6	0.43	228	368	104	1.4	2	196	26
37-1 (2)	9-76	7.6	714	0.0	0.0	0.69	268	408	117	15.2	30	152	36
65-1 (5)	9-76	7.5	646	0.0	0.5	0.58	244	356	102	1.2	24	173	38
71-1 (4)	9-76	7.6	490	0.0	0.6	0.44	232	284	85	3.0	6	98	25
73-1 (3)	9-76	7.7	398	0.0	0.2	0.42	212	216	66	0.2	6	45	18
Ceresco													
58-1 (2)	10-75	7.7	770	0.0	0.0	0.33	332	406	109	14.5	88	89	44
72-1 (4)	10-75	7.7	1016	0.0	0.0	0.45	312	348	103	3.4	220	158	103
76-1	3-79	7.0	662	1.2	0.2	0.39	296	312	96	0.0	114	118	69
Chadron													
D	8-75	7.9	302	0.0	0.0	0.43	168	156	46	0.0	10	0	5
68-2 (2), 68-3 (3), 68-4 (4), 68-5 (5) C	8-75	7.1	298	2.3	0.1	0.41	132	172	43	0.0	24	15	7
IF	8-78	7.9	328	0.0	0.0	0.50	216	196	62	0.6	2	17	14
Chambers													
58-1 (1)	12-74	8.1	142	0.2	0.0	0.34	88	96	22	0.0	4	0	3
70-1 (2)	12-74	8.1	116	0.0	0.0	0.34	84	72	24	0.0	2	0	4
Chappell													
56-1 (1)	6-74	7.7	408	0.0	0.0	0.68	256	240	74	2.2	14	41	39
63-1 (4)	6-74	7.6	434	0.0	0.0	0.68	264	240	75	1.6	18	38	40
66-1 (5)	6-74	7.7	370	0.0	0.0	0.55	208	216	69	2.8	14	29	27
74-1 (6)	6-74	7.6	512	0.0	0.0	0.62	296	288	86	5.0	18	51	35
Chester													
23-1 (1), 48-1 (2) C	12-74	7.8	164	0.0	0.0	0.21	116	132	48	2.2	14	4	13

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Clarks													
37-1 (2)	9-75	7.3	710	0.3	0.2	1.10	296	400	115	6.0	20	200	24
66-1	9-75	7.2	661	0.0	0.4	1.31	308	380	114	0.2	32	165	23
76-1 (1)	8-76	8.9	444	0.3	0.0	1.12	136	88	16	7.0	18	154	71
Clarkson													
75-1	6-76	7.9	560	0.0	0.6	0.22	416	460	134	2.6	8	49	9
77-1	8-77	7.6	874	0.4	0.2	0.31	336	552	155	1.6	2	315	38
Clatonia													
14-1 (1) } C 67-1 (2) } C	12-75	7.4	1532	0.7	0.1	0.54	320	328	85	0.0	580	155	400
Clay Center													
(1)	11-74	7.6	452	0.0	0.0	0.35	208	284	93	2.4	22	93	25
(2)	11-74	7.7	420	0.0	0.0	0.50	188	256	86	0.0	20	107	26
Clearwater													
52-1 (3)	4-75	7.8	222	0.0	0.0	0.30	136	128	45	0.0	0	0	4
64-1	4-75	7.7	242	0.0	0.7	0.30	156	152	50	0.0	0	0	5
Cody													
24-1 (2)	8-75	7.2	282	0.0	0.0	0.18	56	112	37	10.2	6	17	5
66-1 (3)	8-75	7.7	166	0.0	0.0	0.19	56	60	18	2.5	2	0	7
Coleridge													
(1)	11-74	7.4	590	0.0	0.0	0.43	300	428	122	5.6	12	136	26
(2)	11-74	7.6	516	0.0	0.1	0.43	320	384	104	6.3	22	58	32

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Colon													
61-1 (2)	4-77	7.5	370	15.0	0.2	0.42	312	280	80	0.2	0	38	25
68-1 (3)	4-77	7.5	400	0.0	0.2	0.46	312	284	82	0.0	0	38	24
Columbus													
D	10-74	7.4	452	0.0	0.2	0.80	268	312	99	1.0	18	60	23
36-2 (7)	10-74	7.5	366	0.0	0.6	0.41	256	268	86	0.0	18	14	25
48-1 (1)	10-74	7.5	424	0.6	0.7	0.43	284	292	99	0.4	12	54	22
54-1 (10)	10-74	7.2	854	0.5	0.5	0.43	432	488	149	0.0	14	196	66
57-1 (4)	10-74	7.4	554	0.5	0.6	0.50	304	340	101	1.4	22	117	32
61-1 (2)	10-74	7.5	402	0.0	0.6	0.50	248	280	85	0.8	18	49	16
62-1 (8)	10-74	7.5	312	0.1	0.4	0.43	212	204	62	0.6	10	6	12
70-1 (11)	10-74	7.5	342	0.1	0.4	0.43	224	260	74	0.0	6	24	15
71-1 (12)	10-74	7.4	562	1.8	0.6	0.48	300	332	102	0.8	26	82	35
Comstock													
66-1	8-75	7.7	340	0.0	0.0	0.27	208	220	75	4.4	4	15	3
Concord													
62-1 (1)	7-74	7.3	484	0.0	0.0	0.43	304	356	109	1.4	2	105	16
Cook													
43-1 (1)	8-75	7.5	358	3.7	0.0	0.28	276	260	83	0.0	6	47	22
56-1 (2)	8-75	7.7	362	0.0	0.1	0.27	276	272	80	0.0	12	52	21
Cordova													
68-1 (1)	7-76	7.3	282	0.0	0.0	0.26	160	172	50	1.6	2	31	12
74-1	11-76	7.1	294	0.0	0.0	0.31	184	240	67	2.6	10	60	23
Cortland													
37-1	11-78	7.2	354	0.0	0.0	0.27	276	292	83	0.2	14	13	16
68-1	11-78	7.2	540	0.8	0.0	0.24	268	376	107	3.5	18	135	24
75-1	11-78	7.4	368	0.5	0.0	0.28	304	284	83	0.2	20	15	14

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Cozad													
53-1	5-76	7.3	504	0.0	0.0	0.42	220	332	94	1.8	14	114	14
59-1	5-76	7.9	348	0.0	0.0	0.42	224	224	67	1.6	6	45	11
63-1	5-76	7.9	310	0.0	0.0	0.42	216	208	70	1.6	4	41	9
64-1	5-76	7.9	442	0.0	0.0	0.42	196	268	78	1.6	12	113	12
65-1	5-76	8.0	326	0.0	0.0	0.45	204	192	56	1.6	2	32	14
66-1	5-76	8.1	484	0.1	0.0	0.42	224	292	83	1.6	12	122	17
67-1	5-76	8.1	302	0.0	0.0	0.46	200	216	56	0.8	2	36	11
67-2	5-76	8.3	350	0.0	0.0	0.44	204	220	45	0.4	4	56	14
Craig													
IF	11-76	7.9	898	2.1	0.0	0.95	340	544	160	0.8	44	420	41
40-1	11-76	7.5	1308	1.9	0.2	1.30	328	660	196	0.0	66	635	61
Crawford													
D	2-76	8.1	374	0.0	0.0	0.60	268	236	85	1.0	10	30	16
White River	9-75	7.8	234	0.0	0.0	0.62	160	148	43	0.0	2	0	7
Dead Man's	9-75	7.8	302	0.0	0.0	0.75	204	188	64	0.6	2	13	10
Creighton													
56-1 (2)	11-74	7.6	330	0.0	0.0	0.46	192	220	67	7.3	4	14	13
Creston													
66-1 (2)	7-77	7.3	556	0.0	0.1	0.36	348	404	130	3.7	12	104	26
Crete													
31-1 (1)	4-76	7.6	368	1.4	0.5	0.34	232	264	85	0.0	10	82	9
39-1 (3)	4-76	7.8	348	0.2	0.0	0.28	264	236	78	0.0	8	40	8
55-1 (4)	4-76	8.0	334	0.2	0.0	0.28	248	240	77	0.0	8	36	6
65-1 (5)	4-76	8.2	378	0.3	0.5	0.26	252	280	90	0.0	12	52	7
66-1	4-76	8.1	326	0.1	0.1	0.26	232	236	75	0.0	8	45	6
72-1 (6)	4-76	8.1	334	0.3	0.4	0.27	256	248	80	0.0	8	42	5

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Crofton													
63-1 (2)	8-76	7.9	516	0.0	0.0	0.80	276	360	109	5.4	38	80	16
67-1 (3)	8-76	8.1	442	0.0	0.0	0.32	216	340	98	1.5	12	102	6
69-1 (5)	8-76	7.6	434	0.0	0.0	0.33	288	332	99	6.1	8	59	16
69-2 (6)	8-76	7.9	438	0.0	0.0	0.38	324	360	110	4.1	0	41	9
IG	8-76	7.7	362	0.0	0.1	0.41	248	304	82	5.1	4	23	8
Crookston													
59-1	8-75	7.8	278	0.0	0.0	0 39	168	168	54	2.4	4	8	7
Culbertson													
49-1 (3)	6-74	8.0	558	0.3	0.0	1.17	348	336	94	4.4	10	80	49
64-1 (4)	6-74	7.4	550	0.0	0.0	1.14	340	340	98	4.4	9	82	49
Curtis													
53-1 (2)	11-77	7.9	242	0.0	0.0	0.51	176	164	38.4	1.6	9	13	14
68-1 (4)	11-77	7.7	278	0.0	0.0	0.52	172	172	57.6	1.9	4	15	15
Dakota City													
D	2-76	7.6	788	0.2	0.2	0.42	560	680	122	0.8	14	134	20
56-1 (1)	2-76	7.3	826	7.1	0.8	0.46	576	608	165	0.0	12	135	21
58-1 (2)	2-76	7.8	626	11.0	0.4	0.32	480	508	123	0.0	8	119	17
Dalton													
48-1 (3)	6-74	7.2	284	0.0	0.0	0.68	172	152	46	0.4	4	6	16
57-1 (4)	6-74	7.5	290	0.1	0.0	0.68	184	152	48	0.4	4	10	20
Danbury													
46-1	7-76	8.0	444	0.0	0.0	0.42	272	336	91	5.8	26	52	12
68-1	7-76	7.8	466	0.0	0.0	0.41	264	320	93	4.2	26	54	11

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Dannebrog													
39-1 (1)	12-75	7.3	546	0.4	0.5	0.17	356	388	130	0.0	8	63	10
57-1 (2)	12-75	7.4	432	0.0	0.2	0.23	284	300	90	0.0	12	23	11
Davenport													
56-1 (1)	3-77	7.0	454	1.4	0.0	0.25	204	268	82	13.2	44	41	31
57-1 (2)	3-77	7.0	190	0.2	0.0	0.24	144	124	42	2.4	8	11	8
77-1	10-78	6.9	200	0.0	0.0	0.19	148	164	48	1.0	8	13	12
Davey													
62-1 (2)	9-72	8.0	320	0.0	0.0	0.35	248	172	56	0.0	0	5	30
76-1 (3)	1-77	7.6	248	0.0	0.0	0.44	232	196	52	1.5	2	11	44
David City													
47-1 (3)	1-78	7.7	428	1.1	0.4	0.27	308	328	101	0.2	2	59	12
52-1 (5)	1-78	7.7	448	0.6	0.4	0.27	300	328	101	0.0	2	65	11
63-1 (7)	2-76	6.9	798	2.3	1.4	0.27	372	532	165	0.0	8	245	8
66-1 (8)	1-78	7.4	538	0.2	0.6	0.28	368	424	115	0.0	2	92	17
72-1 (9)	1-78	7.9	352	4.5	0.6	0.24	300	320	96	0.2	0	27	9
Dawson													
25-1 (1), 56-1 (2) } C	5-76	7.6	582	0.0	0.4	0.25	304	404	122	2.8	62	102	24
77-1	11-77	7.7	422	0.0	0.2	0.21	232	300	50	0.0	62	82	22
Daykin													
47-1 (1)	11-76	7.2	226	0.0	0.0	0.34	172	152	51	0.0	6	27	16
73-1 (2)	11-76	7.3	278	0.0	0.0	0.34	176	252	53	0.0	8	27	15

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Decatur													
D	7-75	7.4	494	0.0	0.0	0.39	372	428	112	0.0	10	80	11
66-1, 72-1 C	7-75	7.2	546	0.3	0.2	0.38	392	440	125	0.0	8	108	13
Denton													
72-1 (1)	1-77	7.5	1132	1.7	0.2	0.34	240	324	98	0.0	470	96	280
Deshler													
40-1	9-75	7.5	122	0.5	0.0	0.19	72	72	21	2.0	2	0	5
53-1 (3)	9-75	7.4	194	0.0	0.0	0.16	96	108	38	5.2	14	15	9
71-1 (4)	9-75	7.1	180	0.0	0.0	0.14	88	100	30	5.4	14	13	5
DeWitt													
50-1 (2), 54-1 (3), 63-1 (1) C	9-75	6.9	874	0.0	0.0	0.28	164	180	58	2.6	286	103	146
Diller													
36-1 (3)	7-76	6.9	286	0.0	0.4	0.24	136	204	62	9.8	26	76	15
72-1 (5)	7-76	7.4	400	0.0	0.2	0.22	148	212	66	9.2	28	67	16
Dix													
23-1 (1), 54-1 (2), 64-1 (3) C	10-75	7.6	406	0.0	0.0	0.75	276	260	78	3.0	20	43	16
Dixon													
12-1 (1), 49-1 (2) C	4-79	7.3	478	0.0	0.0	0.30	340	388	117	1.4	4	101	9
78-1	12-78	7.3	420	0.8	1.0	0.24	300	332	102	0.0	0	59	18

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Dodge													
34-1 (3)	6-74	7.2	364	0.0	0.0	0.37	296	276	75	5.2	4	6	30
44-1 (2)	6-74	7.4	376	0.2	0.0	0.41	304	280	87	1.8	0	22	25
Doniphan													
63-1 (3)	10-74	7.6	688	0.8	0.0	0.41	200	464	163	6.7	40	150	43
76-1	8-77	7.5	392	0.0	0.0	0.48	156	256	82	5.2	10	138	19
77-1	3-78	7.1	470	0.0	0.0	0.29	160	312	96	7.5	12	180	18
Dorchester													
50-1 (1)	6-76	8.6	352	0.1	0.1	0.34	220	240	78	0.0	6	44	13
56-1 (2)	6-76	8.4	346	0.0	0.2	0.32	220	232	78	0.0	10	49	14
66-1 (3)	6-76	6.4	386	0.0	0.0	0.31	228	248	82	0.0	8	79	19
78-1	6-78	7.7	298	0.1	0.5	0.21	224	220	78	0.2	10	43	13
Douglas													
57-1 (2) C	5-74	7.2	440	2.3	0.2	0.38	260	272	74	2.6	6	51	45
68-1 (3) C													
71-1 (4) C	5-74	7.6	1322	0.4	0.1	1.00	300	820	208	0.2	66	213	104
Dunbar													
70-1	5-77	7.7	*	0.1	0.2	0.36	204	216	67	3.7	10	49	19
40-1	5-77	7.7	*	0.0	0.2	0.41	188	148	45	0.6	0	21	34
Duncan													
38-1 (1)	8-74	8.0	234	0.0	0.0	0.37	88	108	40	7.9	0	10	4
69-1 (2)	8-74	7.7	362	0.0	0.0	0.37	96	160	53	15.1	14	29	12
Dunning													
50-1 (1)	3-76	7.5	150	1.0	0.0	0.25	92	76	22	0.0	0	0	2
67-1 (2)	3-76	6.8	112	0.4	0.0	0.23	52	36	11	0.0	0	0	1

* Insufficient quantity for Total Dissolved Solids

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Dwight													
35-1 (1)	3-72	8.4	500	0.6	0.4	0.52	380	360	93	0.0	4	24	24
71-1 (2)	9-74	7.6	460	0.0	0.4	0.55	360	372	96	0.0	6	31	25
76-1	2-77	7.1	436	0.5	0.5	0.41	300	308	90	0.0	4	50	13
Eagle													
63-1, 67-1 } C	7-73	7.7	554	1.2	0.0	0.52	376	396	102	0.4	20	101	63
77-1	4-77	7.7	646	0.8	0.1	0.38	364	384	99	0.0	18	142	32
81-2	2-81	7.8	598	2.2	0.0	0.42	364	360	90	0.1	28	97	41
81-3	5-81	8.0	530	1.7	0.1	0.38	344	340	90	0.1	24	92	34
Edgar													
56-1 (3)	6-80	7.3	304	0.0	0.0	0.36	188	192	64	6.6	14	30	11
68-1 (4)	6-80	7.3	416	0.0	0.0	0.34	248	252	85	7.5	18	43	18
Edison													
66-1 (3)	7-76	7.7	635	0.0	0.1	0.54	420	452	131	1.7	16	93	23
68-1 (2)	7-76	7.7	338	0.0	0.0	0.37	256	272	83	1.5	10	19	5
Elba													
56-1 (1)	11-74	7.2	352	0.0	0.0	0.33	272	284	96	0.6	8	22	7
68-1 (2)	11-74	7.6	356	0.0	0.0	0.33	268	288	96	0.6	6	22	10
Elgin													
76-1	12-76	8.2	306	0.0	0.0	0.36	236	200	64	0.2	0	6	10
Elk Creek													
55-1 (1)	4-76	7.6	474	0.1	1.1	0.26	390	328	101	4.7	14	55	19
71-1 (3)	5-76	7.6	530	0.0	1.2	0.27	296	360	107	4.5	28	133	14

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Elkhorn													
51-1 (2)	8-76	7.5	336	0.0	0.0	0.25	280	272	78	0.6	0	9	7
71-1 (1)	8-76	7.6	360	0.0	0.0	0.26	272	256	82	0.6	4	21	5
57-1 (3)	8-76	7.2	424	0.0	0.0	0.25	300	336	91	1.8	2	25	6
73-1 (4)	8-76	7.3	404	0.0	0.0	0.27	292	300	90	2.4	6	13	5
Elm Creek													
69-1 (3)	9-74	7.8	404	0.0	0.0	0.35	276	328	96	1.6	8	37	17
73-1 (4)	9-74	7.5	624	0.0	0.0	0.37	336	464	149	3.0	28	138	28
77-1	3-78	7.3	-	0.0	0.0	0.22	272	280	88	1.6	4	32	12
Elmwood													
65-1 (3)	4-76	7.3	322	0.0	0.0	0.24	156	192	56	12.3	20	15	9
Elsie													
49-1 (1)	11-74	6.9	248	0.0	0.0	0.55	172	140	51	0.8	8	2	4
54-1 (2)	6-75	7.4	322	0.0	0.0	0.54	188	176	50	1.4	8	2	5
Elwood													
(1)	9-77	7.6	506	0.0	0.0	0.39	232	352	104	2.1	14	108	17
(2)	9-77	7.7	466	0.0	0.0	0.35	208	324	98	1.9	14	122	15
Emerson													
D	5-76	8.0	590	0.0	0.0	0.89	356	476	131	0.0	6	149	17
52-1 (3)	5-76	8.0	548	0.0	1.0	0.32	352	444	123	0.0	4	131	20
72-1 (4)	5-76	7.7	618	1.1	0.8	0.31	372	480	131	1.2	10	155	17
Endicott													
D	8-76	7.7	428	0.0	0.0	0.37	272	268	85	0.0	32	38	20
67-1 (1)	8-76	7.3	434	0.2	0.4	0.39	276	268	88	0.0	30	40	17

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Ericson													
71-1 (1)	6-76	7.3	100	0.0	0.0	0.19	92	76	26	0.0	0	0	5
Eustis													
39-1 (1)	8-75	7.1	378	0.0	0.0	0.34	244	268	88	4.0	6	15	6
70-1 (3)	8-75	7.2	382	0.1	0.0	0.24	244	264	85	4.2	6	11	4
Ewing													
55-1 (1)	4-75	7.9	180	0.0	0.6	0.46	92	80	27	0.2	0	0	5
67-1 (3)	4-75	7.5	176	0.0	0.7	0.23	68	76	24	2.4	6	0.2	4
73-1 (4)	4-75	7.9	184	0.1	0.0	0.65	88	64	21	0.0	4	0	6
Exeter													
66-1 (5)	11-76	7.7	768	0.0	0.0	0.38	264	484	154	8.2	20	370	24
68-1 (6)	2-76	7.2	1760	0.4	0.0	0.35	288	1140	390	21.4	52	815	28
Fairbury													
D	12-74	8.0	380	0.0	0.0	0.97	204	204	64	3.0	52	14	49
IF	12-74	7.9	396	0.0	0.0	0.35	212	176	59	2.4	42	10	60
(1,2,3) C	12-74	7.8	508	1.6	0.0	0.32	220	216	72	1.4	124	20	86
70-1 (4)	12-74	8.0	274	0.0	0.0	3.0	156	184	61	6.0	6	20	16
Fairfield													
63-1	6-76	8.1	250	0.0	0.0	0.32	160	164	58	3.1	4	21	8
75-1	6-76	8.1	222	0.0	0.0	0.34	168	142	50	2.3	8	19	8
Fairmont													
64-1 (3)	9-76	7.1	708	0.0	0.0	0.30	232	468	142	11.0	22	260	30
71-1 (2)	10-76	7.8	1302	0.4	0.1	0.32	288	740	235	23.4	64	500	75
73-1 (1)	9-76	7.9	690	0.0	0.1	0.34	232	440	142	10.6	22	235	31

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Falls City													
D	1-78	7.5	312	0.0	0.0	0.23	128	160	30	0.2	12	111	32
40-2 (2)	5-76	7.2	612	9.5	0.3	0.33	480	476	136	0.0	6	73	20
40-3 (3)	5-76	7.1	618	11.0	3.5	0.33	500	460	144	0.0	4	56	13
40-4 (4)	5-76	7.1	652	10.0	2.1	0.36	412	580	122	0.0	12	133	33
50-2	5-76	7.1	610	9.5	2.1	0.33	444	560	130	0.0	10	110	23
56-1 (9)	5-76	7.2	644	15.5	2.3	0.34	444	520	134	1.0	12	126	29
62-1 (10)	5-76	7.3	644	6.0	2.1	0.37	408	500	123	0.0	10	115	23
64-1 (11)	5-76	7.1	568	6.5	1.6	0.38	352	440	109	0.0	10	108	22
72-1 (12)	5-76	7.1	536	7.5	1.1	0.39	308	440	101	0.0	12	126	24
72-2 (13)	5-76	7.2	552	6.5	0.6	0.31	228	480	90	0.0	16	164	26
72-3 (14)	5-76	7.4	588	10.5	0.7	0.35	404	540	128	0.0	10	85	16
72-4 (15)	5-76	7.4	510	2.6	0.7	0.40	200	265	69	0.0	16	180	36
Farnam													
(1)	11-74	7.4	356	0.0	0.0	0.50	236	236	72	1.4	0	10	4
(2)	11-74	7.4	372	0.0	0.0	0.50	236	244	66	2.7	4	6	4
Farwell													
35-1 (1)	12-75	7.2	402	1.6	0.0	0.20	296	288	94	0.0	8	8	7
51-1 (2)	12-75	7.2	396	1.4	0.0	0.20	280	280	93	0.0	9	23	6
Filley													
64-1 (3)	3-74	7.6	950	0.1	0.6	0.32	312	676	170	0.4	6	205	47
68-1 (2)	5-76	7.7	1648	9.0	0.6	0.53	312	1020	224	0.0	16	865	50
74-1 (4)	5-76	7.7	1578	0.1	0.1	0.72	276	920	214	1.8	12	840	56
77-1	12-77	7.7	2688	0.4	0.0	1.00	240	1500	432	0.0	18	1590	94
Firth													
41-1	2-77	7.6	324	0.0	0.0	0.39	248	260	77	2.6	6	31	13
71-1	2-77	7.6	310	0.0	0.0	0.38	244	280	78	2.6	4	31	12

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Fordyce													
25-1 (1) } C	11-75	7.6	514	2.6	0.4	0.31	284	384	114	0.0	4	30	13
25-2 (2) } C													
76-1	9-78	7.6	874	0.3	0.1	0.44	208	592	195	0.0	0	315	25
Fort Calhoun													
53-1 (2)	10-73	7.2	490	2.0	0.0	0.35	452	392	120	0.0	16	2	0
61-1 (3)	10-73	7.3	548	6.2	1.9	0.33	488	476	125	0.8	2	29	0
67-1 (4)	1-77	7.4	430	3.5	0.4	0.32	424	380	107	0.0	4	8	8
72-1 (5)	10-73	7.3	524	2.1	0.5	0.37	400	432	125	0.0	22	49	0
Franklin													
29-1 (1)	10-80	7.3	412	0.1	0.0	0.30	240	264	93	1.9	20	66	16
52-1 (3)	10-80	7.5	506	0.0	0.0	0.32	280	308	102	3.5	28	92	29
59-1 (4)	10-80	7.4	430	0.0	0.0	0.33	236	284	93	3.7	28	68	16
62-1 (5)	10-80	7.3	470	0.0	0.0	0.30	280	316	109	2.3	30	100	23
70-1 (6)	10-80	7.6	408	0.0	0.0	0.32	224	292	99	1.9	28	71	14
Fremont													
34-1 (1)	6-76	7.9	406	0.0	0.0	0.52	228	280	86	0.0	12	99	14
39-1 (2)	6-76	7.6	616	0.0	0.4	0.33	212	412	120	0.6	32	215	19
41-1 (3)	6-76	7.7	466	0.0	0.0	0.32	184	280	40	3.2	30	131	20
53-1 (4)	6-76	8.2	672	0.0	0.1	0.32	236	444	134	1.8	20	250	15
54-1 (5)	6-76	7.8	596	0.0	1.0	0.38	252	380	115	0.5	16	203	24
56-1 (6)	6-76	8.1	658	0.7	0.0	0.31	212	440	139	1.6	12	290	18
67-1 (7)	6-76	8.3	272	0.0	0.0	0.39	180	192	62	0.0	12	52	12
70-1 (8)	6-76	8.3	392	0.0	0.3	0.34	188	250	80	0.6	16	105	17
77-1	7-78	7.4	392	0.0	0.2	0.36	152	220	72	6.6	10	93	22
77-2	7-78	7.5	390	0.1	0.6	0.25	172	220	70	0.6	12	101	21
77-3	7-78	7.5	378	0.5	0.1	0.27	172	196	67	0.4	10	86	23
Friend													
45-1	1-77	7.3	540	0.0	0.0	0.34	200	308	98	13.2	24	138	31
54-1	6-76	7.8	360	0.1	0.7	0.31	232	280	86	0.0	12	69	11
77-1	8-77	7.8	410	0.0	0.7	0.34	232	292	85	0.0	8	84	21

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Fullerton													
40-1	8-74	7.5	508	0.0	0.0	0.43	284	360	117	10.8	8	49	10
40-2	8-74	7.5	582	0.0	0.0	0.48	316	392	128	10.2	16	29	5
59-1 } C	3-74	7.5	410	0.0	0.0	0.21	296	312	101	0.0	4	25	15
61-1 } C													
69-1	3-74	7.9	502	0.5	0.0	0.30	336	364	107	0.6	6	84	32
Funk													
38-1 (1)	9-76	7.6	806	3.1	0.0	0.32	256	476	163	6.6	28	315	26
56-1 (2)	9-76	8.0	742	1.2	0.2	0.31	236	440	144	0.0	30	325	26
Garland													
28-1 (1)	7-76	7.8	560	5.5	0.2	0.52	184	256	62	0.2	4	69	20
71-1 (2)	7-76	7.6	546	0.0	0.2	0.54	356	228	61	0.0	2	66	52
Geneva													
60-1 (3)	12-76	7.5	294	1.0	0.0	0.36	180	236	62	0.0	16	49	19
65-1 (4)	12-76	7.7	394	0.2	0.1	0.35	200	252	88	3.7	22	85	22
70-1 (1)	12-76	7.4	428	0.1	0.0	0.34	212	272	86	5.4	18	96	31
71-1 (2)	12-76	7.6	280	0.0	0.4	0.37	200	220	61	0.0	14	49	16
Genoa													
47-1 (1)	1-81	7.5	288	0.0	0.0	0.22	240	240	78	2.3	4	11	10
50-1 (2)	5-76	7.4	626	0.0	0.0	0.42	340	380	115	12.5	14	100	31
53-1 (3)	6-80	7.4	404	0.1	0.0	0.22	256	276	91	1.2	6	36	13
68-1 (4)	6-80	7.2	378	0.0	0.0	0.35	276	288	99	6.4	8	52	7
76-1	6-80	7.2	322	0.0	0.0	0.21	268	224	74	1.0	6	11	16
Gering													
53-3 (7)	7-76	7.8	824	0.0	0.0	0.30	368	272	86	6.4	66	201	135
58-1 (8)	7-76	7.3	744	0.0	0.0	0.25	340	256	94	0.8	34	230	97
58-2 (9)	7-76	7.6	592	0.0	0.0	0.26	264	264	88	1.4	20	203	68
58-3 (10)	7-76	7.6	718	0.0	0.0	0.28	320	276	91	4.5	44	195	96

Continued...

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Gering cont.,													
61-1 (T1)	7-76	7.7	584	0.1	0.0	0.31	252	260	83	1.6	20	225	76
65-1 (T2)	7-76	7.7	608	0.0	0.0	0.28	272	272	88	1.6	24	206	75
65-2 (T3)	7-76	7.6	702	0.0	0.0	0.29	316	256	86	2.8	26	255	108
76-1	10-77	8.1	968	0.0	0.0	0.93	396	132	38	5.2	120	191	350
Gibbon													
40-1 (1)	12-78	7.0	738	0.8	0.0	0.20	244	508	73	16.3	66	215	62
45-1 (3)	12-78	7.1	1332	1.6	0.0	0.21	328	700	226	12.5	110	490	64
56-1 (2)	12-78	7.0	658	0.0	0.0	0.18	184	396	120	18.6	38	205	38
77-1	12-78	7.4	346	0.0	0.1	0.25	220	228	69	0.2	12	47	14
Giltner													
48-1 (1)	7-75	7.5	490	0.0	0.2	0.38	208	296	86	0.0	8	128	58
65-1	7-75	7.1	417	0.0	0.9	0.38	196	272	83	2.0	14	113	18
Gordon													
27-1 (1)	8-74	7.8	302	0.0	0.0	0.37	180	212	66	3.8	12	20	4
35-1 (2)	8-74	7.8	326	0.0	0.0	0.37	188	236	67	5.4	16	20	4
47-1 (3)	8-74	7.8	368	0.0	0.0	0.43	188	236	69	4.6	16	36	11
53-1 (4)	8-74	7.9	330	0.0	0.0	0.52	180	172	53	1.4	10	56	24
60-1 (5)	8-74	7.7	274	0.0	0.0	0.43	196	172	53	0.8	0	56	12
65-1 (6)	8-74	7.8	358	0.0	0.0	0.52	204	192	53	1.6	8	16	30
79-1	1-79	7.5	234	0.0	0.0	0.28	160	172	48	1.2	0	15	12
Gothenburg													
65-1 (5)	5-76	8.0	484	1.0	1.2	0.40	228	276	82	0.0	22	122	23
69-1 (6)	5-76	8.1	558	0.0	0.1	0.44	228	292	90	0.0	20	165	33
72-1	5-76	7.5	318	0.0	0.0	0.46	200	228	70	0.0	10	56	8
72-2	5-76	7.2	312	0.0	0.0	0.41	180	196	61	2.4	6	28	7

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Grafton													
36-1	1-70	6.9	320	4.0	0.1	0.36	220	208	67	0.1	18	6	30
63-1	1-75	7.1	364	0.0	0.0	0.37	212	220	67	1.2	12	31	21
Grand Island													
56-1	10-75	7.2	268	0.0	0.0	0.27	136	176	56	6.7	10	23	7
56-2	10-75	7.0	324	0.1	0.0	0.24	160	216	66	5.2	26	21	8
71-1	10-75	7.2	310	0.0	0.0	0.27	132	184	62	4.4	10	57	7
55-1	10-75	7.1	444	0.0	0.0	0.48	184	284	85	5.2	8	124	15
48-1	10-75	7.4	472	0.0	0.0	0.48	208	308	91	3.8	10	124	15
42-1	10-75	7.2	432	0.0	0.0	0.45	172	268	82	6.5	12	109	14
38-1	10-75	7.6	382	0.0	0.0	0.46	208	264	78	2.2	14	75	10
Greeley													
76-1	7.76	7.7	330	1.8	1.2	0.22	288	272	86	0.0	0	11	6
Greenwood													
26-1 (1)	7-75	7.1	484	1.5	0.0	0.28	268	340	96	0.0	4	131	22
56-1 (2)	7-75	6.9	380	0.1	0.0	0.32	268	276	80	2.0	10	54	18
Gresham													
48-1 (2)	10-74	6.2	386	0.0	0.0	0.35	280	268	85	3.2	8	12	20
68-1 (3)	10-74	6.6	372	0.0	0.0	0.37	280	280	104	3.4	6	12	21
Gretna													
64-1 (2)	9-76	7.8	380	1.5	0.1	0.23	308	332	93	0.0	2	15	8
70-1 (4)	9-76	7.4	374	1.8	0.1	0.26	304	288	88	0.0	2	15	10
72-1 (1)	6-76	7.9	368	0.0	0.0	0.26	304	288	88	0.6	4	23	15
Gurley													
33-1 (2)	6-74	7.5	218	0.0	0.0	0.68	148	136	37	1.8	4	6	15
52-1 (1)	6-74	7.9	210	0.0	0.0	0.75	144	128	35	1.0	2	6	17
72-1 (3)	6-74	7.8	250	0.0	0.0	0.73	148	136	37	2.0	4	4	14

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Haigler													
46-1 (2)	7-76	7.7	2254	5.3	1.1	0.91	288	780	192	0.0	32	1320	300
65-1 (3)	7-76	7.9	288	0.0	0.0	0.70	212	192	58	2.6	2	29	15
Hallam													
54-1 (1)	1-77	7.5	460	0.5	0.2	0.45	340	344	94	0.4	20	56	29
62-1 (2)	1-77	7.4	430	0.5	0.2	0.42	340	328	90	0.0	16	40	28
Hampton													
04-1 (1)	10-75	7.8	312	0.0	0.0	0.31	192	204	67	3.0	10	27	8
62-1 (2)	10-75	8.0	344	0.0	0.0	0.30	232	224	69	4.0	12	27	7
Harbine													
67-1 (1)	10-74	7.5	336	0.0	0.0	0.52	268	276	87	0.8	10	12	13
Hardy													
45-1 (1)	3-76	7.4	558	0.0	0.0	0.40	300	308	96	12.1	24	84	37
73-1 (3)	3-76	7.2	558	0.0	0.0	0.39	300	324	99	12.8	28	85	37
Harrison													
D	5-80	7.6	246	0.0	0.0	0.31	172	180	56	3.7	8	0	7
60-1	8-75	7.6	274	0.0	0.0	0.34	156	176	34	3.4	6	8	7
63-1	8-75	7.9	278	0.0	0.0	0.36	144	156	46	3.0	6	0	4
Hartington													
77-1	2-78	7.8	395	0.1	0.2	0.27	256	312	93	0.0	4	84	9
70-1	11-75	7.7	494	0.0	0.0	0.22	224	368	112	2.0	2	136	12
70-2	11-75	7.7	342	0.0	0.0	0.28	228	252	80	0.4	2	43	11
78-1	3-79	8.0	332	0.0	0.0	0.25	184	220	53	0.4	8	75	19

