Data Collection Program

By Jeremy Gehle

This spring the Nebraska Department of Natural Resources (Department) began a reorganization process that included the addition of a new Data Collection Program. This reorganization was structured to better utilize available resources across all of the Department's Divisions and Field Offices. What was the Floodplain Management, Dam Safety and Survey Division is now the Engineering and Programs Services Division. This Division is made up of the Floodplain Management, Dam Safety, Mapping Programs, and the new Data Collection Program.

The Data Collection Program was created to streamline the acquisition data in the areas of; stream gaging, survey, surface water administration, dam safety, and floodplain management. This Program supports the overall Department mission by coordinating the needs of all Divisions by collecting high quality data, implementing new technologies, and conducting special studies that will be used by the Department's engineers and scientists.

The Data Collection Program (Program) consolidated the Streamgaging and Survey sections. Staff from these two sections as well as a number on temporary employees was combined to facilitate the current and future data needs across the Department and provide support to the Department's Field Offices as needed. It's unlikely that every contingency can be planned for, be it drought or flood; the Data Collection Program was created to be flexible as specific needs arise.

The staff that primarily worked with geodetic surveying before will still continue to provide the Floodplain Management and Dam Safety Programs with the same high quality products as required. The dedicated staff working in this group will also be able to provide support in the areas of surface water administration, dam safety, and stream gaging as needs and priorities dictate.

The Program is still very involved with streamgaging. It supports the review of surface water records, oversees the collection of stream gaging data through telemetry, and provides technical assistance to Field Office personnel. As demands for surface water data continue to grow, this group will research, develop, and recommend specifications for the acquisition and deployment of new equipment at existing gaging stations or new locations that have been deemed significant for future study or to more effectively administer surface water.

Perhaps no group is looking forward to the added flexibility that the new Data Collection Program has to offer more than the five Field Offices across the State. In recent years, the Department has been monitoring floodwaters in one portion of the state while administering for water shortages in others. Each of these extremes takes a toll on the Field Offices. To properly manage the aforementioned circumstances, frequently lower priority but no less important work must be deferred. The Data Collection Program was put together with this in mind. Whether there is too much water or not enough, the Program will be there to provide assistance to

complete the task at hand, and when conditions return to normal, the Program will also lend support to bring any deferred tasks up to current.

Information Technology (IT) Division continues to develop and fine-tune mobile technology applications that are used by staff in the field to access the data that the Department already has as well as collect new data via recently created data entry forms. The Data Collection Program works closely with IT to develop the appropriate tools so that they are intuitive and easily used in the field while still providing everything necessary to the other programs utilizing this data. As the use of technology in the field expands the coordination between the IT Division and the Data Collection Program will be vital as new applications continue to roll out to the Department's staff in the field.

The demands on Nebraska's water supply will only intensify. Having the most accurate and detailed data as possible is critical for the State's scientists and policy makers as they make wise management decisions that affect the future of all Nebraskans. The newly created Data Collection Program will be integral to the proper management and sustainable use of the State's natural resources.

APPLICATION OF REMOTE SENSING AND SURFACE ENERGY BALANCE MODELING TO CLASSIFY IRRIGATED AND NON-IRRIGATED CROP FIELDS

In Nebraska, irrigation accounts for the majority share of the state's total consumptive water use. For effective Integrated Water Management (IWM) from Natural Resources Districts (NRD) to State level, the spatio-temporal quantitative measure of irrigation water distribution and consumption is vital information for modelers and water resources managers. IWM requires high spatio-temporal resolution data with a short latency period to estimate consumptive water use on a timely and regular basis, and increase our understanding of the interconnectivity between surface and groundwater systems in the region. Currently, remote sensing is widely regarded as the most cost-effective and potent method to resolve land use and land cover patterns and track changes over large geographic areas.

Nebraska Department of Natural Resources (DNR) in collaboration with consultant Long Spring Inc. has developed a NDVI-Evaporation Fraction-Green Index (NEG) irrigation classification scheme based on surface energy balance and vegetation indices to classify irrigated cropland and dryland at fine spatial resolution. NEG integrates two new indices that highly contrast the spectral signature of irrigated and non-irrigated fields. The fusion of two indices enhances the classification efficiency by adding another filtering layer which re-characterizes misclassified areas. The inputs of NEG are Landsat imagery, weather data, Digital Elevation Model (DEM) data, and Crop Data Layer (CDL) data which run the Surface Energy Balance System (SEBS) model and derive the two vegetation indices. The structure framework, indices, thresholds, inputs, and output of NEG scheme are shown in the conceptual schema of NEG in Figure 1.

