Dairy Technical and Regulatory Guidance Manual for New Mexico

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SECTION 1—INTRODUCTION

The Dairy Industry in New Mexico

The top agricultural commodity in New Mexico is dairy, and the growth of the dairy industry has helped to stabilize the agricultural economy in New Mexico's dairy-producing regions. Figure 1.1 shows the six major dairy-producing regions in New Mexico and Table 1 highlights the dairy industry's importance to the overall economy of New Mexico.

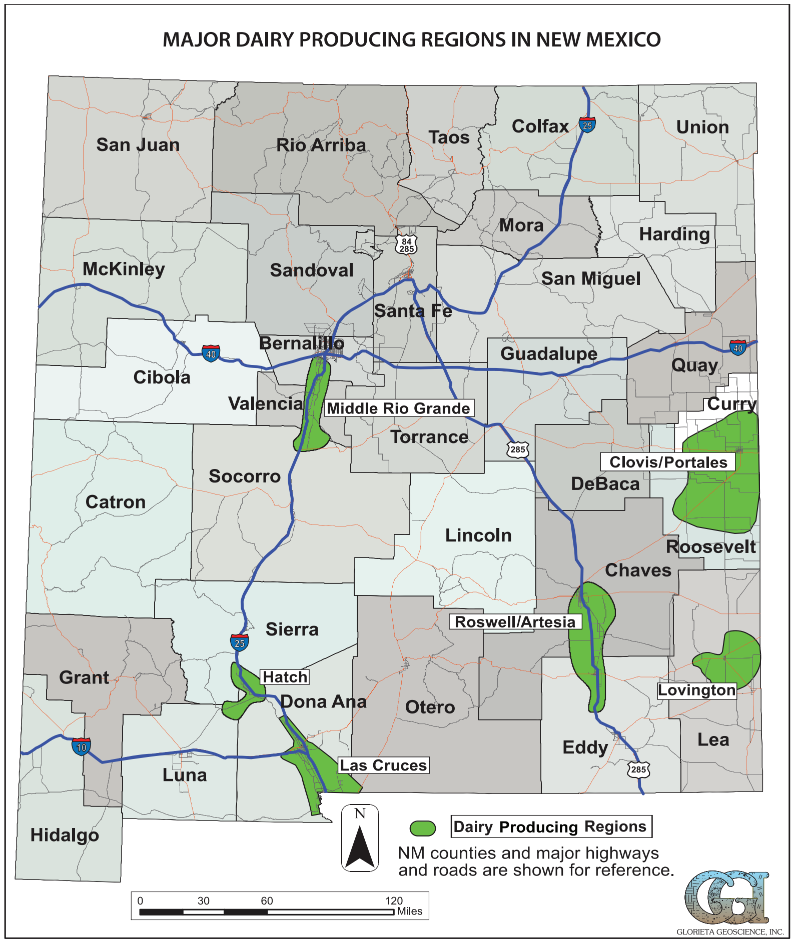


Figure 1.1. **Dairy producing regions in New Mexico.**

The Purpose of This Manual

Since the first large-scale dairy operations started in New Mexico in the mid-1980s, compliance requirements for environmental and water rights permits have increased and become more complex. Not only do dairy producers have to comply with milk quality and other regulations concerning milk production, but they also have to integrate milk production objectives with environmental and water rights regulations. Regulatory compliance requires a significant amount of effort to obtain and maintain water rights and environmental permits.

This Dairy Technical and Regulatory Guidance Manual (Manual) is written to assist New Mexico dairy producers in navigating the complexities of state and federal environmental/water rights regulations. The Manual is designed for a technically capable but nonacademic audience with a strong background in dairy management. Traditional manuals have primarily focused on manure management. Since manure, green water, and storm water generated at dairies are regulated by the New Mexico Environment Department (NMED)-issued **Ground Water Discharge Permits**, the focus of this Manual is on protection of ground water quality. Also addressed are surface water quality and the **National Pollutant Discharge Elimination System (NPDES)** for **Concentrated Animal Feeding Operations (CAFO)** permitting process through the United States Environmental Protection Agency (EPA). To best reflect the water cycle at a dairy, the Manual also focuses on water rights and changes in water quality as it moves through the dairy water cycle. This manual is written to follow water from the well or surface water source through the dairy and to final land application and crop consumptive use. Emphasis is placed on water reuse and water conservation.

This Dairy Technical and Regulatory Guidance Manual is designed to provide an educated dairy producer with tools by which to apply for permits for a new dairy and/or provide existing dairies with a roadmap by which they can remain in compliance with the regulatory requirements of their various environmental and water rights permits. Specifically, the purpose of this manual is to:

1. Help dairy producers navigate the complexities of state and federal environmental regulations and explain which agencies are responsible for which permits.
2. Provide basic scientific primers in the areas of hydrology, geology, soil science, water quality, and agronomy.
3. Help dairy producers by explaining in simple terms the required environmental, water rights, and water supply data to be collected and kept for each facility.
4. Present case studies using actual data that will help an operator negotiate terms and conditions of the required environmental permits.

Table 1. The economic impact of the New Mexico dairy industry (source: NMSU Dairy Extension website, 2025)		
The Economic Impact of Dairy Products	**New Mexico**	**U.S.**
Total economic impact of dairy produced & sold[6]	$2.1B direct, $3.9B indirect	$794B total, $255B direct, $522B indirect
Contribution to GDP[6]	=5.9% of NM '23 GDP ($105.5B)	=3.0% of projected U.S. '24 GDP ($29.2T)
Dairy Receipts – sales of dairy products[3]	$1.23B (31% of total)	$45.9B (8.9% of total)
Total direct jobs generated in dairy industry[6]	6,839 direct jobs	1.1 million direct jobs
Wages earned as result of dairy (direct)[6]	$1.3B paid in direct wages	$183B paid in direct wages
Indirect jobs supported by dairy industry[6]	15,090 indirect jobs	2.1 million indirect jobs
Cheese production[3]	6.9% of U.S. cheese	4th in U.S.
Number of dairy farms[2]	85 farms (avg. '24) = -53% since '04	24,811(avg. '24) = -47% since '14
Total number of milking cows[1,4]	240,000 ('24)	9.342M ('24)
Number of cows per dairy[4]	2,526 ('24) (#1 in U.S.)	357 ('24)
Milk produced[2,4]	5,896 M lbs. ('24)(-10.6%)	226,364 M lbs. ('24)
Contribution to national milk production[2,4]	2.9%	NM is 11th in the U.S.
Milk productivity[2,4]	24,717 lbs./yr	24,117 lbs./yr

Sources: Data available on NMSU Dairy Extension website at https://dairy.nmsu.edu/documents/dairy-status_jan25.pdf

[1] USDA NASS, Feb 2025: https://downloads.usda.library.cornell.edu/usda-esmis/files/h989r321c/mg74sh83p/nc582h285/mkpr0225.pdf

[2] Southwest Marketing Area (FO 126), Jan/Feb 2025: https://www.dallasma.com/order_stats/order_reports.jsp

[3] NMDA 2023-24 Ag Statistics: https://www.nass.usda.gov/Statistics_by_State/New_Mexico/Publications/Annual_Statistical_Bulletin/2023-2024/2023-2024-NM-Ag-Statistics.pdf and USDA ERS Cash Receipts by State (accessed Mar 9, 2025): https://data.ers.usda.gov/reports.aspx?ID=4052#P7765847b3073498b8540dfd1559ca568_2_17iT0R0x31

[4] Progressive Dairyman: https://www.progressivepublish.com/downloads/2025/general/2024-pd-stats-lowres.pdf

[5] Leading States in Cheese production in 2023: https://www.statista.com/statistics/195764/top-10-us-states-for-cheese-production-2008/

[6] IDFA Dairy Delivers (accessed Dec 1, 2024): https://www.idfa.org/dairydelivers#:~:text=The%20Economic%20Impact%20of%20Dairy%20Products&text=In%20fact%2C%20America's%20dairy%20industry,are%20shaping%20the%20dairy%20industry

Environmental History of the New Mexico Dairy Industry

The first modern, large-scale dairy was built in New Mexico in the early 1980s, and the number of dairies increased rapidly throughout the late 1980s and 1990s. During this period of expansion, many dairy producers relied on the former Soil Conservation Service (SCS) (now the Natural Resources Conservation Service [NRCS]) to design their green water and storm water management programs. Unfortunately, these older designs did not adequately protect water quality, and many dairy producers with SCS-designed facilities, who thought they were operating in accordance with current regulations, were forced to redesign and reline their green water and/or storm water lagoons.

First-generation green water lagoons were lined with manure. Later, second-generation lagoons were lined with natural clays. Today, recently constructed lagoons and relined lagoons are primarily lined with synthetic materials. In many instances, dairies have separate green water lagoons and storm water lagoons. Based on groundwater quality data collected over several years, it has been determined that manure-lined lagoons, improperly constructed clay-lined lagoons, and unlined storm water lagoons provide little ground water quality protection. The NRCS now only provides funding and technical assistance for synthetically lined lagoon systems.

For dairies that currently manage their operations according to a Comprehensive Nutrient Management Plan (CNMP) and/or Nutrient Management Plan (NMP), this manual will provide a technical refresher. For dairies that need to upgrade their Best Management Practices (BMPs), this is a how-to manual for updating operations and complying with regulations.

SECTION 2—REGULATIONS AND GUIDELINES

In this section, we present a summary of the environmental regulations and permit requirements that affect New Mexico dairies.

Based on the average herd size, most New Mexican dairies are classified as Concentrated Animal Feeding Operations (CAFOs) by the United States Environmental Protection Agency (USEPA). CAFOs are a subgroup of **Animal Feeding Operations** (AFO) that meet federal criteria primarily based upon the number of animals confined (700 or more milking cows). An AFO is a lot or facility where animals have been, are, or will be stabled or confined and fed or maintained for a total of at least 45 days in any 12-month period, and the animal confinement area does not sustain crops, vegetation, forage growth, or post-harvest residues in the normal growing season. It is not necessary that the same animals are fed or maintained on the lot for the 45-day period, nor do the 45 days need to be consecutive.

There are two different permits that may be required for a dairy operation, the USEPA National Pollutant Discharge Elimination System permit (NPDES/CAFO permit) and the State of New Mexico Environment Department's (NMED) Ground Water Discharge Permit. New Mexico currently only has regulatory authority (primacy) over ground water quality and only issues permits related to ground water discharges. The USEPA maintains regulatory authority over surface water quality and issues surface water permits. Although the two permits have similarities, they are not the same, and compliance with a NMED Ground Water Discharge Permit does not ensure compliance with a NPDES/CAFO permit (if applicable).

A NPDES/CAFO permit is a federal permit intended to protect surface water quality, while a Ground Water Discharge Permit is a state permit intended to protect ground water quality. A more detailed description of the two permits is presented later in this section. A dairy producer who has both permits can maintain a common record-keeping system that will satisfy both the NMED discharge permit and the NPDES/CAFO permit requirements.

2.1 The New Mexico Water Quality Act

The New Mexico Water Quality Act (NMWQA) is a 1978 state law mandating the protection of water quality and is found in Chapter 74, Article 6 of the New Mexico Statutes Annotated (NMSA). This law created the New Mexico Water Quality Control Commission (NMWQCC), which enacts regulations describing the details necessary to implement the provisions of the NMWQA. NMWQCC regulations specific to ground water quality are found in Title 20, Chapter 6, Part 2 of the New Mexico Administrative Code (NMAC) and are locally known as the Dairy Rule. While the NMED does have oversight over some surface water quality programs, it is not authorized to administer the NPDES permit program. The NMED administers the Ground Water Discharge Permit program, and all New Mexico dairies are required to obtain a Ground Water Discharge Permit (DP). Further discussion of water quality definitions and standards is presented in Sections 3.1 and 3.2 of this manual.

2.2 What Do the State Regulations and Permits Allow?

The purpose of the NMWQCC regulations and NMED-issued Ground Water Discharge Permits is to protect ground water with an existing concentration of 10,000 mg/L or parts per million (ppm) or less total dissolved solids (TDS), "for present and potential future use as domestic and agricultural water supply, and to protect those segments of surface waters which are gaining because of ground water inflow" (20.6.2.3101 NMAC). Specific ground water standards are listed in 20.6.2.3103 NMAC, and the regulations allow:

- Degradation of ground water up to the limit of the standard, if the existing concentration of any contaminant conforms to the standard. For example, the NMWQCC standard for chloride is 250 mg/L. Prior to operating a dairy, the background chloride concentration in the ground water is 100 mg/L. In this case, the operation of the dairy can cause the concentration to exceed 100 mg/L but not 250 mg/L (the NMWQCC standard).
- No degradation of ground water beyond the existing concentration, if the existing concentration of any contaminant exceeds the standard. For example, using the standard 250 mg/L for chloride as a guide, the initial pre-dairy background chloride concentration is 400 mg/L. In this case, the dairy would be allowed to discharge, but discharges from the dairy could not cause the chloride concentration to exceed 400 mg/L.

2.3 The Ground Water Discharge Permit (DP)

A Ground Water Discharge Permit (DP) is required for any facility that discharges effluent or leachate that may move directly or indirectly into ground water. DPs are issued under Title 20, Chapter 6, NMAC by the NMED with the goal of ground water protection. A DP is an operational plan that describes how the dairy will manage process-generated wastewater and manure solids in a manner that is protective of ground water quality. This is effectively a contract with the state and is issued for a term of five (5) years. A DP issued by the NMED is not the same as a NPDES permit issued by the EPA (see below). While both permits may have similar elements, compliance with one does not imply compliance with the other. The recordkeeping elements described in Section 6 of this manual have been developed to incorporate the data of both permits into a single set of documents, satisfying the requirements for both.

2.4 Additional New Mexico Environment Department Guidance Documents

The NMED has developed specific guidelines to help dairy operations comply with their Discharge Permit conditions. These include:

- Monitoring Well Construction and Abandonment Guidelines
- Synthetically-Lined Lagoons—Liner Material and Site Preparation Guidelines

These guidelines are provided in Appendix A, and both are electronically available at

https://www.env.nm.gov/gwqb/gw-regulations/

In addition, the NMED recommends the following references for sampling protocols and laboratory methods:

- Standard Methods for the Examination of Water and Wastewater[1]
- Methods for Chemical Analysis of Water and Waste[45]
- Techniques of Water Resource Investigations of the U.S. Geological Survey[51]
- Annual Book of ASTM Standards, Part 31 for Water[2]
- Federal Register, latest methods pursuant to RCRA[42]
- National Handbook of Recommended Methods for Water-Data Acquisition[53]

When working with a technical expert or NRCS staff member, a dairy producer should insist that these standards are met. In the event that a dairy producer is collecting their own samples and submitting them to a laboratory, Appendix E of this manual highlights specific instructions regarding soil, ground water, green water, and manure sampling.

2.5 The Clean Water Act

The Clean Water Act (CWA) is a federal law mandating the protection of surface water quality. The current version of the CWA was finalized in 1977 with the goal of restoring and maintaining “the chemical, physical and biological integrity of the nation’s waters so that they can support the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water.” Subsequently, the Environmental Protection Agency (EPA) enacted regulations to explain and regulate the technical, operational, and legal details necessary for implementation of the CWA. The CWA is found in Title 33 of the United States Code (USC), Sections 1251 et seq. Federal regulations pertaining to environmental protection are found in Title 40 of the Code of Federal Regulations (CFR).

2.6 Surface Water Protection and the NPDES Program

Section 402 of the CWA created the National Pollutant Discharge Elimination System (NPDES) regulatory program. This program regulates the discharge of pollutants from point sources to waters of the United States via an EPA-administered permit program. Section 404 of the CWA defines waters of the United States to include: all interstate waters, intrastate waters used in interstate and/or foreign commerce, tributaries of interstate and intrastate waters (this includes irrigation canals), territorial seas at the cyclical high-tide mark, and wetlands adjacent to all of the above. The CWA definition of a point source is a discrete and direct conveyance from which pollutants are or may be discharged to waters of the United States, and CAFOs are specifically defined as point sources by the CWA. Federal regulations pertaining to the NPDES program are found in Title 40 CFR Sections 122 and 412.

Subsequent court decisions, however, have made permit coverage optional. Obtaining a NPDES/CAFO permit is now a risk-based decision based on the proximity of a dairy to waters of the United States and the potential for a discharge to adversely impact threatened and/or endangered species (see below). If a dairy obtains a NPDES permit, it is authorized to discharge during a chronic or catastrophic rainfall event, as long as it can demonstrate that the system has been designed, built and operated to contain all process-generated waste waters plus the runoff from a 25-year/24-hour rainfall event for the location (see below). For New Mexico dairies, a NPDES permit is obtained from the USEPA Region 6 Office in Dallas, TX. At the time of this publication, a bill was introduced in the 2025 New Mexico Legislative Session that would authorize New Mexico to regulate surface water quality under revisions to the Water Quality Act. This legislation, if enacted, will result in development of a Surface Water quality permitting program and will take years to implement dairy-specific surface water quality regulations.

2.7 Federal Regulations and NPDES Permits

To reiterate, the NPDES program is mandated by specific regulations that were developed in accordance with the general provisions of the Clean Water Act. The NPDES regulations apply specifically to surface water protection, and New Mexico CAFO operators must make a risk-based decision on whether or not to obtain a permit (see Section 1). The CWA and NPDES regulations dictate the minimum requirements of a NPDES permit. For the State of New Mexico, there is a new general NPDES permit for CAFOs (NMG010000), which was described briefly in Section 2.1.

The NPDES permit sets limitations on the quantities, rates, and concentrations of chemical, physical, biological, and other constituents which may be discharged from point sources into waters of the United States. One exception is when “rainfall events, either chronic or catastrophic, cause an overflow of process wastewater from a facility designed, constructed and operated to contain all process generated waste waters plus the runoff from a 25-year/24-hour rainfall event for the location of the point source.” If a dairy has either a general or individual permit, and has been properly operated and maintained, overflows or other discharges during chronic or catastrophic storm events are not considered a violation of the CWA. This would be considered an **authorized discharge**. A **Chronic Storm Event** is a series of wet weather conditions which does not provide the opportunity for normal dewatering of a lagoon system. A **Catastrophic Storm Event** is any single event in which rainfall exceeds the 25-year/24-hour storm event. Catastrophic conditions could also include tornados, hurricanes or other conditions which could cause overflow due to winds or mechanical damage. However, if a dairy does not have either a general or individual NPDES permit and a discharge occurs due to a chronic or catastrophic event, then the discharge is considered unauthorized and a violation of the CWA.

As stated above, the decision about whether or not to obtain a NPDES permit is a risk-based business decision. The decision should be based on the potential for a discharge from a dairy to negatively impact waters of the United States and threatened/endangered species. With a NPDES Permit, a dairy which experiences an authorized discharge will not be in violation of the CWA. If an authorized discharge kills threatened or endangered species, it is classified as an "incidental take," and not considered a violation of the Endangered Species Act (ESA). However, if a dairy does not have a NPDES permit and an unauthorized discharge occurs, the dairy will be in violation of the CWA. If the unauthorized discharge "takes" (kills) threatened or endangered species, that "taking" will be considered a violation of the ESA and potentially subject to numerous penalties and fines.

When deciding whether or not to obtain a NPDES permit, a dairy operation should consider the watershed in which it is located. If streams located downstream of the dairy are known to have threatened or endangered species present, then a NPDES permit may be beneficial. For example, dairies in the Lower Pecos River and Middle Rio Grande watersheds have a high risk of "taking" threatened or endangered species (such as the Pecos Bluntnose Shiner and Silvery Minnow, respectively) during an unauthorized discharge. On the other hand, dairies in the lower Rio Grande or High Plains watersheds (specifically Curry and Roosevelt Counties) have a lower risk of "taking" threatened or endangered species during an unauthorized discharge.

USEPA has issued a NPDES/CAFO permit writer's guidance manual (https://www.epa.gov/npdes/npdes-permit-writers-manual-concentrated-animal-feeding-operations) that is used by both regulators and permittees. While a hydrologic connection between a dairy and surface waters cannot be eliminated, dairies should be designed, built, and operated so that no pollutants are allowed to enter into the environment from the lagoon system, piping or land application areas. Simply put, to stay in compliance with a NPDES/CAFO permit, a dairy operation must demonstrate that the lagoons will not leak into ground water that is connected to surface waters of the United States (see Figures 2.1, 2.2, and 2.3). A dairy operation must also prove that no seepage of green water or manure solids from the land application areas will migrate to ground water and surface water. Clean monitoring wells support the position that a dairy is operating in compliance with permit requirements and according to its Comprehensive Nutrient Management Plan (CNMP) and/or Nutrient Management Plan (NMP).

2.8 The Nutrient Management Plan (NMP)

An annual Nutrient Management Plan is required by both the NMED Dairy Rule and recent NPDES/CAFO regulations. This plan replaces the older Pollution Prevention Plan (PPP). The NMP must include practices and procedures implemented to reach the necessary effluent limitations described above. The NMP should describe how a dairy will be operated and maintained to contain process-generated green waters plus the runoff from a 25-year/24-hour storm. NMPs require the development of an annual nutrient budget for nitrogen that incorporates all components of sources that may contribute nitrogen to soils and ground water. These include green water, storm water, manure solids, fertilizer, and composted material. The nitrogen balance for the NMP also accounts for the total amount of nitrogen added from freshwater irrigation. Consumptive use estimates for individual crops and specific regions are provided by NRCS at:

https://www.nrcs.usda.gov/wps/portal/nrcs/detail/nm/technical/?cid=nrcs144p2_068704

Preparation of the NMP requires utilization of the Soil Test Interpretation software which was developed at NMSU by Dr. Robert Flynn. The software includes a 590 Nutrient Management Job sheet that is to be used for each crop on each land application field. The 590 Jobsheets have multiple inputs and calculations accounting for each output. This manual aims to simplify the process by describing only those inputs which need to be changed to arrive at nutrient estimates. All other fields and tabs can be referenced for context but not changed for the purposes of this NMP. Most of these fields are set to auto populate. A 590 Jobsheet is shown in Appendix E3.

When dairies are applying for NPDES permit coverage, they must submit a NMP with their Notice of Intent NOI (see Section 4). NMPs have annual reporting requirements and are subject to public review and comment. Remember that a NPDES permit is not the same as a Ground Water Discharge Permit, and compliance with one does not necessarily mean compliance with the other. However, the recordkeeping elements described in Section 6 of this manual have been developed to incorporate the requirements of both permits in a single set of documents.

2.9 Natural Resource Conservation Service (NRCS) and Conservation Planning

The Natural Resources Conservation Service (NRCS), formerly known as the Soil Conservation Service (SCS), partners with private landowners and managers to help them conserve their soil, water, and other natural resources. The NRCS provides technical and financial assistance for site-specific conservation activities. The NRCS is not a regulatory agency, so participation in NRCS programs is voluntary. However, use of NRCS planning tools and technical guides can help ensure compliance with the state and federal regulations described above. More information about NRCS programs can be found at www.nrcs.usda.gov/programs or by contacting the local county office.

Conservation planning is a "natural resource problem-solving process." This process combines ecological, economic, and production considerations to meet the specific production and natural resource protection goals of a dairy operation. A conservation plan for a facility can be developed with the assistance of NRCS staff or by a certified conservation planner. A Comprehensive Nutrient Management Plan (CNMP) is a CAFO-specific part of a conservation plan.

2.10 The Comprehensive Nutrient Management Plan (CNMP)

The goal of a CNMP is to document how a dairy plans to manage manure and process wastewater. More specifically, the CNMP should describe the practices to use manure and process wastewater as a beneficial resource in meeting production goals, while addressing the soil and water conservation goals identified in the conservation plan. The NRCS has developed technical guidance for the development of CNMPs that will help satisfy NPDES permit requirements.

Comprehensive Nutrient Management Plans developed in accordance with NRCS guidelines should contain:

- Documentation of site information, production information, applicable permits or certifications, land application site information, manure application plans, actual activity records, mortality disposal, and operations and maintenance
- Documentation that a dairy has considered all six CNMP elements. A final CNMP is not required to include specific practices for all six elements, but at a minimum it must consider all six elements and explain why the element was or was not incorporated into the plan. The six elements are:
    i. Manure and wastewater handling and storage
    ii. Land treatment practices
    iii. Nutrient management
    iv. Recordkeeping
    v. Feed management
    vi. Other utilization activities
- Actions that address water quality criteria for the feedlot, production areas, and land application areas, including the potential for soil erosion. Generally, these actions will be documented in one or more of the six CNMP elements.
- Documentation that the CNMP meets the requirements of Field Office Technical Guide (FOTG) conservation practice standards. See section 2.11 for more details on the FOTG.
- Documentation that a dairy is in compliance with all applicable local, tribal, state and federal regulations.

With the exception of a facility-specific conservation plan, the recordkeeping elements described in Section 6 of this manual have been developed to incorporate these NRCS criteria. Again, the NRCS is not a regulatory agency, so compliance with their technical guidance is only mandatory when a dairy receives NRCS Environmental Quality Initiative Program (EQIP) funding. It is, however, recommended for ensuring compliance with NPDES and NMED regulations. If NRCS conservation practices are used, they must be completed in accordance with the standards described in the Field Office Technical Guides.

2.11 NRCS Field Office Technical Guides (FOTG)

Technical guides are the primary scientific references from NRCS. They contain technical information about the conservation of soil, water, air, and related plant and animal resources. Technical guides used in each field office apply specifically to the geographic area for which they are prepared. These documents are referred to as Field Office Technical Guides (FOTGs). Where applicable, specific sections of the FOTG are referenced in Section 6 of this manual. FOTGs for each state can be found here: https://efotg.sc.egov.usda.gov/#/state/NM.

2.12 Comprehensive Nutrient Management Plan vs Discharge Permit

A Ground Water Discharge Permit (DP) issued by the NMED only covers compliance with NMWQCC regulations. The DP for a dairy includes conditions that address ground water quality protection and nutrient management. Development of a CNMP will not necessarily guarantee compliance with NMWQCC regulations or the conditions of a DP. The specific conditions of a DP are mandatory by state regulation, while those of a CNMP are not (unless receiving financial assistance from the NRCS).

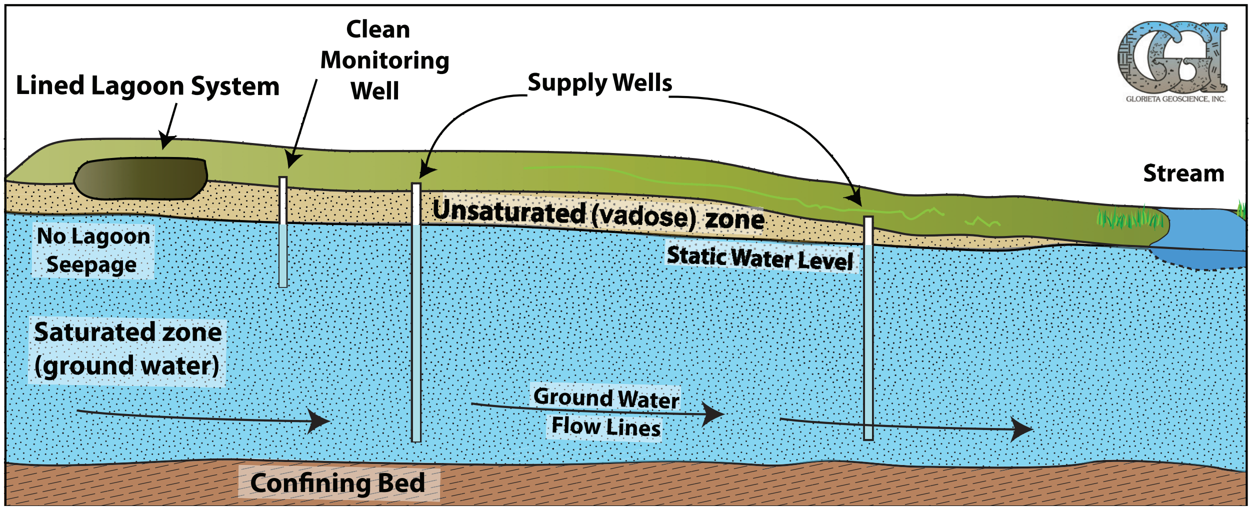


Figure 2.1. Cross-sectional schematic of a typical unconfined aquifer showing a line lagoon system, monitoring well, non-pumping supply wells, and static water level.

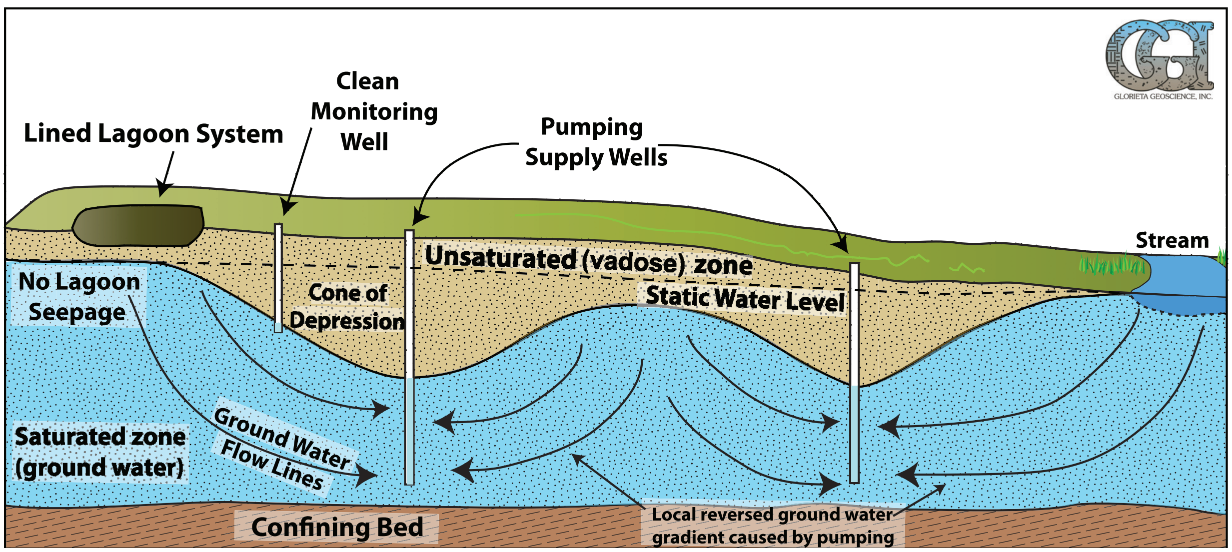


Figure 2.2. Cross-sectional schematic of lined lagoon system, pumping supply wells and coalesced cones of depression.

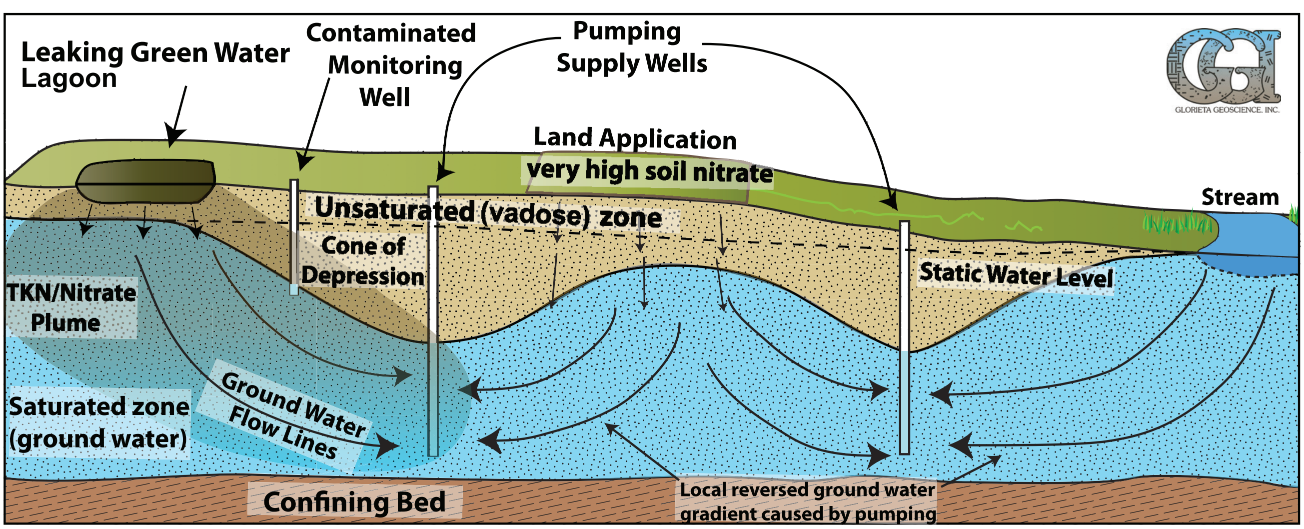


Figure 2.3. Cross-sectional schematic of lagoon system with leaking green water and pumping supply wells.

SECTION 3—THE SCIENCE BEHIND A DAIRY PERMIT

This section describes the various technical and scientific concepts in the fields of water quality, hydrology, geology, and well construction that are part of the dairy permitting process. Solid scientific data and thorough technical design are the strongest defense against frivolous or alleged permit violations. All decisions made for environmental compliance must be backed up by reproducible scientific data. Existing dairies generally have more than five years of green water discharge, land application rates, water quality, water level, and soil chemistry data. These data should be plotted and presented in graphical form to help analyze water quality, water level or soil chemistry trends. Section 7, Case Studies, presents data from various dairies.

3.1 Water Quality Basics

Water quality is influenced by regional and local geology, hydrology and soil types (see Sections 3.2, 3.3, and 3.4). A dairy is designed, constructed, and operated to be protective of both surface and ground water quality. Surface water quality is also influenced by industrial and agricultural discharges, increased erosion due to construction activities, increased runoff from paved surfaces, and discharges from septic/wastewater treatment systems. Leaching of regulated chemicals through soils underlying leaky lagoons or land application areas can cause NMWQCC ground water standards to be exceeded. Section 2 discussed the Clean Water Act (CWA) and the NMWQCC regulations and how they relate to surface water and ground water protection, respectively. This section will introduce additional regulations and definitions that are important to a discussion of water quality. This section will also discuss contaminants that may be discharged from a dairy operation, and their potential impacts on human/animal health and the environment. Finally, the section will discuss the proper location of monitoring wells, domestic wells, and supply/irrigation wells.

EPA uses the terms source, pathway, and target in addressing potential for ground water or surface water contamination. For dairies, the source can be leaking lagoons or over-application of manure and/or green water to land application fields. The pathway for the leaking contaminants is through the unsaturated zone downwards to the ground water aquifer. The target can be a down-gradient drinking water well or surface water in hydrologic connection to ground water. The gradient of the water table is the measure of how much the water level changes over a distance (i.e. the slope of the top of the water table, similar to the slope of a hill at ground surface). A down-gradient well is a well that has a water table elevation lower than an upgradient (e.g., uphill) contaminant source or well.

Recall from Section 2.6, that Section 402 of the federal CWA created the NPDES program to regulate the discharge of pollutants from point sources, including AFOs. For New Mexico dairies, this program is managed by the Region 6 office of the EPA in Dallas, TX. Other programs created by the CWA, however, are administered directly by the State of New Mexico via the NMED Surface Water Quality Bureau. Section 303 of the CWA requires each state to adopt standards for intrastate and interstate surface waters. Unlike the effluent limitations imposed on individual point sources by the NPDES program, the standards required by Section 303 are not source-specific. Rather, they are surface water–specific stream reaches, and they are based upon the designated use of the surface water. Some examples of designated uses include irrigation, marginal warm water aquatic life, livestock watering, wildlife habitat, primary contact and secondary contact. Regulations specific to New Mexico intrastate and interstate surface waters are found in 20.6.4.1 through 20.6.4.901 NMAC.

While the CWA pertains specifically to surface water, the federal Safe Drinking Water Act (SDWA) protects all water (surface or ground) that is or can be used as a source of drinking water[44]. The SDWA was passed in 1974 and was amended in 1996; the full text of this act can be found at 42 USC §300f et seq. The SDWA authorizes the EPA to establish minimum standards to protect drinking water at the tap (regardless of the source) and requires all owners or operators of public water systems to meet certain standards. These standards are described in the EPA's National Primary Drinking Water Regulations, which mandate legally enforceable standards for contaminants that can adversely affect human health. These primary standards are called maximum contaminant levels (MCLs) and cannot be exceeded in drinking water as it is delivered to consumers. There are currently primary standards for 90 chemical, microbiological, radiological, and physical contaminants in drinking water. The EPA has also established National Secondary Drinking Water Standards, which are non-enforceable guidelines (secondary MCLs) for 15 contaminants. Contaminants present in excess of these secondary MCLs do not threaten human health but may cause drinking water to have undesirable taste, odor or color and may damage or reduce the effectiveness of water delivery and treatment systems. These are sometimes referred to as "aesthetic" or "nuisance" effects. The relevance of these distinctions is discussed below.

As discussed in Section 2, a dairy is required to have a NMED-issued Ground Water Discharge Permit for the purpose of ground water quality protection. To comply with a Ground Water Discharge Permit, a dairy may not exceed the NMWQCC ground water quality standards outlined in 20.6.2.3103 NMAC, unless certain conditions apply (see Section 2.1). Because ground water is an important source of drinking water in New Mexico, the NMWQCC regulations include human health standards (20.6.2.3103.A) for ground water that are generally equal to the primary drinking water standards established by the EPA. The

NMWQCC regulations also include non-health-related standards (20.6.2.3103.B and C NMAC) that may or may not be the same as the secondary standards established by the EPA. Because the EPA's secondary ground water MCLs are non-enforceable, states may set their own secondary standards that are more or less stringent than the EPA's recommendations. States may also enforce their secondary standards, as is the case in New Mexico. Compliance with all of the NMWQCC ground water quality standards is mandatory. In general, a Discharge Permit will require a dairy to collect effluent and ground water samples on a quarterly basis and have them analyzed for nitrate-nitrogen (NO3), total Kjeldahl nitrogen (TKN), chloride (Cl), total dissolved solids (TDS) and sulfate (SO_4). Field parameter measurements are required to be submitted to show parameter stabilization. These constituents are discussed in detail below.

In some parts of New Mexico, surface water is used as a source of drinking water and may be impacted directly by runoff and point source discharges, or indirectly via a hydrologic connection to ground water. A dairy should operate in a manner that is protective of surface water, regardless of whether or not a NPDES permit is obtained. If a dairy has a NPDES permit, it must comply with the effluent limitations described in Section 2.7 of this manual and, in the event of any type of overflow/discharge, must collect a sample of the discharge and have it analyzed for fecal coliform,[52] five-day biological oxygen demand (BOD5), total suspended solids (TSS), ammonia-nitrogen (NH_3) and pesticides. These are discussed in detail below.

3.1.a Interpreting Water Quality Results

As previously discussed, quarterly sampling of all monitoring wells is required under the Dairy Rule. Water quality results for constituent concentrations inform and help monitor the subsurface underlying a dairy. This section will discuss how to interpret water quality results and how those results can provide direction to remain in compliance.

Monitoring wells are located strategically across a dairy to monitor and determine if ground water quality is being compromised. Upgradient wells monitor contamination entering a facility from off-site, while downgradient wells show impacts the dairy operations have on ground water. It is important to look at result trends in monitoring wells over time to determine if management practices are adversely affecting the dairy's water quality. When spikes in nitrate occur, certain logical assumptions regarding the cause can often be made. For instance, when a monitoring well adjacent to a lagoon, storm water pond or land application area shows elevated nitrate concentrations it may be assumed that the problem is a function of an ongoing issue with one of these sources. The lagoon liner may be leaking, a runoff pond may be lined with manure or overapplication of green water may have occurred.

In particular, flood irrigation methods tend to result in oversaturation of water at the surface. Nitrogen is predominant near the surface; however, flood irrigation pushes it deeper into the subsurface and accelerates the rate at which it reaches the water table. In this process, plant roots which typically uptake nitrogen near the surface are bypassed and the excess nitrate is driven down into the aquifer. This is one reason why center pivot irrigation is typically better for ground water quality and why the removal and/or conversion of flood fields to center pivots may be a requested corrective action or abatement procedure mandated by the NMED.

The infiltration rate of water can vary drastically depending on several different factors, including soil moisture, soil or rock type, pore space, vegetation type and many other parameters. The time it takes water to infiltrate to the water table also depends on the depth of the water table. Not all precipitation or land-applied water will infiltrate the ground surface, and some may evaporate or runoff. Factors that can affect which water ends up as runoff and which water infiltrates the ground surface include saturation of the subsurface and permeability of the ground. For example, frozen ground is less receptive to ground water infiltration. Generally, water which does infiltrate the subsurface may take anywhere from several months to several years to reach the water table depending on the infiltration rate and travel distance.

It is important to track water quality trends in monitoring and irrigation wells. Understanding the factors that can cause spikes or declines in water quality and the time it takes for those changes to show up in sample results can drive a dairy's management practices.

3.2 Constituents of Concern

The preceding paragraphs discussed different types of water quality standards, outlined the general water quality monitoring requirements for both NMED Discharge Permits and NPDES permits, and provided information on how to interpret water quality results. This section will discuss each of the potential contaminants/constituents of concern (COC) in detail, including their numerical water quality standards, health/environmental effects, monitoring requirements, and what their presence means for a dairy. Most of the standards discussed in this section refer to the concentration of the dissolved (in water) portion of the contaminant and are reported in milligrams per liter (mg/L), which is equivalent to parts per million (ppm). The exceptions to this are the standards for pH, mercury, organic compounds, and non-aqueous phase liquids. Except for pH, which can be measured in the field, analyses for these constituents must be performed by a state-approved laboratory (see Appendix E for sampling instructions and laboratory requirements). The information presented in this section is derived from the following sources:

http://bcn.boulder.co.us/basin/data/FECAL/info
https://www.epa.gov/agriculture/ag-101-overview-agriculture
https://www.epa.gov/sdwa/drinking-water-regulations-and-contaminants
https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations
https://pubs.nmsu.edu/_d/index.html

3.2.a Chloride (Cl)
Chloride is a common component of human and animal diets. Chloride is an important electrolyte that is incorporated into blood and cells, while any excess chloride is excreted in urine. Therefore, when chloride is detected in surface water or ground water, it is a fairly reliable indicator of fecal contamination. Increased chloride concentrations may also be found in areas where reclaimed wastewater is used for irrigation and is treated with chlorine prior to re-use. Water with high chloride concentrations may have a salty taste and contribute to corrosion and staining of water pipes and fixtures. Based on these aesthetic/nuisance concerns, the EPA has recommended a secondary MCL of 250 mg/L for chloride.[46] The NMWQCC standard for chloride in ground water is the same. In addition, the NMWQCC regulations specify other limits for chloride in certain intrastate surface waters. A Ground Water Discharge Permit will require quarterly sampling of lagoons and monitoring wells for chloride. Factors that can also affect high concentrations of dissolved solids such as chloride can include geology, climate, and ground water age.

3.2.b Coliform and Fecal Coliform Bacteria[52]
These bacteria belong to the family Enterobacteriaceae. Coliform bacteria live in soil, water and animal digestive tracts, and are generally harmless. Fecal coliform bacteria only inhabit the digestive tracts of warm-blooded animals and are considered **indicator organisms**. This means that their presence in a water sample is indicative of fecal contamination, as well as of the presence of other pathogenic (disease-causing) bacteria. The test for fecal coliform bacteria is usually a test specifically for *Escherichia coli*, (E. coli) a type of fecal coliform bacteria that is part of the normal bacterial population in the intestinal tracts and feces of all humans and many warm-blooded animals. Some strains of E. coli are harmless, while others can cause serious illness or even death in immunocompromised individuals. Fecal coliform bacteria are most commonly a problem in surface water but can be present in ground water. If a dairy has a NPDES permit, it is required to sample any discharges from the facility for fecal coliform bacteria. Because of the potential health effects of E. coli and other pathogenic bacteria, the EPA has established primary MCLs for both total coliform and fecal coliform bacteria in drinking water. No more than 5% of samples can test positive for total coliform in a month, and no samples can test positive for fecal coliform. In addition, the NMWQCC regulations specify numerical limits for E. coli, usually expressed as colony forming units (CFU) per milliliter, in certain intrastate surface waters.[46] There are no ground water standards for fecal coliform bacteria or *E. coli* in New Mexico.

3.2.c Five-Day Biological Biochemical Oxygen Demand (BOD5)
BOD5 measures the amount of oxygen required by bacteria and other micro-organisms to decompose the organic material in a water sample; this may also be referred to as **biochemical oxygen demand**. This is determined in the laboratory over the course of 5 days at 20oC (93.6^{o}F). In raw wastewater samples, the BOD5 will usually be very high because the amount of organic material available is also very high. In surface waters, high BOD5 means that the amount of oxygen available for aquatic animals is reduced, which can lead to fish kills. If a dairy has a NPDES permit, it is required to sample any discharges from the facility for BOD5. However, this is a reporting requirement as there are no federal or state standards for BOD5 in ground water, drinking water or surface water.

3.2.d Nitrogen Compounds and the Nitrogen Cycle[48,52]
Nitrogen is a nutrient required by all organisms for growth, maintenance and reproduction. There are two forms of nitrogen: organic and inorganic. Organic nitrogen is found in plant and animal cells, where it is a component of proteins and amino acids. Inorganic forms include nitrate (NO_3), nitrite (NO2), ammonia (NH_3)/ammonium (NH_4), and nitrogen gas (N_2). All forms of nitrogen continuously interact with each other in the **nitrogen cycle**. Nitrogen gas is a major component of the earth's atmosphere, but this form of nitrogen cannot be used directly by most plants or animals. It must first be converted to ammonia or nitrate. This process is called **nitrogen fixation** and is most commonly achieved by the biological activity of algae, bacteria and legumes. When these plants and animals die, the nitrogen they contain is broken down by bacteria to form ammonia (**ammonification**). Another type of bacteria then converts ammonia into nitrite, and yet another type of bacteria converts nitrite into nitrate (**nitrification**). The nitrogen cycle is complete when certain fungi and bacteria convert nitrate to nitrogen gas (**denitrification**), which is returned to the atmosphere (see Figure 3.1).

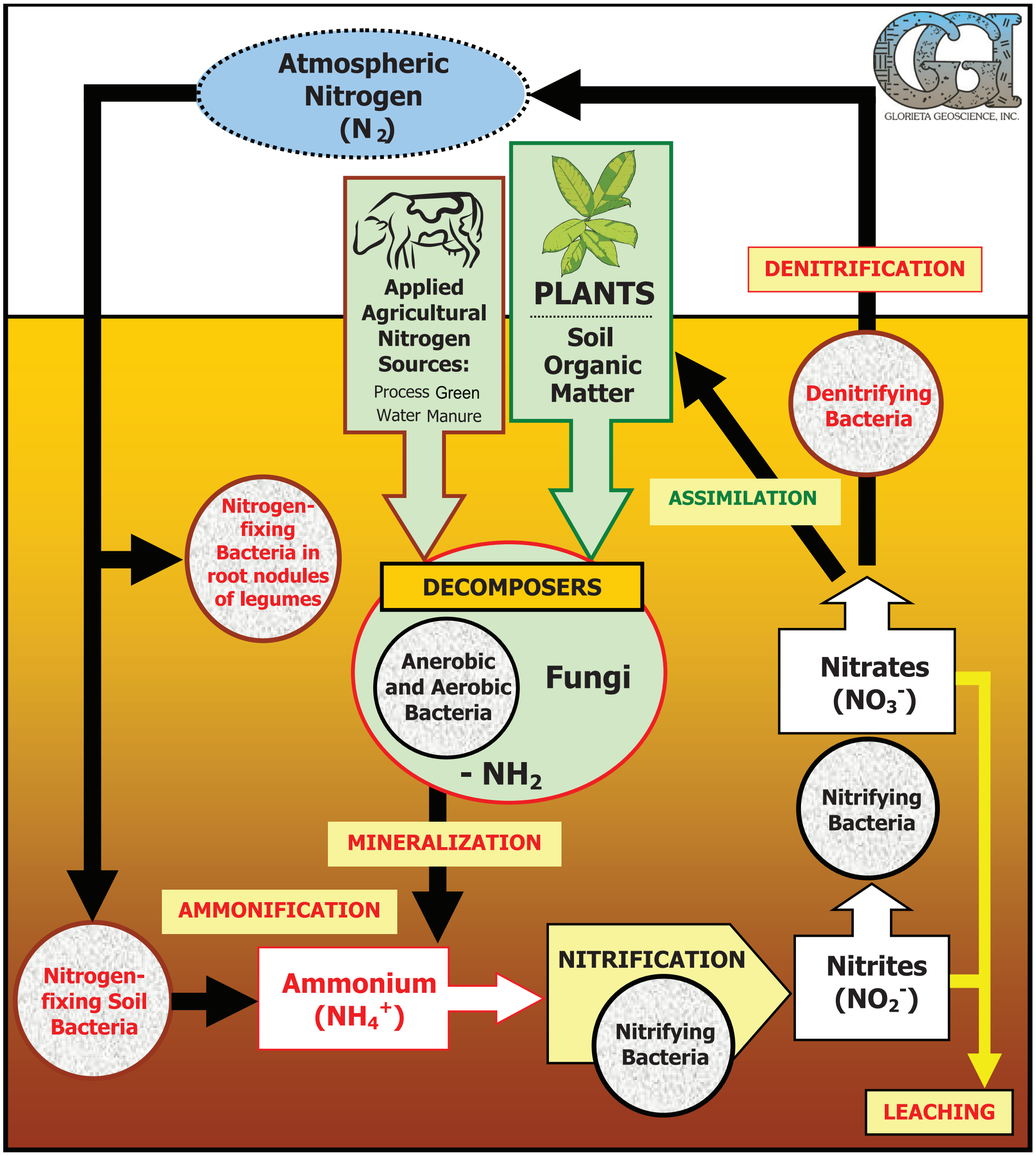


Figure 3.1. **Generalized diagram showing the major elements of the nitrogen cycle. Modified from USGS, 2011.**

Nitrate is the form of nitrogen that is most readily available to plants and can, therefore, be a good source of fertilizer. But because nitrate is very soluble in water it also has the greatest potential to contaminate surface water and ground water. Unlike with phosphorus, contributions of nitrate to surface water from agriculture are primarily through ground water connections and subsurface flows rather than runoff or erosion. Nitrite is toxic to most fish and other aquatic species but does not accumulate in the environment because it is rapidly transformed to nitrate. When ingested, nitrate is converted to nitrite in the intestines, and the nitrite interacts with hemoglobin in blood to produce methemoglobin. This interaction limits the ability of red blood cells to carry oxygen, resulting in a condition called methemoglobinemia or "blue baby" syndrome; this condition can also affect livestock and other animals. For this reason, the EPA has established a primary (health-related) MCL of 10 mg/L for nitrate and 1 mg/L for nitrite in drinking water.[49] The NMWQCC standard for nitrate in ground water is also 10 mg/L , but there is no standard for nitrite. In addition, the NMWQCC regulations specify a maximum nitrate concentration of 10 mg/L for intrastate waters with a designated use of domestic water supply, and a maximum nitrate-plus-nitrite concentration of 132 mg/L for intrastate waters with a designated use of livestock watering.

A Ground Water Discharge Permit will require quarterly monitoring of ground water for nitrate.

Nitrogen in manure solids or green water is mostly organic nitrogen and inorganic **ammonia** nitrogen. In water, ammonia nitrogen exists in two forms: the ammonium ion (NH_4) and ammonia gas (NH_3). The relative concentrations of these two forms depend on the pH (see below) and the temperature of the water. In the environment, ammonia is rapidly converted to nitrate, which, as discussed previously, is used by plants for growth or remains dissolved in water. The conversion of ammonia to nitrate removes oxygen from water (this is known as **eutrophication**), so excess ammonia can result in reduced oxygen concentrations, leading to fish kills. High concentrations of ammonia in surface water may also have direct, toxic effects on aquatic organisms. For these reasons, both the EPA and the NMWQCC have established criteria for maximum ammonia concentrations in surface waters. These concentrations are pH- and temperature-dependent and range from ±0.1 mg/L to ±10 mg/L. If a dairy has NPDES permit coverage, it is required to sample all discharges from the dairy for ammonia to gauge the potential impact of the discharge to surface water. In ground water, most ammonia has been converted to nitrate, and concentrations will be low or non-detectable. A Ground Water Discharge Permit does not require ground water monitoring for ammonia.

Total Kjeldahl Nitrogen (TKN) is a measure of the amount of organic nitrogen plus ammonia/ammonium. Depending on how the analysis is completed, it may also provide a measure of **total nitrogen**, which is equal to organic nitrogen plus ammonia/ammonium plus nitrate/nitrite. As discussed in the previous paragraph, nitrogen in manure solids and green water is mostly organic nitrogen and inorganic ammonia nitrogen. Therefore, the TKN analysis is important for determining the nitrogen content of solid manure and lagoon water. TKN concentrations are used for nutrient management planning and land application data sheets (LADS). There are no state or federal standards for TKN in ground water, surface water, or drinking water, however, a Ground Water Discharge Permit will require quarterly monitoring of lagoon water and ground water. TKN concentrations in dairy lagoons can range from 250 mg/L to 1,000 mg/L, and before land applying, a producer must demonstrate that the crops in land application areas can take up this amount of nitrogen. TKN is not plant-available but can become plant available when it oxidizes to nitrate. In ground water, the ammonia/ammonium portion of TKN is converted to nitrate, so concentrations are usually very low or non-detectable.