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Harvard													
54-1 (1)	11-74	8.0	344	0.0	0.0	0.50	196	220	69	0.2	14	72	27
44-1 (2)	11-74	8.0	336	1.7	0.0	0.50	212	216	67	0.2	8	70	24
61-1 (3)	11-74	7.9	354	0.6	0.0	0.50	180	212	69	0.2	6	68	25
66-1 (4)	11-74	7.9	348	0.0	0.3	0.50	188	232	67	0.2	12	68	24
Hastings													
15-1 (1)	11-75	7.2	278	0.4	0.0	0.40	172	180	58	1.6	8	45	19
46-1 (2)	11-75	8.1	274	0.0	0.0	0.36	176	200	59	1.6	12	38	21
65-1 (3)	11-75	8.3	242	0.0	0.0	0.38	156	172	56	2.4	8	47	15
25-1 (4)	11-75	8.3	274	0.0	0.0	0.37	188	200	62	1.6	8	47	20
30-1 (5)	8-76	7.3	281	0.0	0.0	0.38	160	216	58	0.8	18	47	13
76-1 (6)	8-76	7.4	218	0.0	0.0	0.36	156	152	50	1.9	10	15	9
45-1 (7)	11-75	8.3	272	0.0	0.0	0.35	188	204	61	1.8	0	42	23
48-1 (8)	11-75	7.2	234	0.2	0.0	0.34	156	160	53	1.6	16	39	18
48-2 (9)	8-76	7.3	238	0.0	0.0	0.34	172	148	46	1.9	10	15	6
53-1 (10)	11-75	7.1	224	0.1	0.0	0.31	172	184	51	1.6	8	19	15
56-1 (11)	11-75	7.3	230	0.1	0.0	0.32	156	164	50	2.6	8	25	16
57-1 (12)	11-75	7.7	294	0.1	0.0	0.33	172	212	64	3.0	16	36	13
64-1 (14)	8-76	7.5	222	0.0	0.0	0.34	144	136	43	1.9	6	15	7
64-2 (15)	11-75	7.3	282	0.2	0.0	0.30	172	216	66	0.8	14	61	17
67-1 (16)	11-75	8.2	234	0.0	0.0	0.32	172	164	48	2.8	6	27	13
Hay Springs													
40-1 (1)	8-75	7.7	300	0.0	0.0	0.31	172	164	50	2.0	8	23	10
49-1 (2), 64-1 (3) } C	8-75	7.7	304	0.0	0.0	0.33	164	156	46	1.2	4	25	18
Hayes Center													
53-1	8-76	7.5	294	0.0	0.0	0.74	184	236	45	1.6	4	13	5
46-1	7-76	8.0	268	0.0	0.0	0.76	264	172	45	2.1	4	11	9
69-1	7-76	8.1	260	0.2	0.0	0.74	176	180	43	1.9	4	15	8

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Hebron													
38-1 } C	11-74	8.1	206	0.0	0.0	0.33	132	140	43	4.2	10	4	18
47-1 } C													
56-1 (4)	11-74	8.1	192	0.0	0.0	0.32	140	132	43	1.2	8	6	15
64-1 (5)	11-74	8.0	176	0.0	0.0	0.33	136	128	10	0.6	6	6	15
Hemingford													
46-1 (1)	5-76	8.1	304	0.3	0.0	0.62	204	212	61	1.4	6	51	14
53-1 (2)	5-76	8.0	324	0.0	0.0	0.63	208	212	62	2.1	8	44	16
56-1 (3)	5-76	7.7	476	0.0	0.0	0.59	240	344	88	12.3	18	67	18
65-1 (4)	5-76	8.1	426	0.0	0.0	0.68	236	212	59	2.1	6	113	16
Henderson													
49-1 (1)	7-76	7.6	292	0.0	0.0	0.34	196	232	74	0.0	18	32	14
57-1 (2)	7-76	7.8	444	0.2	0.0	0.38	220	240	99	15.2	32	31	14
+71-1 (3)	7-76	7.4	276	0.2	0.0	0.42	204	244	72	2.4	18	37	17
Henry													
22-1 (1)	7-76	7.9	620	0.1	0.0	0.65	272	372	104	3.3	0	195	39
52-1 (2)	9-76	7.7	600	0.1	0.0	0.66	304	360	117	0.4	14.	182	47
Herman													
D	5-74	7.6	438	0.0	0.0	0.48	340	344	91	0.2	2	22	19
66-1 (3)	5-74	7.3	454	0.2	1.0	0.48	344	336	94	0.0	0	22	19
Hershey													
53-1 (2)	7-74	7.7	722	0.0	0.0	0.57	184	380	120	1.6	8	202	82
66-2 (3)	7-74	7.8	716	0.0	0.0	0.57	184	380	120	1.8	40	201	86

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Hickman													
35-1 (1)	2-77	7.6	642	0.2	0.0	0.32	320	428	123	10.8	34	137	42
49-1 (3)	2-77	7.1	684	0.0	0.3	0.28	288	456	131	3.5	42	191	35
77-1	4-77	7.5	354	0.2	0.1	0.42	264	264	91	3.7	6	23	19
73-1	1-77	7.4	408	0.0	0.0	0.39	260	300	88	8.8	12	34	15
Hildreth													
64-1 (2)	9-76	7.9	472	0.0	0.0	0.29	244	296	102	5.1	18	59	17
44-1	9-76	8.1	472	0.0	0.0	0.28	272	300	88	2.4	8	63	15
Holbrook													
54-1 (2)	10-73	7.4	746	3.5	0.8	0.70	356	504	146	0.0	48	179	--
72-1 (3)	3-77	7.5	662	0.7	0.5	0.68	324	444	133	0.0	60	152	32
Holdrege													
26-1 (4)	9-76	7.8	508	0.2	0.0	0.31	240	348	112	4.2	24	94	6
46-1 (2)	9-76	8.0	538	0.0	0.0	0.31	236	360	115	6.6	24	124	8
49-1 (3)	9-76	7.8	532	0.0	0.0	0.31	232	384	117	6.6	22	122	8
54-1 (5)	9-76	7.9	470	0.0	0.0	0.28	228	300	101	3.0	14	89	7
55-1 (6)	9-76	7.8	512	0.0	0.0	0.38	240	372	120	7.9	32	103	7
62-1 (1)	9-76	7.9	548	0.0	0.0	0.28	228	360	115	7.3	22	111	6
62-2 (7)	9-76	7.8	528	0.0	0.0	0.27	240	368	122	6.3	32	102	8
64-1 (8)	9-76	7.8	530	0.0	0.0	0.27	224	344	114	6.3	20	102	8
69-1 (9)	9-76	7.9	532	0.0	0.0	0.28	232	360	118	6.8	22	122	7
73-1 (10)	9-76	7.9	518	0.0	0.0	0.26	320	368	117	5.8	16	117	9
74-1	9-76	8.0	522	0.2	0.0	0.28	228	352	117	5.8	24	122	8
Holland													
66-1 (1)	2-77	7.8	410	0.2	0.0	0.38	324	320	94	1.0	8	56	25
73-1 (2)	2-77	7.7	418	0.1	0.1	0.38	320	316	96	1.2	6	52	22
Holstein													
67-1 (1)	7-74	7.5	302	0.0	0.0	0.48	176	180	59	0.4	4	54	17
76-1	8-76	7.8	182	0.0	0.0	0.42	116	108	37	2.8	0	11	11

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Homer													
56-1 (2)	2-76	7.3	516	4.5	0.7	0.48	400	436	134	0.0	0	60	7
67-1 (3)	2-76	7.4	446	1.4	0.5	0.54	320	372	102	0.8	0	60	8
79-1	3-80	7.0	440	0.5	0.4	1.28	368	392	118	0.4	14	122	22
Hooper													
51-1 (2)	8-76	7.1	334	0.0	0.0	0.28	192	228	59	5.4	4	25	6
55-1 (1)	8-76	7.2	442	0.0	0.2	0.28	240	300	88	3.3	14	73	8
70-1 (3)	5-78	7.5	350	0.0	0.2	0.24	248	260	77	2.1	6	53	20
Hordville													
58-1 (2)	11-74	7.1	558	0.0	0.0	0.48	316	340	114	3.0	20	68	37
Hoskins													
D	8-76	7.5	522	0.5	0.1	0.23	208	416	112	0.4	2	129	14
58-1 (1)	8-76	7.2	354	7.0	0.2	0.38	316	336	94	1.4	4	17	6
65-1 (2)	8-76	7.4	524	0.3	0.1	0.25	300	392	112	0.0	10	128	14
Howells													
05-1 (2)	6-74	7.1	484	0.1	1.0	0.43	332	388	110	6.7	22	56	28
57-1 (3)	6-74	7.1	552	0.0	0.4	0.37	428	420	126	5.2	22	74	28
76-1	3-77	7.1	478	0.1	0.4	0.39	316	396	114	10.6	16	31	12
Hubbard													
56-1 (2), 74-1 (3) } C	1-75	7.5	420	0.0	0.0	0.43	336	388	110	5.8	4	44	16
Hubbell													
66-1 (1)	11-74	7.5	650	5.0	1.1	.33	372	496	166	2.4	48	111	34
77-1	4-77	8.0	332	0.0	0.0	0.28	248	252	83	1.2	10	11	8

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Humboldt													
(S)	7-76	7.6	380	0.0	0.0	0.29	268	276	80	4.5	4	27	17
56-1 (1)	7-76	7.8	428	0.0	0.0	0.28	272	292	82	4.9	2	38	22
Humphrey													
57-1 (2)	6-76	8.1	732	0.0	0.0	0.52	332	520	139	0.4	6	245	18
65-1 (3)	6-76	8.0	758	0.0	0.0	0.52	324	620	141	0.4	14	230	18
70-1 (4)	6-76	8.1	746	0.0	0.0	0.55	340	516	139	0.4	0	245	17
Hyannis													
60-1 (1)	6-76	7.0	132	0.0	0.0	0.26	84	84	18	1.6	4	8	6
64-1 (2)	6-76	7.1	398	0.0	0.0	0.24	116	252	77	15.6	42	75	11
73-1 (4)	10-77	7.9	266	0.1	0.1	0.29	108	164	48	5.6	22	40	16
Imperial													
45-1 (3)	2-78	7.9	200	0.1	0.0	0.71	152	132	37	1.0	2	19	6
57-1 (4)	7-76	7.7	230	0.0	0.0	0.75	156	168	42	1.8	12	16	11
64-1 (5)	7-76	8.0	190	0.0	0.0	0.76	152	156	40	1.2	4	15	8
70-1 (6)	2-78	8.0	208	0.0	0.0	0.75	148	140	42	1.0	4	15	21
Indianola													
67-1 (2)	1-80	7.0	844	0.0	0.4	0.63	392	556	149	13.6	40	191	35
68-1 (1)	1-80	7.0	864	0.0	0.2	0.63	380	528	152	13.4	46	193	35
77-1	1-80	7.1	650	0.0	0.0	0.89	400	400	114	5.8	16	128	36
Jackson													
48-1 (2)	3-76	7.0	550	0.3	0.0	1.15	368	420	122	0.0	16	128	36
78-1	3-79	7.3	774	1.3	0.1	1.19	348	504	152	0.0	14	225	40

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Jansen													
42-1 (2)	10-74	7.3	596	0.3	0.0	0.52	320	356	114	1.2	26	16	14
70-1 (1)	10-74	7.4	442	0.0	0.0	0.52	292	336	110	4.0	14	39	15
Johnson													
54-1 (3)	4-76	7.1	524	0.1	0.0	0.44	284	352	91	17.5	18	23	17
62-1 (4)	4-76	7.2	518	0.0	0.0	0.53	292	348	88	13.8	24	32	14
67-1 (5)	3-80	7.6	2068	0.2	0.0	0.67	384	1300	269	0.0	6	1075	42
71-1 (6)	4-76	7.2	512	0.0	0.0	0.53	304	344	85	18.6	14	41	13
Julian													
69-1 (2)	8-74	7.8	294	0.0	0.0	0.35	196	164	51	4.8	4	2	24
		ALSO SERVED BY THE OTOE COUNTY RURAL WATER DISTRICT											
Juniata													
58-1 (1)	6-74	7.1	198	0.0	0.0	0.37	144	124	40	1.4	14	6	14
63-1 (2)	6-74	7.7	218	0.0	0.0	0.37	148	164	43	2.0	4	8	15
Kearney													
40-1 (6)	5-76	8.0	742	0.0	0.0	0.36	288	432	128	4.3	38	230	49
41-1 (7)	5-76	8.2	836	0.0	0.0	0.64	320	428	117	8.2	30	310	76
46-1 (8)	5-76	8.2	956	0.0	0.0	0.52	312	432	123	6.4	32	345	78
46-2 (9)	9-70	7.5	1080	0.0	0.0	0.43	320	500	146	8.2	34	200	212
48-2 (2)	11-74	7.7	714	0.0	0.0	0.48	244	384	110	6.9	32	199	84
54-1 (1)	5-76	8.2	860	0.0	0.0	0.33	300	508	157	4.7	48	295	44
54-2 (11)	5-76	8.2	712	0.0	0.0	0.42	292	396	112	6.6	26	245	56
54-3 (12)	5-76	7.9	720	0.0	0.0	0.38	260	372	110	8.6	34	230	53
55-1 (13)	5-76	7.9	822	0.0	0.0	0.32	304	468	146	4.3	40	315	54
57-1 (2)	5-76	8.0	882	0.0	0.0	0.56	308	412	130	4.3	32	320	70
58-1 (3)	5-76	7.8	678	0.0	0.0	0.39	284	440	134	11.0	36	315	64
59-1 (14)	11-74	7.6	694	0.0	0.0	0.37	280	420	128	6.5	40	199	77
61-1 (15)	11-74	7.6	798	0.0	0.0	0.68	284	436	128	8.7	38	204	100
66-1 (16)	11-74	7.6	866	0.0	0.0	0.69	320	524	94	18.9	36	205	144

Continued...

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Kearney cont.,													
68-1 (17)	11-74	7.1	858	0.0	0.0	0.62	316	396	112	6.5	26	201	103
68-2 (18)	5-76	8.2	302	0.0	0.0	0.48	232	224	75	0.0	4	8	7
69-1 (4)	11-74	7.6	620	0.0	0.0	0.71	252	376	99	4.6	28	199	82
71-1 (5)	5-76	8.0	694	0.0	0.0	0.31	288	420	131	5.2	36	175	41
73-1 (19)	11-74	7.2	666	0.3	0.0	0.87	236	328	93	3.0	28	198	66
73-2 (20)	11-74	7.3	720	1.0	0.0	0.65	232	376	114	5.2	34	200	72
Kenesaw													
64-1 (3)	11-74	7.9	172	0.0	0.0	0.41	132	148	43	1.6	4	18	10
66-1 (4)	11-74	7.9	196	0.1	0.0	0.41	136	144	46	1.8	8	18	14
75-1	6-78	7.6	166	0.1	0.0	0.23	136	136	45	1.0	8	23	6
Kennard													
09-1 (1)	1-75	7.5	500	1.2	0.7	0.52	424	396	112	0.0	0	8	27
65-1 (2)	1-75	7.6	420	5.6	1.2	0.34	316	324	85	0.0	2	8	16
Kilgore													
55-1	8-75	7.6	256	0.0	0.0	0.39	136	136	45	2.0	0	0	4
Kimball													
38-1 (3)	9-72	7.9	370	0.0	0.0	0.43	124	208	43	3.0	54	45	26
53-1 (5)	10-75	7.5	346	0.0	0.0	0.62	224	220	67	2.6	16	28	67
55-1 (7)	10-75	7.4	500	0.0	0.0	0.52	256	328	98	5.4	46	66	14
58-1 (8)	10-75	7.4	368	0.0	0.0	0.95	252	248	75	0.2	14	25	11
62-1 (9)	10-75	7.6	280	0.0	0.0	0.60	164	196	56	1.0	12	25	8
62-3 (11)	10-75	7.5	330	0.0	0.0	0.70	204	220	61	1.0	12	18	11
78-1	8-78	7.8	192	0.1	0.0	0.67	124	132	45	1.4	6	13	9
Laurel													
58-1 (1)	7-74	7.4	654	0.0	0.2	0.41	316	480	147	2.2	6	196	30
60-1 (2)	9-75	7.4	348	0.7	0.0	0.44	257	276	94	0.0	18	17	7

Community		Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
LaVista														
GETS ITS WATER FROM METROPOLITAN UTILITIES DISTRICT OF OMAHA														
Lawrence														
60-1 (1)		11-70	8.0	400	0.0	0.0	0.46	244	264	82	0.0	22	6	21
62-1 (3)		9-75	7.9	346	0.2	0.0	0.42	232	276	80	0.0	22	15	5
68-1 (2)		9-75	7.8	332	0.0	0.0	0.42	232	268	80	0.0	22	15	5
74-1 (4)		7-74	7.8	380	0.0	0.0	0.57	232	248	77	0.0	26	15	19
Lebanon														
57-1 (1)		1-81	7.6	584	4.2	0.8	0.74	388	384	110	0.0	24	104	33
71-1 (2)		3-77	7.6	470	0.7	0.0	0.64	304	348	101	2.8	20	69	52
Leigh														
45-1 (2)		3-76	7.6	670	1.2	0.0	0.38	348	408	104	1.2	6	205	36
53-1 (1)		9-73	7.4	650	0.3	0.0	0.55	336	400	104	1.8	4	191	--
74-1		3-76	7.7	672	0.0	0.0	0.38	352	408	106	0.0	4	204	37
Lewiston														
68-1 (1)														
68-2 (2)	C	6-74	7.1	460	0.0	0.0	0.85	316	392	118	9.2	4	49	14
68-3 (3)														
Lexington														
39-1 (4)		12-80	7.8	1394	0.0	0.0	0.49	408	564	181	4.7	46	590	132
39-2 (3)		12-80	7.5	1372	0.0	0.0	0.51	400	604	179	4.7	48	575	100
40-1 (5)		5-76	8.0	1900	0.1	0.0	0.62	472	820	173	4.1	46	930	250
43-1 (2)		11-79	7.7	1468	0.0	0.0	0.46	480	760	200	6.6	50	685	147
48-1 (7)		12-80	7.6	786	0.0	0.0	0.29	340	440	131	2.6	22	250	46
53-1 (1)		1-81	7.5	372	0.0	0.0	0.36	256	236	75	0.6	0	61	18

Continued...

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Lexington cont.,													
56-1 (8)	12-80	7.7	670	0.0	0.0	0.27	320	320	118	2.4	18	180	38
56-2 (9)	12-80	7.6	720	0.0	0.0	0.30	316	430	126	2.4	24	215	26
66-1 (6)	12-80	7.6	1220	0.0	0.0	0.52	428	516	178	5.1	50	600	138
71-1 (10)	12-80	7.9	384	0.0	0.0	0.45	200	260	72	0.8	6	87	14
73-1 (11)	1-81	7.4	488	0.0	0.0	0.42	200	340	104	1.6	16	185	16
Liberty													
56-1 (3)	1-74	8.0	354	7.0	1.1	0.48	48	168	38	0.0	70	144	57
67-1	7-76	7.8	526	0.0	0.0	0.25	264	360	115	10.0	32	87	23
Lincoln													
D	5-74	7.7	480	0.0	0.0	0.95	184	236	74	0.4	16	136	46
F	11-76	8.1	306	0.1	0.0	0.80	188	184	50	0.0	2	67	18
Lindsay													
23-1 (1)	1-77	7.3	360	0.0	0.0	0.33	280	280	82	0.0	2	19	10
43-1 (2)	1-77	7.5	344	0.0	0.0	0.31	272	280	82	0.2	6	29	6
75-1	1-77	7.4	364	0.0	0.0	0.28	268	304	94	2.3	8	23	6
Litchfield													
71-1 (1)	5-81	7.4	526	0.0	0.0	0.19	332	356	118	6.8	16	29	10
49-1 (2)	5-81	7.4	628	0.0	0.0	0.19	404	440	142	3.6	24	56	13
Lodgepole													
34-1 (2)	10-75	7.7	422	0.0	0.0	0.60	244	248	78	3.0	18	41	22
46-1 (3)	10-75	7.6	374	0.0	0.0	0.56	200	204	15	4.0	10	30	15
64-1 (4)	10-75	7.5	352	0.0	0.0	0.59	208	216	62	3.4	16	36	15
75-1 (5)	12-76	7.2	426	0.0	0.0	0.50	216	212	64	3.4	14	31	31

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Long Pine													
S	5-78	7.4	112	0.0	0.0	0.18	56	64	16	1.0	0	15	6
Loomis													
67-1 (3)	9-76	8.0	502	0.1	0.0	0.28	220	336	104	4.3	20	68	10
77-1	10-77	7.9	379	0.0	0.0	0.19	220	276	94	2.8	6	43	8
Louisville													
46-1 (1)	10-75	7.1	464	0.1	1.1	0.32	276	284	88	0.8	52	23	28
51-1 (2)	10-75	7.2	486	0.4	1.2	0.34	212	232	69	0.4	88	54	58
Loup City													
(1)	7-74	7.2	414	0.0	0.0	0.32	292	340	107	0.6	6	24	13
(2)	7-74	7.1	406	0.0	0.0	0.30	288	324	104	1.0	4	18	12
Lyman													
43-1 (1)	7-76	7.5	1086	0.0	0.0	1.20	420	284	91	7.0	44	375	180
47-1 (2)	7-76	8.1	1112	0.0	0.1	1.18	416	276	98	2.8	40	445	194
61-1 (4)	7-76	7.5	1082	0.1	0.1	1.19	400	272	99	2.8	32	420	175
Lynch													
#1	10-75	7.6	1422	1.4	3.3	0.72	244	920	221	0.0	10	710	82
S	9-76	8.0	266	0.0	0.0	0.23	184	212	78	0.2	2	45	5
Lyons													
51-1 (1)	1-77	7.5	436	1.0	1.5	0.34	320	340	83	0.0	12	25	21
76-1 (2)	8-76	7.6	396	1.3	1.5	0.33	352	380	104	0.0	4	27	16
78-1	7-78	7.2	480	1.8	1.8	0.31	316	412	90	0.0	14	32	12
F	1-77	8.0	380	0.2	0.1	0.32	308	312	88	0.2	16	23	21

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Macy													
F (1973)	1-76	7.2	960	1.1	0.2	1.67	292	508	154	0.0	56	355	58
F (1964)	1-76	7.2	956	1.1	0.2	1.62	296	512	155	0.0	56	365	52
Raw (1973)	1-76	7.2	952	1.0	0.1	1.61	288	516	152	0.0	56	350	56
Raw (1964)	1-76	7.3	944	1.5	0.2	1.67	296	508	152	0.0	56	440	58
D	1-78	7.8	1320	0.4	0.0	1.70	280	516	157	0.0	54	330	47
Madison													
58-1 (1)	6-76	8.3	330	0.0	0.0	0.25	256	260	80	0.6	2	17	7
71-1 (2)	6-76	8.2	412	0.0	0.0	0.29	308	324	101	0.8	4	21	8
Madrid													
29-1 (1)	5-74	8.0	260	0.0	0.0	0.69	172	168	43	1.4	2	4	10
51-1 (2)	5-74	8.0	220	0.0	0.0	0.65	180	168	43	1.2	6	2	9
Magnet													
62-1 (1) } C 61-1 (2) } C	1-75	7.6	582	0.0	0.0	0.32	284	436	120	0.0	0	196	25
Malcolm													
65-1 (1)	11-79	7.4	650	0.6	0.3	0.44	384	352	93	0.0	54	98	60
71-1 (2)	11-79	7.5	656	1.5	0.0	0.54	380	348	96	1.1	56	91	62
Malmo													
04-1 (1)	4-76	7.3	436	0.2	0.0	0.28	256	280	80	8.2	14	40	12
Marquette													
50-1 (1)	11-74	8.1	600	0.0	0.0	0.53	228	392	123	1.4	8	196	33
71-1 (2)	11-74	8.1	684	0.0	0.0	0.57	268	408	138	6.7	10	194	48

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Maskell													
Wally's Place	3-76	7.3	1350	2.5	0.0	2.00	164	860	248	0.0	52	795	41
Cafe	3-76	7.2	1374	2.7	0.0	1.90	168	880	264	0.0	54	786	41
37-1 (1)	3-76	7.2	1362	4.7	0.1	1.80	172	820	264	0.0	46	786	41
74-1	2-76	7.5	472	0.0	0.0	0.48	336	356	99	3.9	2	52	10
Mason City													
43-1	7-75	7.1	534	0.0	0.0	0.44	348	384	120	5.8	6	21	13
59-1	7-75	7.2	386	0.0	0.0	0.32	276	284	93	1.0	0	17	4
Maywood													
45-1 (2)	6-73	7.7	410	1.8	0.0	0.55	304	340	116	0.3	36	30	13
46-1 (1)	7-76	7.9	338	0.0	0.0	0.59	212	252	72	3.3	6	19	8
58-1 (3)	7-76	8.0	278	0.0	0.0	0.60	176	196	51	3.7	4	11	7
77-1	2-78	7.8	272	0.0	0.0	0.57	168	176	50	2.5	4	23	8
McCook													
27-1 (1)	6-73	7.7	732	0.0	0.0	0.93	384	440	120	0.4	24	195	77
27-2 (2)	6-73	7.6	694	0.0	0.0	0.91	360	404	114	2.8	30	181	84
36-1 (3)	5-79	7.2	712	0.0	0.0	0.81	376	396	112	3.7	28	189	68
44-1 (4)	5-79	7.2	712	0.1	0.1	0.50	380	408	123	7.5	28	165	54
55-1 (5)	5-79	7.1	722	0.1	0.0	0.52	368	420	126	8.1	34	171	56
59-1 (6)	5-79	7.2	602	0.0	0.0	0.37	380	364	114	3.3	18	127	49
76-1	5-79	7.1	650	0.0	0.0	0.49	368	428	126	8.4	32	165	58
McLean													
49-1 (1)	7-74	7.3	730	0.0	0.2	0.62	320	508	123	11.2	32	109	28
Mead													
58-1 (1)	5-75	7.5	428	1.0	0.5	0.52	312	296	94	0.4	2	43	16
69-1 (3)	8-76	7.6	318	0.1	0.0	0.48	248	260	70	3.3	4	34	12
76-1	3-78	7.8	392	1.8	0.2	0.62	276	316	88	3.0	0	59	15

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Meadow Grove													
49-1 (2)	8-76	7.5	324	0.0	0.0	0.36	232	252	77	2.4	10	36	7
70-1 (3)	8-76	7.5	262	0.0	0.0	0.34	232	224	66	0.0	2	13	4
Memphis													
72-1 (1)	3-77	7.1	204	0.0	0.0	0.38	152	140	38	1.2	4	15	12
Merna													
06-1 (1)	7-75	7.3	302	0.0	0.0	0.32	204	200	68	2.2	4	0	6
55-1 (2)	7-75	7.5	268	0.0	0.0	0.32	168	172	52	2.0	0	0	3
North	4-80	7.7	242	0.0	0.0	0.21	208	172	61	1.4	0	0	5
Merriman													
29-1 (1)	8-74	7.8	160	6.1	0.1	0.50	104	100	26	0.6	2	4	5
56-1 (2)	8-74	8.0	170	0.8	0.1	0.50	104	84	21	0.6	0	6	5
Milford													
54-1 (3)	7-76	7.1	330	0.0	0.0	0.40	276	212	69	3.2	6	44	34
54-2 (2)	7-76	7.9	366	0.0	0.0	0.29	244	204	70	1.2	4	38	23
59-1 (1)	7-76	7.4	376	0.0	0.0	0.29	236	208	66	2.4	4	40	23
64-1 (4)	7-76	7.1	368	0.0	0.0	0.34	204	216	72	6.0	4	73	36
73-1	12-76	7.4	412	0.0	0.0	0.31	216	224	72	6.8	8	71	31
Millard													
73-1 (1)	9-75	7.4	316	0.0	0.0	0.26	268	284	83	0.0	6	17	8
53-1 (2)	9-75	7.4	306	0.1	0.0	0.76	274	268	82	0.0	0	15	7
61-1 (3)	9-75	7.5	318	0.0	0.0	0.25	284	280	88	1.4	4	17	8
66-1 (4)	9-75	7.2	318	0.0	0.0	0.25	284	280	86	0.0	6	13	9
68-1 (5)	9-75	7.3	304	0.0	0.0	0.36	272	284	83	1.4	2	11	7
70-1 (6)	9-75	7.1	294	0.0	0.0	0.28	272	256	75	0.4	0	13	8

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Miller													
50-1 (1)	7-75	7.2	352	0.0	0.0	0.37	244	244	85	1.0	4	8	5
+73-1 (2)	7-75	7.2	344	0.0	0.0	0.34	248	252	82	1.6	2	0	3
Milligan													
39-1 (2)	5-74	7.5	454	0.0	0.0	0.33	232	276	85	2.2	16	96	31
74-1 (3)	5-74	7.5	438	0.2	0.0	0.33	224	280	83	2.2	16	84	31
Minatare													
20-1 (1)	5-74	8.3	796	0.0	0.2	0.80	344	312	91	4.4	30	198	170
55-1 (2)	5-74	8.6	782	0.0	0.0	0.70	308	324	88	2.8	28	199	126
Minden													
D	10-76	8.0	342	0.1	0.0	0.94	220	256	85	0.0	10	71	23
45-1 (4)	9-76	8.0	636	0.3	0.0	0.41	264	388	131	7.7	54	150	23
65-1 (1)	9-76	7.9	504	1.2	0.0	0.38	268	324	106	4.9	22	102	18
65-2 (2)	9-76	8.0	394	1.4	0.4	0.40	236	256	80	0.0	10	73	12
71-1 (3)	9-76	8.0	436	3.9	0.4	0.40	232	276	90	0.1	10	103	13
Mitchell													
41-1 (1)	7-76	7.5	576	0.0	0.0	0.33	300	296	96	1.4	18	156	47
53-1 (2)	7-76	7.7	546	0.0	0.0	0.34	264	268	82	2.6	14	180	41
62-1 (3)	7-76	7.4	620	0.0	0.0	0.50	260	300	99	5.6	14	201	46
Monowi													
24-1 (1)	10-75	7.9	1256	0.0	0.0	1.28	420	52	144	0.0	450	6	495
Monroe													
46-1 (1)	8-74	7.7	398	0.1	0.0	0.41	272	276	86	1.6	8	18	14
75-1	7-77	7.7	368	0.0	0.0	0.39	286	300	91	0.6	6	33	8

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Moorefield													
31-1 (1)	11-74	6.8	382	0.0	0.0	0.57	212	248	66	2.0	2	6	4
71-1 (2)	11-74	7.1	338	0.0	0.0	0.55	216	224	61	1.0	2	4	4
Morrill													
48-1 (1)	9-77	7.8	826	0.2	0.0	0.54	304	484	147	14.8	38	270	52
53-1 (4)	7-76	7.5	736	0.0	0.0	0.67	312	260	78	2.6	20	245	99
71-1 (5)	7-76	7.6	680	0.0	0.0	0.74	308	240	70	1.4	20	215	96
Morse Bluff													
79-1	6-79	7.3	350	0.2	0.0	0.21	288	292	93	2.1	4	51	14
78-1	8-78	7.3	530	0.0	0.1	0.35	400	412	122	1.8	20	51	26
62-1	9-75	7.2	386	0.2	0.1	0.29	284	304	93	0.0	2	50	9
Mullen													
48-1 (1)	6-76	7.5	110	0.0	0.0	0.24	80	64	19	0.0	2	0	7
59-1 (2)	6-76	7.5	124	0.0	0.0	0.24	92	76	29	1.6	2	8	6
68-1 (3)	6-76	7.6	130	0.0	0.0	0.24	84	76	27	1.0	2	0	6
73-1	6-76	7.5	102	0.0	0.0	0.27	72	68	18	0.0	0	0	6
Murdock													
39-1 (1) } C 54-1 (2) } C	4-76	7.2	278	0.0	0.0	0.32	148	160	48	3.9	4	41	6
Murray													
67-1 (3)	3-77	7.2	314	0.4	0.0	0.48	240	292	78	8.2	8	27	8
Naper													
56-1 (1)	8-72	7.7	250	0.1	0.0	0.19	78	168	54	4.0	2	4	11
66-1 (2)	8-72	7.6	220	0.0	0.0	0.23	60	148	48	4.8	4	8	11

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Naponee													
63-1 (4)	3-77	7.7	518	0.2	0.3	0.38	312	420	128	1.9	22	117	12
NE City													
D	10-78	8.1	422	0.0	0.0	0.95	128	172	38	0.0	18	159	48
56-1 (1)	10-78	7.5	514	5.5	1.2	0.41	252	276	77	0.0	16	154	46
56-2 (2)	10-78	7.5	466	2.5	1.2	0.40	220	272	72	0.0	14	175	50
56-3 (3)	10-78	7.4	544	3.5	1.2	0.40	248	300	85	0.0	14	165	46
64-1 (4)	10-78	7.5	502	4.0	1.3	0.40	232	304	80	0.0	18	157	48
69-1 (5)	10-78	7.4	516	5.0	1.3	0.40	240	264	78	0.0	14	165	39
Nehawka													
D	12-76	7.2	452	0.1	0.0	0.32	220	380	114	0.8	16	41	16
69-1 (1)	12-76	7.0	470	18.8	3.7	0.28	312	384	115	0.0	34	56	18
75-1 (2)	12-76	7.0	440	14.0	2.4	0.32	356	412	118	0.4	12	38	11
Neligh													
D	8-76	7.4	280	0.0	0.0	1.20	232	220	69	0.0	0	11	4
57-1 (9)	8-76	7.9	282	0.0	0.0	0.34	252	232	77	1.0	2	13	4
61-1 (10)	8-76	7.5	258	0.0	0.0	0.37	220	204	64	0.0	0	11	6
62-1 (11)	8-76	7.4	342	0.0	0.0	0.38	252	288	86	5.8	4	32	5
73-1	8-76	7.5	254	0.0	0.0	0.48	212	216	66	1.9	4	8	5
Nelson													
58-1 (1)	11-74	7.8	422	0.0	0.0	0.46	256	300	93	0.6	30	24	18
64-1 (2)	11-74	7.8	416	0.0	0.0	0.46	248	288	94	0.4	30	22	19
Nemaha													
68-1 (1)	11-74	8.0	438	0.0	0.0	0.41	280	344	122	9.8	8	33	13
69-1 (2)	11-74	7.9	390	0.0	0.0	0.41	272	332	82	6.2	4	27	12