The implementation of NEG scheme in Nebraska has shown promising results. Without recalibrations the scheme has shown a strong agreement with observed irrigation patterns across the different climatic zones of the state and the different precipitation scenarios during growing seasons. That is, the scheme has performed with remarkable accuracy and consistency across the dry and wet regions of the state, and during dry, normal and wet growing seasons. Furthermore to test the potential of this scheme across different spatial settings, NEG scheme has been extend to California central valley with comparable performance. The results of NEG scheme are verified with field ground truth data and NASS county irrigation estimates. With ancillary techniques to gap-fill missing data due to clouds and stripping in Landsat data, NEG irrigation classification scheme is stilled in mapping, quantifying, and monitoring irrigated croplands with complete spatial coverage, from field to regional scale.

The complete derivation of the scheme is described in the final project report, *"Land Use Classification: A Surface Energy Balance and Vegetation Index Application to Map and Monitor Irrigation in Nebraska"*

*http://www.dnr.ne.gov/media/iwm/*LAND USE CLASSIFICATION: A SURFACE ENERGY BALANCE AND VEGETATION INDEX APPLICATION TO MAP AND MONITOR IRRIGATION IN NEBRASKA.pdf

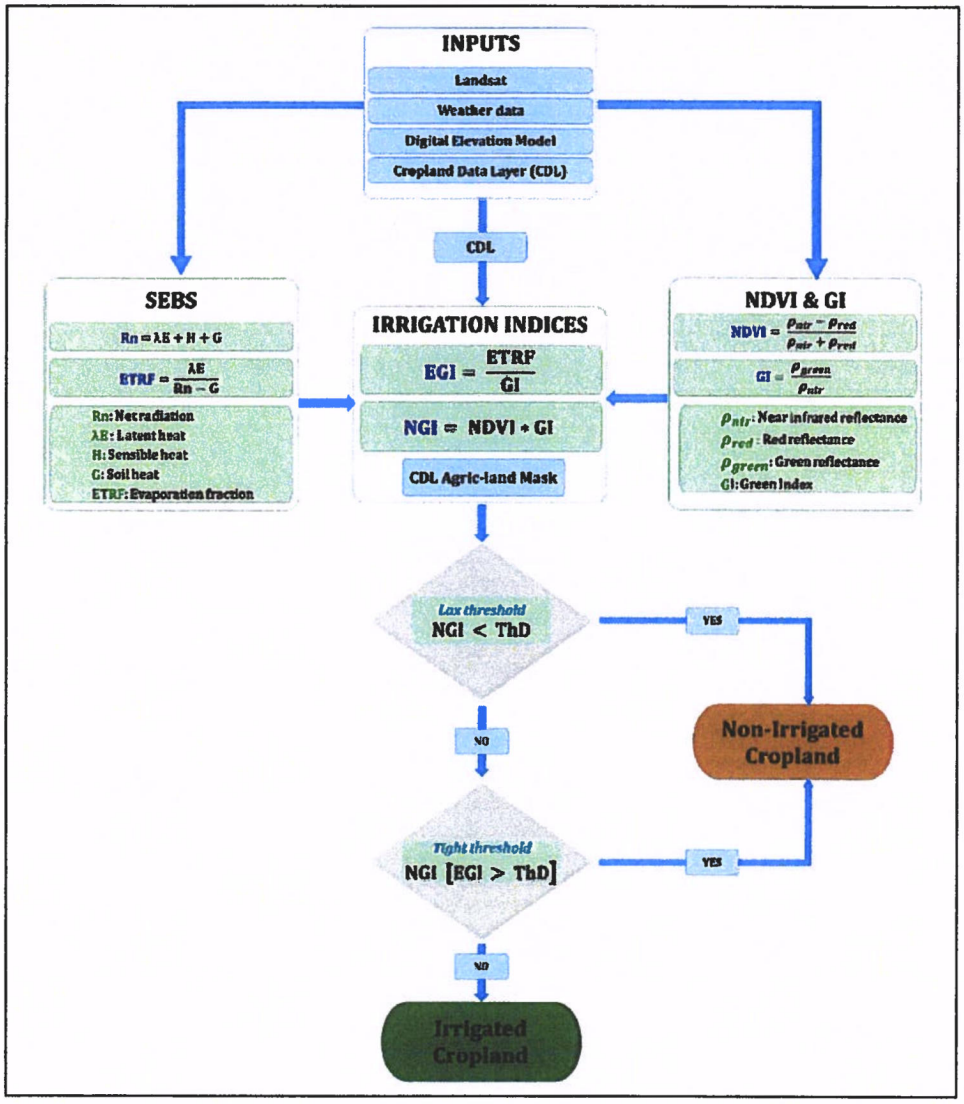

Figure 1: Schema of NEG Irrigation classification scheme. *Thd = Threshold*

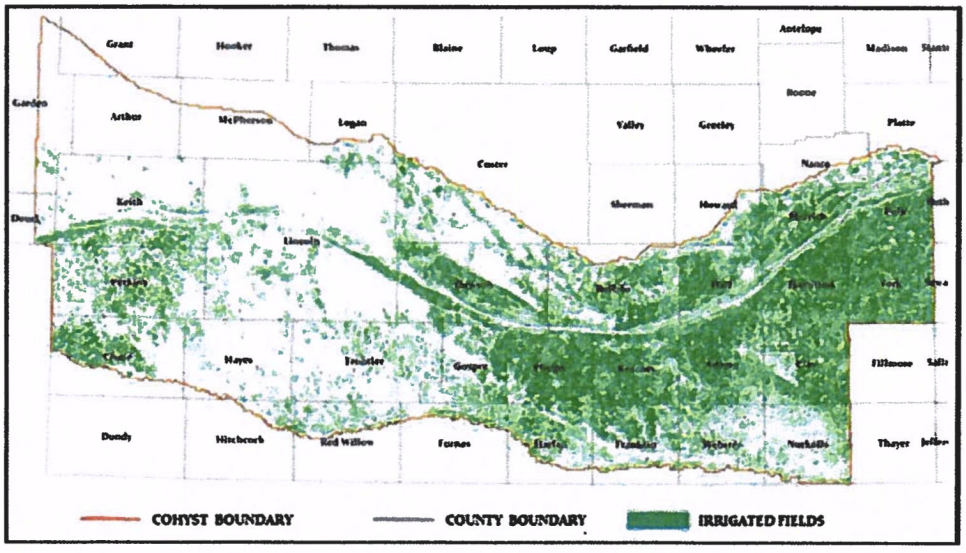

Figure 2: Spatial distribution of NEG derived irrigated fields in the COHYST model region during the growing season of 2010

STATUTES RELATED TO DIVERSION RATES

NEBRASKA LEGISLATURE

The official site of the Nebraska Unicameral Legislature

http://uniweb.legislature.ne.gov/

Nebraska Revised Statute 46-231

Amount and priority of appropriation; determination; limitation of amount; storage water.

Each appropriation shall be determined in its priority and amount by the time at which it is made and the amount of water which the works are constructed to carry. An appropriator shall at no time be entitled to the use of more than he or she can beneficially use for the purposes for which the appropriation has been made, and the amount of any appropriation made by means of enlargement of the distributing works shall be determined in like manner.