3.2.e Pesticides

Pesticides are substances or mixtures of substances intended for preventing, destroying, repelling, or mitigating any pest. The term pesticide also applies to herbicides, fungicides and other substances used to control pests. This definition does not include drugs for human or animal use, nor does it include fertilizers or other crop nutrients. Pesticide contamination frequently affects surface water and, to a lesser extent, ground water in areas with significant agricultural and/or industrial use. Some pesticides can have adverse impacts on aquatic life and may persist in the environment for long periods of time. While the EPA has established primary standards for some pesticides in drinking water, other state and federal standards are narrative or specific to one or more surface waters.[49] If a dairy has NPDES permit coverage, it is required to sample any discharges from the facility for the pesticides most likely to be present in the waste stream. There are no NMWQCC standards for pesticides in ground water, although specific pesticides may be regulated under the toxic pollutant criteria discussed below.

3.2.f pH[48,52]

pH represents the concentration of hydrogen ions (H+) in water and is measured on a scale of 0 to 14. Using this scale, a pH of 7 is considered "neutral," a pH less than 7 is acidic, and a pH greater than 7 is basic/alkaline. The pH of surface water and ground water is primarily determined by the geologic and hydrologic setting, but may be influenced by air pollution, mine drainage and the carbon dioxide concentration of the water. Most organisms have an optimal pH for growth but can tolerate variations of 2 or 3 pH units higher or lower than the optimum. Outside of this pH range, an organism will not be able to grow or survive. In general, very high (>9.5) or very low (<4.5) pH values are unsuitable for most aquatic organisms. These high and low pH ranges are not considered to have human health effects, but they can have nuisance effects. Water with low pH (acidic) can have a bitter or metallic taste and can corrode pipes. Water with high pH (basic or alkaline) can feel slippery, have a "soda" taste, and can lead to scaling and sedimentation. Based on these non-health related effects, the EPA has recommended a secondary MCL of 6.5 to 8.5 for drinking water. The NMWQCC standard for pH in ground water is between 6 and 9, and this is the standard that must be met at all dairies. In addition, the NMWQCC regulations specify pH ranges for certain intrastate surface waters. A NMED-issued Discharge Permit may require quarterly sampling of lagoons and monitoring wells for pH. While pH can be measured in the field, a dairy may also request this analysis from laboratory samples.

3.2.g Phosphorus (P)[48,52]

Phosphorous is an element naturally found in rock, soil and organic material, and is a nutrient necessary for all organisms to carry out basic life functions. Phosphorus is also a major component of fertilizer and is present in manure solids and green water and sewage. Like nitrogen, phosphorus can be organic or inorganic and can be dissolved in water or exist as particulate matter. Unlike nitrogen, phosphorus is not very soluble in water and tends to remain bound to the soil. Organic phosphorus is part of plant or animal tissue and can also be formed from the break-down of fertilizers or pesticides. Inorganic phosphorus includes orthophosphates and polyphosphates. Orthophosphate is produced by natural processes and is found in sewage; it is the most stable form of phosphorus and is the form used by plants. Polyphosphate is the type of phosphorus found in detergents and boiler water; in water, polyphosphate is unstable and eventually converts to orthophosphate.

Because phosphorus binds tightly to soil particles where it can be used by plants, it can provide valuable nutrients for crops (see Section 3.4) when applied at agronomic rates. But when excess phosphorus is applied, either in fertilizer or manure solids or green water, it can be carried to surface waters by erosion and/or runoff. In fresh-water lakes and rivers, phosphorus is commonly a **growth-limiting nutrient**, which means that it is not readily available in the amounts needed by aquatic plants. When excess phosphorus reaches these waters, however, the aquatic plants have more than enough phosphorus, and their growth is accelerated, resulting in an **algae bloom**. When these plants die, they are consumed by bacteria that use oxygen in the process of decomposing the plants. Consequently, increased plant growth leads to increased bacterial activity and decreased oxygen concentrations in the water. This process is called **eutrophication**. When oxygen concentrations drop too low for fish to breathe, fish kills can result. In addition, algae blooms can restrict recreational opportunities, clog pipes and cause foul odors. Despite these issues, there are no national or state standards for phosphorus in drinking water, surface water or ground water. The EPA has, however, recommended the following: (1) total phosphates should not exceed 0.05 mg/L in a stream at a point where it enters a lake or reservoir, and (2) total phosphorus should not exceed 0.1 mg/L in streams that do not discharge directly into lakes or reservoirs. Phosphate is a form of phosphorus found in water, and total phosphorus refers to dissolved phosphorus plus suspended/particulate phosphorus. Because phosphorus primarily affects surface waters, a NMED-issued Discharge Permit should not require ground water monitoring for this constituent. The NMWQCC regulations have established limits on total phosphorus for certain intrastate surface waters, mostly in areas of the state with little or no dairy activity. If a dairy has a NPDES permit or is receiving NRCS funding, it will be required to incorporate plans for phosphorus land application, erosion control, and soil sampling in its NMP or CNMP (see Section 6.5).

3.2.h Sulfate (SO4)

Sulfate occurs naturally in ground water in varying concentrations, depending on the local geologic and hydrologic setting. When ground water is contaminated with wastewater (from human or animal sources), this creates low oxygen (anoxic) conditions that force bacteria to use sulfate (rather than oxygen) to generate energy. This is called **anaerobic respiration**, and results in the production of hydrogen sulfide that can give water a rotten egg odor. High sulfate concentrations can be the result of the geologic setting and/or contributions from wastewater, so it is important to have good background water quality data. High sulfate concentrations may have a laxative effect and produce diarrhea in infants, children and young animals. Therefore, the EPA has recommended a **health-based advisory value** (non-enforceable) of 500 mg/L. Drinking water and ground water with high sulfate concentrations may also have an unpleasant taste or odor. This could result in palatability issues for a dairy herd, resulting in inadequate hydration. Based on these aesthetic concerns, the EPA has recommended a secondary MCL of 250 mg/L sulfate in drinking water. The NMWQCC standard for sulfate in ground water is 600 mg/L. In addition, the NMWQCC regulations specify limits for sulfate in certain intrastate surface waters. A Ground Water Discharge Permit may require a dairy to monitor sulfate concentrations in the ground water.

3.2.i Total Dissolved Solids (TDS)

TDS are solids in water that can pass through a filter, and TDS is a measure of the amount of material dissolved in water. In general, the TDS concentration is the sum of cations (positively charged particles) plus anions (negatively charged particles). These include carbonate, bicarbonate, sulfate, phosphate, nitrate, calcium, magnesium, sodium and organic ions. High TDS concentrations in surface water can reduce water clarity, increase water temperature, and result in density changes that affect the flow of water into and out of plant and animal cells. High TDS concentrations in ground water or drinking water are indicative of high concentrations of the ions listed above and are generally correlated with impaired water quality. TDS is not considered to present a risk to human health, but it can affect the odor, color and taste of drinking water. It may also result in increased scaling and sedimentation in water pipes and fixtures. Due to these aesthetic/nuisance effects, the EPA has recommended a secondary MCL of 500 mg/L for drinking water. The NMWQCC standard for TDS is 1,000 mg/L in ground water, and this is the standard that must be met at a dairy. In addition, the NMWQCC regulations specify other limits for TDS in certain intrastate surface waters. A Ground Water Discharge Permit will require quarterly sampling of lagoons and monitoring wells for TDS.

3.2.j Total Suspended Solids (TSS)
TSS are solids in water that can be trapped by a filter; TSS plus TDS are equal to the total solids in a water sample. TSS can include sediment, decayed organic matter, industrial wastes and sewage. In surface water, high concentrations of TSS can block light required by aquatic vegetation and increase surface water temperatures. This results in decreased oxygen available for fish and other aquatic species and can lead to fish kills. High concentrations of TSS can also decrease water clarity, clog fish gills, and prevent egg and larval development of aquatic animals. High TSS may also be an indicator of the presence of other pollutants that are likely to be attached to sediment particles. If a dairy has a NPDES permit, it is required to sample any discharges from the facility for TSS, but as with BOD5, this is a reporting requirement as there are no federal or state standards for TSS in ground water, drinking water or surface water.

3.2.k Toxic Pollutants
These include disease-causing agents that, after discharge and upon exposure, ingestion, inhalation or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will cause death, shortened life spans, disease, adverse behavioral changes, reproductive or physiological impairment or physical deformations in such organisms or their offspring. Under certain (but very unlikely) circumstances, a dairy could be required to monitor ground water samples for toxic pollutants. Regardless of whether or not the dairy has NPDES permit coverage, it may not discharge toxic pollutants to waters of the United States. Toxic pollutants are defined by Section 307(a) of the CWA, and a state-specific list of toxic pollutants can be found in the NMWQCC regulations (20.6.2.7.T.2 NMAC).

3.3 Tracking the Source of Nitrogen Contaminants

Although dairies may be a source of nitrates contributing to ground water contamination, there are also other sources of nitrates that may be present in the vicinity of a dairy. Other sources of nitrates can include decaying biomass, septic tanks, municipal wastewater discharges, and chemical/synthetic fertilizers. If any of these sources are near a dairy and a monitoring well or supply well shows high nitrate concentrations, a study can be performed using both general chemistry and stable isotopes of nitrogen and oxygen to track the source.

3.3.a Determining the Source of the Nitrate
Tracers such as chloride (Cl), caffeine or stable isotopes of nitrogen (N), hydrogen (H), oxygen (O), and boron (B) can be used to track the source of nitrate. Note that stable isotopes are not radioactive and do occur naturally. Nitrogen has two stable isotopes:

- All N-atoms have 7 protons and 7 electrons
- Most N-atoms have 7 neutrons -> ^{14}N
- Some N-atoms have 8 neutrons -> ^{15}N

3.3.b Using Isotopes to determine Nitrogen source
Biological processes generally uptake the lighter isotope forms (e.g., 14N), therefore the ratio of ^{15}N:^{14}N increases as one moves up the food web. A lower $\delta^{15}N$ ratio means relatively less of the heavy ^{15}N isotope is present in the sample. Biologic processes result in different isotopic structures. By observing $\delta^{15}N$ concentrations, nitrate sources can be distinguished to some extent (Figure 3.2). Fertilizer has relatively low $\delta^{15}N$ concentrations and relatively high $\delta^{18}O$ concentrations and is distinctive when compared to biologic sources of nitrate, which has relatively high δ15N concentrations and relatively low $\delta^{18}O$ concentrations. As shown in Figure 3.3, manure and septic system effluent have similar high $\delta^{15}N$ signatures and cannot be easily distinguished from one another.

Isotopic analyses cannot completely eliminate all potential sources as human, as manure solids or green water may overlap fields. However, isotopes can be used to distinguish synthetic fertilizer from manure as the source of nitrate in ground water.

Other tracers include chlorides and oxygen isotopes (^{18}O). High chloride tends to be associated with manure solids and green water, but some areas have ground water with naturally occurring high chloride concentration (Figure 3.4). Research by McQuillan[34] shows that Chloride/nitrate ratios of greater than 16:1 are indicative of dairy sources while ratios of less than 16:1 suggests stronger septic contributions to ground water. Nitrate (NO_3) contains both N and O and by analyzing their stable isotopes we can gain additional information.

The $\delta^{15}N$ and $\delta^{18}O$ ratios can be used to distinguish NO_3 fertilizer from manure/septic sources even if denitrification is occurring (Figure 3.5), but technology is not currently available to distinguish between human waste/manure solids and green water as source.

Lagoon water is exposed to evaporation and has a different isotopic signature than ground water or well water. Septic system water is not exposed to evaporation. If lagoon water enters ground water, it will locally change the isotopic signature. As shown in Figure 3.6, nitrate/chloride ratios may change over time at individual dairies.

- Determining the source of NO_3 contamination in ground water is complex and has many variables such as:
- No single analysis will yield conclusive results
- Multiple samples over time are needed to determine the source
- The more data collected, or wells sampled the better
- The more information on ground water quality/chemistry and ground water flow direction from existing data the easier it is to distinguish potential sources.

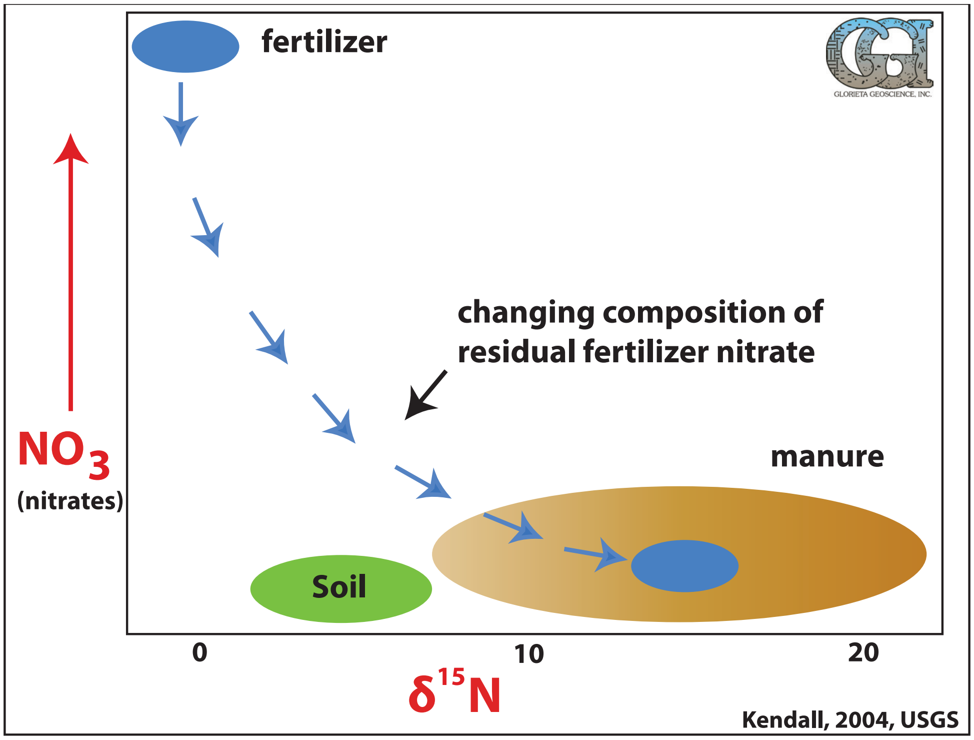


Figure 3.2. Changing chemical composition of residual fertilizer nitrate. Modified from Kendall, 2007.

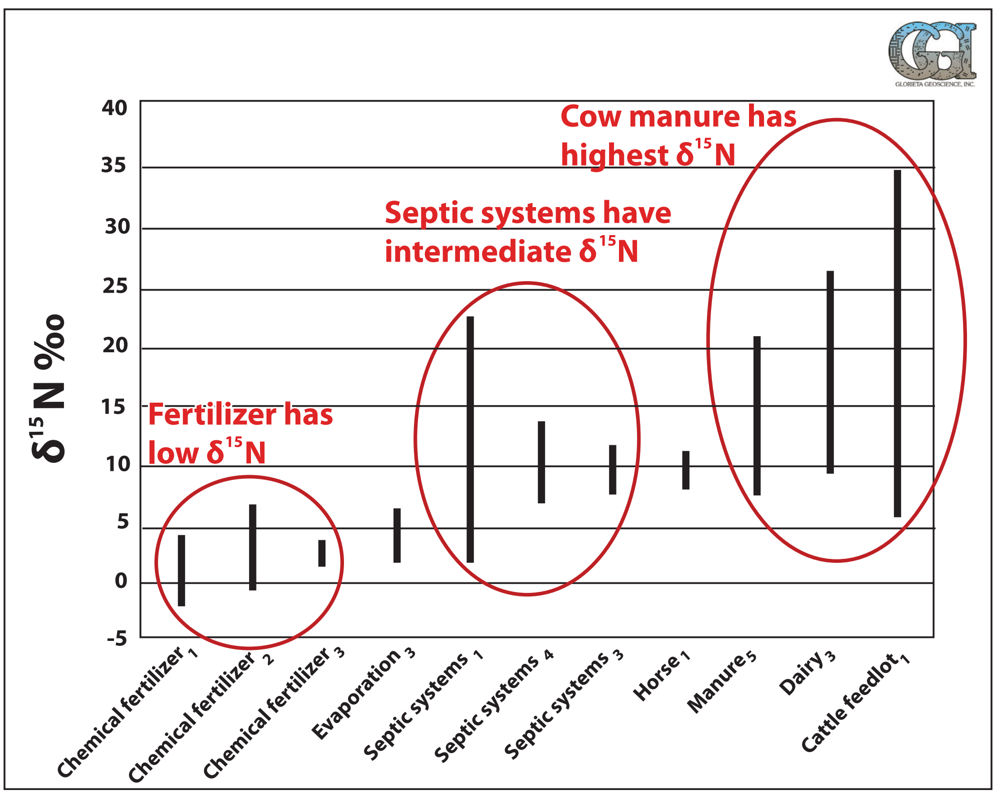


Figure 3.3. Isotopic signature ranges (δ15N) of different NO3 sources (Fogg et al., 1998; Karr, 2002; McQuillan, 2004; Aravena et al., 1993; Clark and Fritz, 1997).

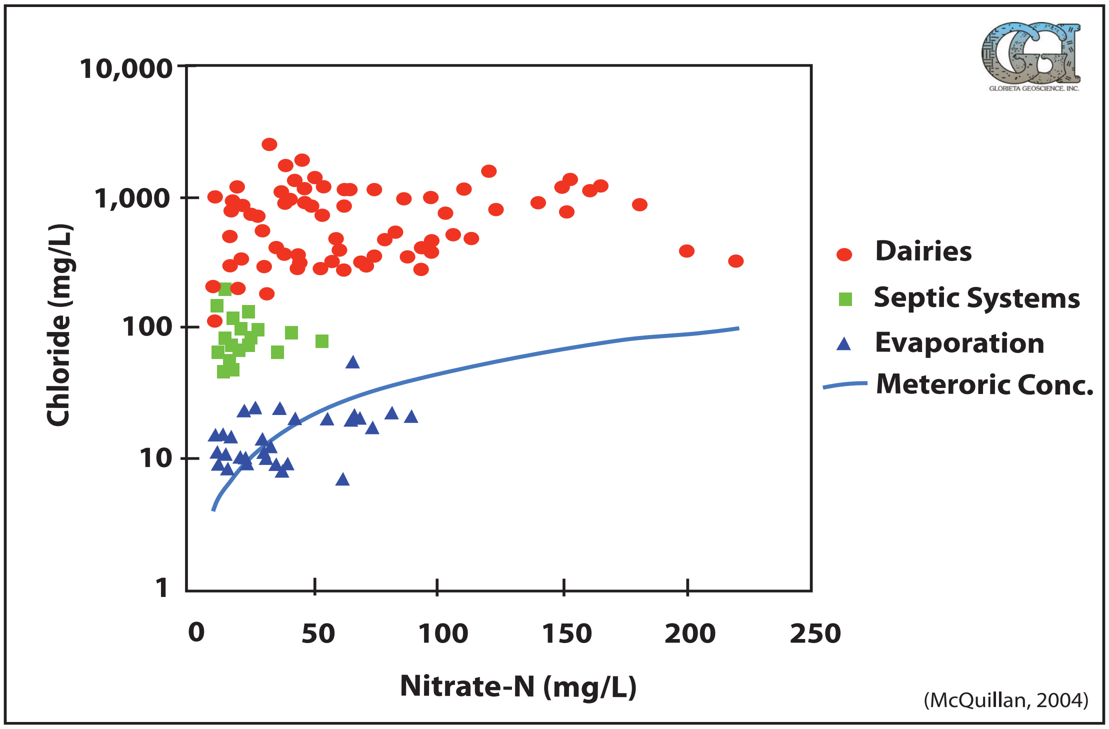


Figure 3.4. **Middle Rio Grande Valley, NM, chloride/nitrate ratios. (Chloride and nitrate in contaminated groundwater. All data are from the Middle Rio Grande, NM. Background chloride at each site is less than 20 mg/L). Modified from McQuillan, 2004.**

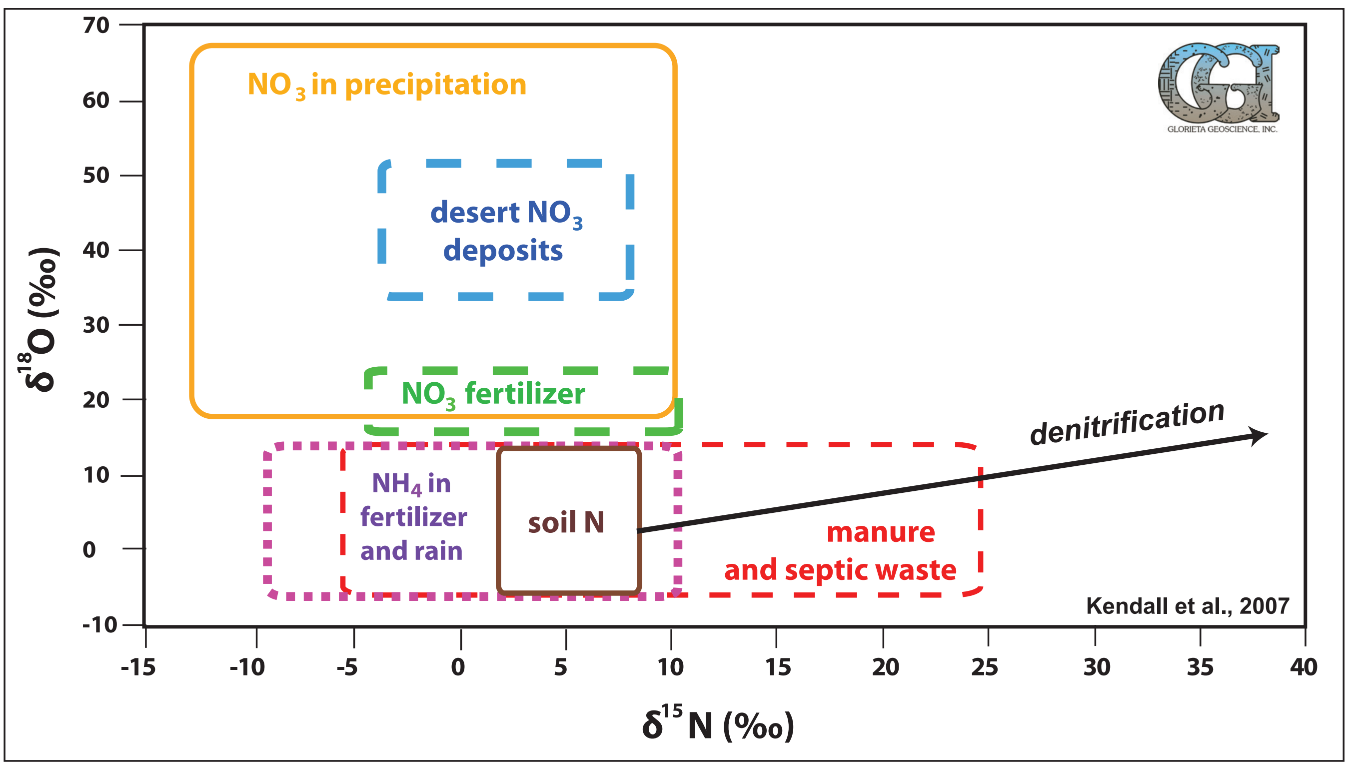


Figure 3.5. **Isotopic signatures (δ18O [‰] and δ15N [‰]) of precipitation, desert deposits, fertilizer, fertilizer and rain, soil, and manure and septic waste; and the denitrification curve (Kendall et al., 2007).**

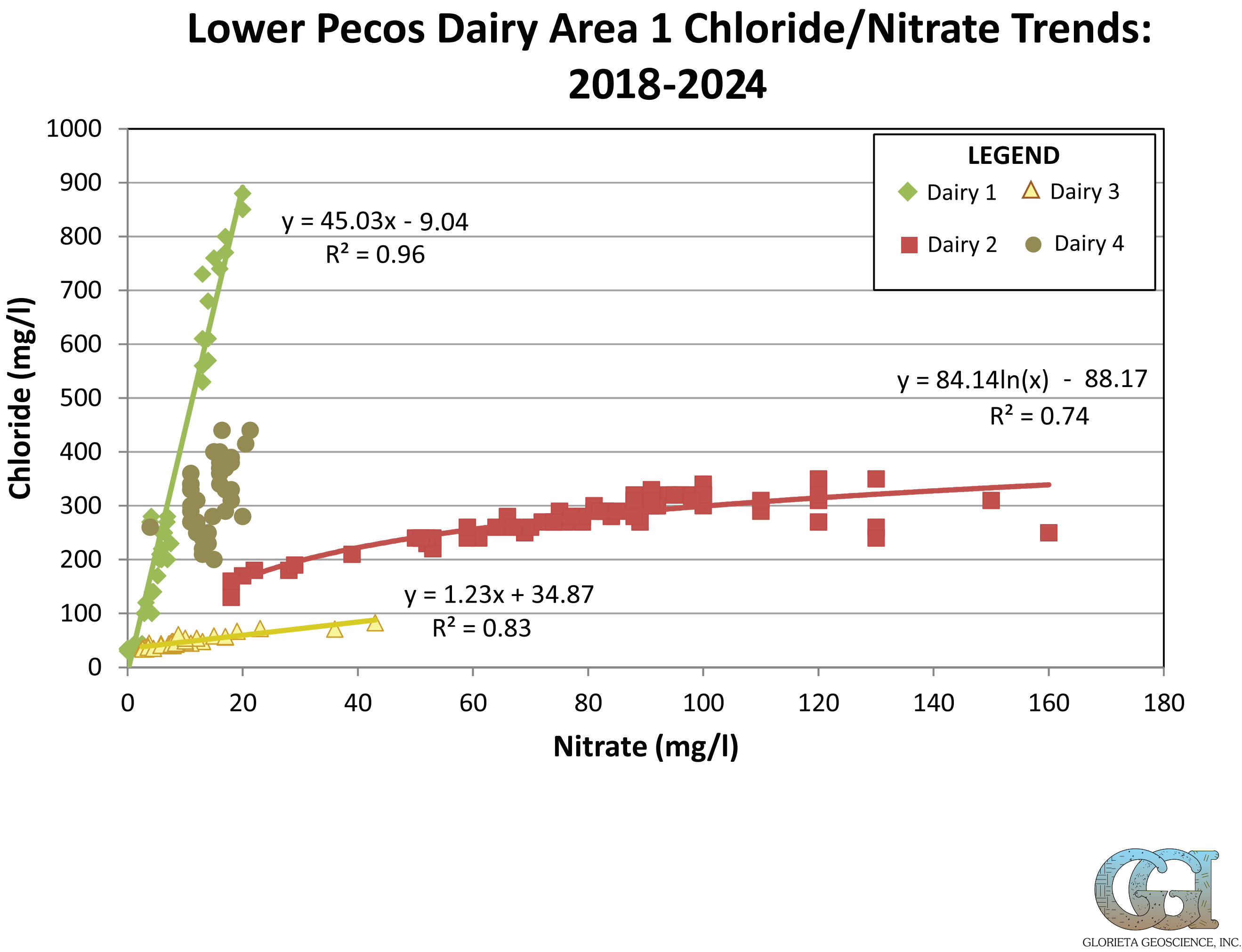


Figure 3.6. **Lower Pecos Dairy Region Chloride/Nitrate Trends: 2018-2024 (Lazarus and Naumburg, 2011).**

3.4 Ground water and Monitoring Wells

The purpose of a ground water monitoring well network is to monitor ground water quality in the shallowest aquifer most likely to be affected by a dairy's discharge. Monitoring wells provide an "early warning system" for operational issues that could lead to ground water contamination and violation of Discharge Permit conditions. A Ground Water Discharge Permit will generally require a dairy to have at least three monitoring wells. One monitoring well must be located hydrologically upgradient of discharge locations such as lagoons or land application areas, while a minimum of two monitoring wells must be located down-gradient. Depending on the layout, size and complexity of the underlying aquifers, additional monitoring wells may be required to adequately monitor a facility. The Dairy Rule sets the prescriptive locations for monitoring wells.

For protection against future liabilities, it is critical to install and sample the monitoring wells prior to starting dairy operations. It is also a condition of approval for a NMED Ground Water Discharge Permit. By establishing background (pre-dairy) water quality conditions, a dairy protects itself from future liabilities if an upgradient well shows high contaminant concentrations originating offsite.

Figure 3.7 shows a typical dairy configuration (for the fictional Happy Cow Dairy) with separate green water and storm water lagoons and properly located monitoring wells. A dairy can eliminate one monitoring well if it has a combined lined green water/storm water lagoon system.

In Figure 3.7, Monitoring Well 3 (MW 3) is located hydrologically upgradient of the dairy. The purpose of this upgradient monitoring well is to provide "background" water quality data. The term "background" refers to the quality of ground water that is not impacted by a dairy as it flows beneath the property. Samples from these upgradient wells are collected to determine if contaminants are flowing onto the dairy and how the operations of the dairy are impacting ground water. To determine if the dairy operations are impacting the ground water, a producer will need to compare water quality data from the upgradient monitoring well with data from the downgradient monitoring wells. In Figure 3.7, Monitoring Well 2 (MW 2) is located downgradient of the lagoon system, Monitoring Well 1 (MW 1) is located down gradient of the land application area and Monitoring Well 4 (MW 4) is located down gradient from the separate storm water (or runoff) lagoon. If the lagoon system has been properly constructed and maintained, contaminant concentrations in MW 2 and MW 4 should be comparable to those in MW 3 or equal to the background conditions. If, however, a distribution pipe is leaking or the lagoon liner has been damaged or the storm water lagoon was not lined, contaminant concentrations will likely increase in MW 2 and MW 4. Similarly, if a reasonable nutrient balance is being maintained in the land application areas, contaminant concentrations in MW 1 will be comparable to those in MW 3. If nutrients are being over-applied, however, contaminant concentrations will increase in MW 1. In both cases, increasing contaminant concentrations are providing clues that certain operational issues need to be addressed. By knowing this information, a producer can resolve these issues before ground water standards are exceeded and permit conditions violated.

Monitoring wells must be installed in accordance with NMED guidelines (see Appendix H). Their locations and elevations at the top of the well casing must also be surveyed to the nearest hundredth of a foot by a licensed professional surveyor. To avoid cross-contamination between sample locations, it is important that protocol is followed when collecting environmental samples. Detailed instructions for collecting ground water samples are provided in Appendix E. Appendix E also provides instructions for collecting lagoon water samples for NMED Discharge Permit compliance and discharge/overflow samples for NPDES permit compliance. Examples of water quality data and case studies related to water quality are provided in Section 7.

3.5 Domestic Well Locations

The location of on-site and off-site domestic wells must be considered when planning a new dairy or operating an existing dairy. Due to the health issues associated with contaminants such as nitrate and fecal coliform, it is very important for dairies to minimize the transport of these contaminants to existing or potential sources of drinking water. In areas where water is supplied by a public system, water quality at the tap is the responsibility of the system's operator. In New Mexico, however, many dairies are located in rural areas where residents (including dairy owners and their families) rely on private wells for their drinking water. In these areas, ground water contamination from any source can present problems for private wells.

As discussed, water quality regulations pertaining to New Mexico dairies are designed to be protective of ground water and surface water. While drinking water regulations are not directly applicable, some ground water and surface water standards are the same as drinking water standards (e.g., nitrate). While regulatory compliance is required, a dairy should also consider the benefits of voluntarily being a "good neighbor" by operating and maintaining their systems in a way that does not negatively impact the domestic water supply. In New Mexico, all domestic wells must be located and completed in accordance with the OSE's rules and regulations for construction, repair and plugging of wells (19.27.4 NMAC).

3.6 Supply and Irrigation Well Locations

Contamination of supply wells and/or irrigation wells can result when they are improperly located, constructed or completed in the wrong aquifer. Contamination of supply wells by nitrate or sulfate can adversely affect herd reproductive health and milk production, while contamination of irrigation wells with chloride or TDS can also adversely affect crop production.

In addition, NPDES regulations prohibit land application of manure or process-generated green water within 100 feet of agricultural well heads, open tile-line intake structures or other conduits to surface water. Alternatively, a dairy may use a 35-ft vegetated buffer between land application areas and these structures.

3.7 The Ground Beneath the Dairy—The Basics of Geology

New Mexico is very diverse in rock types and geologic formations. The depositional environments, volcanic eruptions, and tectonic history of the state involves about every major geologic process known on earth. The arid climate of the Southwest United States prevents extensive plant growth and leaves much of the rock exposed for scientific study. The low rainfall and warm temperatures experienced by most of the state impact the rock weathering processes and often helps to preserve geologic features.

3.7.a Varieties of Rocks

There are three main rock types: igneous, metamorphic and sedimentary. Igneous rocks are formed from the cooling and hardening of molten rock such as magma or lava. The two types of igneous rocks are extrusive and intrusive. Extrusive rocks are volcanic rock which cooled from molten rock on the surface of the earth (lava). Intrusive rocks, or plutonic rock, are rocks that cooled from a magma chamber located underground. Magma chambers vary greatly in size from many square miles to smaller feeder chambers, which are essentially the underground parts of a volcano that never made it to the surface. Volcanic rock includes lava, ash, and tuff. New Mexico has many volcanic areas that range in age from 60 million years old to about 3,800 years old[14,57]. Many of these volcanoes are associated with the plate.

In New Mexico, intrusive rocks like granite range in age from Precambrian (about 1.4 to 1.8 billion years old) to Tertiary (about 37 million years old) and are generally found in fault-block mountains such as the Sandia Moun-

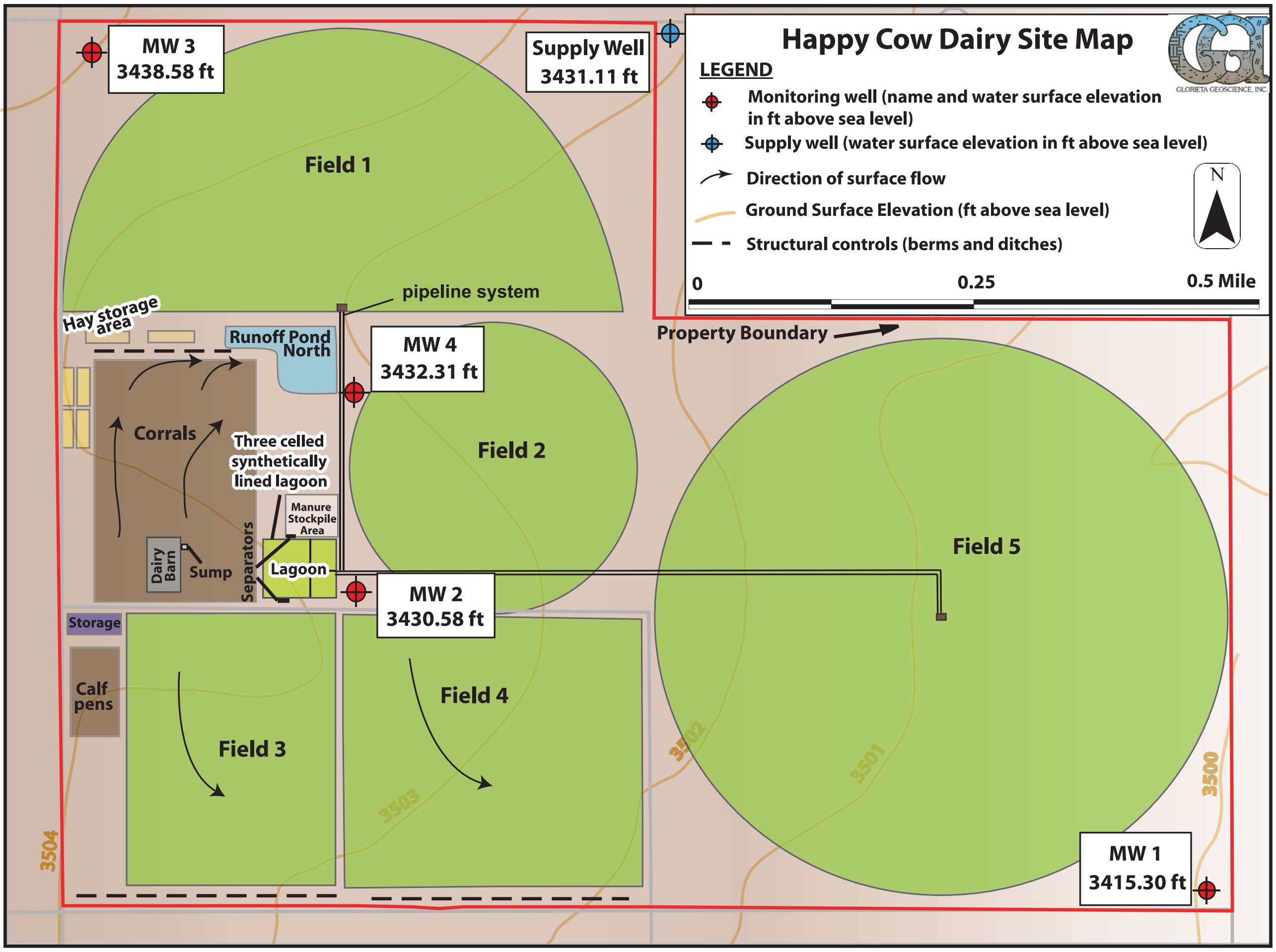


Figure 3.7. **Happy Cow Dairy—Typical dairy configuration with monitoring wells.**

tains east of Albuquerque, Sangre De Cristo Mountains near Santa Fe, or in eroded volcanic/intrusive mountains like Sierra Blanca. Since intrusive rock is formed far below the earth's surface, it must be brought up to the surface after it forms. In many cases, this rising force is due to faulting related to the opening of the Rio Grande Rift accompanied by erosion, which removes the overlying rock to expose the underlying intrusive rock.

Sedimentary rock in New Mexico includes clastic rock, created by deposition and lithification of clasts, such as clay, sand, or pebbles, and chemical or biochemical rocks that are created by chemical and biological precipitation of minerals such as calcite, gypsum and halite (salt). The most common types of sedimentary rock found across New Mexico include sandstone, siltstone, shale, mudstone and limestone, with relatively significant deposits of gypsum and salt in the southeastern part of the state. Sedimentary rocks in New Mexico range from late Cambrian-age (490 million years old) to the recent past. Younger formations include some semi-consolidated rocks of the Santa Fe Group sediments in the Rio Grande Rift. As with many sedimentary rocks, these sediments provide an aquifer for towns and cities along the Rio Grande.

Porosity is the amount of void space between sediments or grains in a rock. In sedimentary rocks such as sandstone, the amount of void (or pore) space can be quite significant. Igneous rocks, which cool from molten magma or lava, contain intergrown crystals and can have very limited void spaces and low porosity. Secondary porosity is void space that is created after a rock forms. This secondary porosity forms as rocks break or fracture over time or as rocks get shifted around through faulting and tectonic movement. The permeability of a rock is the connectedness of the void spaces. The more connected the pore spaces, the greater the ability of water to flow through the rock. Rocks with high permeability allow water to flow through them very rapidly (feet per year), while water movement through rock with low permeability is very slow (feet per century). Porosity and permeability are the dominant factors or properties which control the ability of water to flow through a rock or sediment. These properties determine whether rock formations or sediments within the saturated zone will be an aquifer or an aquitard.

3.7.b Faults and Fractures in the Rocks

Faulting and fracturing of rock are important in the formation and control of aquifer systems. In bedrock of any type, fracturing can create secondary porosity, which greatly increases the overall permeability of a rock. The cracks and fractures along a fault zone can allow water to flow rapidly. In areas where limestone or igneous rocks are dominant these cracks and factures may be the only portions of the rock which hold water.

Faults can also create barriers to ground water flow within aquifers or can delineate the edge of an aquifer. Deeper parts of the Santa Fe Group aquifer, in the middle Rio Grande dairy-producing region, have faults that cut through the partially consolidated sandstone, creating zones of concentrated cementation of the sand grains. This cement fills the void spaces within the sandstone, limiting the permeability, which makes it more difficult for ground water to travel through the aquifer. In some scenarios, faults can create compartments in an aquifer that separate different areas of ground water flow like an ice-cube tray. When a well is pumping in one compartment of the aquifer, the ground water from the other compartments does not readily flow in to refill the water that is taken out by the well, which leads to significant drawdown of the aquifer in the area near the well.

3.7.c Surface Landforms and Physiographic Provinces

The physiographic provinces of New Mexico (Figure 3.8) are regions with particular patterns of landforms (e.g., mountains, river floodplains, canyons) that differ significantly from adjacent regions. Each of these provinces has had a distinctive geologic and hydrologic history that has led to the features that we see today[16].

New Mexico has six major physiographic provinces that influence the dynamics of water flow and distribution:

1. Rio Grande Rift – The Rio Grande Rift forms the tectonically well-defined eastern side of the southeastern Colorado Plateau, southern Rocky Mountains, and western Great Plains. It is one of the classic continental rifts of the world with similar size and geometry of half-graben basins, rift flanks characterized by young volcanism, and transfer zones similar to the East African Rift[25]. The Rio Grande Rift is further defined by the continental-scale river, the Rio Grande, flowing from the southern end of the Rocky Mountains and into the southern Basin and Range.
2. Southern Rocky Mountains Province – The Southern Rocky Mountains are part of the southern end of the unusual mountain belt, greater than 600 miles from the convergent plate margin near the west coast of the United States. The Rocky Mountains are formed by "thick skinned", deep basement rock-cored arched features. Paleozoic and Mesozoic rocks bend and/or are faulted upwards as they enter the Rocky Mountains from both the Colorado Plateau and Great Plains sides[21]. The Rocky Mountains host many high-elevation ski resorts and hiking trails popular in the western United States.
3. Colorado Plateau – The Colorado Plateau is characterized by relatively flat-lying, but high elevation Paleozoic and Mesozoic sedimentary rocks compared to the more highly deformed rocks in the adjacent Rocky Mountain and Basin and Range provinces. The Colorado Plateau is deeply carved by the Colorado River and its tributaries that have sculpted its high relief landscapes. The iconic features within the Colorado Plateau include the Grand Canyon, Canyonlands, and the Grand Staircase-Escalante[23].
4. Mogollon–Datil Volcanic Field Province – The Mogollon-Datil Volcanic field is part of the Arizona Transition Zone, bordering the southern transitional boundary of the Colorado Plateau to the southern Basin and Range. The Mogollon-Datil Volcanic field was part of a major event in western North America known as the Ignimbrite Flare-up, where large-scale, violent, felsic-volcanic eruptions occurred, significantly shaping the fabric of the North American continent[7].
5. Basin and Range Province – The Basin and Range Province borders the southern Rio Grande Rift, western edge of the Colorado Plateau and extends across the western United States to the eastern Sierra Nevada Mountains in California. The Basin and Range Province is characterized by thin, stretched out continental crust with extensive normal fault systems featuring evenly spaced parallel mountain ranges and intervening desert Basins[15].
6. Southern Great Plains Province – The Great Plains form the eastern slope of the Rocky Mountains. The Great Plains expanse is a broad flatland of prairie and grasslands from the Rocky Mountains and east to the Mississippi River. Streambeds of the Great Plains are generally characterized as outwash from the Rocky Mountains. Although large-scale glaciation in the Pleistocene did not cover the southern Great Plains, the glaciation to the north highly influenced river coarse and connectivity within the Southern Great Plains[12].

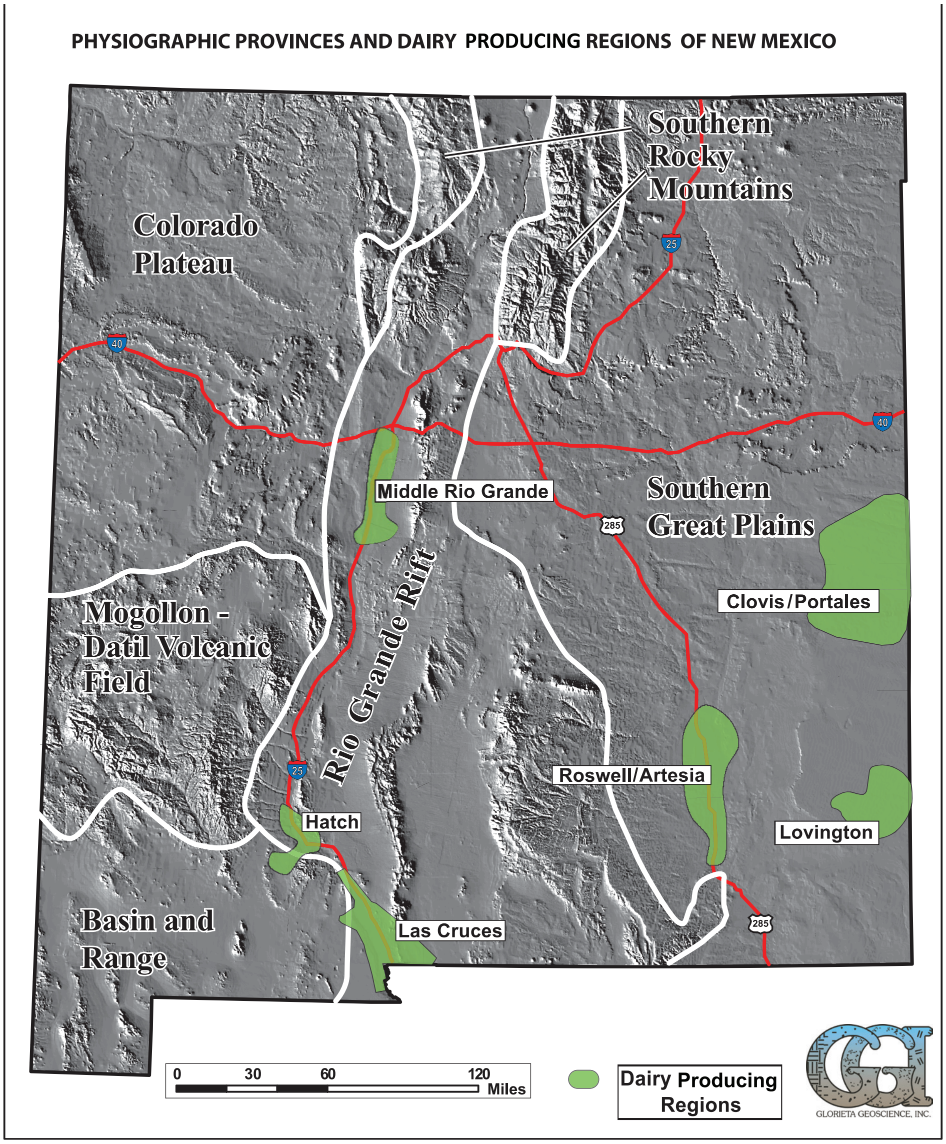


Figure 3.8. **Physiographic provinces and dairy-producing regions of New Mexico. Modified from Fenneman, 1928.**

3.8 Water Movement—The Basics of Hydrology

Water is neither created nor destroyed on the planet, it only changes forms. The hydrologic cycle is the continuous cycle of water on the surface, in the atmosphere and below the surface of the earth. Worldwide, water occurs on the surface as streams, lakes, wetlands and oceans. The surface water also includes ice in the form of snow, glaciers and polar icecaps. The water below the ground surface includes ground water and soil water. In the atmosphere, water takes the form of moisture in the air (humidity), condensate moisture (clouds) or falling moisture (rain or snow). In New Mexico, the surface water is limited to streams, lakes, wetlands and occasionally snow fields in mountains. The hydrologic cycle in the state can be approximated by the simplified diagram in Figure 3.9[13,22].

Precipitation, which is the source of all fresh water, varies substantially across the state. The annual total precipitation across New Mexico ranges from 8-10 inches in lowland desert areas and as much as 40 inches in the high alpine mountains.The rate of evaporation of surface water is also quite variable across the state, with the maximum occurring at lower elevations in the southern part of the state. The water that reaches the ground in vegetated areas is primarily taken up and used by the plants in a process called transpiration. The processes of evaporation and transpiration are generally combined under the term evapotranspiration. In New Mexico, approximately 97% of the precipitation in the state returns to the atmosphere due to evapotranspiration, leaving only 3% as surface water and infiltration into the ground [22].

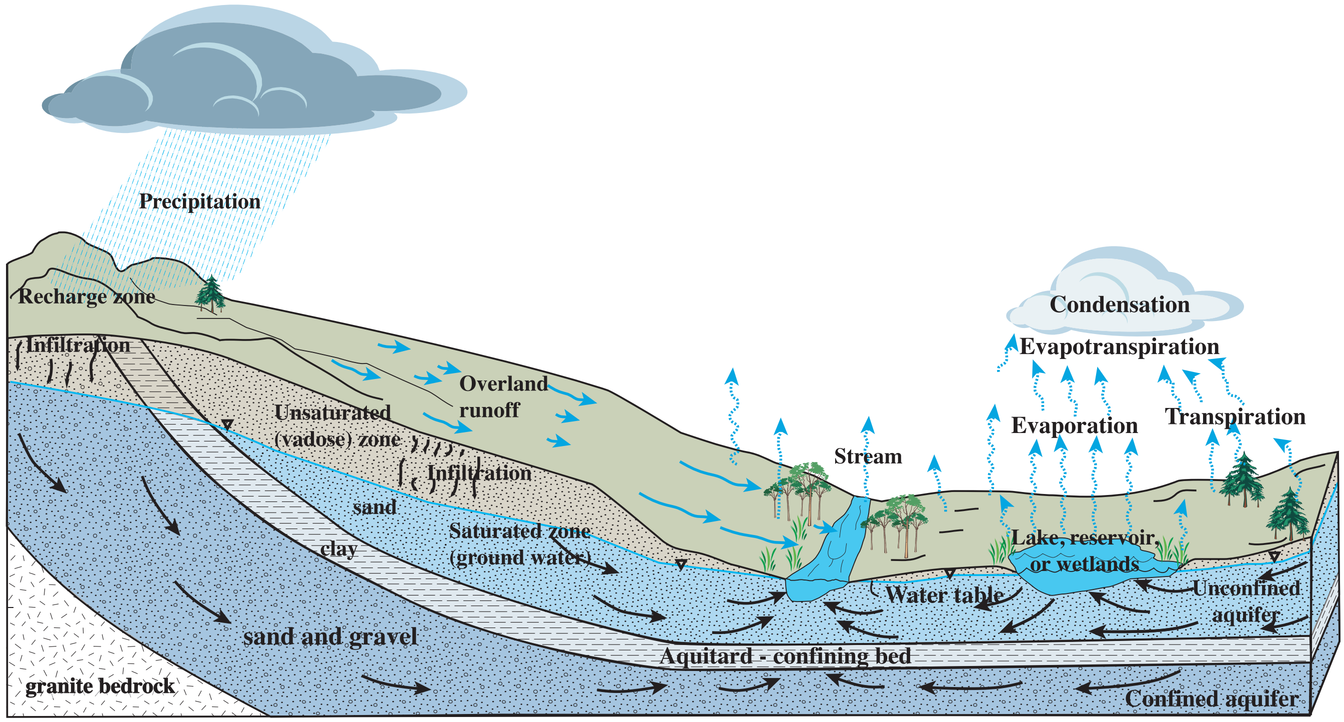


***Figure 3.9*. The hydrologic cycle. (Modified from Johnson, 2003 and Driscoll, 1986).**

Ground water is found beneath the ground surface in pore spaces and fractures of rock formations. An aquifer is a geologic formation or a group of formations that contain enough water to yield economically usable quantities of water from a well or spring. Ground water is recharged by surface water infiltrating the aquifer. Natural ground water discharges at the surface through springs, seeps, streams, and wetlands. Ground water also discharges at the surface by the construction and operation of production wells for agricultural, municipal, domestic and industrial uses. These discharges often require that ground water be withdrawn or lifted to the surface by a pump or bailer. Hydrogeology, or ground water hydrology, is the study of ground water distribution and movement.

Water below the land surface occurs in two zones, the unsaturated zone (also called the vadose zone) and the saturated zone (also called the phreatic zone)[58]. The water in the unsaturated vadose zone, which may sometimes be called soil water, is mixed with air in the void space, or pores, between the grains of sand, gravel and cracks within rocks. This water is held in place by capillary forces and is therefore too difficult to extract for use at the surface. Water in the unsaturated zone will migrate downwards when gravity forces exceed capillary suction forces. Vadose zone water is used by plants where the plant roots come in contact with water. Since this water is relatively close to the surface, in New Mexico's dry environment, it is also possible for it to evaporate directly from the soil. The unsaturated vadose zone water that is not used by plants or evaporated back to the atmosphere is slowly infiltrated deeper into the ground until it reaches the top of the saturated zone, commonly referred to as the water table. Differences in the rate of infiltration of water through the unsaturated zone can cause differences in the rate at which recharge from precipitation reaches the water table. This creates non-uniform rates of water-level rise and results in changes in hydraulic gradient that manifest as changes in the rate and direction of ground water flow. When the top of the water table is measured and calculated, it is often referred as the "potentiometric surface" and a "potentiometric surface map" is a map showing the elevation and contours of this surface.

The saturated zone is below the unsaturated vadose zone and is characterized by a complete saturation of the pore spaces with water. In the saturated zone the soil and rock pore spaces and voids become completely saturated with water. This water is called ground water, and it is the water tapped by wells. The pressure of the ground water is high enough that the water will flow from the surrounding rocks into void space of an open well that is constructed with perforated casing, or screen, in the saturated zone. Within the saturated zone there are different types of rock or sediments that hold water called aquifers.