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Newcastle													
48-1 (1)	12-76	7.6	400	0.0	0.1	0.32	304	304	86	2.3	8	15	6
75-1 (2)	12-76	7.4	372	0.2	0.1	0.35	304	316	88	1.2	4	19	9
Newman Grove													
50-1 (1)	4-77	7.2	374	0.0	0.0	0.28	328	312	91	1.2	6	19	15
63-1 (2)	4-77	7.2	374	0.0	0.0	0.30	300	308	94	1.4	8	23	11
Newport													
66-1 (3)	11-77	7.4	208	0.0	0.0	0.28	148	160	51	1.4	8	21	11
Niobrara													
73-1 (1) C 73-2 (2)	11-74	7.4	302	0.3	0.8	0.46	152	164	53	0.0	6	35	11
55-1 C 63-1	11-75	7.9	358	0.3	1.0	0.35	168	232	75	0.0	6	88	11
Norfolk													
F	8-76	7.8	400	0.0	0.0	0.29	272	296	94	0.0	4	13	7
29-1 (1)	8-76	7.4	440	3.9	0.1	0.32	280	356	109	0.0	18	82	8
30-1 (2)	8-76	7.6	386	0.7	0.1	0.32	264	324	102	0.0	8	59	7
34-1 (3)	8-76	7.5	334	0.6	0.2	0.30	252	244	91	0.0	6	45	7
47-1 (4)	8-76	7.6	600	1.5	0.3	0.35	304	444	133	0.0	24	169	17
54-1 (5)	9-76	7.6	484	0.9	0.1	0.36	304	384	118	0.0	24	109	16
67-1 (6)	8-76	7.6	306	0.0	0.0	0.29	244	268	80	0.0	2	21	5
67-2 (7)	8-76	7.5	286	0.0	0.0	0.36	232	228	74	0.0	0	21	8
71-1 (8)	8-76	7.4	404	0.0	0.0	0.34	276	304	96	0.0	6	58	5
71-2 (9)	8-76	7.4	596	0.0	0.0	0.28	288	440	138	0.0	2	96	7
75-1	8-76	7.5	378	0.0	0.0	0.31	272	296	94	0.0	0	51	9
75-2	8-76	7.8	404	0.0	0.0	0.29	264	324	96	0.0	2	80	8

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
North Bend													
D	9-75	7.4	574	0.0	0.0	0.39	304	344	109	0.0	30	104	18
North Loup													
51-1 (1)	4-70	7.8	620	0.0	0.1	0.25	384	384	122	1.2	30	37	93
73-1 (2)	7-74	7.1	574	0.0	0.2	0.37	368	388	117	0.6	16	76	49
North Platte													
26-1 (4)	8-77	8.2	624	0.0	0.0	1.00	240	308	91	6.6	36	148	63
31-1 (6)	7-75	8.1	1122	0.0	0.0	1.20	320	440	134	2.4	46	465	132
37-1 (7)	8-77	8.1	948	0.0	0.0	1.13	268	408	120	3.3	34	420	120
47-1 (5)	8-77	8.1	318	0.0	0.0	0.67	132	160	51	0.0	14	73	25
56-1 (9)	7-75	8.3	630	0.0	0.0	0.46	168	304	98	1.6	30	220	31
60-1 (11)	7-75	8.0	542	0.0	0.0	0.53	152	268	85	1.6	22	200	23
61-1 (8)	7-75	8.3	506	2.8	0.0	0.60	180	248	75	1.4	20	148	30
63-1 (12)	7-75	8.3	820	0.4	0.0	1.43	248	296	85	3.4	66	270	98
63-2 (13)	8-77	7.8	788	0.0	0.0	1.65	256	336	93	2.6	54	335	112
+63-3 (16)	7-75	8.3	664	0.2	0.0	0.42	216	268	99	1.4	56	180	44
46-1 (18)	7-75	8.3	600	0.0	0.0	0.48	216	256	82	1.4	36	151	45
48-1 (19)	7-75	8.2	674	0.0	0.0	0.42	184	344	110	1.0	100	138	34
67-1 (10)	7-75	7.9	686	0.0	0.0	1.07	244	288	83	1.2	46	200	61
67-2 (14)	7-75	7.9	384	0.0	0.0	0.41	152	164	53	0.0	16	82	22
69-1 (15)	7-75	8.1	358	0.0	0.0	0.44	88	160	50	1.0	14	84	13
74-1 (17)	7-75	8.1	330	0.0	0.0	0.46	112	152	50	0.0	14	84	12
Oakdale													
53-1 (2) } C 72-1 (3) } C	9-75	7.2	292	0.1	0.6	0.33	208	208	64	0.0	2	13	8
Oakland													
D	9-76	7.9	760	0.4	0.0	1.09	332	448	146	0.0	38	245	50
54-1 (2)	9-76	7.6	676	14.0	0.8	0.67	356	436	130	0.0	26	185	38
58-1 (3)	9-76	7.5	778	0.8	0.2	1.14	340	456	144	0.0	38	245	47

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Obert													
69-1 (2)	6-74	7.3	318	0.0	0.0	0.28	252	284	88	6.7	6	8	11
Oconto													
34-1 (1)	8-75	7.1	348	0.0	0.0	0.25	228	224	74	2.4	0	11	6
49-1 (2)	8-75	7.1	350	0.0	0.0	0.22	228	232	78	2.6	2	11	4
Odell													
31-1 (1)	7-76	7.7	540	0.0	0.0	0.25	284	388	106	5.8	70	67	20
71-1 (3)	7-76	7.6	2022	0.0	0.0	0.44	272	1480	512	2.4	16	1210	14
Ogallala													
39-1 (1)	3-78	7.2	338	0.3	0.0	0.55	184	200	66	2.3	4	51	16
64-1 (2)	3-78	6.9	378	0.0	0.0	0.57	188	256	80	4.7	10	82	16
60-1 (3)	6-76	8.2	276	0.0	0.0	0.62	168	164	46	2.4	6	25	10
63-1 (4)	3-78	7.1	288	0.6	0.0	0.65	156	236	51	1.9	4	21	9
64-2 (5)	3-78	6.1	322	0.0	0.0	0.62	172	204	61	1.6	16	39	20
68-1 (6)	3-78	7.0	952	0.3	0.0	0.04	172	532	208	0.8	42	450	43
77-1	3-78	7.4	198	0.5	0.0	0.65	156	144	54	1.4	4	27	15
63-2	3-78	6.9	230	0.0	0.0	3.59	148	140	50	1.9	4	17	9
Ohiowa													
68-1 (1)	1-75	7.1	660	0.0	0.2	0.53	344	452	138	0.8	2	152	20
Omaha													
+F F	1-74	9.5	413	0.0	0.0	1.01	65	154	38	0.75	15	205	60
Missouri River	1-74	8.1	616	-	-	0.63	184	270	68	0.8	12	207	60
++PR F	1-74	9.3	380	0.0	0.0	0.98	113	160	41	1.05	40	109	42
++PR Field C	1-74	7.7	553	0.02	0.3	0.44	208	248	71	1.18	42	112	42

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
O'Neill													
D	7-74	7.7	188	0.0	0.0	1.11	124	104	35	0.0	0	0	10
46-1 (1)	7-74	7.7	182	0.0	1.6	0.35	100	116	32	1.6	0	2	11
46-2 (2)	7-74	7.7	182	0.0	0.0	0.41	116	100	34	0.0	0	0	10
52-1 (3)	7-74	7.8	228	0.0	0.7	0.33	148	132	45	0.0	0	0	11
66-1 (5)	7-74	7.7	234	0.0	0.0	0.32	92	116	38	7.1	6	8	12
Ong													
68-1 (1)	9-75	7.3	288	0.0	0.0	0.40	148	172	62	32	12	23	7
Orchard													
46-1 (2)	5-70	7.8	310	0.0	0.0	0.33	232	212	76	1.3	2	2	14
67-1 (3)	4-75	7.4	310	0.0	0.7	0.34	208	208	67	2.2	6	0	7
77-1	12-77	7.5	322	0.1	0.0	0.23	228	264	96	6.6	8	8	8
Ord													
59-1 (1)	3-77	7.7	458	0.0	0.0	0.43	252	316	96	3.0	16	100	16
59-2 (2)	3-77	7.6	476	0.0	0.0	0.44	244	316	98	3.3	4	103	15
71-1 (3)	3-77	7.7	482	0.0	0.0	0.44	254	316	94	2.6	8	94	14
74-1 (4)	3-77	7.3	462	0.1	0.0	0.26	300	356	125	0.4	16	56	10
Orleans													
47-1 (2), 48-1 (3) } C	6-74	7.5	866	0.1	0.0	0.52	372	576	180	4.4	52	197	58
55-1 (7), 57-1 (8) } C	6-74	7.5	682	0.0	0.0	0.53	348	468	141	1.2	42	169	47
Osceola													
51-1 (1)	7-73	8.0	442	0.2	0.0	0.41	300	344	107	2.6	8	59	26
56-2 (2)	7-76	7.4	448	0.0	0.0	0.27	292	312	102	0.4	8	50	7
64-1 (4)	7-73	8.5	426	0.3	0.0	0.35	312	332	109	2.6	10	59	27
72-1 (5)	7-76	7.3	482	0.0	0.0	0.26	296	332	107	3.4	8	49	13

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Oshkosh													
45-1 (1)	11-74	8.0	368	0.0	0.0	0.71	212	204	64	0.4	10	31	24
45-2 (2)	11-74	7.9	382	0.0	0.0	0.71	212	204	64	0.4	16	31	26
63-1 (3)	11-74	7.9	412	0.0	0.0	0.68	196	228	69	0.4	12	78	23
Osmond													
59-1 (3)	9-75	7.3	398	0.0	0.0	0.22	256	300	102	7.7	10	43	8
65-1 (4)	9-75	7.7	400	1.9	0.0	0.22	276	300	96	7.9	8	47	7
Otoe													
60-1 (3)	10-75	7.1	438	8.2	2.8	0.42	368	376	101	0.0	20	6	13
Overton													
37-1 (1)	7-76	8.0	1234	0.0	0.0	0.38	412	560	161	8.6	34	505	109
46-1 (2)	7-76	8.2	1164	0.0	0.0	0.38	420	520	157	6.4	28	465	176
Oxford													
(3)	11-70	8.0	500	0.1	0.0	0.50	296	332	91	3.2	16	24	57
(4)	11-70	7.4	450	0.0	0.0	0.41	264	264	88	3.2	22	8	21
(5)	11-74	7.8	370	0.0	0.0	0.50	248	252	80	1.4	6	14	13
(6)	11-74	7.7	372	0.0	0.0	0.50	252	260	80	1.4	2	10	12
Page													
(2)	6-70	7.6	145	0.0	0.0	0.26	72	84	27	4.8	4	2	11
Wells 1 & 2 C	4-75	7.4	196	0.0	0.0	0.28	76	92	32	5.0	8	2	5
Palisade													
(1)	11-74	7.9	316	0.0	0.0	0.89	200	188	48	1.0	6	16	20
(2)	11-74	7.9	348	0.0	0.0	0.91	212	196	54	0.6	4	14	21

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Palmer													
(1)	11-74	7.5	330	0.1	0.4	0.57	264	244	75	0.0	10	12	19
(2)	11-74	7.6	304	0.9	0.4	0.57	252	256	72	0.4	10	6	20
77-1	11-77	7.6	422	0.2	1.0	0.42	344	332	94.4	3.0	0	15	20
Palmyra													
15-1 (1)	9-75	7.1	818	0.4	0.0	0.23	332	580	197	28.2	96	85	21
71-1	9-75	7.3	414	0.0	0.3	0.28	280	292	102	4.6	10	32	8
71-2 (6)	9-75	7.8	412	0.0	0.0	0.31	260	292	98	9.1	8	32	14
73-1 (4)	9-75	7.3	304	4.0	2.3	0.40	240	216	69	0.0	8	21	11
74-1 (5)	9-75	8.7	278	34.5	2.7	0.40	204	168	53	0.6	2	15	14
Panama													
57-1 (2)	8-72	7.6	770	0.0	0.0	0.78	352	312	74	0.0	52	144	108
68-1 (5)	2-77	7.4	494	6.8	0.7	0.84	368	360	88	0.0	12	78	32
Papillion													
46-1 (1)	6-76	8.0	280	0.0	0.0	0.28	260	260	69	3.7	10	13	11
46-2 (2)	6-76	8.3	280	0.0	0.0	0.27	236	256	67	2.6	8	15	9
56-1 (3)	6-76	7.5	400	0.0	0.0	0.22	324	352	101	1.8	8	47	12
62-1 (4)	6-76	7.8	300	0.0	0.0	0.22	240	252	66	0.8	8	44	11
67-1 (5)	6-76	8.2	344	0.0	0.0	0.41	236	284	78	2.3	20	47	13
Pawnee City													
56-1 (1)	2-77	7.1	304	0.0	0.0	0.41	224	232	70	0.8	4	32	10
66-1 (2)	2-77	7.5	332	0.0	0.0	0.38	236	260	75	2.3	4	38	10
77-1	10-77	7.6	390	0.5	0.0	0.37	280	300	91	1.9	2	48	16
Paxton													
54-1 (2)	6-74	7.0	1380	0.1	0.0	0.91	260	740	203	8.5	56	213	142
66-1 (3)	6-74	7.3	774	0.0	0.0	0.28	140	492	154	1.8	40	205	47

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Pender													
(1)	12-74	7.5	512	0.0	0.0	0.46	312	352	98	3.0	2	49	16
(3)	12-74	7.4	458	4.9	0.4	0.33	300	308	91	0.0	4	20	14
(4)	12-74	7.7	518	0.0	0.0	0.48	324	360	99	3.4	4	56	17
(5)	12-74	7.6	476	0.0	0.0	0.41	320	356	99	2.2	2	39	15
78-1	1-78	7.6	420	0.0	0.0	0.26	316	344	98	3.2	2	47	14
Peru													
47-2 (East)	8-74	7.7	736	5.2	0.4	0.71	496	556	152	3.2	32	74	30
67-1 (West)	8-74	7.5	700	3.3	0.5	0.73	496	520	149	4.2	28	72	31
Petersburg													
10-1 (1)	4-75	7.4	314	0.1	0.0	0.30	208	196	69	0.0	2	0	4
17-1 (2)	4-75	7.4	312	0.0	0.0	0.30	212	204	67	0.0	4	4	6
Phillips													
70-1 (1)	8-75	7.0	622	0.0	0.0	0.40	220	368	717	7.9	22	215	30
Pickrell													
52-1 (1)	7-76	7.6	608	0.0	0.0	0.19	268	436	146	28.1	28	82	13
65-1 (2)	7-76	7.6	632	0.2	0.0	0.26	244	456	141	30.3	48	93	15
75-1 (3)	7-76	7.6	466	0.0	0.0	0.23	256	328	102	12.1	14	52	12
75-1 (3)	1-82	7.7	360	1.0	0.2	0.24	316	300	88	8.9	12	13	10
81-1	1-82	7.8	354	0.1	0.0	0.22	314	300	93	1.3	14	15	<10
81-2	1-82	7.8	358	0.0	0.0	0.22	320	296	86	0.0	10	11	<10
Pierce													
40-1 (1)	8-76	7.6	222	0.0	0.0	0.22	164	180	56	1.9	4	19	5
53-1 (2)	8-76	7.7	174	0.0	0.0	0.22	152	164	57	1.0	0	13	3
64-1 (3)	8-76	7.8	196	0.0	0.0	0.20	152	176	51	1.4	2	11	4

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Pilger													
08-1 (1) } C 39-1 (2) } C	4-74	8.3	606	3.1	1.6	0.41	344	428	125	0.0	40	43	39
74-1	11-76	7.5	542	1.9	1.2	0.38	356	412	110	0.0	16	98	21
Plainview													
40-1 (1)	9-75	7.6	312	5.8	0.0	0.31	192	212	67	3.6	0	11	8
54-1 (2)	9-75	7.6	308	0.4	0.0	0.30	208	200	75	1.2	0	8	6
62-1 (3)	9-75	7.3	304	0.0	0.0	0.32	200	216	70	4.2	0	8	7
Platte Center													
(1 & 2) C	9-75	7.2	428	0.2	0.0	0.26	276	316	112	0.8	6	29	9
76-1	9-76	8.1	644	1.9	1.5	0.26	444	468	149	0.0	50	49	24
78-1	3-79	7.3	450	0.2	0.0	0.23	292	320	100	1.6	4	23	14
Plattsmouth													
D	5-76	8.9	264	0.0	0.0	0.25	136	136	21	0.8	28	64	34
49-1 (1)	1-74	7.5	488	12.0	1.7	0.37	372	396	104	0.2	18	46	36
45-1 (2)	1-74	7.5	576	10.5	2.3	0.37	416	440	126	0.4	26	66	48
55-1 (6)	1-74	7.4	470	9.5	2.8	0.37	376	392	112	0.2	24	66	48
Pleasant Dale													
68-1 (1)	3-76	7.3	438	0.0	0.0	0.24	292	324	97	4.3	8	73	8
Pleasanton													
51-1 (2)	12-76	7.6	366	0.0	0.4	0.31	268	300	90	0.0	6	21	10
Plymouth													
60-1 (3)	6-74	7.4	444	0.0	0.0	0.35	188	296	94	9.8	40	90	36

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Polk													
06-1 (1)	11-74	7.6	426	0.0	0.0	0.41	272	264	83	1.4	10	22	24
54-1 (2)	11-74	7.4	518	0.0	0.0	0.41	328	320	102	3.4	14	25	35
Ponca													
30-1 (2)	7-74	7.5	478	0.6	0.0	0.57	324	332	99	1.4	4	35	12
63-1 (3)	7-74	7.3	954	0.2	0.0	1.18	240	720	178	1.4	24	206	39
Potter													
D	12-76	7.8	250	0.0	0.0	0.62	248	152	45	2.3	6	15	10
67-1 (4)	10-75	7.7	224	0.0	0.0	0.62	148	156	48	2.0	4	15	8
51-1 (3)	10-75	7.6	360	0.0	0.0	0.62	196	232	69	5.6	12	45	10
Prague													
D	5-74	7.2	594	0.0	0.0	0.35	304	364	101	0.4	28	60	41
06-1 (1)	10-72	7.6	530	6.5	0.0	0.37	320	300	91	0.0	40	47	21
61-1 (2)	4-74	7.9	364	20.5	2.3	0.33	276	300	75	0.2	8	31	27
70-1 (3)	4-74	7.4	566	10.0	4.0	0.37	344	380	106	0.0	46	57	39
Primrose													
24-1 (1)	6-76	7.3	306	0.0	0.0	0.29	260	256	77	2.1	0	13	10
78-1	4-78	7.8	298	0.1	3.3	0.26	248	---	86	1.9	2	13	7
Ragan													
68-1 (1)	11-74	7.8	408	0.0	0.0	0.32	232	268	86	1.4	18	20	6
Ralston	GETS ITS WATER FROM METROPOLITAN UTILITIES DISTRICT OF OMAHA												

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Randolph													
02-1 (1)	7-74	7.4	440	0.0	0.0	0.37	288	360	102	2.5	4	96	19
55-1 (2)	7-74	7.6	462	0.0	0.0	0.37	308	372	109	3.4	8	101	19
69-1 (3)	7-74	7.5	450	0.0	0.0	0.37	288	344	109	3.4	6	93	18
Ravenna													
40-1 (1)	12-76	7.8	318	0.0	0.0	0.26	272	280	96	0.2	5	6	--
52-1 (2)	12-76	7.7	306	0.0	0.0	0.25	272	272	90	0.0	21	10	--
55-1 (3)	11-74	7.6	418	0.6	0.4	0.34	284	296	96	0.0	16	6	--
68-1 (4)	12-76	7.8	300	2.0	0.0	0.27	276	280	88	0.0	11	5	--
Raymond													
75-1 (2)	1-77	7.7	366	0.0	0.0	0.43	284	284	85	6.0	10	19	32
Red Cloud													
34-1 (3)	12-74	7.0	688	0.0	0.0	0.32	412	524	168	3.6	64	115	54
34-2 (4)	12-74	7.2	786	0.3	0.1	0.23	328	512	163	8.7	100	186	80
34-3 (5)	12-74	7.8	680	0.0	0.0	0.32	332	528	173	17.4	68	123	44
55-1 (6)	12-74	7.6	286	0.0	0.0	0.28	220	240	77	0.6	8	34	17
55-2 (7)	12-74	7.8	292	0.9	0.0	0.26	216	248	77	0.6	12	32	17
Republican City													
50-1 (1)	6-74	8.0	536	0.1	0.0	0.32	268	388	126	4.0	60	63	18
64-1 (2)	6-74	7.6	534	0.0	0.0	0.26	332	440	146	7.5	62	37	20
72-1 (3)	6-74	7.5	350	0.0	0.0	0.28	260	288	94	2.6	14	22	14
Reynolds													
56-1 (1)	11-74	7.6	378	0.0	0.0	0.30	276	276	96	2.4	16	6	25
Rising City													
64-1 (1)	9-75	6.8	804	0.3	0.0	0.35	280	500	160	14.3	14	250	15
69-1 (2)	9-75	6.9	670	0.0	0.0	0.32	276	420	134	8.1	14	180	15

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Riverton													
54-1 (1)	11-74	7.7	368	0.0	0.1	0.43	224	280	93	0.6	16	80	26
68-1 (2)	11-74	7.8	520	0.1	0.4	0.37	272	368	120	1.0	32	105	38
Roca													
50-1 (1)	2-77	7.4	550	1.1	0.4	0.35	408	436	125	0.0	42	50	34
73-1 (2)	2-77	7.4	550	1.0	0.4	0.35	416	436	128	0.0	42	50	35
Rogers													
17-1 (1)	5-76	7.4	400	0.0	0.0	0.29	300	328	90	1.2	8	59	14
Rosalie													
10-1 (1) } C 18-1 (2) } C	3-76	7.1	344	0.0	0.0	0.31	324	304	88	1.0	0	13	7
Roseland													
77-1	5-78	7.3	284	0.0	0.0	0.25	216	228	80	3.3	6	32	21
77-2	5-78	7.3	198	0.0	0.0	0.34	140	172	62	0.4	2	25	12
Royal													
24-1	9-75	7.3	282	0.0	0.0	0.31	188	192	66	4.0	2	8	5
Rushville													
D	1-75	---	---	---	---	0.84	---	---	--	---	--	--	--
(2)	8-75	6.9	622	0.0	0.0	0.18	216	384	120	30.5	58	61	11
(3)	8-75	7.3	292	0.0	0.0	0.32	148	140	42	2.6	2	27	14
Ruskin													
(2)	9-75	7.4	380	0.0	0.0	0.29	240	276	96	1.2	30	19	11

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Salem													
64-1 (4)	5-76	7.5	808	16.0	3.1	0.24	460	660	165	1.6	94	65	27
70-1 (6)	5-76	7.4	560	0.0	5.0	0.29	380	384	117	0.0	42	67	34
78-1	6-78	7.0	330	0.0	1.7	0.17	220	240	72	3.0	12	31	17
Sargent													
55-1 (1)	12-76	7.9	258	0.0	0.0	0.21	140	156	61	11.3	8	11	4
62-1 (2)	12-76	7.9	176	0.0	0.0	0.28	156	164	54	3.3	4	11	3
69-1 (3)	12-76	8.1	228	0.0	0.2	0.25	180	180	62	1.2	10	19	9
Schuyler													
46-1 (12)	10-79	7.0	410	0.0	0.0	0.29	264	300	88	4.1	12	61	7
60-1 (14)	10-79	6.8	426	0.0	0.0	0.31	236	336	88	21.0	30	67	8
67-1 (15)	10-79	7.4	446	7.0	0.6	0.26	256	304	85	4.9	24	71	8
70-1 (16)	10-79	7.1	486	0.0	0.4	0.37	340	376	115	0.4	30	71	18
74-1 (18)	10-79	7.2	644	0.1	0.0	0.32	280	484	136	3.3	146	86	8
Scotia													
60-1 (1)	3-76	7.0	470	0.0	0.0	0.22	300	340	110	1.4	6	58	4
65-1 (2)	3-76	6.9	444	0.1	0.0	0.19	304	324	104	0.0	4	47	5
Scottsbluff													
40-1 (3)	6-76	7.9	754	0.0	0.0	0.60	288	360	98	4.1	22	260	76
47-1 (4)	5-79	7.5	638	0.0	0.0	0.40	268	312	85	1.8	22	225	81
51-1 (5)	6-76	8.0	702	0.0	0.0	0.42	284	368	96	5.1	18	225	68
51-2 (6)	6-76	8.0	686	0.0	0.0	0.34	284	328	106	6.4	20	235	69
51-3 (7)	6-76	8.1	682	0.0	0.0	0.31	264	316	94	5.6	22	205	43
59-1 (8)	5-79	7.4	702	0.1	0.0	0.30	280	356	102	2.6	38	235	88
65-1 (9)	6-76	7.8	682	0.0	0.0	0.50	284	344	93	0.0	8	225	56
70-1 (10)	6-76	8.1	776	0.0	0.0	0.52	284	396	102	5.4	38	270	54
70-2 (11)	6-76	8.0	590	0.0	0.0	0.44	300	304	86	2.4	14	205	66
72-1 (12)	6-76	8.0	644	0.0	0.0	0.43	252	328	94	4.1	16	195	52
77-1	11-77	2.0	450	0.0	0.0	----	---	300	99	0.2	20	---	41
79-1	2-80	7.7	638	0.1	0.0	0.54	288	356	107	6.2	20	245	41

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Scribner													
D	8-76	7.5	430	1.8	0.1	0.95	256	296	90	0.0	14	65	7
06-1 (2)	8-76	7.4	486	5.8	1.1	0.34	260	408	126	2.1	18	148	6
50-1 (1)	8-75	7.4	426	0.5	0.4	0.30	264	300	91	0.0	14	65	8
Seward													
41-1 (4)	8-75	6.9	440	0.0	0.0	0.30	224	260	88	6.7	8	106	24
46-1 (5)	8-75	7.2	358	0.0	0.0	0.29	220	216	70	4.2	2	58	23
56-1 (7)	8-75	7.3	350	0.0	0.0	0.28	224	204	67	5.4	4	45	28
57-1 (8)	8-75	7.7	364	0.0	0.0	0.27	215	228	74	3.2	6	80	24
62-1 (6)	4-79	7.1	346	0.0	0.0	0.21	232	204	67	6.6	2	45	31
66-1 (9)	8-75	7.6	338	0.0	0.0	0.27	216	212	69	3.2	6	52	24
67-1 (10)	8-75	7.0	406	0.0	0.0	0.26	204	240	78	6.7	6	98	29
72-1 (11)	8-75	7.2	454	0.0	0.0	0.26	216	264	85	7.5	8	117	28
72-2 (12)	4-79	7.1	386	0.0	0.0	0.21	225	244	82	7.0	6	97	30
Shelby													
64-1 (2)	11-74	7.2	272	0.0	0.0	0.50	216	228	72	2.0	2	14	21
Shelton													
49-1 (2)	3-81	7.6	838	0.8	0.1	0.27	328	504	163	0.1	36	305	36
58-1 (1)	3-81	7.5	930	0.0	0.0	0.31	320	640	184	0.0	54	355	29
66-1 (3)	3-81	7.6	968	0.0	0.0	0.39	324	660	186	0.5	54	400	32
78-1 (4)	3-81	7.6	916	0.0	0.0	0.31	332	580	181	4.1	50	315	31
Shickley													
40-1 (1)	12-74	7.9	276	0.0	0.0	0.46	160	162	51	1.2	12	22	22
52-1 (2)	12-74	7.9	286	0.3	0.0	0.48	164	172	53	1.2	14	24	20
Sholes													
65-1 (2)	7-74	7.5	526	0.0	0.0	0.35	264	332	104	2.0	2	206	14

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Shubert													
26-1 (1)	6-73	8.5	298	0.0	0.0	0.32	196	248	69	6.4	18	23	24
56-1 (2)	5-76	7.7	298	0.0	0.0	0.28	196	212	62	6.4	12	35	11
Sidney													
36-1 (1)	10-75	7.2	404	0.0	0.0	0.44	224	248	72	4.8	18	32	14
41-1 (2)	10-75	7.3	420	0.0	0.0	0.45	224	248	77	4.8	28	30	16
43-1 (3)	10-75	7.3	418	0.0	0.0	0.48	240	252	75	5.4	16	32	15
49-1 (4)	10-75	7.4	404	0.0	0.0	0.51	200	208	59	5.4	24	35	21
54-1 (6)	10-75	7.3	430	0.0	0.0	0.52	228	264	70	5.6	28	30	19
61-1 (7)	10-75	7.6	434	0.0	0.0	0.49	224	256	77	6.0	36	38	21
76-1 (8)	7-76	7.9	472	0.0	0.0	0.52	304	288	83	4.7	28	43	33
Silver Creek													
53-1 (4)	2-76	7.6	630	2.5	1.0	0.50	256	348	104	0.0	26	203	31
68-1 (5)	9-75	7.1	496	0.7	0.1	0.34	236	268	88	0.2	20	131	20
Smithfield													
53-1 (1)	8-75	7.2	554	0.0	0.0	0.20	216	360	118	2.4	22	151	5
Snyder													
45-1 (2)	5-75	7.6	332	0.0	0.0	0.37	292	280	85	2.6	4	17	22
55-1 (3)	5-75	7.8	340	0.6	0.0	0.34	252	340	83	2.4	2	17	18
South Sioux City													
F1	5-80	7.1	1184	0.0	0.0	0.59	388	760	208	0.8	44	520	60
F2	5-80	7.1	1186	0.0	0.0	0.61	392	880	---	0.6	46	520	62
36-1 (1)	2-76	7.5	414	101	1.6	0.35	304	308	96	0.0	16	29	5
54-1 (3)	2-76	7.4	382	0.5	0.7	0.33	308	300	80	0.0	8	18	6
56-1 (4)	2-77	7.7	1106	5.0	0.7	0.41	584	780	206	0.0	144	225	69
65-1 (5)	12-78	7.0	1146	1.6	0.6	0.59	360	880	202	0.2	44	505	90
73-1 (6)	12-78	6.9	1000	1.0	0.4	0.58	668	760	179	0.0	20	280	76
78-1 (7)	12-78	7.2	1032	0.1	0.1	0.51	336	575	152	0.4	32	400	81

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Spalding													
72-1 (3)	6-76	7.4	202	0.0	0.1	0.31	176	168	53	1.0	2	0	6
40-1 (2)	6-76	7.4	184	0.0	0.4	0.27	124	148	48	0.0	0	0	7
Spencer													
S	6-74	8.1	374	0.2	0.5	0.41	192	224	74	1.8	6	83	27
06-1 (1)	10-75	7.3	1328	0.0	1.4	0.38	332	1000	276	0.0	30	585	16
54-1 (2)	6-74	7.4	356	1.2	0.2	0.37	184	228	78	2.0	4	86	19
63-1 (3)	10-75	7.3	1172	1.9	0.7	0.37	268	920	228	0.8	14	575	16
70-1 (4)	6-74	6.9	1158	11.0	1.0	0.34	256	860	240	2.0	10	210	68
+71-1 (5)	10-75	7.9	264	0.8	0.0	0.22	124	160	53	1.4	0	28	8
Sprague													
67-1 (1)	1-77	7.6	464	0.0	0.0	0.38	308	332	99	4.5	10	58	27
Springfield													
41-1 (1)	6-73	8.5	334	1.1	0.0	0.28	280	292	78	1.8	10	12	24
49-1 (2)	6-76	8.4	300	0.7	0.0	0.27	256	248	69	0.8	2	11	11
70-1 (3)	6-76	7.3	264	0.0	0.0	0.31	236	248	67	1.2	0	8	12
Springview													
12-1 (1) } C 40-1 (2) } C	7-75	7.8	224	0.0	0.0	0.28	92	108	34	6.2	4	0	6
55-1 (3)	7-75	7.7	248	0.0	0.0	0.24	80	124	37	10.4	10	7	7
+71-1 (4)	8-78	7.6	146	0.0	0.0	0.23	72	104	24	3.0	4	8	5
Stamford													
50-1 (1) } C 64-1 (2) } C	7-76	7.7	508	0.0	0.0	0.32	268	283	115	4.4	38	87	14

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Stanton													
55-1 (4)	10-72	7.7	960	0.6	0.0	0.35	368	476	136	0.0	10	147	27
59-1 (5)	5-75	7.0	696	0.3	0.0	0.27	388	520	153	8.7	18	151	15
68-1 (6)	7-75	7.1	616	0.0	0.0	0.30	352	420	130	6.5	10	135	14
73-1	7-75	7.3	300	0.0	0.0	0.16	192	224	72	2.4	2	38	4
Staplehurst													
46-1 (1)	7-74	8.0	540	0.0	0.0	0.48	304	332	104	8.9	28	72	58
65-1 (2)	7-74	8.3	364	0.0	0.0	0.46	296	264	86	1.0	0	12	46
Stapleton													
(W 1 & 2) C	3-76	7.3	156	0.2	0.0	0.26	88	84	27	0.8	0	0	4
St. Edward													
34-1 (1)	8-74	7.9	324	0.0	0.0	0.41	232	252	78	0.6	4	8	9
54-1 (2)	8-74	7.9	272	0.0	0.0	0.41	204	188	61	0.6	4	0	5
66-1 (3)	8-74	7.8	276	0.2	0.0	0.41	188	180	59	0.6	0	2	5
Steele City													
64-1 (1)	12-74	8.1	262	0.0	0.0	0.34	112	144	35	7.3	8	29	22
St. Paul													
36-1 (4)	12-74	7.7	518	0.0	0.0	0.35	292	324	98	4.8	10	39	22
48-1 (5)	12-74	7.7	650	0.0	0.0	0.37	276	396	123	10.0	20	97	23
52-1 (1)	12-74	7.6	532	0.0	0.0	0.33	272	340	107	6.3	12	35	13
55-1 (3)	12-74	7.7	584	0.0	0.0	0.35	268	364	110	8.7	18	67	18
61-1 (2)	12-74	7.8	436	0.0	0.1	0.46	236	264	82	1.2	6	27	10
69-1 (4A)	12-74	7.7	528	0.0	0.0	0.41	312	352	85	0.6	4	39	14
72-1 (6)	12-74	7.9	482	0.0	0.0	0.41	200	368	85	5.2	14	60	18