An allotment from the natural flow of streams for irrigation shall not exceed one cubic foot per second of time for each seventy acres of land and shall not exceed three acre-feet in the aggregate during one calendar year for each acre of land for which such appropriation has been made, and an allotment shall not exceed the least amount of water that experience may indicate is necessary, in the exercise of good husbandry, for the production of crops. Such limitations do not apply to storage waters or to water appropriations transferred pursuant to sections 46-2,122 to 46-2,125 and 46-2,127 to 46-2,129.

When storage water is being used in addition to the natural flow, the person in charge of the ditch or canal shall, upon his or her request and within twenty-four hours thereof, be notified in writing by the user of such storage waters of the time of withdrawal from natural streams to be distributed according to law.

When an appropriation is for irrigation purposes and the amount is so small that a proper distribution and application is impractical, as much water as the applicant can use without waste may be allotted for a limited time so fixed by the department

as to give each appropriator his or her just share without violating other rights, so long as (1) the volume of water used in a twenty-four-hour period does not exceed the amount of water that would otherwise have been allowed at the approved fixed continuous rate for a twenty-four-hour period or (2) the volume of water used in a seven-day, Monday-through-Sunday period does not exceed the amount of water that would otherwise have been allowed at the approved fixed continuous rate for a seven-day period. The department shall determine schedules among appropriators to assure that other rights are not violated.

Source: Laws 1919, c. 190, tit. VII, art. V, div. 2, § 11, p. 837; C.S.1922, § 8430; Laws 1929, c. 133, § 1, p. 486; C.S.1929, § 81-6311; R.S.1943, § 46-231; Laws 1987, LB 140, § 5; Laws 1993, LB 789, § 1; Laws 1995, LB 99, § 15; Laws 2000, LB 900, § 103.

Annotations

A user may not appropriate water without a valid permit specifically defining the source of the appropriation. Northport Irr. Dist. v. Jess, 215 Neb. 152, 337 N.W.2d 733 (1983).

Property rights in water for irrigation consist not alone in the amount of, but also in the priority of, the appropriation. Vonburg v. Farmers Irr. Dist., 132 Neb. 12, 270 N.W. 835 (1937).

Appropriator takes subject to rights of all prior appropriators, and cannot infringe upon their privileges. Farmers Canal Co. v. Frank, 72 Neb. 136, 100 N.W. 286 (1904); Crawford Co. v. Hathaway, 67 Neb. 325, 93 N.W. 781 (1903).

Nebraska Revised Statute 46-273

Water; United States may furnish to individuals; conditions and requirements.