An aquifer is a layer of relatively porous rock or sediment that contains and transmits ground water in economic quantities. Wells are generally completed into zones where water can be extracted easily and in a quantity that satisfies the demand of the well owner[13]. In many dairy-producing areas, domestic and production wells are completed into the shallowest aquifers due to cost. Since these aquifers are near the surface, they are also the most vulnerable to contamination. Not every rock layer holds or transmits water. Aquitards or aquicludes such as clay are layers with very low permeability, so water has great difficulty traveling through them. When these layers are located on top of an aquifer, they are called confining units and separate the layers of water bearing rock (aquifers). The presence of a confining unit between aquifers is favorable when selecting a location for a dairy. It adds a level of protection between the dairy operations and the deeper aquifers and is a natural safeguard for ground water quality protection.

An unconfined aquifer is the uppermost aquifer below the surface and its surface is at atmospheric pressure. This aquifer includes the vadose zone, which is comprised of the unfilled or dry portions of the aquifer. These aquifers are hydrologically connected to the earth surface, meaning water can flow directly from the land surface through the vadose zone to the aquifer below. As the amount of precipitation increases or decreases, the water table below will react and either rise or fall. The lower, saturated zone of an aquifer, where all pore spaces are filled with water, is called the saturated or phreatic zone. The surface or the top of the phreatic zone is called the water table.

A confined aquifer is a water bearing unit with a confining unit located above it, which separates it from the unconfined aquifer and land surface above. Unlike an unconfined aquifer, a confined aquifer is hydrologically disconnected from the land surface by a confining unit that impedes the downward movement of water and is under pressure. The impermeable layers associated with confined aquifers are called aquitards and aquicludes. An aquitard is a layer of sediment or rock with relatively low permeability that slows down the movement of water from an adjacent aquifer but does permit very limited vertical movement of ground water. An aquiclude is a confining bed or layer of rock or sediment with very low permeability which excludes the movement of water and allows virtually no ground water movement.

A confined aquifer does not receive recharge or infiltration from directly above, but rather some distance away. Sometimes that recharge area has a higher elevation and the aquifer can become pressurized. This pressurization creates something called “Artesian Conditions.” Artesian conditions are formed in a confined aquifers which slope downgradient from their recharge zone. When this pressure is significantly greater than atmospheric pressure, the water in a well can be pushed upward above the water table when the confining unit is punctured by the well. These wells are called “artesian wells.” A “flowing” artesian well occurs when the recharge area is high enough and upward pressure is great enough to push to the water all the way to the land surface. Figure 3.10 is a graphic representation of geologic and topographic conditions affecting artesian wells.

Water, like all things, must follow the laws of gravity. Water flows from a location of high elevation to a location of low elevation. Ground water in an aquifer flows in a downward direction. As a result, the ground water table or potentiometric surface also slopes downward. The slope of this surface is called the hydraulic gradient and indicates the direction of ground water flow. The hydraulic gradient is calculated from ground water elevation measurements taken from wells in the aquifer. The hydraulic gradient is the slope of the potentiometric surface in a confined aquifer and the slope of the water table in an unconfined aquifer (Figure 3.12).

Characteristics of an aquifer reflect the geology and structure of the underlying substrate and topography on which it occurs. Weathered and fractured crystalline rocks usually yield little water, but sediments and sedimentary rocks often provide greater amounts of water, resulting in productive and useful aquifers. Geologic formation types considered to be the most productive aquifers are typically unconsolidated to poorly cemented alluvial valley-fill sediments that are deposited in association with a major river valley or subsiding structural basin.

Porosity and permeability are the controlling factor for another aquifer characteristic called specific yield. This characteristic is a measurement of the quantity of water that will drain from an unconfined geologic unit due to the force of gravity. The measurements are taken from a unit volume of unconfined aquifer and are expressed in terms of a percentage. Not all of the water in the pore spaces can be drained out due to capillary forces (surface tension) holding the water to the surfaces of the aquifer material and due to the permeability of the rock.

Water can exist in aquifers under two different pressure conditions: unconfined and confined (see Figure 3.11). The shallowest ground water beneath most dairies is unconfined. Unconfined conditions occur where the water in the aquifer is in equilibrium with atmospheric pressure through openings in the aquifer that lead up to the ground surface. This type of aquifer is also sometimes referred to as a water-table aquifer[13].

Confined aquifer conditions occur when the ground water is isolated from the atmosphere by a confining bed of very low permeability. The confined aquifer generally has water pressure higher than atmospheric pressure, which will cause water to rise in a well to a level higher than the aquifer. These aquifers are sometimes also called artesian. The water level in a well that taps a confined aquifer represents the confining pressure at the top of the aquifer. The confining pressure is defined as the vertical distance between the water level in the well and the top of the aquifer[13]. The elevation to which the water in a well rises is called the potentiometric level. Confined aquifers are recharged from an unconfined area as shown in Figure 3.11.

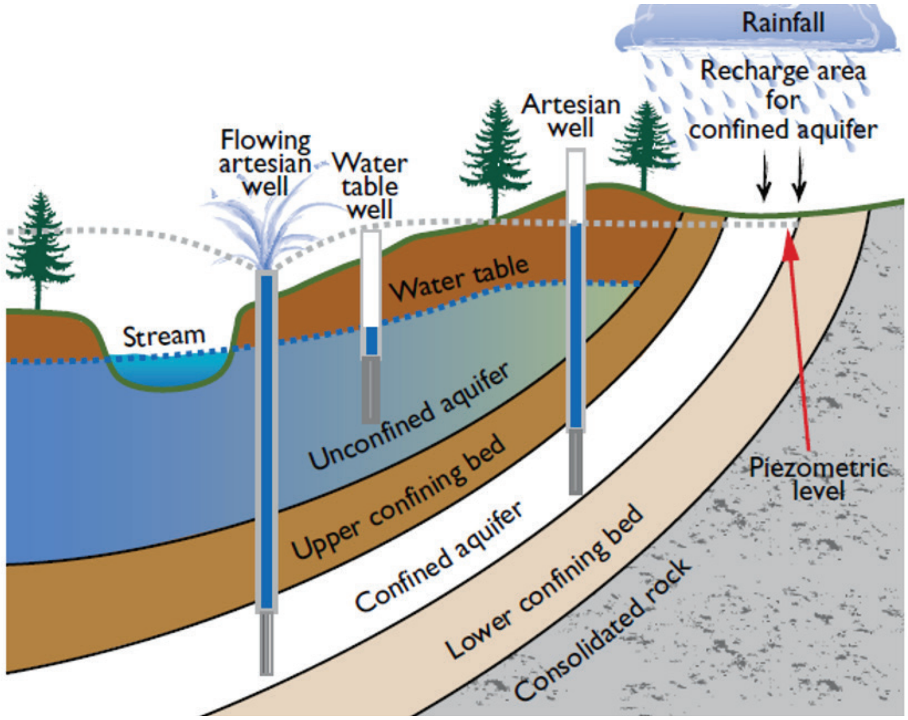


Figure 3.10. **Geologic and topographic conditions affecting artesian and flowing artesian wells. From USGS, 2019.**

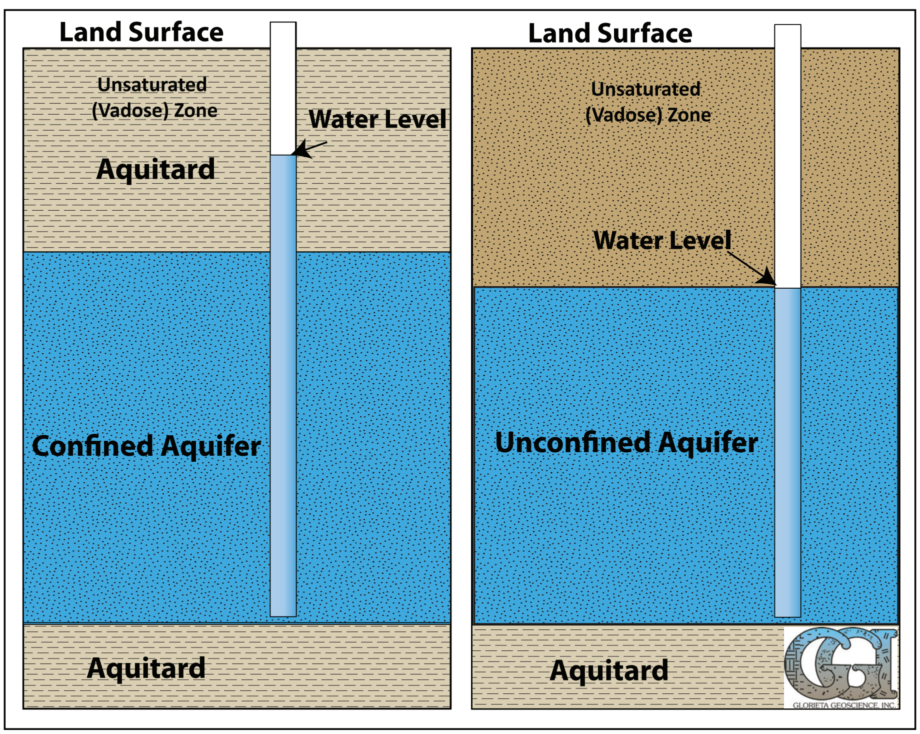


Figure 3.11. **Monitoring wells and potentiometric levels in confined and unconfined aquifers.**

3.9 Ground Water – The Potentiometric Surface Map

The water table is the upper surface of the saturated zone underlying a dairy and a potentiometric surface map is a contour map of the top of the water table. Figure 3.12 is an example of a potentiometric surface map. These maps are created by measuring the depth to water in several wells that are completed in the same aquifer and spaced out across the area. The depth to water measurements are converted to ground water elevations, then used to construct a potentiometric surface map. In addition to showing ground water contours, the information from these maps can be used to determine other aquifer properties such as ground water flow direction and hydraulic gradient. Water levels reported by drillers are useful for estimating ground water elevations at a specific location but monitoring wells are designed and constructed to collect information from a specific aquifer or portion of an aquifer.

To construct a potentiometric surface map, first, the correct well locations must be known. A dairy discharge permit requires all elevations of all monitoring wells to be surveyed to the nearest 0.01 ft. Second, water levels must be measured at each well. Since the depth to water in many shallow aquifers are subject to seasonal changes, all of the water level measurements collected and used to construct the water table map should be collected in a relatively short time period. The water level in the wells is measured to within 0.01 ft using either an electronic sounder, which will emit a beep or buzz when the probe reaches the water in the well, or a steel tape, which is lowered into the well down below the expected water depth, then pulled out and noted where the tape is wet. The depth to water is generally measured from the ground surface or from the top of the well casing. If the top of casing is used as the measuring point, then the difference between the top of the well casing and the ground surface is subtracted or added to the water level measurement, depending on whether the well casing is completed above ground or below ground surface.

The depth-to-water measurement is then subtracted from the ground surface elevation at each well and the ground water elevation at each well is plotted on a map next to the well location. Then, ground water elevation contours are drawn at regular intervals such as 1, 10, 50, or 100 feet depending on the change in ground water elevation across the map area. An example of a potentiometric surface map, including the plotted ground water elevation measurements and potentiometric surface contours, is shown in Figure 3.12.

The direction of ground water flow at the top of the aquifer is perpendicular to the potentiometric surface contour lines and flows in the direction of decreasing ground water elevation. In unconfined aquifers, the ground water elevation contours will often mimic the topographic contours. As a result, the ground water flow direction also often mimics the surface water flow direction. If this pattern does not occur, it is often due to man-made influences such as: large volume ground water pumping from nearby irrigation or municipal wells which can artificially lower the water table or irrigation ditches and flood-irrigated fields, which can artificially raise the water table during the irrigation season.

The potentiometric surface map shows the elevations of the top of the water table and can be useful in estimating the expected depth to water in the areas between the measured wells. This information can be used to determine the effects of changing pumping or irrigation to water level over time and to determine the likely path of contaminant migration, which follow ground water flow direction. For potentiometric surface maps to be a truly useful tool, it requires that they be made regularly over time. When compared to older maps, newer maps can be used to help observe changes in ground water elevation and flow direction over time. In lieu of constructing quarterly potentiometric surface maps, one can use well hydrographs (graphs of water level versus time) to determine if the ground water elevations and gradients are constant or changing. Figure 3.13 shows hydrographs of wells with changing ground water elevations. The figure shows ground water elevation lines crossing, which indicates seasonal changes in ground water flow direction. Information shown in this hydrograph is important for determining how often ground water elevation data should be collected or if additional monitoring wells may be required to understand the changing ground water flow direction. Figure 3.14 shows an example of hydrographs of wells with ground water elevations that are generally constant (ground water elevation lines do not cross). In this case, yearly potentiometric maps are likely sufficient.

It is important to remember that ground water flow is a three-dimensional system with different zones and rates of flow. The water table contouring (potentiometric surface map) described above is a measure of the upper, unconfined aquifer and is primarily measuring water level in the aquifer and mapping the direction of ground water flow and slope of the water table. The ground water flow system also contains a vertical component of flow through the aquifer. A map of the deeper zones of an aquifer can be made in the same way as the potentiometric surface map except that the wells measured must have screened casing in the deeper portion of the aquifer. Many production wells for drinking water and irrigation are completed deeper than the monitoring wells so that they are capable of producing larger amounts of water. When the depth to water in these wells is compared to nearby monitoring wells, there is often a difference that will provide information on the vertical component of ground water flow.

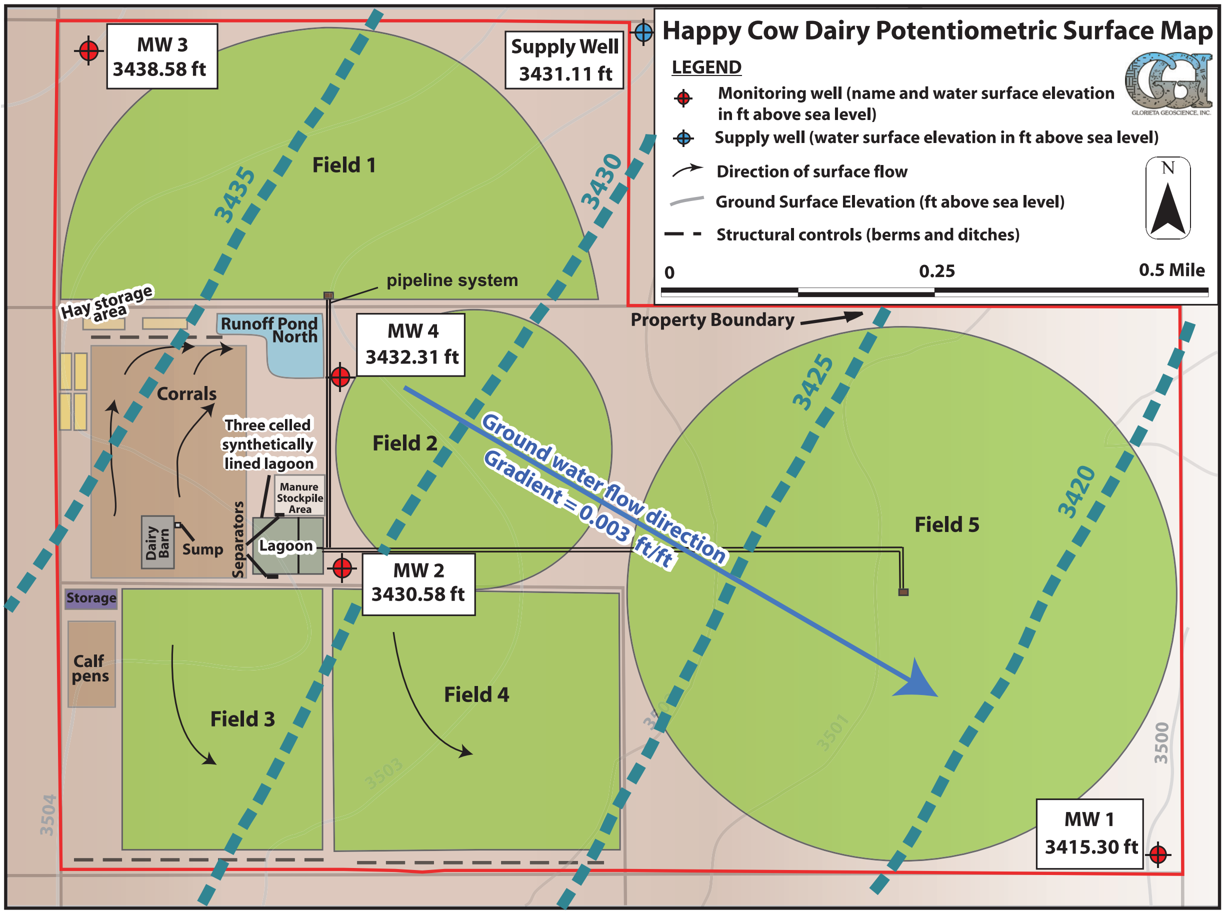


Figure 3.12. **Happy Cow Dairy potentiometric surface map.**

3.10 Wells and Their Impact on Surface Water and Ground Water

The vast majority of water used in New Mexico comes from ground water. Therefore, it is important to understand how wells and ground water interact to make the best use of a limited resource. Prior to extensive municipal, agricultural, and domestic well pumping, all aquifers were generally in a state of dynamic equilibrium, which means that the input into the aquifer (precipitation or stream leakage) were equal to the aquifer output (springs).

In aquifers where the rate of water removal is greater than the rate of recharge into the well, the pumping of the well will cause a depression in the water table surrounding the well. If the aquifer is uniform in composition, this water table depression will take the form of a circular cone called a cone of depression (see Figure 3.15).

In aquifers where the permeability is high and the well pumping rate does not exceed the aquifer recharge, the cone of depression will be wide and shallow, allowing the aquifer to fully recover to the pre-pumping state when the well is turned off. In areas where the well pumping exceeds the aquifer recharge and permeability, which is a very common situation, the cone of depression is steep and will never fully recover to the original aquifer state. When a large number of wells are completed into the same aquifer, the cones of depression from all of the wells will coalesce to a more or less uniform area-wide decline in the water table elevation (see Figures 3.15 and 3.16).

Under natural conditions, an aquifer is considered to be in a state of equilibrium. In nearly every aquifer studied in New Mexico, the amount of water pumped from wells exceeds the amount of water that is recharging the aquifer. Therefore, it is expected that some aquifers may no longer be useable if well pumping is not reduced, and manufactured recharge projects are not started. The longevity of an aquifer is dependent on the input and output of the aquifer system. The natural inputs include infiltration recharge (from precipitation), recharge from surface water bodies (streams and lakes), and underflow from surrounding aquifer systems. Aquifer outputs include discharge from the aquifer into springs and surface water bodies, evapotranspiration, underflow into adjacent aquifer systems, and pumping from wells.

Date	MW-1	MW-2	MW-3
1/11/2022	47.15	47.55	44.15
6/29/2022	38.23	51.31	46.31
8/30/2022	43.46	46.19	46.00
11/20/2022	48.85	48.64	39.93
2/22/2023	49.75	51.81	43.71
5/31/2023	45.95	53.50	45.00
7/25/2023	40.30	52.92	47.00
10/29/2023	40.20	52.80	45.00
2/10/2024	48.00	54.54	44.00
5/1/2024	46.00	55.55	45.00

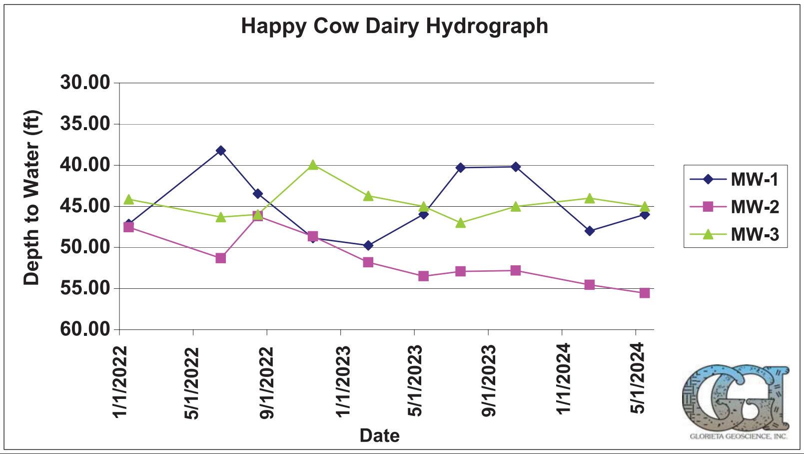


Figure 3.13. **Depth-to-water dataset and hydrograph from Happy Cow Dairy demonstrating a changing ground water gradient.**

Date	MW-1	MW-2	MW-3
8/4/2022	15.25	9.50	16.20
10/4/2022	13.67	8.32	14.68
2/1/2023	14.44	9.58	15.02
6/7/2023	13.58	7.86	16.25
7/12/2023	14.07	7.42	14.88
10/18/2023	10.52	7.27	12.00
1/31/2024	13.92	9.34	14.75

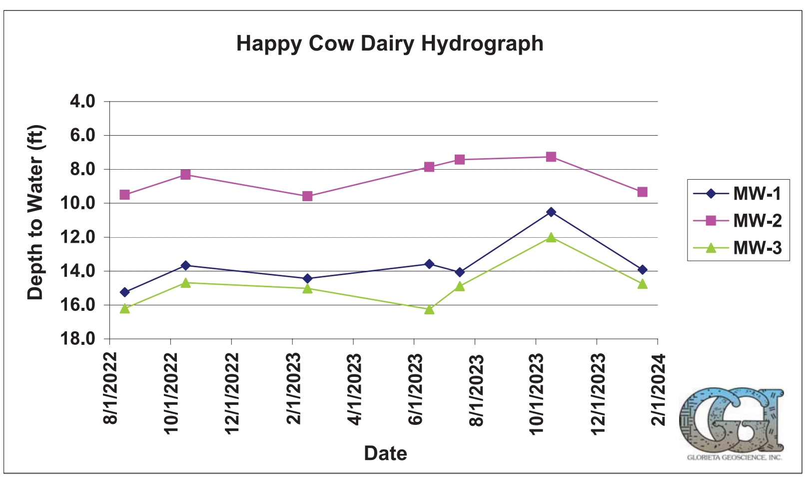


Figure 3.14. **Depth-to-water dataset and graph from Happy Cow Dairy with generally constant ground water gradient.**

Measured water level declines have occurred due to pumping in the High Plains/Ogallala aquifer. For that reason, the NMED now requires data showing that dairies will have at least a five-year supply of fresh water for blending with green water for irrigation. Many wells in the Ogallala aquifer have experienced long-term water-level declines, and some dairies in Roosevelt and Curry Counties only have tens of feet of water remaining in the underlying aquifer. These water level declines are caused by irrigation pumping and occur on both sides of the Texas/New Mexico border.

For confined aquifers, the natural recharge areas are generally in surrounding highlands where there is more precipitation and lower rates of evaporation due to cooler temperatures. For unconfined aquifers, local streams are often interconnected with the shallow aquifers and act as both a natural area of recharge to shallow aquifers and as discharge points, depending on the relative elevation of the water table to the stream.

Streams that receive or gain water from the underlying aquifer through the streambed are called gaining streams. Streams that lose water by infiltration through the streambed to an underlying aquifer are called losing streams. Figure 3.17 highlights the ground water flow patterns in both a gaining and losing stream. Sometimes streams change from gaining to losing or vice versa due to seasonal changes in stream flow or water levels in the aquifer. Many streams have reaches that are gaining and reaches that are losing. These changes are natural and are often due to changes in the geometry of the stream and aquifer or changes in the underlying geology or rock type. For a stream to gain water from the aquifer, the streambed must be lower in elevation than the surrounding water table. Conversely, a losing stream must be higher in elevation than the surrounding aquifer. If the amount of water flowing down a stream is greater than stream bed infiltration rates, a losing stream may both recharge the underlying aquifer and flow on the surface. In this situation, the losing stream is connected to the underlying aquifer by a continuous saturated zone from the streambed down to the aquifer. If the flow of the stream is less than the rate of stream bed infiltration, the stream and aquifer may be separated by an unsaturated zone, as water infiltrates down to the water table but does not completely saturate the vadose zone in between. The state of the stream can also change due to pumping from wells completed into the underlying aquifer. In cases where the stream and aquifer are separated, pumping a well in the aquifer will not cause direct stream depletions. As shown in Figure 2.2 and Figure 3.16, if wells are pumped from the aquifer at a rate that exceeds the natural recharge to the aquifer, the pumping can intercept ground water flow into the stream or induce recharge from the stream into the aquifer, thus causing a decrease in the stream flow and a change from gaining stream to losing stream.

Effects from a single pumping well on stream flow depletion are relatively small and could be absorbed by the aquifer and stream, but most aquifers are tapped by hundreds of wells and the combined effect of these wells on stream flow is regional in scale. The effect of pumping can also reverse the direction of ground water flow between the aquifer and the stream, which may affect the transport of contaminants associated with surface water. In a losing stream, contaminated water can be drawn from the stream into the aquifer that provides ground water to municipal and domestic drinking water wells. A gaining stream reach implies that a hydrologic connection from the aquifer to surface water exists and any contaminates in the aquifer will eventually discharge to a stream.

3.11 Aquifer Types Found in New Mexico

There are three major types of aquifers in New Mexico: unconsolidated/semi-consolidated alluvial aquifers, consolidated sedimentary rock, and fractured crystalline bedrock. Unconsolidated or semi-consolidated alluvial aquifers include shallow ground water adjacent to streams and deeper valley and basin-fill aquifers created by the erosion and deposition of sand and gravel in lowland basins. Unconsolidated and semi-consolidated alluvial aquifers are found along the length of the Rio Grande valley, the eastern border of the state, and in closed basins of central and southwestern New Mexico (Figure 3.18). The ground water in alluvial aquifers occurs in the pore spaces between the grains of sand and gravel. The coarse-grained sand and gravel portions of alluvial aquifers have high permeability and are among the highest yielding aquifers in the state.

Sedimentary rock aquifers are typically in consolidated sandstone, conglomerate, clay/shale, and limestone layers. The water in these aquifers occurs in the pore spaces between the cemented sand and gravel or in the case of limestone, fractures in the rock. In limestone aquifers, the water carried through the small fractures reacts with the rock, slowly dissolving the rock and causing the fractures to widen over time, often resulting in larger cavities and caverns. Limestone aquifers are also in the category of high-yield aquifers in New Mexico and typically supply the majority of water used in the Roswell, Artesia, and Carlsbad areas.

Fractured crystalline rock aquifers include metamorphic, igneous, and some volcanic rock. These rock types have intergrown crystals and virtually no porosity. The only permeability in these types of rock is through secondary porosity as water moves through the fractures created after they formed. This type of aquifer generally does not yield large amounts of water and tends to only be tapped by domestic wells.

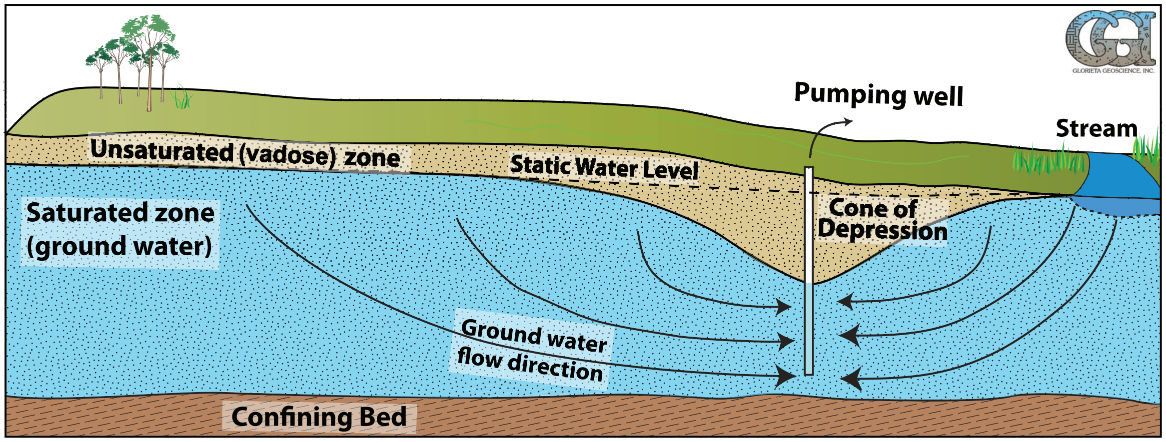


Figure 3.15. **Cross-sectional schematic of water table cone of depression.**

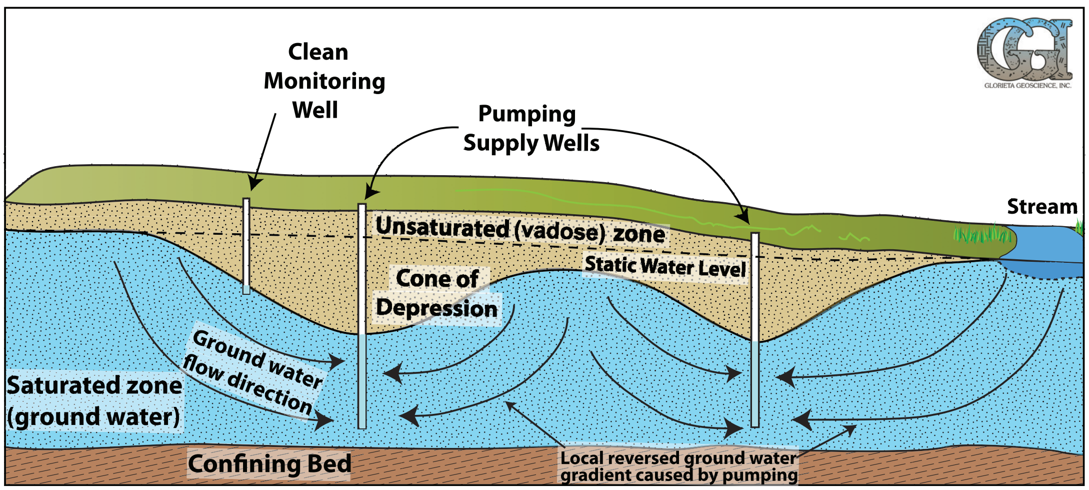


Figure 3.16. **Cross-sectional schematic of pumping supply wells and coalesced cones of depression.**

3.12 Local Geology and Hydrology of New Mexico Dairy Regions

The dairy producing regions in New Mexico occur within the Middle Rio Grande valley (Bernalillo to Truth or Consequences); Lower Rio Grande valley (Truth or Consequences to the Mexican border); Roswell Artesian Basin (Roswell/Artesia/Carlsbad); and Southern Great Plains (Clovis/Portales/Hobbs/Lovington) (Figure 3.8). These dairy regions exist in areas where there is available water, relatively flat land, and a suitable climate for raising cows. Many of the dairy regions coincide with other agricultural regions that share the same general land, water and climate needs to provide some support for dairies, such as farms that grow feed for the cows. The availability of water and suitable landscape for agriculture is dependent on the geologic and hydrologic background of the area.

3.12.a Middle Rio Grande Region (Bernalillo to Truth or Consequences)

The tectonic, volcanic, and sedimentation activities of the Rio Grande Rift and the river itself have shaped the landscape and hydrology of the Rio Grande Valley. The rift-related faults and volcanoes created mountain ranges and highlands that were subsequently eroded and deposited in deep sedimentary basins in the center of the rift[6]. These sedimentary basins are now important deep ground water reservoirs for the municipalities located near the Rio Grande. The depth to water in the Santa Fe Group aquifer system varies widely, ranging from less than 2 feet near the river to more than 1,000 feet in the western portion beneath the West Mesa near Albuquerque[6]. The deeper parts of the aquifer are still connected to the river, but on a very long-time scale.

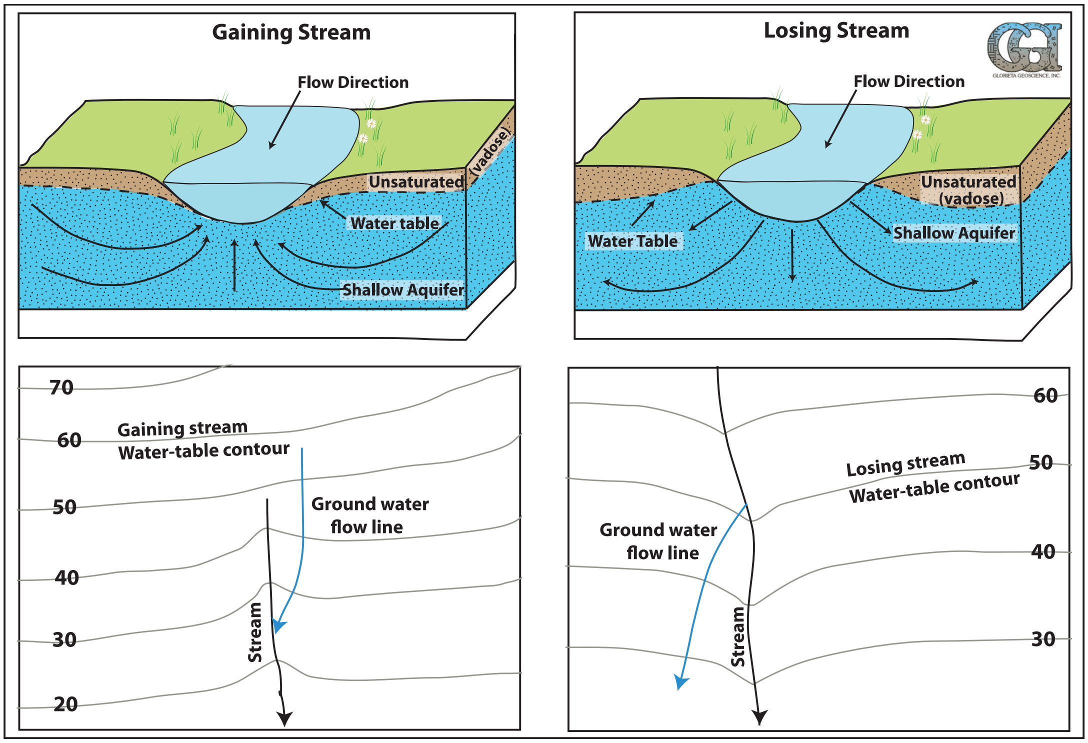


Figure 3.17. **Gaining stream and losing stream, cross-sectional schematic (upper) and plan-view water table contour map (lower). Modified from Winter et al., 1998.**

The inner valley near the Rio Grande has a shallow aquifer that is in direct hydrologic communication with the flow of the river. Figure 3.17 highlights how surface water and ground water in a shallow aquifer interact. In some areas, the elevation of the water table is above the base of the stream and water flows from the aquifer into the river, creating a gaining stream. In other areas, the elevation of the shallow aquifer is deeper than the base of the stream and water flows from the stream into the underlying aquifer, creating a losing stream. The shallow aquifer is tapped by many domestic, irrigation, and some municipal wells, and the hydrology of the river valley has been significantly modified by human interaction. A complex network of irrigation canals and ditches diverts water from the river, drains return excess irrigation water back to the river, and intercepts lateral flow in the shallow aquifer near the river.

The Rio Grande Valley between San Acacia and Elephant Butte Reservoir can be envisioned as a sand- and gravel-filled trough with a shallow trench running down the middle. The sides of the trough are the uplands and mountains rising to the east and west of the river; the bottom of the trough is formed by deep, compacted sediments. At the north end of the trough, water flows into the trench (the Rio Grande) through the diversion dam at San Acacia. At the south end, the Rio Grande flows into Elephant Butte Reservoir and eventually "drains" from the trough through Elephant Butte Dam into the Mesilla Valley. As water flows down the Rio Grande, some of it seeps through the riverbed and spreads out underground, but it can only seep so far before it hits the relatively impermeable sides and bottom of the trough. So, as the trough gradually fills with water, the sand and gravel become saturated from the bottom up and the water table rises. Once the water table reaches the base of the trench, the seepage is reduced and more of the water entering the valley at San Acacia stays in the riverbed all the way to Elephant Butte. Of course, the trough model is an oversimplification of the actual system; some river water can leak out the sides and bottom of the trough, and some water enters the trough from sources (such as rising geothermal waters) other than the river[8].

3.12.b Lower Rio Grande Region (Truth or Consequences to the Mexican Border)

The southern region of the Rio Grande rift is significantly wider than it is north of Truth or Consequences. The rift boundaries at Elephant Butte are at the base of the Animas Range in the west and the Sacramento Mountains, approximately 60 miles to the east. The Rio Grande valley south of Truth or Consequences has coarse-grained, semi-consolidated Tertiary–Quaternary age, rift-fill sediments derived from erosion of the uplifted highlands and some interbedded basalt flows[31]. "Dairy row," near Las Cruces, is situated in the Rio Grande flood plain and on older low river terraces that slope down from the Organ Mountains.

The shallow ground water in the Rio Grande floodplain is closely tied to the flow of the river. See the Middle Rio Grande section for information on the hydrology of the shallow alluvial aquifer.

The plains southwest of Hatch in the Nutt–Hockett Basin are underlain by Quaternary age alluvial fans composed of coarse sand and gravel that eroded off the Tertiary volcanic highlands to the south and west. Over-pumping of the shallow alluvial aquifer has caused farmers and some dairies to drill deep production wells into the Tertiary volcanics to depths exceeding 1,000 feet.

3.12.c Roswell Artesian Basin Region

The regional geology of the Roswell/Artesia/Carlsbad area consists of the Permian to Tertiary age sedimentary basin alternately called the Roswell Artesian Basin. The sedimentary rock of this basin consists of limestone, sandstone, mudstone, and shale, with significant components of evaporite deposits such as gypsum and salt[28]. The most important limestone formation in this area is the San Andres Formation, which caps the crest and eastern slope of the Sacramento Mountains and is the host rock of the artesian aquifer for the Roswell/Artesia area. The San Andres Formation also forms an important oil and gas reservoir in the deeper basin east of Roswell. The sedimentary rock is cut by a series of parallel faults and folds located northwest of Roswell that are called the Pecos buckles. Fractures in the rock associated with the buckles provide conduits for surface water recharge to the aquifer and ground water flow within the aquifer[28].

The San Andres Limestone is overlain by the fine-grained sedimentary rocks of the Artesia Group. This group of rock consists of mudstone, shale, and evaporite deposits (salt and gypsum) that form a confining layer over the San Andres artesian aquifer. This confining layer separates the lower artesian aquifer from the shallow alluvial aquifer on top of the Artesia Group confining beds.

The 10- to 15-mile-wide corridor surrounding US highway 285 to the east side of the Pecos River between Roswell and Brantley Lake (north of Carlsbad), is underlain by a shallow alluvial aquifer consisting of unconsolidated sand and gravel derived from the eroding slopes of limestone and sandstone on the east side of the Sacramento Mountains. This aquifer is generally less than 250 feet thick and provides water for irrigation, livestock, and domestic uses along this corridor[5].

The shallow alluvial aquifer is separated from the deeper artesian aquifer by the low-permeability beds of mudstone and evaporites in the Artesia Group, which form a confining seal that keeps the water in the eastern parts of the artesian aquifer under pressure. The artesian aquifer is recharged in the highlands on the eastern slopes of the Sacramento Mountains and along the Pecos Buckles fractures and limestone sinkholes (see Figures 3.18 and 3.19). The artesian aquifer contributes some of its water to the shallow aquifer in the area north of Roswell where the confining beds are absent or thin. As the artesian aquifer dips down to the east, the confining beds are thicker and the pressure of the overlying rock and water flowing down the slope from the mountains increases. The artesian aquifer is 300 to 500 feet thick and extends under the Pecos River where the top of the aquifer is reached at a depth of approximately 1,100 feet. The artesian aquifer does not extend very far beyond the Pecos River due to the discharge of water into the river and because of the decrease in permeability of the carbonate rocks farther to the east. The carbonate rocks of the San Andres Formation continue toward the east where they are tapped for oil and gas reserves.

3.12.d Southern Great Plains Region (Clovis/Portales/Hobbs/Lovington)

The eastern border of New Mexico south of I-40 is underlain by the Ogallala Formation aquifer (also known as the High Plains Aquifer), which is the principal source of water in this area and western Texas. The Ogallala Formation is composed of sands and gravels that were eroded off the eastern front of the Sacramento and Guadalupe Mountains between 13 and 5 million years ago. The upper portion of the Ogallala Formation consists of a caliche caprock between 10 and 40 feet thick. This formation overlies older, less permeable rock that prevents or slows the infiltration of ground water below the Ogallala Formation. In eastern New Mexico, the Ogallala Formation overlies Triassic-, Jurassic-, and Cretaceous-age siltstone, mudstone, and minor evaporite deposits. The thickness of the Ogallala is variable and reaches a maximum of about 350 feet where it fills in previously existing channels cut into the older, underlying rock. The upper surface of the formation is fairly flat with a slope of 10 to 15 feet per mile toward the southeast. The Ogallala Aquifer is recharged by direct precipitation and minor playa lake surface water that seeps through the fractured caliche caprock into the permeable sediments. The aquifer is unconfined, and the water table slopes approximately 12 feet per mile toward the southeast, which indicates that the ground water flow is in the same direction. The aquifer saturation decreases in thickness toward the west and north. There may still be some minor springs that are natural discharge points from the Ogallala, but most of the springs have already dried up due to pumping from wells. The relatively impermeable, older rock below the Ogallala Formation prevents most ground water from infiltrating any deeper into the ground (McAdam, 1984).

Agricultural development in this area expanded rapidly after 1940, and by 2015 the water level in the aquifer had declined by as much as 234 feet near the Texas-New Mexico border[33]. The average rate of water level decline from pre-development (about 1950) to 2015 for the High Plains Aquifer in New Mexico was 16.5 feet (0.25 feet per

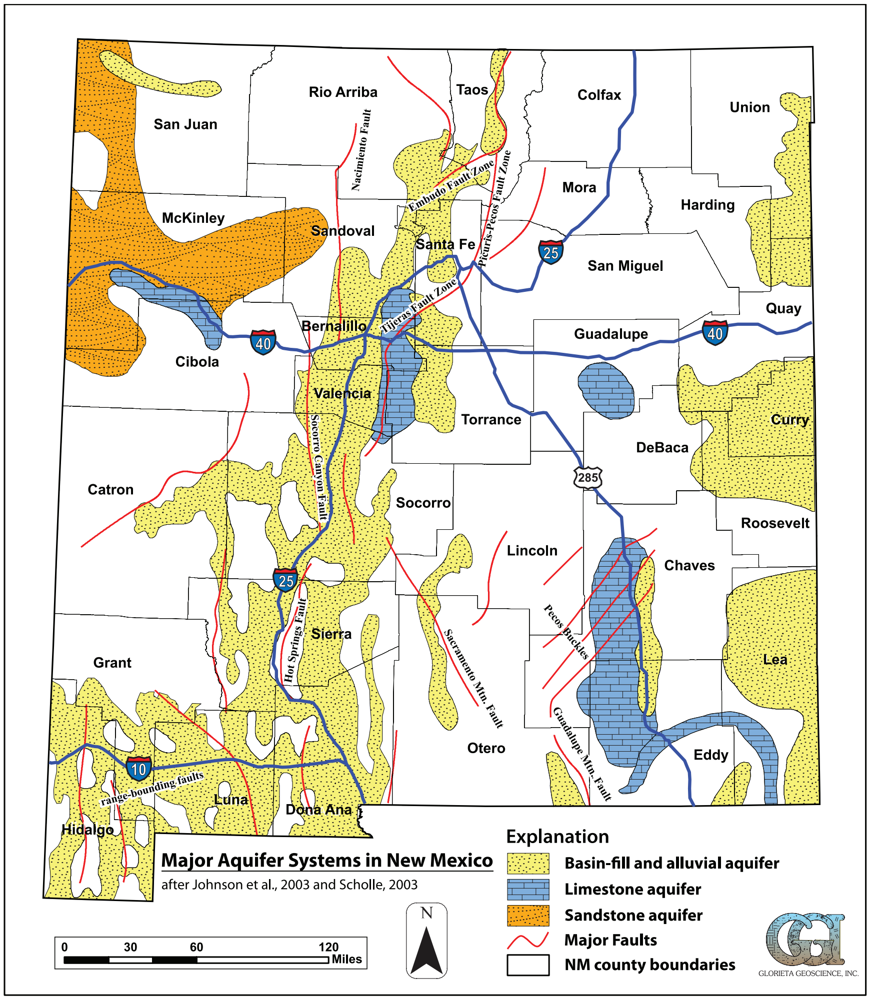


Figure 3.18. Major aquifer types in New Mexico. Modified from Johnson, et al., 2003 and Scholle, 2003.

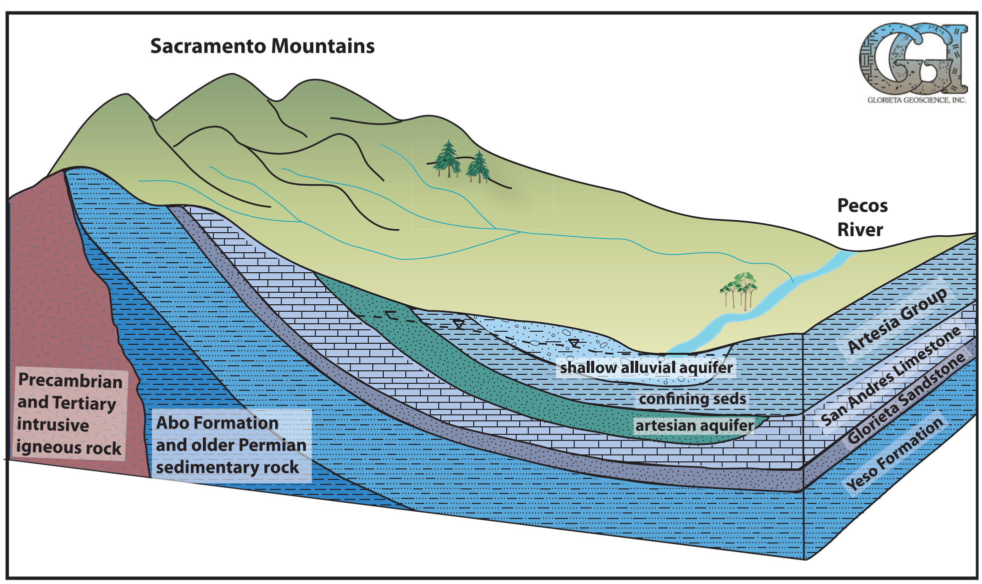


Figure 3.19. Cross-section schematic of the geologic formations and aquifers beneath the Sacramento Mountains and in the Roswell Artesian Basin, showing Artesia Group and San Andreas Aquifer. Modified from Winter et al., 1998

year). Across the Texas border, the decline is more significant, with a weighted average of 41.1 feet of water level change (0.63 feet per year)[33]. The saturated thickness of the Ogallala in the Clovis and Portales areas has decreased by at least 50% since predevelopment and decreased between 25-50% in the Lovington area[33]. These water level declines could make the Ogallala aquifer economically non-viable as a source of irrigation water in the near future.

The decline in water level of the High Plains Aquifer, or any aquifer, can be mitigated somewhat by better conservation practices, which can help to prolong the life of the aquifer. If water level declines persist into the future, they will drop to the point that some dairies may only be able to pump water for dairy use and irrigation use will become uneconomical. If this occurs, insufficient ground water will be available for blending with green water for irrigation, and dairies may have to either change their green water management practices to total evaporation or relocate to a more water-rich region.

3.13 Soil Basics

The earth is covered by a thin layer of naturally occurring unconsolidated material composed of minerals, organic matter, and living organisms called soil. Soil is the most important resource supporting plant and animal life and is a reservoir for nutrients, including those added at dairies through application of manure solids, green water, and chemical fertilizers. Soils must be managed so they are not overloaded with nutrients and micronutrients, and so that they remain stable and do not erode at excessive rates. Soil is typically composed of 50% solids (45% minerals and 5% organic matter) and 50% pore space filled with 25% air and 25% water.[9] Plants absorb nutrients and water from the soils using roots. How nutrients, organic matter and microbial populations are managed is key to building soil health.

3.13.a Soil Genesis

Soil is primarily composed of minerals and particles derived from weathered rock (parent material) broken down over millions of years. This process of breakdown is often referred to as "weathering" and can be caused by physical factors (wind, running water, glaciers, rain, root growth, etc.), chemical factors (chemical reactions), and/or biological factors. Many soil properties are determined by the parent material or type of rock from which they originated.

3.13.b Soil Texture and Structure

Mineral soil particles vary considerably in size and the classification of soils is based on that variability, beginning with the smallest particles such as clays, silts, sands, and gravel. The distribution of particle sizes in the soil is called soil texture and the specific arrangement of soil particles into aggregates is called soil structure. The structure and texture of a soil provides a great deal of information about stability, strength, and drainage of a soil, important characteristics to understand before cultivating a farm. For example, sandy soils have open pore spaces and are often well-drained soils. Clay rich soils have smaller soil pore spaces which hold less air, do not allow water to move as freely, and are often classified as poorly drained. In the arid New Mexican environment, plant roots in poorly drained soils cannot obtain the oxygen they need and typically do not grow well. Drainage conditions can often be determined by soil color. Gray or gley soils indicate that the soils formed in anerobic or anoxic (without oxygen) condition. Orange, red, and dark brown colorations indicate aerobic (oxygen rich) conditions. Mottled soils, or soils with blotchy gray, orange, and red color patterns indicate a water table that fluctuates seasonally, creating both aerobic and anaerobic conditions.

Soil structure has a significant influence on water and air movement, biological activity, root growth, and seedling emergence. Structure along with texture affects soil porosity and permeability. Soils are classified based on structure into groups based on shape: platy, prismatic, columnar, blocky, and granular. Finer textured soils typically have denser, blocky, columnar, or prismatic soil structure which will greatly reduce the amount of air and water that can move freely through the soil. In turn, this will affect the plant's ability to propagate roots through the soil. Sandy or gravelly soils tend to have a more granular structure and are best for growing most crops, as they allow easy movement of air and water through the soil.

Soils accumulate organic matter from various sources. Grasslands have dense, fibrous, shallow root systems, and grassland soils are usually dark grayish brown in color to the depth of the roots (at approximately 12 to 30 inches). In a deciduous forest, leaves which fall to the ground are collected into an organic mat above the more mineral rich horizons. As they slowly decay, they are incorporated into the soil and supply the root system below.

3.13.c Soil Profile

The vertical cross section of a soil, visible in a dug pit or stream cut bank, is called a soil profile, and horizontal individual layers of a soil profile are soil horizons. The uppermost horizon, called the O horizon is comprised of organic matter such as leaves and grasses in varying levels of decay. This layer may or may not be present in all soil profiles. The A horizon, rich in organic matter, is called topsoil and is considered the zone of leaching. Leaching is the loss of materials from the O and A horizon when water carries clay and soluble organic matter downward. These leached materials accumulate in the B horizon, called subsoil. Below that is the C horizon, making up the weathered parent material of rock and minerals. Underneath the C horizon lies un-weathered bedrock, called the R horizon.

The number of horizons and their thicknesses vary with different soils.

3.14 Soils as a Nutrient Source

Soil is a natural reservoir of nutrients, and when dissolved in water, these nutrients are absorbed through a plant's root system. While soils naturally contain a certain amount of nutrients, there is not always enough to meet the agronomic demand of crops. To meet the nutrient demands of their crops, farmers use a wide variety of sources such as green water, manure solids, fertilizers, and other supplements. As discussed previously, a nutrient management plan takes into consideration natural soil nutrients and crop uptake when determining the rates of what additional source to apply. Soil testing helps determine the available nutrient status of fields and helps ensure that over-application of manure solids and/or green water does not occur.

Primary nutrients or macro-nutrients, such as nitrogen (N), phosphorus (P), and potassium (K) are required by all plants in significant quantities. These nutrients are often depleted in the soil since plants use them in large quantities for growth and survival. In New Mexico's arid environment, secondary nutrients such as calcium (Ca), magnesium (Mg) and sulfur (S) are more abundant in soils and therefore, addition by farmers is not always necessary. Plants require some additional elements, including but not limited to iron (Fe), chloride (Cl), copper (Cu), zinc (Zn), manganese (Mn), boron (B), and molybdenum (Mo) in very small quantities (or micro quantities). These elements are referred to as micronutrients.

Soil testing needs to be performed in each land application field following standard sampling protocols required in a discharge permit. The soil samples should be sent to soil testing labs for analysis for NRCS 590 Nutrient Management parameters and/or other parameters required in a discharge permit. See Section 7 for details on soil sampling parameters and interpretation of results.

3.15 Soil Nutrients and Crop Selection

Dairy green water and manure solids have significant value as organic fertilizer because they contain primary nutrients (N, P, K), secondary nutrients, micronutrients, and beneficial microbes. Many dairy farmers in New Mexico grow crops with dairy manure and green water as the sole nutrient source without using chemical fertilizers. The nutrient sources dissolved in water provide readily absorbed (chemical fertilizers) or later absorbed after mineralization (organic manure and green water) nutrients through plant roots. Some farmers have reported that adding manure solids to their fields increases the water-holding capacity of sandier soils by up to 20%, saving the equivalent amount of irrigation water.

To manage land application fields within a CNMP or to follow BMPs, the critical questions that should be asked by a dairy operator are:

- What quantity of each nutrient is taken up by the crops grown?
- Are nutrients being applied at rates higher than the crops can take up?
- If over-application of nutrients occurs, what happens to excess nutrients?
- How does a dairy track nutrient application rates?