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Steinauer													
		WATER FROM PAWNEE RWD #1											
Stella													
67-1 (3)	12-74	7.8	238	0.6	0.0	0.30	132	164	43	7.7	6	14	17
71-1 (4)	12-74	7.2	620	0.0	0.0	0.48	332	374	101	0.0	58	119	72
71-2 (5)	12-74	7.4	478	0.0	0.0	0.43	328	304	80	0.0	38	38	54
Sterling													
21-1 (1)	6-74	6.8	572	0.0	0.0	0.28	240	376	122	20.8	32	80	50
52-1 (2)	6-74	7.1	434	0.1	0.0	0.28	272	300	98	7.9	20	60	38
Stockville													
39-1 (1)	7-70	7.8	320	0.0	0.0	1.18	212	208	61	2.2	6	4	18
72-1 (2)	7-75	7.5	312	0.0	0.0	0.57	204	212	58	3.2	6	21	4
Stratton													
(2)	12-74	7.5	716	0.0	0.5	0.93	292	408	100	0.0	24	198	56
(6)	12-74	7.4	566	0.0	0.0	1.14	264	312	83	0.0	18	156	50
(7)	12-74	7.5	526	0.3	0.1	1.17	280	292	75	0.0	18	126	57
(8)	12-74	7.6	502	0.0	0.0	1.12	252	300	74	1.0	13	136	41
75-1	6-75	7.6	830	0.0	0.2	1.20	348	368	104	2.6	24	138	82
Stromsburg													
55-1 (1)	8-78	6.7	538	0.0	0.7	0.22	372	384	112	2.8	38	52	26
68-1 (2)	8-78	7.0	334	0.0	0.4	0.24	260	268	88	1.2	8	36	11
+72-1 (3)	8-78	7.0	462	1.0	0.0	0.27	288	328	101	2.3	8	54	15
Stuart													
30-1 (1)	9-75	6.9	192	0.0	0.0	0.32	84	92	27	1.2	0	8	8
49-1 (2)	9-75	7.1	198	0.0	0.0	0.29	88	80	22	0.8	0	0	7
71-1 (3)	9-75	6.9	182	0.0	0.0	0.28	96	96	40	0.2	0	0	8

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Superior													
D	11-76	7.5	402	0.0	0.0	1.32	240	248	83	6.0	22	44	33
71-1 (1)	11-76	7.4	422	0.0	0.0	0.28	232	252	83	2.8	32	56	34
71-2 (2)	11-76	7.3	356	0.0	0.0	0.28	236	244	78	4.5	14	42	29
71-3 (3)	11-76	7.3	426	0.0	0.0	0.25	240	260	70	8.4	20	52	32
71-4 (4)	11-76	7.4	466	0.0	0.0	0.28	288	308	99	4.5	26	75	42
71-5 (5)	11-76	7.2	446	0.0	0.0	0.28	264	288	94	4.3	36	50	33
73-1 (6)	11-76	7.4	462	0.0	0.0	0.35	284	248	85	3.3	22	64	51
73-2 (7)	11-76	7.3	378	0.0	0.0	0.26	224	220	72	7.9	16	38	33
73-3 (8)	11-76	7.3	364	0.0	0.0	0.26	220	232	74	4.9	24	50	32
73-4 (9)	11-76	7.3	378	0.0	0.0	0.28	248	244	80	6.2	20	31	34
Sutherland													
(2)	12-74	7.8	692	0.0	0.0	0.35	172	400	123	2.6	28	201	39
(3)	12-74	7.7	602	0.0	0.0	0.50	220	308	107	2.7	20	185	42
(4)	12-74	7.8	710	0.2	0.0	0.37	132	424	130	1.6	30	204	33
Sutton													
46-1 (1)	6-74	7.2	342	0.0	0.0	0.33	200	216	80	2.0	18	27	23
54-1 (2)	6-74	7.6	342	0.0	0.0	0.32	196	216	75	1.8	6	31	22
70-1 (3)	7-74	7.6	344	0.0	0.0	0.33	216	208	69	0.8	14	25	25
Swanton													
35-1 (1)	9-75	7.5	442	0.0	0.0	0.39	200	268	85	3.6	24	90	22
Syracuse													
50-1 (4)	9-76	7.4	746	0.0	0.5	0.29	364	468	139	1.6	90	152	63
56-1 (8)	9-76	7.7	334	0.0	0.0	0.33	260	176	54	0.6	8	27	44
57-1 (9)	5-71	7.7	480	2.4	0.2	0.57	284	264	72	0.0	28	66	60
63-1 (10)	9-76	7.4	356	0.0	0.0	0.31	224	224	66	6.6	10	40	34
64-1 (11)	9-76	8.0	320	0.7	0.2	0.31	252	224	70	0.6	6	49	33
66-2 (16)	9-76	7.7	690	0.0	0.5	0.26	328	468	141	1.9	80	150	48
66-3 (17)	9-76	7.7	400	0.3	0.0	0.28	252	248	78	1.4	16	76	46
68-1 (1)	1-80	7.4	312	0.0	0.0	0.29	248	224	67	1.4	4	11	13
76-1	3-77	7.7	282	0.0	0.0	0.39	282	236	67	1.5	2	15	17

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Table Rock													
58-1 (1)	8-75	7.4	902	0.2	0.0	0.19	216	540	177	40.0	172	121	38
72-1 (3)	8-75	7.5	472	0.7	0.0	0.34	316	312	85	1.0	8	71	25
Talmage													
D	3-76	7.4	382	0.1	0.4	0.33	268	220	66	0.0	10	71	32
58-1 (2)	1-75	6.9	422	18.5	0.8	0.34	260	204	58	0.0	0	45	44
72-1 (3)	1-75	7.0	462	2.6	0.7	0.34	268	224	62	0.0	10	68	46
Tecumseh													
48-1 (1)	7-76	7.4	438	0.0	0.0	0.34	300	324	101	3.2	4	78	10
48-2 (2)	7-76	7.5	510	0.0	0.0	0.34	252	340	104	3.7	4	93	13
52-1 (3)	7-76	3.0	498	0.0	0.0	0.38	276	344	106	3.0	4	95	12
67-1 (4)	7-76	7.4	524	0.0	0.0	0.34	272	368	107	1.9	6	103	14
Tekamah													
49-1 (3)	5-74	7.1	550	0.0	0.0	0.35	284	356	66	6.2	12	84	24
55-1 (2)	5-74	7.5	416	0.0	0.0	0.33	308	320	88	0.8	0	10	12
59-1 (1)	5-74	7.4	550	0.0	0.2	0.50	336	400	109	3.0	8	74	18
59-2 (4)	5-74	7.3	522	0.0	0.0	0.55	308	360	101	1.6	12	109	34
Terrytown													
54-1 (1)	10-73	7.8	564	0.9	0.0	0.48	244	276	82	0.8	18	189	--
54-2 (2)	6-70	8.0	675	0.0	0.0	0.43	312	364	110	2.0	26	146	183
64-1 (3)	10-73	7.9	564	0.2	0.0	0.43	236	276	74	0.8	20	189	--
70-1 (4)	10-73	7.8	522	0.0	0.0	0.52	224	256	82	0.4	14	175	--
Thedford													
46-1 (1)	6-76	7.3	154	0.0	0.0	0.23	108	104	29	0.8	14	0	7
68-1 (2)	6-76	7.6	116	0.0	0.0	0.24	84	76	27	1.0	2	8	6

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Thurston													
54-1 (4) } C 64-1 (3) } C	5-76	8.0	586	1.5	1.3	0.34	468	404	131	1.2	2	99	16
Tilden													
56-1 (2)	6-76	7.4	---	0.7	0.8	0.40	232	240	75	0.0	6	25	8
69-1 (3)	6-76	7.5	---	0.5	0.4	0.34	212	220	70	0.6	10	25	7
71-1 (4)	6-76	7.4	---	1.4	0.3	0.35	228	232	74	0.0	6	23	8
Tobias													
06-1 (1)	9-75	7.1	760	0.0	0.0	0.54	304	516	158	10.8	44	185	23
Trenton													
53-1 (2)	6-74	7.3	986	0.1	1.4	1.22	356	536	146	1.2	36	203	112
71-1 (7)	6-74	7.7	518	0.6	0.3	1.17	264	284	78	0.0	22	146	58
74-1 (8)	7-74	7.5	526	0.3	0.2	1.14	344	328	93	0.0	16	76	42
Trumbull													
56-1 (1)	12-74	7.6	436	0.0	0.0	0.53	212	280	90	3.2	8	107	26
65-1 (2)	12-74	7.7	438	0.0	0.0	0.53	216	280	90	3.0	10	105	26
Uehling													
54-1 (1)	8-76	7.6	1780	0.9	0.2	1.80	180	920	288	0.0	138	970	162
75-1	8-76	7.7	350	0.4	0.7	0.55	300	324	90	0.0	10	40	27
Ulysses													
27-1 (2)	7-76	7.3	380	0.0	0.0	0.32	296	244	--	1.2	6	23	13
54-1 (3)	7-76	7.3	436	0.0	0.0	0.32	264	268	80	4.9	12	40	18

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Unadilla													
61-1 (2)	10-75	6.8	526	0.0	4.6	0.35	300	388	94	4.6	36	68	15
66-1 (3)	10-75	6.9	562	0.0	1.0	0.34	288	392	94	8.3	46	80	18
70-1 (4)	10-75	6.9	398	0.0	0.0	0.28	244	276	78	3.8	14	56	14
Union													
27-1 (1)	10-75	6.9	450	0.0	0.0	0.32	272	360	98	13.8	10	30	6
56-1 (2)	10-75	6.8	538	0.0	0.0	0.28	224	368	104	8.3	28	106	7
70-1 (3)	10-75	7.1	354	0.0	0.0	0.32	220	260	69	7.3	2	29	5
73-1 (4)	10-75	7.1	344	0.0	0.0	0.35	244	268	72	5.0	10	21	5
Upland													
52-1 (2)	9-76	7.8	488	0.0	0.0	0.30	216	272	91	1.2	10	93	17
Utica													
61-1 (1)	3-77	7.0	410	0.1	0.0	0.34	192	268	85	11.7	0	59	17
67-1 (2)	3-77	7.2	328	0.0	0.0	0.32	224	236	67	5.8	20	27	21
74-1	8-77	7.3	328	0.3	0.0	0.31	236	248	82	7.3	8	34	26
Valentine													
26-1 (1)	3-81	8.1	432	0.0	0.0	0.12	172	280	106	14.3	18	56	10
47-1 (3)	8-77	7.4	338	0.0	0.0	0.21	104	156	58	21.6	4	7	2
50-1 (4)	8-77	7.9	208	0.3	0.0	0.18	128	148	58	1.8	6	15	4
55-1 (5)	8-77	7.9	478	0.2	0.0	0.24	172	284	96	14.8	34	43	4
62-1 (6)	8-77	8.0	376	0.0	0.0	0.23	172	256	91	12.7	16	45	2
76-1 (7)	8-77	8.0	204	1.2	0.0	0.26	100	132	50	6.4	8	7	2
76-2 (8)	8-77	8.2	136	1.1	0.0	0.23	100	116	37	1.4	0	0	2
Valley													
35-1 (1)	8-77	7.7	362	0.0	0.6	0.30	184	232	70	1.7	16	69	19
55-1 (2)	8-77	7.7	282	0.0	0.7	0.36	184	176	53	0.4	10	63	17
40-1 (3)	8-77	7.6	348	0.5	0.2	0.29	184	220	69	0.0	16	65	18

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Valparaiso													
(1)	12-74	7.6	498	0.0	0.1	0.53	320	376	100	2.7	4	56	12
68-1 (2)	12-74	7.6	622	0.0	0.4	0.52	372	476	145	2.6	24	103	17
Venango													
(1)	12-74	7.9	248	0.0	0.0	0.60	144	148	45	1.8	6	12	12
Verdel													
21-1 (1)	10-75	7.9	1110	0.0	0.0	1.75	376	44	128	0.8	330	78	400
Verdigre													
46-1 (2)	11-76	7.6	490	1.5	0.5	0.41	264	352	117	6.0	2	108	15
71-1 (3)	11-76	7.6	746	1.7	2.3	0.46	284	500	162	1.0	18	300	27
77-1	7-77	7.5	616	1.7	2.5	0.50	208	400	112	0.0	4	295	28
Verdon													
71-1 (3)	6-76	8.2	386	0.0	0.0	0.21	164	260	78	12.1	52	51	17
65-1 (2)	6-76	8.1	254	0.0	0.0	0.23	164	184	56	7.3	2	21	9
Waco													
55-2 (2)	7-76	7.3	520	0.0	0.0	0.24	272	340	109	12.1	24	41	17
72-1 (3)	7-76	7.4	368	0.1	0.1	0.29	224	244	80	0.0	10	45	11
Wahoo													
33-1 (1)	10-75	7.6	472	0.0	0.0	0.32	256	300	88	6.3	10	58	14
38-1 (2)	6-73	8.4	408	0.0	0.0	0.30	256	260	75	9.1	8	20	32
53-1 (3)	10-75	7.4	440	0.0	0.0	0.32	244	276	80	2.6	10	58	12
63-1 (4)	10-75	7.5	488	0.0	0.0	0.34	272	304	88	5.4	16	62	17

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Wakefield													
D	12-74	7.5	442	0.0	0.0	0.43	340	352	101	0.0	2	41	20
63-1 (1)	11-76	7.6	476	2.9	0.6	0.35	344	380	106	0.0	16	60	17
64-1 (2)	11-76	7.6	422	1.5	1.0	0.32	348	360	102	0.0	6	49	15
Wallace													
46-1 (1)	12-74	8.1	280	0.0	0.0	0.60	180	184	69	1.4	8	8	5
75-1	8-75	7.8	304	0.0	0.0	0.42	180	196	53	2.0	6	15	5
Walthill													
D	3-76	7.2	544	0.0	0.0	0.80	316	408	123	0.0	22	144	12
47-1 (2), 62-1 (1) } C	7-74	7.5	556	1.3	0.1	0.91	316	404	125	0.6	24	138	29
Waterloo													
50-1 (1)	6-78	7.9	344	0.9	1.0	0.38	228	276	85	0.0	14	59	15
+69-1 (2)	6-78	7.9	308	1.3	0.8	0.51	204	240	75	0.0	8	57	11
Wauneta													
43-1 (1)	12-74	7.9	276	0.0	0.0	0.95	188	180	46	1.4	4	16	16
50-1 (2)	12-74	7.8	302	0.0	0.0	0.95	192	192	51	1.8	2	31	19
72-1 (3)	12-74	7.8	294	0.2	0.0	0.91	196	196	45	1.4	4	16	22
Wausa													
21-1 (1)	3-76	7.2	454	0.0	0.0	0.51	292	340	99	0.0	2	91	5
74-1 (2)	3-76	7.3	444	0.0	0.0	0.62	300	372	96	0.0	0	91	6
Waverly													
61-1 (1)	1-77	7.7	444	0.2	0.0	0.46	292	320	96	0.4	22	93	52
72-1 (3)	1-77	7.6	510	0.0	0.0	0.40	272	300	88	3.5	18	108	66

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Wayne													
48-1 (3)	9-73	7.5	598	0.0	0.0	0.35	344	444	130	4.8	10	130	--
54-1 (4)	11-76	7.5	610	0.0	0.0	1.31	348	456	134	4.7	10	156	24
64-1 (5)	11-76	7.5	624	0.0	0.0	0.33	348	460	134	4.3	8	158	25
70-1 (6)	11-76	7.4	742	0.0	0.0	2.40	356	532	154	6.4	4	225	26
70-2 (7)	11-76	7.5	514	0.0	0.0	5.80	348	384	110	2.4	8	80	25
Weeping Water													
57-1 (1)	2-76	7.4	224	0.0	0.0	0.36	164	128	40	1.0	0	19	12
57-2 (2)	2-76	7.1	190	0.0	0.0	0.27	152	116	32	2.3	0	15	9
76-1	10-76	7.3	150	0.0	0.0	0.26	152	120	32	1.6	0	8	18
Western													
65-1 (2)	6-77	7.4	460	0.4	0.0	0.38	280	340	109	5.4	26	36	21
68-1 (3)	10-74	6.7	414	0.0	0.0	0.48	324	340	101	4.0	10	24	20
75-1	11-78	7.3	424	0.0	0.0	0.25	296	320	101	1.9	10	31	19
Weston													
30-1 (1) } C 58-1 (3)	4-76	7.4	388	0.1	0.0	0.32	252	268	80	0.8	10	40	8
West Point													
F	11-76	7.7	280	0.0	0.0	0.33	236	260	69	0.8	6	8	8
51-1 (4) 52-1 (5) } C 56-1 (6)	11-76	7.1	434	0.0	0.0	0.20	208	348	99	11.1	30	67	13
61-1 (7)	7-73	8.0	332	2.6	0.0	0.32	248	264	70	0.0	14	25	26
75-1 (8)	11-76	7.4	310	2.3	1.6	0.35	224	232	69	0.2	6	11	12

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Wilber													
38-1 (2)	7-77	6.9	254	0.2	0.0	0.26	156	148	42	1.2	30	19	32
53-1 (3)	10-75	7.6	256	0.0	0.0	0.23	156	142	48	2.4	20	23	16
65-1 (4)	9-75	7.1	294	0.1	0.0	0.24	168	160	56	2.0	34	19	21
75-1 (1)	6-77	7.3	332	0.0	0.0	0.28	168	180	53	4.9	46	31	40
Wilcox													
12-2 (2)	9-76	7.8	420	0.3	0.0	0.21	216	272	88	4.3	18	50	15
67-1 (3)	9-76	8.0	544	0.1	0.0	0.25	232	300	100	6.6	24	59	17
Wilsonville													
47-1 (2)	7-76	7.3	456	0.0	0.0	0.61	252	268	90	7.3	14	61	14
49-1 (1)	7-76	7.4	456	0.0	0.0	0.59	260	272	91	6.4	22	52	14
Winnebago													
D	3-76	7.3	1458	0.2	0.0	2.61	180	880	248	0.8	106	795	42
56-1 (2)	1-74	7.3	1142	3.7	0.2	1.14	264	720	195	0.0	94	208	123
72-1	5-76	7.8	1496	0.0	0.0	2.79	180	880	243	0.0	104	310	61
Winnetoon													
(W 1 & 2) C	12-74	7.5	510	0.0	0.0	0.52	272	328	101	17.4	12	39	32
Winside													
53-1 (2)	8-72	8.0	1000	0.0	1.4	0.55	436	512	139	0.0	22	148	37
57-1 (3)	7-75	7.2	528	0.1	0.2	0.29	384	376	101	0.0	4	77	25
73-1 (4)	7-75	7.2	582	0.2	0.0	0.29	376	412	106	2.0	10	108	30
Winslow													
41-1 (1)	3-76	7.4	568	2.8	0.7	0.30	328	400	120	0.0	26	150	24

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
Wisner													
41-1 (2)	3-76	7.8	578	0.0	0.0	0.40	368	424	115	3.0	10	87	9
67-1 (3)	3-76	7.8	618	0.1	0.0	0.37	376	468	126	1.7	8	131	11
Wolbach													
46-1 (1)	9-76	7.9	476	0.1	0.0	0.21	260	296	98	1.0	6	11	6
49-1 (2)	9-76	7.8	615	0.0	0.0	0.19	356	404	133	1.4	24	40	13
55-1 (3)	9-76	8.1	582	0.0	0.1	0.19	356	408	133	1.4	22	41	13
77-1 (4)	8-77	7.4	394	0.0	0.0	0.21	292	304	117	0.6	4	19	10
Wood Lake													
22-1 (1)	8-70	7.3	90	0.0	0.0	0.21	52	48	14	2.2	0	2	6
49-1 (2)	8-77	7.8	92	0.0	0.0	0.27	48	68	19	3.3	4	7	6
Wood River													
73-1 (3)	2-82	7.5	456	0.0	0.0	0.29	324	392	126	18.7	14	100	10
Old North Well	2-82	7.2	584	0.0	0.0	0.20	276	420	128	16.7	16	106	10
81-1	2-82	7.7	318	0.0	0.2	----	248	236	66	0.0	16	19	12
Wymore													
41-1 (1)	7-76	8.3	380	0.0	0.0	0.29	268	268	82	1.9	8	45	15
41-2 (2)	7-76	7.8	352	0.0	0.0	0.27	256	272	80	2.6	8	38	13
41-3 (3)	7-76	7.9	364	0.0	0.0	0.29	260	284	83	1.9	8	41	13
41-4 (4)	7-76	8.0	350	0.0	0.0	0.26	256	280	82	2.6	8	51	14
54-1 (5)	7-76	7.9	358	0.0	0.0	0.27	264	276	82	1.9	8	41	13
Wynot													
49-1 (2)	6-74	7.8	682	3.2	0.2	0.55	312	532	163	2.0	6	198	23
70-1 (1)	6-74	7.6	676	1.3	0.2	0.55	320	512	157	1.8	4	198	23

Community	Sampled	pH	TS	Fe	Mn	F	Alk	Hard	Ca	NO_3	Cl	SO_4	Na
York													
37-1 (9)	7-76	7.3	462	0.0	0.0	0.31	260	296	91	7.1	18	84	30
48-1 (10)	7-76	7.3	438	0.0	0.0	0.30	268	280	85	5.8	16	58	31
56-1 (12)	7-76	7.4	376	0.0	0.0	0.28	256	276	86	4.3	14	58	22
62-1 (4)	7-76	7.3	378	0.0	0.0	0.26	240	244	67	5.3	18	47	20
64-1 (13)	7-76	7.3	560	0.1	0.0	0.27	312	356	110	13.2	26	76	38
68-1 (3)	7-76	7.8	292	0.2	0.0	0.30	216	216	70	0.0	12	37	17
73-1	7-76	7.8	298	1.6	0.0	0.33	224	216	66	0.0	10	41	21
Yutan													
08-1 (1), 48-1 (2), 69-1 (3) C	9-74	7.4	418	0.0	0.0	0.41	300	284	86	0.0	10	46	52

Nebraska Department of Health
Division of Environmental Engineering

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MUNICIPAL WATER TREATMENT PLANTS

KEY TO "TREATMENT"

A ---- Aeration
C ---- Coagulation
D ---- Disinfection
F ---- Fluoridation
G ---- Gravity Filtration
I ---- Ion Exchange Softening
L ---- Lime Softening
P ---- Pressure Filtration
Ps---- Presedimentation
S ---- Sedimentation
Sq---- Sequestration
R ---- Recarbonation

KEY TO "CHEMICALS"

1 ---- Activated Carbon (C)
2 ---- Aluminum Sulfate ($Al_2(SO_4)_3 \cdot 14\ H_2O$)
3 ---- Ammonia (NH_3)
4 ---- Hypochlorite
5 ---- Chlorine (Cl_2)
6 ---- Copper Sulfate ($CuSO_4 \cdot 5\ H_2O$)
7 ---- Hydro-fluosilicic Acid (H_2SiF_6)
8 ---- Lime
9 ---- Polyphosphate
10---- Polymeric Flocculant
11---- Potassium Permanganate ($KMnO_4$)
12---- Sodium Aluminate ($Na_2OAl_2O_3$)
13---- Sodium Carbonate (Na_2CO_3)
14---- Sodium Silico Fluoride (Na_2SiF_6)
15---- Caustic Soda (Na_2O)
16---- Sodium Fluoride (NaF)
17---- Carbon Dioxide (CO_2)
18---- NaOH

MUNICIPAL WATER TREATMENT PLANTS

MUNICIPALITY	TREATMENT	CHEMICALS
Albion	F	7
Alliance	Sq	9
Arlington	A, G, S, Sq	9
Auburn	A, D, F, G, S	5, 13, 16
Bassett	F	7
Belden	F	7
Bellevue	A, D, E, L, S	1, 7, 12
Bellwood	Sq	9
Bennet	D, Sq	4, 9
Blair	Ps, S, C, D, F, G, L	1, 2, 5, 7, 8
Bloomfield	F	7
Blue Hill	F	7
Brock	D	4
Brownville	A, D, P, S	5
Butte	A, D, S	5
Cairo	Sq	9
Chadron	C, D, G	1, 2, 6
Colon	Sq	9
Columbus	D, F	5, 7

MUNICIPAL WATER TREATMENT PLANTS

MUNICIPALITY	TREATMENT	CHEMICALS
Cook	F	7
Craig	A, D, G, S	5, 10, 11
Crawford	A, D, G, S, Sq	5, 9
Creighton	F	7
Crete	D, Sq	4, 9
Crofton	C, F, D	4,14
Dakota City	A, C, D, F, G, S, L, R	2, 5, 7, 8, 15, 17
David City	A, C, F, G, S, L, R	5, 7, 8, 10, 17
Decatur	A, P, S	
Deshler	D	4
Elgin	F	7
Emerson	A, F, G, S	14
Endicott	A, D, P, S	4
Fairbury	D, F, Sq	5, 7, 9
Falls City	A, C, D, F, G, L, S, R	2, 5, 8, 17, 7
Fordyce	Sq	9
Fullerton	F	7
Giltner	Sq	9
Grand Island	D	5

MUNICIPAL WATER TREATMENT PLANTS

MUNICIPALITY	TREATMENT	CHEMICALS
Greeley	A, D, P	4
Hartington	F	7
Herman	A, D, P, S	4
Hickman	F	7
Holland	D	4
Hoskins	A, C, D, P, S	2, 4, 13
Humphrey	F	7
Jackson	Sq	9
Kearney	F	7
Kennard	Sq	9
Laurel	F	7
Leigh	Sq	9
Lincoln	A, C, D, F, G, S	3, 5, 7
Lyons	A, D, G, S, F	5, 7, 11, 18
Millard	D, F,	5, 14
Minden	A, D, F, S	5, 7
Nebraska City	A, D, F, G, S, L	5, 7, 8
Neligh	F	7
Nelson	F	7

MUNICIPAL WATER TREATMENT PLANTS

MUNICIPALITY	TREATMENT	CHEMICALS
Norfolk	A, D, G, S	5
North Bend	A, G, S	
Oakland	A, D, P, S	5
Ogallala	F	14
Omaha (Florence Pt.)	C, D, G, F, Ps, L	1, 2, 5, 7, 8, 10, 13
Omaha (Platte R.)	D, G, L, F	2, 5, 7, 8, 11
O'Neill	F	7
Osmond	F	14
Palmer	Sq	9
Papillion	A, D, F, G, S	5, 7, 11
Pilger	Sq	9
Plattsmouth	A, D, F, G, S, L,	5, 7, 10, 11, 13
Prague	A, D, P, S	2, 5
Red Cloud	F	14
Rushville	F	7
Santee	D	5
Scribner	A, D, F, P, S	5, 7
Shelton	Sq, D	4, 9
South Sioux City	A, C, D, F, G, S, Sq	5, 7, 13, 9

MUNICIPAL WATER TREATMENT PLANTS

MUNICIPALITY	TREATMENT	CHEMICALS
Steel City	D	5
Stella	F	7
Stromsburg	Sq	9
Superior	D, F	5, 7
Syracuse	F	7
Talmage	D	5
Tecumseh	F	7
Tilden	F	7
Uehling	Sq	9
Utica	F	7
Valley	D, Sq	9
Wakefield	A, P, S	
Walthill	A, G, D	5
Waterloo	D, Sq	4, 9
Wausa	F	14
Wayne	F	7
West Point	A, D, P, S	5
Winslow	Sq	9

MUNICIPAL WATER TREATMENT PLANTS

MUNICIPALITY	TREATMENT	CHEMICALS
Cass C. (Beaver Lake)	C, D, G, Ps, S	2, 4, 10
Douglas Co. (Riverside Lanes)	A, C, D, P, S	2, 5, 11, 13
Dakota Co. (Lewis & Clark NRD)	C, D, Ps, S, G	2, 5, 10
Richardson Co. (Indian Cave St. Park)	A, G, F, S, D, L, C	4, 8, 10, 17

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APPENDIX E

STATUS OF PUBLIC WATER SUPPLIES IN NEBRASKA

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I. SUMMARY

The purpose of this paper is to identify current and future quality and quantity problems of community water systems in Nebraska. Based on standards established by the National Interim Primary Drinking Water Regulations and analyses of community water systems, the health-related contaminants of greatest concern are: microbiological contamination of unchlorinated drinking water in distribution systems, which are poorly managed and maintained, and nitrate pollution of groundwater.

The presence of fecal coliform bacteria, indicating microbiological contamination, usually related to inadequate water pressure associated with undersized water distribution mains and poor household plumbing resulting in sanitary wastewaters entering the potable water piping. These problems are most common in villages with neglected water systems. Since available technology and established management techniques can be applied to prevent contamination from human wastes, communities that do not comply with the microbiological standard are being encouraged to correct system deficiencies. If necessary, an enforcement action by the State Health Department can require disinfection of the water by chlorination to insure a bacteriologically safe supply.

Nitrate contamination of groundwater from fertilization and irrigation of agricultural lands is a very serious problem for the following reasons: (1) Infiltration of nitrate to the aquifer under cultivated land, particularly corn fields, cannot be prevented. (2) The only water source available for most rural communities is groundwater from the same aquifer being recharged with high-nitrate water percolating downward under cultivated land. (3) Buildup of the nitrate content in many regions is expected to increase with the maximum reaching a level significantly greater than the maximum contaminant level established as the drinking water standard, perhaps even 4 or 5 times greater. (4) Although the maximum contaminant level for nitrate, being established to eliminate any possibility of infant methemoglobinemia, is very conservative, the future nitrate levels forecast to occur in the groundwater of agricultural regions are also likely to make the water unfit for adult consumption. (5) A technically and economically feasible treatment process for removal of nitrate from water, under study by the Environmental Protection Agency, is not presently available. Based on this assessment of the problem, the status quo in agricultural practices and design of community water systems will result in irreversible groundwater contamination with no apparent solution for rural communities that rely on groundwater for their water source. The affected communities, boards of their natural resources districts and the State can either accept this fate or undertake studies to search for preventative and remedial measures.

Potential community water quantity problems relate to seasonal lowering of groundwater levels caused by irrigation withdrawals and diminishing flows in rivers and streams that recharge aquifers used as sources for municipal supplies.

Irrigation pumping around a rural community can produce both a gradual yearly lowering of the water level from mining of the groundwater and sharp temporary declines during the irrigation season. Municipal wells compete for the same groundwater when the demand in the community is greatest during the summer. In most regions of extensive groundwater irrigation, municipal wells cannot compete against irrigation wells because of their larger numbers and capacities and greater tolerance to lowering water levels. Most officials of towns that have abandoned wells because of declining water levels view well replacement as a business expense associated with the agricultural economy. Nevertheless, this acceptance may change if water levels continue to decline resulting in either loss of additional wells or reduction of well yield because of a diminishing supply of groundwater. Natural resources districts should be encouraged to consider municipal water supplies in the management of their water resources.

Rivers and streams recharge adjacent aquifers that may be relied on as sources for community water supplies. Although each well site has unique hydrogeological features, all rely on some minimum instream quantity and duration of surface flow. During dry periods with little or no flow, well water withdrawn temporarily reduces the quantity of groundwater stored in the aquifer. Replenishment occurs during subsequent wet periods. For example, well fields for Grand Island, Fremont, Lincoln, and Omaha induce seepage directly from the Platte River. Groundwater storage is sufficient to maintain municipal withdrawals during occasional periods of low or no flow condition in the River, so long as surface flows are large enough to permit infiltration throughout most of the year. Since data are not available to recommend minimum stream flows needed for municipal supplies, a study is recommended to (1) identify rivers and streams that recharge municipal supplies, (2) determine a method for evaluating the quantity and duration of flow required for induced recharge, and (3) estimate the minimum stream flows for supplying existing well fields and those sites suitable for future development.

II. RECOMMENDATIONS

1. A community system that does not meet the standard for microbiological quality should be required to perform a sanitary survey to determine the sources of contamination and submit to the State Health Department a schedule of remedial actions to bring the system into compliance. If a community frequently fails to meet the coliform criterion, the State Health Department should order the installation and continuous operation of chlorination equipment for disinfection of the drinking water and correction of obvious system deficiencies.

2. The State Health Department should coordinate the evaluations of community water systems with increasing nitrate concentrations in their groundwater supplies. Rather than acting solely as a regulatory agency, the Department should encourage and monitor research studies and site investigations to collect data as a basis for recommending remedial actions. Community officials, utility personnel, and boards of natural resources districts must all be included in the evaluation proceedings since groundwater contamination from nitrate infiltration is regional and not confined to the boundaries of the municipality. Also, the prosperity of rural towns is based on the agricultural economy. The alternative to the Department assuming a leadership role in addressing the problem of nitrate pollution is for each community to attempt its own solution, while the State acts only as an enforcement agency makes the community and the State adversaries. (Detailed recommendations are given in section 2. Nitrate, (e) Summary and Recommendations.)

3. A renewable variance should be issued by the State Health Department to all public water supplies that exceed the maximum contaminant level for selenium. If a variance granted for this reason is questioned, the Department should be petitioned to conduct a field survey to determine if dietary intake of selenium from the water supply in that community is excessive.

4. Omaha is the only community water system with a trihalomethane level approaching the maximum contaminant level. The Metropolitan Utilities District has undertaken remedial measures in water treatment that are expected to maintain the total trihalomethane concentration under the health limit specified by the National Primary Drinking Water Regulations.

5. Communities with fluoride concentrations less than the optimum level should be encouraged to add supplemental fluoridation.

6. Groundwater contamination from irrigated agriculture, currently exemplified by increasing nitrate content, could also result in infiltration of synthetic organics, such as, chlorinated hydrocarbons and chlorophenoxys, which are included in the water quality monitoring program. In addition, the State should selectively test for other chemicals, like atrazine, to monitor the infiltration of contaminants significant to both agricultural and municipal uses of groundwater.

7. Communities with inadequate water sources should investigate the feasibility of a regional water system either as a special project through their natural resources district or by a cooperative effort among neighboring communities.

8. In regions of lowering groundwater levels, natural resources districts should be encouraged to consider the adverse effects on community water supplies of seasonal water level declines caused by agricultural irrigation.

9. A study should be sponsored by the State to determine minimum stream flows needed for municipal aquifer recharge. Of particular concern is the Platte River since it is the source of groundwater recharge for the well fields of major metropolitan areas.

III. SAFE DRINKING WATER ACT

Public concern over the quality and safety of drinking water provided by public water systems resulted in regulatory legislation by the Congress of the United States in 1974. The Federal Safe Drinking Water Act requires the owner of each public water system to demonstrate the safety of delivered water to the U.S. Environmental Protection Agency, (EPA) at all times. Under the law, the administrator of EPA is required to establish limits on contaminants that may be harmful to the health of consumers; administer monitoring and reporting requirements necessary to assure conformance; and enforce the provisions of the law and regulations promulgated thereunder. The law extends to all piped water systems that provide drinking water to more than 25 persons daily, or that distributes water through at least 15 service connections.

The Congress recognized the position of the several states in their attempts to regulate the quality of drinking water and authorized the administrator of EPA to delegate enforcement authority to those that enacted legislation and carried out enforcement actions in a manner no

less stringent than practiced on the federal level. Grant funds were made available to states choosing to accept such responsibility. The State of Nebraska was among the first of the states to assume this primary enforcement responsibility in June 1977. The state law and regulations provide for plan review, operator training, laboratory services and similar activities of preventive nature that are not required by the federal program. In general, the following discussion emphasizes those features of the regulatory program that are common to and enforceable at both state and federal levels.