The United States of America is hereby authorized, in conformity to the laws of the State of Nebraska, to appropriate, develop, and store any unappropriated flood or unused waters, in connection with any project constructed by the United States pursuant to the provisions of an Act of Congress approved June 17, 1902, being An Act providing for the reclamation of arid lands (32 Stat. L. 388), and all acts amendatory thereof and supplemental thereto. When the officers of the United States Bureau of Reclamation determine that any water so developed or stored is in excess of the needs of the project as then completed or is flood or unused water,

the United States may contract to furnish such developed, stored, flood, or unused water, under the terms and conditions imposed by Act of Congress and the rules and regulations of the United States, to any person who may have theretofore been granted a permit to appropriate a portion of the normal flow of any stream, if the water so appropriated shall, during some portion of the year, be found insufficient for the needs of the land to which it is appurtenant. The United States and every person entering into a contract as herein provided shall have the right to conduct such water into and along any of the natural streams of the state, but not so as to raise the waters thereof above the ordinary high water mark, and may take out the same again at any point desired, without regard to the prior rights of others to water from the same stream; but due allowance shall be made for losses in transit, the amount of such allowance to be determined by the Department of Natural Resources. The department shall supervise and enforce the distribution of such water so delivered with like authority and under the same provisions as in the case of general appropriators.

Source: Laws 1919, c. 190, tit. VII, art. V, div. 3, § 28, p. 856; C.S.1922, § 8478; C.S.1929, § 46-628; R.S.1943, § 46-273; Laws 1955, c. 183, § 5, p. 517; Laws 1987, LB 140, § 10; Laws 2000, LB 900, § 126.

Annotations

Contract restricting use of storage water by any one landowner to an amount sufficient to irrigate one hundred sixty acres was valid. Frenchman Valley Irr. Dist. v. Smith, 167 Neb. 78, 91 N.W.2d 415 (1958).

Injury to reclamation service, by taking seepage water which the United States had a contract to sell, may be enjoined. Ramshorn Ditch Co. v. United States, 269 F. 80 (8th Cir. 1920).

The scope of the appropriative rights in connection with a federal reclamation project are the same as those in connection with any irrigation canal, and includes the right to collect seepage waters from any parts of the lands and to reapply them upon any other lands within the project and under the appropriation. United States v. Tilley, 124 F.2d 850 (8th Cir. 1941).

Nebraska Revised Statute 46-739

Management area; controls authorized; procedure.

(Note: This is language authorizing local governmental units, called Natural Resources Districts (NRD), to manage and limit the use of ground water if the elected board follows statutorily prescribed procedures to adopt ground water control areas or enter into Integrated Management

Plans with the Nebraska Department of Natural Resources. When you see the word "district" in this statute, it refers to the local NRD. Also, when searching Nebraska statutes, "ground water" is two words.)

(1) A district in which a management area has been designated shall by order adopt one or more of the following controls for the management area:

(a) It may allocate the amount of ground water that may be withdrawn by ground water users;

(b) It may adopt a system of rotation for use of ground water;

(c) It may adopt well-spacing requirements more restrictive than those found in sections 46-609 and 46-651;

(d) It may require the installation of devices for measuring ground water withdrawals from water wells;

(e) It may adopt a system which requires reduction of irrigated acres pursuant to subsection (2) of section 46-740;

(f) It may limit or prevent the expansion of irrigated acres or otherwise limit or prevent increases in the consumptive use of ground water withdrawals from water wells used for irrigation or other beneficial purposes;

(g) It may require the use of best management practices;

(h) It may require the analysis of water or deep soils for fertilizer and chemical content;

(i) It may impose mandatory educational requirements designed to protect water quality or to stabilize or reduce the incidence of ground water depletion, conflicts between ground water users and surface water appropriators, disputes over interstate compacts or decrees, or difficulties fulfilling the provisions of other formal state contracts or agreements;

(j) It may require water quality monitoring and reporting of results to the district for all water wells within all or part of the management area;

(k) It may require district approval of (i) transfers of ground water off the land where the water is withdrawn, (ii) transfers of rights to use ground water that result from district allocations imposed pursuant to subdivision (1)(a) of this section or

from other restrictions on use that are imposed by the district in accordance with this section, (iii) transfers of certified water uses or certified irrigated acres between landowners or other persons, or (iv) transfers of certified water uses or certified irrigated acres between parcels or tracts under the control of a common landowner or other person. Such approval may be required whether the transfer is within the management area, from inside to outside the management area, or from outside to inside the management area, except that transfers for which permits have been obtained from the Department of Natural Resources prior to July 16, 2004, or pursuant to the Municipal and Rural Domestic Ground Water Transfers Permit Act shall not be subject to district approval pursuant to this subdivision. If the district adopts rules and regulations pursuant to this subdivision, such regulations shall require that the district deny or condition the approval of any such transfer when and to the extent such action is necessary to (A) ensure the consistency of the transfer with the purpose or purposes for which the management area was designated, (B) prevent adverse effects on other ground water users or on surface water appropriators, (C) prevent adverse effects on the state's ability to comply with an interstate compact or decree or to fulfill the provisions of any other formal state contract or agreement, and (D) otherwise protect the public interest and prevent detriment to the public welfare. Approval of any transfer of certified water uses or certified irrigated acres under subdivision (1)(k)(iii) or (iv) of this section shall further be subject to the district having complied with the requirements of section 46-739.01;