By asking the above questions, a dairy producer will know if they are going in the right direction, since environmental compliance and nutrient management of the land application area revolve entirely around these items. The composition of dairy manure and green water varies from dairy to dairy. For example, dairy farms that use copper sulfate foot bath can expect higher concentration of copper in their dairy green water and storm water runoff. The nutrient makeup of the dairy manure or green water should be evaluated before land application to crops and a producer should determine if the crops can take up all the nutrients applied.

3.16 Soils, Crops, and Contaminant Transport

Crops can only use a certain quantity of nutrients for their growth and survival in one crop cycle. The crop uptake is referred to as agronomic uptake and depends on several parameters such as crop type, crop yield, location, climate, soil type, and preexisting nutrient, micronutrient, and macronutrient concentrations. Established crop uptake values for all major and minor crops under cultivation are in publications from universities, local research stations, and County Extension centers. These publications provide average crop uptake information for individual crops grown in an area and are referred to as book values. These book values can be used in conjunction with crop yield data to estimate crop uptake from each land application field. The NMED developed the Land Application Data Sheets (LADS) spreadsheet, which allows a producer to select crops and input yield data, then calculates crop uptake using book values. How to use the LADS spreadsheet and interpret results is described in detail in section 7.3.

To provide an example with specific data, this manual looks at a dairy in the Roswell area, where typical yields for corn silage are in the range of 25-35 tons per acre. With the estimated average yield for a 120-acre center pivot at 30 tons/acre and assumed book values for percentage nitrogen of 1.28% and percentage dry matter of 35%, the anticipated nitrogen removed by the corn crop is approximately 300 lbs. N/acre. In this scenario, increasing the percentage dry matter increases the nitrogen removed, while a lower dry matter % reduces the amount of nitrogen removed. This is why it is important to take tissue samples during harvest, in order to provide the most accurate data possible for determining the land application area's nitrogen balance.

Winter crops, such as barley, wheat, and triticale tend to have lower yields than summer crops such as corn, canola, or sorghum. Average yields for wheat silage are typically 6-10 tons/acre in the Roswell region. Again, if we assume a 120-acre center pivot with an average yield of 8 tons/acre and book values for percentage nitrogen (1.60%) and percentage dry matter (28%), the estimated nitrogen removal for the wheat crop is 72 lbs. N/acre. Again, tissue samples are important for nitrogen calculations as they provide precise data on dry matter and nitrogen which can significantly alter the amount of nitrogen removal which is estimated.

Once an accurate estimate for nitrogen uptake by crops is calculated, it can then be determined approximately how much green water, manure, and/or chemical fertilizers can be land applied without overapplication occurring. The amount applied compared with the amount removed is called the nitrogen balance. During low crop yield years or years where crops die or go fallow, more nitrogen is applied than can be removed, and the excess can result in nitrogen leaching below the root zone resulting in potential ground water contamination. However, the impact may not occur for several years depending on the depth-to-water in monitoring wells. Soil testing can provide the dairy with a prompter indication that excess nitrogen may reach the water table. Soil nitrogen values can vary significantly over the course of a calendar year, which is why they are a good indicator of overapplication. Over application of nitrogen tends to show up quickly in soil sampling results and declines before the next annual sampling event, assuming that over application is not continuous. It is important to note, however, that excess nitrogen removal and limited green water application may result in a future crop that is deficient in nitrogen. This is a delicate balance between providing crops with the requisite nutrients and over application of nitrogen.

3.17 Determining Field-Specific Nutrient Uptake

Crop uptake information specific to a dairy is possible by taking tissue samples from a crop in the harvest stage and sending it to an agricultural laboratory for tissue analysis. Usually, the crop tissue samples are analyzed for percent nitrogen (%N) and/or percent crude protein (%CP). If samples are analyzed for %CP, then %N can be obtained by using the formula:

Crude Protein (%) = Nitrogen in crop tissue (%) × 6.25 (for all forages and feeds except wheat grains)

The quantity of nutrients land applied via dairy manure and green water can be estimated only by keeping track of volumes applied through the entire year and submitting lagoon, tissue, and manure solids samples to a laboratory for analysis of the required parameters, specifically Total Kjeldahl Nitrogen (TKN) for the green water. This is why even though the Dairy Rule only requires annual sampling of green water lagoons, it is a recommended best management practice to include lagoon samples within the quarterly monitoring scope. The amount of green water and/or manure which can be applied is planned for in a NMP and is submitted within the annual report to the NMED. The TKN value of green water used within the NMP is averaged from the previous year's sampling. Outlier TKN values are common when the lagoon has recently been pumped down and a higher percentage of solids is present in the lagoon sample, or if climatic effects have resulted in additional evaporation of the lagoon water. That is why an average from four quarterly samples is much more indicative of the amount of TKN. Additional information on crop sampling and interpretation is provided in Section 7.3.

At the end of the year, if it is determined that the quantity of nutrients applied to crops is well above the agronomic uptake, then the fate and transport of excess nutrients that were land applied should be assessed. Soil is the sink for all nutrients that are land applied. If the crops cultivated in one crop season do not take up the entire quantity of nutrients land applied during the crop season, the excess nutrients remain in the soil waiting to be taken up through the root zone, or they may start to leach down below the root zone. For example, excess nitrate not utilized during the growing season has the potential of leaching into deeper layers. Excess phosphorus has the potential of being eroded from the shallow soils by surface runoff. Thus, nutrients useful for plant growth can become contaminants if they are present in the soils above desirable levels. The contaminants can also leach downward towards ground water below the soil. The United States Fish and Wildlife Service is concerned about micronutrients and heavy metals entering the food chain through wildlife that eat the plants growing in the soil to which they have been over-applied. Contaminants can also migrate to adjacent properties through movement of ground water.

3.18 Currently Grown Crops

Having understood the risks of soil contamination and that any nutrients land applied can only be removed by crop uptake—it is critical that dairy producers integrate NMP data when selecting crops to grow. A cropping pattern is often based on the feed requirements at a dairy, so it is important to plan and design a pattern that will uptake all nutrients from dairy manure and green water generated annually.

Another critical element in selecting a cropping pattern is crop suitability. Crops grown at dairy farms in New Mexico include alfalfa, corn, triticale, sorghum, pasture or Bermuda grasses, cotton, winter wheat, oats, barley, chiles, canola, and pecans. As mentioned earlier, crop uptake depends on percent nitrogen and crop yield. For example, a corn silage and triticale silage cropping pattern with average yields per acre of 4.7 tons and 20 tons, respectively, can take up approximately 248 lbs./ac/year (uptake obtained by substituting yield values in the NMED LADS Spreadsheet and book values for dry matter and %N).

However, due to a variety of factors, crops are not always harvested at every dairy or during every growing cycle. In some cases, alternative methods like grazing are practiced. In other cases, crop production may be too low to economically harvest. Calculating N-uptake from grazing systems can be challenging since crop yield cannot be estimated as accurately as with harvested crops. This is further complicated as nitrogen is also added back into the system by the grazing cattle via excretion. NMSU has developed a user-friendly application, Grazing-N, for estimating N balance on intensively managed grazing systems. A free copy of the Grazing-N spreadsheet software with detailed instructions on how to use the software for estimating nitrogen removal is available online at http://aces.nmsu.edu/ces/dairy/publications.html

3.19 Making Changes

The basic principle in land application of dairy manure, green water, and chemical fertilizers is that nutrients (especially nitrogen and phosphorus) applied to land application fields should be removed by the crops grown in the land application fields. If the selected cropping pattern's uptake is not high enough to remove all the nitrate and/or phosphorus generated from the dairy, then alternative crops with higher crop uptake need to be substituted. Examples of crops with higher nitrate uptake include Bermuda grass and non-nitrogen-fixing alfalfa. Please consult with the nearest NMSU extension center for more information on selecting crops with high N-uptake. Alternative methods of addressing over-application issues are either reducing discharge, managing water use, or employing water conservation practices in the milking parlor. Since the common practice at many dairies is to land apply dairy manure and green water to grow crops, it is prudent to follow a Comprehensive Nutrient Management Plan when practicing land application.

SECTION 4—PERMITTING FOR EXISTING DAIRIES

In 2011, the New Mexico Water Quality Control Commission (NMWQCC) issued a new set of water quality regulations targeted at dairy facilities in New Mexico. These regulations, found in 20.6.6 NMAC, became known as the Dairy Rule. The Dairy Rule encompasses all permitting requirements and regulations related to dairy operations, from the permitting process to guidelines regarding closure. Prior to the Dairy Rule, all dairy facilities were permitted under a general NMED Ground Water Discharge Permit. However, since adoption of the Dairy Rule, the NMED now requires an individual Ground Water Discharge Permit for each dairy facility, which we will refer to as a "Dairy Permit," in order to discharge water from a dairy facility. In this section, we will discuss the processes to either renew a NMED Dairy Permit with no changes or renew and modify a Dairy Permit. An existing NMED Dairy Permit is effective for five (5) years, after which time it can either be renewed or renewed and modified. The NMWQCC Regulations outline the following definitions of dairy permit:

- Dairy permit – a NMED Ground Water Discharge Permit, which includes a discharge plan approved by the department.
- Dairy permit renewal – the re-issuance of a discharge permit for the same, previously permitted discharge.
- Dairy permit modification – a change to the requirements of a discharge permit that results from a change in the location of the discharge, a significant increase in the quantity of the discharge, a significant change in the quality of the discharge, or as required by the NMED secretary.

The NMED requires that permits be renewed prior to their expiration date to provide continuous coverage. However, Section 20.6.2.3106 NMAC allows administrative continuation of an existing discharge permit after it expires. If a discharge permit renewal is submitted at least one (1) year before its expiration date, and no violation of the discharge permit occurs on the date of its expiration, then the discharge permit is administratively continued until the application for renewal has been approved or disapproved by the NMED. An example of a NMED Ground Water Discharge Permit and Laboratory Reports is presented in Appendix F.

4.1 Inspections and Compliance History

All CAFOs and Dairy Permit holders must allow entry/inspection by authorized personnel from the EPA for CAFO/NPDES permit inspections, as well as the NMED Ground Water Quality Bureau or the Surface Water Quality Bureau. Most New Mexico dairies have had inspections by both agencies in the past. The EPA is a regulatory agency that evaluates permit compliance or non-compliance. The EPA inspectors are not at the dairy to assist the producer with NPDES/CAFO permit compliance. While the NMED is also a regulatory agency, their inspections are focused on assisting with permit compliance. Prior to entering the dairy, inspectors from any agency are required to follow standard biosecurity measures. It is the dairy producer's responsibility to inform the inspector of any concerns regarding biosecurity that have not been met.

The EPA has primacy over and inspects dairies to ensure that operators comply with the federal CWA/NPDES regulations discussed in Section 2. While the state of New Mexico has primacy over ground water discharge permits, the EPA is still authorized to conduct inspections at New Mexico dairies related to those permits to ensure that there are no discharges to surface waters of the U.S. or connections to surface water via ground water connection or flow path.

The EPA conducts three primary types of inspections of dairies:

- To determine that the dairy qualifies as a Concentrated Animal Feeding Operation (CAFO) and requires a permit.
- To determine whether a CAFO is complying with federal environmental laws and/or permits.
- To determine if a dairy is designed, built, and operated to retain the 25-year/24-hour storm event.

When an inspector from either the NMED or the EPA comes to inspect a dairy, they will likely require the following information:

- When was the last inspection?
- What measures were enacted to address previous issues?
- Are the records of inspections and follow-up action data located on site?

It is important that a dairy producer is able to answer all of these questions and has all inspection reports and follow-up documents readily available for the inspectors to review. In addition, the inspector will inspect the dairy's recordkeeping notebook. As discussed in other sections, proper recordkeeping and documentation is essential for ensuring compliance with state and federal regulations. A complete and up-to-date recordkeeping notebook helps create a favorable first impression and lets the inspector know that the dairy is putting effort into remaining in compliance. If any questions or permit issues arise while the inspector is there, they will request the appropriate documentation from within the recordkeeping notebook and/or additional follow-up information when the inspection report is received. Recordkeeping requirements are described further in this section and in Section 6.

When the EPA inspector has completed their inspection, the dairy producer is entitled to an "exit interview." At that time the inspector should inform the producer of any problems that require immediate attention. The EPA will generate a written inspection report at a later date and provide it to the dairy for their records; the dairy may also receive an Administrative Order or a Request for Additional Information. The inspection report will most likely include observation of operational or recordkeeping issues that may warrant correction. It is important to address these issues as quickly as possible and keep all documentation of changes or repairs in the recordkeeping notebook.

The most important thing a dairy should do upon receiving the inspection report is to review it carefully for errors, misunderstandings, or inaccuracies. If any errors, misunderstandings, or inaccuracies are identified, a written response should be immediately submitted to the EPA describing them in detail. Inspection reports are on file with the EPA and if the dairy does not submit a written response to the inspection report, it is presumed to be accurate. Therefore, a written response (if necessary) is an important part of EPA documentation and can protect a dairy from third-party citizen lawsuits.

If the inspection report reveals issues that need to be addressed, the dairy should provide the EPA with a written list of improvements or repairs that will be made with a schedule for improvements/repairs. If weather or other factors set back the improvement schedule, notify the EPA in writing prior to the end of the initial schedule and submit a revised schedule. Make sure to clearly and directly list the circumstances that caused the delay.

While not totally inclusive, the following are some common EPA inspection issues that can be easily corrected with careful recordkeeping and documentation of dairy operations:

- Insufficient storage in lagoons
  - Provide the on-site engineering drawings for the lagoon construction that specify the design volumes. This information will show that the lagoon is designed, constructed, and operated to maintain the volume of water produced from a 25-year/24-hour storm event.
- Insufficient freeboard in the lagoon
  - Show the EPA weekly inspection staff-gage data.
  - Ask for verification of EPA field calculation.
  - Show the EPA any CAFO/NPDES or Discharge Permit documents that detail how much freeboard the lagoon is designed for and (if appropriate) indicate that the lagoon is within the freeboard limitation.
- Land application of green water and manure is not at agronomic rates
  - Provide the inspector with LADS from a NMED Dairy Permit to prove that land application rates are at agronomic rates.
  - Provide the inspector with soil chemistry data showing how operations are within limits based on the N or P levels of land application areas.

- Documentation of “no hydrologic connection to surface water” required by EPA.
    - Provide the inspector with lagoon recertification engineering data.
    - Provide the inspector with lagoon liner as-builts.

Unlike the EPA, an inspector from the NMED will likely ask for a tour of the facility in advance of their arrival. This request is preferably for a tour from the facility owner and/or dairy manager, but in the event they are unavailable, the technical expert for the dairy may act in place of the owner/operator. NMED inspectors will typically ask to “follow the water,” which simply means showing the path of the water from discharge at the barn and milking parlor through to the lagoon, to where water is stored prior to land application, and ultimately to the fields that receive the water. It is important to ensure the dairy is using its best management practices and that any hose leaks, water ponding, or excess solids issues are resolved prior to the inspection.

4.2 The NMED Regulatory Approach

As discussed, EPA-issued permits are designed to be protective of surface water quality, and that is the main concern of EPA inspectors when they visit a dairy. NMED-issued Ground Water Discharge Permits are designed to be protective of ground water quality, and their inspection approach and regulatory approach to dairy management is designed as such. When preparing a discharge permit renewal application, a dairy manager needs to consider whether or not the dairy has synthetically lined lagoons or properly constructed and maintained clay-lined lagoons(s) and whether the soils and ground water have concentrations of nitrate, chloride, or TDS in excess of regulatory limits. If constituent concentrations exceed New Mexico Water Quality Control Commission (NMWQCC) standards, then the facility is at risk for corrective action and/or abatement. These topics will be covered in greater detail in sections 4.16 and 4.17. If quarterly monitoring reports indicate that a dairy is being properly operated, and does not wish to change the location, quantity or quality of their discharge, they can simply submit a renewal application to the NMED. The NMED will allow up to a 10% change in the quantity of discharge before requiring a discharge permit modification. However, please be aware that increasing discharge at a dairy facility may also incur an increased discharge permit fee once the total discharge crosses the next threshold.

When the NMED determines whether a dairy can renew a permit or is required to submit a renewal and modification, they will review the dairy’s quarterly monitoring reports to see if the operations have resulted in soil or ground water contamination. If the reports demonstrate contamination, the NMED may require modifications to the permit before the expiration date. As mentioned above, the preparation of a Corrective Action Plan (CAP) may also be required. The NMED, under the Dairy Rule has the option to move a dairy into “abatement” vs corrective action. A CAP is administered under a diary’s discharge permit and is reviewed by the NMED discharge permit reviewer. If placed in abatement, the dairy is regulated by a separate abatement regulatory program resulting in significant additional prescriptive reporting.

Alternatively, a permit modification can be proposed when a renewal application is submitted. As mentioned in the introduction of Section 4, renewal applications are due at least one (1) year before the discharge permit expiration date. A request for permit modification should be proposed if operational changes are made that will affect the location, quantity or quality of the discharge or less stringent monitoring requirements are proposed. In order to request less stringent monitoring requirements, a variance request will need to be filed with the NMWQCC. A dairy operation may propose less stringent monitoring requirements only if the lagoons are synthetically lined and monitoring reports consistently show contaminant concentrations below regulatory limits. Regardless of variance approval, some monitoring will most likely still be required, but the number of monitoring wells and the frequency of soil sampling may be reduced. The proposed monitoring plan is included in Section D of Part II of the permit application form linked here: https://www.env.nm.gov/forms/

All dairy discharge permits include monitoring and reporting requirements. Dairies with synthetically lined lagoons, uncontaminated soils and monitoring wells should have the minimum monitoring requirements written into their permits. There are two approaches for monitoring to protect ground water contamination beneath dairies. The first is a “soil based” top-down monitoring approach, which uses double liners with leak detection, suction lysimeters beneath lagoons, and soil chemistry as an indicator of potential downward migration or leaching of nitrogen through or below the root zone and vadose zone. This soils-based approach is most appropriate for new dairies that have established background water quality and soil chemistry prior to discharging. This approach is also appropriate for existing dairies with synthetically lined lagoons, uncontaminated soils, and uncontaminated monitoring wells. The second monitoring approach is a “ground water based” bottom-up approach and is how the NMED has typically regulated dairies in the past. This approach has historically looked at ground water quality more than soil chemistry. Regardless of the monitoring approach, the NMED’s focus is on the protection of ground water quality.

NMED Ground Water Discharge Permits are designed to be protective of ground water quality. EPA’s NPDES/CAFO permits are designed to be protective of surface water quality and hydrologically connected ground water. If a dairy is designed, constructed, and operated so that ground water and soils are uncontaminated, then they are in a position to propose fewer wells and/or less frequent sampling of wells. If ground water has been impacted with high nitrate, TDS or chloride, a dairy should immediately evaluate their manure management system and/or green water application to make sure that operations are in accordance with BMPs.

In addition to a ground water monitoring plan, NMED Ground Water Discharge Permit applications now require the following additional elements:

- Surface soil survey and characterization of vadose zone geology
- Location map identifying features (sinkholes, playas, springs, etc..) within a one-mile radius of the dairy (submitted in conjunction with a table of all domestic and industrial wells within the specified radius)
- Flood zone map
- Average daily discharge volume
- Photographic documentation of settled solids
- Photographic documentation of flow meter
- Potentiometric surface/ground water elevation contour map
- Monitoring well logs
- Lagoon design drawings and specifications
- Land application information showing both infrastructure and an NMP

4.3 Monitoring Plan Requirements

All Dairy Permits require monitoring plans, which are outlined in NMAC 20.6.6.23. Section D of the permit application form includes the Monitoring Plan (20.6.2.3107.A NMAC). When preparing a discharge permit renewal, the monitoring requirements of the existing permit should be evaluated to make sure they are currently necessary and warranted for the next 5 years. For example, if a dairy has plans to convert a field from flood irrigation to center pivot irrigation, or to stop irrigating certain fields, that information should be included in the monitoring plan. In many instances, monitoring requirements can be modified if the field data is available to back up the requests. Any wells deemed unnecessary to monitoring requirements should be plugged and abandoned.

The Dairy Rule allows for request of a variance to requirements of the Dairy Rule (20.6.6.18). This variance allows for a discharger to propose alternative technical procedures. This is the time to use historic reproducible sampling data to support the proposal to change or reduce monitoring requirements.

4.4 NMED Ground Water Discharge Permit Information and Compliance

A NMED-issued Discharge Permit will contain the following information.

- Permit ID Number.
- Permitted Discharge Volume.
- Physical Description of the Dairy.
- List of all Wastewater Impoundments.
- Permitted Land Application Area.

The permit will also contain:

- Documentation on the installation, maintenance, and use of effluent (green water) monitoring devices.
- Documentation on the installation, maintenance and use of monitoring devices for ground water.
- Monitoring plan for vadose zone.
- Quarterly submission of monitoring reports pursuant to requirements in the discharge plan and methods used to obtain those results.
- Submission of a monitoring well proposal, if the NMED determines the proposed monitoring plan is not sufficient in monitoring all contamination sources.
- Submission of a Corrective Action Plan if the NMED determines ground water quality at the Dairy to be above state standards due to the Dairy's management practices.
- Results of annual submission of soil sampling.
- Annual submission of a Nutrient Management Plan if the facility land applies.
- Monitoring data for 5 years.
- Contingency plans to address potential system failures.
- Closure plan that extends beyond termination or expiration of permit.

Facility-specific requirements of the permit may also include specific provisions for soil sampling, grazing, ground water monitoring, lagoon construction, nutrient management where land application occurs and frequency of monitoring. Always refer to the Discharge Permit for site-specific requirements and always keep a copy of the permit on site.

4.5 NMED Administrative Modifications to NMED Sampling and Reporting Requirements

The NMED has the following soil monitoring and reporting requirements for the dairy industry. The sampling and reporting requirements include:

- The first (1st) foot of soil collected will be one surface composite soil sample.
- Two sub-surface composite soil samples (2nd and 3rd foot) will be collected.
- Composite soil samples shall be collected according to the following procedure.
  - Each surface and sub-surface soil sample shall consist of a single composite of 15 soil cores collected randomly throughout each field.
  - If a field is divided into differing management units, soil samples shall be collected from each management unit.
  - If a field or management unit consists of considerably different soil textures, soil samples shall be collected from each soil texture within each field or management unit.
  - Surface soils samples (1st foot) shall be collected from a depth of 0 to 12 inches.

- Each 2nd-foot sub-surface soil sample shall be collected from a depth of 12 to 24 inches.
  - Each 3rd-foot sub-surface soil sample shall be collected from a depth of 24 to 36 inches.
- Each surface composite sample shall be analyzed for:
  - pH, electrical conductivity (EC), TKN, NO_3-N, chloride (Cl), organic matter (OM), potassium (K), phosphorus (P), sodium (Na), calcium (Ca), magnesium (Mg), sulfate (SO_4), soil texture, and determination of the sodium adsorption ratio (SAR) Sub-surface (second- and third-foot) samples shall be analyzed for EC, NO_3-N, and Cl.

Annual soil samples are to be collected and analyzed from each field and/or management unit within the permitted land application area that has received or is actively receiving green water and/or stormwater during the term of the current permit. Fields that do not receive green water during the term of the permit would only need to be sampled during the first year of the permit.

Livestock grazing on land application areas

- The NMED will consider the practice of livestock grazing for nitrogen removal from land application areas if a plan is submitted for review as part of an overall comprehensive nutrient management plan for land application areas. The proposal must adequately demonstrate that nitrogen removal can be quantified with reasonable certainty.

4.6 Ground water Monitoring Wells—Their Design and Location

The design of a ground water monitoring well network is based on monitoring potential contaminant source areas for the entire facility, including the production area and land application fields. Monitoring wells will be located both upgradient and downgradient of all potential sources of contamination including green water lagoons, stormwater impoundments, and fields within the land application area. An upgradient well is required to monitor contamination coming onto the facility from off-site. As discussed previously, upgradient wells provide a baseline for contamination coming onto the site and can show dairy practices are not responsible for constituent concentrations above state standard. Alternatively, if the dairy's practices are contributing to and/or enhancing contamination, this will be illustrated by the difference between concentrations in upgradient and downgradient monitoring wells. As previously discussed, the NMED will consider requests for a reduced number of monitoring wells on a case-by-case basis, based on site-specific information and proposals submitted to the NMED during the permit development period (new or renewed permits).

During the permit renewal process, the applicant may request wells to be removed from the permit which are dry, damaged, or redundant for source monitoring. The applicant may also request that wells which have been added to the corrective action's quarterly sampling requirement be included in the permit. At the time of permit renewal, the NMED may require monitoring of additional contaminant sources. If so, monitoring well locations must be proposed and submitted to the NMED within 60 days of issuance of the new permit. Proposals address monitoring wells which were negotiated during the permit process. If the locations are approved, monitoring wells can be shared by more than one (1) dairy. Generally, one dairy's downgradient well could serve as their neighbor's upgradient well. This is an arrangement that can be negotiated between the two facilities in the form of an access agreement that allows permission for the well to be sampled by both facilities.

Upon approval of any monitoring well proposal, monitoring well drilling and installation will occur within 120 days. Within the proposal, the technical expert/consultant shall provide precise locations/coordinates of the monitoring wells, field verify that they do not interfere with dairy and/or farming operations and assure that they are not located near any utility lines. Based on NMED monitoring well construction requirements, monitoring wells must be constructed with 20 feet of slotted screen, with no more than 15 feet of screen positioned below the water table. In cases where site-specific ground water monitoring data indicates that the water table is currently dropping at a rate greater than two feet per year, the NMED will consider requests to install monitoring wells with screen lengths greater than 20 feet. This situation is most likely to occur in the High Plains Aquifer, where excessive withdrawals due to agriculture are affecting long-term water availability. When feasible, a dairy in the Clovis-Portales region may request productions well be utilized as a monitoring well where appropriate. Due to the nearly 300-foot depth to water (DTW) in this region, drilling monitoring wells can be at considerable cost to the dairy. In such cases, the NMED may allow the dairy to sample production wells rather than require the facility to drill a new monitoring well. Under these circumstances, it is necessary for the dairy to stop pumping from the production well 48 hours prior to sampling in order to allow water levels to stabilize and a reliable DTW can be measured in the well. If these measures are not taken before each sampling event an accurate estimation of ground water flow direction cannot be determined. NMED guidelines for monitoring well construction require that newly installed monitoring wells be completed with grout-sealed annular spaces. See Figure 6.2 for a visual representation of a newly installed monitoring well. Section D of 20.6.6.23 outlines the requirements for monitoring well construction and completion.

Many dairies submit their Dairy Discharge Permits with more land application fields than required for the calculated agronomic uptake of green water. If these fields do not receive green water and/or stormwater discharges, then a dairy operation is not required to install corresponding infrastructure on these fields. Once a dairy intends on applying green water to a field, they must notify the NMED prior to discharging and an additional downgradient monitoring well will likely be required.

4.7 Lagoon Certification and Scaled Facility Maps

Any applicant who is constructing a new impoundment or modifying an existing impoundment must submit detailed construction plans, specifications and design calculations to the NMED under the requirements of 20.6.6.17.c NMAC. The survey and capacity calculations of pre-existing lagoons and impoundments shall be done by a licensed New Mexico professional surveyor. While many dairies already submit scaled facility maps with topography and aerial photography, the NMED is now formally requiring them. When submitted, these scaled facility maps must document the techniques used to locate the mapped objects (i.e., GPS, land survey, digital map interpolation, etc.) and the relative accuracy of the data (i.e., +/– feet or meters).

4.8 Setback Requirements for New Discharge Permits

Any applicant applying for a new discharge permit must adhere to setback requirements for both the commercial dairy production area and land application area per 20.6.6.16 NMAC.

Production area requirements include the following:

- Greater than 200 feet from the 100-year flood zone of any watercourse.
- Greater than 200 feet from a lakebed, sinkhole, or playa lake.
- Greater than 200 feet from any spring identified on a U.S. Geological Survey topographic map and not identified as a supply of water for human consumption.
- Greater than 350 feet from a private domestic water well or spring that supplies water for human consumption.
- Greater than 1000 feet from any water well or spring that supplies water for a public water system.

Land application area setback requirements are:

- Greater than 100 feet from the 100-year flood zone of any watercourse.
- Greater than 100 feet from a lakebed, sinkhole, or playa lake.
- Greater than 100 feet from a private domestic water well or spring that supplies water for human consumption.
- Greater than 200 feet from any water well or spring that supplies water for a public water system.

4.9 Expiration Date

At least one year before permit expiration, a renewal application or renewal with modifications application is required to be submitted to the New Mexico Environment Department. This is provided that there are no violations of the current permit conditions, no changes affecting the location, quality, and quantity of discharge, and the existing permit will not expire until the renewal application has been approved or disapproved. The permitting timeline and public notice requirements are detailed in Figure 4.1.

4.10 Application Fees for Filing Applications

In addition to an application fee of $100, a permit fee based on the classification of a facility (agricultural) and the volume of discharge, is required by the NMED, with half due upon application submittal. The NMED fee schedule is presented in the NMWQCC regulations in Section 20.6.2.3114, Table 1.

4.11 Public Notice

Section E of 20.6.6.12 NMAC of the NMWQCC Regulations addresses “Public notice preparation” for discharge permit renewals or renewal modifications, and Section F of 20.6.6.11 NMAC addresses public notice preparation for new discharge permit applications. Figure 4.1 provides a summation of the timeline for public notice and participation. Note that the timeline provides the schedule that an ideal discharge permit would follow. A public hearing may result from the public notice process, regardless of compliance history.

4.12 Public Hearing

If the NMED Secretary determines that there is significant public interest in a permit, a public hearing will be scheduled. Even if the dairy is in compliance with existing permit requirements, the public notice process allows the interested public to protest a permit renewal. The secretary may also deny requests for a hearing that do not meet the requirements of Subsection K of 20.6.2.3108 NMAC. The NMED public hearing is a quasi-judicial administrative hearing heard by a NMED hearing officer. Hearing participants are the applicant, the protesting parties, and the NMED. At the hearing, an applicant will be presenting a case on why the requested permit should be granted. It is recommended that the applicant retain an attorney to represent them at the permit hearing and expert witnesses to present the scientific data supporting the permit. Each party has the opportunity to present direct testimony and to conduct cross-examination. The hearing officer may also ask questions of all parties.

After the conclusion of the hearing, the hearing officer prepares a Hearing Officer’s report and submits it to the NMED Secretary. The report summarizes the evidence, prepares Findings of Fact and Conclusions of Law, and submits a Recommended Final Order. After receiving the report, the NMED Secretary can either approve granting of the discharge permit as submitted, approve granting the discharge permit with conditions, or deny the permit. If any party involved in the hearing is aggrieved by the Secretary’s decision, that party can appeal the Secretary’s action to the NMWQCC. The NMWQCC will schedule a hearing

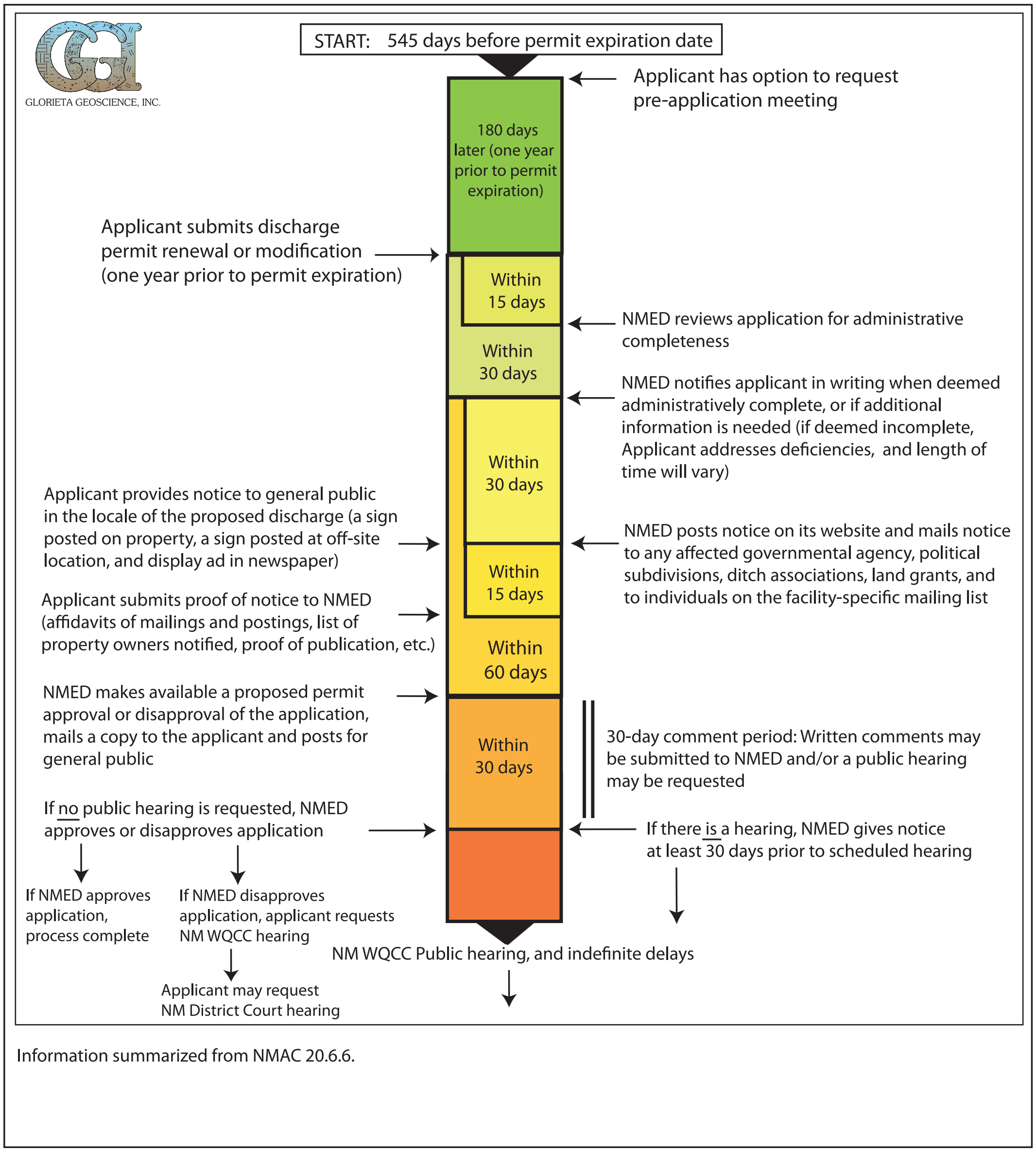


Figure 4.1. **Ground Water Discharge Permit public notice and participation timeline (20.6.6 NMAC).**

on the record from the administrative hearing. If any participating party is aggrieved by the NMWQCC decision on the appeal the aggrieved party can appeal to New Mexico District Court.

4.13 Preparing a Discharge Permit Renewal with Modification

An application for discharge permit renewal must include and adequately address all the information necessary for evaluation of a new discharge permit. The discharge plan file contains previously submitted materials that may be included by reference in a permit renewal. The NMED has a standard discharge permit application form that must be completed, although materials submitted as part of an expiring permit may be referenced. The application form consists of four parts, which are available on the NMED's website with a link provided in Appendix A. The information on the forms should be administratively and technically accurate and complete. The NMED's website describes the submittal requirements for renewal applications.

When a permit renewal or renewal with modification is prepared, it should use the data collected during the previous five (5) years (or longer). Since the discharge permit is a "plan of operations," it should evaluate the accuracy of historic data and analyze to determine if any present permit conditions need to be amended. If the dairy has stayed in compliance with the Discharge Permit conditions during the previous 5-year permit period, there should be at least 20 quarters of discharge, water quality, water level, and soil data available. This data should be used to evaluate whether to simply renew a discharge permit or to modify it.

Depending on the answers to the checklist of questions asked in Worksheet 1 (see below), a dairy operator may find they need to modify their Discharge Permit. It is at the time of the Notice of Intent (NOI) that compliance requirements become effective. See section 4.19 for details on Notice of Intent (NOI). Recordkeeping requirements for compliance with the expired general permit are described in Section 6. There are no fees associated with submitting a NOI permit when applying for a renewal. If a dairy is adding additional land application areas not previously permitted, they are required to apply for a modification. Keep in mind that even if a renewal-only application is submitted, the NMED may propose to require additional monitoring or types of monitoring when they approve the application.

Based on answers to the questions in Worksheet 1, if it is determined that modifications to the current permit are needed, then the following questions should be considered before proceeding:

- Can the discharge be reduced?
  - Have all leaking hoses been identified and fixed?
  - Will the number of milking cows increase?
  - Are water conservation techniques in the milking parlor employed to reduce discharge?
  - Have workers been trained to eliminate water waste?
  - Are supply and parlor sump meters properly calibrated?
  - Can automatic shut-off valves be installed in the milking parlor?
  - Can the frequency of wash pen use be reduced?
  - Are corrals flushed or scraped?
  - Can more water be recycled?
  - Is reverse osmosis reject water entering the green water stream?
  - Can the TKN concentration be reduced in the lagoon(s)?
  - Is a separator in use?
  - Is the solids management program working properly?
  - Are feed lanes flushed?
  - Is it possible to change from flush to scrape?
  - Are there proven additives that will reduce the TKN in the lagoon?
  - Is more land needed on which to recycle green water?

If the volume or concentration of regulated chemicals in the discharge cannot be reduced, then a modification to the current permit is required. Since a permit application has been submitted and a fee for the existing permit has been paid, it is best to modify the permit at the end of the five (5) year period (the time of renewal). This is the time to plan for long-term improvements and changes in operational practices. It is also the time to add as much additional land application area as possible and apply for additional lagoons or storage volume if an expansion is anticipated in the next five (5) years.

4.15 Legal Responsibilities Under the Discharge Permit

A NMED-issued Ground Water Discharge Permit requires identifying the individuals responsible for the discharge. A permit applicant is effectively entering into a contract with the State of New Mexico to operate within the terms and conditions of the approved discharge permit. These terms and conditions include accepting responsibility for conducting an abatement program if ground water becomes contaminated and financing a closure plan that could continue beyond the operational life of the dairy. An applicant should read the discharge permit carefully and always operate the dairy to be protective of water quality. If new construction or new monitoring wells are planned, submit the engineering plans and monitoring well plans to the NMED prior to construction. The NMED must approve these plans prior to construction and/or monitoring well installation.

4.16 Corrective Action Under Dairy Discharge Permits

The NMED may require corrective action on the part of any dairy facility where at least one monitoring well exceeds the ground water standard for one constituent and exceeds the concentration of the constituent measured by the upgradient well. Upgradient wells measure contaminant concentrations as they enter the facility from off-site sources. If contamination increases as ground water moves through the facility's subsurface, this indicates the dairy is contributing to contamination. If constituent concentrations decrease, then this suggests best management practices at the dairy are reducing impacts. While corrective action can be administered for any exceedance of a constituent concentration, excess nitrate is typically responsible for corrective actions imposed by the NMED. Corrective action is usually administered as a requirement upon issuance of a new discharge permit and/or permit renewal. New permits require a Corrective Action Plan (CAP) to be submitted within 120 days of the permit issuance. This plan must detail the remediation measures to be taken by the dairy to address the exceedances. The NMED has 60 days from receipt of the CAP to approve or disapprove the remediation measures outlined in the plan. Additional corrective action may be deemed unnecessary if the actions undertaken to mitigate contamination improve water quality to below state standards for two consecutive quarters.

***Worksheet 1.* Checklist of questions to ask prior to renewing or modifying your discharge permit.**			
Question	**Yes**	**No**	**Do Not Know**
Is my daily discharge within permitted discharge volumes?			
If your discharge is greater than the permitted volumes and you cannot reduce green water generation, proceed to permit modification section below.			
Can I reduce water use in the milking parlor?			
Are my meters accurate?			
Are my lagoons lined?			
Do my green water lagoons have sufficient volume to hold 60 days of average daily discharge plus 2 feet of freeboard if land application is practiced or NRCS-designated volume if total evaporative? If I have a separate storm water lagoon do I have sufficient storage volume to retain the runoff from the 25-year/24-hour storm event?			
If I have a combined green water/storm water lagoon do I have sufficient volume to hold 60 days of average daily discharge plus the runoff from the 25-year/24-hour storm event plus 2 feet of freeboard?			
For total evaporative lagoons, do I have enough storage to successfully evaporate all my green water and storm water?			
Are my lagoons leaking?			
Are muy lagoons structurally sound?			
Is my production area graded so all runoff water is directed to my storm water lagoon?			
Are my monitoring wells constructed properly constructed and lcoated?			
Have any of my monitoring wells gone dry?			
Is my water table declining at a rate such that I want to ask to install more than 20 feet of screen in the replacement monitoring well?			
Is the water quality of my upgradient monitoring below or above WQCC standards?			
Is the Nitrate concentration of the upgradient MW above or below the nitrate concentration of down-gradient monitoring well?			
Are there any offsite sources that potentially contribute to ground water contamination?			
Do I have monitoring wells that show exceedances of WQCC water quality regulations?			
If yes, is the source identified?			
Does the ground water flow direction beneath my dairy remain fairly constant or change?			
If I need to drill an additional monitoring well, are there any existing monitoring wells that I can abandon?			
Are there any monitoring wells that can be sampled less frequently?			
Is my lagoon TKN the same as it was 5 years ago?			
If your lagoon TKN is higher than predicted you may have to acquire additional land application fields (modification) or start applying green water to already permitted fields.			
Do I have sufficient crop land to apply my green water at agronomic rates?			
If no, reduce your green water production or acquire additional land application fields; proceed to permit modification section below.			
Do I have sufficient water rights to blend fresh water with green water?			
Is the nitrate concentration in the soils beneath muy land application areas low, medium, or high?			
Do I have nitrate concentrations over standards in my monitoring well downgradient of my land application area?			
Do I need to change my cropping pattern to increase my nitrogen uptake?			
Have I been applying green water and manure solids at agronomic rates?			
Is my record-keeping up to date and supportive of the permit renewal I am requesting?			
Do I have a successful animal mortality management program?			
Have I been implementing and following Best Management Practices (BMPs) on my dairy?			

The NMED may require any number of corrective actions to address exceedances in ground water standards under the following conditions:

- Replacement of a clay liner or pre-dairy rule liner not composed of 40/30-mil HDPE or equivalent.
- Non-functioning monitoring wells.
- Improperly located and/or completed monitoring wells.
- Exceedances of daily discharge for 12 or more consecutive weeks.
- Insufficient capacity in the impoundments – these include lagoons, stormwater ponds and runoff ponds.
- Inability to preserve more than two feet of freeboard in impoundments.

Corrective action is the first step undertaken by the NMED to improve water quality at a dairy facility. In order for corrective action measures to denote progress, the NMED needs to see a substantial improvement in water quality over time. Corrective actions the dairy may implement to reduce nitrate contamination may include:

- Conversion of flood irrigation fields to center pivot irrigation.
- Limiting green water or manure application to land application fields.
- Working with an agronomist to determine which crops maximize nitrogen removal.
- Extract nitrogen from the subsurface through a cycle of pump and treat; nitrogen is removed through phytoremediation.
- Reduce dairy's overall discharge.

It is important to note that remediation methods often take a significant amount of time before constituent concentrations decline and measurable progress can be noted. In many cases, the local geology may be a constraining factor, which limits the ceiling to water quality improvement. One such example exists in the Roswell Artesian Basin, where total dissolved solids (TDS) and chloride (Cl) concentrations will always be elevated due to the presence of the regional limestone aquifer. Additionally, nitrate contamination may also result from non-dairy sources such as local septic systems. Previous research has shown chloride/nitrate ratios can be used to determine the exact source of contamination. If corrective action does not sufficiently mitigate contamination, then additional measures such as abatement will be required. For more information on abatement, see Section 4.16.

4.17 Abatement Under NMED Ground Water Discharge Permits

Discharge Permits include an option for the NMED to place a dairy into Abatement rather than Corrective Action. Requirements for an Abatement Plan are more prescriptive than CAP and are administered by a separate NMED program. The NMWQCC regulations define abatement plan as "a description of any operational, monitoring, contingency and closure requirements and conditions for the prevention, investigation and abatement of water pollution, and includes Stage 1, Stage 2, or Stage 1 and 2 of the abatement plan, as approved by the NMED Secretary." Section 20.6.2.4000 NMAC of the NMWQCC regulations addresses the prevention and abatement of water pollution. The purpose of the abatement requirements is to:

1. Abate pollution of subsurface water so that all ground water that has a background concentration of 10,000 mg/L or less TDS is either remediated or protected for use as domestic and agricultural water supply.
2. Remediate or protect those segments of surface waters which are gaining because of subsurface-water inflow, for uses designated in the Water Quality Standards for Interstate and Intrastate Streams in New Mexico (20.6.4 NMAC).
3. Abate surface-water pollution so that all surface waters of the State of New Mexico are remediated or protected for designated or attainable uses as defined in the Water Quality Standards for Interstate and Intrastate Streams in New Mexico (20.6.4 NMAC).

A dairy may be required to abate both the vadose zone and ground water so that any excess nitrate or other constituents in the vadose zone do not leach down into ground water. The abatement regulations also require the responsible person to abate soils and/or ground water to the background concentration. If a dairy is required to submit an abatement plan, all the preoperational background water quality and soil data collected are used to establish the soil and ground water concentrations that have to be achieved. The NMED's objective is to abate ground water pollution at any place of withdrawal for present or reasonably foreseeable future use, where the TDS concentration is 10,000 mg/L or less, and to abate surface-water contamination to conform to the Water Quality Standards for Interstate and Intrastate Streams in New Mexico (20.6.4 NMAC).

Additional wells may be required if the Dairy is under abatement and the source of the contamination, as well as the extent of the contamination plume has not been determined and needs to be further constrained. In this instance, the NMED may require a partial sampling scope with monitoring well sampling required under the Discharge Permit semi-annually, while requiring a full scope with ground water quality sampling for abatement wells semi-annually. An abatement program is considered complete after a minimum of eight (8) consecutive quarterly samples from all compliance sampling stations meet the abatement standards that were based on background concentrations or based on WQCC standards.

If a dairy is unable to fully achieve abatement standards agreed on with the NMED using commercially accepted abatement technology pursuant to an approved abatement plan, they may propose that compliance with abatement standards is technically infeasible. There are a variety of methods available to prove technical infeasibility and the NMED will also evaluate experimental technologies to achieve alternate abatement standards. The NMED may also accept non-invasive remediation methods such as monitored natural attenuation (MNA). To determine whether MNA or more active approaches to site remediation are appropriate, the dairy must first build a conceptual model of the site that identifies the source, migration pathway, contaminant of concern, and potential receptors (targets). Common active remediation techniques include source area excavation, containment, and injection and extraction wells. There are many additional technologies which are used, of which information is available on the EPA website. The NMED will not approve an alternate abatement plan if it results in a concentration that is greater than 200% of the abatement standard for that contaminant.

The critical component of any abatement plan is to identify if any receptors (domestic wells, municipal supply wells, surface water with threatened or endangered species habitat) will potentially be impacted. If the NMED agrees that nitrate or other contaminants will not reach a receptor, then the dairy is in a stronger position relative to additional abatement activities. In these cases, a dairy may propose monitoring to show that the contaminants will not leave the property or reach a receptor. If there is a potential risk to a receptor, such as a domestic well, one abatement option would be to provide water for the person/community which is served by that well.

4.18 Existing NPDES/CAFO Permitting

If a dairy has an expired NPDES/CAFO general permit, it is required to follow all terms and conditions of this permit until the new rule and permit are finalized. As discussed in Section 2, the decision whether or not to obtain a NPDES permit is a risk-based business decision. Even though the requirements of a NMED Ground Water Discharge Permit and a NPDES/CAFO permit have significant overlap, they are separate and distinct permits with different objectives and regulatory oversight. Compliance with a NMED Ground Water Discharge Permit does not guarantee compliance with a NPDES/CAFO permit.

EPA Region 6 has recognized that a NMED Ground Water Discharge Permit is protective of surface and ground water quality but will not recognize a ground water permit as a functional equivalent of a NPDES/CAFO permit. If a dairy is in compliance with all the conditions of their Ground Water Discharge Permit, then it likely is in substantial compliance with a NPDES/CAFO permit. However, without the NPDES/CAFO permit, all discharges to Water of the United States will be considered a CWA violation. Even if a dairy decides not to obtain a NPDES/CAFO permit, to avoid CWA violations, it should operate and follow the requirements of a NPDES/CAFO permit.

When deciding whether or not to obtain NPDES permit coverage, a dairy should consider the watershed in which it is located. For example, dairies in the Lower Pecos River watershed and the Middle Rio Grande watershed have a high risk of "taking" threatened or endangered species (Pecos bluntnose shiner and silvery minnow, respectively) during an unauthorized discharge. On the other hand, dairies in the lower Rio Grande watershed or on the High Plains (e.g., Curry and Roosevelt counties) have a low risk of taking threatened or endangered species during an unauthorized discharge. While lower Rio Grande dairies still have some risk of discharging to waters of the United States and violating the CWA, the High Plains dairies have minimal risk of doing the same.

If the decision is made to obtain a NPDES/CAFO permit, a dairy must submit a Notice of Intent (NOI) to EPA Region 6 and to the NMED Surface Water Quality Bureau. See the NPDES/CAFO permit section in Section 5 for a discussion of individual versus general permits.

4.19 What is included in the NOI?

A link to the NOI form (2B NPDES) is provided in Appendix B. The information provided must include:

- Name of owner or operator.
- Facility location and mailing address.
- Latitude and longitude of production area.
- Topographic map showing specific location of production area.
- Specific information about the number and types of animals, whether in open confinement or housed under one roof.
- Type of containment and storage and total storage capacity for manure, litter, and process wastewater
- Total number of acres under control of applicant available for land application.
- Estimated amount of manure, litter, and processed wastewater generated per year.
- Estimated amounts of manure, litter and processed wastewater transferred to other persons per year.
- Certification that a nutrient management plan has been completed and is being implemented.

Permit coverage and compliance requirements are effective upon submittal of the NOI. Recordkeeping requirements for compliance with the expired general permit are described in Section 6. There are no fees associated with submitting a NOI. However, once a NOI has been submitted the dairy must make sure and be in compliance with all NPDES/CAFO requirements.

4.20 Revisions to NPDES/CAFO Permitting

In February 2003, EPA issued revised Clean Water Act (CWA) permitting requirements and effluent limitations for CAFOs. The revised regulations expanded the number of CAFOs required to seek a NPDES permit and added requirements applicable to land application of manure by CAFOs. In February 2005, the Second Circuit Court of Appeals issued its decision in Waterkeeper Alliance et al. v. EPA regarding legal challenges to the 2003 rule (Waterkeeper, 2005). Among other things, the court directed EPA to:

- Remove the requirement for all CAFOs to apply for NPDES permits.
- Add requirements for Nutrient Management Plans (NMPs) to be submitted by CAFOs with their permit applications, reviewed by permitting authorities and the public, and the NMP terms incorporated into permits.

In November 2008, USEPA published the "2008 revision to the 2003 Final CAFO Rule."

Key revisions

The final rule includes two key changes that address the Waterkeeper court decision. First, it revises the requirement for all CAFOs to apply for NPDES permits and instead requires only those CAFOs that discharge or propose to discharge to apply for permits. As explained in the final rule, this evaluation calls for a case-by-case determination by the CAFO owner or operator as to whether the CAFO does or will discharge from its production area or land application area based on an objective assessment of the CAFO's design, construction, operation, and maintenance. The final rule also provides a voluntary no discharge certification option for CAFOs that do not discharge or propose to discharge. A properly certified CAFO demonstrates to the permitting authority that it is not required to seek permit coverage.

Second, the rule adds new requirements relating to NMPs for permitted CAFOs. CAFO operators were already required to develop and implement NMPs under the 2003 rule; the new rule requires CAFOs to submit the NMPs along with their NPDES permit applications. Under the new rule, permitting authorities are required to review the NMPs and provide the public with an opportunity for meaningful review and comment on the plans. Permitting authorities are also required to include the terms of the NMP as enforceable elements of the permit. The final rule lays out a process for including these facility-specific provisions in both individual and general permits.

- New certification option:
  - Adds voluntary "no discharge certification" option for CAFOs that do not discharge or propose to discharge.
- Additional Nutrient Management Plan (NMP)-related requirements:
  - Adds requirements for operators to submit NMPs with permit applications or notices of intent (NOIs) for general permit coverage; permit authorities and public review of NMPs; terms of NMP into permit.
  - Allows two approaches for rates of application as terms of NMP.
- Affirms BCT limitations:
  - Best Conventional Technology (BCT) limitations established in 2003 represent the Best Conventional Control Technology for achieving fecal coliform reductions.

Determining which CAFOs must seek permit coverage

- How does a CAFO know if it needs to apply for permit coverage?
  - The Final Rule calls for a case-by-case determination of whether the CAFO does or will discharge from its production or land application area based on an objective assessment of the CAFO's design, construction, operation, and maintenance.
- If an unpermitted CAFO is previously discharged and has permanently fixed the cause of the discharge, does it need to apply for a permit?
  - A CAFO that has had a discharge in the past and has taken the steps necessary to permanently fix the cause of the discharge is not required to apply for a permit if it is designed, constructed, operated, and maintained for no discharge.
- Does a CAFO need to obtain permit coverage to claim the agricultural storm water exemption for precipitation-related discharges from land application?
  - A CAFO that does not have any discharge other than agricultural stormwater and that does not propose to discharge is not required to seek permit coverage. In the Final Rule EPA clarifies the applicability of the agricultural stormwater exemption to unpermitted CAFOs.