1. MAXIMUM CONTAMINANT LEVELS

The National Interim Primary Drinking Water Standards (EPA, 1976) are listed in Table 1. For microbiological quality, treated water is tested at various points in the distribution system for coliform bacteria. Direct testing for pathogenic microorganisms is not feasible because of the complexity and difficulty of laboratory analyses. Since large numbers of coliforms are excreted in the feces of man, presence of these nonpathogenic bacteria indicates the possibility of fecal pollution and presence of microbes or viruses causing enteric diseases. The safety of processed water meeting the criterion of 1 coliform organism per 100 ml is based on the statistical improbability of ingesting any pathogens.

The minimum number of coliform samples tested is based on the population served by the water system with a minimum of one sample each month per 1000 population or less. The supplier of water for a non-community water system collects one sample in each calendar quarter that the system is in operation. In Nebraska, the owner of the water system is responsible for sample collection on an established schedule. The samples are then mailed to an assigned laboratory for testing by the State Health Department.

Presence of chemicals in excess of the maximum contaminant levels established to protect health constitutes grounds for rejection of the water supply. The inorganic chemicals listed in Table 1 (except for nitrate) are poisons that affect the internal organs of the body. In arriving at specific limits, the total environmental exposure of people to a specific toxin is considered. The lowest practical level is selected to minimize the amount of toxicant contributed by water particularly when other sources including milk, food, and air are known to represent a major exposure. Nitrate nitrogen in excess of 10 mg/l can cause poisoning in susceptible infants, whereas adults can ingest much greater concentrations without an adverse reaction.

Table 1. Maximum Contaminant Levels (Approval Limits for Health), National Interim Primary Drinking Water Regulations, Environmental Protection Agency

MICROBIOLOGICAL CONTAMINANTS

When 10 ml portions of water are tested by the multiple-tube fermentation method, not more than 10 percent in any month shall show the presence of coliform bacteria. No more than 3 portions from one sample shall contain coliforms where less than 20 samples are tested per month; in larger systems, no more than 3 portions may be positive in 5 percent of the samples analyzed. (If the portions tested are 100 ml, not more than 60 percent shall show presence of coliforms.) When the membrane filter technique is used with 100 ml portions, the arithmetic mean coliform density shall not exceed 1 per 100 ml. The maximum density in one sample is 4 per 100 ml for less than 20 samples per month, or 5 percent of the samples where more than 20 samples are tested per month.

INORGANIC CHEMICALS IN MILLIGRAMS PER LITER	
Arsenic	0.05
Barium	1.0
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.0
Selenium	0.01
Silver	0.05

Recommended and approval limits in milligrams per liter for fluoride are based on the annual average of the maximum daily air temperatures.

Temperature F	Recommended Optimum	Approval Limit
53.7 and below	1.2	2.4
53.8 to 58.3	1.1	2.2
58.4 to 63.8	1.0	2.0
63.9 to 70.6	0.9	1.8
70.7 to 79.2	0.8	1.6
79.3 to 90.5	0.7	1.4

Continued

ORGANIC CHEMICALS IN MILLIGRAMS PER LITER	
Total trihalomethanes	0.10
Chlorinated hydrocarbons	
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
Chlorophenoxys	
2,4-D	0.1
2,4,5-TP (Silvex)	0.01

RADIONUCLIDES IN PICOCURIES PER LITER	
Natural	
Gross alpha activity	15
Radium-226 + radium-228	5
Man-made	
Gross beta activity	50
Tritium	20,000
Strontium-90	8

TURBIDITY

The monthly average shall not exceed 1 turbidity unit (TU). (With state approval 5 TUs may be allowed provided it does not interfere with disinfection, maintenance of chlorine residual, or bacteriological testing.) The maximum two-day average is 5 TUs.

To prevent cases of infantile methemoglobinemia, the population in areas containing high nitrate water should be warned about the potential dangers of using it for infant feeding. Concentrations of fluoride above the approval limits produce objectionable dental fluorosis. The optimum concentrations for reduction of dental caries with no esthetically significant mottling for Nebraska is 1.0 mg/l, based on the annual average of the maximum daily air temperatures. Certain organic chemicals taken into the body at low levels over a long time period are suspected as causing chronic diseases, such as, cancer. Studies conducted on laboratory animals are extrapolated to arrive at the maximum contaminant levels since effects on humans are not known. Ingesting radionuclides increases the health risk of cancer. Turbidity is caused by insoluble, microscopic particles that impede the passage of light through water. The limit is one turbidity unit to insure noninterference with disinfection, maintenance of a chlorine residual, and microbiological testing.

In Nebraska, the State Health Department collects and analyzes all samples from community water systems for chemical contamination. Minimum testing for inorganic chemicals is yearly when surface water is the source and at 3-year intervals from groundwater supplies. If a maximum contaminant level is exceeded, the community is responsible for collecting and transporting additional samples to the laboratory for retesting. Nitrate is the only inorganic chemical limited for both community and non-community systems. Organic chemical analyses are repeated at 3-year intervals on community water systems and radionuclides are monitored on a 4-year cycle, unless more frequent testing is warranted.

Secondary maximum contaminant levels are recommended by the Environmental Protection Agency for adoption by the states to maintain esthetic qualities of drinking water. The levels listed in Table 2 represent reasonable goals for municipal supplies. Instead of being dangerous to human health, excess concentrations of these substances make drinking water less palatable and usable; however, they do not constitute grounds for rejection of the water supply unless their concentrations are extraordinary. A high content of chloride and sulfate salts have taste and laxative properties; scale or corrosion of pipe and tank interiors results from chemical imbalance; iron and manganese cause brownish-colored stains on porcelain and in laundry; and visual impurities (color, foaming) and odors are unesthetic. States may establish higher or lower secondary maximum contaminant levels depending on local conditions, such as availability of an alternate source of water.

Table 2. Secondary Maximum Contaminant Levels (Levels for Esthetics) Recommended by the Environmental Protection Agency

Chloride	250 mg/l
Color	15 color units
Copper	1 mg/l
Corrosivity	Noncorrosive
Foaming agents	0.5 mg/l
Iron	0.3 mg/l
Manganese	0.05 mg/l
Odor	3 threshold odor number
pH	6.5 - 8.5
Sulfate	250 mg/l
Total dissolved solids	500 mg/l
Zinc	5 mg/l

2. REPORTING, RECORD KEEPING, AND PUBLIC NOTIFICATION

Communities are required to report any disruption in service that may affect water quality, expansion of the system, or changes in principal

personnel and management. Owners of public water systems are also directed to maintain records of microbiological analyses, violations of the drinking water regulations, and copies of all written reports by consultants or owners relating to sanitary surveys. Recommended record keeping includes: maps of the distribution system, card files on appurtenances, well construction and pumping data, usage of chemicals for chlorination and fluoridation, treatment plant operations, pressure and flow tests, and measurements of water consumption.

Public notification is required when drinking water contains a health-related contaminant in excess of the specified maximum level. Failure of a system owner to submit water samples for testing is also an infraction entailing public notification. For acute situations, mass media including radio, television, and newspapers are most effective. However, less critical notices can be disseminated by enclosing them with the customer water bills. Notices written in a clear concise style state the nature of the problem, the contaminant of concern, and preventative measures that can be taken by the public. An explanation of the significance or seriousness to public health may be incorporated into the notice. Public notification is also required when a variance or exemption is granted. Non-community water systems must notify customers by appropriate warnings, for example, a notice at a recreational area may be a sign near the water faucet.

3. EXEMPTIONS AND VARIANCES

A state may temporarily exempt a public water system from a maximum contaminant level, or treatment technique, due to compelling factors providing the health risk is reasonable. Within one year of granting an exemption, the state prescribes a schedule implementing corrective measures to bring the system into compliance. Exemptions are most likely to be granted for quality problems that can be resolved by available technology. For example, if the contaminant was trihalomethanes, control could be by either adjusting the chemical processing or constructing additional treatment units. Unless amended, the federal law prohibits the extension of exemptions beyond January 1, 1981.

A state may grant a variance, which is renewable, for a public water system that cannot meet a maximum contaminant level provided that: (1) the contaminant is a characteristic of the raw water source, (2) treatment techniques have failed to remove or sufficiently reduce the contaminant, and (3) the health risk is reasonable. The owner is required to study the problem and submit a schedule for compliance. Issuing a variance is not considered appropriate by EPA unless the best available treatment techniques have been applied and demonstrated to be ineffective in removing the contaminant.

IV. PUBLIC WATER SYSTEMS IN NEBRASKA

As defined by the National Interim Primary Drinking Water Regulations (EPA, 1976), a public water system provides piped water for human consumption to at least 15 service connections or serves an average of 25 or more individuals daily for a minimum of 60 days of the year. Such a system is further classified as either a community water system or non-community water system. Community systems serve at least 15 service connections used by year-round residents or serves at least 25 year-round residents. All other water purveyors are considered non-community systems. The major difference between classifications is the applicability of maximum contaminant levels and monitoring requirements. Drinking water in community systems cannot have contaminant levels greater than the health-related maximums for inorganic chemicals, fluoride, organic chemicals, turbidity, coliform bacteria, or radioactivity. Non-community systems are required to meet only the national contaminant levels for microbiological quality and nitrate ion, hence, monitoring is restricted to testing for coliform bacteria and concentration of nitrate-nitrogen. Table 3 enumerates the monitored water systems in Nebraska.

Table 3. Numeration of Community and Non-Community Water Systems in Nebraska Monitored for Quality of Drinking Water

COMMUNITY WATER SYSTEMS		
M	(municipal) villages and cities	459
N	(non-municipal) mobile home parks, subdivisions, institutions, camps, and industries	175
D	(districts) sanitary improvement and rural water districts	42
G	(government) agencies and institutions	5
	Total	681
NON-COMMUNITY WATER SYSTEMS		
Schools, restaurants, motels, resorts, country clubs, airports, industries, and highway rest areas		
	Total	723

V. PROBLEMS OF QUALITY

1. MICROBIOLOGICAL CONTAMINATION

Several infectious intestinal diseases of man are transmitted by drinking water contaminated with fecal wastes. Pathogens excreted in feces of infected persons include bacteria, viruses, protozoa, and parasitic worms. By instituting environmental health programs, waterborne outbreaks of common bacterial diseases of the world--typhoid, cholera, and dysentery--are rare in the United States. Two of the diseases most likely to be transmitted by drinking water in the United States are Type A hepatitis and Giardiasis. Caused by a virus, the symptoms of infectious hepatitis are loss of appetite, fatigue, nausea, and pain. The most common characteristic feature of the disease is a yellow color that appears in the white of the eyes and skin, hence the common name yellow jaundice. Giardiasis is an intestinal infection of a protozoan (microscopic animal) causing diarrhea, vomiting, and lowgrade fever. The acute stage usually lasts only 3 or 4 days. Although seldom fatal, these diseases are debilitating for sensitive persons.

Testing water for disease-producing organisms to determine microbiological quality is not feasible because of the difficulties in testing for human pathogens. Instead, water is examined for the presence of coliform bacteria as organisms indicating contamination by fecal wastes. Coliform bacteria that reside in the intestinal tract of man are excreted in large numbers in feces of man and other warm-blooded animals. Pathogenic bacteria, viruses, and protozoans causing enteric diseases in man originate from the same source, namely, fecal discharges of diseased persons. Consequently, water contaminated by fecal pollution is identified as being potentially dangerous by the presence of coliforms. In piping networks receiving groundwater, microbial contamination can occur in the distribution piping as a result of inadvertent cross connections with sanitary facilities. Examples are back syphonage from wash basins and bathtubs, improper flush valves on toilets, and hose extensions from water faucets into drains and tanks. The typical water system in Nebraska has household plumbing defects, small municipal water mains resulting in low pressures, and an unchlorinated supply. Maximum coliform counts often occur during late summer when the water pressure in the distribution system is lowered by lawn and garden watering. A number of remedial actions can be taken including enforcing a plumbing code to reduce the possibility of cross connections, increasing water pressure by installing larger pipes and additional wells, reducing peak water consumption by metering and pricing, and maintaining a protective residual concentration of chlorine in the water throughout the system from wells to customer faucets. In low concentration, dissolved chlorine gas disinfects water by killing microorganisms.

Approximately 100 community systems in Nebraska during 1979 had coliform counts in excess of the mean contaminant level of 1 per 100 ml in 25 percent or more of the water samples submitted. Furthermore, for many of these municipalities microbial contamination has been a recurring problem over the past 3 years. Since the most likely source is fecal waste from humans entering the potable water system, noncompliance with the microbiological standard is considered a serious public health hazard. Sixty-eight communities were sent a written notice in June, 1980 with regard to their noncompliance recommending remedial actions. Communities that frequently failed to meet the coliform criterion were ordered to install equipment for continuous application of chlorine to the water entering the piping network and to correct obvious system deficiencies.

2. NITRATE

The nitrate ion is the common inorganic form of nitrogen found in water solution. In agricultural regions, the high use of nitrogen fertilizers to increase crop yield has resulted in unused nitrate migrating down into soils below the root zone of the crop. Irrigation has increased the infiltration rate of nitrate into the underlying groundwater. In recent years, the nitrate levels in well supplies of many rural towns have increased dramatically with 18 community supplies now exceeding the 10 mg/l drinking water standard. Nitrate in water used to prepare the feeding formula of infants can cause methemoglobinemia. Adults can ingest much higher levels of nitrate with no apparent ill effects. The 10 mg/l maximum contaminant level established by the National Interim Primary Drinking Water Regulations has been criticized as being very conservative and established for the protection of only a small segment of the population, infants under 3 months of age. Nevertheless, a significant increase in the maximum contaminant level allowed in community systems is unlikely, even though 20 mg/l is now permitted in non-community supplies. Actually the discussion of whether the limit should be 10 or 20 mg/l may not be of great significance since the concentration in several rural communities in Nebraska is expected to exceed 20 mg/l in the near future. Treatment processes for removal of nitrate from water are still under development and, if perfected, are

expected to be very costly to operate. When grouped in a series of sentences as follows, the key aspects of the nitrate problem are sobering. A significant reduction in groundwater contamination cannot be achieved without changing agricultural practices. The only feasible source of water supply for most rural villages is the groundwater. In many community supplies, the nitrate levels in future years are expected to greatly exceed the present maximum contaminant level. And finally, the technology for removal of nitrate is not established and economic feasibility of processing the entire water supply for a community is very doubtful.

a) Drinking Water Standards and Regulations

The National Interim Primary Drinking Water Regulations (EPA, 1976) establishes the maximum contaminant level at 10 milligrams per liter of nitrate-nitrogen for public water supplies. In 1980, the allowable level for non-community water systems was raised to 20 mg/l (Federal Register, 1979). Community supplies still remain at the 10 mg/l limit. The 1962 Public Health Service Drinking Water Standards stated that nitrate should not exceed 10 mg/l if a more suitable supply can be made available. (A greater concentration did not constitute grounds for rejection of the supply.) A footnote suggested public notification warning of potential dangers of using a water exceeding 10 mg/l nitrate-nitrogen for infant feeding. The World Health Organization International Standards (WHO, 1971) state that a concentration in excess of 10 mg/l nitrate-nitrogen is a health hazard to infants and possibly older children. The WHO European standards are a recommended concentration of less the 11.3 mg/l, an acceptable range of 11.3 to 22.6 mg/l, and above 22.6 mg/l is not recommended. In the United Kingdom if the nitrate content is between 11.3 and 22.6 mg/l, water authorities inform physicians in the area of the possibility of infant methemoglobinemia and make low-nitrate bottled water available on request. Water with a nitrate concentration in excess of 22.6 mg/l is considered unfit for consumption by children of less than 6 months and bottled water containing low-nitrate is normally made available to such children by water authorities at their expense. Concentration limits in most European countries are in this same range, for example, in Luxembourg the limit is 11.3 mg/l while Germany specifies 20 mg/l.

The health concern of excess nitrate in the drinking water is expressed as follows: "Serious and occasionally fatal poisoning in infants have occurred following ingestion of well waters shown to contain nitrate at concentrations greater than 10 mg/l nitrate-nitrogen." (EPA, 1976) The illness is infant methemoglobinemia caused by nitrite combining with hemoglobin to reduce the oxygen-carrying capacity of the blood. In most cases of the disease, the nitrite is derived from in vivo reduction of nitrate in the well water used to prepare the artificial formula fed to the infant. Mortality from methemoglobinemia is extremely rare, the condition easily diagnosed, and rapidly reversible with clinical treatment. The cyanosis is cured by a single intravenous injection of methylene blue. Infants under 3 months of age are the most susceptible population while adults, owing to a lack of evidence, are not susceptible to methemoglobinemia.

The majority of evidence supporting the maximum contaminant level of 10 mg/l is based on data collected in the 1940s. Comly (1945), a physician in Iowa City, correlated incidents of cyanosis in infants to high nitrate concentrations in well waters used to prepare baby formula; in one documented case, the concentration in an unboiled sample of water was 140 mg/l and in another it was 90 mg/l. Although the text of the paper dealt primarily with diagnosis and treatment, Comly did describe the typical high-nitrate water wells as ..."old, dug rather than drilled, had inadequate casings or none at all, and were poorly covered so that surface water, animal excreta and other objectionable material could enter freely. In every one of the instances in which cyanosis developed in infants the wells were situated near barnyards and pit privies." In order to estimate the dangerous level of nitrate, dug wells of similar construction to those associated with cases of infant methemoglobinemia were tested for nitrate content. The well waters that ..."might be seriously toxic to infants if fed in any appreciable amounts" ...contained more than 65 mg/l nitrate-nitrogen. Comly's recommendation was stated as follows: "The nitrate-nitrogen of the water given to the infants varied from 64 to 140 parts per million, (milligrams per liter), and the severity of symptoms seemed to parallel roughly the amount of nitrate present. Although no definite statement can be made, it would seem advisable to recommend that well water used in infant feeding possess a nitrate content no higher than 10 or, at the most, 20 parts per million."

Walton (1951), a sanitary engineer with the U.S. Public Health Service, reported the results of a survey in the United States on incidence of methemoglobinemia caused by nitrate-contaminated drinking water. From the 49 questionnaires returned, 17 of the states reported a total of 214 verified cases of infant methemoglobinemia resulting from varying concentrations of nitrate in the water used in preparing feeding formula. No cases were attributed to raw water

with less than 10 mg/l nitrate-nitrogen. Five incidents (2.3 percent of the total) were associated with 11 to 20 mg/l, 36 cases (16.8 percent) corresponded to 21 to 50 mg/l, and the remaining 80.9 percent involved water containing greater than 50 mg/l. The majority of the study data came from Minnesota reporting a total of 129 cases with none below 10 mg/l, 2 between 11 and 20 mg/l, and 25 at approximately 40 mg/l. Although 10 mg/l was suggested by Comly (1945), the American Public Health Association Committee conducting the survey pointed out that most of the cases studied were associated with a concentration in excess of 40 mg/l and commented that it is "impossible at this time to select any precise concentration of nitrates in potable waters fed infants which definitely will distinguish between waters which are safe or unsafe...".

The National Research Council of the National Academy of Sciences has conducted an environmental assessment of nitrates (NAS, 1978). Based on the scientific data available, the Academy endorses the maximum contaminant level of 10 mg/l since at this concentration nitrate in water exhibits no significant adverse health effects. "There is no convincing scientific evidence to indicate that a more stringent standard would confer additional health protection; however, as noted, a less stringent standard that permitted higher exposures would entail a greater risk." (NAS, 1978, p. 6) "Even in the absence of more conclusive data about the hazards to health, the 10 mg/l nitrate-nitrogen drinking water standard has been a useful policy tool. The existence of the standard has led to extensive monitoring of nitrate levels in water and has stimulated concern over methods to control contributions of nitrate from many different sources." (NAS, 1978, p. 600)

b) Effects on Human Health

Infant methemoglobinemia occurs as follows: (1) Infants have gastric juice with a relatively high pH allowing nitrate-reducing bacteria to grow in the intestine converting nitrate taken in feeding formula to nitrite. (2) The nitrite is rapidly absorbed into the blood readily oxidizing the iron of hemoglobin to the ferric state to form methemoglobin. (3) The excess methemoglobin, which cannot transfer oxygen, results in cyanosis giving the baby a blue color. Infants in the first three months are particularly susceptible for several reasons: relatively high pH in the intestinal tract, high fluid intake with feeding formula, the dominant form of hemoglobin at birth is hemoglobin F that is more exposed to methemoglobin formation, decreased enzyme activity for the normal methemoglobin reduction, and the greater likelihood of gastrointestinal disturbances during infancy. Methemoglobinemia is readily diagnosed and rapidly reversible with clinical treatment. After identification, treatment consists of injecting methylene blue into the blood in a single dose of approximately 1 mg per kg of body mass; improvement occurs within a few minutes. The incidence of infant methemoglobinemia are extremely rare, even in regions of known high nitrate drinking waters in private wells. Very few mothers today are using powdered formula reconstituted with water. Methemoglobinemia has not been identified with breast-fed infants or those given whole cow's milk or a liquid formula requiring no dilution. The only documented case in recent years in Nebraska occurred when a three week old baby was fed powdered formula mixed with water taken from a private rural well.

Healthy adults are able to consume large quantities of nitrate in drinking water without adverse effects. Adults have a more acidic intestinal tract preventing the growth of nitrate reducing bacteria, adult hemoglobin is less easily oxidized to methemoglobin, and a higher enzyme activity restoring the oxygen-transporting capacity of blood. Even though some individuals have predisposing conditions causing risk, no reports of adult methemoglobinemia from drinking water have been confirmed. (NAS, 1978, p. 5) Likewise, no evidence exists to presuppose that pregnant women or elementary school children are more susceptible than adults.

Nitrate hypothetically could be a precurser for nitrosamines that are suspected carcinogens having induced tumors in laboratory animals. However, the extent of human nitrosation in vivo is unknown and no human cancer has been positively attributed to nitrosamines. (NAS, 1978, p. 4) The principle sources of nitrate in the average adult diet are vegetables and saliva amounting to about 130 mg ingested per day. This amount is significantly greater than intake in drinking water, for example, 2 liters per day at 10 mg/l would equal 20 mg/d. The source of about three quarters of the ingested nitrite is from saliva. Nitrate is produced in the oral cavity by bacterial reduction of nitrate in ductal saliva. The main origin of dietary nitrosamines appears to be foods and tobacco smoke. (NAS, 1978, Chapter 9)

c) Occurrence in Groundwater

The common forms of nitrogen are as nitrogen gas (N_2), liquid or gaseous ammonia (NH_3), ammonium ion (NH_4^+), nitrate ion (NO_3^-), and nitrogen bound in organic matter. Common reactions involving inorganic nitrogen are as follows:

Synthesis into plant tissue: NO_3^- or $NH_4^+ \xrightarrow{\text{photosynthesis}}$ Organic-N (1)

Decay of plant tissue: Organic-N $\xrightarrow[\text{decomposition}]{\text{bacterial}} NH_4^+$ (2)

Nitrification (aerobic): $NH_4^+ + O_2 \xrightarrow[\text{oxidation}]{\text{bacterial}} NO_3^-$ (3)

Denitrification (anaerobic): $NO_3^- + AH_2 \xrightarrow[\text{reduction}]{\text{bacterial}} N_2\uparrow + A + H_2O$ (4)

The most stable nitrogen form in water solution is the nitrate ion. After application, ammonia fertilizers are readily nitrified to the nitrate ion (Equation 3). Decomposition of organic matter also results in nitrate except the reaction is slower since deamination (Equation 2) must precede nitrification (Equation 3). Being unreactive, nitrate is also the most mobile form of nitrogen found in soils. If not synthesized by plants (Equation 1), nitrate is readily leached from the soils by rainfall or irrigation water infiltration. Although conversion to nitrogen gas (Equation 4) is possible in a lower soil profile where anaerobiosis may exist, this reaction also requires a supply of reduced organic matter (AH_2), warm temperature, and the presence of reducing bacteria. More likely, nitrate transported below the root zone of vegetation will eventually appear in the underlying groundwater.

Nitrate appearing in groundwater can originate from several sources: synthetic fertilizers, mineralized organic soil nitrogen, animal manures, wastewaters, and atmospheric fallout. In Nebraska, the most likely cause leading to the widespread buildup of underground nitrate is the heavy application of ammonia fertilizers applied to corn since the early 1950s. Under the current economic situation of agriculture, applying fertilizer at the most efficient dose for crop response to minimize fertilizer loss is unrealistic. "Maximum economic efficiency of production requires inputs of fertilizer nitrogen in excess of the amount taken up by the crop. Even under favorable conditions, the efficiency of fertilizer nitrogen recovery by crops is seldom more than 70 percent, and the average value is probably nearer to 50 percent"..."in addition, the optimum rate of fertilizer application is influenced by a multitude of site-specific conditions, about which information is generally inadequate." (NAS, 1978, p. 519) Irrigation of corn has also increased dramatically in many regions during the past 30 years. A combination of excess nitrogen applied to the soil and overwatering by irrigation, as well as heavy rainfall events, promotes leaching of nitrate below the uptake zone of shallow rooted plants.

An example of nitrate contamination of groundwater from fertilized irrigated agriculture is the Central Platte Region (Spalding, et. al., 1978 and Gormly and Spalding, 1979). Figure 1 shows the aerial extent of high nitrate groundwater in portions of Buffalo, Hall, and Merrick Counties. In the lower diagram, the town of Wood River that is centrally located in a high nitrate zone has had drinking water in its distribution system approaching 20 mg/l. On the west and east ends of this region are Kearney and Grand Island, respectively, with a combined population of greater than 50,000. Fifty percent of Merrick County (upper diagram) is underlain by groundwater with concentrations from 1.5 to 3 times the 10 mg/l recommended drinking water limit. The concentration of nitrate ion is greatest in the upper stratum of groundwater and decreases with depth. Thus, the most recent infiltration reflects greater contamination than the groundwater in storage. A stable equilibrium will eventually result in the leachate and withdrawn irrigation water approaching the same nitrate concentration. Under minimum fertilizer use and recommended application of irrigation water, the equilibrium concentration is expected to be 30 to 40 mg/l, although a higher content is possible. Figure 2 shows typical profiles of nitrate nitrogen concentrations in the groundwater in the Central Platte Region (Spalding and Exner, 1980). Groundwater with the least nitrate is in the semi-confined lower aquifer. The town of Gibbon recently drilled a well into this aquifer for a source of low-nitrate water. Wood River is currently taking the same action. The well casings are sealed from the surface through the silty clay layer to prevent the upper high-nitrate water from flowing directly into the well. However, if a large number of irrigation wells are also drilled into this lower stratum, it will also become contaminated. Reserving this deep aquifer for public water supplies and precluding penetration of irrigation wells would help preserve a suitable drinking water supply for this region.

During fiscal year 1979, the Nebraska Department of Health tested 451 community water systems for inorganic chemicals identified as health-related contaminants. The results (NDH, 1979) listed the 18 communities in Table 4 as exceeding the maximum contaminant level for nitrate. Four of the communities have populations over 500 with Wood River at 1,147 being the largest. The average population of the other 14 towns is 260 persons, ranging from 117 to 489. The nitrate concentrations listed in Table 4 are from samples taken from the distribution piping representing a blend of the well waters being pumped into the system. Samples from individual wells have tested significantly higher

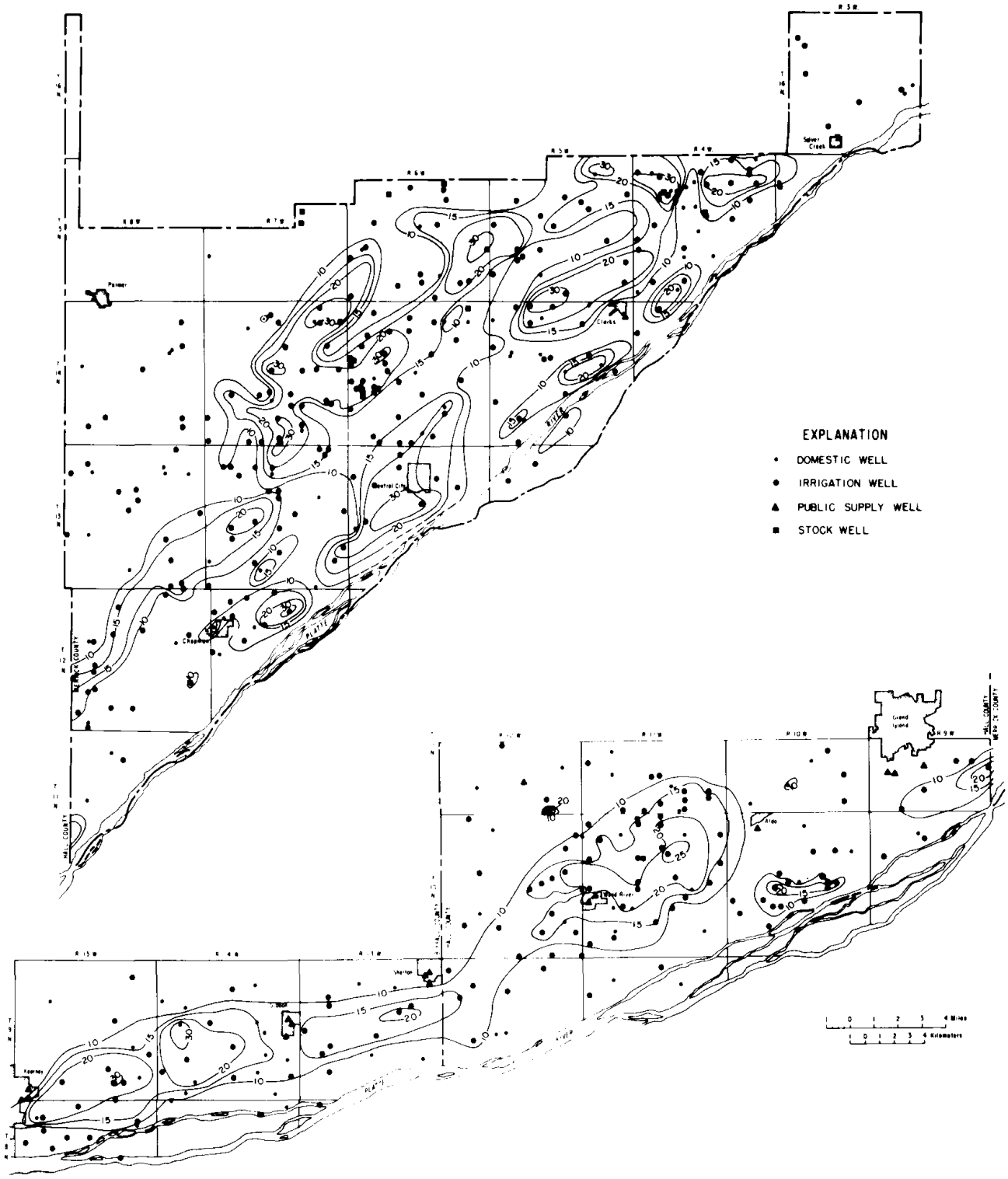


Figure 1. Areal distribution of groundwater nitrate nitrogen from samples collected in summers of 1974, 1976 and 1977. (From J. R. Gormly and R. F. Spalding (1979) "Sources and Concentration of Nitrate-Nitrogen in Groundwater of the Central Platte Region, Nebraska," Ground Water, vol. 17, no. 3.)

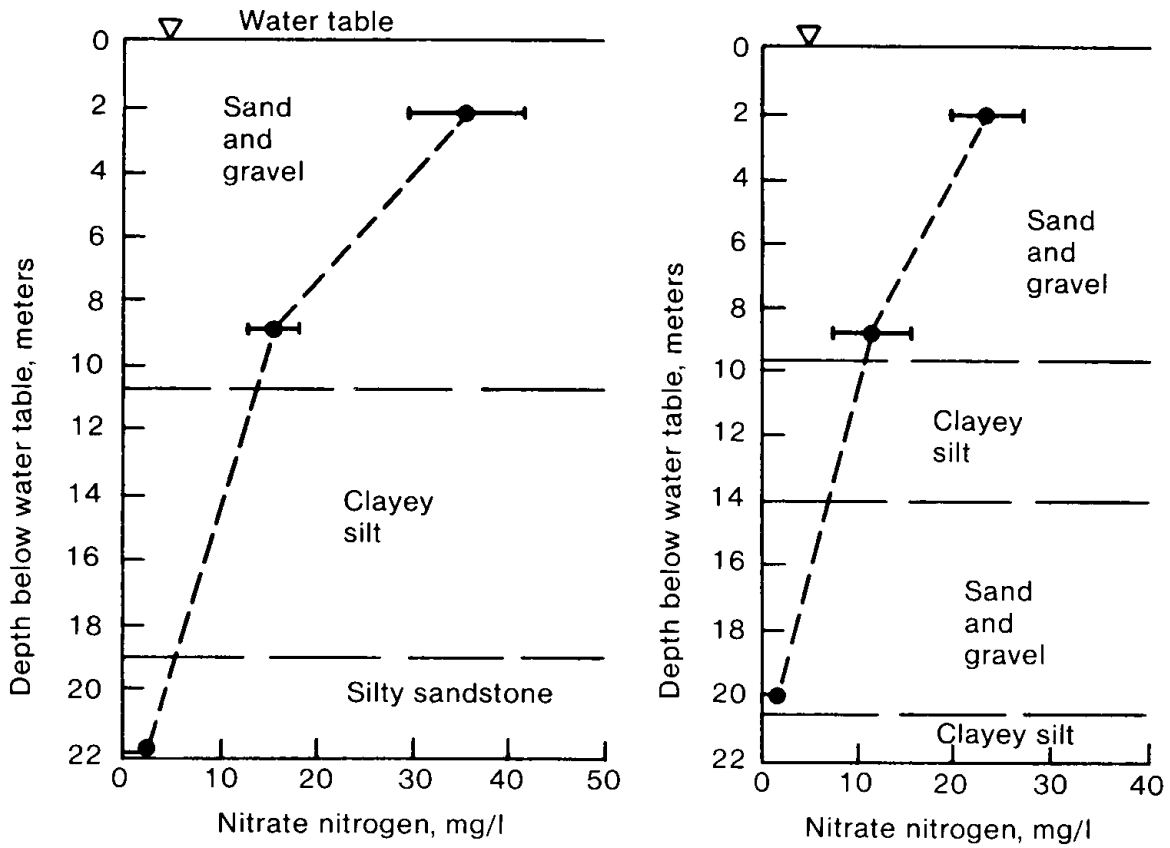


Figure 2. Profiles of nitrate nitrogen concentration in the groundwater in the Central Platte Region, Nebraska. (From R. F. Spalding and M. E. Exner (1980) "Areal, Vertical, and Temporal Differences in Ground Water Chemistry, I. Inorganic Constituents," Journal of Environmental Quality, vol. 9, no. 3.)