(l) It may require, when conditions so permit, that new or replacement water wells to be used for domestic or other purposes shall be constructed to such a depth that they are less likely to be affected by seasonal water level declines caused by other water wells in the same area;

(m) It may close all or a portion of the management area to the issuance of additional permits or may condition the issuance of additional permits on compliance with other rules and regulations adopted and promulgated by the district to achieve the purpose or purposes for which the management area was designated; and

(n) It may adopt and promulgate such other reasonable rules and regulations as are necessary to carry out the purpose for which a management area was designated.

(2) In adopting, amending, or repealing any control authorized by subsection (1) of this section or sections 46-740 and 46-741, the district's considerations shall

include, but not be limited to, whether it reasonably appears that such action will mitigate or eliminate the condition which led to designation of the management area or will improve the administration of the area.

(3) Upon request by the district or when any of the controls being proposed are for the purpose of integrated management of hydrologically connected ground water and surface water, the Director of Natural Resources shall review and comment on the adoption, amendment, or repeal of any authorized control in a management area. The director may hold a public hearing to consider testimony regarding the control prior to commenting on the adoption, amendment, or repeal of the control. The director shall consult with the district and fix a time, place, and date for such hearing. In reviewing and commenting on an authorized control in a management area, the director's considerations shall include, but not be limited to, those enumerated in subsection (2) of this section.

(4) If because of varying ground water uses, varying surface water uses, different irrigation distribution systems, or varying climatic, hydrologic, geologic, or soil conditions existing within a management area the uniform application throughout such area of one or more controls would fail to carry out the intent of the Nebraska Ground Water Management and Protection Act in a reasonably effective and equitable manner, the controls adopted by the district pursuant to this section may contain different provisions for different categories of ground water use or portions of the management area which differ from each other because of varying climatic, hydrologic, geologic, or soil conditions. Any differences in such provisions shall recognize and be directed toward such varying ground water uses or varying conditions. Except as otherwise provided in this section, if the district adopts different controls for different categories of ground water use, those controls shall be consistent with section 46-613 and shall, for each such category, be uniform for all portions of the area which have substantially similar climatic, hydrologic, geologic, and soil conditions.

(5) The district may establish different water allocations for different irrigation distribution systems.

(6)(a) The district may establish different provisions for different hydrologic relationships between ground water and surface water.

(b) For management areas a purpose of which is the integrated management of hydrologically connected ground water and surface water, the district may establish different provisions for water wells either permitted or constructed before

the designation of a management area for integrated management of hydrologically connected ground water and surface water and for water wells either permitted or constructed on or after the designation date or any other later date or dates established by the district. Permits for construction of new wells not completed by the date of the determination of fully appropriated shall be subject to any conditions imposed by the applicable natural resources district.

(c) For a management area in a river basin or part of a river basin that is or was the subject of litigation over an interstate water compact or decree in which the State of Nebraska is a named defendant, the district may establish different provisions for restriction of water wells constructed after January 1, 2001, if such litigation was commenced before or on May 22, 2001. If such litigation is commenced after May 22, 2001, the district may establish different provisions for restriction of water wells constructed after the date on which such litigation is commenced in federal court. An appeal from a decision of the district under this subdivision shall be in accordance with the hearing procedures established in the Nebraska Ground Water Management and Protection Act.

(d) Except as otherwise authorized by law, the district shall make a replacement water well as defined in section 46-602, or as further defined in district rules and regulations, subject to the same provisions as the water well it replaces.

(7) If the district has included controls delineated in subdivision (1)(m) of this section in its management plan, but has not implemented such controls within two years after the initial public hearing on the controls, the district shall hold a public hearing, as provided in section 46-712, regarding the controls before implementing them.

(8) In addition to the controls listed in subsection (1) of this section, a district in which a management area has been designated may also adopt and implement one or more of the following measures if it determines that any such measures would help the district and water users achieve the goals and objectives of the management area: (a) It may sponsor nonmandatory educational programs; and (b) it may establish and implement financial or other incentive programs. As a condition for participation in an incentive program, the district may require water users or landowners to enter into and perform such agreements or covenants concerning the use of land or water as are necessary to produce the benefits for which the incentive program is established and shall further condition participation upon satisfaction of the requirements of section 46-739.01.