Voluntary no discharge certification option

- What is the incentive for an unpermitted CAFO to certify?
  - A properly certified CAFO makes an up-front demonstration to the USEPA Region 6 Administrator that it does not have to get a permit. In the event of a discharge from a CAFO with a valid certification, the CAFO would only be subject to liability for the unpermitted discharge, not for failure to seek permit coverage prior to the discharge.
- What are the qualifications for the voluntary certification option?
  - In order to properly certify under the voluntary option, a CAFO must be designed, constructed, oper-

ated, and maintained for no discharge in accordance with rigorous eligibility criteria, including a technical evaluation of open manure storage structures and development and implementation of an NMP that ensures no discharge.
  - The CAFO also must submit a signed statement to include general information about the facility and description of eligibility.
  - If a CAFO meets all of the eligibility and submission requirements, its certification will become effective upon submission without required review by the permitting authority.
- If a properly certified CAFO discharges, can it recertify?
  - After a discharge from a properly certified CAFO, the CAFO can recertify if it permanently fixes the cause of the discharge, and it has not previously recertified after a discharge from the same cause. The CAFO's recertification is submitted for a 30-day review.

Surface water protection and the NPDES program

- The permit prohibits "discharge of process wastewater pollutants to Waters of the United States" except when "rainfall events, either chronic or catastrophic, cause an overflow of process wastewater from a facility designed, constructed and operated to contain all process generated waste waters plus the runoff from a 25-year/24-hour rainfall event for the location of the point source."
- If a dairy has a general permit (or an individual permit) and has been properly operated and maintained, overflows or other discharges during chronic or catastrophic storm events are not a violation of the CWA. This would be considered an authorized discharge. The conditions described in this section are known as effluent limitations.
- Chronic rainfall is a series of wet weather conditions, the total volume of which exceeds the total volume of the 25-year/24-hour storm event and does not provide the opportunity for dewatering.
- Catastrophic rainfall events are any single event which would exceed the 25-year/24-hour storm event. Catastrophic conditions could also include tornados, hurricanes, or other catastrophic conditions that could cause overflow due to winds or mechanical damage.

Nutrient Management Plan (NMP)

- The NMP is the key operational plan for the CAFO permit.
- A NMP is required by the most recent NPDES/CAFO rule.
- The NMP must include practices and procedures necessary to implement the effluent limitations described above. That plan outlines how a dairy is to be operated and maintained to contain process-generated green waters plus the runoff from a 25-year/24-hour storm event.
- CAFO operators were already required to develop and implement NMPs under the 2003 rule.
- The new rule requires CAFOs to submit the NMPs along with their NOI/NPDES permit applications.
- Under the new rule, permitting authorities are then required to review the NMPs and provide the NMPs for public comment.
- Permitting authorities are required to include the terms of the NMP as enforceable elements of the permit.
- The final rule lays out a process for including these facility-specific provisions in both individual and general permits.
- The NMP must include practices and procedures necessary to implement the effluent limitations described above.

NMP-related requirements

- EPA (or the State) is required to make the entire NMP and the draft terms of the NMP available to the public.
- EPA (or the State) must incorporate the terms of the NMP into the permit, which include the information, protocols, best management practices (BMPs) and other conditions in the NMP necessary to meet the NMP requirements of the 2008 rule.

There are two approaches in the final rule for expressing rates of application—the "linear approach" and the "narrative approach." The "linear approach" expresses field-specific maximum rates of application in terms of the amount of nitrogen and phosphorus from manure, litter, and process wastewater allowed to be applied. The linear approach sets fixed rates of nutrient application based on a cropping system that is fixed in the plan. Just about any change, including crops grown, soil fertility, or manure nutrient analysis results, will require that the NMP be resubmitted for further review, re-approval, and new public notice.

The linear approach NMP must identify or analyze:

- The actual crop(s) planted and actual yield(s) for each field.
- The actual nitrogen and phosphorus content of the manure and green water.
- The amount of manure and green water applied to each field during the previous 12 months and, for any CAFO that implements a nutrient management plan that addresses rates of application:
  - The results of any soil testing for nitrogen and phosphorus taken during the preceding 12 months.
  - The amount of any supplemental fertilizer applied during the previous 12 months.
  - The fields available for land application.
  - Field-specific rates of application properly developed to ensure appropriate agricultural utilization of the nutrients in the manure and green water.
  - Any timing limitations identified in the nutrient management plan concerning land application on the fields available for land application.

At a minimum, the factors or terms of the NMP must include:

- The outcome of the field-specific assessment of the potential for nitrogen and phosphorus transport from each field.
- The crops to be planted in each field or any other uses of a field such as pasture or fallow fields.
- The realistic yield goal for each crop or use identified for each field.
- The nitrogen and phosphorus recommendations from sources specified by the EPA for each crop or use identified for each field.
- Credits for all nitrogen in the field that will be plant available.
- Consideration of multi-year phosphorus application.
- Accounting for all other additions of plant available nitrogen and phosphorus to the field.
- The form and source of manure and green water to be land-applied and the timing and method of land application.
- The methodology by which the nutrient management plan accounts for the amount of nitrogen and phosphorus in the manure, green water, litter, and process wastewater to be applied.

The "narrative rate approach" expresses the field-specific rate of application as a narrative rate prescribing how to calculate the amount of manure, litter, and process wastewater allowed to be applied. This approach requires the CAFO to specify in their NMP the method by which they will calculate the year-by-year actual manure application rates for each field, using up-to-date field-specific information and consistent with sound agronomic use. As long as the producer applies manure to those fields using year-by-year field-by-field analysis and these methods and crops are specified in the original NMP, no subsequent NMP review and approval is needed. EPA recognizes that the "narrative approach" provides a CAFO operator significantly more flexibility than using the "linear approach." As such, this manual focuses on requirements of the "narrative approach." For those CAFO operators who select the linear approach, it is suggested that the linear approach sections in the 2008 rule be referenced.

The narrative approach expresses rates of application according to the following specifications:

- The terms include maximum amounts of nitrogen and phosphorus derived from all sources of nutrients, for each crop identified in the nutrient management plan, in chemical forms determined to be acceptable to the EPA, in pounds per acre for each field, and certain factors necessary to determine such amounts.
- At a minimum, the factors that are terms must include:
    - ○ The outcome of the field-specific assessment of the potential for nitrogen and phosphorus transport from each field.
    - ○ The crops to be planted in each field or any other uses such as pasture or fallow fields (including alternative crops identified in the NMP).
    - ○ The realistic yield goal for each crop or use identified for each field.
    - ○ The nitrogen and phosphorus recommendations from sources specified by the EPA for each crop or use identified for each field.
    - ○ The terms include the methodology by which the nutrient management plan accounts for the following factors when calculating the amounts of manure and green water to be land applied.
    - ○ Results of soil tests conducted in accordance with protocols identified in the nutrient management plan
    - ○ Credits for all nitrogen in the field that will be plant available.
    - ○ The amount of nitrogen and phosphorus in the manure and green water.
    - ○ Consideration of multi-year phosphorus application.
    - ○ Accounting for all other additions of plant available nitrogen and phosphorus to the field.
    - ○ The form and source of manure and green water and the timing and method of land application.
    - ○ Volatilization of nitrogen and mineralization of organic nitrogen.

Changes to a Nutrient Management Plan (NMP)

The 2008 Revision to the Final CAFO rule defines substantial changes to the terms of a NMP to include, but not limited to:

- Addition of new land application areas not previously included in a NMP.
- Any changes to the field-specific maximum annual rates for land application and to the maximum amounts of nitrogen and phosphorus derived from all sources for each crop.
- Addition of any crop or other uses not included in the terms of a NMP and corresponding field-specific rates of application.
- Changes to site-specific components of a NMP where such changes are likely to increase the risk of nitrogen and phosphorus transport to waters of the U.S. Since substantial changes or modifications to the NMP are now subject to public inspection and comment, a dairy operator should work with their consultant, agronomist, and nutritionist to include all possible crops, land application areas, and land application techniques in the original NMP to minimize the potential for a lengthy CAFO application period.

- The terms of the NMP should include alternative crops in a NMP that are not in the current planned crop rotation.
- When a NMP includes alternative crops, they must be listed by field, in addition to the crops identified in the planned crop rotation for that field. The NMP must include realistic crop yield goals and the nitrogen and phosphorus recommendations from sources specified by the EPA for each crop.
- Timing of application for each field as related to calculation of application rates is not a term of the NMP.

NPDES/CAFO options available for a dairy producer in New Mexico

Under the revised CAFO rule producers have three primary options if they want to avoid potentially substantial Clean Water Act (CWA) penalties:

1. Obtain a NPDES permit with the associated NMP that has been reviewed and commented on by the public, approved by the permitting authority, and complies with the terms of that permit and the NMP.
2. Do not obtain a NPDES permit, but
   a. Operate the production areas and land application areas so as not to have a discharge under any circumstances,
   b. Use a sound nutrient management system for land application of manure that complies with the agricultural stormwater exemption requirements, and
   c. Demonstrate through modeling that a production facility will not discharge and certifies "no discharge" to the permitting authority.
3. Do not obtain a NPDES permit but
   a. Operate the production area and land application areas and manage manure and green water so as not to have a discharge under any circumstances, and
   b. Use a sound nutrient management system for the land application of manure that complies with the agricultural storm water exemption requirements.

The important issue to consider when determining whether or not to obtain a NPDES/CAFO permit is that if a dairy will be in violation of the CWA if it has a discharge and does not have a NPDES/CAFO permit.

SECTION 5—PERMITTING FOR NEW DAIRIES

When considering establishing a new dairy, look for land with abundant water and water rights, productive farmland for land application and crop production, and consider the distance from neighbors. Some dairy producers conduct exploratory drilling programs to determine if natural clays that act as aquicludes are present below the surface. Designing new dairies is beyond the scope of this manual, but the following are questions that any potential dairy producer should think about when working with a dairy design team.

Plan as far into the future as possible when applying for permits for a new dairy. The following questions are important when locating and designing a new dairy.

- Location, Location, Location
  - Do local zoning regulations allow construction of a dairy on this property?
  - Are there any houses or neighbors close by that may be impacted by the dairy?
  - Will the lagoons be set back or buffered from adjacent houses?
  - Will the lagoons and land application fields be located upgradient of municipal or domestic supply wells?
  - How far is the dairy from surface water bodies and drain tiles?
  - Is ground water deep or shallow?
- Water Use and Supply
  - How many cows will be milked at full build-out?
  - How many gallons per day of green water will be generated per cow?
  - How many dry cows and heifers will be onsite?
  - How many gallons per day of green water will be discharged into the green water lagoon system?
  - Are irrigated lands being retired with the water rights converted to "commercial dairy use?"
  - Are water rights available? If so, are there any restrictions?
  - Are sufficient water rights available for the planned commercial dairy requirements?
  - Are sufficient water rights available for blending fresh water and green water to grow a crop and apply green water at agronomic rates?
  - Can existing wells produce 100% of the dairy and irrigation supply needs?
- Land Application
  - How many acres of land application area will be included in this permit and future permits if expanded?
  - What crops will be grown?
  - What is the projected crop yield?
  - What is the background/pre-dairy soil chemistry?
  - Will the planned crops take up sufficient nitrogen to allow the application of nitrogen at agronomic rates?
  - Are there enough wells to supply the dairy and irrigated fields?

- Lagoon Design
    - ○ How many acre-feet will the lagoons have to hold to contain 60 days of green water, all the water from a 25-year/24-hour storm event, and direct precipitation? All while maintaining 2 feet of freeboard?
    - ○ Is enough land available to build the lagoons and perform maintenance on the walls and outer perimeter?
    - ○ Should the lagoon be lined with a synthetic liner?
    - ○ Does the location have a hydrologic connection to surface water?
    - ○ Can a hydrologic connection be proven?
    - ○ Should separate lined green water and stormwater lagoons be built or should a combination lined green water/stormwater lagoon system be used?
    - ○ Should the lagoons be designed and constructed for a green water capacity greater than currently needed?
    - ○ Should double-lined lagoons with interstitial monitoring access be considered for an alternative approach to monitoring wells (see Figure 5.1)?
    - ○ Will a flush system be used?
    - ○ What type of solids separator will be used?
    - ○ What is the amount of lagoon storage life before solids have to be cleaned out?

5.1 Establishing Background Conditions

A dairy producer is required to establish background water quality conditions prior to discharging. These background conditions are used to monitor compliance with permit conditions and protect the dairy from potential future allegations of being a pollution source.

- If upgradient or other monitoring wells are already contaminated, then a dairy is allowed to contribute regulated chemicals to the aquifer up to that concentration but cannot exceed that higher concentration. If background water quality is clean, a diary cannot exceed the WQCC regulatory standards.
- Background depth to water and water quality as required in a Ground Water Discharge Permit may be established by using nearby offsite data.
- As with establishing background water quality, background soil chemistry should also be established to have a baseline for comparison of future soil sample results.
- Monitoring Plan: If possible, propose a top-down (CNMP- and soils-based) monitoring plan rather than a bottom-up (ground water based) monitoring plan.

5.2 New Mexico Environment Department Ground Water Discharge Permits

Any new dairy operation proposing to discharge effluent or leachate, either directly or indirectly into ground water, is required to apply for a Discharge Permit. Before applying and submitting application forms, consider all of the questions listed above. The required forms are available on the NMED website (link provided in Appendix A). There are four parts to the permit application: Part I of the application deals with Administrative Completeness; Part II deals with Operational, Monitoring, Contingency, and Closure Plans; Part III deals with Additional Proposals and Conditions; and Part IV deals with Site Information.

Historically, the NMED regulatory approach has been to base permit conditions on ground water quality, with requirements for quarterly monitoring from on-site monitoring wells. If a new dairy is being built, use the opportunity to request a soils-based discharge permit rather than a ground water quality–based permit. A soils-based permit is a top-down approach that allows a dairy to carefully monitor soils for nitrate, TDS, and chloride concentrations as indicators of potential nitrate leaching through the vadose zone. By monitoring soil quality, a dairy should be able to intercept ground water contamination that may otherwise affect future permitting and carry the potential for corrective action measures/abatement and possibly fines. New dairy producers may also want to consider constructing double-lined lagoons with leak detection and request a waiver on monitoring well sampling near the lagoon system. If soils are clean and remain unimpacted during the permit term, a producer may request “alternative monitoring standards” (see Section B of permit application form) when applying for a discharge permit.

All new dairies, even with a top-down regulatory approach, are required to install ground water monitoring wells prior to discharging to establish background water quality conditions. When designing the monitoring plan, a new dairy has more flexibility than an existing dairy. A permit application with language that includes provisions to reduce monitoring requirements should be submitted if soils and ground water show no impact from nitrogen prior to discharging, the nitrate concentrations in ground water do not change during a time period agreed upon with the NMED, and soil nitrogen concentrations remain low. After that time period (possibly eight quarters) has passed, then a request to sample fewer ground water monitoring wells or a request to sample monitoring wells less frequently can be made to the NMED.

5.3 Fees for a New Application

A fee is required to the NMED with every discharge permit application. All applications must pay an application fee of $100 plus a permit fee that is based on classification and volume of discharge (dairy is classified as agricultural in the NMWQCC regulations). The NMED fee schedule is presented in the WQCC regulations in Section 20.6.2.3114 NMAC, Table 1.

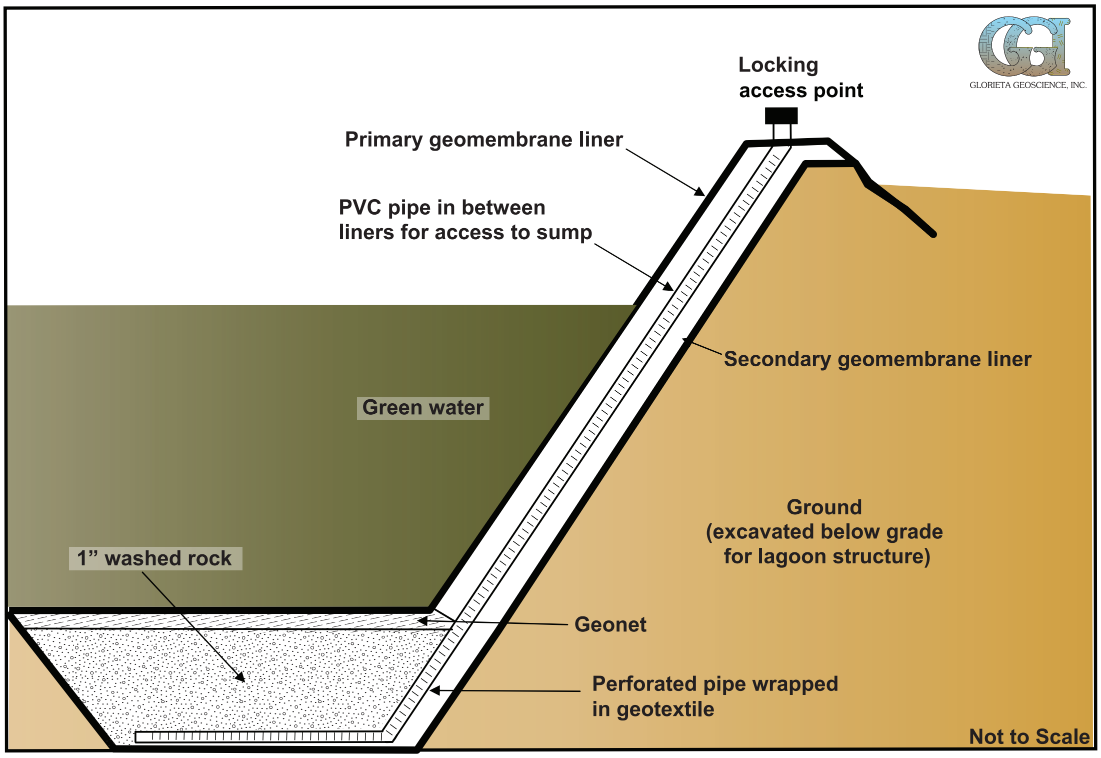


Figure 5.1. **Schematic diagram of a double-lined lagoon with leak detection (after U.S. EPA, 2011).**

5.4 Public Notice

Sections 20.6.6.12.E, 20.6.6.14, and 20.6.6.15 of the Dairy Rule address public notice requirements for dairy permits and Figure 4.1 provides a flow chart of the timeline for public notice and participation. Note that the flow chart in Figure 4.1 provides an ideal timeline, provided there are no requests for a public hearing or other administrative roadblocks. In the design and construction of any dairy operation, at least six months should be allowed for approval of the Discharge Permit application.

5.5 NPDES/CAFO Permitting

NPDES regulations and CAFO permitting were discussed extensively in Section 2 and in this section. Again, the decision to obtain NPDES permit coverage is a risk-based decision, on the proximity of your dairy to waters of the United States and the potential for a discharge to adversely impact threatened and/or endangered species (see below). Regardless of the decision to obtain permit coverage, it is in the dairy's best interests to design, construct and operate the new dairy as if it does have permit coverage.

There are two different NPDES/CAFO permits for which a CAFO can apply: a general permit and an individual permit. Both permits are issued and administered by USEPA Region 6 and are not administered by the NMED. Most dairies applying for NPDES/CAFO coverage apply for a general permit rather than an individual permit. The general permit is a statewide permit that has been issued based on comprehensive consultation on potential environmental impacts by USEPA with the U.S. Fish and Wildlife Service, State Historic Preservation Office, and other sister agencies. When general permit coverage is available, it means that a dairy facility can file for coverage with assurances that USEPA consultation with these agencies has resulted in conclusions that no significant impact to the environment will occur if general permit conditions are followed. If a dairy facility has had an illegal discharge or is proposing to construct a CAFO in an environmentally or archaeologically sensitive watershed, it may be required to apply for individual permit coverage. In this case the dairy is responsible to conduct costly environmental, archaeological, and threatened and endangered species studies on a site-specific basis, rather than relying on studies performed statewide for the general permit.

Should a dairy operation decide to seek permit coverage, it will need to submit Form 2B NPDES (Appendix A) to EPA Region 6 and the NMED Surface Water Quality Bureau. Be aware that coverage and compliance requirements are effective upon submittal of the NOI, which includes the dairy's NMP. Since a NMED-approved Ground Water Discharge Permit is protective of water quality, some dairies chose to take the extra step to obtain NPDES/CAFO permit coverage as a form of "inexpensive discharge insurance."

SECTION 6—COMPLIANCE RECORDKEEPING AND FORMS

This section will cover the reporting and recordkeeping requirements for staying in compliance with NMED and/or NPDES/CAFO Permits. Environmental regulations are a complex maze with many different reporting and testing requirements. Remember that a Ground Water Discharge Permit is not equal to a NPDES/CAFO permit. Federal permits require that stormwater lagoons must be designed, constructed, and operated to hold the 25-year/24-hour rainfall storm, while there are no state-specific requirements for stormwater lagoons in New Mexico. Standard recordkeeping forms are presented in Appendix G. The most efficient way to remain in compliance with the recordkeeping portions of permits is to conduct weekly inspections of the dairy. Blank copies of weekly, monthly, and annual inspections are presented in Appendix G. Having weekly reports helps an operator notice and address maintenance issues in a timely manner and will show the NMED or the EPA inspectors that the facility is serious about staying in compliance with permits.

6.1 General Facility Information and Standard Requirements

A dairy facility is required to keep copies of all permits on site, preferably in the dairy office or electronically. All documents and reports must be signed by the owner or authorized representative.

All records must be maintained on site for at least five years. These records include:

- Engineering design and as-builts for the facility lagoon system.
- Documentation of proper liner installation including records of engineering tests for the liner and seams bonding (these should be on site permanently).
- Freeboard records in lagoons and stormwater ponds.
- Periodic records of manure solids removal, rainfall events, maintenance of structural and non-structural runoff controls.
- Records of stormwater lagoon pumping (i.e., during storm events or emergencies).
- Documents for any changes to pollution prevention plans or nutrient management plans
- Scaled site map for production area and land application fields.
- All NMED requirements in Section B-3 of permit application.
- All NPDES requirements, including
    - Outline of the drainage area for collection for the stormwater system.
    - Details of structural run-on/run-off controls for surface drainage.
    - Property boundaries for the dairy.

In addition to the previous list of documents, NRCS requires the CNMP include:

- Land application areas on aerial photos (where available).
- Individual field maps, including setbacks, buffers, and design information.
- Soil classification and soil survey maps.
- Phosphorus Index, Irrigation Leaching Index and Wind Erosion Ratings of land application fields.
- Identification of sinkholes, streams, springs, lakes, ponds, wells, gullies, and drinking water sources.
- Types of animals and phases of production.
- Number of each animal type, average weight, and period of confinement.

6.2 Water Use: Discharge Water and Stormwater

Both NMED and NPDES/CAFO permits require that a dairy maintains records of water use and green water generation.

- Flow meter readings (preferably from the incoming meter to the milking parlor, sump meter to lagoons, and meter to land application areas).
- Diagram of fresh water in and green water out/recycled.
- Discharge quantity.
- Discharge quality (TKN/nitrate can exceed NMWQCC standard).
- Backflow prevention.
- Prevent run-on from contact with animals or waste.
- Records showing no direct contact between animals and waters of the U.S.
- Calculations and supporting documentation.
- Documentation of irrigation water rights.
- Description of potential pollutant sources contributing to runoff.

6.3 Green Water Lagoon, Stormwater Lagoon, and Other Retention Structure Design

As stated above, both the NMED and NPDES/CAFO permits require a description of the types of storage/containment facilities and a demonstration of adequate storage for:

- 21 days of daily the maximum daily discharge volume authorized by the discharge permit while preserving two feet of freeboard (20.6.6.17.c.3 NMAC).
- Volume of wet manure generated.
- Volume of water used for manure and waste removal.
- Volume of cleanup or wash water for the dairy operation.
- Any other water generated from the dairy operation.

Other data in an onsite recordkeeping book should include:

- Rainfall record from a 25-yr/24-hr storm event (using the on-site rain gauge or U.S. Weather Service information).
- Runoff from a 25-yr/24-hr storm event.
- Runoff calculations from the production area caused by a 25-yr/24-hr storm event.
- Calculations for runoff volume from all open lot surfaces within the dairy.
- Calculations for runoff volume from areas between open lot surfaces.
- Calculations for any runoff volumes from any roofed areas that are within the dairy and have runoff directed to retention facilities.
- **Retention Freeboard Documentation**
  - Records showing that two feet of freeboard are maintained.
  - Plans to restore freeboard as soon as conditions allow.
  - Depth marker.
  - Weekly inspection.
  - Solids accumulation monitoring and removal information.
  - Plan for periodic removal and available equipment.
- **Documentation of Well Protection for Drinking Water Sources**
  - Lagoon location and operation cannot impair public and neighboring private drinking water wells.
  - Manure/green water storage no closer than distances specified by State regulations or state-issued permits (NMAC 20.6.6.16)
    - Private drinking water wells have a minimum setback of 350 feet from the dairy production area (including wastewater impoundments).
    - Public water wells or springs require a setback distance of at least 1,000 feet from the dairy production area.

6.3.a Design and Final Construction (As-builts) Records

Retain all documents with calculations and assumptions for the design and final construction of retention structures. These include any calculations, plans, and drawings developed by the following three standards:

- Professional engineering (private industry standards).
- NRCS technical standards (especially for EQIP projects).
- NMED guidelines.

6.3.b Maintenance Records for Retention Structures

Additional records not found in the previous sections but that would be required for review include:

- Weekly inspections of freeboard, berm conditions, liner conditions, pipelines to lagoons or between lagoons, structural and non-structural runoff controls, and meters.
- Equipment identified in the emergency plan for use in case of spills or releases.

6.4 Liner Requirements for Lagoon and Retention Structures

To address general NMED liner requirements, consider the following:

- Existing dairies should refer to their specific permit requirements.
- Has the clay lined lagoon been recertified within the last five years?

Or

- Does the facility have documentation of compliance with synthetic liner requirements?
- New dairies should anticipate having to install synthetic liners (see NMED guidelines).
- Funding for new lagoons at existing dairies may only allow synthetic liners.

6.4.a The EPA NPDES/CAFO Liner and/or Storm Requirements

The dairy must install a liner in the green and/or storm water lagoons to prevent potential contamination of ground water OR the dairy must provide documentation that no liner is required.

- No significant leakage from retention structure OR no hydrologic connection to ground water.
- Must be certified by a professional engineer or ground water scientist.
- Natural liners (including clay liners) must have a hydraulic conductivity $\leq 1 \times 10\text{-}7$ cm/sec or less.
- Natural liner thickness must be ≥ 1.5 feet.
- Supporting maps showing ground water flow paths or that leakage enters confined environment.

6.4.b Lagoon Liner Maintenance Requirements

- Keep animals out (fences).
- Keep berms free of debris, vegetation, etc.
- Weekly inspections.
- Maintain sufficient volume for solids accumulation.
- Keep separator manure contained.
- Weekly inspections of lagoon stormwater runoff ponds for structural integrity.

See Figure 6.1 for a diagram of a lagoon that meets the requirements in this section.

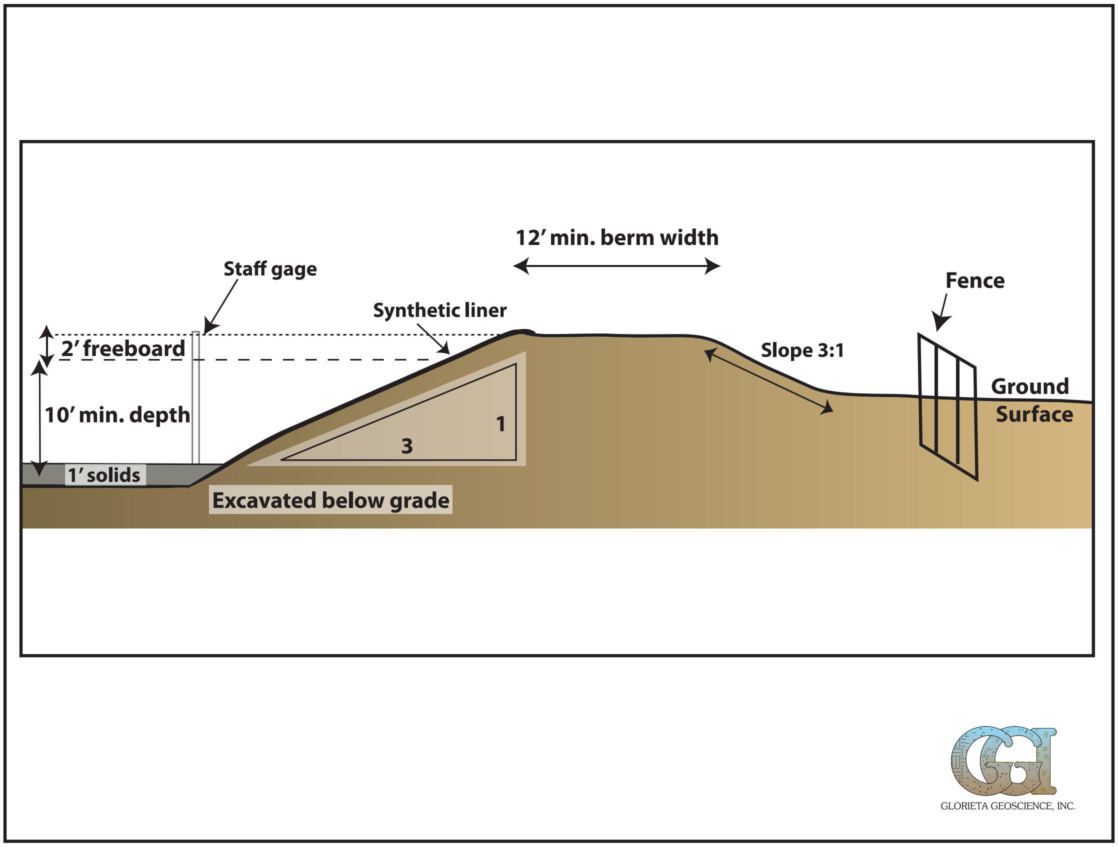


Figure 6.1. **Schematic diagram showing lagoon infrastructure dimensions.**

6.5 Nutrient Management Plan

A NMP is a part of the NPDES/CAFO regulatory/permit requirements. Dairies are required to demonstrate that their land application rates will minimize nitrogen (N) and phosphorus (P) transport from fields to surface waters. To accomplish this, the Nutrient Management Plan must address the following:

- Field-specific assessment of the potential of N and P transport.
- No discharge of green water from land application fields to waters of the United States is allowed unless it results from a storm in excess of the 25-year/24-hour storm event and the dairy has already been applying green water and manure solids at proper agronomic rates.
- Field-specific assessment of nutrients (N and P) applied and crop uptake.
- Identify areas with high erosion potential and identify corrective measures to control erosion and runoff.
- Address form, source, amount, timing, and method of application to achieve realistic production goals while minimizing N and P transport.
- Include appropriate flexibilities for implementing nutrient management practices.
- Set-back requirements are 100 ft from downgradient surface water, open tile line intake structures, sinkholes, agricultural well heads or other conduits to surface water OR a 35-ft vegetated buffer.
- No land application when ground is frozen or saturated (unless dewatering).
- Manage irrigation to minimize or reduce puddling and ponding.

6.5.a Manure Solids—Removal and Management

A dairy must maintain adequate storage capacity for the manure solids generated. Items to be considered in manure management include the following:

- Manure piles should not be located in 100-year flood plains unless adequately protected.
- Surface flows must be directed around manure storage piles or runoff from manure storage areas must be retained on-site.
- Apply manure at agronomic rates when combined with other nutrient sources (green water or fertilizers).
- Use buffers or edge-of-field grass strips to separate watercourses from runoff.
- Do not apply manure solids when the ground is frozen or saturated.

6.5.b Off-Site Transfer of Manure

When transferring manure offsite, records of the transfers must be kept (except for small truckloads, such as in a light truck or small trailer). Five years of the following records must be kept by large CAFOs pursuant to CFR 122.42(e)(3):

- The date of the transfer
- Recipient name and address
- The type of manure (dry, wet, green water)
- Approximate amount of manure transferred

The producer must also provide the manure recipient with the most current yearly nutrient analysis for the manure collected and stored at the dairy.

6.5.c Manure Sampling

Manure sampling should be conducted annually with records maintained for the following:

- Annual laboratory sample for nitrogen (N) and phosphorus (P).
- Description of sampling and analytical methods.
- Use of lab results for Land Application Data Sheets (LADS) or NRCS 590 Jobsheets.
  - LADS: https://cloud.env.nm.gov/water/pages/view.php?ref=5551&k=dac3ff0bdd
  - NRCS 590 Jobsheets (Contact NRCS).
- Analytical results provided to recipients or vendor of manure.

6.6 Permit Documentation for Process Water, Soils, and Crops

In addition to the documents related to daily operation and construction of structures used, the following documentation is needed.

6.6.a Documentation for Green Water (Process Water) Sampling

- Sampling schedule and locations in accordance with the NMED Ground Water Discharge Permit
- Sample analysis for parameters in accordance with the NMED permit
- Describe sampling and analytical methods
- Use results for land application data sheets

6.6.b Documentation of Soil Properties and Sampling Associated with Land Application Areas

- Description, limitations, and capabilities for each field
- Sample soil annually for nitrogen.
- Sample soil every five years for phosphorus (this is a NPDES/CAFO requirement).
- Other sampling schedule and sampling parameters in accordance with the NMED permit.
- Describe sampling and analytical methods.
- Use results for land application data sheets.
- NRCS considerations: phosphorus, potassium, heavy metals, and salts.
- Phosphorus Index.

6.6.c Documentation for Crops

- Crop planting and harvesting information for each land application field.
- Sampling schedule in accordance with the NMED permit; yearly for NPDES/CAFO permit.
- Describe sampling and analytical methods (converting crude protein to N concentration).
- Use results for LADS and to show that green water and/or manure solids are being applied at agronomic rates.
- Reference the NMED LADS workbook or others.

6.6.d Land Application Data Sheets

LADS must be maintained on-site for five years and available for inspection. The information in each LADS is specific to each land application field.

For each field:

- Crops planted/harvested and targeted/expected/actual crop yields.
- Dates that manure, green water, and/or chemical fertilizers were applied to each field.
- Dates chemical fertilizers were applied.
- Weather conditions at the time of application and for 24 hours pre- and post-application.
- General soil moisture conditions at the time of application.
- Explanation of basis for determining manure application rates.
- Calculations showing total N, P and K to be applied each field, including sources other than manure, litter, or process wastewater.
- Total amount actually applied, including documentation (flow meters, manure spreader calibration, etc.).
- Method used to apply manure, litter, and process wastewater.
- Demonstrate nutrient balance
  - Per NMED regulations, the facility's land application practices cannot exceed harvested crop nitrogen uptake by more than 25%
  - Per federal regulations, the facility's land application practices cannot exceed the harvested crop nitrogen uptake unless specific conditions apply.
  - Records of crop planting and harvesting, crop irrigation, manure, and chemical fertilizer application.

6.6.e Periodic Monitoring Reports Submitted to the NMED

The NMED Ground Water Discharge Permits issued subject to the Dairy Rule have requirements for quarterly reporting. The NMED's general requirements include the following (see Ground Water Discharge Permit to find specific requirements).

- Depth to most shallow ground water and ground water elevation contour map.
- Monitoring well sampling results for the following constituents:
  - TKN
  - Nitrate-N
  - TDS
  - Chloride
  - Sulfate
- Lagoon and other effluent sampling results.
  - TKN
  - Nitrate-N
  - TDS
  - Chloride
  - Total Sulfur
- Monthly meter readings of effluent discharge to the lagoons (sump meter readings).
- Land application data sheets.

6.6.f Annual Reporting Requirements to the NMED and EPA

See Ground Water Discharge Permit for annual reporting requirements.

The NMED requires quarterly monitoring of ground water quality, as per the discharge permit. However, during the first quarter of every year, there are also additional requirements that need to be submitted with the monitoring report. New discharge permits require reporting of monitoring well samples, ground water flow direction, and land application data. The annual report, typically submitted May 1st, includes the following additional requirements:

- Soil sampling of all land application fields.
- An annual Nutrient Management Plan (NMP) for all land application areas.
- Ground water quality sampling of all irrigation wells – please note, irrigation samples can be taken during any quarter in the previous calendar.
- Monthly documentation/records of backflow inspections for all irrigation wells.
- Tissue sampling of all harvested crops.
- Scale weight tickets for harvested crops.

A NPDES/CAFO Annual inspection should be performed by an "authorized person" and submitted to EPA Region 6 (Dallas, Texas). An authorized person can be the owner, a manager, or someone with legal authority to represent the dairy in such matters. The annual inspection should provide notation of findings that include:

- Number and type of animals.
- Estimated amount of total manure, litter, and process wastewater generated in previous 12 months.
- Estimated amount of total manure, litter, and process wastewater transferred to other persons in previous 12 months (does not include small pickup loads).
- Total number of acres available for land application.
- Total number of acres used for land application.
- Summary of all manure, litter, and process wastewater discharges from production area during previous 12 months (include date, time, and approximate volume).
- Statement indicating whether current version of NMP was developed or approved by a certified nutrient management planner.

The annual NPDES/CAFO report must be submitted by March 1 of each year to EPA Region 6 (Dallas, Texas).

6.7 Inspections and Maintenance Records

Every dairy should follow their inspection schedule, including corrective actions, maintenance and manure handling, and equipment testing. Weekly inspections are a valuable tool for preventing catastrophic or minor spills or identifying maintenance problems. Whenever maintenance on any structures or equipment is performed, record the maintenance item or task into the recordkeeping book. A sample inspection book is included in Appendix G. The following schedule for inspections is recommended.

- Daily inspection items
  - Water lines, including drinking and cooling water.
  - Backflow prevention devices.
- Weekly inspection items
  - Freeboard levels in green water lagoons and stormwater ponds as indicated by a depth marker or staff gauge.
  - Depth marker must indicate minimum capacity to contain runoff and direct precipitation from storm events.
  - Lagoon berm integrity
  - Discharge meters.
  - Stormwater diversion devices.
  - Runoff diversion structures.
  - Berms around land application areas.
  - Devices channeling contaminated stormwater to wastewater, manure storage, and containment structures.
  - Manure, litter, and process wastewater impoundments.
  - Sump, drains, and ditches.

- Periodic (based on operation, equipment age, and manufacturer).
  - Manure application equipment and other land application equipment.
  - Solids separators and their components.
  - Sump pumps.
  - Lagoon aerators.

6.8 Employee Training

Recordkeeping books have a section for employee training. Each dairy should periodically have training sessions with their employees on topics including but not limited to the following examples:

- Emergency procedures such as stormwater lagoon pumping or lagoon failure.
- Manure management.
- Green water management.
- Lagoon berm maintenance.
- Chemical handling and storage.
- Recordkeeping assignments and storage of records.
- Changes in safety and operational procedures.
- Water conservation.

6.9 Contingency, Emergency Action, and Closure Plans

Contingency Plans are required as part of a NMED permit. Review the permit for dairy specific requirements. There are generally five broad contingencies addressed in a permit:

- System failure (such as green water pumps, saturated fields, or broken pipes).
- Exceedance of wastewater quality/quantity limits of the permit.
- Violation of ground water quality or surface water quality standards that may initiate remediation of soil and/or ground water.
- Loading of soils above nitrogen limits.
- Unauthorized releases or spills.

6.9.a Offsite Discharges, Spills, Overflows and Emergency Action Plans

If a discharge to surface waters of the United States, or an off-site discharge occurs, first take the actions needed to stop the discharge, if it is safe to do so. Immediately thereafter, notify the EPA Region 6, the NMED, US Fish and Wildlife, and the New Mexico Game and Fish Department. If the spill or discharge remains within the property boundaries, correct the problem, record it in the CAFO records book and notify the NMED. Be accurate and honest while reporting spills.

The NMED Discharge Permits require verbal notification within 24 hours of the discovery of a discharge. The notification must provide the information required by 20.6.2.1203.A.1 NMAC. Within seven days of discovering the discharge, a written report to the NMED verifying the oral notification and providing any additional information or changes must be submitted. A corrective action report must be submitted within 15 days after discovery of the discharge. This report should include:

- Description of events leading up to spill
- Steps taken to address the situation, including equipment on site or available
- Spill volumes and period of discharge
- Rainfall information
- Receiving water (i.e., the surface water)
- Collect sample as soon as safely possible, OR collect from retention structure when conditions allow:
  - Fecal coliform
  - Biochemical-oxygen Demand (BOD)
  - Chemical Oxygen Demand (COD)
  - Settleable Solids
  - pH
- If the dairy does not have a NPDES/CAFO permit
  - It cannot destroy or adversely modify critical habitat for threatened or endangered species (see previous discussions about risk-based decision for NPDES permit)
  - It cannot "take" threatened or endangered species or cause harm to migratory birds
  - It must notify appropriate officials of die-offs

6.9.b Violations of NPDES/CAFO Permits

EPA gives incentives to promote environmental compliance. The EPA or the NMED can waive or reduce a penalty if the dairy participates in compliance incentive programs or voluntarily reports and correct violations as soon as possible.

6.9.c Closure Plans for a Dairy

The future of a dairy may include the potential for closure, sale of the property, or change in use of the land. The NMED Ground Water Discharge Permit will require a closure plan that includes the following:

- Cap or plug lines to prevent flow of wastewater to treatment/disposal system.
- Empty lagoons, perforate or remove liners, and re-grade to surface topography.
- Appropriately dispose of solids.
- Continue post-operational ground water monitoring for specified time (at least two years or eight consecutive quarters; more if ground water standards exceeded).
- Enact contingency plans, if necessary.
- Financial assurance that a dairy can continue post-operational monitoring and/or enact contingency plans.

6.10 Mortality and Medical Waste Handling

A dairy should keep records of dead animals hauled offsite.

- Make sure any dead animal hauler has a permit for dead animal disposal.
- Dead cows may be composted onsite in accordance with NRCS guidelines. Stormwater runoff from the compost area must be contained.
- Dead animals must not be disposed of into any liquid manure or process wastewater system.
- Prevent discharge of any pollutants to surface waters.
- Comply with state and local regulations for disposal of medical waste and/or sharp object waste (hypodermic needles).

6.11 Chemicals Used in the Dairy Operation

Disposal of any materials into containment structures is prohibited. Unless the substances are involved in proper operations and maintenance of the facility, those substances are not specifically prohibited. For chemicals used at a dairy, the following safeguards should be followed:

- Keep a list of all chemicals that are used, stored, or disposed of at the CAFO.
- Maintain Materials Safety Data Sheets (MSDS) for all onsite chemicals.
- Consider where chemicals are stored.
- Consider where chemicals are loaded, unloaded and/or mixed.
- Consider how empty containers and waste are disposed of.
- Determine what practices are employed to keep chemicals from inappropriately entering storage structures.
- Identify safety and operating procedures for preventing and cleaning up spills, including equipment and personnel needed.

No discharge of toxic pollutants as defined by Section 307(a) of the Clean Water Act is allowed (toxic pollutants are discussed in Section 2).

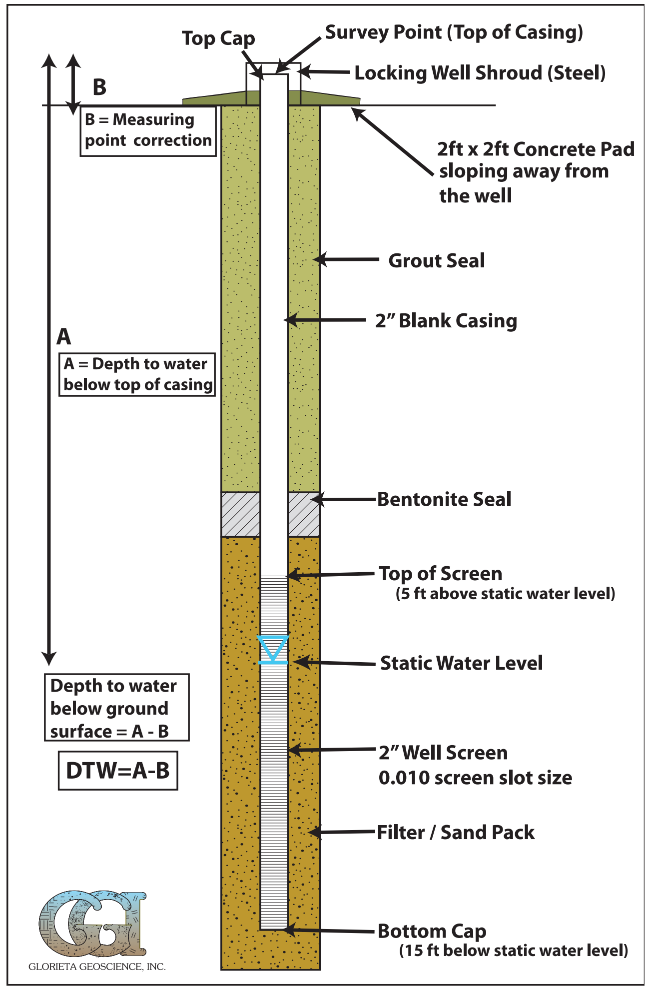


Figure 7.1. **Diagram showing a properly completed monitoring well.**

SECTION 7—CASE STUDIES

In this section, case studies are presented on the various scientific and technical reporting and analysis requirements for a permit. Most of these data have been collected from New Mexico dairies.

7.1 Providing Accurate Information

Ground water information is important to a dairy for help with both water supply and environmental compliance issues. Quarterly ground water level monitoring determines if seasonal changes in ground water flow direction could affect monitoring well locations. Potentiometric surface maps are used to determine if upgradient, off-site pollution is flowing onto a dairy. They may also show no upgradient contaminant sources. Hydrographs are used to calculate yearly water level declines or rises in production wells. The hydrograph data may also be used to determine construction requirements for any future monitoring wells.

Depth to water, ground water elevation, and flow direction: How are these determined?

Section 3.8 of this manual describes the basic concepts of ground water hydrology. These case studies demonstrate the practical applications of those concepts with respect to permit compliance and provide examples of ground water monitoring data. In general, NMED Discharge Permits require the ground water information described in this section to be submitted as part of quarterly and/or annual reporting; see individual permit for details. Because NPDES permits pertain only to surface water protection, the information described in this section is not normally a reporting requirement for a NPDES permit.

For new dairies, information about depth to ground water at the proposed facility can be obtained from a variety of sources. One source of information is the New Mexico Office of the State Engineer WATERS Database (http://nmwrrs.ose.state.nm.us/nmwrrs/index.html). This database includes water levels reported by drillers upon the completion of domestic or irrigation wells. Additional sources of information include direct measurements from nearby supply or monitoring wells or published data from existing reports or studies. Eventually this information will be used to locate and design monitoring wells.

For existing dairies, depth to ground water for reporting purposes is measured in onsite monitoring wells. These monitoring wells should be completed in the shallowest aquifer most likely to be affected by a permitted discharge. As their purpose is different than supply/irrigation wells, they are often shallower and not completed in the same aquifer. As the shallow aquifer is seldom used for supply/irrigation wells, water level data from monitoring wells is generally more accurate and often used for measuring depth to water, calculating ground water elevations, and collecting water quality samples. Monitoring wells must be installed in accordance with NMED guidelines (link to guidelines is provided in Appendix G). The locations and top of casing (TOC) elevations of all monitoring wells must be surveyed to the nearest one-hundredth of a foot by a licensed professional surveyor.

Depth to ground water (DTW) is a direct measurement of the vertical distance between the ground surface and the top of the water table (aquifer); depth to ground water is reported in feet below ground surface (BGS) measured to the nearest one-hundredth of a foot. In general, the depth to ground water is measured relative to the top of the monitoring well casing, then corrected for the difference between the top of the casing and the ground surface.

In Figure 7.1, the distance between the top of the monitoring well casing (not the top of the well vault or other exterior surface casing) and the top of the water table is represented by “A” feet. For this example, let’s say that distance is 50.25 feet. The distance between the top of the casing (TOC) and the ground surface is represented by “B” feet. For example, that distance is 3.00 feet. To determine the depth to ground water, simply subtract the second number (B), the amount of casing above ground, from the first number (A). Using this example, the depth to ground water (DTW) based on the ground surface is:

Distance A – Distance B = DTW

50.25 feet – 3.00 feet = 47.25 feet BGS

Next, calculate the **ground water elevation**. This is the elevation of the ground water relative to mean sea level and is reported in feet. To calculate the ground water elevation, the elevation at the top of the monitoring well casing is required; this information will be included in the report received from the surveyor. Say the example monitoring well shown in Figure 7.1 has a TOC elevation of 4,250.75 feet above mean sea level. Ground water elevation is the difference between the TOC elevation and distance A, as shown in the figure. Using this example, the ground water elevation is:

4,250.75 feet – 50.25 feet = 4,200.50 feet AMSL

Once the depth to ground water has been collected and a ground water elevation is calculated for all wells, a potentiometric surface (top of water table) map can be produced, and ground water flow direction can be determined. To determine the **ground water flow direction**, a map of the facility is needed that includes the surveyed locations of the monitoring wells. Next to each well location, write the ground water elevation. Just like a stream flowing from a high mountain elevation to a lower valley elevation, ground water flows under the influence of gravity from the highest elevation to the lowest. Referring back to Figure 3.12, this map shows the elevations of the top of the water table and a ground water flow direction to the southeast.

What is a hydrograph and what is needed for its construction?

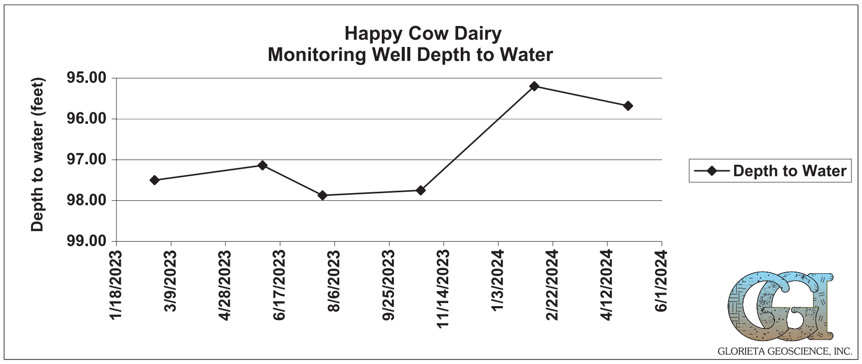
A hydrograph is a graph of water level versus time; it shows how the depth to water or ground water elevation beneath a dairy changes over time. A hydrograph can be easily constructed using a spreadsheet program and plotting depth to water or ground water elevation on the y-axis (vertical) versus the date on the x-axis (horizontal). An example is provided in Figure 7.2.

Potentiometric surface map versus hydrograph: which one is needed??

The potentiometric surface map will show ground water gradient. These maps show if monitoring wells are properly located with respect to process water lagoons, storm water impoundments, and land application areas. With the exception of an upgradient “control” monitoring well for measuring background water quality, the remaining monitoring

Date	Depth to Water (DTW) (ft)	Well Head Elevation (ft asl)	Ground Water Surface Elevation (ft asl)
2/22/23	97.50	3485	3387.50
6/7/23	97.14	3485	3387.86
7/26/23	97.87	3485	3387.13
10/24/23	97.75	3485	3387.25
2/5/24	95.20	3485	3389.80
5/1/24	95.68	3485	3389.32

******ft asl* **is feet above sea level**



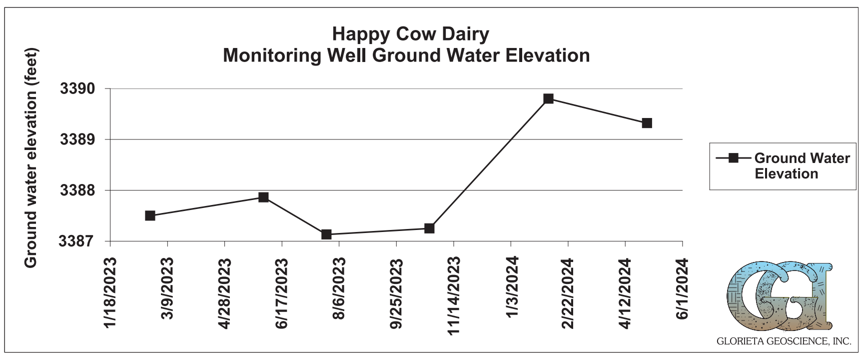


***Figure 7.2*. Happy Cow Dairy monitoring well water levels, ground water elevations, and hydrographs.**

wells should be located downgradient of potential sources of ground water contamination. The purpose of these down-gradient monitoring wells is to provide an “early detection system” to warn if lagoons/impoundments are leaking or if the nutrient uptake capacities of the crops are being exceeded in land application areas. A new dairy should review existing ground water data to determine the best locations for proposed monitoring wells. Existing dairies need to examine both potentiometric surface maps and hydrographs to determine if monitoring wells are properly located. In some cases, only a hydrograph will need to be submitted to the NMED with quarterly and annual reports. Exceptions to this are discussed below.

When preparing a quarterly and/or annual report, a hydrograph for each monitoring well should always be constructed by adding the current quarter’s data to data from previous quarters. In addition, data plotted from all of the monitoring wells on a single hydrograph will show if the ground water flow direction is changing over time.

In Figure 7.3, the hydrograph lines showing depth to water for each monitoring well do not cross but diverge. Therefore, it can be concluded that the ground water flow direction is consistent and does not change significantly.