Table 4. Public Water Supplies in Nebraska That Exceeded The 10 mg/l Maximum Contaminant Level For Nitrate in Fiscal Year 1979

Community	Population	Milligrams/Liter	Community	Population	Milligrams/Liter
Allen	309	12.2	**Hardy**	250	10.8
Belgrade	210	11.7	**Johnson**	350	10.8
Bennet	489	13.4	**Pickrell**	182	11.7
Bradshaw	347	12.5	**Rising City**	344	11.9
Diller	287	12.9	**Sprague**	119	11.1
Duncan	298	10.8	**Tobias**	124	14.5
Elmwood	548	12.5	**Verdon**	265	15.4
Exeter	759	24.4	**Wood Lake**	117	18.9
Fairmont	761	12.7	**Wood River**	1147	18.3

STATE OF NEBRASKA
DEPARTMENT OF HEALTH

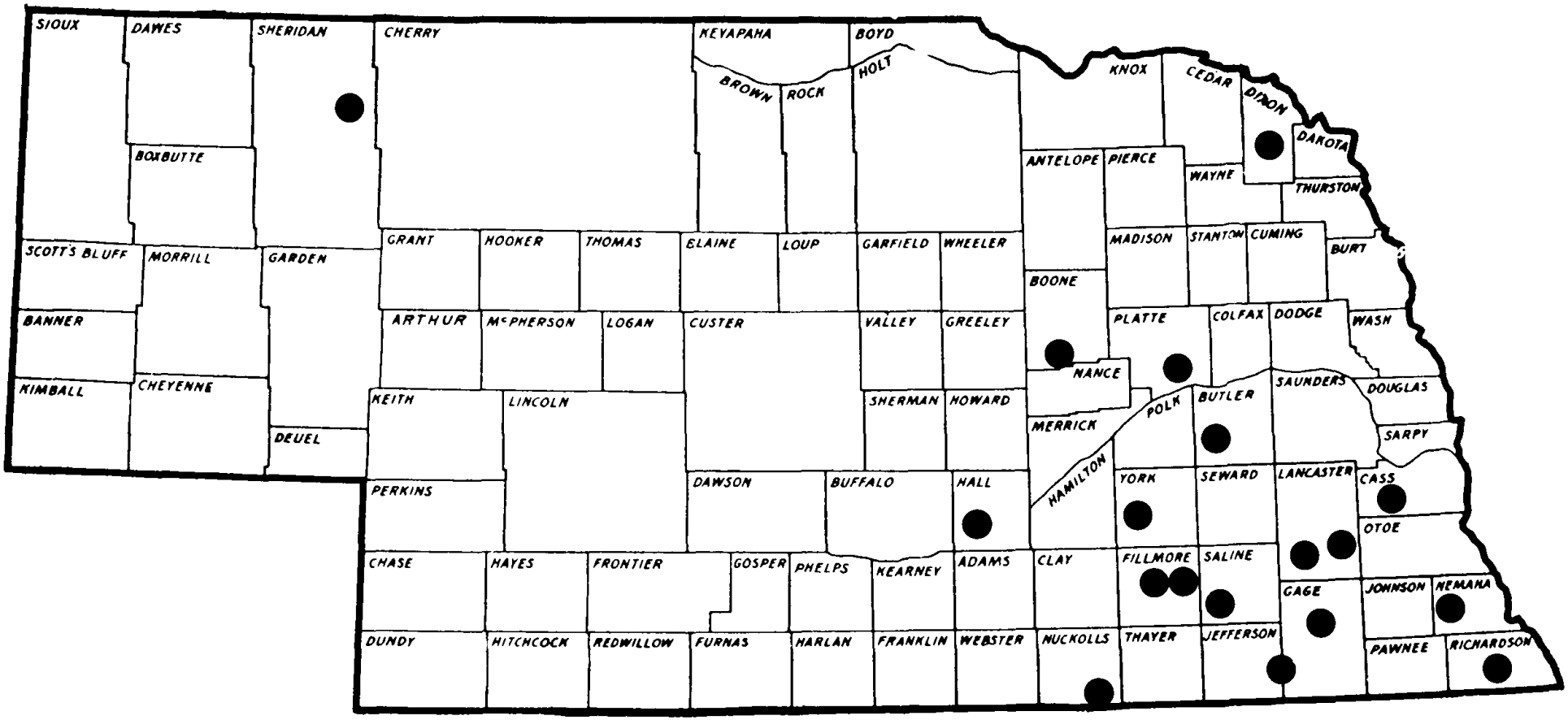


Figure 3. Locations of communities listed in Table 4 that exceeded the 10 mg/l maximum contaminant level for nitrate in fiscal year 1979 (NDH, 1979).

often approaching and occasionally exceeding 20 mg/l. The locations of the communities listed in Table 4 are plotted in Figure 3. Most are located in southeast Nebraska, which is a highly productive agricultural region.

In a cursory study for this report, ten of the communities in southeast Nebraska with high-nitrate water were visited by personnel in the Environmental Engineering Division who have professional status in environmental engineering and geology. Elmwood was the only community where the contamination was identified as originating from a point source. Professor William Wayne (Geology, UNL) had studied the site in 1977 and concluded the major source of nitrate entering the aquifer was from a cattle feeding area on the east edge of the village. New wells are being installed on the west edge of the town. Tobias has a shallow hand-dug well recharged by infiltration from an area largely within the village boundaries. Likely sources are decomposition of organic matter and chemical fertilizers placed on gardens and lawns. Percolation from septic tanks is unlikely since the village is sewered.

The aquifers penetrated by municipal wells in Liberty and Sprague are probably recharged by water percolating through fertilized corn fields that are terraced and cultivated to reduce erosion and maximize infiltration of precipitation (Figure 4). Groundwater contamination by natural percolation of high-nitrate porewater under fertilized arable land was demonstrated by Young and Gray (1978).

One half of the communities included in this preliminary review of nitrate sources (Bradshaw, Exeter, Fairmont, Pickrell, and Rising City) are surrounded by fertilized cornfields, many irrigated by either surface or spray application of groundwater. The community wells were deep, often 150 to 250 feet, and screened in a lower semi-confined aquifer of water bearing sand and gravel. The probable means of nitrate contamination is shown schematically in Figure 5. The irrigation wells extract water from the same deep aquifer as the community wells causing a sharp decrease in water pressure in the lower aquifer during the irrigation season. (Refer to Figure 10b for the seasonal effect of irrigation pumping of water from a semi-confined aquifer.) Infiltration of irrigation water and natural precipitation leach nitrate from fertilizer and decaying organics in the topsoil down into the porous silty soil stratum below the root zone. This water perched on the semi-confined stratum, probably containing 40 to 60 mg/l of nitrate, gradually seeped downward recharging the underlying sand and gravel aquifer. At least a portion of this perched water channels directly down the gravel packs surrounding the well casings. By this process of withdrawal and recharge, the lower aquifer is contaminated by the salts leached from the upper soils. Increases in total dissolved solids, sulfate, and nitrate are all indicators of this exchange. The long-term equilibrium of nitrate concentration in the groundwater is apt to be over 50 mg/l nitrate-nitrogen if current fertilization and irrigation practices are continued in the future.

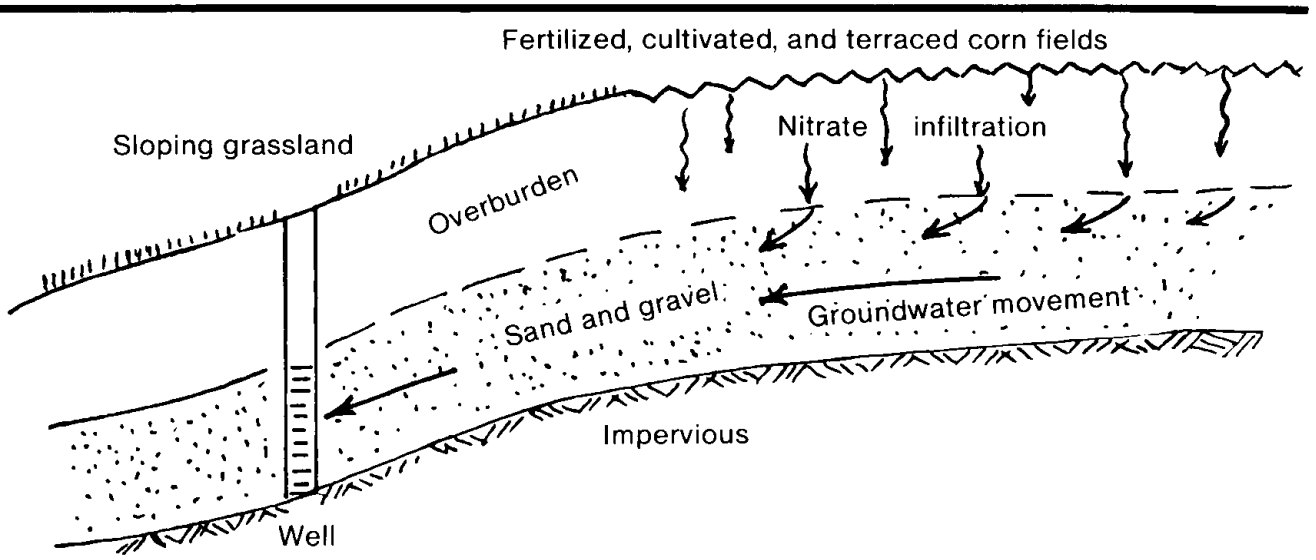


Figure 4. Precipitation percolating through fertilized corn fields conveys high-nitrate porewater to the underlying aquifer. After infiltrating the aquifer, this water moved downgrade and is withdrawn by the municipal well.

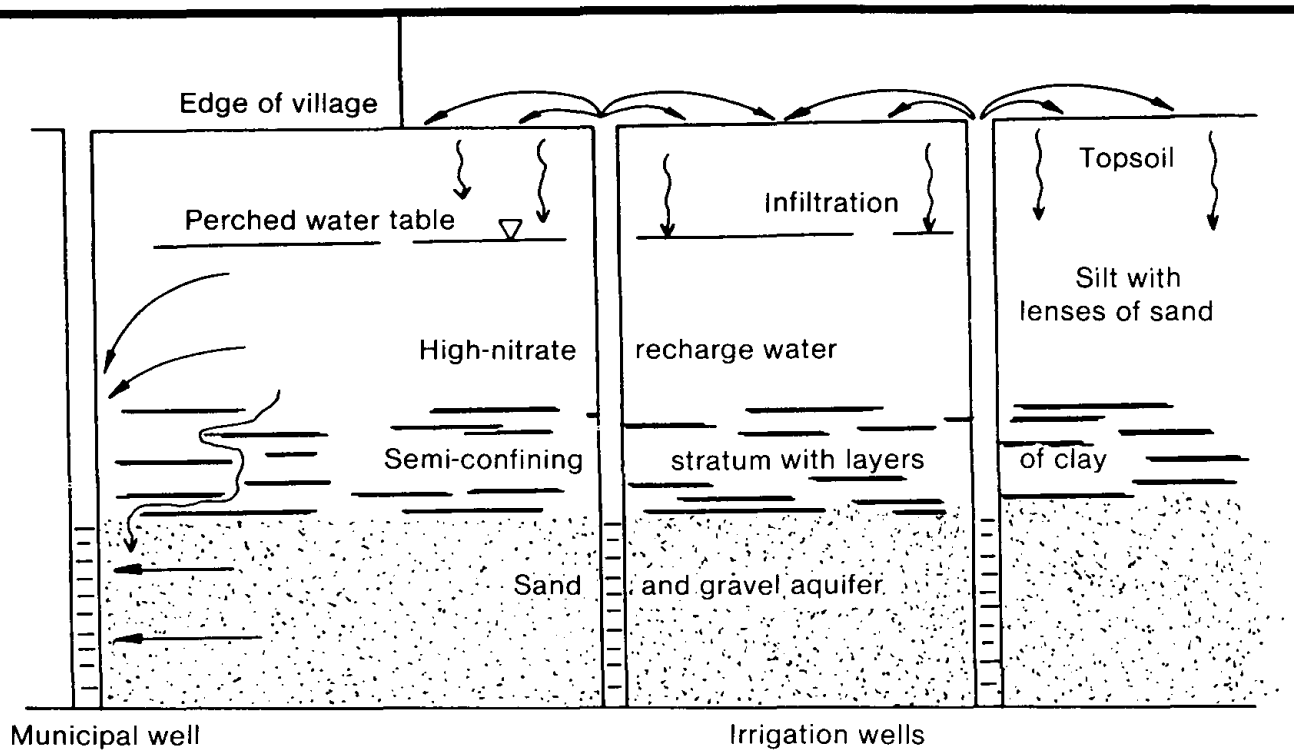


Figure 5. The probable means by which municipal wells are contaminated with nitrate in small communities surrounded by fertilized, irrigated corn fields.

d) Alternate Sources or Treatment of Water Supplies

The alternatives to ensure low-nitrate water supplies for communities in rural Nebraska are (1) protection of the aquifer used as the source for drinking water, (2) importation of municipal water through a pipeline from a reliable source, and (3) treatment of the contaminated groundwater to remove the nitrate.

The best option, although sometimes unrealistic, is to protect and prevent contamination of the aquifer to be used solely as a source of drinking water. If the groundwater recharge area is definable and able to be isolated, a land use plan can be established to ensure infiltration of high quality water. For instance, the recharge area can be maintained as unfertilized, terraced grassland so that precipitation is not contaminated as it percolates through the soil profile. (Refer to Figure 4.) This occurs naturally in many communities in eastern Nebraska. A second technique is to reserve a deeper semi-confined aquifer for municipal use by excluding penetration of irrigation wells. For example, in several areas of the Central Platte Region, a deeper aquifer with low-nitrate water is available (Figure 2). The town of Gibbon in Buffalo County has constructed a municipal well to draw water only from this deeper aquifer by sealing off the upper strata to prevent entrance of contaminated water. Wood River in Hall County and Pickrell in Gage County are also drilling wells to penetrate an aquifer containing uncontaminated, ancient water. Whether deeper wells will provide a lasting solution is questionable since high-nitrate water will recharge the deeper aquifer. The quantity of uncontaminated water available from a deep well will be significantly reduced if irrigation wells are allowed to draw from this same deep aquifer. Thirdly, if neither the infiltration area can be isolated nor new wells extended to a deeper aquifer, the only other method of preventing nitrate contamination of the groundwater supply is to restrict fertilization and irrigation in the recharge zone surrounding community wells. Even though these three methods involving land use planning to protect groundwater quality appear unacceptable, they may be the best and most feasible alternatives. Unfortunately, the use of groundwater and land resources for high-yield agricultural production often conflicts with municipal use of the groundwater as a public supply.

Importing water from a nearby uncontaminated source may be a reasonable alternative for a few communities. If the town is located near the Platte River, water can be withdrawn from wells located near the bank and transported through a

pipeline to the town. Water infiltrating aquifers from the Platte River is of high quality. For example, near Grand Island the nitrate content of the river water ranges from zero to 1.30 mg/l, averaging 0.43 mg/l for the years 1964 through 1977. If a village is near a larger community, water may be purchased from that utility. Or, a large water district may be formed to serve both rural water customers and the small towns in a region. Even though this is an appealing concept, the excessive cost makes regional water systems impractical. (Refer to VII. QUANTITY CONCERNS, 1. Regions of Limited Groundwater Supplies.) Bottled water for infant feeding is considered a temporary solution in communities where the drinking water contains greater than the maximum contaminant level of 10 mg/l but does not exceed about 20 mg/l. If the nitrate concentration is so high as to render the community supply unsuitable for human consumption, bottled drinking water could be delivered to all residents by the local water utility. The legality of a community piping a nonpotable supply to houses and businesses for domestic use, except human consumption, and delivering bottled drinking water has not been established.

Being chemically unreactive, the nitrate ion cannot be precipitated and filtered from water by conventional treatment processes. The unreactive nature of the nitrate ion is evidenced by its ability to pass unhindered through a porous soil profile into the groundwater. Of the demineralization processes that can separate salts from water, only reverse osmosis and ion exchange are being considered for municipal treatment. Reverse osmosis forces water under high pressure through a membrane that inhibits the passage of salt ions. Unfortunately, the sulfate ion being divalent is removed in preference to the monovalent nitrate ion. Membrane processes are therefore inefficient in removal of nitrate from groundwaters with high sulfate content that are typical in Nebraska. Ion exchange is the only method being given serious consideration for removal of nitrate at this time. A pilot plant is presently being operated to process high-nitrate well water at McFarland, California by the Boyle Engineering Corporation. A strongly basic anion exchanger, which uses sodium chloride as a regenerant, appears to be the most promising system under development. All ion exchange resins preferentially remove divalent ions, therefore, both sulfate and nitrate ions are extracted and replaced by chloride ions. When the capacity for exchanging nitrate ions is depleted, a regenerating solution with a high salt content is pumped through the bed to displace the sulfate and nitrate ions and rejuvenate the exchanger. The volume of the waste backwash brine is significant, amounting to about 5 percent of the water processed. The major disadvantages of ion exchange treatment are the high operating costs and the problem of waste brine disposal. The total cost for ion exchange processing is likely to be 25 to 50 cents per 1000 gallons of treated water. For comparison, the cost of water charged consumers in small communities in Nebraska is about 20 cents per 1000 gallons. Because of the high cost of nitrate removal from an entire municipal supply, household ion exchange units may be an alternate method for purifying drinking water. However, operational problems, such as the difficulty in testing for the nitrate ion, may preclude the use of individual household units. Also, legal responsibility for maintenance and operation has not been established for individual households units processing a community supply.

e) Summary and Recommendations

Informing rural communities and the boards of natural resources districts about nitrate contamination of groundwater is absolutely essential. Governmental officials should be aware of the drinking water regulations, effects of nitrate on human health, occurrence in groundwater, and the difficulty in treatment for removal of nitrate. Communities with only a few milligrams per liter of nitrate appearing in recent years should take appropriate actions to protect the quality of their well water supply. Nitrate contamination of groundwater is irreversible and, once a community source is contaminated, corrective measures to provide drinking water are likely to be either extremely expensive or impossible. Those town systems with nitrate concentrations currently greater than 10 mg/l must undertake studies to determine the best remedial actions. If the present trend in nitrate contamination of groundwater continues, many communities will not have a potable water source in the future. Based on the anticipated rate of nitrate concentration increase, the groundwater in several regions of the state is likely to be 3 or 4 times the health-related 10 mg/l limit in 10 to 20 years.

A comprehensive plan to address the problem of nitrate in community water supplies must include research studies and site investigations. The following suggested studies, listed by order of importance, should be considered for implementation as soon as possible.

1. The State Health Department in cooperation with the affected communities and boards of the local natural resources districts should encourage and monitor site investigations to help communities locate low-nitrate water sources.

2. The Department should set up regulations for monitoring and controlling the distribution of bottled drinking water by communities that cannot meet the nitrate quality specified by the National Interim Primary Drinking Water Regulations.

3. The long-term benefits of well relocation and deep grouting of well casings should be studied in the communities currently undertaking this construction, such as, Pickrell and Wood River.

4. If either ion exchange or another method of removing nitrate from water is developed, the State of Nebraska should sponsor a study to determine the feasibility of using such treatment by installing individual household units rather than processing the entire community water supply.

5. The model suggesting the probable means by which municipal wells are contaminated as shown in Figure 5 should be investigated.

The following are recommended regulatory actions based on the measured nitrate-nitrogen level in a community water system.

Nitrate Level	Recommended Regulatory Actions
10 to 19 mg/l	1) The health authorities and physicians in the community are notified to be alert for cases of infant methemogloginemia. 2) Public notification is instituted to warn the local people and the traveling public in locations where vacationers are likely to fill drinking water containers. 3) A consulting engineer or geologist is employed by the community to investigate and report on alternative methods of providing the community with a water of acceptable quality. 4) The community provides low-nitrate water for infant feeding upon request.
20 to 29 mg/l	1) Items 1, 2, and 3 above. 2) The community now delivers bottled water to individual households with infants and other potentially susceptible persons.
At 30 mg/l	1) The community submits to the State Health Department a complete report on the water supply system indicating the probable source of the nitrate contamination and proposed actions. The report must include a plan for instituting delivery of bottled water to all residents.
At 40 mg/l	1) The community system is declared to be a nonpotable supply, unfit for human consumption. Notices warning citizens and the traveling public must be posted at all water outlets and faucets that could be used for withdrawing drinking water.

3. SELENIUM

Selenium is a trace metal naturally occurring in soils derived from sedimentary rocks. Upon oxidation to the selenate ion, it can percolate to groundwater and be synthesized by plants. Effects upon human health have not been clearly established--a low selenium diet is beneficial, while high doses can produce undesirable physical manifestations. Neither extreme dietary deficiency nor toxicity is apparent in the human population of the United States. The conservative mean contaminant level proposed in the National Interim Primary Drinking Water Regulations is not justified by recent studies and should not be enforced by either the State or the Environmental Protection Agency.

a) Drinking Water Standards in Regulations

The current maximum contaminant level for selenium (EPA, 1976) is 10 micrograms per liter as established by the Drinking Water Standards Committee (PHS, 1962). Prior to 1962 the health-related level was 50 micrograms per liter.

The 50 ug/l standard relies on field studies (Smith, et. al., 1936, 1937) that considered the effects of selenium on rural populations of seleniferous regions, mostly with soils derived from Cretaceous shale. Boyd County, Nebraska was one of the study areas. The survey included information from about one hundred families on the extent of local foods in the diet, general physical condition, and urine analysis for selenium content. Evaluation of the data assumed higher concentrations of selenium in urine represented a greater intake and correspondingly higher concentration in body tissues. Secondly, the abnormally high incidence of bad teeth, yellowish discoloration of the skin, skin eruptions, chronic arthritis, and diseased nails of the fingers were attributed to selenium, even though, other conditions may cause these disorders. "The incidence of vague symptoms of ill health,

particularly those suggestive of gastric or hepatic disorders, appeared to be sufficiently high to indicate the probability of cause and effect" (Smith and Westfall, 1937).

Later laboratory studies on cats and rabbits fed naturally occurring selenium in their diet (Smith, 1941) led to a correlation between toxicity and the level of selenium in the urine of laboratory animals. Doses in excess of 0.5 mg/kg°d, reflecting 5 mg/l or more in the urine, are likely to be damaging to tissues, while small animals ingesting 0.1 to 0.2 mg/kg°d resulted in 1 to 2 mg/l in their urine without apparent unfavorable effects. Smith (1941) inferred from these laboratory animal studies that the human subjects investigated in the field survey were absorbing from 0.01 to 0.1 or possibly as much as 0.2 mg of selenium per kilogram of body mass per day. For a 70 kg man, this amounts to an intake of 700 to 7000 ug/d, up to 14 mg/d.

The majority of selenium intake is related to consumption of food associated with a well-balanced human diet, for example, on a dry mass basis meat contains approximately 0.2 to 0.3 mg/kg, milk and whole egg average 0.14 and 1.0 mg/kg respectively, fish is 1.5 mg/kg and bread ranges from 0.1 to 5 mg/kg (NAS, 1971). The average daily intake of selenium by the American population approximates 200 ug/d (EPA, 1976). As a conservative limit, allowable human intake from sources other than food equals Smith's lower limit less the normal dietary intake (700 less 200) or 500 ug/d. Applying a limit of 50 ug/l to 2 liters of drinking water consumed per day incorporates a factor of safety of 5 before reaching the threshold of suspected minor effects adverse to human health.

Lowering the approval level from 50 ug/l to 10 ug/l in 1962 presumed possible carcinogenicity based on rats fed a diet containing selenium (PHS, 1962). These results could not be substantiated in recent testing. Apparently, selenium at high concentrations produced chronic toxic hepatitis which resembles hyperplasia (Shamberger, 1970). In fact, mice receiving a diet containing 1.0 mg/kg sodium selenite reduced tumors induced by other chemicals. (Shamberger, 1970). Field surveys of dietary selenium and human cancer mortality in the United States revealed that regions with higher selenium content had reduced incidence of cancer (Shamberger and Willis, 1971). Scientific evidence available at this time suggests that selenium is not carcinogenic (NAS, 1976). A Report of the Safe Drinking Water Committee (NAS, 1977) recommends raising the current maximum contaminant level. Rather than concern for toxicity, the literature indicates a greater potential for selenium deficiency.

b) Effects on Human Health

Selenium being an essential trace element follows Bertrand's Law of optimal nutritive concentration (Schroeder, 1973). Dietary deficiency retards growth while excess results in toxicity. The width of the plateau of sufficiency (between deficiency and toxicity) varies with the species of plant or animal. For humans, the plateau is wide since the body can excrete the selenium in excess of biological needs, within a reasonable upper limit.

The minimum intake of selenium for optimum human health is not well defined. Furthermore, only limited data are available on the amounts supplied in human diets. Since all foods contain trace amounts of the element, most people in the United States are receiving some dietary selenium. It is found in human blood, urine, milk and tissues even in nonseleniferous areas. Selenium tablets are available in 20 and 50 ug doses, particularly in health food stores, with a label stating: The Committee on Dietary Allowances of the National Academy of Sciences has approved a provisional recommended daily allowance of 50-200 ug/day. Also, the Food and Drug Administration has approved the use of selenium as an agricultural food additive for livestock.

Historically, selenium was recognized as the toxicant associated with cattle diseases referred to as "alkali disease" or "blind staggers." Instances occurred when range cattle grazed on seleniferous vegetation (Anderson, et. al., 1961). The most common poisonous plants are range weeds, such as, several species of **Astragalus** that can accumulate selenium in excess of 1000 mg/kg while grasses growing in the same area containing less than 10 mg/kg. Relative to human poisoning, the few existing reports fail to clearly establish that selenium caused the signs of toxicity observed (NAS, 1976). This reinforced the earlier statement by the National Academy of Sciences in 1971: There is no evidence that any people in the United States are suffering from toxic levels of selenium in food.

The quantity of selenium in municipal water supplies (43 samples) range from 0.1 to 400 ug/1 (NAS, 1974). Even the maximum level in this range is apparently not sufficient to produce noticeable toxicity in humans owing to the lack of reported cases of chronic selenosis. The only case of human poisoning from drinking water occurred when an isolated family consumed water containing 9 mg/l; their food was free of selenium. The children, ranging from 6 months to 10 years, showed no abnormalities other than lassitude, total or partial loss of hair, and loss of fingernails, which are chronic symptoms in humans similar to alkali disease in livestock. Regrowth of hair and nails began after changing

to an alternative water supply. The parents and the dog also displayed some symptoms of poisoning. (Rosenfeld and Beath, 1964) As is apparent from these limited data, a great deal more information is needed prior to establishing a realistic maximum contaminant level of selenium in drinking water.

c) Occurrence in Groundwater

Selenium exists naturally in sedimentary rocks of Cretaceous age with shales containing the highest amounts. The elemental form Se°, as found in unweathered rock, is insoluble and immobile. When oxidized, selenite ($SeO_3^{=}$) and selenate ($SeO_4^{=}$) are formed. Selinite found in acid soils is usually bound as ferric selenite that has an extremely low solubility. In alkaline soils of semi-arid regions, the common form is selenate that is soluble in water and available to vegetation. Thus, plants growing in alkaline seleniferous soils incorporate the selenium biochemically in their structure. Consumption of these plants by animal and man introduce the element into the food chain. Also in these regions, surface streams and groundwater contain low concentrations of selenium as selenate.

A survey of selenium in groundwater of Nebraska (Engberg, 1973) showed the highest concentrations, up to 480 ug/l, were in wells in eastern Boyd County, which is an area where some exposed rocks and soils are from Pierre Shale. Northern Phelps County showed amounts up to 100 ug/l in a region irrigated by Platte River water. Other wells with greater than 10 ug/l were in scattered locations throughout the state.

The Nebraska Department of Health surveys the quality of drinking water in 681 community water systems and 723 non-community systems. During fiscal year 1979, 451 water supplies were tested for inorganic chemicals identified as health-related contaminants by the National Interim Primary Drinking Water Regulations (EPA, 1976). The public water system surveillance program (NDH, 1979) listed the 16 communities in Table 5 as exceeding the maximum contaminant level for selenium. Their locations are plotted in Figure 6. The two largest cities in violation were Holdrege and Seward having 17 and 16 ug/l, respectively. Only Humphrey, population 862, tested greater than 50 ug/l.

d) Alternate Sources or Treatment of Water Supplies

Selenium in well water, most likely to be in the stable soluble selenate form, is not removable from solution by conventional treatment methods of chemical coagulation or lime-precipitation softening. The only techniques technically possible, but infeasible, are reverse osmosis and ion exchange (EPA, 1977). Costs of installation and operation of these processes are extremely unrealistic for community water systems.

New uncontaminated water sources may be difficult to find in seleniferous regions. Groundwater with reduced selenium content may be either at different depths or considerable distances away in aquifers recharged by nonseleniferous water. Locating wells to provide a water with less than 10 ug/l is likely to be an expensive trial and error procedure. Impounding surface supplies on shale soils may not resolve the selenate problem. Furthermore, a filtration plant would then be required for processing the water supply to remove conventional surface-water contaminants.

Table 5. Public Water Supplies in Nebraska That Exceeded The 10 ug/l Maximum Contaminant Level For Selenium in Fiscal Year 1979

Community	Population	Micrograms/Liter
Brainard	309	20
Concord	180	15
Dixon	128	24
Dunbar	252	17
Edgar	707	15
Funk	143	16
Goehner	113	17
Holdrege	5635	17
Howells	682	43
Humphrey	862	70
Maskell	43	18
Milligan	319	18
Pender	1229	46
Seward	5294	16
Tobias	124	46
Wilcox	208	19

e) Summary and Recommendations

The following conclusions are based on evidence available in literature on selenium.

(1) Selenium has not been clearly identified as a health hazard to persons residing anywhere in the United States. The maximum contaminant level of 10 ug/l cannot be justified, nor can any rational limit be established based on present knowledge.

(2) Low dietary intake of selenium is beneficial to human health, apparently reducing carcinogenicity.

(3) Selenium is a natural trace metal associated with specific geological formations.

(4) Alternate sources of uncontaminated water

STATE OF NEBRASKA
DEPARTMENT OF HEALTH

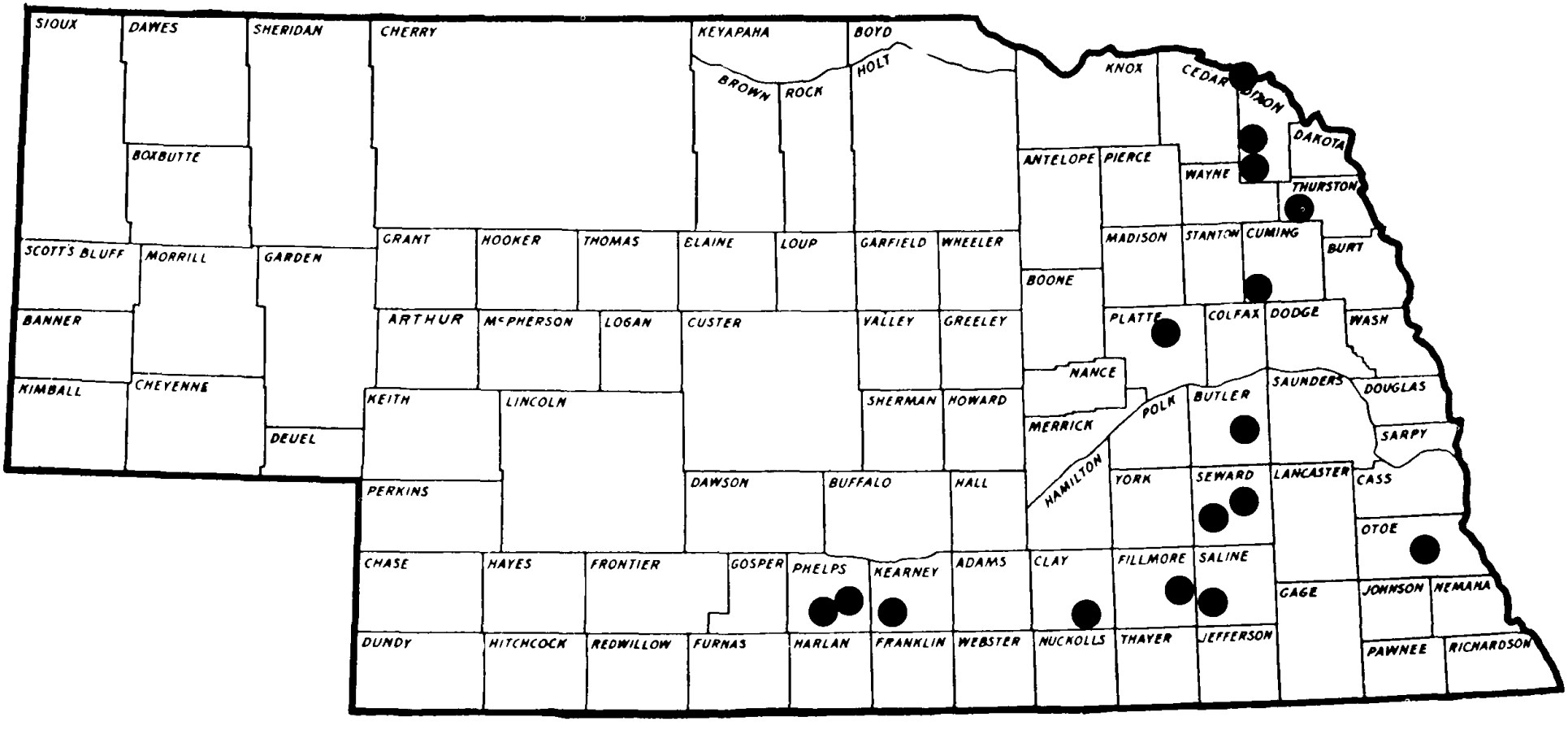


Figure 6. Locations of communities listed in Table 5 that exceeded the 10 ug/l maximum contaminant level for selenium in fiscal year 1979 (NDH, 1979).

may not be readily available in seleniferous areas, and treatment processes to remove selenate from water are infeasible for community supplies.

Section 1415 of the Safe Drinking Water Act (Public Law 93-523) states: "A State which has primary enforcement responsibility for public water systems may grant....(a variance)....because of characteristics of the raw water sources which are reasonably available to the systems, cannot meet the requirements respecting the maximum contaminant levels of such drinking water regulation despite application of the best technology, treatment techniques, or other means, which the Administrator (of the Environmental Protection Agency) finds are generally available taking costs into consideration. Because a State may grant a variance under this subparagraph, the State must find that the variance will not result in an unreasonable risk to health." This provision in the Act applies directly to the situation of selenium in the public water supplies in Nebraska and leads to the following recommendation.

A renewable variance should be issued by the State to all public water supplies in Nebraska that exceed the maximum contaminant level for selenium, regardless of the measured concentration. If a variance granted for this reason is questioned, the Nebraska Department of Health should be petitioned to conduct a field study to determine if dietary intake of selenium from the water supply in that community is excessive.

4. TRIHALOMETHANES

The maximum contaminant level for total trihalomethanes of 0.10 mg/l (maximum three-month average) is applicable to community water supplies serving populations in excess of 75,000 where disinfection is practiced as part of the treatment process. In addition to these cities, monitoring is required at all communities with populations down to 10,000. Water utilities are also requested to submit design proposals for granular activated carbon absorption systems to achieve the recommended level. (Federal Register, 1978) Trihalomethanes, particularly chloroform and bromodichloromethane, are suspected as having adverse effect on human health by increasing the risk of cancer. These halogenated substances are formed during disinfection by the reaction of chlorine with certain inorganic compounds like humic acids that naturally occur in surface waters.