Source: Laws 1975, LB 577, § 11; Laws 1978, LB 217, § 2; Laws 1979, LB 26, § 4; Laws 1980, LB 643, § 13; Laws 1981, LB 146, § 9; Laws 1982, LB 375, § 19; Laws 1983, LB 23, § 7; Laws 1983, LB 506, § 1; Laws 1984, LB 1071, § 8; Laws 1986, LB 894, § 25; Laws 1993, LB 131, § 30; R.S.1943, (1993), § 46-666; Laws 1996, LB 108, § 31; Laws 1997, LB 877, § 6; Laws 2000, LB 900, § 196; Laws 2001, LB 135, § 2; Laws 2001, LB 667, § 9; R.S.Supp.,2002, § 46-656.25; Laws 2004, LB 962, § 79; Laws 2006, LB 1226, § 27; Laws 2009, LB477, § 6.

Cross References

Municipal and Rural Domestic Ground Water Transfers Permit Act, see section 46-650.

Nebraska Revised Statute 46-281

Artesian water; waste prohibited.

It shall be unlawful for any owner or owners, lessee or lessees, occupier or occupiers, foreman or superintendent of any farm, town lot or other real estate in the State of Nebraska, where artesian water has been found or may be found hereafter, to allow the water from wells or other borings or drillings on any farm, town lot, or other real estate in Nebraska to flow out and run to waste in any manner to exceed what will flow or run through a pipe one-half of one inch in diameter, except where the water is first used for irrigation, or to create power for milling or other mechanical purposes.

Source: Laws 1897, c. 84, § 1, p. 358; R.S.1913, § 3527; C.S.1922, § 2927; C.S.1929, § 46-172; R.S.1943, § 46-281.

Passing of Reservoir Inflow for Livestock Water
The DNR LFO Guideline

Statute 46-241 (paragraph 5) reads in part:
"Every person who owns, controls, or operates a reservoir or intentional underground water storage facility, except political subdivisions of this state, shall be required to pass through the outlets of such reservoir or facility, whether existing or hereafter constructed, a portion of the measured inflows to furnish water for livestock in such amounts and at such times as directed by the department to meet the requirements for such purposes as determined by the department, except that a reservoir or facility owner shall not be required to release water for this purpose which has been legally stored."

Course of action:

1. **Check statutes to see if amendments to 46-241 have been made and apply changes.**

2. As outlined in the statute, **storage reservoirs owned or operated by political subdivisions**(NRDs, Counties, the state of Nebraska, USA etc) are exempt but not prohibited from passing inflow for livestock-**if this exemption applies** you can offer suggestions to the dam owner concerning amounts of inflow and guidelines for the amount necessary, but **DNR should not write an order or be involved any further,** such as opening gates or monitoring activities
3. **If reservoir is privately owned or operated:**
    a. **Check for inflow** to reservoir and document amount (either estimate or measure)
    b. Check site of request to **verify the need for water.** Measure or estimate flow and document water availability, and channel conditions etc.
    c. **Observe number of head and type of livestock** for which water is requested(count and/or ask owner)
    d. **Determine amount of water needed** taking into account distance, channel conditions, temperature, number of head, type of livestock and/or other factors that apply. Generally, DNR uses 25 gallon/head/day for cattle, and 10 to 20 gallons/day/head for other types of livestock. For example, for 10 head of cattle, the math would be 10 head X 25 gallons/head/day or 250 gallons/day. Remember this is gallons per day not gallons per minute.
    e. **Write the reservoir owner an order** to pass amount of water needed-the method by which he passes water is up to the owner-typical methods used but not limited to: would be opening a gate on the outlet works, siphoning or pumping water either over the dam or over the riser. Keep in mind that the release should not exceed inflow amount when writing the order, but that water can be released at a higher rate than inflow amount but over a shorter duration.
    f. **Monitor** the site at least weekly to insure compliance or the need for adjustment in the amount needed-continue with and document ongoing communications with both parties. Document changes, and write a new order any time changes in the amount, timing or method to be used to pass water, and/or other factors change.

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- Experiment Station
- Public Service Activities
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Food and Water Requirements for Livestock

Water is ALWAYS given free choice to all animals. Animals (except birds), like people, can go extended periods of time without food, but can only last a couple of days at the most without water. The values, below, are approximate per adult animal per day and may vary greatly with temperature, workload, stress and disease. Sources of feed should be identified before a disaster.

In general most herbivorous animals are going to eat approximately 1-2% of their body weight in some form of "roughage." Roughage is hay or hay-like products (pellets, cubes, hay, etc.) In an emergency grain products ("concentrates") need not be given.