In Figure 7.4, the hydrograph lines showing depth to water for MW-1 and MW-3 crossed four times from January 2022 through May 2024. This means that the ground water flow direction changes throughout the year. To determine the impact of these changes on the ground water flow direction, a hydrograph should be prepared using well elevations of the water table (AMSL) instead of the depth to water measurements. Once that data is known, a ground water potentiometric surface map similar to Figure 3.12 will need to be constructed to analyze the changes. This data and map will need to be submitted to the NMED with the next report.

Date	MW-1	MW-2	MW-3
8/4/2022	15.25	9.50	16.20
10/4/2022	13.67	8.32	14.68
2/1/2023	14.44	9.58	15.02
6/7/2023	13.58	7.86	16.25
7/12/2023	14.07	7.42	14.88
10/18/2023	10.52	7.27	12.00
1/31/2024	13.92	9.34	14.75

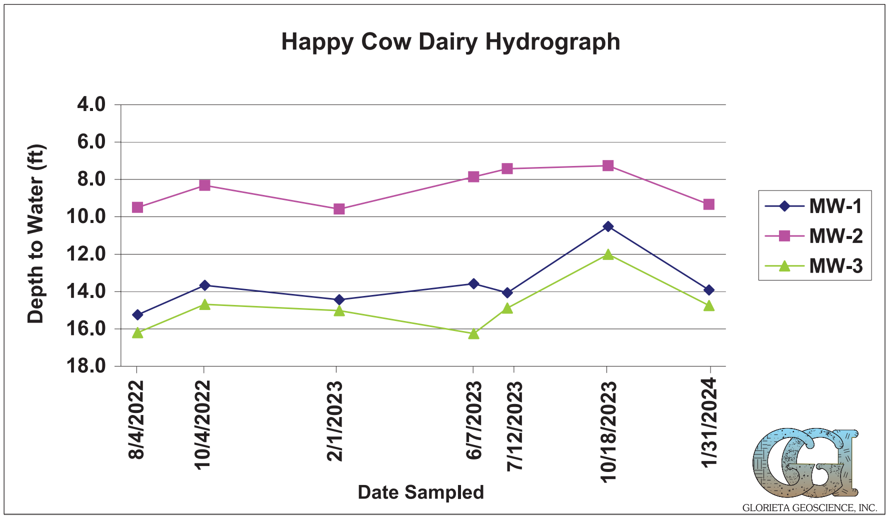


Figure 7.3. **Depth-to-water dataset and hydrograph from Happy Cow Dairy with generally constant ground water flow direction (gradient).**

Date	MW-1	MW-2	MW-3
1/11/2022	47.15	47.55	44.15
6/29/2022	38.23	51.31	46.31
8/30/2022	43.46	46.19	46.00
11/20/2022	48.45	48.64	39.93
2/22/2023	49.75	51.81	43.71
5/31/2023	45.95	53.50	45.00
7/25/2023	40.30	52.92	47.00
10/29/2023	40.20	52.80	45.00
2/10/2024	48.00	54.54	44.00
5/1/2024	46.00	55.55	45.00

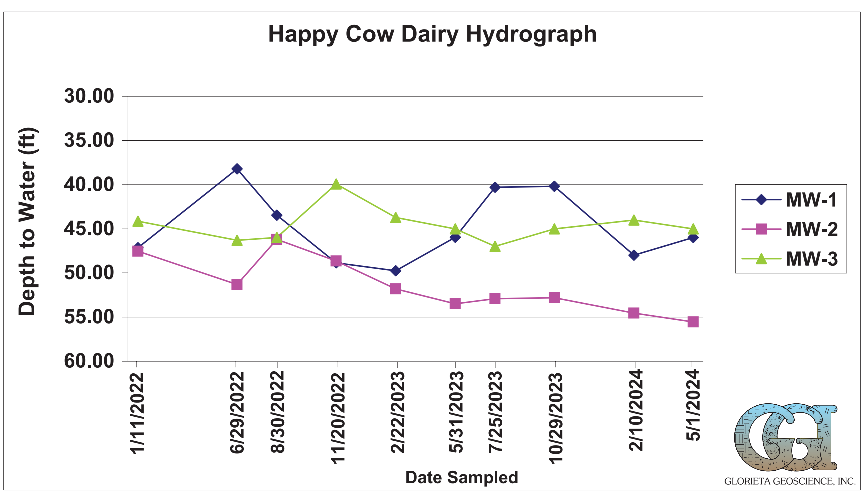


Figure 7.4. **Depth-to-water dataset and graph from Happy Cow Dairy with changing groundwater flow direction (gradient).**

Another thing to consider is how a changing ground water flow direction could impact the dairy's ground water monitoring program. If the change is permanent or consistently changing with the seasons, the NMED may require you to relocate your monitoring wells or add additional wells to ensure adequate ground water monitoring during the changes. Some changes in ground water flow direction may be controllable by the dairy, but not all. Seasonal changes or those brought about by hydrologic connections to surface water or ditches are generally beyond the control of a dairy operator. On the other hand, changes caused by the pumping of supply wells (see below) may be easier to address.

How does pumping from water supply wells or shallow surface water flows affect depth to water?

As discussed in Section 3.10, if the dairy's water supply well(s) is completed in the same aquifer as the monitoring wells, pumping from the supply well(s) could affect ground water flow direction. Figure 3.13 shows the potentiometric surface flowing towards the southeast. Figure 7.5 is the same dairy as Figure 3.13, but with pumping supply well pumping along the northern boundary of the map. The ground water flow direction in Figure 7.5 has been modified by pumping, and ground water is now flowing northward towards the supply well rather than to the southeast.

At dairies located close to surface water such as the Rio Grande and its canals or the Lower Pecos River and the Hagerman Canal, the shallow aquifer is in direct hydrologic communication with surface flows. Seasonal variations in flow in the rivers and unlined canals can affect ground water flow direction. If the dairy is located next to a gaining river reach, the elevation of the water table is higher than the river and ground water flow direction is towards the river. If the dairy is located next to a losing river reach, the elevation of the water flowing in the river is higher than the ground water and ground water flows away from the river towards the aquifer. Figure 3.17 highlights ground water flow directions in both losing and gaining settings.

Figure 7.6 shows potentiometric surface maps for Happy Cow Dairy located adjacent to a river and canal. The ground water flow direction in June 2021 is to the southeast. The ground water flow direction in July 2021, one month later, is to the north, at almost a 130-degree difference in orientation from the previous month.

What should be known about water quality and water quantity?

Section 3.8 of this manual describes basic information about water quality and water quantity. This section demonstrates the practical applications of those concepts with respect to permit compliance and provides examples of the type of information needed to submit to permitting agencies. In general, a NMED Discharge Permit will require quarterly reporting of depth to ground water, monitoring well and lagoon sampling data, and volumes of discharge to both lagoons and land application areas. Discharge volumes are required to be completed for LADS so that nutrient balances can be calculated (see Section 7.3). Because NPDES permits pertain only to surface water protection, the reporting requirements do not usually include information about ground water quality but may need to include information about discharge quantity.

For new dairies, a NMED Discharge Permit application must include the pre-discharge concentration of Total Dissolved Solids (TDS) in the ground water most likely to be affected by the proposed discharge (i.e., the shallowest ground water beneath the site). Remember from Section 2.1 that the NMWQCC regulations are designed to protect ground water with an existing TDS concentration of 10,000 mg/L or less. Information about pre-discharge water quality may be obtained from existing monitoring or supply wells, from reports published by the New Mexico Office of the State Engineer or the United States Geological Survey, or other reputable sources. An application will also need to include the expected concentration of certain contaminants (usually nitrate, TKN and chloride) in the proposed discharge. This information can be obtained from NMSU County Extension Offices, county NRCS Service Centers, or other published sources.

To determine the conditions of the site prior to dairy operations, a producer may also want to determine pre-discharge concentrations of nitrate, TKN, and chloride by sampling any on-site or nearby wells. This information is important for demonstrating water quality conditions prior to the operation of the dairy. For example, if the location of a proposed dairy is in an area with high concentrations of nitrates from septic tanks and leach fields, then nitrate concentrations in ground water may already exceed the NMWQCC standard of 10 mg/L. This information coupled with ground water flow direction information could be used to demonstrate that the operating dairy is not the cause of ground water quality impairment. If background sampling shows no impairment of ground water and water quality is good, then this information would show that there are no contaminant sources upgradient of a dairy.

For existing dairies, an operator is required to monitor through regularly scheduled sampling and reporting the concentrations of certain contaminants in the lagoon water and ground water; these requirements are outlined in a NMED-issued Discharge Permit. Ultimately, the ground water monitoring program at a dairy serves as a kind of "early warning system" for problems such as a leaking lagoon or pipeline or over-application of nutrients to crops. Under this system, problems can often be detected early by comparing water quality data from an upgradient "control" monitoring well with data from at least two downgradient monitoring wells (see Figure 3.12).

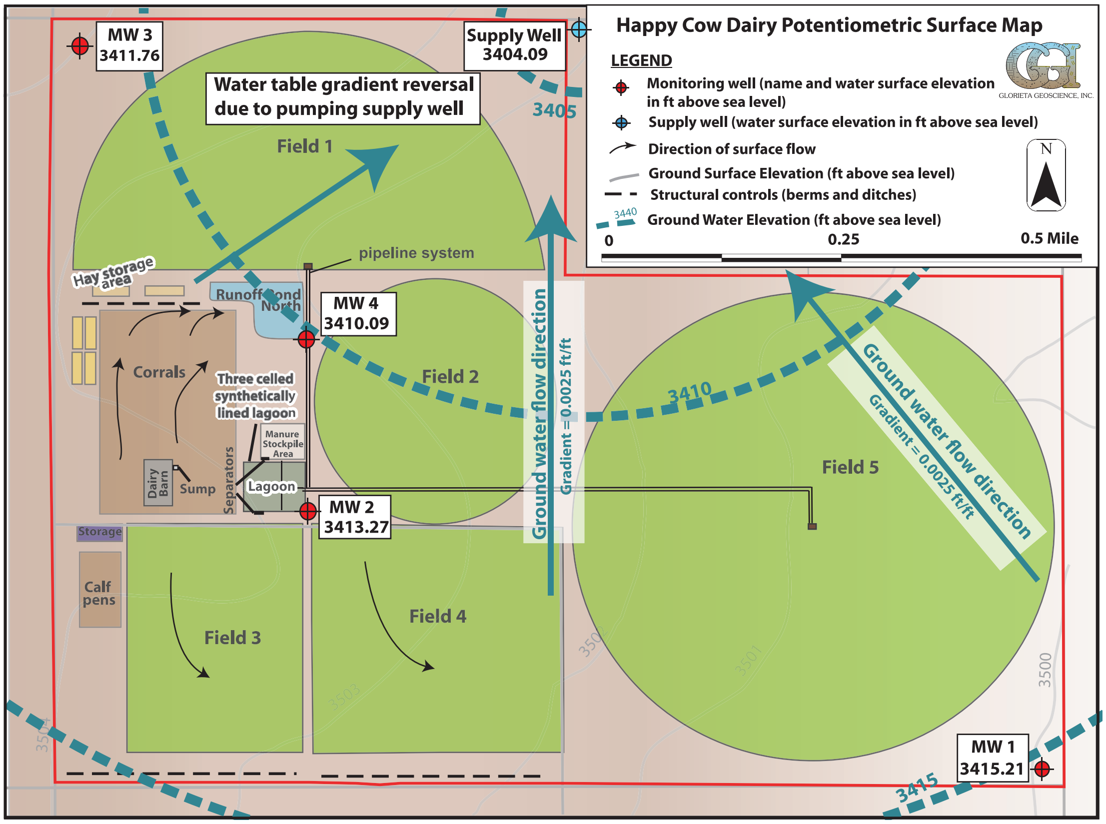


Figure 7.5. **Happy Cow Dairy potentiometric surface map showing drawdown from nearby supply well.**

Most NMED Discharge Permits require at least three monitoring wells, but more may be required depending on the layout of the dairy production and land application areas. In general, a dairy producer will have to collect lagoon and ground water samples on an annual basis and have them analyzed for TKN, nitrate, TDS, and chloride. Additional sampling requirements may be included in the dairy's Discharge Permit. Methods for sample collection are described in detail in Appendix E, along with minimum requirements for selecting an appropriate analytical laboratory.

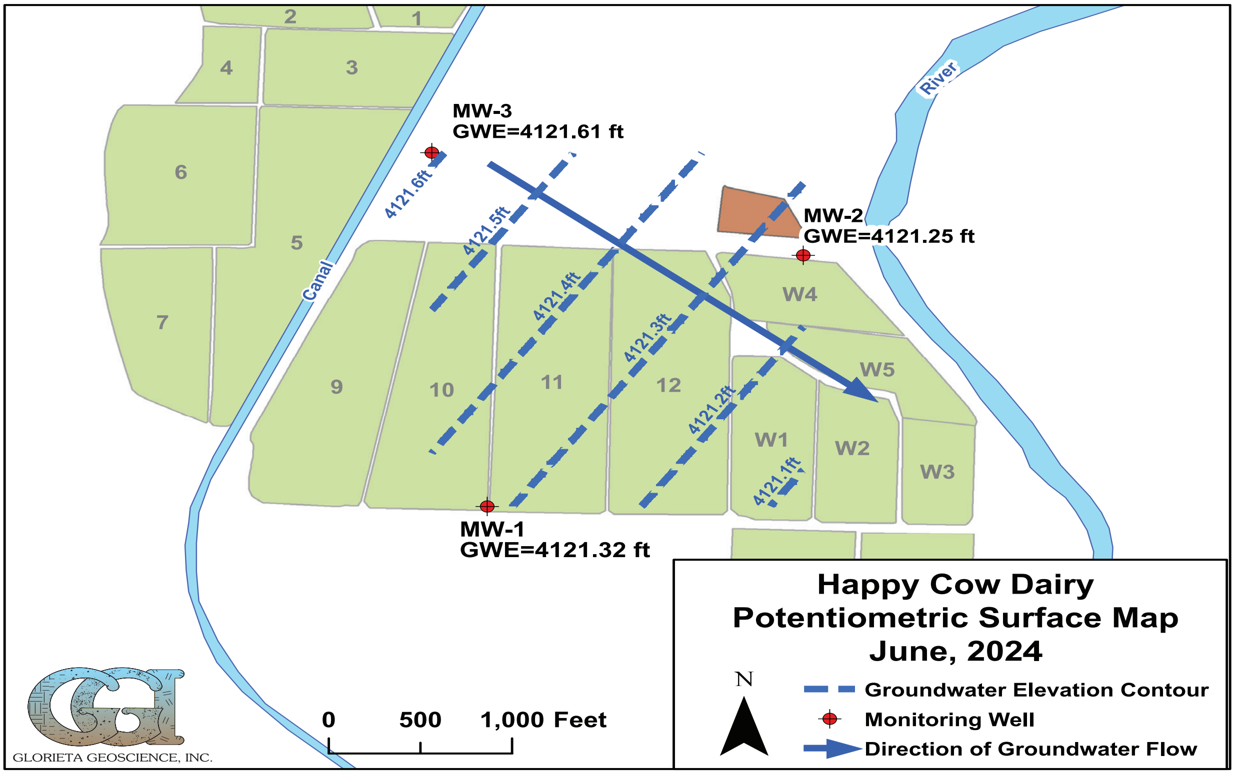
Why should I plot my water quality data?

Similar to the hydrographs described above, plotting water quality data is easily done using a spreadsheet program, by plotting the concentration of the contaminant of concern on the y-axis (vertical) versus the date on the x-axis (horizontal). This will need to be completed for each monitoring well, plus lagoon(s) as specified in the facility Discharge Permit. These plots generally need to be submitted to the NMED, along with the data in tabular form and copies of the raw analytical data received from the laboratory. Each contaminant of concern can be plotted on a separate graph or all on one graph for each monitoring well. Also, it is often helpful to plot the contaminants of concern on the same graph as changes in depth to water. That way, it can be determined if changes in the water table are linked to changes in water quality.

Figures 7.7 and 7.8 are copies of a laboratory report for samples collected in June 2021. Compare these results with the previous month or year to make sure there is no significant change, up or down. If a significant change in concentration from the previous quarter is present, call the analytical lab and ask them to check their analytical data. If the lab indicates that their data is reproducible and sound and the concentration is higher than WQCC standards, a confirmatory sample from the well must be collected.

Figure 7.9 (top graph) shows a plot of nitrate concentrations over time. Although the graph appears to show significant fluctuations in nitrate over time, the scale on the y-axis only represents the range from 4.6 to 6.0 ppm. The data show that this monitoring well does have nitrate present, but amounts are below the WQCC standard of 10 mg/L.

The water quality analysis for lagoons should always show a higher concentration of TKN with low nitrate concentrations as the green water in the lagoon has not oxidized/mineralized to nitrate. If a monitoring well shows increasing or suddenly high TKN concentrations, then a fresh source of nitrogen is possible, such as a leaking lagoon, pipeline, or land application field that has had excess nitrogen applied. High TKN in a monitoring well is a cause for concern and the source should be identified and removed immediately.



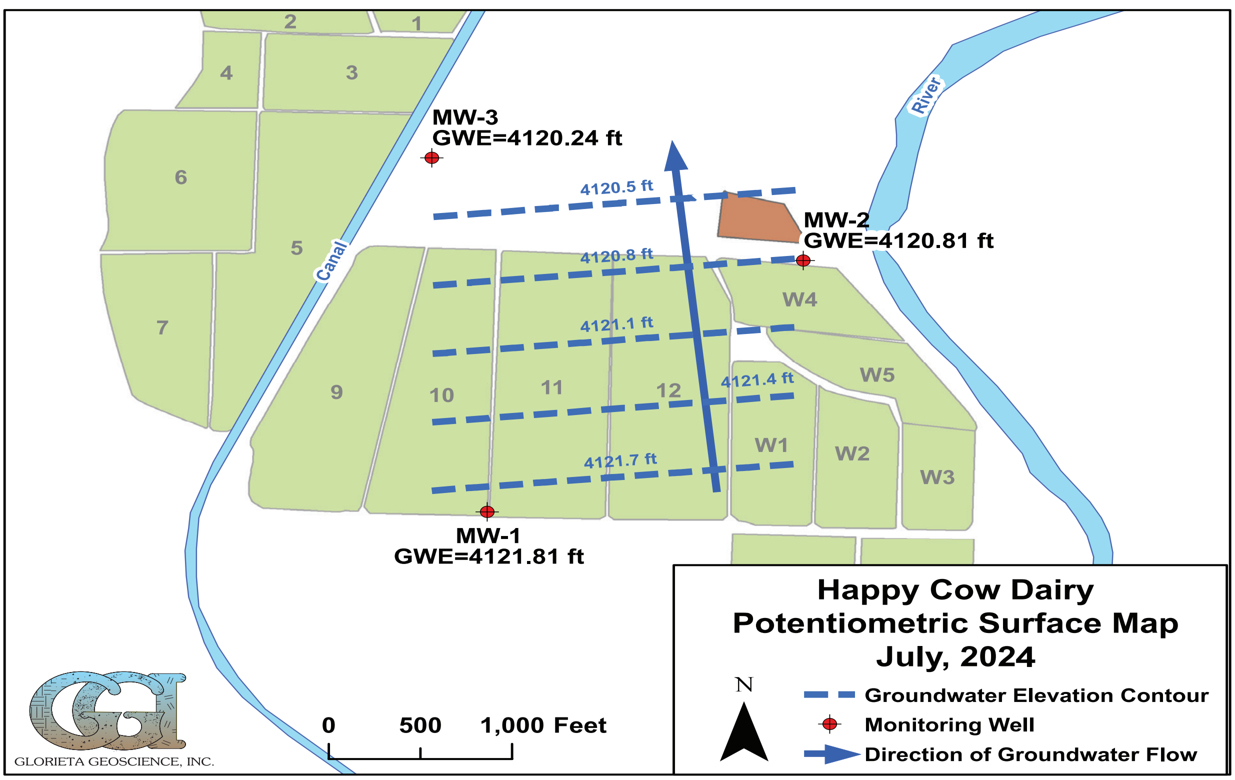


Figure 7.6. **Happy Cow Dairy potentiometric surface maps showing changes in groundwater flow direction between June and July 2024.**

Environmental Analysis Laboratory

Analytical Report
Date Reported: **6/25/2024**

CLIENT: Happy Cow Dairy   **Matrix:** AQUEOUS   **Client Sample ID:** Monitoring Well 1
Collection Date: 6/8/2024

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 300.0: ANIONS						
Chloride	42	5.0		mg/L	10	6/9/2024
Nitrogen, Nitrate (As N)	4.6	1.0		mg/L	10	6/9/2024
Sulfate	190	5.0		mg/L	10	6/9/2024
SM2540C MOD: TOTAL DISSOLVED SOLIDS						
Total Dissolved Solids	672	20.0	*	mg/L	1	6/17/2024
SM 4500 NORG C: TKN						
Nitrogen, Kjeldahl, Total	380	1.0		mg/L	1	6/21/2024

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Figure 7.7. **Water quality laboratory report from Happy Cow Dairy monitoring well sample.**

What do the water quality graphs mean?

In Figure 7.9, the TKN concentrations in the lagoon water fluctuate over time, almost doubling from February 2020 to March 2021. While there are no standards for these constituents in the lagoon water, the current quarter's TKN concentration must be used to demonstrate the nutrient balance for both NMED-issued permits and, as applicable, for NPDES permits. A doubling of TKN concentrations could lead to adding significantly more nutrients to the land application fields, an undesirable result which would require a permit modification.

For monitoring wells, New Mexico has ground water quality standards for nitrate, chloride, and TDS. As discussed in Section 3.3, the ground water standard (10 mg/L) for nitrate is also the drinking water standard and is based on the potential risk to human (and animal) health. The ground water standard for chloride is 250 mg/L, and the standard for TDS is 1,000 mg/L. The standards for chloride and TDS are based primarily on "aesthetic" concerns, such as taste, odor, and appearance. However, high salinity is a concern for irrigation as it can reduce crop yields and reduce the diversity of crops which can be grown. Concentrations of TKN in ground water are usually negligible or non-detectable (refer to Section 3.3 for discussion of nitrogen species). The graph shown in Figure 7.9 is a simple example of data from a "typical" monitoring well. To keep these examples simple, only nitrate concentrations are plotted. We can assume that, when nitrate concentrations are high, concentrations of TDS and chloride are also high.

Analytical Report

Environmental Analysis Laboratory

Date Reported: **6/25/2024**

CLIENT: Happy Cow Dairy **Matrix:** AQUEOUS **Client Sample ID:** Lagoon **Collection Date:** 6/8/2024

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 300.0: ANIONS						
Chloride	380	50		mg/L	100	6/9/2024
Nitrogen, Nitrate (As N)	ND	1.0		mg/L	10	6/9/2024
SM2540C MOD: TOTAL DISSOLVED SOLIDS						
Total Dissolved Solids	3730	200	*D	mg/L	1	6/17/2024
SM 4500 NORG C: TKN						
Nitrogen, Kjeldahl, Total	380	10	D	mg/L	1	6/21/2024
EPA METHOD 200.7: METALS						
Sulfur	20	10		mg/L	1	6/11/2024

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matri:		

***Figure 7.8*. Water quality laboratory report from Happy Cow Dairy lagoon sample.**

An example of a water quality data graph for the Happy Cow Dairy is shown in Figure 7.10. Each well or data point provides a piece of information about the status of the water quality of the dairy and future considerations for changes in operation, possible sources of problems, or the possible trends that need to be addressed.

MW-A. This monitoring well is located upgradient from the dairy, and the nitrate concentration is less than 1 ppm, well below the NMWQCC standard of 10 mg/L.

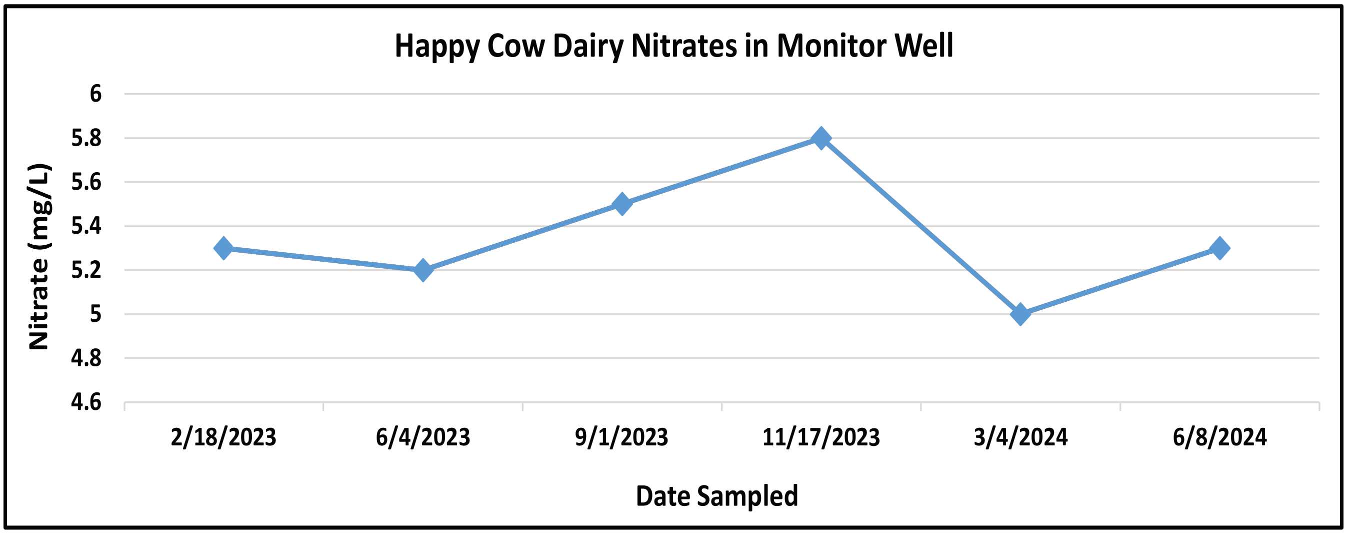
MW-B. This monitoring well is located downgradient from a lagoon that used to be clay-lined, but had a synthetic liner installed in 2017. These data show that, while nitrate concentrations increased during the life of the clay liner, they began to decrease within one year of the installation of the synthetic liner.

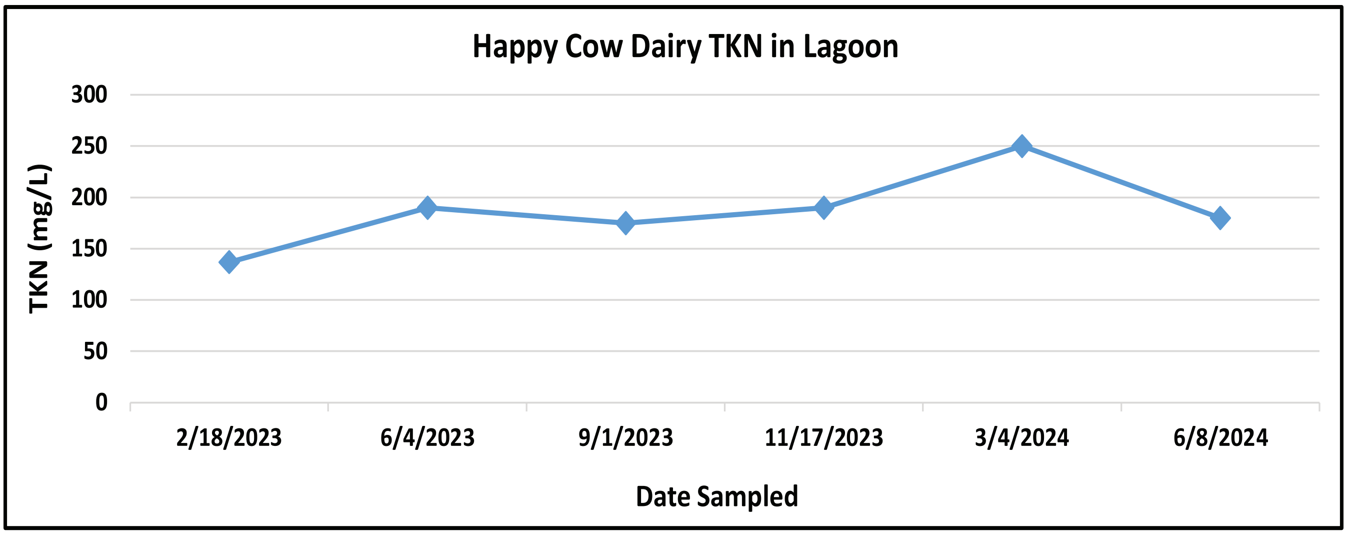
MW-C. This monitoring well is located downgradient from a land application area that is irrigated with a center pivot. In general, this graph shows that nitrate concentrations are below the standard. The exception to this is a spike in 2019 that was attributed to a leaking irrigation pipe. After the pipe was repaired, nitrate concentrations eventually returned to pre-leak conditions.

MW-D. This monitoring well is located downgradient from a flood-irrigated land application area where the depth to water is shallow. In this monitoring well, the nitrate concentration is consistently above the standard, indicating over-application of nitrate and that this producer's irrigation practices have remained unchanged since operations began.

Monitor Well			Total Depth 200 ft		
Date	DTW (ft)	TDS (mg/L)	Cl (mg/L)	TKN (mg/L)	Nitrate (mg/L)
2/18/2023	97.50	2300	170	1.7	5.3
6/4/2023	97.14	2600	140	<1.0	5.2
9/1/2023	97.87	2500	150	1.4	5.5
11/17/2023	97.75	2500	160	<1.0	5.8
3/4/2024	95.20	2200	140	<1.0	5.0
6/8/2024	95.68	2200	150	1.8	5.3

Lagoon				
Date	TDS (mg/L)	Cl (mg/L)	TKN (mg/L)	Nitrate (mg/L)
2/18/2023	4765	130	137	0.01
6/4/2023	1900	99	190	>1.0
9/1/2023	2380	110	175	>1.0
11/17/2023	1600	130	190	>1.0
3/4/2024	2700	160	250	>1.0
6/8/2024	2200	80	180	>1.0





GLORIETA GEOSCIENCE, INC.

Figure 7.9. **Dataset of Happy Cow Dairy monitoring well and lagoon sample laboratory results; graphs of nitrates in monitoring well (top) and TKN in lagoon (bottom).**

Date	MW-A Nitrate (mg/L)	MW-B Nitrate (mg/L)	MW-C Nitrate (mg/L)	MW-D Nitrate (mg/L)
4/1/2019		2.7		17.8
6/1/2019		5.3		13.5
10/1/2020		4.4		17.1
4/1/2020		8.1		15.3
7/1/2020	0.51	7.9		14.8
10/1/2020	0.46	10.0		19.5
1/1/2021		8.6		16.4
4/1/2021	0.38	18.9		11.1
7/1/2021	0.37	14.4		21.3
10/1/2021	0.56	14.8	0.2	20.5
1/11/2022	0.41	13.0	0.1	17.0
6/29/2022	0.36	13.4	1.5	17.4
8/30/2022	0.39	14.1	1.7	16.0
11/20/2022		15.0	13.0	17.0
2/22/2023	0.4	13.0	3.2	18.0
5/31/2023	0.39	12.0	1.8	17.0
7/25/2023		10.1	1.5	17.0
10/29/2023	0.33	9.8	0.3	18.0
2/5/2024	0.43	9.0	0.5	16.0
5/1/2024	0.39	9.5		33.0

No data means monitoring well was not sampled.

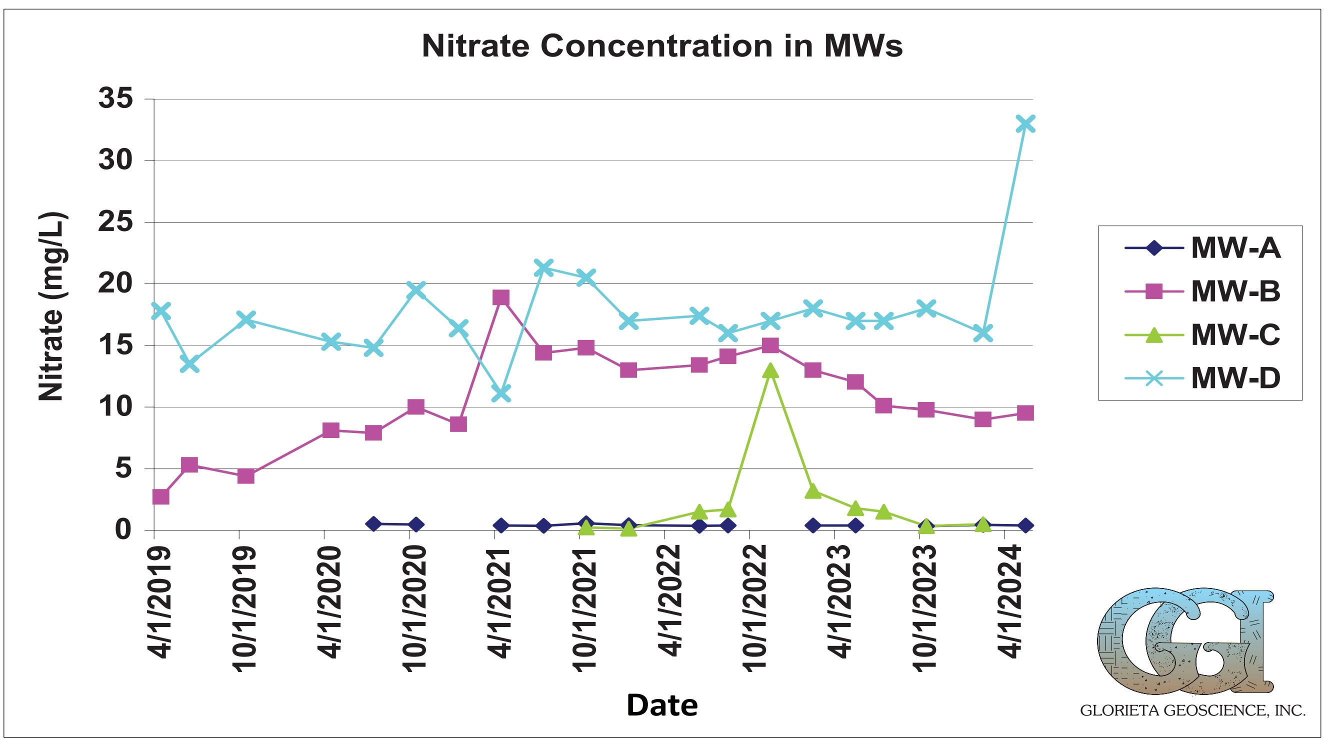


Figure 7.10. **Dataset and graph of Happy Cow Dairy monitoring well nitrate data in four different monitoring wells.**

SECTION 8—DETERMINING DAIRY DISCHARGE

New dairies have to estimate the amount of process-generated green water and storm water that will be discharged to the proposed lagoon/storage system and all assumptions and calculations used to determine this volume must be included with the application for both a NMED-issued Discharge Permit and a NPDES permit. A dairy will also have to estimate how much of this green water will be discharged to land application areas. Water use and methods for conservation are discussed in detail in Section 3.6 of this manual. Proposed discharge volumes can also be determined by consulting with a NMSU Dairy Extension specialist, by consulting published reports/specifications, or by working with established companies that design and build dairies. Remember that water use (for both commercial and irrigation purposes), and thus water discharge, may be limited by the water rights granted by the Office of the State Engineer. The volume of flow from the barn(s) to lagoon system will be the permitted discharge that cannot be exceeded on any given day.

Section 8.1 Calculating Discharge

For existing dairies, the NMED may currently allow a dairy to calculate their discharge volume based on how much fresh water is used in the milking barns. At the time of the permit, the dairy will most likely be required to install a flow meter to measure discharge from the barn(s) to the lagoon(s). If no changes are anticipated when renewing a permit, then at least two years of flow data must be submitted to the NMED and the highest monthly discharge multiplied by a "peaking volume" of 1.5. For example, if the highest monthly discharge volume is 350,000 gallons, then the peaking volume would be:

350,000 gallons per month x 1.5 = 525,000 gallons per month

To get a maximum discharge volume, divide the peaking volume by 30 days per month:

525,000 gallons per month / 30 days per month = 17,500 gallons per day (gpd)

This will be a conservative daily discharge volume. A dairy must also demonstrate that they have adequate storage (see Section 6) and/or adequate acreage for land application of this permitted discharge volume. As with a new dairy, it may also be required to install meters to measure the discharge from the lagoon system to land application areas. Sample meter readings and water volume calculations are provided in Figure 8.2.

Figure 8.1 presents discharge data from a dairy in New Mexico prior to and after implementing water conservation practices in the milking parlor. Happy Cow Dairy had an approved discharge permit for 80,000 gpd. At Happy Cow Dairy, the average daily discharge decreased from 102,000 gpd down to 78,795 gpd, below the 80,000 gpd specified in its permit. In this case, it was discovered that leaking hoses, constantly running hoses, and faulty valves (when not in use) in the milking barn were the primary sources of the excess discharge. These examples show how important it is to analyze weekly meter readings to make sure to follow water conservation methods in the milking parlor and that there are no leaks. Had water use continued above the permitted discharge, the dairy would have had to apply for a discharge permit modification because of an increase in discharge, as well as potentially build additional lagoons for extra green water storage capacity.

Figure 8.2 shows an example of weekly green water meter reading accounting. By recording the meter reading before and after land application, the amount of green water applied to each field can be calculated. Land application data is required with quarterly reporting under 20.6.6.25.G NMAC, and tracking total land application of green water can help determine the source of high nitrates in soils or ground water at the dairy.

Because flow meters differ, how meters are read and how those readings are recorded and used for calculations will vary. A dairy operator is usually required to report their average monthly discharge volume to the NMED; these numbers are to be included with quarterly reports. If a dairy is over-discharging, they will need to evaluate the water-use practices and consider implementing conservation practices. If the dairy continues to over-discharge, it will have to apply to the NMED for a discharge permit modification prior to the expiration date of the existing permit. If the dairy has a NPDES permit, annual reporting is required and meter readings can be used for the following elements in those reports:

1. Calculations of the volume of process green water generated during the 12-month reporting period
2. Calculations of the total amount of nutrients applied to each field
3. Demonstration of adequate storage capacity

This section should demonstrate the importance of a good "accounting system" for water use and discharge. This information is crucial for both proper management of resources and permit compliance.

8.2 Soil Quality, Soil Chemistry, and Nutrient Management

Section 3.14 describes basic information about soils as a nutrient source, and their potential role in contaminant transport. This section demonstrates the practical applications of those concepts with respect to permit compliance and provides examples of the type of information needed to submit to permitting agencies. The NRCS soil rating is designed for soil test interpretation of the plough layer, which is the first foot (0–12 inches). However, the same classification may be used for deeper layers (second and third feet). NRCS soil test interpretation does not change with soil type.

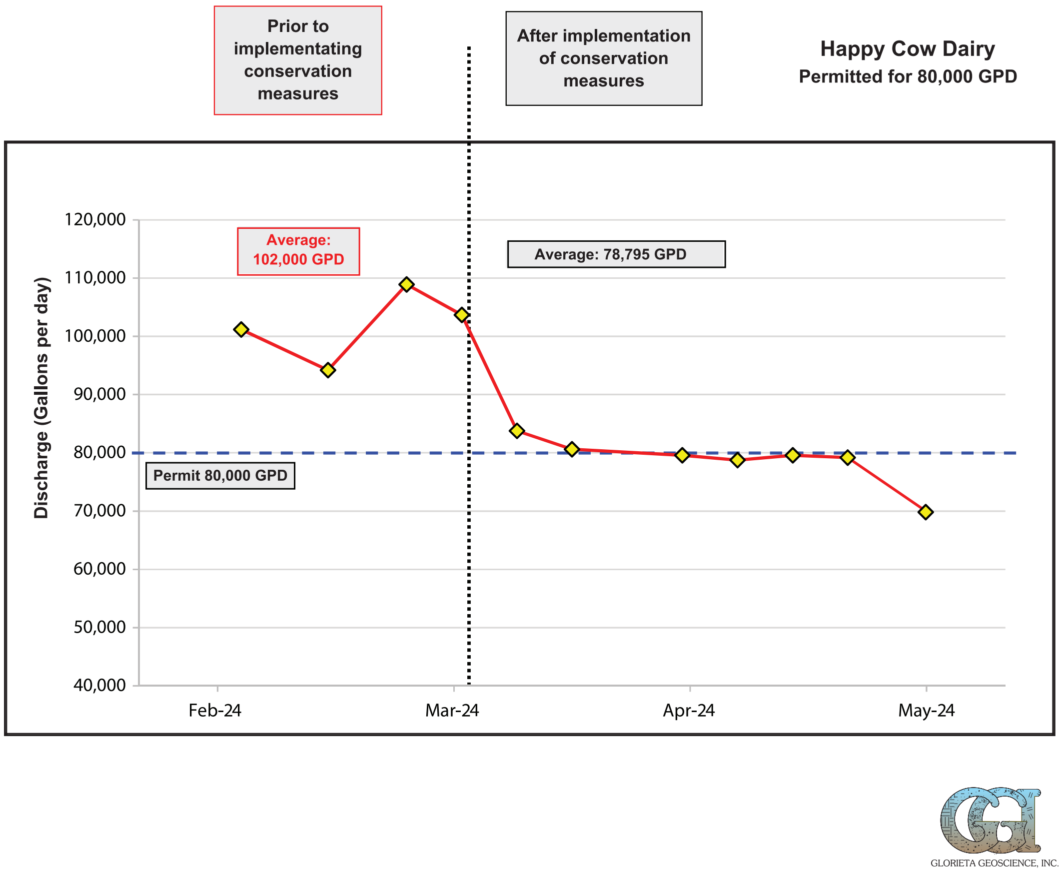


Figure 8.1. **Hydrograph of average daily discharge at Happy Cow Dairy, before and after implementing water conservation practices.**

For new dairies, information on soil quality is not typically required for either a NMED Ground Water Discharge Permit application or a NPDES/CAFO permit application. It is prudent, however, to collect and analyze soil samples prior to commencing discharge and land application. This will help evaluate the chemistry and types of soils present under a proposed facility prior to land application, which in turn will help in planning for future crops and/or soil amendments.

Prior to implementation of the Dairy Rule, the NMED had no general permit requirements for submitting the results of soil sampling, but under the Dairy Rule, facilities are required to soil sample one (1) time per year. NPDES permits also have requirements for soil quality considerations. These requirements are part of the NMP and are discussed in detail in Section 6.5. NPDES permit requirements include soil sampling at least once every year for nitrogen and once every five (5) years for phosphorus, in addition to field-specific assessments of the potential for runoff of nitrogen and phosphorus. CNMP guidance documents, such as the New Mexico Nutrient Management (Code 590) Conservation Practice Standard, specify annual soil testing for fields that receive organic sources of fertilizer (i.e., manure and green water). For a CNMP, soil analyses must include pH, electrical conductivity (EC), soil organic matter (OM), nitrate-nitrogen, phosphorus, potassium, magnesium, calcium, and sodium adsorption ratio (SAR). At a minimum, the required sampling should be performed for permit compliance (NMED, NPDES or both), plus any additional soil sampling that will be used to determine crop production goals. Local NRCS Field Offices or NMSU county Extension offices will be able to assist with selecting the appropriate testing protocol and schedule. Methods for sample collection are described in detail in Appendix E, along with requirements for selecting an appropriate analytical laboratory, and which analyses to request.

For compliance with NMED Ground Water Discharge and NPDES/CAFO permits, a dairy is only concerned with collecting soil samples from fields that receive manure and/or green water. If a CNMP is part of a NRCS-sponsored program, soil samples usually have to be collected from all fields, regardless of the nutrient source (manure, commercial fertilizer, legume credits, irrigation water, etc.).

For purposes of this section, assume that samples are collected only from fields receiving manure and/or green water and with nitrate concentrations. Following the sample collection protocol described in Appendix E, samples should be collected from depths of 0 to 12 inches, 12 to 24 inches and 24 to 36 inches. Once the results have been received, a simple spreadsheet program can be used to plot

Happy Cow Dairy 1								GLORIETA GEOSCIENCE, INC.
Summary of Lagoon to Land Application Fields meter readings								
Meter ID	65-4-321	Meter Multiplier: 0.001 (ac-ft)						
Start Date	End Date	Field irrigated	Acres	Crop at the time of Irrigation	Start meter reading (A)	End meter reading (B)	Volume applied (ac-ft) [C = (B-A)*0.001]	Volume applied (gal) [C*325851)]
1/4/2024	1/10/2024	8	120.0	Triticale	128440	131710	3.3	1,065,533
1/10/2024	1/22/2024	3	17.0	Triticale	131,709	132,467	0.8	246,995
1/22/2024	1/31/2024	2	10.5	Triticale	132,467	132,680	0.2	69,406
1/31/2024	1/31/2024	1	10.0	Triticale	132680	133160	0.5	156,408
1/31/2024	2/17/2024	4	23.5	Triticale	133160	134310	1.2	374,729
2/17/2024	2/27/2024	8	120.0	Triticale	134310	139280	5.0	1,619,479
2/27/2024	2/27/2024	1	10.0	Triticale	139,280	140,560	1.3	417,089
2/27/2024	2/27/2024	2	10.5	Triticale	140560	141,900	1.3	436,640
2/27/2024	2/27/2024	3	17.0	Triticale	141,900	144,080	2.2	710,355
2/27/2024	3/5/2024	4	23.5	Triticale	144080	147080	3.0	977,553
3/5/2024	3/11/2024	8	120.0	Triticale	147080	150710	3.6	1,182,839
3/11/2024	3/11/2024	2	10.5	Triticale	150,710	151,280	0.6	185,735
3/11/2024	3/27/2024	3	17.0	Triticale	151,280	151,770	0.5	159,667
3/27/2024	4/3/2024	1	10.0	Triticale	151,770	152,000	0.2	74,946
4/3/2024	4/9/2024	8	120.0	Triticale	152,000	157,060	5.1	1,648,806
4/9/2024	4/9/2024	1	10.0	Triticale	157,060	157,410	0.4	114,048
4/9/2024	4/9/2024	2	10.5	Triticale	157,410	157,780	0.4	120,565
4/9/2024	4/9/2024	3	17.0	Triticale	157,780	158,370	0.6	192,252
4/9/2024	6/12/2024	4	23.5	Triticale	158,370	159,190	0.8	267,198
6/12/2024	6/12/2024	8	120.0	Corn	159,190	167,080	7.9	2,570,964
6/12/2024	6/12/2024	3	17.0	Corn	167,080	167,700	0.6	202,028
6/12/2024	6/13/2024	4	23.5	Corn	167,700	168,570	0.9	283,490
6/13/2024	6/23/2024	8	120.0	Corn	168,570	179,090	10.5	3,427,953
6/23/2024	6/23/2024	2	10.5	Corn	179,090	179,540	0.5	146,633
6/23/2024	6/23/2024	3	17.0	Corn	179,540	180,260	0.7	234,613
6/23/2024	7/25/2024	4	23.5	Corn	180,260	181,260	1.0	325,851
7/25/2024	8/1/2024	8	120.0	Corn	181,260	186,370	5.1	1,665,099
8/1/2024	8/4/2024	8	120.0	Corn	186,370	190,570	4.2	1,368,574
8/4/2024	8/4/2024	2	10.5	Corn	190,570	190,940	0.4	120,565
8/4/2024	8/4/2024	3	17.0	Corn	190,940	191,530	0.6	192,252
8/4/2024	8/18/2024	4	23.5	Corn	191,530	192,340	0.8	263,939
8/18/2024	8/18/2024	2	10.5	Corn	192,340	193,250	0.9	296,524
8/18/2024	8/18/2024	3	17.0	Corn	193,250	194,710	1.5	475,742
8/18/2024	8/22/2024	4	23.5	Corn	194,710	196,740	2.0	661,478
8/22/2024	8/29/2024	8	120.0	Corn	196,740	207,110	10.4	3,379,075
8/29/2024	8/29/2024	2	10.5	Corn	207,110	207,980	0.9	283,490
8/29/2024	8/29/2024	3	17.0	Corn	207,980	209,380	1.4	456,191
8/29/2024	8/30/2024	4	23.5	Corn	209,380	211,310	1.9	628,892
8/30/2024	9/15/2024	8	120.0	Corn	211,310	221,190	9.9	3,219,408
9/15/2024	10/12/2024	8	120.0	Corn	221,310	225,190	3.9	1,264,302
10/12/2024	11/15/2024	8	120.0	Corn	225,190	226,890	1.7	553,947

***Figure 8.2*. Meter readings of lagoon discharge to land application fields at Happy Cow Dairy.**

changes in nitrate concentration with depth (as shown in Figures 8.3 and 8.4).

Soils data from land application fields with low to medium nitrogen concentrations are shown in Figure 8.3. The majority of these fields exhibit soil nitrate concentrations between low and moderate; however, based on these data, the dairy can continue to apply green water and manure solids at agronomic rates with its current cropping pattern. Figure 8.4 shows soils data from land application fields with sufficient to excessive nitrate concentrations.

As discussed in Section 3.17 (also see New Mexico NRCS Nutrient Management Job Sheet 590), soil analytical results are used to classify fields as having Deficient (0-10 ppm), Low (10-20 ppm), Moderate (20-30 ppm), Sufficient (30-50 ppm), or Excessive (>50 ppm) nitrate concentrations. Assuming that the nutrient application rate is based on nitrogen (versus phosphorus, see below), a dairy is not allowed to apply additional nutrients to soils with Sufficient or Excessive nitrate concentrations. Figure 8.4 shows that a dairy should not continue to apply additional nitrogen sources to any of the fields due to Sufficient or Excessive nitrogen concentrations because increased nitrogen concentrations in the soil indicate that the crops cannot use the nitrogen stored in the soil. As discussed in Section 3.7, the unused nitrogen is soluble in water and has the potential to leach down into ground water and surface water where there is a hydrologic connection. These data should be used as a clue that land application practices need to be modified. If a field has high nitrate concentrations, it may not be permitted to receive land applied manure solids or green water. In the case of high nitrate concentrations below 36 inches, it will be difficult, if not impossible, to plant a crop that has a rooting depth greater than 36 inches. This would leave a contaminant source in the soil that may leach downward into ground water. Soil chemistry issues should be addressed immediately by modifying cropping pattern or green water/manure application methods before ground water becomes impaired or any discharge to surface waters from the nitrate over-applied to fields occur. If the total nitrogen produced in by the operation cannot be reduced, then a permit modification will be required to add additional land application fields.

Phosphorus vs Nitrogen

New Mexico regulations are nitrogen or N-based because New Mexico soils are generally low in phosphorus. However, agencies like EPA and NMED Surface Water Quality Bureau are concerned about contamination of surface waters (rivers, lakes, etc.) by runoff from dairies. The major nutrient of concern in surface water runoff is phosphorus (P). Although there are no likely human health hazards associated with phosphorus, it is damaging to aquatic ecosystems.

The movement of phosphorus in runoff from agricultural land to surface water can cause nutrient enrichment and accelerate **eutrophication**. Eutrophication is characterized by an abundant accumulation of nutrients that support a dense growth of algae and other organisms, the decay of which depletes the shallow waters of oxygen due to the heavy oxygen demand by microorganisms that contribute to the decay. Oxygen-deficient water cannot support aquatic wildlife and can cause an ecosystem to collapse. The control of point sources of phosphorus results in the control of eutrophication. In general, phosphorus transported from runoff from a thin layer of surface soil (0.05 to 0.10 inches) contains particulate phosphorus (75 to 90%) and small portions of dissolved phosphorus.

Requirements for crop sampling and nutrient balance

Operating dairies generate green water every day of the year and disposing and/or reusing green water in an environmentally safe way has always remained a challenge in the dairy industry across the country. Based on green water disposal methods, dairies in New Mexico can be categorized into either land application dairies or total evaporative dairies. The majority of the dairies in New Mexico land apply green water for crop production. Total evaporative dairies are not commonly used due to the high costs involved in constructing and lining the required large surface area lagoons. Land application of green water also requires cost as lined storage lagoons and infrastructure from lagoons to fields is needed. Many dairy producers choose land application because of the additional value from the manure solids and green water, despite the potential costs involved with possible ground water and soils contamination.

Improper land application or over-application has the potential for causing nitrate contamination of ground water and soils, a major concern since New Mexico is an N-based state. The determination of whether a dairy is applying green water according to agronomic uptake should be calculated by a technical expert and nutrient application rates should be adjusted. LADS are required to be submitted to the NMED on a quarterly basis.

8.3 Land Application Data Sheets (LADS)

LADS is an easy-to-use spreadsheet application developed by the NMED that allows dairy farmers to input crop production and nutrient application data and generates output that compares nitrogen applied via green water, manure solids and fertilizers with nitrogen uptake by the crops.

Filling out LADS: LADS have to be filled out for each field specified in the discharge permit. If no green water is land applied, a statement of "no land application" has to be submitted in place of LADS. In the LADS spreadsheet, data must be entered in white-colored cells. The green-colored cells and blue-colored cells are automatically populated with results based on the supplied entries.