A 1976 national survey by the Environmental Protection Agency listed the following results of laboratory analyses on two municipal water supplies in Nebraska: Lincoln 0.028 mg/l trihalomethanes and Omaha 0.116 mg/l. The value for Lincoln is well below the health limit, as expected for a groundwater. Omaha's Missouri River plant is the water supply in Nebraska expected to have significant formation of trihalomethanes upon chlorination.

The critical time of the year for increased trihalomethanes is in the spring when water quality deteriorates as a result of runoff from snowmelt and rain washing organic residue from the land surface into rivers. Nevertheless, at Omaha's Missouri River plant, revised chlorination practices have reduced measurements in the water at the treatment plant to a tolerable range of 0.07 to 0.08 mg/l in the spring of the year. Occasionally, water in the distribution piping exceeds 0.10 mg/l since chlorine added for a protective disinfection residual continues to slowly form trihalomethanes in the treated water. The average 3-month level is still expected to remain below the 0.10 mg/l health limit.

During May, 1980, water in Omaha's distribution system originating from the Platte River plant contained greater than 0.10 mg/l trihalomethanes. The raw water source for this plant is groundwater drawn from wells in a coarse sand and gravel aquifer adjacent to and recharged directly by the Platte River. Factors contributing to this high level were: spring runoff resulting in soluble organics in the river water drawn through the porous aquifer; high pH caused by lime addition for water softening; post chlorination to establish a free residual for protection against bacterial contamination in the distribution system; and, the long residence time of several days in the pipe network. The Metropolitan Utilities District is modifying treatment practices in precipitation softening and chlorination to reduce the trihalomethane concentration to less than 0.01 mg/l.

Pending regulations of the Environmental Protection Agency include requiring public water supplies with high trihalomethanes to provide treatment using filtration through granular activated carbon. In this process, water is passed through beds of granular carbon to absorb dissolved trace organics; spent carbon is regenerated by heating in a furnace. This treatment is costly and may not be the optimum method of controlling organic contaminants in all cases. Dictating specific treatment processes is not considered a regulatory function. Therefore, the State Health Department opposes promulgating regulations relative to specific treatment techniques. Communities are encouraged to apply the best available technology to meet quality standards specified by the Primary Drinking Water Regulations.

5. FLUORIDE

Excessive fluoride ion in drinking water causes

dental fluorosis or mottling of teeth. Conversely, communities whose drinking water contains no fluoride have a high prevalence of dental caries. Optimum concentrations in public water supplies, generally in the range of 0.8 to 1.2 mg/l, reduce dental caries to a minimum without causing noticeable dental fluorosis. Fluoride also benefits older people by increasing the toughness of their bones. Approximately one half of the nation's population consumes water containing near optimum fluoride content with approximately 90 percent of these residing in communities that deliberately add a chemical compound to provide fluoride ion.

Of the 681 community water systems in Nebraska serving approximately 1,200,000 persons, 65 communities with a combined population of 80,000 have natural fluoride levels between 0.7 mg/l and 1.4 mg/l. (The lower level of 0.7 mg/l is considered adequate making supplemental fluoridation uneconomical in small towns.) Another 700,000 persons served by 46 water systems, including Omaha and Lincoln, provide fluoridation to the optimum concentration of 1.0 mg/l. Therefore, one sixth of the water systems supply water with adequate natural or supplemented fluoride to approximately 65 percent of the population served by public supplies.

Other communities should be encouraged to provide supplemental fluoride since their natural concentration is usually only 0.3 to 0.4 mg/l. In many cities and towns, the water source is several independent wells each requiring installation of a chemical injection unit. The capital expenditure and operating cost of such a system often discourages elected officials from promoting adoption of fluoridation. Yet, except in rare instances, fluoridation is a sound economic investment when related to the alternative of increased cost of dental care and loss of teeth.

No water supplies in Nebraska exceed the maximum contaminant level of 2.0 mg/l causing dental fluorosis.

6. CHLORINATED HYDROCARBONS, CHLOROPHENOXYS, AND OTHER SYNTHETIC ORGANICS

Environmental exposure and chronic health effects of organic chemicals are of major interest to the Environmental Protection Agency. Animal bioassay tests at high dosages indicate that some organics identified in drinking water in trace amounts are toxicants, carcinogens, mutagens, and teratogens. The effect on humans of long-term ingestion of very low levels of organic chemicals in drinking water is not known. The results of epidemiological studies are vague and the majority of organic contaminants identified in drinking water have not been examined for potential health effects. Yet, the concern is real and should be taken seriously by persons responsible for protection of public water supplies.

Maximum contaminant levels (EPA, 1976) for six pesticides are:

Chlorinated hydrocarbons:		
Endrin	0.0002	mg/l
Lindane	0.04	mg/l
Methoxychlor	0.1	mg/l
Toxaphene	0.005	mg/l
Chlorophenoxys:		
2,4-D	0.1	mg/l
2,4,5-TP Silvex	0.01	mg/l

Other synthetic organics are currently being considered for regulation and more information is being gathered in the National Organics Monitoring Survey of drinking water supplies in 113 cities.

Chlorinated hydrocarbon insecticides are of particular concern because of their wide use, resistence to degradation, and storage in mammalian fat after being absorbed into the body. The approval limits are based almost entirely on the intake causing minimal toxic effects in rats and dogs extrapolated to human intake in terms of mg of chemical per kg of body mass. For human water intake, the daily consumption is assumed as 2 liters for a human adult with a mass of 70 kg. After determining the dietary levels of endrin, lindane, and toxaphene affecting animals, the safe exposure levels for humans were taken as 1/500th of these values. The factor for methoxychlor was 1/100, since study data were determined from human rather than animal exposure. These safe levels for maximum total exposure are further reduced by apportioning 20 percent of the dietary intake of water. Thus, maximum contaminant levels for water are taken as 1/5 of the safe exposure.

Two widely used chlorophenoxy herbicides are 2,4-D and 2,4,5-TP (silvex). Toxic levels for these synthetic chemicals are considerably higher than chlorinated hydrocarbons. For example, a daily dosage of 500 mg (about 7 mg/kg) produced no apparent ill effects in a human volunteer over a 21-day period. The maximum contaminant levels were determined from long-term no-effect dosages (mg/kg/day) for rats and dogs using a factor of 1/500 for extrapolation to safe human intake plus 1/5 for allocating 20 percent to water.

None of the six pesticides listed in the drinking water standards have been found in any community supplies in Nebraska to date (NDH, 1979). Nevertheless, other studies reveal the potential

for contamination of groundwater with organic chemicals used in agriculture is possible, in fact, quite likely to occur in irrigated regions with porous soil profiles. A field study (Spalding, et. al., 1979) in Merrick County showed atrazine infiltrating from tail water recovery (reuse) pits through the coarse-textured soils to nearby irrigation wells. Traces of atrazine in the groundwater occurred along with high concentrations of nitrate--both originating from application in irrigated agriculture. "Although atrazine is not toxic to humans, the cumulative buildup in groundwater could result in ecological damage to phytotoxically sensitive plants." (Spalding, et. al., 1979) Since atrazine is applied in combination with nitrogen fertilizers, (Wolfe, et. al., 1976), speculated possible formation of N-nitroso derivatives that are suspected carcinogens. Under laboratory reaction conditions, nitrosoamines could be produced from atrazine and nitrite and, although this is not likely to occur under actual field conditions, this example serves as a warning that even synthetic organics labeled harmless may be transformed to dangerous compounds.

Industrial waste impoundments, landfills, storage piles and chemical spills are point sources that can disperse organics in groundwater contaminating substantial portions of an aquifer. Because of their adverse effects at very low concentrations and resistence to degradation, the chemicals of greatest concern are petroleum products, phenolic compounds, and pesticides. Improper disposal of wastes containing these substances causes long-term contamination likely to persist from decades to hundreds of years. Control is best achieved by regulating the source of pollution rather than relying on remedial corrections. Gasoline and other fuels are, by far, the most prevalent contaminants reported in spills and leaky or ruptured buried pipelines and storage tanks. Most recorded cases of accidental contamination could have been prevented by good management through providing barriers, preventing indiscriminant dumping, and proper clean up of spills.

The following are recommendations regarding organic compounds:

(1) A special study should be funded to review agricultural use of synthetic organic chemicals including amounts applied, their probability of infiltrating through different soil profiles, potential damage to sensitive crops irrigated with contaminated groundwater, and the possibility of maximum contaminant levels for drinking water being applied by the Environmental Protection Agency.

(2) Municipalities and natural resource districts should monitor handling and disposal of synthetic organics particularly petroleum products, phenols, and pesticides within their jurisdictions to reduce the possibility of local groundwater contamination.

7. CONSTITUENTS NOT RELATED TO HUMAN HEALTH

National Secondary Drinking Water Regulations, nonenforceable at the federal level, relate to the esthetic qualities of drinking water. Issued by the EPA as guidelines, a state may adopt portions of these regulations as part of its drinking water program making them enforceable within the state. The approval limits for esthetics are based on factors that render a water less desirable for use. The common contaminants in Nebraska's water supplies are iron and manganese, hardness, and dissolved salts.

a) Iron and Manganese

The secondary maximum contaminant levels for iron and manganese are 0.3 mg/l and 0.05 mg/l, respectively. Groundwaters often contain trace amounts of these metals as soluble (invisible) ions. When exposed to oxidation, they are transformed to stable insoluble forms that appear as minute rust particles that settle in water mains and storage tanks. Evidence of excess iron and manganese in a water supply is the staining of bathroom fixtures and rust-colored water as a result of flushing settled solids from the system during periods of high water consumption. Dissolved iron in groundwater also promotes the growth of filamentous iron bacteria creating reddish-colored slimes inside water mains. With age, these growths die and decompose releasing foul tastes and odors, such as, hydrogen sulfide (rotten egg) odor to the water. Periodic flushing of distribution pipes, as practiced by many small communities, is useful for ejecting accumulations of rust particles and bacterial growths. Nevertheless, the only permanent solution to iron and manganese problems is removal by treatment of the well water.

Traces of iron and manganese appear in groundwater supplies scattered throughout the state with higher concentrations in eastern Nebraska, particularly in the region along the Missouri River. Although the metal concentrations in Platte River water are not sufficient to cause problems in small communities, the larger cities either provide water treatment or tolerate the unesthetic problems created by the iron and manganese. Approximately 35 community supplies in Nebraska have treatment plants for iron and manganese removal. The most successful systems employ aeration and chemical oxidation followed by granular-media filtration.

b) Hardness

A portion of the dissolved solids in natural water results from calcium and manganese ions. These multivalent ions precipitate forming scale in pipes and interfere with laundering by causing increased soap consumption. Public acceptance of hardness varies and, although many customers may object to a water harder than 150 mg/l, the maximum level considered for public supply is 300 to 500 mg/l. In Nebraska, the hardness in most municipal supplies falls in the range between 200 and 400 mg/l with some 100 mg/l and a few over 500 mg/l. Omaha and six other communities reduce the hardness in their water supplies by precipitation softening. In cities with relatively high hardness, some customers soften individual supplies using household ion exchange units. This process removes the calcium and magnesium ions replacing them with sodium ions.

c) Sulfate and Chloride

The suggested secondary maximum contaminant level for sulfate and chloride are 250 mg/l each. The recommended maximum total dissolved solids, which is the mineral content or residue upon evaporation, is 500 mg/l. Above these levels, salts can impart a detectable taste to water. High sulfate content can also have a laxative effect on unacclimated, sensitive persons. Excess salinity in irrigation water, particularly sodium chloride, can interfere with plant growth, while at low concentrations both sulfate and chloride are essential plant nutrients.

The concentrations of sulfate and chloride in Nebraska's groundwaters rarely exceed 200 mg/l and 40 mg/l, respectively. High sulfate is often related to aquifers recharged by Platte River water that contains approximately 200 mg/l. While irrigation does raise salinity through water loss by evaporation and transpiration, the rate of increasing concentrations of sulfate and chloride are low. Measurements of salt buildup in Holt County (Spalding, et. al., 1978) and Merrick County (Exner and Spalding, 1979) showed the most serious concern is the more rapid increase in nitrate ion from infiltration of fertilizer.

VI. QUANTITY CONCERNS

1. REGIONS OF LIMITED GROUNDWATER SUPPLIES

Groundwater is the principal source for public supplies in Nebraska. The only two municipalities withdrawing surface supplies are Crawford from the White River and Omaha that draws over one half of its supply from the Missouri River. Other cities, although not using surface waters directly, depend on induced recharge of aquifers adjacent to rivers. The obvious example is the Platte River providing the water that infiltrates the municipal well fields for major cities such as Grand Island, Lincoln, and Omaha. The yield of well fields along the Platte would be greatly diminished without flowing water for recharge during the majority of the year.

Groundwater supplies are not uniformly distributed and are actually least abundant in the most-populated eastern portion of the state. Figure 7 shows an estimate of the statewide distribution of groundwater in aquifers of coarse-textured sediments. The quantity of water in storage is expressed in equivalent feet of water, for example, 4 feet of water is equivalent to a saturated sand and gravel aquifer with a thickness of about 20 feet. The highest storage volumes are in the western two thirds of the state associated with deep deposits of sand and gravel. The lesser aquifers, though still providing substantial well yields, are sandstones and fractured chalks. In the southeastern section of the state and extending up the eastern edge along the Missouri River, the geological formation is glacial drift consisting of till (clayey soil) with intermittent sand and gravel layers underlain by bedrock. The glacial till is a poor source providing small to negligible quantities of groundwater. Likewise, because of low permeability, shale and limestone bedrocks are usually unsatisfactory. Moderate yields of acceptable quality are sometimes available from deeper sandstone. The best wells are those penetrating the moderately thick deposits of sand and gravel. Still, well pumping may be operated at low rates, for instance, 50 to 100 gallons per minute. (Deep wells penetrating thick porous aquifers in the central and western regions of the state yield several hundred gallons per minute.)

The Farmers Home Administration (FmHA) of the U.S. Department of Agriculture started a program in 1967 to provide loans and grants for rural water districts. The objective is to encourage nonprofit associations and communities to develop central water systems to supply isolated farmsteads, villages, and small cities up to 10,000 population. Eligibility requirements include: primary use by farmers and rural residents, lack of sufficient funds, inadequate existing facilities, a legal authority for project control, and the grant for construction must be used to reduce customer costs. The interest rate on loans is 5 percent and repayment may be extended up to 40 years. These costs are passed on to customers by establishing a minimum monthly fee plus a charge based on consumption. The average water bills during 1979 in existing rural water districts of Nebraska range from $15 to $35 per month. The actual costs without grants and low-

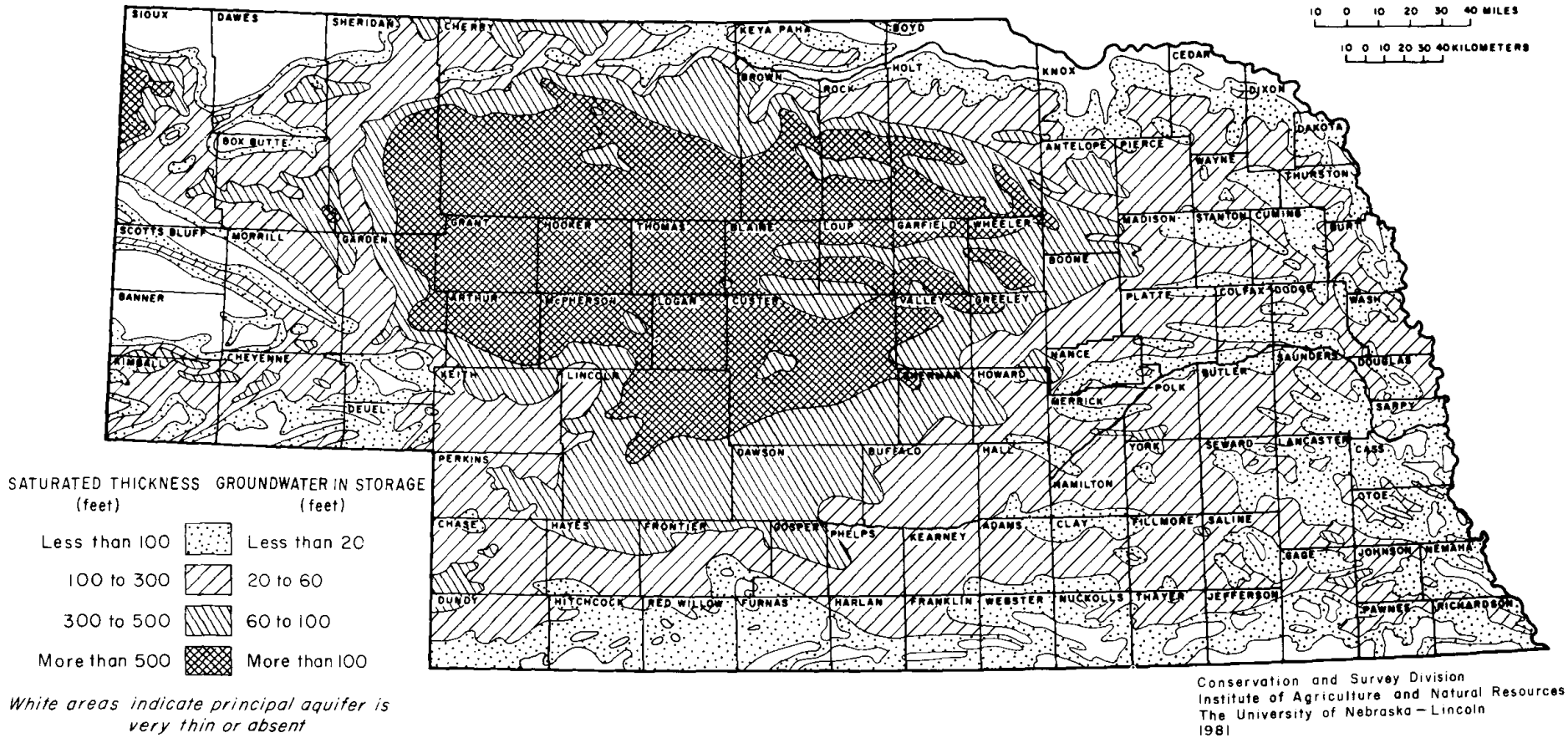


Figure 7. Groundwater storage map of Nebraska.

(Conservation and Survey Division, University of Nebraska)

Table 6. Rural Water Districts in Nebraska

District Name	Number of Connections	Residential Users	Farm Users	Commercial Users	Unused Services	Users Consuming Less Than 4000 gal/mon
Pawnee #1	439	11	428	0	31	229
Cuming #1	144		132	12	12	37
Lancaster #1	682	400	280	2	100	419
Richardson #1	260		257	3	7	101
Otoe #1	226		226	2	2	81
Richardson #2	192	13	170	9	6	60
Nemaha #2	207	31	174	2	12	48
Nemaha #1	180	20	160	0	29	Unknown
Otoe #3	781	265	498	18	300	398
Otoe #2	258	89	168	1	13	145
Johnson #1	298	45	250	3	25	100
Boyd #2	133	0	133	0	23	72
Dawes #1	70	0	70	0	11	19
Boyd #1	23	0	23	0	0	0
Cass #1	603	266	334	3	77	190
Little Blue NRD	142	35	107	0	19	30
Total	4,640	1,175	3,410	55	646	1,806
Percentage of Connections	100%	25%	73%	1%	14%	39%

Source: 1979 Nebraska Community Programs Progress Report, Nebraska Rural Water Association

interest loans from FmHA would be considerably greater. For example, construction costs for existing systems ranged from $3000 to over $10,000 per connection depending on the areal extent of the piping system and the water source. (The feasibility of rural water districts is discussed in *Water Well Journal*, Vol. XXXIV, June 1980.)

The rural water districts in Nebraska, as listed in a 1979 progress report, are shown in Table 6. The data given for each system are the total number of connections, residential, farm and commercial users, the number of unused services, and the number consuming less than 4000 gallons of water per month.

Only a few villages are connected to the piping systems. The large majority of connections are isolated farms and residential units. While 39 percent of all customers use less than 4000 gal/mon, the average water consumption among districts ranges from 4000 to 14,000 gal/mon per user. Seven rural water districts purchase water from nearby cities, 8 systems are supplied by district owned wells, and one system both purchases and supplies its own water. Figure 8 locates the rural water districts listed in Table 6. Comparing this diagram with the groundwater storage map in Figure 7 shows districts located in areas of limited underground water supplies. Since rural residents rely on groundwater as their source, the locations of piped water systems correspond to regions of unreliable supplies.

Further development of rural water systems is likely to be very limited in the near future. First, the loan and grant program funded by the federal government through FmHA is forecast to be reduced. Based on a restricted budget, only small pipe networks could be funded in Nebraska and villages would be excluded. (Unsubsidized financing of rural water systems is very costly.) The Natural Resources District Statutes of Nebraska (1972) prevents formation of new rural water districts as separate nonprofit organizations. Water systems must now be special projects of natural resources districts, yet, these districts are not legally obligated to study problems of domestic water supplies. (Natural resources districts are charged primarily with conservation of soil and water resources.) Villages can circumvent the Natural Resources District Statutes by applying the 1962 Inter-Local Cooperation Act.

STATE OF NEBRASKA
DEPARTMENT OF HEALTH

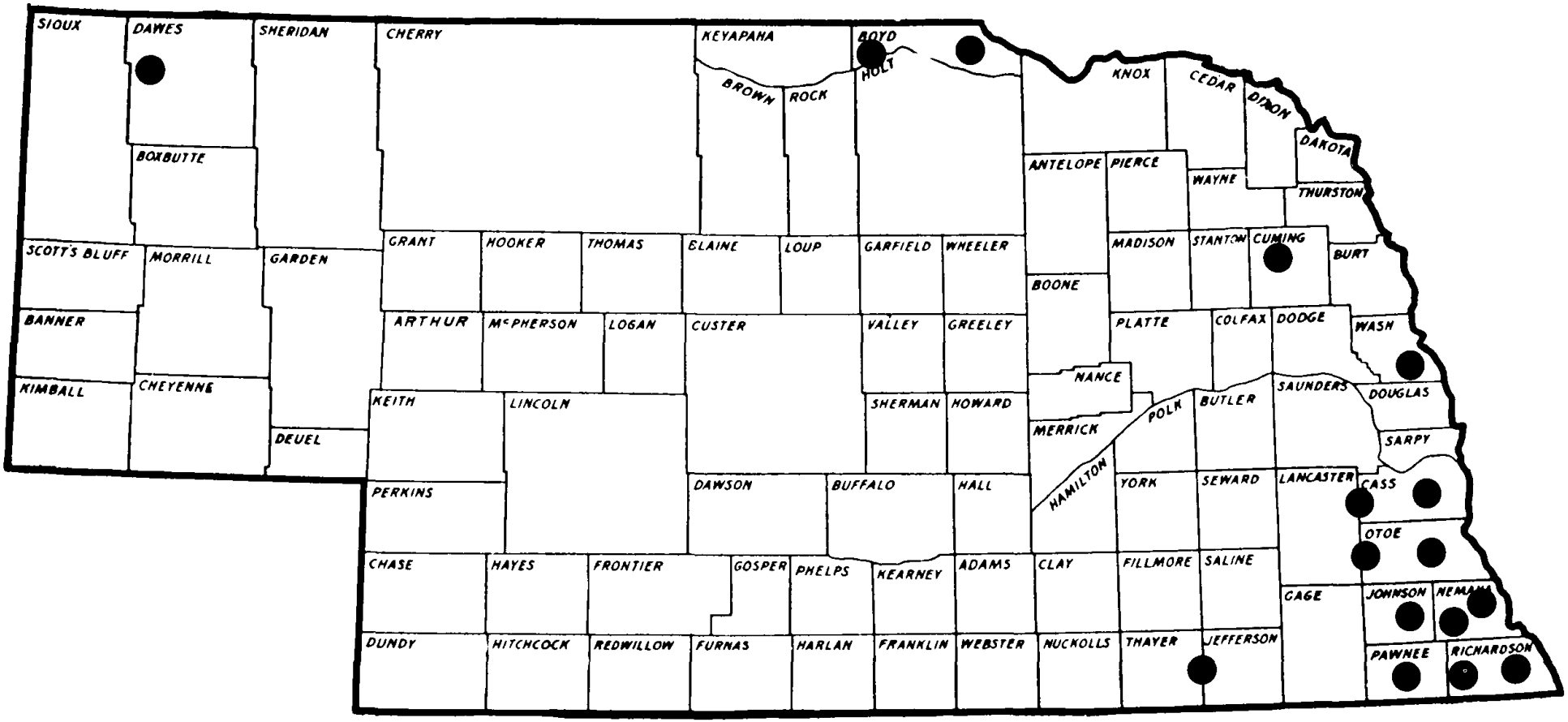


Figure 8. Location map of rural water districts in Nebraska listed in Table 6.

This legislation allows municipalities to develop joint facilities including a water supply, however, often parochial interests preclude such cooperation. Communities with inadequate water supplies, caused either by lack of quantity or poor quality, should investigate the feasibility of an improved water system both as a special project through their natural resources district and by a cooperative effort among neighboring communities.

2. REGIONS OF LOWERING GROUNDWATER LEVELS

The Conservation and Survey Division of the University of Nebraska and the U.S. Geological Survey conduct a water level measurement program in Nebraska. One objective is to determine changes in the amount of groundwater in storage and to identify areas where water levels are declining. Using continuously recording observation wells, water table measurements are compared to predevelopment levels. In the following eight areas, groundwater levels have been declining primarily due to increased irrigation withdrawals: Big Blue River and Little Blue River basin, Central Platte River area, Valley County, Holt County, Box Butte County, Cheyenne County, northeast Nebraska area, and southwest Nebraska area.

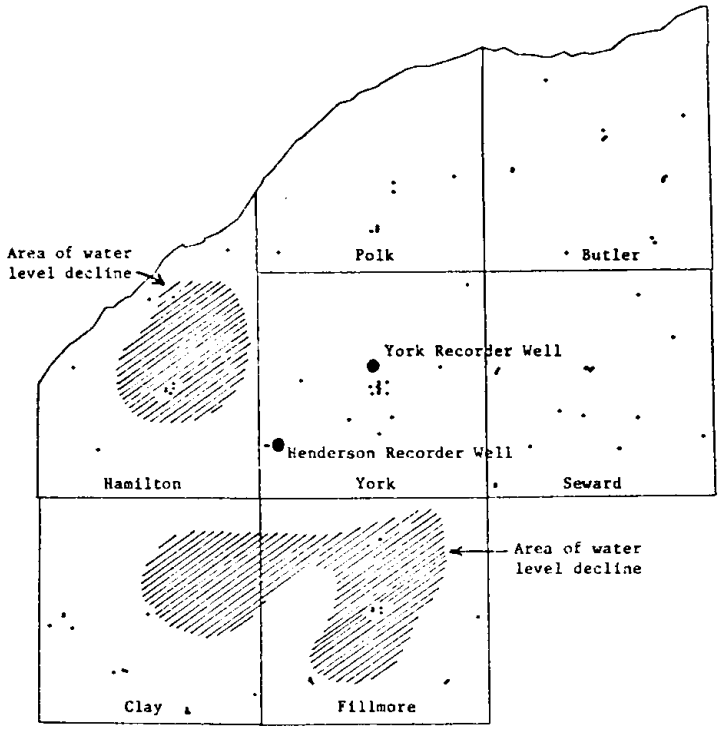
Municipal wells in the Big Blue River and Little Blue River basin are influenced by irrigation more than other regions. For the seven counties most influenced, Figure 9 shows the locations of 79 municipal wells and the areas of greatest water level decline. The Henderson and York recorder wells, graphed in Figure 10, illustrate the trend of steady decline of groundwater levels in the region. Fluctuations in the Henderson record show a vertical drop corresponding to the irrigation season, followed by gradual recovery until the next year. The shape of this curve is typical for an unconfined aquifer of sand and gravel. If the aquifer is partially confined by low permeability layers, the water level drawdown during irrigation withdrawals is greater in magnitude and recovery is more rapid. This is characteristic of the York recorder well where layers of sand and gravel are interbedded with layers of clay resulting in a semi-confined aquifer.

Overdraft of groundwater for irrigation results in a gradual water level descent that is permanent plus sharp temporary declines during the crop-watering seasons. When withdrawing water from the same aquifer, the deepest wells with the largest pumps are most competitive. Well performance is adversely affected when the water level drops below either the pump impeller or the well screen. If the pump is suspended too high in a well, failure occurs when the water level in the casing drops below the pump impellers. The usual solution is to lower the pump to near the bottom of the well by extending the column pipe. In areas of declining groundwater, pumps are hung as low as possible in new wells. If the water level declines below the solid well casing, both air and groundwater are drawn into the well through the screen. Although irrigation wells can tolerate pumping air, municipal wells discharging into a piping system cannot. This condition also results in a buildup of scale on the screen that restricts inflow, thus, reducing well yield and energy efficiency. Although screens can be partially restored by acid-cleaning, a municipal well may be abandoned rather than being rejuvenated for operation in the future at a reduced yield. Because finer screens are used in municipal wells, they are more likely to be damaged than irrigation wells that have larger screen openings.

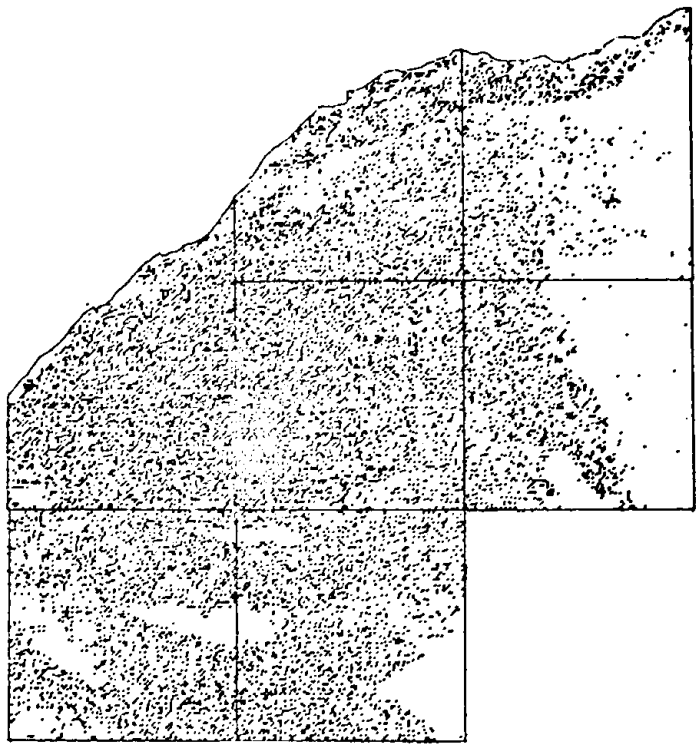
In recent years, 10 city wells have been abandoned in Hamilton, York, and Fillmore Counties because of declining water levels during the irrigation season. Generally, the wells were usable during the winter and spring but had to be operated at greatly reduced rates during the summer when they were most needed. Some of the abandoned wells were drilled 50 years ago and relatively shallow (80 to 100 ft.), while others were modern wells installed in the 1940s and 1950s at depths in excess of 100 ft. Replacement wells are being drilled as deep as possible, extending to bedrock which is often 200 or more feet deep. Most municipal officials presently view well replacement as a business expense associated with the agricultural economy. Nevertheless, this acceptance may change if water levels continue to decline resulting in either loss of additional wells, which currently cost about $70,000 each or loss of well yield because of a diminishing supply of groundwater. Natural resources districts should be encouraged to consider municipal water supplies in the management of their water resources.

3. INSTREAM FLOWS FOR AQUIFER RECHARGE

The groundwater in aquifers underneath and adjacent to a watercourse is often hydraulically connected to the surface water flowing over the stream bed. Lowering the groundwater level by pumping wells located along the bank induces infiltration of the surface water into the aquifer. When the river channel is dry, induced recharge cannot occur and the wells withdraw water from underground storage. The purpose for maintaining a minimum streamflow for a specified portion of the year is to ensure an adequate recharge so that pumping will not excessively dewater the aquifer. Instream flows are the indirect sources

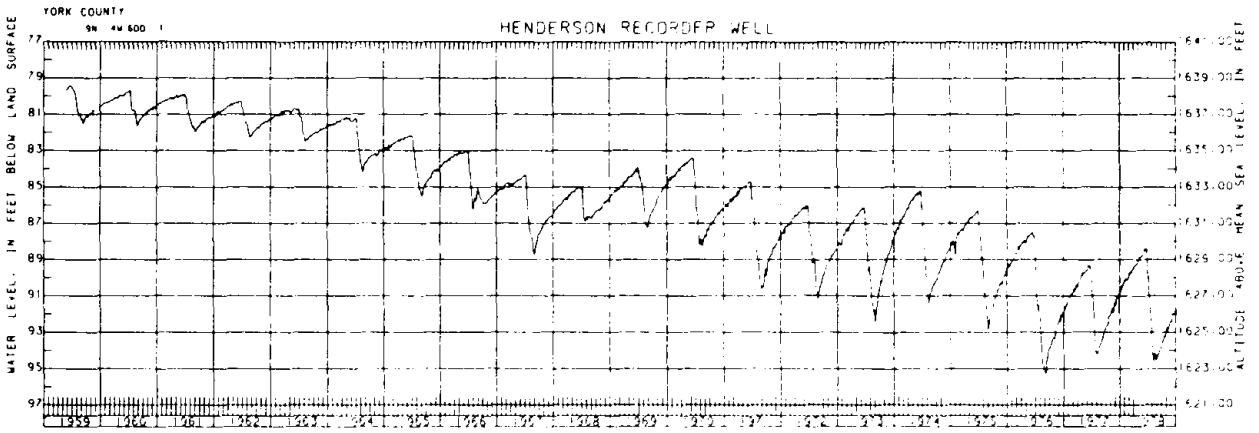


(a) Locations of municipal wells. (From Nebraska Natural Resources Commission)

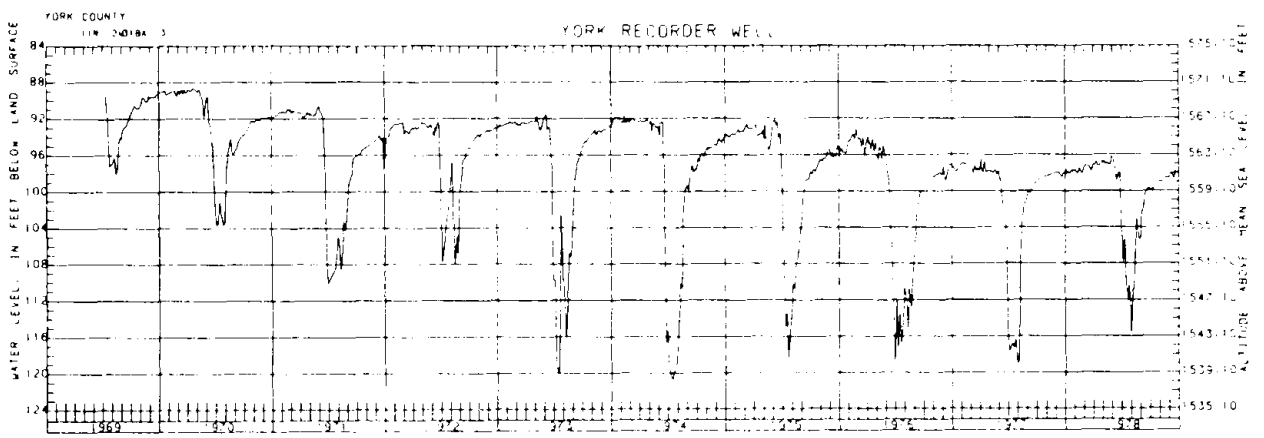


(b) Locations of irrigation wells. (From Conservation and Survey Division)

Figure 9. The counties of greatest groundwater level decline in the Big Blue River and Little Blue River basin have 79 registered municipal wells and thousands of irrigation wells. Groundwater levels in the shaded areas of the upper diagram have declined more than 20 feet since 1950. The charts from the recorder wells at York and Henderson are graphed in Figure 10.