Disaster Food Schedule

SPECIES	>WATER (Summer/Winter)	>FOOD (Type)	>FEED (Quantity)	FEED (Frequency)
Beef Cattle	5-15 Gallons	alfalfa &/ or oat	15-30 lbs	Daily
Dairy Cattle	5-30 Gallons	alfalfa	15-40 lbs	Daily
Horses	5-15 Gallons	alfalfa &/ or oat	8-15 lbs	2x Daily
Pigs	1-2 Gallons	pig pellets/mixed grains	1-7 lbs (depending on weight of pig)	once or twice daily
Llamas	2-5 Gallons	alfalfa &/ or oat hay	2-4 lbs	2x Daily
Sheep	1-2 Gallons	alfalfa	2-5lbs	Daily
Goats	1-2 Gallons	alfalfa &/ or oat hay	1-5 lbs	Daily

**supplementing the diet with grain is helpful*
***always supplied free choice*

During and Following a Disaster

Your personal safety and that of those around you should always be your first concern. A pre-determined plan will help you remain calm and think clearly. Remember to communicate and cooperate with all emergency personnel. If you must leave the premises let someone know where you are going and try to remain in contact with that person.

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AS1763

Livestock Water Requirements

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Providing adequate water to livestock is critical for animal health and production. A 10 percent loss of body water is fatal to most species of domestic livestock.

Water accounts for more than 98 percent of all molecules in the body and between 50 and 81 percent of an animal's total body weight at maturity. Water is required for regulation of body temperature, growth, reproduction, lactation, digestion, lubrication of joints, and eyesight.

Livestock water requirements vary significantly depending on the species. Water consumption is influenced by a number of factors, including age, rate of gain, pregnancy, lactation, activity, type of diet, feed intake and environmental temperature. Livestock obtain water to meet their requirements from wells, fountains, surface water and moisture found in feedstuffs.

NDSU EXTENSION SERVICE

July 2015

Beef Cattle

Water requirements of beef cattle are a function of the stage of production, lactation and environmental temperature **(Table 1)**. Beef cattle water requirements increase as the weight of the animal increases, during pregnancy and lactation, and with elevated temperatures. Water requirements also vary depending on the moisture in feedstuffs **(Table 2)**. Limiting water intake reduces feed consumption and animal performance.

Table 1. Estimated daily water intake (gallons per head per day) for beef cows based on temperature and level of production.

	Growing Cattle			Finishing Cattle			Pregnant Cows		Lactating Cows	Mature Bulls	
Temp.	400 lb	600 lb	800 lb	600 lb	800 lb	1,000 lb	900 lb	1,110 lb	900 lb	1,400 lb	16,000 lb
40	4.0	5.3	6.3	6.0	7.3	8.7	6.7	6.0	11.4	8.0	8.7
50	4.3	5.8	6.8	6.5	7.9	9.4	7.2	6.5	12.6	8.6	9.4
60	5.0	6.6	7.9	7.4	9.1	10.8	8.3	7.4	14.5	9.9	10.8
70	5.8	7.8	9.2	8.7	10.7	12.6	9.7	8.7	16.9	11.7	12.6
80	6.7	8.9	10.6	10.0	12.3	14.5			17.9	13.4	14.5
90	9.5	12.7	15.0	14.3	17.4	20.6			16.2	19.0	20.6

Adapted from Nutrient Requirements of Beef Cattle: Seventh Revised Edition: Updated 2000, 2000, NRC

Table 2. Water consumption estimates for beef cattle based on thermal environment and dry-matter (DM) intake.

Thermal Environment	Water Requirements
> 95 F	8 to 15 pounds of water per pound of DM intake
77 to 95 F	4 to 10 pounds of water per pound of DM intake
59 to 77 F	3 to 5 pounds of water per pound of DM intake (young and lactating cattle require 10 to 15 percent more water)
29 to 59 F	2 to 4 pounds of water per pound of DM intake
< 29 F	2 to 3 pounds of water per pound of DM intake (increases of 50 to 100 percent occur with a rise in ambient temperature following a period of very cold temperatures; for example, a rise from minus 5 to 30 F.)

Adapted from Effects of Environment on Nutrient Requirements of Domestic Animals, 1981, NRC

Dairy Cattle

Water constitutes 87 percent of milk with, approximately 30 percent of water consumed by dairy cattle being lost through milk. Thus, dairy cattle water requirements are strongly influenced by the stage of production and level of milk production **(Table 3)**.

The majority (about 83 percent) of water consumed by dairy cattle is consumed by drinking, with the remaining water coming from feedstuffs. Water requirements are influenced by the animal's diet and will increase with increases in dry matter, salt and protein.

Table 3. Water requirements (gallons per head per day) for dairy cows based on level of production.

Class	Age	Milk Production	Water Intake
		(lbs milk/day)	
Calves	1 to 4 months		1.3 to 3.5
Heifers	5 to 24 months		3.8 to 9.6
Milking cows	24 + months	30	18 to 22
Milking cows	24 + months	50	23 to 27
Milking cows	24 + months	80	30 to 36
Milking cows	24 + months	100	35 to 41
Dry cows	24 + months		9 to 13

Horses

Horse water intake is highly variable. Water intake is a based on body weight, age, diet, exercise intensity and duration, lactation and temperature **(Table 4)**. Horses fed a fiber-rich forage-based diet require more water than those fed a more digestible grain diet. Horses that are hot from exercise should have limited access to water to prevent colic, laminitis and/or exertional rhabdomyolysis (tying up).