The LADS spreadsheet has four input worksheets and one summary sheet linked to the input sheets: "Information Input Worksheet," "Effluent Discharges from Lagoon to a Land Application Field," "LADS – Effluent," and "Total Nitrogen Applied to the Land Application Field."

i. Information Input Worksheet (Figure 8.5): Under general information needed, enter facility name, DP#, time frame of reporting period, field name or field number, acres, and method of irrigation. Under crop information needed, select the crop(s) from the pull-down menu. The percent nitrogen and percent dry matter values are populated automatically. If crop analysis data is available, enter the percent nitrogen and percent dry matter—the entered values, instead of published values, will be used for crop uptake calculations. Enter wet yield of the crop; dry yield is calculated by the worksheet based on percent dry matter. Based on the input data, pounds (lbs.) of nitrogen removed per year is calculated automatically by the worksheet.

ii. Effluent Discharges from Lagoon to a Land Application Field (Figure 8.6): Enter beginning and ending green water meter readings for each month, either in gallons or in acre-feet. If lagoon meter data is not available, enter beginning and ending hours of application with gallons/hour information. The total effluent applied per month is calculated automatically by the worksheet.

iii. LADS – Effluent (Figure 8.7): Based on the meter readings entered in the lagoon discharge worksheet, volume of effluent applied to the field is automatically calculated in this worksheet. This worksheet also requires that the crop at time of application and total nitrogen (TKN +

Table of and graph of soil nitrate concentrations at Happy Cow Dairy (deficient to moderate)

Happy Cow Dairy - Soil Sampling (9/20/2024)					
Location	Field 1	Field 2	Field 3	Field 4	Field 5
Depth (in.)	Nitrate(mg/kg)	Nitrate(mg/kg)	Nitrate(mg/kg)	Nitrate(mg/kg)	Nitrate(mg/kg)
0-12	21.9	16.3	22.2	22.4	5.2
12-24	23.8	17.9	24.2	18.2	5.6
24-36	21.1	17.6	18.0	11.9	7.6

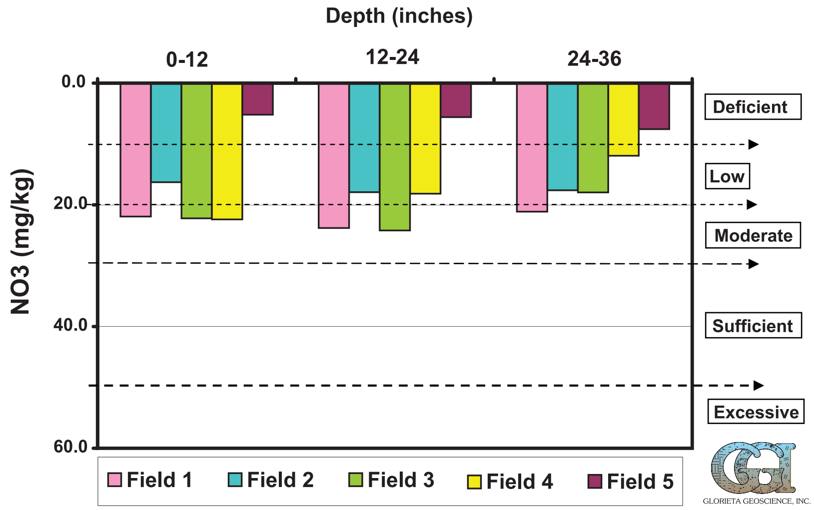


Figure 8.3. **Dataset and bar graph of Happy Cow Dairy soil nitrate concentrations on land application fields; threshold concentrations from NMSU (2015).**

Table of Happy Cow Dairy land application field high soil nitrate lab results

Happy Cow Dairy - Soil Sampling (9/20/2024)					
Location	Field 1	Field 2	Field 3	Field 4	Field 5
Depth (in.)	Nitrate(mg/kg)	Nitrate(mg/kg)	Nitrate(mg/kg)	Nitrate(mg/kg)	Nitrate(mg/kg)
0-12	153.5	113.9	155.5	156.7	36.3
12-24	166.7	125.5	169.5	127.2	39.1
24-36	147.8	123.3	125.7	83.5	53.0

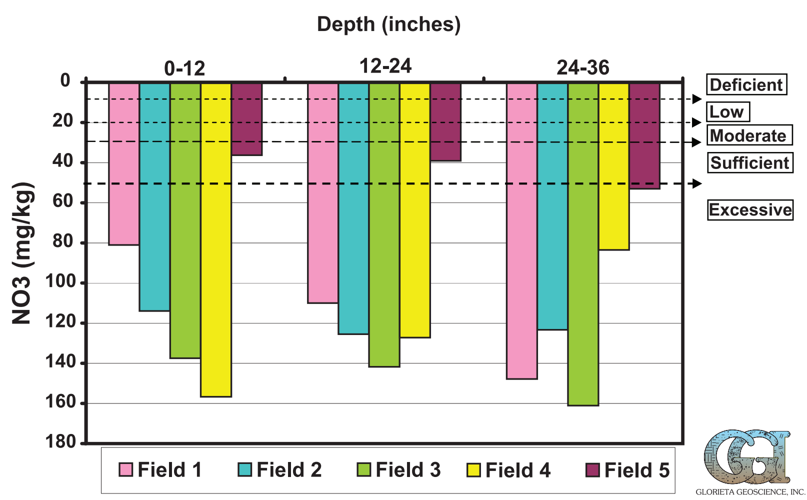


Figure 8.4. **Dataset and bar graph of Happy Cow Dairy high soil nitrate concentrations on land application field; threshold concentrations from NMSU (2015).**

NO3-N) be entered. The TKN and NO3-N information can be obtained from the laboratory analysis report. Make sure to enter total nitrogen information for the corresponding sampling month and continue entering the same total nitrogen information until new sampling results are available. In the example of a LADS spreadsheet, the lagoon was sampled in January, April, July, and October, and the total nitrogen number in January is applied to February and March as the lagoon was not sampled during those two months. The lagoon was sampled again in April, the total nitrogen number was updated with the new analysis results, and the April total nitrogen number was repeated for May and June until the lagoon was sampled again. Follow the same procedure if on a semi-annual sampling schedule: repeat the same total nitrogen number for six months until the lagoon is sampled again. The amount of nitrogen applied via green water is automatically computed in pounds per acre in this worksheet.

iv. Total Nitrogen Applied to the Land Application (Field 8.8): Information cannot be entered in this worksheet. This worksheet summarizes pounds of nitrogen applied through effluent, manure solids and chemical fertilizer for each month and calculates total nitrogen applied for the year in pounds/acre. Total nitrogen uptake of crops in pounds/acre is presented on the top left-hand corner of the worksheet.

Interpretation: In the example LADS spreadsheet, Total nitrogen applied is 367.75 lbs. N/ac, while the calculated total nitrogen uptake is 277 lbs. N/ac. This nitrogen uptake is greater than the nitrogen applied.

If the total nitrogen uptake in the Total Nitrogen Applied worksheet is greater or equal to total nitrogen applied in pounds/acre, the particular land application field is not over-applied during the reporting period. If the total nitrogen uptake is less than the total nitrogen applied, it means that fields are over-applied during the reporting period and continuing this practice could lead to potential nitrogen overloading of soils. Necessary corrective actions need to be taken to ameliorate the over-application. Remember, soil needs to be sampled on all land application fields and the soil test results submitted to the NMED.

It is common for the NMED to request corrective actions if soil samples show high or very high nitrates, especially if the nitrate concentrations increase with depth. Corrective actions can include applying green water at rates less than agronomic rates, changing cropping patterns to include high nitrate uptake crops or deep-rooted crops if nitrates have leached below the first two feet, or other measures. Consult the nearest county Extension specialist to get more information on corrective actions.

Information Input Worksheet

General Information Needed

Facility Name	DP#	Reporting Period From (m/d/y)	Reporting Period To (m/d/y)	Field Name or Number	Acres	Method of Irrigation
Happy Cow Dairy		1-Apr-24	30-Jun-24	1	120	Pivot

Crop Information Needed

Crop	% Nitrogen*		% Dry Matter		Yield Information***				Dry Yield in lbs/ac		lbs N/ac removed	lbs N/ac removed field/yr
	harvest crop analysis**	published value	harvest crop analysis**	published value	bu/ac	dry wt. lb/bu	wet yield (T/ac)	dry yield (T/ac)	harvest by the bushel	harvest by tonage		
Corn, Silage		1.28%	30.00%				31.69	9.51		19,014	243	277
Triticale, silage		1.92%	15.00%				5.89	0.88		1,767	34	

Notes: * Enter a lab analysis result for the harvested crop or typical published value will automatically appear. Attach copy of the lab analysis report.
** If the harvested crop analysis (ie feed crop analyses) reports only % Crude Protein (%CP): % Nitrogen = %CP divided by 6.25
***When entering yields, enter Bushels/acre **OR** wet yield (tons/acre)

Alfalfa research has shown that nitrogen fixing in alfalfa decreases lbs of N removed to 60% unless grower is using a non-nitrogen fixing variety.
-- Therefore, if you choose any alfalfa crop other than those designated as "non N-fixing", the worksheet automatically credits only 60% N removal. Provide documentation if crop is a "non N-fixing" variety.

NMED - Ground Water Quality Bureau

Form Last Updated: October 3, 2006

Figure 8.5. **2024 LADS Worksheet: Information Input Worksheet for Happy Cow Dairy.**

Effluent Discharges from Lagoon to a Land Application Field

DP #: ______ **Facility Name:** Happy Cow Dairy **Report Period**
From: 1-Apr-24
Field: 1 **Method of Irrigation:** Pivot **To:** 30-Jun-24

JANUARY									
Date	Meter Reading (gallon)		Meter Reading (acre-ft)		Meter Reading (hour)			Gallons of	
(m/d/y)	Beginning	Ending	Beginning	Ending	Beginning	Ending	calibration (gals/hr)	Effluent Applied	
01/25/24			823.98	825.65				545475	
01/26/24			826.55	828.965				786278	
01/29/24			832.189	832.935				243085	**Total Effluent**
									Applied Jan
									1,574,838

FEBRUARY									
Date	Meter Reading (gallon)		Meter Reading (acre-ft)		Meter Reading (hour)			Gallons of	
(m/d/y)	Beginning	Ending	Beginning	Ending	Beginning	Ending	calibration (gals/hr)	Effluent Applied	
02/21/24			833.933	836.924				974620	
02/23/24			838.535	839.311				252860	
									Total Effluent
									Applied Feb
									1,227,481

MARCH									
Date	Meter Reading (gallon)		Meter Reading (acre-ft)		Meter Reading (hour)			Gallons of	
(m/d/y)	Beginning	Ending	Beginning	Ending	Beginning	Ending	calibration (gals/hr)	Effluent Applied	
03/03/24			840.348	842.230				613252	
03/04/24			843.709	848.539				1573860	
03/15/24			851.139	855.024				1265931	**Total Effluent**
03/25/24			864.816	886.439				7045876	**Applied Mar**
									10,498,919

APRIL									
Date	Meter Reading (gallon)		Meter Reading (acre-ft)		Meter Reading (hour)			Gallons of	
(m/d/y)	Beginning	Ending	Beginning	Ending	Beginning	Ending	calibration (gals/hr)	Effluent Applied	
									Total Effluent
									Applied Apr
									0

MAY									
Date	Meter Reading (gallon)		Meter Reading (acre-ft)		Meter Reading (hour)			Gallons of	
(m/d/y)	Beginning	Ending	Beginning	Ending	Beginning	Ending	calibration (gals/hr)	Effluent Applied	
05/30/24			910.993	911.346				115025	
									Total Effluent
									Applied May
									115,025

JUNE									
Date	Meter Reading (gallon)		Meter Reading (acre-ft)		Meter Reading (hour)			Gallons of	
(m/d/y)	Beginning	Ending	Beginning	Ending	Beginning	Ending	calibration (gals/hr)	Effluent Applied	
06/16/24			953.563	962.797				3008908	
06/25/24			965.512	968.967				1125815	
									Total Effluent
									Applied Jun
									4,134,723

NMED, Ground Water Quality Bureau   Form Last Updated: October 3, 2007

Figure 8.6. **2024 LADS Worksheet: Effluent Discharges from Lagoon to Land Application Field 1 at Happy Cow Dairy.**

New Mexico Environment Department

Ground Water Quality Bureau

Land Application Data Sheet - Effluent

Last Updated: June 14, 2003

DP#: ____________

FACILITY NAME: Happy Cow Dairy

FIELD: 1 ACRES: 125.0 REPORT PERIOD - FROM: 1-Apr-24 TO: 30-Jun-24

CROP 1: Corn, Silage YIELD: 26.88 T/ac

CROP 2: Triticale, silage YIELD: 5.86 T/ac TOTAL NITROGEN UPTAKE OF CROP(S): 240 lbs/ac

CROP 3: Corn, Silage YIELD: ____________

Effluent

DATE/MONTH OF APPLICATION	CROP IN AT TIME OF APPLICATION	A VOLUME OF EFFLUENT APPLIED [1] gal	B LAB RESULTS [2] (TKN + NO3-N) mg/l	C NITROGEN CONCENTRATION (B x 8.3452 x 10^{-6}) lbs/gal	D TOTAL NITROGEN (A x C) lbs N	E NITROGEN (D/acres) lbs N/acre	APPLICATION METHOD Flood, Sprinkler, etc.
January	Triticale, Silage	1,574,838	150	0.001	1971.35	15.77	Pivot
February	Triticale, Silage	1,227,481	330	0.003	3380.38	27.04	Pivot
March	Triticale, Silage	10,498,919	330	0.003	28913.14	231.31	Pivot
April	Triticale, Silage		330	0.003			Pivot
May	Triticale, Silage	115,025	330	0.003	316.77	2.53	Pivot
June	Corn, Silage	4,134,723	330	0.003	11386.68	91.09	Pivot
July							Pivot
August							Pivot
September							Pivot
October							Pivot
November							Pivot
December							Pivot
					Total Nitrogen Applied from Effluent (lbs/ac)	367.75	

Figure 8.7. **2024 LADS Worksheet: Land Application Data Sheet – Effluent for field 1 at Happy Cow Dairy.**

SECTION 9—WATER RIGHTS

This section provides a brief discussion of water rights as they apply to a dairy's operations. A detailed explanation of New Mexico water rights is beyond the scope of this manual.

9.1 Water Rights: An Overview of a Dairy's Water Uses

Dairies in New Mexico need water and associated water rights for a wide variety of operational uses. Water is needed for cow drinking, cow cooling, milk cooling, parlor clean-up, lane flushing, tank and milk line cleaning, dust suppression, construction, and irrigation. The amount of water used at a dairy is dependent on how the dairy was designed and how individual dairy producers and their staff operate the dairy. Many dairies are designed to conserve and recycle water. The same water can be used for milk cooling, parlor flushing, and subsequent irrigation or land application. The bulk of water used in the production area of a dairy is for cow drinking and milking parlor clean-up. Depending on the season, cows drink between 28 and 55 gallons per day (gpd). Depending on water conservation practices, water used for parlor cleanup ranges from 3 to 5 gpd per cow to more than 100 gpd per cow.

Conservation of water within the dairy operations (1) reduces the need to transfer/retire water rights; (2) lessens the energy or electrical cost to pump ground water; and (3) reduces the size requirements for green water lagoon(s). The greatest waste of water generally occurs within the milking parlor, where clean-up hoses may be running unattended or there may be unmaintained plumbing resulting in slow leaks. These common issues are easily eliminated through routine inspections, employee awareness training, and good maintenance practices. Some dairies control water use within the milking barn by installing timers on the wash hoses or automatic shut-off switches.

Conservation of water in the milking parlor is the intersection of management, training, water rights, water conservation, and environmental permit compliance. Dairy green water lagoons are designed to accommodate 60 days of green water storage plus direct precipitation based on a designated volume of daily green water discharge. If a dairy generates excess green water in the milking parlor (wasting water), water rights are unnecessarily used and can result in daily discharges that exceed the maximum permitted discharge under a Ground Water Discharge Permit. Figure 9.1 shows a schematic of common water uses in a dairy.

Total Nitrogen Applied to the Land Application Field

DP#: ______

Facility Name: Happy Cow Dairy

Field: 1 Acres: 125

Reporting Period: From: 1-Apr-24 To: 30-Jun-24

Total Nitrogen Uptake of Crop(s) : 240 lbs/ac

Crops grown: Corn, Silage Triticale, silage

JANUARY	
Nitrogen Source	lbs N/ac
Effluent	15.77
Manure Soilds	
Chemical Fertilizer	
Total N Applied in Jan	**15.77**

FEBRUARY	
Nitrogen Source	lbs N/ac
Effluent	27.04
Manure Soilds	
Chemical Fertilizer	
Total N Applied in Feb	**27.04**

MARCH	
Nitrogen Source	lbs N/ac
Effluent	231.31
Manure Soilds	
Chemical Fertilizer	
Total N Applied in Mar	**231.31**

APRIL	
Nitrogen Source	lbs N/ac
Effluent	
Manure Soilds	
Chemical Fertilizer	
Total N Applied in Apr	

MAY	
Nitrogen Source	lbs N/ac
Effluent	2.53
Manure Soilds	
Chemical Fertilizer	
Total N Applied in May	**2.53**

JUNE	
Nitrogen Source	lbs N/ac
Effluent	91.09
Manure Soilds	
Chemical Fertilizer	
Total N Applied in Jun	**91.09**

JULY	
Nitrogen Source	lbs N/ac
Effluent	
Manure Soilds	
Chemical Fertilizer	
Total N Applied in Jul	

AUGUST	
Nitrogen Source	lbs N/ac
Effluent	
Manure Soilds	
Chemical Fertilizer	
Total N Applied in Aug	

SEPTEMBER	
Nitrogen Source	lbs N/ac
Effluent	
Manure Soilds	
Chemical Fertilizer	
Total N Applied in Sept	

OCTOBER	
Nitrogen Source	lbs N/ac
Effluent	
Manure Soilds	
Chemical Fertilizer	
Total N Applied in Oct	

NOVEMBER	
Nitrogen Source	lbs N/ac
Effluent	
Manure Soilds	
Chemical Fertilizer	
Total N Applied in Nov	

DECEMBER	
Nitrogen Source	lbs N/ac
Effluent	
Manure Soilds	
Chemical Fertilizer	
Total N Applied in Dec	

TOTAL N APPLIED FOR THE YEAR	
Nitrogen Source	lbs N/ac
Effluent	367.75
Manure Soilds	
Chemical Fertilizer	
Total N Applied for the Year:	**367.75**

NMED - Ground Water Quality Bureau

Form Last Updated: June 14, 2003

Figure 8.8. **2024 LADS Worksheet: Land Application Data Sheet – Total Nitrogen Applied to Land Application Field 1 at Happy Cow Dairy.**

9.2 Who Administers the State's Water Rights?

The ground water and surface water resources of New Mexico are public waters under the supervision of the Office of the State Engineer (OSE). Water rights in New Mexico are administered under the doctrine of "prior appropriation." The "prior appropriation" rule gives priority to the most "senior" or oldest water right owner over a more "junior" or younger water right owner. This priority is determined by when the senior water right was put to beneficial use as compared to the later "junior water right" user. A beneficial use is the direct use or storage and use of water for a beneficial purpose including but not limited to agricultural, municipal, commercial, industrial, domestic, livestock, fish and wildlife, and recreational uses. Beneficial use is the basis, the measure, and the limit of a water right. In instances where there is a water shortage and no sharing agreements can be reached, the senior water right holder has the right to put 100% of their water right to beneficial use before a junior appropriator can take their water right pursuant to this priority call.

Water used within the dairy production area is generally classified by the OSE as "commercial dairy use." All dairies in the state rely on ground water as their source of water for the commercial side of their operation (e.g., milking parlor operations, cow watering, and misters). Depending on the location of the dairy, either ground water or surface water sources are used for irrigation. Surface water rights are created by either establishing a pre-1907 historic use or by a recognized post-1907 permit. Ground water rights are established either by historic use that predates the OSE control over a ground water basin (see Figure 9.2 for declared ground water basins) or by subsequent permit whereby surface water rights are transferred to ground water. A water right comprises the following elements:

- Source of water
- Point of diversion
- Priority date
- Place of use
- Purpose of use
- Quantity of water

When researching a water right, these elements may be found and described in sufficient detail on one or more documents:

- Declaration of ownership of a water right prepared by the owner and on file with the OSE
- Water right permit issued by the OSE
- Proof of Beneficial Use (PBU) filed at the OSE
- A License issued by the OSE
- A signed and recorded Order of a state or federal court in a basin-wide water right adjudication

Water rights are real usufructuary rights that can be bought, sold, or traded separately from the land. A usufructuary right means that the water is owned by the State of New Mexico and a person has the right to use the state's water through a permit, declaration, license, or adjudicated right. A water right description found on a real estate deed or plat map may be an important source of information but is no substitute for the above-listed OSE or legal documents.

9.2.a Source of Water

The surface water source (spring or stream sources) or underground water basin (aquifer) are specifically identified in a water rights application and/or permit. For example, the recognized sources of water in the Roswell Basin include the Pecos River (surface water), the shallow (alluvial) aquifer, or the deep (artesian) aquifer. Each water source is administered differently, and a permit from the OSE is required to change or consolidate sources. On the High Plains, the Ogallala Aquifer and related shallow alluvial aquifers are the recognized sources of water. The OSE considers all ground water in the Middle Rio Grande to be stream connected and administers ground water based on the rate of water level declines and effects on surface water flows. In the Middle Rio Grande, post-1907 priority surface waters are generally owned or controlled by the Middle Rio Grande Conservancy District (MRGCD). Ground water in the lower Rio Grande is administered in a manner similar to the Middle Rio Grande, but the Elephant Butte Irrigation District (EBID) controls most surface waters.

9.2.b Point of Diversion

The point of diversion of a water right identifies the location (coordinates) of the head works of the ditch (acequia) or well(s) from which water is diverted from its natural course. Surface water points of diversion are usually located with great precision. Wells have traditionally been located based on the Public Land Survey System (PLSS), a common subdivision of public lands into sections, townships, and ranges. Under this system, the OSE has required that wells be located to the nearest 10-acre tract within a section quadrant (e.g., ¼ of ¼ of ¼ of Section [A], Township [B], Range [C] NMPM), so closely spaced wells may have the same location description. With the introduction of GPS technology and computerized mapping systems, the OSE is now requiring well locations to be provided within a 5-meter (16.4-ft) accuracy.

9.2.c Priority Date

The priority date of a water right is usually the date the water was first put to beneficial use and in certain circumstances, that can be either the date the diversion works were started or the date of permit application. When acquiring a water right for transfer to a dairy, the dairy should attempt to purchase the earliest (most senior) priority water right possible. For example, most ground water rights in the Mesilla Valley (Lower Rio Grande) are junior to surface water rights within the Elephant Butte Irrigation District (EBID). Under proposed OSE rules, these junior ground water rights may be curtailed if the flow of the Rio Grande is insufficient to meet the needs of the senior surface water right holder. Similarly, junior ground water rights in the Roswell Basin may be curtailed if there is insufficient water in the Pecos River to meet the demand of senior water users in the Carlsbad Irrigation District (CID).

9.2.d Place of Use

The place of use of water rights (the lands to which the water right is appurtenant) is usually legally described using the PLSS system of section, township, and range subdivision of land. Irrigated lands are generally quantified to the nearest 1/100th of an acre. Commercial water use areas within a dairy are typically described to the nearest 10-acre tract.

9.2.e Purpose of Use

The state of New Mexico does not acknowledge any hierarchy of water uses. Practically any use of water not deemed to be a waste of water is permissible and equal to any other water use. Water uses within a dairy operation may include irrigation, commercial dairy operation, parlor clean-up, livestock watering, sanitation (livestock), domestic/sanitary (employee use), milk cooling, equipment cleaning, and other occasional, incidental uses.

9.2.f Quantity (Irrigation)

To most dairy producers, the most important element of any water right is the annual amount of water that may be diverted and consumed, usually stated in units of acre-feet per annum (often abbreviated as AFY or ac-ft/yr). Irrigation rights contain two elements: (1) a diversion right or duty of water (Farm Delivery Requirement [FDR]), which is the annual maximum amount of water delivered at the farm headgate per irrigated acre (ac-ft/ac/yr), and (2) the Consumptive Irrigation Requirement [CIR] for irrigation, which is the portion of the FDR that is consumed by the crop or lost to evapotranspiration in the field. In some areas of the state, the OSE also recognizes an off-farm conveyance loss factor (referred to as carriage loss) for surface water delivery systems (Project Diversion Requirement). Irrigation wells are assumed to be located next to the land they water, therefore carriage loss is not usually associated with ground

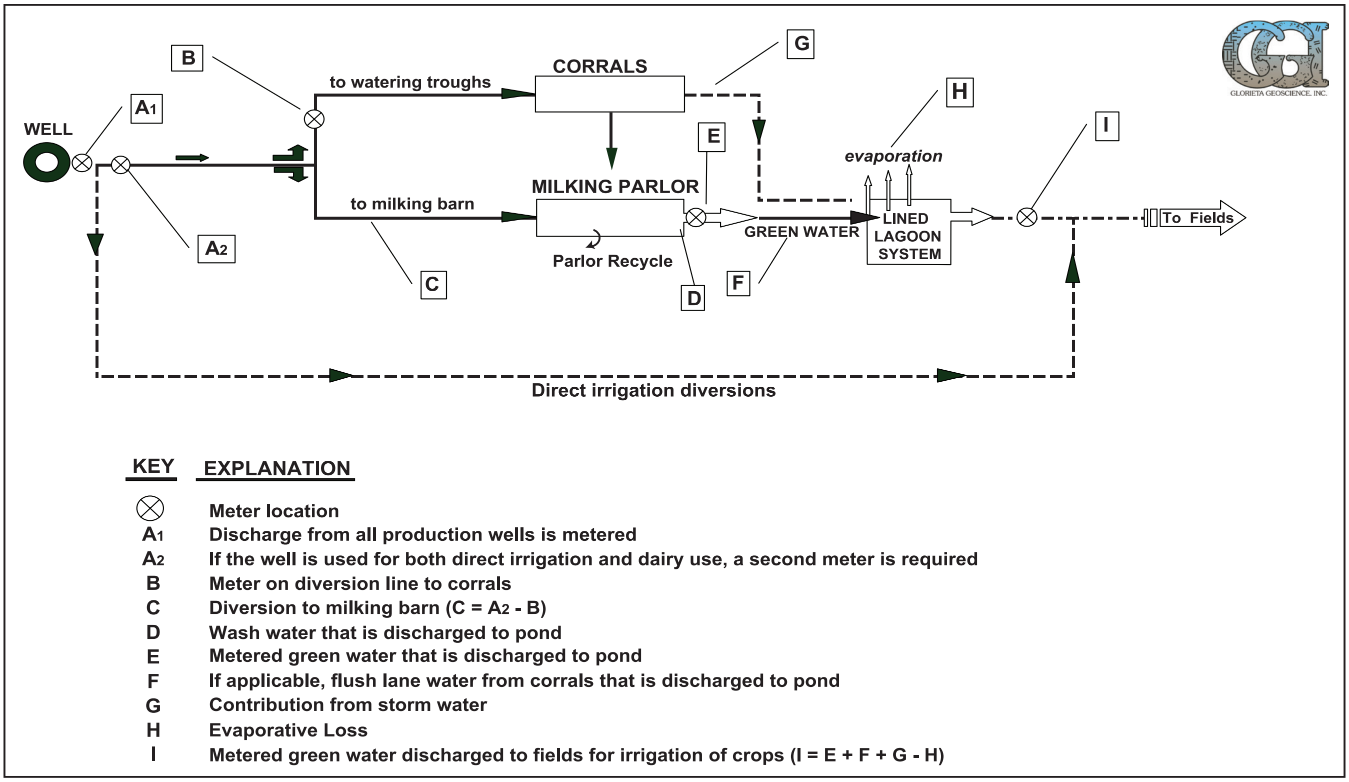


Figure 9.1. **Schematic of typical dairy water use and green water generation for irrigation purposes.**

water rights. However, the Roswell Basin is unique in that a carriage loss factor (2 ac-in/ac) has been recognized for ground water irrigation rights with an unlined ditch conveyance. The total amount of irrigation water that can annually be diverted under an irrigation right is calculated as:

(FDR + carriage loss) × acreage

The OSE may require well metering to ensure irrigation use does not exceed the allowable diversion limit. With few exceptions, the OSE has not mandated metering of on-farm surface water irrigation deliveries. Irrigation consumptive use is not monitored. However, this quantity plays a role in transfers from irrigation to commercial use. Values for FDR and CIR relevant to dairy-producing areas are summarized in Table 2.

9.2.g Quantity (Commercial/Dairy)

For the purpose of water right accounting, the OSE considers all commercial water uses within the dairy production area to be fully consumptive. Simply stated, the diversion and consumptive use elements of the water right are the same. An exception is applied in the Roswell Basin to irrigation rights that have been converted to commercial dairy use. In this instance, metered dairy green water recycled for irrigation is credited by the OSE as the difference between the CIR and FDR components of the original irrigation water right. Since commercial dairy uses are fully consumptive, any green water generated by the dairy operation can be fully depleted as long as the dairy maintains control over the water and doesn't return it to a public water supply source. The water can be reused many times over, whether for land application or dairy operations, without further approval from the OSE and is only subject to environmental permitting.

9.3 How to Obtain a Water Rights Permit

Since the water resources of the state have been fully appropriated for many years, many dairies, particularly those located on the High Plains (Roosevelt, Curry, and Lea Counties) or along the lower Pecos River Valley, were established by converting an existing irrigation water right to dairy use. It is expected that in the future, all new dairies or dairy expansions will require the conversion of an existing water right (usually an irrigation right). This conversion or water right permitting process (see Figure 4.8 and Section 4.11) typically requires the following:

- Determining the validity and transferability of a water right.
- Making an application to the OSE.
- OSE acceptance of the application for publication.
- Publication of a summary of the application in a newspaper of local circulation.
- Technical review.
- Findings and permit action (approval with conditions or denial).
- Permit implementation and compliance

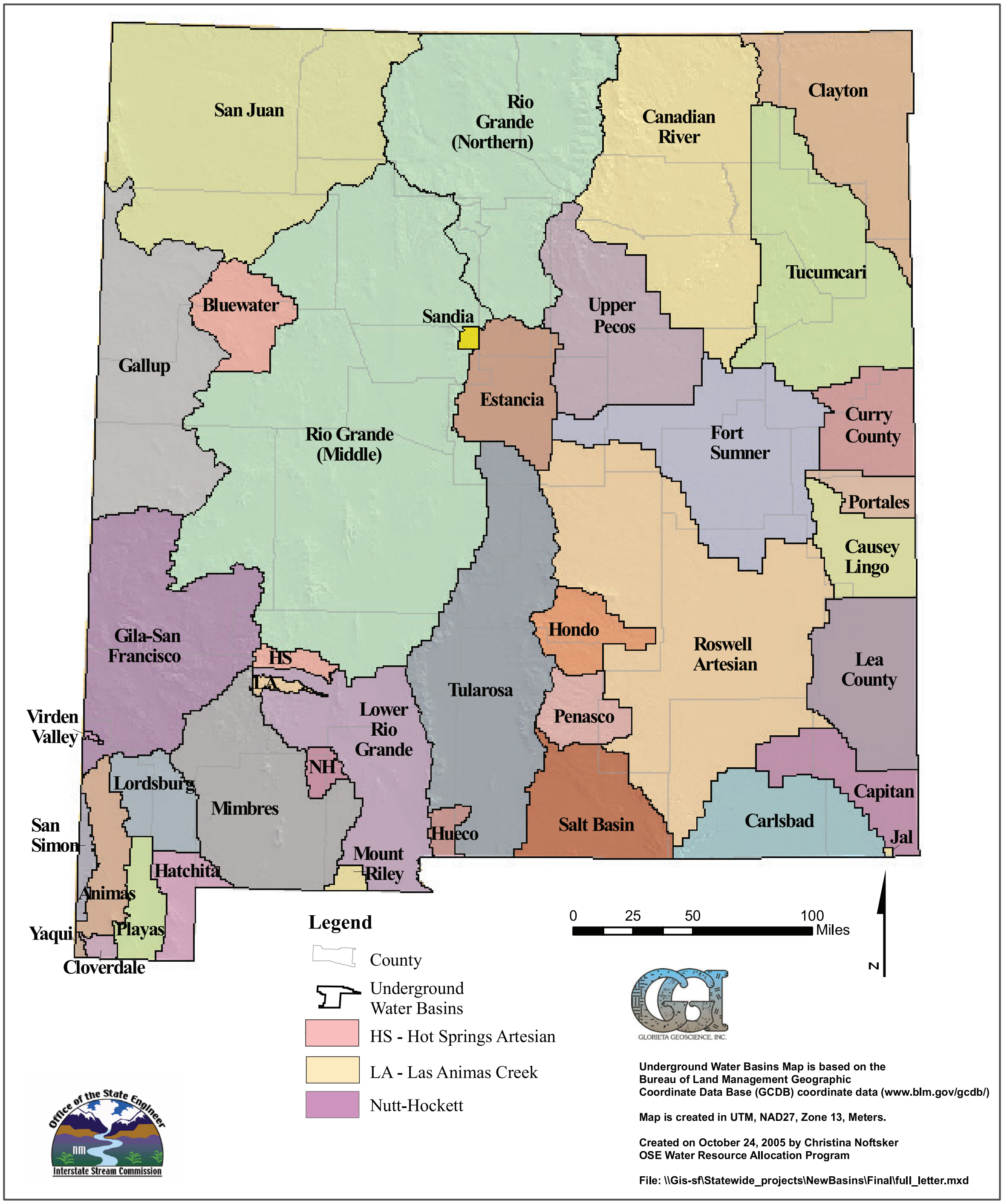


Figure 9.2. **New Mexico Office of the State Engineer underground water basins in New Mexico.**

Table 2. Summary of Farm Delivery Requirement and Consumptive Irrigation Requirement Dairyland Data			
OSE Administrative Area	**FDR**	**CIR**	**Carriage Loss**
Carlsbad Irrigation District	3.697 ac-ft/ac	2.218 ac-ft/ac	NA
Carlsbad GW Basin	3.0 ac-ft/ac	2.1 ac-fit/ac	NA
Roswell Basin	3.0 ac-ft/ac	2.1 ac-ft/ac	2 ac-in/ac-ft
Ft. Sumner Basin (flood)	2.4 ac-ft/ac	1.44 ac-ft/ac	NA
Ft. Sumner Basin (pivot)	2.2 ac-ft/ac	1.44 ac-ft/ac	NA
Ft. Sumner Irrigation Dist.	2.5 ac-ft/ac	1.44 ac-ft/ac	NA
Curry Basin	3.0 ac-ft/ac	1.29 ac-ft/ac	NA
Portales Basin	3.0 ac-ft/ac	1.29 ac-ft/ac	NA
Lea County	3.29 ac-ft/ac	2.14 ac-ft/ac	NA
Middle Rio Grande	3.0 ac-ft/ac	2.1 ac-ft/ac	NA
Mesilla Valley Admin. Area	4.16 ac-ft/ac	2.25 ac-ft/ac	NA
Nutt-Hockett	3.23 ac-ft/ac	1.94 ac-ft/ac	NA

9.3.a Validation and Transferability

Purchasing or leasing water rights is similar in many respects to the acquisition or lease of real estate. Dairy producers must exercise the same level of caution and due diligence to ensure that the water rights proposed for transfer to their dairies are valid, transferable under the applicable rules of the OSE, and in a quantity sufficient to meet dairy and irrigation objectives.

To determine the validity of a water right, the dairy producer should first examine the validity of ownership claims, foundation documents (e.g., declaration, permit or adjudication order), previously granted license, history of use or non-use and compliance with applicable OSE conditions of use. Unlike real estate transactions, title insurance and title searches do not typically include the water rights or "title assurances" that typically come with the land or previous commercial activity. Purchasers can minimize the risk associated with purchasing off-site water rights by having a clear and comprehensive purchase agreement, which states that they are purchasing only the consumptive use water rights (or CIR if an irrigation right) approved by the OSE. Anyone purchasing water rights should make the purchase of off-site water rights contingent on OSE approval of the transfer application.

The options for moving and/or transferring water rights within a basin are explained in detail in basin-specific guidelines, available on the OSE's webpage. If a dairy owns water under two different water rights and wants to combine the locations of use while not changing the authorized point of diversion, they can comingle water rights. This process is done under OSE form WR-06, the Application to Change Place and/or Purpose of Use.

An applicant may also file an application to combine and/or comingle water rights with different points of diversion. In this case, the water from each point of diversion from each water right can be pumped to any permitted place for use. Therefore, a maximum pumping limit needs to be placed on each point of diversion and that amount will be modeled by a technical expert and/or the OSE to determine if there are any impacts of increased pumping from the current point of diversion. If no pumping limit is placed on each point of diversion, then the OSE has to model each point of diversion with the potential maximum pumping amount.

In New Mexico, basin-specific requirements determine how water rights are administered by the OSE. Depending on the basin, each irrigated acre of land has an existing duty or crop water requirement associated with it. For example, in the Roswell Artesian Basin, one acre of land has a duty of water of 3 acre-feet of water. If there is more than 3 acre-feet per acre of land in this basin, it is referred to as a 'stacked irrigation right.' When applying for a stacked irrigation right, justification for the stacking has to be provided and an explanation must be given as to why the stacking is not detrimental to the conservation of water. Stacking irrigation rights is an efficient way to repay an over-diversion from the previous 5-year accounting period.

Finally, it is important to note that water cannot be transferred without having proven beneficial use. In order to prove beneficial use, the water right holder must have diverted the permitted amount/duty for any given year, not the five-year accounting period total. The OSE also requires the applicant to file a proof of beneficial use application, along with a completed survey of the wells authorized for use under the water right.

9.3.b Making Application to the OSE

In order to transfer a water right, an application must be filed indicating that one or more actions will take place:

- Change the point of diversion from surface water to ground water
- Change point of diversion from one well to another
- Change place of use (irrigated land to dairy; irrigated land to new irrigated lands)
- Change purpose of use (irrigation to commercial dairy)
- Change in the amount of diversion
- Combine water rights presently under separate permit
- Commingle water rights to allow a dairy to combine places of use (i.e., consolidate water rights from multiple properties without changing how each well is used)

When changing the purpose of use from an irrigation water right to "commercial dairy," the dairy producer should be as thorough as possible in describing future uses, including construction, dairy barn operations, livestock watering, cooling water, misters for cow cooling, and dust suppression. If a portion of the water right will continue to be used for irrigation, then that should also be clearly stated in the application. When changing a water right, the description of the designated places of use should be as general as possible to allow the dairy producer to reconfigure their operation (e.g., location of corrals, irrigated tracts, hay barns, etc.), eliminating the need to file a future application with the OSE to designate a new place of use.

A dairy producer should craft their water rights applications with as much flexibility and creativity as possible. For example, a producer can apply for water use within the production area that exceeds the current water needs but allows them to increase their herd size and water use without subsequent application. In this case, an application should be written to explain how the dairy will continue to use water for irrigation purposes until it is needed for dairy purposes. Figure 9.3 presents a schematic flow diagram of the water rights application process at the OSE and the court appeal process.

The OSE requires different forms and supporting information depending on the action requested, and filing fees may vary accordingly. It is often prudent to contact the regional OSE office and find out who will be reviewing the application, then request they review a draft of the application before formal submittal.

9.3.c Publication

Public notice of the application must be published once a week for three consecutive weeks as an ad in the legal section of the local newspaper and also posted on the OSE website for 70 days. The OSE prepares the Public Notice and provides it back to the applicant for a review of accuracy. The applicant should check every word, number, period, and comma for accuracy prior to submitting it for legal publication. The newspaper must be of general circulation in the county or counties affected by the water rights transfer. Publication in two or more newspapers may be required if the transfer-from and transfer-to locations are in different counties, or if granting the application may have a substantial effect beyond county boundaries. The applicant is responsible for publishing the public notice, but the OSE specifies the form and content of the notice and which newspaper(s) it must be published in.

The applicant has the burden to ensure that the exact content of the public notice is complete and correct. To minimize the chance of having to re-publish due to typographic or other errors, an applicant should carefully review the legal notice provided by the OSE. In addition, the applicant should ask the newspaper to provide a proof copy for review prior to publication. It is also prudent to obtain a copy of the newspaper for the notice's first date of publication to ensure there are no printing errors.

9.3.d Protest of the Application

The water right application process is public and allows individuals and private and public entities to protest or object to the granting of the application. Valid protests must be sent to the OSE within 10 days after the last (third) date of publication of the legal notice.

9.4 Evaluation of Water Rights Application by the OSE

After an application is filed with the OSE, agency staff review it for completeness and accuracy. Once the application is determined to be complete, a legal notice of the change is published by the applicant in a newspaper of wide circulation in the affected county(ies) for three consecutive weeks in a newspaper designated by the OSE. Additionally, the application is posted on the OSE website for 70 days.

9.4.a Unprotested Applications

If the application is unprotested, the OSE will begin research to determine: (1) if the water rights transfers are valid, (2) if sufficient water is available for the intended purposes of the application (3) if granting the application will not result in impairment to existing water rights, (4) if granting the application will not be contrary to the conservation of water within the state, and (5) if granting the application will not be detrimental to the public welfare of the state. If the research shows that the transfer request is valid, sufficient water is available, and the application is in the best interest of the state of New Mexico and the public, the Office of State Engineer (OSE) will approve the application, usually with conditions. If the criteria are not met, the OSE will deny the application (19.2.26.12 NMAC).

Once the OSE has acted to approve or deny an application, the applicant has 30 days to review the OSE's action and either accept the decision or file a grievance with the OSE objecting to the denial of the permit or objecting to one or more of the permit conditions. The grievance is processed either through mediation or administrative hearing before an agency-appointed hearing examiner. If the hear-

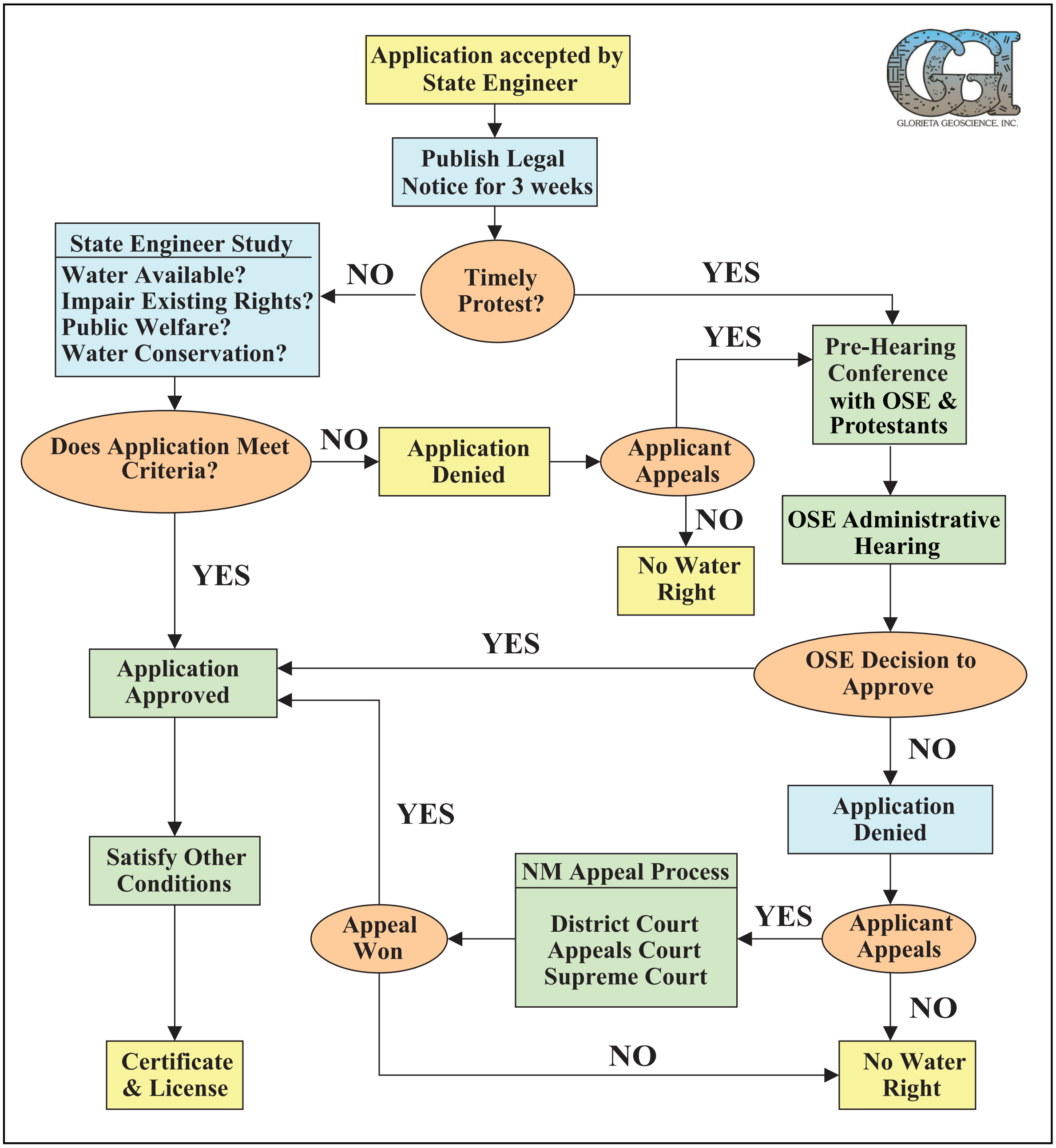


Figure 9.3. **New Mexico Office of the State Engineer water rights application flow chart.**

ing process upholds the OSE's decision, the applicant may appeal in District Court and, if necessary, up through the judicial appeal process.

9.4.b Protested Applications

As previously stated in Section 2.16d, a valid protest must be sent to the OSE within 70 days from the date of publication on the OSE website. For the protestant to claim impairment, they must own a water right. Any person or firm who believes their water rights will be adversely impacted by a new application or that an application may be contrary to water conservation may protest an application (19.2.26.12.E NMAC). In the initial effort to resolve the protest, the applicant and protestant(s) will be encouraged to resolve their differences through mutual discussions or agency-sponsored mediation. If the parties cannot resolve their differences through mediation, the OSE will schedule the application for an administrative hearing before an OSE-appointed hearing examiner. During the course of the hearing, the applicant carries the burden of proof to demonstrate that the same five criteria used to evaluate unprotested applications can be met. Once the OSE has acted to approve or deny a protested application, both the applicant and protestants have 30 days to review the OSE's action and either accept the decision or file an appeal in District Court, and if necessary, up through the judicial appeal process.

During the course of the hearing the applicant carries the burden of proof to demonstrate:

- The nature, extent and validity of the water right proposed for transfer.
- That sufficient wet water is available for the intended purposes of the application.
- That granting the application will not result in impairment to existing water rights.
- That granting the application will not be contrary to the conservation of water within the state.
- That granting the application will not be detrimental to the public welfare of the state.

9.4.c Hydrologic Analysis and Review

A hydrologic analysis is usually required by the OSE to demonstrate the following:

- Hydrologic feasibility and sustainability of the project.
- Effects (drawdown) at wells of other ownership.
- Surface water depletion effects.
- Timing and magnitude of spring flow depletions and/or surface water depletion effects.
- Timing and disposition of return flows.

This analysis is performed by the OSE Hydrology Bureau regardless of whether or not the application has been protested. Their analysis is forwarded to the Water Rights Bureau staff. In many cases the applicant may find it to their advantage to have the hydrologic analysis performed or verified by a consultant specializing in surface and ground water hydrology. These consultants may be able to work cooperatively with OSE staff and with technical consultants who may have been retained by the protestants.

9.4.d Public Welfare and Conservation

Before granting a permit to transfer water rights, the applicant must also demonstrate that the transfer will not be contrary to the conservation of water within the state and will not be detrimental to the public welfare of the state. Conservation of water and public welfare are determined on a case-by-case basis. To ensure conservation of water, standard OSE conditions of permit approval require the permit applicant to implement the best management practices or highest level of technology that is economically feasible. Since the applicant carries the burden of demonstrating that granting the permit will not be contrary to conservation of waters of the state, the applicant should support their application with documentation describing water conservation technologies, both within the commercial dairy operations and on the irrigated fields. This is especially true if the permit application has been protested.

Generally speaking, the OSE recognized that commercial and irrigation water use within a dairy operation are a legitimate use of water equal to all other water uses except for waste. Again, the applicant carries the burden of demonstrating that granting the permit will not be detrimental to the public welfare of the state. The applicant should support their application with documentation describing the economic benefits (e.g., positive economic impacts such as employment, local tax payments, etc.) of the proposed action. The applicant should also provide documentation showing the dairy operation's compliance with applicable local, state, and federal regulations.

9.4.e Permit Implementation and Compliance

The OSE can act to deny, partially approve, or approve the permit application with specific conditions of approval. Conditions of approval often found in dairy permits include:

- Specific limits on annual diversion and consumptive use in acre-ft/yr.
- Requirement for metering of wells.
- Requirement for separate metering of commercial dairy use.
- Requirement for separate metering of green water used for irrigation purposes.
- Monthly or quarterly reporting of water usage.
- Filing maps of former and new places of use (moved from and moved to).
- Due date for filing proof of completion of works (PCW) or other diversion works.
- Due date for proof of beneficial use (PBU).

After approval or denial of an application, the applicant has 30 days to review the OSE's action and either accept the permit as issued or file a grievance with the OSE requesting that either the denial be reconsidered or the OSE modify one or more of the permit conditions. Both applicants and protestants aggrieved with the final decision of the OSE have the right to appeal the OSE's decision in New Mexico District Court.

9.5 OSE Administration of Water Rights in Dairy Producing Areas

In addition to general policies, procedures, and conditions of approval that apply to a water right permits, the OSE has a number of basin-specific guidelines and policies that apply only in certain ground water or surface water basins. These guidelines and policies reflect local hydrologic conditions of each basin. New Mexico dairies are dominantly located in the following OSE ground water basins: Roswell, High Plains, Middle Rio Grande, Mesilla Valley–Lower Rio Grande, and Nutt–Hockett basins.

Administration of water rights varies from basin to basin, and each basin has several factors that complicate the transfer of water. Each basin generally has a basin-specific ground water model used by the OSE to estimate drawdown in the applicant's well, wells of other ownership, and surface water depletions caused by ground water pumping. The basin-specific OSE guidelines, policies, and other factors relevant to the ability of dairies to transfer and/or move water rights are summarized below.

Middle Rio Grande Basin
Complicating Factors

- Critical Management Areas (CMAs)
- Endangered Silvery Minnow
- Imported water
- Interstate compacts
- Competition for water with Tribes/Pueblos and municipalities
- Surface water shortages
- Not adjudicated

Mesilla Valley/ Lower Rio Grande Basin
Complicating Factors

- Rio Grande compact delivery requirements to Texas and Mexico
- New ground water appropriations must offset 100% of their depletions on the Rio Grande
- Limits on allowable annual rates of ground water level decline
- Limits on moving wells closer to the Rio Grande
- Elephant Butte Irrigation District (EBID) is active in reviewing water right applications
- EBID irrigation rights cannot be moved outside its boundaries
- Active Water Resource Management (AWRM) regulations will apply
- All agricultural wells must be metered as of 2008
- Not adjudicated

Roswell Artesian Basin
Complicating Factors

- Water rights are adjudicated.
- All wells are metered.
- Pecos River Compact requires surface water deliveries to Texas.
- Ground water pumping has direct effect on stream flows.
- The NM Interstate Steam Commission has purchased junior rights, and retired them to contribute stream flow to Texas and has developed an artesian well field to pump into the river to maintain flows.
- Lower Pecos is habitat to endangered Pecos Blunt-Nosed Shiner.
- Two production aquifers, shallow and artesian with "confining" layer separating the 2 aquifers.
- Limits on water level declines.
- OSE has limits on water right transfers in and around areas of high aquifer salinity (measured as chloride).
- Ground water models used to predict surface water and ground water impacts from transfers or combine/comingle.
- Limits on moving:
  - water rights between shallow and artesian aquifers
  - wells closer to the Pecos River
  - water rights around areas of high aquifer salinity (measured as chloride)
  - moving water rights closer to the Pecos River results in haircuts
- Five-year accounting periods; 100% penalty for over-diversions.
- Annual diversions may exceed the annual FDR, however the total amount diverted in the accounting period cannot exceed 5 times the FDR.
- Carryover of up to 2/3 of the annual FDR allowed between accounting periods.
- Pecos Valley Artesian Conservancy District (PVACD) and the Carlsbad Irrigation District (CID) are both active in reviewing water right applications and PVACD has protested at least one dairy water right application.
- Hagerman Cone Critical Management Area (limits on annual rate of water level decline in the shallow aquifer)

High Plains/Ogallala Aquifer (Curry, Roosevelt, and Lea Counties)
Complicating Factors

- Limits on allowable annual rate of water level decline.
- Irrigation wells generally not metered.
- Water quality impact assessment may be required.
- Special well construction provisions to protect High Plains aquifer.
- 660-foot minimum well spacing.
- Some areas closed to new ground water development
- Limited Ogallala Aquifer thickness.
- Ground water model to assess shifted depletion effects.
- Transfer cannot result in more than 1 ft/40 years draw-down in model cells.
- Not adjudicated.

Nutt–Hockett Basin

- Few dairies in Nutt–Hockett basin.
- OSE generally recognizes 3.23 ac-ft/acre FDR.
- Requires creativity and effort to obtain flexible permit conditions.

9.6 Flexible Water Rights Permit Conditions

A water rights application should be written to maximize flexibility in how water rights will be put to beneficial use. When an application is prepared, it is generally transferring an older irrigation right to a commercial dairy right. The dairy producer should apply for a water right permit that has the same priority date as the older irrigation right, thus allowing for expansion of the dairy if the land base can support it. In these cases, the amount of water applied for in the transfer will be in excess of the commercial dairy water requirement.