(a) The Henderson well record of water level measurements in an unconfined sand and gravel aquifer.



(b) The York well record of water level measurements in a semi-confined aquifer of sand and gravel strata interbedded with layers of clay.

Figure 10. Recorder well records from Henderson and York, Nebraska. Both graphs show a steady decline in groundwater levels with time and seasonal fluctuations that coincide with irrigation withdrawals. (From Conservation and Survey Division, University of Nebraska-Lincoln)

for many community water supplies. The Platte River is particularly important since it serves major metropolitan areas.

Much of the Platte River is a wide, shallow, braided stream flowing over thick beds of sand and gravel making it an excellent groundwater source from wells located near its banks. High flows occur with sufficient frequency to scour the river bed maintaining good recharge conditions. Because of its reliability as a water source, the major cities in Nebraska have located well fields in the Platte River Valley. The importance of the Platte River as a municipal water source will increase in the future as a result of additional urbanization and diminishing groundwater resources in other areas.

Consider the well field for the City of Lincoln in the Platte River Valley near Ashland. The wells are located in a sand aquifer adjacent to the river channel inducing infiltration of the river water. The chemical composition of the groundwater withdrawn is nearly identical to that of the river water. However, none of the bacterial or organic pollutants existing in the river water have been

identified in the well water. In addition to purification by filtration, the aquifer equalizes the temperature of the recharge water. While the river water temperature varies from 80°F in the summer to 33°F in the winter, the well water remains within 3° of 56°F year around. This shows that the water entering from the river is held for weeks and probably even months before being extracted allowing time for the sand to act as a heat exchanger, warming the winter recharge water and cooling the summer recharge. For considering water quantity, Marlette (1968) prepared a computer model to determine the drawdown of water levels in the aquifer with limited induced recharge from the river. He concluded that the well field could supply near maximum water pumpage of 80 million gallons per day for more than 30 days with no flow in the river before excessive decline of the water table would occur. However, if the Platte River were dry for over 60 days, drawdown of the groundwater level would require reducing the quantity of water being withdrawn and some wells would probably be shut off to prevent dewatering of the screens. Marlette cautioned that although..."the well field can operate for 30 days without recharge (this) does not mean that the well field is not dependent upon river recharge. Such recharge is the source of most of the water produced from the wells."

In the Central Platte Region, the Platte River provides a high-quality supply for cities and towns where groundwaters inland from the river are becoming increasingly contaminated with nitrate.

Unfortunately, the benefit of the Platte River, and other streams, as a source of municipal supply is paradoxically both unquestioned and ignored. In Nebraska, minimum streamflows are not legally considered as a beneficial use of water. Gessaman and Aiken (1979) discuss the physical and legal considerations of instream flows, which is currently a major water policy issue. The following recommendation is directed to resolving this issue relative to municipal supplies.

A study should be sponsored by the State to determine the need and method of protecting minimum instream flows for municipal aquifer recharge, with special emphasis on the Platte River. The investigation should include at least the following: (1) identify the rivers and streams that recharge municipal supplies; (2) project municipal needs at both existing and new wellfield sites; (3) evaluate the influence of no flow conditions on aquifers at specific sites (cities should share in the costs of evaluating their well fields); (4) study the legal considerations of establishing appropriative water rights; and (5) define the required minimum streamflows at specific locations and recommend proposed legislation to protect municipal water supplies.

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APPENDIX F

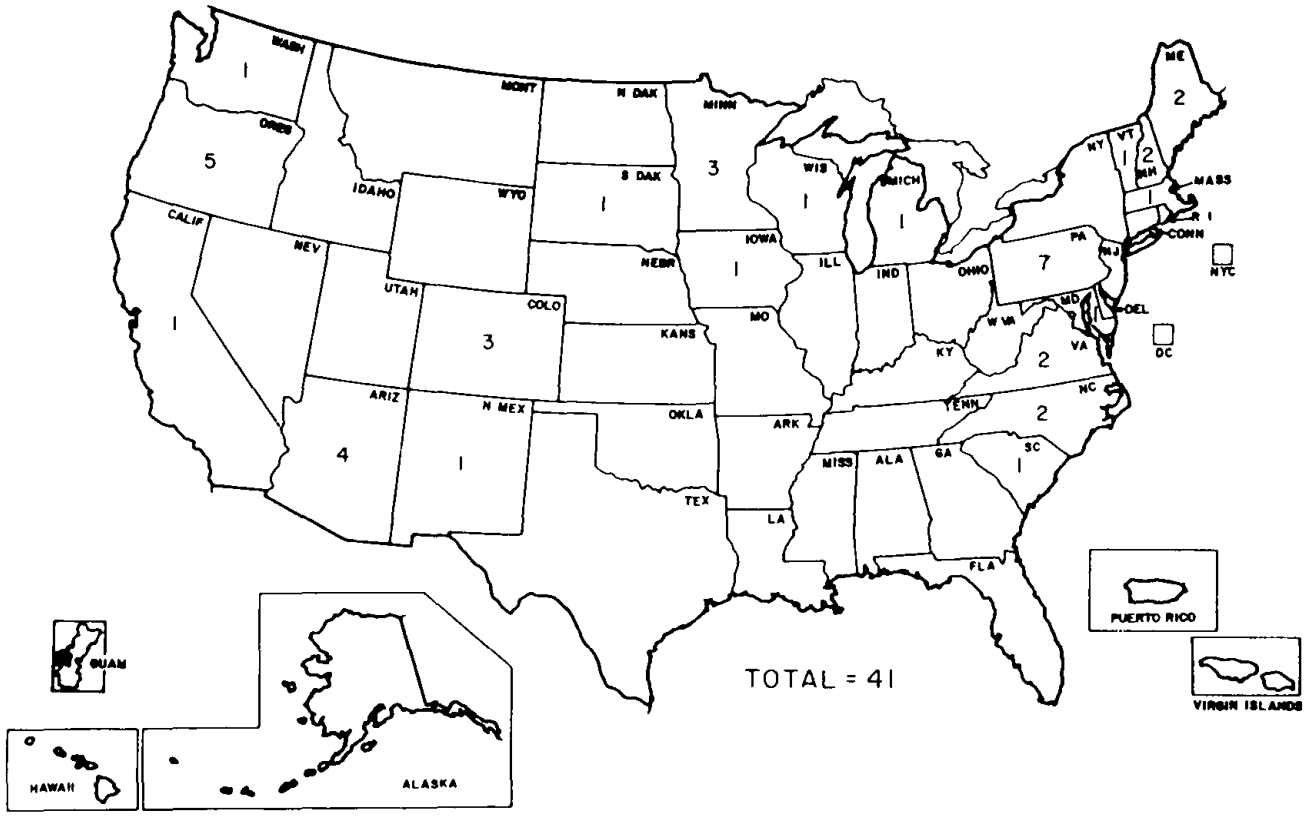
WATERBORNE DISEASE BACKGROUND MATERIAL*

*** Material contained in this Appendix is from:**

Cross Connection Control Manual
U.S. Environmental Protection Agency
Water Supply Division, 1974
EPA 430/9-73-002

Centers for Disease Control
Water-related Disease Outbreaks
Surveillance
U.S. Department of Health and
Human Services
Public Health Service

Figure 1. WATERBORNE DISEASE OUTBREAK, UNITED STATES, 1979[1]



[1] From Centers for Disease Control, Water Related Disease Outbreaks, Surveillance, U.S. Department of Health and Human Services, Public Health Service.

Table 2. Waterborne Disease Outbreaks by Etiology and Type of Water System, 1979

	Public Water Systems				Private		Total	
	Community		Noncommunity		Water Systems			
	Outbreaks	Cases	Outbreaks	Cases	Outbreaks	Cases	Outbreaks	Cases
AGI*	12	2946	9	454	1	12	22	3412
Giardia	2	3744	0	2120	0	7	7	5864
Chemical	5	60	0	0	2	9	7	69
Norwalk Agent	0	0	2	296	0	0	2	296
Shigella	1	14	0	0	1	4	2	18
Salmonella	0	0	1	61	0	0	1	61
Total	23	6764	14	2931	4	25	41	9720

* Acute gastrointestinal illness of unknown etiology.

Preliminary Line-Listing - Water-related Disease Outbreaks (WRDO's), 1981

1981 Waterborne Outbreaks

State	Month	WRDO Report Filed?	Status As WRDO	Reported By	County	City	Etiology*	Cases	Deficiency*** System**	Location	Source	Median Incubation Period
Az	June	Yes	Probable	Dominquez	Navajo	Pinetop	AGI	326	G, 2	subdivision	wells	96 hrs
Az	July	No	Possible	Sacks	----	----	----	265	--------		----	----
Calif	March	No	Possible	Ephraim	----	----	----	55	----	town	well	----
Calif	April	No	Doubtful	----	Placer	----	AGI	61	----	restaurant	----	24-48 hrs
Calif	May	No	Probable	----	Shasta	Redding	AGI	12	I, 5	boat	----	----
Colo	March	No	Probable	newspaper	----	Vail	Rotavirus	2500	G, 3	town	----	----
Colo	March	No	Possible	Istre	----	----	AGI	----	MG, 3	ski ranch	well	24-48 hrs
Colo	June	No	Probable	Gaspard	----	Estes Park	**Giardia**	12	G, 3	town	creek	----
Colo	July	No	Probable	Gaspard	----	Winter Park	**Giardia**	5	G, 3	town	creek	12 hrs
Colo	Aug	No	Probable	Gaspard	----	Empire	**Giardia**	110	G, 3	town	creek	----
Colo	Aug	No	Probable	Gaspard	----	Green Mountain Falls	AGI	578	G, 3	town	creek	96 hrs
Colo	Sept	No	Probable	Gaspard	----	Red Feather Lakes	**Giardia**	32	NG, 3	camp	creek	----
Colo	Nov	No	Probable	Gaspard	----	Aspen Highlands	**Giardia**	20+	G, 3	town	creek	----
Colo	Dec	No	Probable	Gaspard	San Juan	Florida River Estates	**Giardia**	14	G, 3	town	spring	----
Conn	Aug	No	Possible	Kircher	----	----	----	60	----	----	well	----
Fla	Nov	No	Possible	Mallson	----	----	**V. parahemolyticus**	801	----	----	----	----
Ga	Oct	No	Probable	Goodman	Cobb	----	----	1	I, 2	home	well	----
Ill	Sept	No	Definite	Brown	McHenry	----	**Campylobacter**	81	G, 4	subdivision	----	----
Iowa	June	No	Probable	Lerche	----	----	AGI	14	----	camp	wells	24 hrs
La	June	No	Possible	----	----	----	**V. chol.**, non-tox.	----	----	----	----	----
La	Aug	No	Possible	Johnston	----	----	----	3	----	----	----	----
Maine	Sept	No	Possible	Gensheimer	----	----	**Giardia**	7	----	----	----	----
Maine	Oct	No	Definite	Gensheimer	----	Jonesboro	Fluoride	31	NG, 5	school	----	1.5 hrs
Maine	Oct	No	Possible	Gensheimer	----	----	**Giardia**	4	NG, 3	camp	----	----
Mi	Aug	Yes	Definite	Jenkins	Garrett	Oakland	? Norwalk	72	NG, 2	condo	well	48 hrs
Mich	Aug	No	Possible	Remis	----	----	Hepatitis A	25	----	----	----	----
NH	Jan	No	Possible	Falk	----	Hudson	Arsenic	----	----	town	wells	----
NH	Aug	No	Possible	Horan	----	----	Hydrocarbons	100	----	----	----	----
NH	June	No	Doubtful	Lapham	----	Aliquia	AGI	150	----	dude ranch	well	----
Ore	Feb	No	Possible	Helgerson	----	----	AGI	40	NG, ?	lodge	----	24 hrs
Ore	Sept	No	Doubtful	Shipps	----	Warm Springs	**Giardia**	11	----	reservation	stream	6 days
Penn	May	Yes	Possible	DeMelfi	Northum-burland	Sunbury	AGI	51	NG, 2	restaurant	well	35 hrs
Penn	Aug	No	Possible	Hines	----	Monroeville	AGI	28	G, ?	town	----	24 hrs
SC	Oct	No	Possible	Lybarger	----	----	**Giardia**	53	----	----	----	----
Vt	Oct	No	Probable	Spitalny	Rutland	----	AGI	29	NG, ?	restaurant	----	----

CHAPTER 2. PUBLIC HEALTH SIGNIFICANCE OF CROSS-CONNECTIONS*

* From Cross Connection Control Manual, U.S. Environmental Protection Agency

According to the official investigation of the 1933 Chicago epidemic of amebic dysentery, "...old and generally defective plumbing and cross-connections potentially permitting back-siphonage from fixtures such as bathtubs and toilets..." were to blame for contamination of the drinking water supply.

The event and its sad result -- the death of 98 persons -- dramatized the concern that public health officials feel about the dangers of cross-connections. Because such plumbing defects are so frequent, and the opportunity for contaminants to invade drinking water through cross-connections is so general, enteric infections caused by drinking water may occur in almost any city on any day.

Published histories of massive enteric infections caused by cross-connections abound. While the following cases have their natural appeal as historical literature, they are listed here mainly to illustrate the serious consequences of cross-connections, their ubiquity, their frequency, and their peculiarity.

BRUCELLOSIS AT THE FAUCET

In 1938, 80 students at a large midwestern university reported remittent fevers, malaise, headache, and anemia. Their symptoms led to a diagnosis of undulant fever (brucellosis). Curiously, only those students who had been working in the cultivation of bacteria in one of the laboratories were affected. The mystery was how the brucella cultures in the laboratory could have been transmitted to the students. Finally, a hose was found connected to a faucet in the laboratory. The other end of the hose was submerged in water containing brucella. A temporary reversal of pressure, possibly the consequence of a demand for water in another part of the system, had drawn the water teeming with brucella into the drinking supply. Of the 80 students affected, one died.

SEWAGE IN THE WATER MAIN

In Newton, Kansas, in 1942, one of the town's two water supply mains had been taken out of service on September 2, 7, and 8. A house service connection to this main supplied three frostproof hydrants and two frostproof toilets. It was assumed, from subsequent events, that some unknown person or persons tried to obtain water from a hydrant connected to the main out of service. When no water flowed, the anonymous agents departed, leaving the valve open. On September 10, it was discovered that a neighboring toilet sewer was clogged and that sewage had overflowed into the hydrant box. It was learned that for 2 days all the sewage from the toilets of 10 families had been permitted to flow into the water main. When the main was put back into service, there was no attempt to sterilize it. More than 2,500 persons in all parts of the town suffered enteric disorders as a result. Stool cultures and pathological findings from two autopsies diagnosed the illness as bacillary dysentery. In addition to the widespread illness in the town, it is believed that the infection was carried aboard a number of troop trains which were watered in Newton at that time.

PRESSURE DROP

In 1942 a casting plant in Pittsburgh employing 500 persons undertook to install new water connections. During installation, the city water supply was shut off. It is believed that a drop in pressure in the drinking water lines of the plant permitted river water to pass through a valved connection to the drinking water. Twelve hours after the first new connection to the city water was installed, many of the employees suffered mild intestinal disorders. Two weeks later, after another shutdown to make a second connection from the plant system to the city water, there was a second outbreak of intestinal disturbances among the employees.

DEFECTIVE VALVE

Aboard a vessel in a west coast shipyard in 1943, a valve on the main line, connecting the drinking water to the fire water supply, was found to be defective and the cause of an outbreak of gastroenteritis. The pumping of contaminated harbor water through the fire waterlines aboard the vessel had forced bacteria into the drinking supply through a cross-connection. As a result, 1,179 men became ill.

ARSENIC IN REVERSE

A California laborer had been using an aspirator, attached to a garden hose, to spray a driveway with weedkiller containing arsenic. Sometime while he was at the job, the water pressure reversed. Taking no notice of the incident, the man disconnected the hose and, feeling thirsty, drank from the bib of the hose connection at the house. Arsenic in the waterline killed him.

PEAK DEMANDS

At a large aviation plant on the west coast, officials learned that the difference between a 3-inch water main and an 8-inch main was the determining cause for a high rate of absenteeism. When it was discovered that 25 to 40 percent of the employees were suffering from gastroenteritis, the plumbing system was suspected. Investigators found that there was such a demand on the 3-inch main at peak periods that the outflow produced enough of a vacuum to allow waste water to be backsiphoned through cross-connections into the drinking water system. After an 8-inch main was installed, the high rate of infection subsided.

THE VACUUM BREAKER

In April 1944, after an outbreak of gastroenteritis in an Oklahoma school, it was found that none of the flushometer valve toilets with submerged inlets were provided with vacuum breakers, which prevent atmospheric pressure from forcing waste water into the supply lines. Each night, to conserve water and eliminate the possibility that rooms might be flooded if a leak should develop, the custodian turned off the valve of the main supply line. As the pressure in the supply lines was cut off, atmospheric pressure on the toilet bowls moved the waste water up into the drinking supply. Most of the people affected were those who drank from faucets on the first floor of the school; there were progressively fewer cases on the second and third floors, as the atmospheric pressure moved less of the waste water to those heights.

WRONG VALVE

At a school in Milford, Nebraska, the fire lines and hydrants were separate from the domestic water supply, although the two systems were connected through a valve at the pumphouse. The source of water for the fire system was the river. In January 1947, following a fire, someone negligently opened the connecting valve at the pumphouse, and river water entered the domestic water supply. About 150 people came down with gastroenteritis.

TEN-PERCENT POLIO INCIDENCE

In 1932, during a 5-week period, more than 10 percent of the 347 children in Huskerville, near Lincoln, Nebraska, contracted polio. A study of the water supply revealed that the afflicted children lived in areas where flush valve water closets lacked vacuum breakers. A time relationship was found also in places where extreme fluctuations of pressure in the water mains might have permitted waste water to be forced into the drinking supply.

DYSENTERY AT SEA

In 1952 a large oceangoing vessel set sail from its berth with every indication that things were shipshape. A day or so later and 300 miles out, over a thousand cases of dysentery developed among those on board. Contaminated water was blamed for the episode and the evidence indicated that while tied up at its moorings, the ship's fresh-water tanks had been contaminated. A cross-connection was the most likely explanation.

A DRINK OF CHROMATES

Chromates are one of the chemicals for which the Public Health Service Drinking Water Standards prescribe the very low amount of 0.05 parts per million as the limit that can be tolerated in a drinking water supply. In 1958 an employee using a drinking water fountain in a large city library noticed that the water stream issuing from the spout was yellowish, and the matter was called to the attention of the building engineer. Upon investigation, it was found that the chilled-water pipe system supplying the fountains was directly connected to another chilled-water system in which heavy dosages of chromates were used for corrosion control. Someone forgot to close the valve!

HARBOR WATER THREATENS VESSEL CREWS

At about 2 p.m. on June 29, 1960, on a large pier installation in an eastern port harbor, a worker noticed evidence of salt in the potable water supply. Investigation showed that salt water from the harbor had been pumped into the pier's potable water pipes. The fire systems of three vessels anchored nearby had been connected to the fresh water piping system and high fire-pump pressures apparently did the rest. One measurement of chlorides at a "fresh" water outlet showed 6,425 parts per million. Only prompt and vigorous action by a sanitary engineer is believed to have prevented widespread illness.

ANTIFREEZE

Usually service stations supply antifreeze for automotive equipment, not for people to drink. The reverse was true during October of 1961 when there occurred one of the most bizarre

backsiphonage episodes on record. In a midwestern city, ethylene glycol antifreeze was being pumped from a large storage tank to an antifreeze distribution system. This system was cross-connected to the city water supply lines and it was estimated that over 100 gallons of 60 percent ethylene glycol were pumped into the water mains. Samples from the water pipes showed the presence of from 1.5 to 2.0 percent ethylene glycol, or up to 20,000 parts per million of this toxic chemical agent. A homeowner reported a bitter taste and reddish color to the water department. Radio announcements, a shutdown of the water supply to the area affected, and repeated flushings were required to cope with the situation.

OUTBREAK FELLS SHIPYARD WORKERS

The time was 7 a.m. on September 28, 1962, at a large eastern shipyard. Beginning then and throughout the day, some 700 men reported ill with gastroenteritis. All had drunk water from the yard area where they worked and one water sample showed coliforms in excess of 240 per 100 millimeters. Investigators concluded that a temporary cross-connection had been made between the potable water lines and pipes containing river water for firefighting purposes. They stated that "...such an episode may occur again if steps are not taken to insure that such ill-considered cross-connections cannot be made by accident."

The following incidents occurred after the publication of the first edition of this manual. They show that cross-connection continues to be a serious hazard to water supplies and only constant vigilance in their detection and elimination can reduce the ever-present risk of contamination from these sources.

ARSENIC POISONING

On a private farm in Texas in 1963, five people were poisoned with arsenic from drinking water. The source of drinking water was a cistern. A cotton defoliant tank which contained arsenic was improperly connected to the cistern. Backsiphonage occurred, and of the five people who drank the water, three died.

NURSES ILL

Backsiphonage caused by defective plumbing in a new student nurses building was blamed for an outbreak of disease in 1963 in Ohio. It was necessary for 100 of the student nurses to be quarantined for 2 weeks. Bacteriological examination showed that the drinking water was contaminated. The city health commissioner theorized that salmonella was brought into the building by some of the girls and then spread by defective plumbing.

ELEVEN VOMITING CADDIES

Eleven caddies experienced nausea, severe vomiting, and abdominal cramps after consuming a "soft drink" at a New York golf club in 1964. The beverage was commercially prepared by the mixture of syrup with carbonated water in a vending machine. Investigation revealed that a pipe carrying water into the machine was connected to the recirculating water heating system instead of the drinking water system. The day before the incident a lye and chromate solution was added to the hot water system.

RAW WATER FROM A DRINKING FOUNTAIN

A New England town had two separate water systems -- one for potable water, the other for fire protection. The fire protection system pumped untreated water directly from a river. In 1967, at an industrial plant in town, workers mistook a fire system line for a fresh-water line and connected a bubbler to it. After drinking the water from the bubbler, seven people developed infectious hepatitis and over a hundred people were ill with gastroenteritis.

SHIGELLOSIS

In 1967, an outbreak of gastroenteritis occurred at a small private college in Pennsylvania. Almost one-quarter of the 700 students and faculty were affected. The only factor in common to all those who became ill was the consumption of water or food that had been prepared using water from the school water system. Investigation of the water system revealed that a waterline had broken in the kitchen of the school cafeteria flooding both the kitchen and the cafeteria. Cross-connections were found between the sewage system and the fresh-water system that could have resulted in backsiphonage of sewage into the water system as a consequence of negative pressure during the break in the waterline. It was concluded that the outbreak probably resulted from the presence of Shigella sonnei in the water system. The inoculum would have been of sufficient size to overcome the chlorine in the water.

FOOTBALL TEAM STRICKEN

In October 1969, most of the members and coaches of a college varsity football team

became ill with infectious hepatitis. The water supply on the practice field was found to be the cause. A drinking fountain and the irrigation system for the field were on the same line. A heavy fire demand in the area had created a negative pressure in the waterlines and caused contaminated surface water around the sprinklers to be siphoned into the potable water lines. Players and coaches drinking from the fountain became ill and the school was forced to cancel the remainder of the football schedule.*

* Although not stated in the EPA publication, about 87 players and coaches were affected by the outbreak with 54 of those being symptomatic.

TEMPORARY HYDRANT CONNECTIONS

A serious emergency invoking the contamination of a water supply was caused by a truck filling from a city water supply. In 1971, a contractor using a tank truck with a rig designed to pump and spray a mixture of water, fertilizer, grass seed, and woodpulp was working on the grounds of a subdivision. The contractor was using a direct connection to a fire hydrant to fill the tank with water, which was then mixed with the fertilizer, etc. A high-pressure pump then sprayed the mixture onto the ground. As the woodpulp circulated through the tank piping system, it plugged one of the lines while the pump continued to run creating a very high pressure in the tank. This pressure was higher than the water supply system pressure and it forced the solution of fertilizer into the water system. Several people in the subdivision became ill after drinking the water, but the contamination was discovered and quick action in flushing and disinfecting the lines eliminated the danger.

APPENDIX G

SUMMARY OF HEARING POLICY ISSUE STUDY ON MUNICIPAL WATER NEEDS

2:00 p.m., 7:00 p.m.
September 8, 1982
Lincoln, Nebraska
Nebraska State Office Building

PUBLIC NOTICE

Legal notice of this hearing was published in five newspapers across the State of Nebraska. Press releases were sent to every newspaper and radio station and T.V. station in the state. Copies of the report were also mailed to approximately 240 individuals on a mailing list maintained by the Commission.

HEARING PROCEDURE

This hearing was held simultaneously with hearings on three reports produced by the **Selected Water Rights Issues Policy Study**. Robert W. Bell and Henry P. Reifschneider presided jointly over the hearing and James R. Cook conducted the hearing. A brief summary of each report was presented prior to the receipt of testimony. Those present were given an opportunity to testify on all of the reports. An informal question and answer period was conducted, and an opportunity for additional testimony was offered prior to the conclusion of the hearing.

TESTIMONY OFFERED

1. **Mr. William Schreffler, Grand Island, Assistant City Attorney.** In his presentation, Mr. Schreffler suggested that under current law municipalities have no real rights to use water, but are responsible for providing a large number of people with water for domestic and other needs. He felt that uses of water for production of electricity are important municipal uses. Concern was expressed that municipalities do not currently have adequate representation on some public entities, like Natural Resources District and the Natural Resources Commission. Mr. Schreffler testified that the *"Municipal Water Needs"* report indicates that something does need to be done and he noted general support for all of the alternatives in the report except those calling for no change. He pointed out that *Alternative* #7 (allow municipal zoning around municipal wellfields) was extremely important and that the Grand Island wellfield was an example of a municipal source being threatened by other uses. He acknowledged that the authority to be granted by *Alternative* #7 would be very controversial and suggested that a neutral party could perhaps be charged with the responsibility for administering that alternative. The alternatives related to systems problems (*Alternative* #10 through #15) were described as all viable, with the greatest needs occurring in communities smaller than Grand Island. Mr. Schreffler concluded by noting that the study was most comprehensive and by emphasizing that municipal water needs must receive greater recognition than at present.

In response to a question from Robert Bell, Mr. Schreffler indicated that he did not have an immediate opinion as to whether municipalities ought to be able to enter upon land to drill some test holes before a decision is made to purchase that land for use as a wellfield.

2. **Russ Edeal, testifying on his own behalf.** Mr. Edeal specifically addressed a number of the alternatives in the report. With respect to *Alternative* #2 (adding municipal use to the preferences system), he expressed concern about putting all of municipal use on the same level as domestic use. Noting that large portions of municipal use are devoted to commercial and industrial purposes; he felt that agriculture uses could be unduly jeopardized. He suggested that since agriculture and industry are both economic uses of water, perhaps they should be given equal preferences. Mr. Edeal testified against *Alternative* #6 (increasing the urban representation on natural resources district boards), saying that he didn't believe the alternative would improve natural resources districts or their accountability to municipalities. He noted that

some natural resource districts currently have a large number of members who reside in small municipalities and that going to a strictly population basis could in fact eliminate some of this type of representation. With respect to *Alternative* #15 (NRD assumption of small municipal water systems), Mr. Edeal raised a number of questions and expressed a general concern that the alternative was not necessary or workable. *Alternative* #16 was described as being too narrow on the basis that sharing of supplies may be necessary for more than just satellite communities and should be considered on a larger scale. Mr. Edeal also stated that in his opinion the report should contain some discussion about municipalities developing storage sites for municipal water supply.

Robert Bell asked Mr. Edeal if there was some better way to get municipal representation on NRD boards. Mr. Edeal responded that urban residents ought to be able to gain election to the board by waging aggressive campaigns for the positions.

Henry Reifschneider asked Mr. Edeal to further explain his reasons for opposing *Alternative* #15. Mr. Edeal explained that he felt *Alternative* #15 was beyond the current technical and financial capabilities of many natural resources districts.

3. **Steven Oltmans, Manager, Lower Elkhorn Natural Resources District.** Mr. Oltmans explained the policy of his natural resources district in assisting communities with municipal water problems. He stated that his NRD is willing to include small municipalities in a rural water system operated by the Natural Resources District if the need for such a system is present; he added that such systems will not be developed by his board simply for convenience purposes. Mr. Oltmans suggested that the emphasis on *Alternative* #15 be changed to encourage NRD assistance to small communities rather than NRD take over of those municipal systems. With respect to *Alternative* #6, he agreed with Mr. Edeal that municipalities have a capability under the present election procedure to largely determine the results of NRD elections. He concluded his testimony by noting that the ability of natural resources districts to undertake many of the tasks addressed by the municipal water needs report depends upon financing and by suggesting that the actual situation regarding municipal water use is not as gloomy as the report tends to indicate.

APPENDIX H

SUMMARY OF HEARING POLICY ISSUE STUDY ON MUNICIPAL WATER NEEDS

2:00 p.m., 7:00 p.m.
September 29, 1982
Ogallala, Nebraska
Ogallala Holiday Inn

PUBLIC NOTICE

Legal notice of this hearing was published in nine newspapers across the State of Nebraska. Press releases were sent to every newspaper and radio station and television station in the state. Copies of the report were also mailed to approximately 240 individuals on a mailing list maintained by the Commission.

HEARING PROCEDURE

This hearing was held simultaneously with hearings on three reports produced by the Selected Water Rights Issues Policy Study. Henry P. Reifschneider, Wayne Johnson, and Maureen Monen presided jointly over the hearing and James R. Cook conducted the hearing. A brief summary of each report was presented prior to receipt of testimony. Those present were given an opportunity to testify on all of the reports. An informal question and answer period was conducted, and an opportunity for additional testimony was offered prior to the conclusion of the hearing.

TESTIMONY OFFERED

1. **Mr. James Hunzeker, Nebraska Rural Water Association.** Mr. Hunzeker explained that Nebraska was one of 31 states in the National Rural Water Association. He noted the Association works for towns of under 10,000 population, but primarily for towns in the 100 to 500 population range. He said that some states, such as Iowa, have had problems in administering the Safe Drinking Water Act. He noted that Iowa had lost its primacy back to the federal government.

Mr. Hunzeker than stated that he felt Nebraska's implementation of the Safe Drinking Water Act was better than any of the other 31 states in the Association. He said that Nebraska has not had many court problems or other problems. He felt that Cliff Summers, who wrote much of the municipal report and is in charge administering the Safe Drinking Water Act was to be commended. He noted that proper management and metering are big problems as the report mentions. He said that he would be inclined to go along with whatever Cliff Summers might recommend.

2. **Mr. Wayne Heathers, Manager, Middle Republican NRD.** Mr. Heathers stated that the alternatives revising election procedures for NRD members and placing operation of small municipal systems with NRDs won't solve problems. He said that he personally has strong reservations about taking over operation and maintenance of small municipal systems because small towns need someone on the site.

3. **Mr. Don Steen, Village of Morrill.** Mr. Steen said that he was testifying for the Mayor of Morrill. He stated that Morrill has a good water supply but that it is financially strapped. He said that some of the alternatives in the Municipal Water Needs report would worsen that situation.

He said that *Alternative* #11 which requires audits would be hard on the village clerk. He said that *Alternative* #14 which would require backflow prevention devices, meters, and chlorination would cost over $60,000 in Morrill, not including chlorination. He said that Morrill's water is pure without chlorination and that backflow devices would serve no purpose with the current types of toilets in homes. He said that the alternative is too expensive and that Morrill is too small a town to need this. He noted that restrictions and regulations have already caused Morrill to go from six to seventeen employees in a period when they have had only a very small increase in population. In response to a question on how Morrill handles repairs Steen said that equipment and lines have been replaced with general

funds on a need basis. He said that it would cost $150 per home to put in backflow devices and meters.

4. **Mr. Kent Miller, Manager, Twin Platte NRD.** Mr. Miller noted *Alternative* #6 to revise NRD selection procedures would cause serious problems for his district. He said that it would result in 12 to 13 directors in his district being from the City of North Platte. He said that a considerable turnover of Board members would take place.

5. **Mr. Dick Hawes, Metropolitan Utilities District, Omaha.** Mr. Hawes said that alternatives in the report should not be deleted because they are politically unfeasible. He noted that most of them will probably be submitted with a recommendation for rejection.

Mr. Hawes then presented his thoughts on municipal uses and their place in the preference system. He said that non-municipal uses are not included on the totem pole at all. He said that on the groundwater statutes municipal use is not included and does not come under domestic uses. He stated that he would present an amendment to the Public Advisory Board the following day which would place municipal uses on the groundwater preference statutes under only domestic use. He noted that there was some concern that the industrial portions of municipal uses might take large amounts of water but that his amendment would seek to avoid that.

Hawes commented that 6% to 7% of Nebraska's water use is municipal water, but that half of that is in Lincoln or Omaha where it doesn't affect agricultural water supply. He said that much of the remaining water use is not consumptive in nature. That leaves 1 1/2% to 2 1/2% of water consumption. He stated that only about 1/3 of that is industrial and that almost all of the industrial is related to agriculture.

Hawes then commented about suggestions that the domestic portion of municipal water use be separated from the non-domestic portion and be given a higher preference. He said that it is much easier to define domestic and non-domestic municipal use when you don't work for a city water department. He stated that the separation was impractical.

Hawes pointed out that he was only suggesting that municipal use be added to the groundwater statutes. He said that there was no point in upsetting everyone on surface water when only four systems use that source.

6. **Other Comments.** Mrs. Lyons asked whether Nebraska should have a potable and non-potable water system such as many places in Europe do. Mr. Hawes replied that this only doubles investment in the system and that Nebraska does not have the treatment problems found in Europe. Clayton Lukow asked whether it might be a fantasy that preferences could ruin cities. He said there was universal knowledge that water is an important need and that we may be attacking a phantom tiger.