Table 4. Estimated daily water intake (gallons per head per day) for horses as influenced by class, activity level and temperature.

Class	Activity Level	Body Weight	Temp.	Water Intake
		(lb)	(F)	
Yearling	Moderate	661	14	4.8
Yearling	Moderate	661	68	5.0
Pregnant		1,102	68	8.1
Lactating		1,102	68	13.5
Mature	Idle	1,102	-4	11.1
Mature	Idle	1,102	68	8.2
Mature	Idle	1,102	86	12.7
Mature	Moderate	1,102	68	10.8
Mature	Moderate	1,102	95	21.7

Adapted from Nutrient Requirements of Horses: Sixth Revised Edition, 2007, NRC

Sheep

Table 5 lists water requirements for different categories of sheep. Sheep are able to obtain most of their water requirements from forage consumption. In addition to weight and level of production, water intake also increases in response to increases in environmental temperature.

Table 5. Water intake (gallons per head per day) for sheep.

Class	Weight	Water Intake
	(lbs)	
Lambs	5 to 20	0.1 to 0.3
Feeder lambs	60 to 110	1.0 to 1.5
Pregnant ewes	175 +	1.0 to 2.0
Lactating ewes	175 +	2.0 to 3.0
Rams	175 +	1.0 to 2.0

Swine

Table 6 provides water requirements for swine based on level of maturity and weight. Other factors that influence swine water requirements include diet, temperature, housing and feeding methods.

Water intake increases as protein and salt increase in the diet. Swine fed a high-energy diet that are deprived of water (such as can occur during power outages) then are allowed free access to water (power restored) are at risk of salt poisoning (cerebral edema). They should be given access to water sparingly until fully rehydrated.

Table 6. Water requirements (gallons per pig per day) for swine.

Class	Water Intake
Nursery (up to 60 lbs)	0.7 to 1
Grower (60-100 lbs)	2 to 3
Finishing (100-250 lbs.)	3 to 5
Nonpregnant gilts	3 to 5
Pregnant sows	3 to 6
Lactating sows	5 to 7
Boars	3 to 6

Dehydration

Limited water access, limited water availability, environmental temperatures, stress and illness can result in dehydration or lack of water. Common signs of dehydration include lethargy, tightening of the skin, weight loss, and drying of mucous membranes and eyes.

Here are some other symptoms:

Cattle and sheep – The eyes will appear sunken and dull. In lactating dairy cows, dehydration results in a near cessation of milk production.

Horses – Dehydration reduces skin elasticity. One way to determine if a horse is dehydrated is by skin folds. Pull the skin over the shoulder and hold a moment. Release and count the seconds until the fold disappears. If the horse is dehydrated, the skin will stand for several seconds.

Swine – Dehydration can result in salt poisoning and often is fatal. Early signs of dehydration in swine include thirst, constipation, skin irritation and lack of appetite. This often is followed by nervousness, apparent deafness and blindness. Pigs affected by salt poisoning will be uncoordinated and have intermittent convulsions.

Stress

Reduced water consumption can be a sign of unfamiliarity, sickness or other stressors. New animals initially may refuse water due to unfamiliarity of water sources and differences in palatability.

Water intake in new livestock should be monitored carefully to make sure they have located the source and are consuming water. With lightweight calves and sheep, be sure the watering source is of adequate height to allow access because animals may not be able to reach the source.

Water Quality

Water consumption can be impacted by water quality. Livestock that are provided low-quality water will have reduced water and feed intake, resulting in reduced production. Certain salts and gases in solution, such as those consisting of sodium, potassium, calcium, magnesium, chloride and sulfate make water more palatable. However, these same salts and gases can be toxic if present in excess.

Livestock never should be forced to drink dirty or contaminated water. Dirty or stale water can reduce water consumption. Providing grazing livestock with fresh water has been shown to increase weight gains.

Dirty water is a host for disease organisms. Disease can spread rapidly if animals drink from the same water source, so sick animals should be isolated and waterers should be cleaned frequently.

Waterers can be disinfected using a dilute bleach solution following cleaning. A dilute bleach solution of 2 to 3 ounces for each 50 gallons of tank capacity of bleach containing 5.25 percent sodium hypochlorite applied weekly also will suppress algae growth.

Proper installation of the waterer or tank base will prevent fecal contamination of water. The base should be wide enough so animals easily can place their front legs on it while drinking, but not their hind legs. This will keep animals from defecating in the water.

Summary

Water is an important, but often overlooked, nutrient. Livestock water requirements are affected by many factors including, size, productivity, diet and environmental conditions. Good water quality and cleanliness can increase water intake and improve livestock production. Limited access or reduced water consumption can result in dehydration, which can be fatal to livestock.

Cover photo by Gerald Stokka

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200-7-15