For flexibility, an applicant should apply to use the full amount of transferred water for either dairy or irrigation purposes, as long as it does not exceed the total approved transfer amount. This can be accomplished in the field by having separate metering of irrigation and commercial dairy water, and then gradually retire irrigated lands as the commercial dairy use increases.

In filing the application, the applicant should seek a permit that offers maximum flexibility for dairy operations. This would include incorporating language that would allow:

- Continued irrigation as the dairy's commercial side builds out over time.
- Blending of green water and fresh water to achieve both agronomic and environmental objectives.
- Return flow credit or credit back for carriage loss (Roswell Basin) for dairy barn green water used for irrigation.
- Multiple source wells.
- Fallow field rotation.
- Reconfiguration of the production area (e.g., changes in the location of corrals, irrigated tracts, hay barns, etc.).

9.7 Active Water Resources Management

In 2004, the OSE initiated a process and enacted AWRM rules to enable the office to undertake priority administration of select basins. The Lower Pecos River and the Lower Rio Grande systems were identified as high priority for AWRM, and the OSE has enacted proposed rules to govern them. The AWRM process encourages senior and junior water right owners to enter into water shortage sharing agreements. In the absence of a shortage sharing agreement, the OSE would enforce priority administration by curtailing diversions by junior water right owners. Since many dairy water right permits are for junior ground water rights, a prolonged shortage of surface water supply to senior water right owners on the lower Pecos River or Lower Rio Grande could have an adverse impact on these junior ground water rights. The dairy producer can avoid curtailment of their junior water rights if they can find a senior surface water or ground water right holder willing to lease them the necessary amount of water rights for the duration of the shortage. The OSE has committed to establishing an expedited procedure for facilitating these temporary transfers. However, the OSE has also warned that in the event of a prolonged shortage, only long-term or permanent transfers will be accepted.

9.8 OSE Requirement for Metering Water Usage

Most OSE water rights permits for dairies will require a dairy producer to meter all freshwater use. If a dairy operation is claiming a return flow credit from green water discharged to land application fields, then it must also meter this usage (also required to meter green water applied to fields for DP compliance). As part of the permit conditions, a dairy operator is required to submit the make, model, and serial number of all meters, and keep accurate records of when the meter turns over or is repaired/calibrated or replaced.

Keeping close track of metered freshwater use is critical to the success of overall farming operations. A Ground Water Discharge Permit is based on having sufficient water rights and wet water to blend with green water to grow a viable crop on land application fields. If a dairy operation has exceeded its water right limit, insufficient fresh water will be available to grow crops and crop yield will be lower than predicted. If the crop yield is lower than predicted or planned, a dairy runs the risk of applying green water above the preferred agronomic rate, which can result in the dairy being out of compliance with their discharge permit or EPA-administered NPDES/CAFO permit. If a dairy applies green water at rates that exceed the agronomic rate and runoff from the land application fields to waters of the state or waters of the United States occurs, they no longer qualify for the Agricultural Storm Water Exemption and will be in violation of the federal Clean Water Act.

9.9 OSE Dam Safety Bureau

The Dam Safety Bureau of the OSE has jurisdiction over the design and construction of "jurisdictional" dams in the state as defined in the NM Stat §72-5-32 (2020). This statute, updated in 2020, changes the definition of a jurisdictional dam to exclude the following:

- Dam that is less than 25 feet in height and less than 50 acre-feet of storage.
- Dam that is less than six (6) feet in height, regardless of storage capacity.
- Dam with less than 15 acre-feet of storage, regardless of height.

The responsibilities of the Dam Safety Bureau include inspecting existing dams to verify they are operated and maintained in a safe condition, reviewing plans and specifications for new dams and modifications and repairs to existing dams, and ensuring compliance with State Engineer design criteria. The bureau also inspects construction to verify that dams are built or repaired in accordance with approved plans on file with the OSE.

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ACKNOWLEDGEMENTS

The authors would like to acknowledge the following individuals for their contributions to this manual. Beverley Idsinga, Executive Director of Dairy Producers of New Mexico provided the impetus to update this manual. Larry "Boot" Pierce and Elisabeth "Lisa" Vulpas of Glorieta Geoscience critically reviewed and edited this manual. D.L. Sanders, former Chief Counsel of the New Mexico State Engineer Office critically reviewed the water rights section. The following staff at Glorieta Geoscience (in alphabetical order) contributed sections or portions of the manual: Paul Drakos, Dane Goble, Meghan Hodgins, and Jim Riesterer.

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APPENDIX A: ONLINE LINKS TO GUIDANCE DOCUMENTS, PUBLICATIONS, AND REGULATIONS

This list of links to web sites includes those referenced in the text and other sites that can provide information.

CAFO Final Rule
https://www.epa.gov/npdes/npdes-cafos-regulatory-documents

Clean Water Act Summary and Full Text
https://www.epa.gov/laws-regulations/summary-clean-water-act

Dairy Producers of New Mexico
http://www.nmdairy.org

Environmental Protection Agency (EPA)
http://www.epa.gov

EPA CAFO Forms and Applications
https://www.epa.gov/npdes/npdes-applications-and-forms-epa-applications

EPA General Information on CAFOs
https://www.epa.gov/npdes/animal-feeding-operations-regulations-and-guidance

EPA General Information on Water Quality (Office of Water)
https://www.epa.gov/wqc

EPA Links to Environmental Laws
https://www.epa.gov/laws-regulations

EPA Region 6 General Information for CAFOs
https://www3.epa.gov/npdes/pubs/region6.pdf

NMAC 20.6.6 - Ground Water Protection – Supplemental Permitting Requirements for Dairy Facilities
https://www.srca.nm.gov/parts/title20/20.006.0006.html

Natural Resources Conservation Service (NRCS) New Mexico
https://www.nrcs.usda.gov/wps/portal/nrcs/site/nm/home/

NRCS Agronomy Technical Note
https://www.cabq.gov/municipaldevelopment/documents/nm-nrcs-agronomy-technical-note-revised-universal-soil-loss-equation.pdf

NRCS Animal Waste Management Handbook
https://www.nrcs.usda.gov/wps/cmis_proxy/https/ecm.nrcs.usda.gov%3A443/fncmis/resources/WEBP/ContentStream/idd_2013EB6E-0000-CC50-9954-882ADB95846B/0/IL651.1007_Mortality_Composting_Dec2019.pdf

NRCS Electronic FOTGs by County
https://efotg.sc.egov.usda.gov/#/

NRCS New Mexico Area Offices
https://www.nrcs.usda.gov/nm-contacts

NRCS List of Practice Standards
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/?cid=nrcsdev11_001020

NRCS New Mexico AFO/CAFO Animal Waste Management
https://www.nrcs.usda.gov/getting-assistance/technical-assistance/manure-and-nutrient-management

NRCS Phosphorus Index Technical Note
https://www.nrcs.usda.gov/sites/default/files/2023-05/Iowa-PhosphorusIndex2023.pdf

NRCS Technical Guidance for CNMPs
https://www.nrcs.usda.gov/state-offices/maryland/comprehensive-nutrient-management-planning

New Mexico Department of Agriculture (NMDA) Dairy Permits
https://nmdeptag.nmsu.edu/licensing-and-registrations/dairy-permits.html

NMDA Dairy Inspection Information
https://nmdeptag.nmsu.edu/inspections/dairy-inspection-info.html

NMDA Milk Protection
http://nmdaweb.nmsu.edu/animal-and-plant-protection/Dairy.html/

New Mexico Office of the State Engineer
https://www.ose.state.nm.us/

New Mexico State University (NMSU) Cooperative Extension Service
https://extension.nmsu.edu/

NMSU Agronomy Publications Listing
https://pubs.nmsu.edu/_a/index.html

NMSU Dairy Publications Listing
https://pubs.nmsu.edu/_d/index.html

NMSU Grazing-N application
https://pubs.nmsu.edu/_d/D209/index.html

NMED Surface Water Quality Bureau CAFO Questions & Answers
http://www.nmenv.state.nm.us/SWQB/CAFO/index.html

New Mexico Water Quality Control Commission Regulations for Ground and Surface Water Protection
https://www.env.nm.gov/regulatory-resources/

New Mexico Environment Department (NMED) Monitoring Well Guidelines
https://cloud.env.nm.gov/water/pages/view.php?ref=5584&k=0472e4b026

NMED Synthetically Lined Lagoon Guidelines
https://cloud.env.nm.gov/water/pages/view.php?ref=5585&k=0d476cdee8

NMED Ground Water Discharge Permit Application
https://www.env.nm.gov/forms/

NMED Notice of Intent to Discharge
https://cloud.env.nm.gov/water/pages/view.php?ref=4391&k=1f039cf0e7

NMED Public Notice Summary
https://www.env.nm.gov/public-notices/

NMED Electronic LADS
http://www.nmenv.state.nm.us/gwb/New_Pages/forms/LADS%20workbook-version%201.xls

NMED Paper LADS
http://www.nmenv.state.nm.us/gwb/New_Pages/forms/LAD%20Sheet%20-%20combo.xls

NPDES CAFO NOI (Form 2B)
https://www.epa.gov/sites/default/files/2019-05/documents/form_2b_epa_form_3510-2b.pdf

NPDES Compliance Checklist
https://www.epa.gov/sites/default/files/2015-10/documents/npdesinspect_0.pdf

NPDES Inspection Manual
https://www.epa.gov/compliance/compliance-inspection-manual-national-pollutant-discharge-elimination-system

USDA Milk Safety References
https://www.fda.gov/food/guidance-documents-regulatory-information-topic-food-and-dietary-supplements/milk-guidance-documents-regulatory-information

USDA Pasteurized Milk Ordinance
https://www.fda.gov/media/114169/download

APPENDIX B: LIST OF ACRONYMS AND ABBREVIATIONS

ac-ft	Acre-feet
AFO	Animal Feeding Operation
afy	Acre-feet/year
AMSL	Above Mean Sea Level
ASTM	American Society for Testing and Materials
AWRM	Active Water Resources Management
BGS	Below Ground Surface
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
byo	Billion years old
CAFO	Concentrated Animal Feeding Operation
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CFU	Colony Forming Unit
CID	Carlsbad Irrigation District
CNMP	Comprehensive Nutrient Management Plan
CIR	Consumptive Irrigation Requirement
CWA	Clean Water Act
DP	Discharge Permit
DTW	Depth to Water
EBID	Elephant Butte Irrigation District
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESA	Endangered Species Act FDR Farm Delivery Requirement
FOTG	Field Office Technical Guide
FSID	Fort Sumner Irrigation District
ft	Foot (feet)
GDP	Gross Domestic Product
GGI	Glorieta Geoscience, Inc.
gpd	Gallons per day
GWQB	Ground Water Quality Bureau, New Mexico Environmental Department
LADS	Land Application Data Sheet
MCL	Maximum Contaminant Level
mg/L	Milligrams per liter
MP	Measuring Point
MRGCD	Middle Rio Grande Conservancy District
MSDS	Material Safety Data Sheet
MW	Monitoring well
my	Million years
MYO	Million years old
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMP	Nutrient Management Plan
NMSA	New Mexico Statutes Annotated
NMSU	New Mexico State University
NMWQCC	New Mexico Water Quality Control Commission
NOI	Notice of Intent
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSE	Office of the State Engineer
PBU	Proof of Beneficial Use
PCW	Proof of Completion of Wells
PPE	Personal Protection Equipment
ppm	Parts per million
PPP	Pollution Prevention Plan
PVACD	Pecos Valley Artesian Conservancy District
SDWA	Safe Drinking Water Act
SAR	Sodium Absorption Ratio
SWQB	Surface Water Quality Bureau, New Mexico Environmental Department
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TOC	Top of Casing
T or C	Truth or Consequences
TSS	Total Suspended Solids
USC	United States Code
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WQCC	Water Quality Control Commission

APPENDIX C: LIST OF AGENCIES WITH CONTACT INFORMATION

Environmental Protection Agency (EPA) Region 6 Main Office
1201 Elm Street
Suite 500
Dallas, TX 75270
214-665-2760
https://www.epa.gov/aboutepa/epa-region-6-south-central

Natural Resources Conservation Service (NRCS)
New Mexico State Office
100 Sun Avenue N.E.
Suite 602
Albuquerque, NM 87109
Phone: 800-410-2067
Fax: 505-761-4400
https://www.nrcs.usda.gov/wps/portal/nrcs/main/nm/contact/state/

New Mexico Department of Agriculture (NMDA)
MSC 3189 NMSU
PO Box 30005
Las Cruces, NM 88003-8005
Phone: 575-646-3007
https://www.nmda.nmsu.edu/

New Mexico Environment Department (NMED)
Environmental Health Division, District I Office
5500 San Antonio Dr. NE
Albuquerque, NM 87109
Phone: 505-222-9500

NMED Environmental Health Division
District III Office
1170 North Solano Drive, Suite M
Las Cruces, NM 88001
Phone: 575-524-6300
Fax: 575-526-3891

NMED Environmental Health Division
District IV Office
1914 W. Second
Roswell, NM 88201
Phone: 575-624-6046
Fax: 575-624-2023

NMED Ground Water Quality Bureau
Harold Runnels Building
1190 St. Francis Drive
Suite N4050
Santa Fe, NM 87502
Phone: 505-827-2855
https://www.env.nm.gov/gwqb/

NMED Surface Water Quality Bureau
Harold Runnels Building
1190 St. Francis Drive
Suite N4050
Santa Fe, NM 87502
Phone: 505-827-2855
https://www.env.nm.gov/surface-water-quality/

New Mexico State University (NMSU)
Bernalillo County Extension Office
1510 Menaul NW
Albuquerque, NM 87107
Phone: 505-243-1386
Fax: 505-243-1545
http://bernalilloextension.nmsu.edu

NMSU Chaves County Extension Office
200 E. Chisum, Door #4
Roswell, NM 88203
Phone: 575-622-3210
Fax: 575-622-3882
http://chavesextension.nmsu.edu

NMSU Curry County Extension Office
818 Main St.
Clovis, NM 88101
Phone: 575-763-6505
Fax: 575-762-7876
http://curryextension.nmsu.edu

NMSU Doña Ana County Extension Office
530 North Church Street
Las Cruces, NM 88001
Phone: 575-525-6649
Fax: 575-525-6652
http://donaanaextension.nmsu.edu

NMSU Eddy County Extension Office
1304 West Stevens
Carlsbad, NM 88220
Phone: 575-887-6595
Fax: 575-887-3795
http://eddyextension.nmsu.edu

NMSU Lea County Extension Office
100 N. Main, Ste. 10
Lovington, NM 88260
Phone: 575-396-2819
Fax: 575-396-2971
http://leaextension.nmsu.edu

NMSU Roosevelt County Extension Office
705 East Lime Street
PO Box 455
Portales, NM 88130
Phone: 575-356-4417
Fax: 575-359-1322
http://rooseveltextension.nmsu.edu

NMSU Socorro County Extension Office
198 Neel Avenue
Socorro, NM 87801
Phone: 575-835-0610
Fax: 575-838-4066
http://socorroextension.nmsu.edu

NMSU Valencia County Extension Office
PO Drawer 1059
404 Courthouse Road
Los Lunas, NM 87031
Phone: 505-565-3002
Fax: 505-565-1316
http://valenciaextension.nmsu.edu

NRCS Clovis Service Center
918 Parkland Dr.
Clovis, NM 88101
Phone: 575-762-4769
Fax: 855-538-6003

NRCS Deming Service Center
405 East Florida St.
Deming, NM 88030
Phone: 575-546-9692
Fax: 855-538-6003

NRCS Las Cruces Service Center
760 Stern Drive
Las Cruces, NM 88005
Phone: 575-522-8775
Fax: 855-538-6003

NRCS Los Lunas Service Center
2600 Palmilla Road
Los Lunas, NM 87031
Phone: 505-865-4643
Fax: 855-538-6003

NRCS Lovington Service Center
401 E. Tatum Highway
Lovington, NM 88260
Phone: 575-396-5857
Fax: 855-538-6003

NRCS Portales Service Center
050 Highway 467
Portales, NM 88130
Phone: 575-356-6629
Fax: 855-538-6003

NRCS Roswell Service Center
300 N. Pennsylvania Avenue
Suite 3
Roswell, NM 88202
Phone: 575-622-8746
Fax: 855-538-6003

NRCS Socorro Service Center
103 Neel Avenue N.W.
Socorro, NM 87801
Phone: 575-835-1710 x3
Fax: 575-835-3872 or 855-538-6003

United States Food and Drug Administration (FDA)
Center for Food Safety & Applied Nutrition
5100 Paint Branch Parkway
College Park, MD 20740
http://www.cfsan.fda.gov/list.html

APPENDIX D: GLOSSARY

25-year/24-hour storm event: Maximum 24-hour precipitation event with a probable recurrence interval of once in 25 years, as defined by the National Weather Service in Technical Paper Number 40, "Rainfall Frequency Atlas of the United States," May 1961, and subsequent amendments, or equivalent regional or state rainfall probability information developed therefrom.

100-year flood plain: Flat or nearly flat land adjacent to a stream or river that experiences flooding at an elevation that has a 1% chance of occurring in any given year (i.e., during a 100-year flood). [17]

100-year storm: Rainfall event that statistically has a one in one hundred chance (1%) of occurring in any given year, as defined by the National Weather Service in Technical Paper Number 40, "Rainfall Frequency Atlas of the United States," May 1961, and subsequent amendments, or equivalent regional or state rainfall probability information developed therefrom. A 100-year storm may or may not result in a 100-year flood, depending on watershed conditions and the duration of the storm.

Acequia: A gravity-driven canal used for irrigation; usually a historically engineered waterway communally owned and operated. [16]

Agricultural storm water discharge: This type of discharge is excluded from the definition of a point source by the Clean Water Act and is, therefore, not subject to NPDES regulations. In the context of this manual, this type of discharge is defined as manure, litter, and process (generated) wastewaters from the land application areas of a CAFO where the manure or process wastewater has been applied in accordance with site-specific nutrient management practices that ensure appropriate agricultural utilization of the nutrients in the manure or process wastewater. [6]

Aggrieval: Appeal of administrative decision made by the OSE or NMED.

Agronomic rate: Land application of nutrients via manure solids, green water and/or fertilizers at rates that provide optimal growth and health of the crop.

Animal confinement areas: Considered to be part of production area; includes open lots, housed lots, feedlots, confinement houses, stall barns, free stall barns, milkrooms, milking centers, cowyards, barnyards, medication pens, walkers, animal walkways and stables. [3]

Ammonia-nitrogen: A form of nitrogen found primarily in manure solids and green water. In water, ammonia exists as both the ammonium ion (NH4+) and ammonia gas (NH3). The relative concentrations of these depend on the pH and the temperature of the water. In the environment, ammonia is rapidly converted to nitrate-nitrogen (see below).

Animal Feeding Operation (AFO): Lot or facility (other than an aquatic animal production facility) where the following conditions are met: (1) animals (other than aquatic animals) have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, (2) crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility. Two or more AFOs under common ownership are considered to be a single AFO for the purposes of determining the number of animals at an operation, if they adjoin each other or if they use a common area or system for the disposal of wastes. [3]

Aquifer: Water-bearing rock or sediment formations capable of yielding water in sufficient quantity to constitute a usable water supply. [7]

Authorized Discharge: An overflow or discharge that occurs during a chronic or catastrophic storm event, and is therefore not considered a violation of the Clean Water Act. [3]

Bailer: A hollow cylindrical tube with a check valve on the bottom to allow sample water into and hold sample in the tube during sampling. Attached to the top of the tube is a rope/string used to raise and lower it into a well or lagoon for sampling. [9]

Beneficial use: The direct use or storage and use of water by man for a beneficial purpose including, but not limited to, agricultural, municipal, commercial, industrial, domestic, livestock, fish and wildlife, and recreational uses. Beneficial use shall be the basis, the measure, and the limit of a water right.

Best Management Practices (BMPs): Schedule of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce pollution of waters of the United States; BMPs also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. [1, 3]

Best Professional Judgment (BPJ): The method used by permit writers to develop technology-based NPDES permit conditions, in those circumstances where there is no applicable effluent limitation guideline, on a case-by-case basis using all reasonably available and relevant data. [1, 3]

Biochemical Oxygen Demand, 5-Day (BOD5): Laboratory measurement of the amount of oxygen consumed in 5 days at 20oC by microorganisms as they decompose organic matter. High BOD concentrations will adversely impact fish or other aquatic life that requires oxygen to live. BOD is defined as a conventional pollutant under the federal Clean Water Act. [1, 3]

Buffer zone: The area near the border of a protected area; a transition zone between areas managed for different objectives. [1, 3]

Catastrophic storm event: A storm event greater than the 25-year/24-hour storm event, including an event such as a hurricane or a tornado. [3]

Chloride (Cl-): Ionized form of the element chlorine that is a common component of human and animal diets. Chloride is an important electrolyte that is incorporated into blood and cells; excess chloride is excreted in urine. Therefore, it is a fairly reliable indicator of fecal contamination.

Chronic storm event: A series of wet weather events that precludes normal dewatering of a lagoon system. [3]

Coliform bacteria: A group of bacteria defined by specific experimental conditions. Some coliform bacteria are natural inhabitants of soil and/or water; others (see fecal coliform bacteria) typically inhabit the intestinal tract of warm-blooded animals and, if detected in water samples, are indicative of contamination by manure solids and green water. A positive test for total coliform bacteria does not necessarily mean that fecal coliform bacteria are present. [3, 1]

Comprehensive Nutrient Management Plan (CNMP): A comprehensive nutrient management plan is required by the NRCS when it provides incentive payments and cost-share money to implement conservation practices. A CNMP is designed so that both production and natural resource protection goals are achieved, and a CNMP specifically addresses air quality and pathogens. [10]

Cone of depression: A three-dimensional shape in the form of an inverted cone that develops in the water table as a result of pumping from a well located at the center of the cone. [7]

Confined aquifer: A water-bearing formation in which the groundwater is isolated from the atmosphere at the point of discharge by relatively impermeable geologic formations; confined groundwater is generally subject to pressure greater than atmospheric. This type of aquifer is sometimes also called an artesian aquifer. [7]

Conservation plan: "A combination of land uses and farming practices to protect and improve soil productivity and water quality, and to prevent deterioration of natural resources on all or part of a farm. Plans may be prepared by staff working in conservation districts and must meet technical standards. For some purposes, such as conservation compliance, the plan must be approved by the local conservation district. Federal law requires that conservation plans for conservation compliance must be both technically and economically feasible." [1, 3]

Conservation practice: "Any technique or measure used to protect soil and water resources for which standards and specifications for installation, operation, or maintenance have been developed. Practices approved by USDA's Natural Resources Conservation Service are compiled at each conservation district in its Field Office Technical Guide." [1, 3]

Containment: "Structures used to control runoff of precipitation that comes into contact with manure, feed and other wastes on open feedlots. Examples of containment structures are lagoons and holding ponds." [1, 3]

Dairy permit: a NMED Ground Water Discharge Permit, which includes a discharge plan approved by the department.

Dairy permit renewal: The re-issuance of a NMED Ground Water Discharge Permit for the same, previously permitted discharge.

Dairy permit modification: A change to the requirements of a NMED Ground Water Discharge Permit that results from a change in the location of the discharge, a significant increase in the quantity of the discharge, a significant change in the quality of the discharge; or as required by the secretary.

Discharge: Volume of water that passes a given location within a given period of time; usually expressed in cubic feet per second (cfs) for surface water, or as gallons per minute (gpm) for discharge from wells [12]. In the context of an NMED-issued discharge permit, discharge means the maximum number of gallons per day that will be treated and/or disposed of [13]. In the context of point source regulation and NPDES permitting, this term refers to the discharge of manure, litter or process wastewater from the production area and/or land application area to waters of the United States (see overflow) [3].

Discharge of a pollutant: Any addition of any pollutant or combination of pollutants to waters of the United States from any point source. [2]

Effluent: "Water mixed with waste matter." [1, 3]

Effluent Limitations: Any restriction established by the federal government or by the state on quantities, rates, and concentrations of chemical, physical, biological, and other constituents which are discharged from point sources into waters of the United States. [3]

Erosion: The process by which rocks and soil are worn away by water or wind. [1, 3]

Eutrophication: A process in which water bodies receive excess nutrients, such as nitrogen or phosphorus, resulting in accelerated plant growth. When the plants die, oxygen is consumed during decomposition and less oxygen is available for other organisms, causing them to die. [15]

Evaporation: Slow vaporization of liquid from water surfaces and land surfaces into water vapor.

Evaporation pond: In regions where evaporation exceeds rainfall, this type of pond can be used to separate manure solids from liquids by allowing the water to evaporate from the pond surface. [1, 3]

Fecal coliform bacteria: A group of bacteria that inhabit the intestines of warm-blooded animals. The presence of fecal coliform bacteria in water samples is indicative of contamination by manure solids and green water and the probable presence of other pathogens. Most tests for fecal coliform bacteria specifically detect E. coli. [1, 3]

Freeboard: The distance between the highest allowed wastewater level in a manure storage/ treatment structure and the top edge of the structure. [1, 3]

Green water: See process (generated) wastewater.

Groundwater: Interstitial water that occurs under a pressure equal to or grater than atmospheric pressure in saturated earth material and which is capable of entering a well in sufficient amounts to be utilized as a water supply. [13, 14]

Groundwater elevation: (also hydraulic head) The elevation of the upper saturated surface of an unconfined aquifer, typically measured in feet above mean sea level; can be calculated by subtracting ground surface elevation from depth to water measured in a monitoring well. [14]

Groundwater gradient: (also hydraulic gradient) The change in groundwater elevation over a given distance; generally stated in terms of feet of elevation per feet distance. [14]

Holding pond: A pond that is used to store wastewater or polluted runoff, generally for a limited time, such as after a large rainfall event. [1, 3]

Hydrograph: For monitoring or supply wells, a hydrograph shows changes in depth to groundwater or groundwater elevation versus time. For streamflow, a hydrograph plots the stream flow (usually in cubic feet or meters per second) versus time. [7]

Hydrologic connection: Interflow and exchange between surface impoundments and surface water through an underground corridor or groundwater; decreased hydrologic connection (as a result of lagoon construction, liners, etc.) reduces the potential for the transfer of pollutants from CAFO containment structures into surface waters. [3]

Irrigation: Applying water (or wastewater) to land areas to supply the water and/or nutrient needs of crops. Techniques for irrigating include furrow irrigation, sprinkler irrigation, drip irrigation, and flooding. [1, 3]

Isotope: Elements with same atomic number (number of atoms) but with different mass number (atomic mass); Variations in atomic mass of the same chemical element can be used to identify the source of different contaminants, or chemicals.

Land application: The removal of wastewater and waste solids from storage and containment structures and distribution to, or incorporation into the soil, primarily for beneficial reuse purposes such as growing crops. [1, 3]

Land application area: "Land under the control of an AFO owner or operator, whether it is owned, rented or leased, to which manure, litter or process wastewater from the production area is or may be applied." [1, 3]

Large Concentrated Animal Feeding Operation (Large CAFO): An AFO is defined as a Large CAFO if it stables or confines as many or more than 700 mature dairy cows, whether milked or dry (or 1,000 heifers or cow/calf pairs). Large CAFOs shall not discharge of manure, litter or process wastewater pollutants into waters of the United States from the production area. However, if the production area is designed, constructed, operated and maintained to contain all manure, litter, and process wastewater including the runoff and direct precipitation from the 25-year/24-hour rainfall event, then discharge to waters of the United States is allowed (see definition of agricultural stormwater discharge). [3]

Liner: Typically a plastic/polymer membrane or clay layer installed in a lagoon impoundment, in order to prevent leachate, liquid waste components, or green water from leaking into the ground around and below the impoundment. [1,3]

Liquid manure: Manure to which wash water, runoff, precipitation, etc. have been added; usually consists of less than 8% solids. [1, 3]

Lysimeter: "Structure containing a mass of soil, and designed to permit the measurement of water draining through the soil"; can be used to measure the amount of actual evapotranspiration that is released by plants, usually crops or trees. By recording the amount of precipitation that an area receives and the amount lost through the soil, the amount of water lost to evapotranspiration can be calculated. [12]

Manure: Fecal and urinary output of livestock and poultry; may include spilled feed, bedding, or soil. [1, 3]

Manure Storage Area: This area includes but is not limited to lagoons, runoff ponds, storage sheds, stockpiles, under house or pit storages, liquid impoundments, static piles, and composting piles. [1, 3]

Medium Concentrated Animal Feeding Operation (Medium CAFO): An AFO is defined as a Medium CAFO if it stables or confines 200 to 699 mature dairy cows, whether milked or dry (or 300 to 999 heifers or cow/calf pairs), and either one of the following conditions are met: (1) pollutants are discharged into waters of the United States through a man-made ditch, flushing system, or other similar man-made device; or (2) pollutants are discharged directly into waters of the United States which originate outside of and pass over, across, or through the facility or otherwise come into direct contact with the animals confined in the operation. [3]

Milking parlor wash water: Water used to rinse the animals and equipment during the milking process to improve sanitation. Used wash water typically includes manure, feed solids, and hoof dirt along with detergents and disinfectants that are being used at the operation. The amount of wash water used each day depends upon the number of animals milked and the management practices followed. May also be referred to as green water or process-generated wastewater. [1, 3]

Milligrams per liter (mg/L): Unit used to measure the concentration of a constituent in water or wastewater; it represents 1 milligram (0.001 gram) of a constituent in 1 liter of water and is approximately equal to one part per million (ppm). [11]

Monitoring well: A well constructed or used for the purposes of water level and/or water quality data collection. Monitoring wells are often required by regulatory agencies with the goal of detecting contamination downgradient from a potential source of pollutants.

Nitrate-nitrogen (NO3-N): A form of inorganic nitrogen used by plants for maintenance and growth. Nitrate-nitrogen comes from various sources, including the nitrification of ammonium via bacteria. Nitrate-nitrogen is water-soluble and, therefore, has the greatest potential for groundwater contamination. When ingested, nitrate (NO3) is converted to nitrite (NO2) in the stomach and intestines, and nitrite interacts with hemoglobin in the blood to produce methemoglobin. This compound limits the ability of red blood cells to carry oxygen, resulting in a condition called methemoglobinemia or "blue baby syndrome." [8]

Nitrite-nitrogen (NO2-N): A form of nitrogen that is an intermediate in the nitrification reactions that convert ammonium to nitrate-nitrogen. Nitrite is toxic to most fish and other aquatic species, but does not accumulate in the environment because it is rapidly transformed to nitrate. [8]

Nitrogen uptake: The amount of nitrogen absorbed from the soil by plants and used for maintenance and growth. Most plants take nitrogen, usually in the form of nitrate-nitrogen, from the soil continuously throughout their lives, and nitrogen demand usually increases as plant size increases. Nitrogen uptake values can be found in numerous published sources, or can be determined directly from analysis of crops; nitrogen uptake is usually reported in pounds per acre.

Non-Point Source: Diffuse pollution source without a single point of origin or not introduced into a receiving stream from a specific outlet; pollutants are generally carried off the land by stormwater; common nonpoint sources are agriculture, forestry, urban, mining, construction, dams, channels, land disposal, saltwater intrusion, and city streets. [3]

Nutrient Management Plan (NMP): Required by CAFO regulation promulgated in 2003; NMP must include best management practices and procedures necessary to implement applicable effluent limitations and standards. [3]

Open lot: Confinement areas (i.e., pens or corrals) with dirt, concrete, or other paved or hard surfaces wherein animals or poultry are substantially or entirely exposed to the outdoor environment except for small portions of the total confinement area affording protection by windbreaks or small shed-type shade areas. [1]

Overflow: The discharge of manure or process wastewater resulting from the filling of wastewater or manure storage structures beyond the point at which no more manure, process wastewater, or stormwater can be contained by the structure. [1]

Pathogen: Pathogens include viruses, bacteria, fungi, and parasites that invade the body and can cause health issues. [18]

Permeability: The property or capacity of a porous rock, sediment, or soil for transmitting a fluid under hydraulic gradient; it is a measure of the relative ease of fluid flow under unequal pressure. [11]

pH: A measure of the concentration of hydrogen ions (H+) in water on a scale of 0 to 14. Using this dimensionless scale, a pH of 7 is neutral, a pH greater than 7 is alkaline/basic, and a pH less than 7 is acidic. [11]

Phosphorus (P): An element naturally found in rock, soil and organic material. Phosphorus is a nutrient that is necessary for all organisms to carry out basic life functions and, in fresh water, it is often a growth-limiting nutrient. Phosphorus in the environment tends to remain bound to soil particles, where it can be carried to surface waters by runoff or erosion. Excess phosphorus in surface waters can result in algae blooms and eutrophication. [10]

Phosphorus Index: The Phosphorus Index is an NRCS tool used to assess landforms and management practices for the potential risk of phosphorus runoff to surface waters. This tool can be used to identify sites where the risk of phosphorus runoff is higher relative to other sites, and can be the basis for planning corrective soil and water conservation practices and management techniques. [10]

Point Source: "Any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fixture, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft from which pollutants are or may be discharged."[1]

Pollutant: Dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, certain radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water. [1]

Pollution Prevention Plan (PPP): Required by NPDES General Permit for New Mexico CAFOs; a PPP shall be prepared in accordance with good engineering practices and should include measures necessary to limit pollutants in runoff; the plan shall describe and ensure the implementation of practices which are to be used to ensure compliance with the limitations and conditions of the permit. [23]

Potentiometric surface: An imaginary surface representing the total hydraulic head (pressure) of groundwater in a confined aquifer that is defined by the level to which water will rise in a well. [11]

Process (generated) wastewater: Water directly or indirectly used in the operation of the AFO for any or all of the following: spillage or overflow from animal or poultry watering systems; washing, cleaning, or flushing pens, barns, manure pits or other AFO facilities; direct contact swimming, washing or spray cooling of animals; dust control; also includes any water which comes into contact with any raw materials, products or byproducts, including manure, litter, feed, milk, eggs or bedding. [3]

Production area: This area includes animal confinement areas, manure storage areas, raw materials storage areas, and waste containment areas. [3]

Production well: Also referred to as a water supply well; a well used to retrieve water from an aquifer for use (e.g., agricultural, domestic, industrial, irrigation).

Raw materials storage area: This area includes but is not limited to feed silos, silage bunkers, and bedding materials. [1]

Retention Facility (Structure): All collection ditches, conduits and swales for the collection of runoff and wastewater. Also includes all basins, ponds, pits, tanks and lagoons used to store wastes, wastewaters and manures. [1]

Runoff: The portion of precipitation, snowmelt, or irrigation water that flow over the surface of the land into streams or other surface-water. It can carry pollutants from the air and land into receiving waters. [1]

Small CAFO: An AFO that is designated as a CAFO and does not meet the size requirements of a Medium CAFO. For dairies, this means less than 200 mature dairy cows or less than 300 heifers or cow/calf pairs. An AFO may be designated as a small CAFO if it is a significant contributor of pollutants to waters of the United States. [3]

Solid manure: Combination of urine, bedding, and feces with little or no extra water added. It is usually found in loafing barns, calving pens, and dry open lots with good drainage. [1]

Specific Yield: A measurement of the quantity of water that will drain from an unconfined geologic unit due to the force of gravity

Storage: The structures used to hold manure, litter, or process wastewater to reduce the need for frequent hauling and/or land application; storage allows land application to occur when soil and climatic conditions are suitable and/or when crop requirements dictate timing. [1]

Storage pond: An impoundment used to hold liquid manure and wastewater. [1]

Sulfate (SO4-): Sulfate occurs naturally in groundwater in varying concentrations, depending on the local geologic and hydrologic setting. Sulfate concentrations can be increased due to contamination with wastewater. High sulfate concentrations in drinking water may have a laxative effect and produce diarrhea in infants, children and young animals. High sulfate concentrations may also result in drinking water with an unpleasant taste or odor. [24]

Surface water: For the purpose of this manual, surface water is synonymous with waters of the United States.

Total Dissolved Solids (TDS): The amount of dissolved material in water, equal to the sum of cations plus anions. High concentrations of total dissolved solids may result in impaired aquatic habitat, unpalatable drinking water and increased corrosive action. [19]

Total Kjeldahl Nitrogen (TKN): Nitrogen in the form of organic proteins or their decomposition product ammonia, as measured by the Kjeldahl laboratory method. Equal to the concentrations of organic nitrogen plus ammonia and ammonium. The analysis for TKN may also be performed to provide a measure of total nitrogen. [20]

Total nitrogen: Equal to the sum of concentrations of organic nitrogen plus ammonia/ammonium plus nitrate/nitrite. [21]

Total Suspended Solids (TSS): A measure of the material suspended in wastewater; high concentrations of total suspended solids may result in the impairment of aquatic habitat. [1]

Toxic pollutant: Pollutants, or combinations of pollutants, including disease-causing agents, which after discharge and upon exposure, ingestion, inhalation or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will, on the basis of information available to the EPA Administrator, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction) or physical deformations, in such organisms or their offspring. Also see 20.6.2.7 NMAC [13] for a state-specific list of toxic pollutants. [22]

Unconfined aquifer: Generally the most shallow aquifer, where the water table is exposed to the atmosphere through openings in the overlying, unsaturated materials that allow equalization of water pressure with atmospheric pressure; un-capped by an aquiclude/aquitard, and receives recharge from the overlying ground surface. [7]

Unsaturated zone: See vadose zone.

Vadose zone: Area immediately below the ground surface, in which pore space in soil or rock contains either air or water. The water content of this zone can fluctuate with percolation from the surface. Also referred to as the unsaturated zone. [7]

Waste Containment Area: This area includes settling basins and areas within berms and diversions which separate uncontaminated stormwater. [3]

Wastewater: Water containing waste (i.e., manure, sewage) or water contaminated by waste contact, including process-generated and contaminated rainfall runoff. [1]

Water right: Generally refers to the right of the user to divert and/or consume water from a water source (e.g., a river, stream, pond, or source of groundwater) for a specified use (i.e., irrigation, livestock, domestic, etc.). The main components of a water right in New Mexico are priority date, point of diversion, place of use, purpose of use, owner and quantity of water. [25]

Water table: The surface between the vadose zone and the groundwater; that surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere. [7]

Waters of the United States: As defined by the Clean Water Act [33 U.S.C. §1251 et seq. (1972)], waters of the United States include: all interstate waters, intrastate waters used in interstate and/or foreign commerce, tributaries of interstate and intrastate waters, territorial seas at the cyclical high tide mark, and wetlands adjacent to all of the above. [2]

Definitions modified from the following sources:

[1] Appendix K of https://www.epa.gov/npdes/npdes-permit-writers-manual-concentrated-animal-feeding-operations

[2] 33 U.S.C. §1251 et seq. (1972)

[3] Environmental Protection Agency 40 Code of Federal Regulations Parts 9, 122, 123 and 412 [FRL–7424–7] RIN 2040–AD19 National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitation Guidelines and Standards for Concentrated Animal Feeding Operations (CAFOs), http://www.epa.gov/npdes/regulations/cafo_fedrgstr.pdf

[4] Staley et al., 2007

[5] Driscoll, 1986

[6] Glossary of https://www.epa.gov/npdes/npdes-permit-writers-manual-concentrated-animal-feeding-operations

[7] Winter, T. C., Harvey, J. W., Franke, O. L., and Alley, W. M. (1998). Ground Water and Surface Water, A Single Resource (Circular 1139). Denver: U.S. Geological Survey, 79 p.

[8] https://www.epa.gov/ground-water-and-drinking-water

[9] Wilde, Franceska D., Dean B. Radtke, Jacob Gibs, and Rick T. Iwatsubo, editors, 2002, National Field Manual for the Collection of Water-Quality Data, Chapter A2. “Selection of Equipment for Water Sampling,” (USGS Techniques of Water-Resources Investigations Book 9)

[10] NRCS (Natural Resources Conservation Service) General manual Title 180 Part 409 (GM_180_409_10 - 409.10) Minimum Standards for Providers of Conservation Technical Assistance Associated with Comprehensive Nutrient Management Plans, [http://www.nrcs.usda.gov/technical/ecs/nutrient/pindex.html]

[11] http://nm.water.usgs.gov/glossary.html

[12] Modified after W. B. Langbein and K.T.Iseri, 1972, Manual of Hydrology: Part 1. “General Surface-Water Techniques” (USGS Water Supply Paper 1541-A Methods and practices of the Geological Survey) http://water.usgs.gov/wsc/glossary.html

[13] New Mexico Water Quality Control Commission (NMAC.20.6.2) Title 20 Environmental Protection, Chapter 6 Water Quality, Part 2 Ground and Surface Water Protection

[14] Heath, Ralph C., 1983, Basic ground-water hydrology, USGS Water Supply Paper Report Number 2220, 84 pp.

[15] Mueller, David K. and Dennis R. Helsel, 1996, Nutrients in the Nation’s Waters—Too Much of a Good Thing?, U.S. Geological Survey Circular 1136, 31pp, [http://pubs.usgs.gov/circ/circ1136/]

[16] https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_067306.pdf

[17] http://www.weather.gov/glossary/glossary.php?letter=number

[18] https://www.fda.gov/drugs/news-events-human-drugs/studying-how-pathogens-cause-disease

[19] http://pubs.usgs.gov/of/2000/ofr00-213/manual_eng/glossary.html

[20] https://www3.epa.gov/npdes/pubs/glossary.pdf

[21] https://www3.epa.gov/npdes/pubs/glossary.pdf

[22] https://www3.epa.gov/npdes/pubs/glossary.pdf

[23] https://www.epa.gov/sites/default/files/2015-10/documents/sw_swppp_guide.pdf

[24] https://www.epa.gov/sites/default/files/2014-09/documents/support_cc1_sulfate_dwreport.pdf

[25] New Mexico Statutes Chapter 72

APPENDIX E1: GENERAL LABORATORY ANALYSES INFORMATION

Laboratory Analyses Generally Required by NMED for Dairy Discharge Permits

Sample Location	Sampling Schedule	Constituents	Laboratory Analysis Method
Monitoring Well	quaterly	TKN, NO_3-N, TDS, Cl	EPA Method 300.0
Green Water Lagoons	quarterly	TKN, NO_3-N, TDS, Cl	
Soil (LAA fields)	annually	TKN, NO_3-N	

Total Kjeldahl nitrogen: TKN
Nitrate-nitrogen: NO_3-N
Total dissolved solids: TDS
Chloride: Cl

The laboratory that conducts the analyses must follow an approved standard method as shown below.

Natural Resources Conservation Service (NRCS) Common Constituents that Are Required by NMED and the Laboratory Method that Must Be Followed

Constituents	Approved Laboratory Analysis Methods
Total Kjeldahl nitrogen: TKN	SM 4500 Norg C
Nitrate-nitrogen: NO_3-N	EPA Method 300.0
Total dissolved solids: TDS	SM 2540 C
Chloride: Cl	EPA Method 300.0
Additional analyses that are sometimes required by NMED	
Ammonia: NH_3	SM 4500 NH_3
Biochemical Oxygen Demand: BOD	EPA MEthod 405.1, SM 5210
Fecal Coliform	SM 9222D
Phosphorus: P	EPA Method 200.7, 6010C
Pottasium: K	EPA Method 200.7, 6010C

The NMED requires producers to test their soil annually. NRCS requires soils to be tested every four years. NMED requirements and provide the dairy with good background soils data. Parameters needed to complete the NRCS code 590 Nutrient Management parameters include pH (saturated paste); EC saturated paste (in mmho/cm); organic matter (as a percent); nitrate-N (ppm); TKN (ppm); phosphorous (P) (Sodium bicarbonate extractable, in ppm); water-soluble potassium (K) (in ppm); and manganese (Mn), calcium (Ca), sodium (Na), copper (Cu), zinc (Zn), magnesium (Mg), and iron (Fe) (all in ppm).

APPENDIX E2: GROUNDWATER SAMPLING PROCEDURE FOR DAIRY AND SIMILAR SITES

Pre-sampling Requirements: Sample kits with proper containers and proper preservatives; field notebook; sampling equipment (pump, bailers, water level meter); access to monitoring wells (lock keys, gates, well locations, etc.); arrangements for shipping samples.

General Health and Safety Directives:

Recommended PPE: Appropriate work attire; nitrile or latex gloves.

1. Access Monitoring Well

Unlock and open well vault. Remove the temporary plug at the top of the casing. Inspect the condition of well for damage or signs of tampering (staining/discoloration). Note the inside diameter of the well casing (typically either a 2-inch interior diameter [ID] or a 4-inch ID) and any marks that would indicate a measuring point on the well casing. Enter observations/comments in field notebook.

2. Measurement of Static Water Level

Use a calibrated water level meter (sounder) to measure the depth to water in the well. Inspect the meter for the following conditions.

a. Any contamination that may affect the well water quality, especially on the probe tip and probe housing.
b. Any evidence of cracking in the meter tape that may cause false readings.
c. Any evidence of large kinks or bends of the meter tape that may affect the calibration.

Test the water level meter prior to first use for a sampling event to ensure proper operation. Some meters have a self-test mode, others may require immersion into a clean container of water.

Lower the water level meter until an alarm indicates contact with the water surface. This may be a light or audible alarm, or both, depending on the model of the water level meter. Make sure that the meter tape is free of any adhesion to the well casing that may occur on deeper wells (100 ft or greater). Note the depth to the static water level to a measuring point (MP) on the casing. The MP may be an existing mark (a mark by a marking pen or a cut in the casing), the highest point of an uneven cut at the top of the well casing, or the north side of the well casing. The measurement must be to the hundredth of a decimal place or 0.00 ft.

Lift the meter probe above the static water level and repeat the measurement using the same MP. Ensure that the two measurements are within (±) 0.05 feet for an accurate reading. Repeat with a third measurement if the two previous measurements have greater than the acceptable margin of error.

If the total depth of the monitoring well in not known, measure the total depth of the well with the meter, but with the alarm off. Use the same MP as the static water level measurement. The total depth of the well must be estimated based on feeling the weight of the meter probe as the bottom of the well is reached. This measurement will require several attempts before a consistent depth measurement can be made. The total depth measurement of a well should be taken periodically since many monitoring wells will accumulate sediment in the bottom that will change the depth of the well. As a general rule, the total depth should be measured at least once per year.

Measurement of static water levels should be conducted at all wells prior to sampling the wells. Monitoring wells should be measured starting with the least contaminated well and ending with the well with the highest contamination.

Decontamination of the probe and lower portion of the water level meter wire/tape is to be done between wells with a solution of Alconox (or equivalent soap) and distilled water (or DI water). Any portion of the meter that comes in contact with the well and well water should be decontaminated.

3. Calculate Purge Volume

The accepted volume for successful purging of the well prior to sampling is three (3) bore volumes. There are 0.218 gallons per vertical foot of water in a well with 2-inch (ID) well casing and 0.653 gallons per vertical foot of water in a well with 4-inch (ID) well casing. If the monitoring well casing has an inner diameter other than the standard 2 or 4 inches, you will need to make a calculation of the volume per foot for that particular well ID based on the following equation for the column of a one-foot-tall cylinder:

Volume of a cylinder = π × r2 x h
Where r = inner radius of the casing in feet
(½ × ID ÷ 12 [inches per ft]), h = height of 1 ft,
π = 3.1416

Equation becomes:
V (gallons per ft) = [3.1416 × (D ÷ 24)2] × 7.48
Where D = well casing ID in inches, and there are 7.48 gallons in 1 ft3

For example:
Well casing ID = 4 inches
V (gal/ft) = 3.1416 × [(4 ÷ 24)2] × 7.48
= 3.1416 × 0.028 × 7.48
= 0.653 (gal/ft)

To calculate the purge volume, first multiply the height (h) of the water column [total depth of well – depth to water in feet] by 0.653 (for a 4-inch well) or 0.163 (for a 2-inch well) to get the total volume of water in the well casing. Then multiply this calculation by three to get the required three well bore volumes for purging.

Use the following formulas:
Height of water column
(**h**) = total depth of well – depth to water

One Well Bore Volume
(**BV**) = (**h**) × 0.653 (gal/ft) = Gallons (for 4-inch ID well casing)
Or
(**BV**) = (**h**) × 0.163 (gal/ft) = Gallons (for 2-inch ID well casing)

Minimum purge amount:
BV × 3 = 3 BV

Complete a table similar to the example below.

Calculate the required purge volume for each well prior to pumping. You will need to pump out three times the volume of water calculated to be in the casing.

Monitoring Well ID	Total depth of well (in ft) A	Depth to water (in ft) B	Water colun height (in ft) h = (A-B)	One well bore volume (in gal) BV = (h x gal/ft)	Total purge volume (in gal) 3 x BV	Actual volume purged (in gal) or Purge Time	Sample Time or Pump Depth
MW 1							
MW 2							
MW 3							
MW 4							

4. Well Purging Procedures

a. Purging with a bailer: On shallow, small-diameter wells, or if equipment failure does not permit purging with a pump, a single-use (disposable) bailer can be used. Attach a single-use bailer to an unused, clean rope or strong string (white nylon braided mason's twine or equivalent) with an appropriate length to reach below the static water level and capable of suspending the full bailer's weight. A weighted bailer is preferred for purging. A recommended step is to wind the rope on a reel used for lawn hoses or extension cords. Make sure that the bailer rope is attached to the reel or some other surface feature prior to bailing. Try to keep the bailer rope from becoming contaminated by surface debris or other materials that could impact the sample.

b. Purging with a pump: Place pump in well casing and lower to the water column. Placement of the pump below the middle of the screen and above the bottom of the well casing is critical for proper purging. The purge pump may be placed near the very bottom of the well if the observed conditions require this position (e.g., small water column, a history of poor recharge). Start the purging and monitor the pumping time and measure flow (gallons per minute) with a five-gallon bucket or other known volume container. Adjust the flow of the purge pump as needed to ensure a steady rate of flow.
   Divide required purge volume (gallons) by flow (gallons per minute) to figure time needed to pump three well bore volumes. Pump well until the required amount has been purged. Purging more than three well bore volumes is acceptable but will not necessarily improve the quality of the sample.

c. Special conditions: If the well becomes dry during the purging for the minimum volume (three bore volumes), suspend the purging activity. Note the time in your field notebook. Wait a sufficient amount of time for the well to recharge, then obtain a sample with a disposable bailer. The recharge time varies from a few minutes to possibly an hour.

5. Groundwater Sample Preparation

After the three well bore volumes have been pumped, the monitoring well is ready to sample. Make sure you are wearing disposable protective gloves to prevent cross-contamination and provide protection from preservative, preferably non-latex (nitrile or polyvinyl are suitable). Also, change your gloves between samples at each monitoring well.

It is best to pull the pump after purging and use a bailer to sample the well. Tie string to bailer and drop into well, pull up the bailer and fill bottles. The submersible pump may be used for sampling if proper decontamination procedures have been followed and the pump flow was constant through the purging process. **Be sure to fill the unpreserved bottles first followed by the sample bottles with preservative last**.

Label sample bottles immediately so there will be no confusion between samples collected from each well. Typically, bottles with preservative will be analyzed for TKN and nitrate-N. Unpreserved bottles will be analyzed for TDS and chloride. Note time of collection, the date, and the monitoring well number on sample bottle. Place the labeled sample bottles on ice as soon as they are filled and labeled.

Sample notes should have the minimum following information.

1. Site or Location (facility name)
2. Well name or number
3. Date of sample
4. Time of sample
5. Name of person performing sample
6. Preservation (such as acid type or "cold" for no preservation)
7. The types of analyses
8. Any noticeable odor, color, sediment amount in the sample

Custody-control tape may be applied to the individual bottles, or to the shipping container based upon the method of delivery to the laboratory.

Lagoon Samples: The same general procedures for groundwater samples should be applied to lagoon samples. Special care should be used regarding personal safety when obtaining samples directly from the edge of lagoons, as the footing in these areas can be dangerous and could cause falls into the lagoon. This sample should be obtained with a container that will provide a composite or mixed representative sample of the lagoon water. A sample "dipper" can be constructed by attaching a clean, plastic container with a wide opening to a length of light-weight wooden pole or pipe, such as PVC. This dipper must either be a one-use sampling device that is disposed of after each sample location or must be decontaminated between sample locations as described below (section 8) for the pump.

6. Quality Control of Samples

The base requirement for Quality Control (QC) for this procedure is compliance with the standard operating procedure (SOP). Requirements for QC samples are not necessary at this time due to the limited number of samples at each dairy or facility with a discharge permit. Standard practice by the United States Environmental Protection Agency requires QC samples such as duplicate samples for a facility with a number of samples equal to 10 or greater, or trip blanks and field blanks with a sampling procedure that involves analyses for volatile organic compounds (e.g., solvents and gasoline).

There are specific “holding times” for the analytical procedure being performed on the samples. The holding time is the amount of time allowed between collecting the sample and analyzing the sample at the laboratory and is specific to the analytical method being used for the samples. The laboratory will provide guidance as to the limits of the holding times for the list of chemicals that are being sampled.

As part of the QC process, the scheduling of sampling events and the required time for delivery to the analytical laboratory must be estimated in order to be less than the shortest holding time for all of the chemicals being analyzed in the sample. This estimate must also permit an acceptable amount of time for the laboratory to perform their preparation work before analysis.

7. Sample Handling and Shipping

Samples should be examined for accurate labeling for both the individual sample bottles and the Chain-of-Custody Document supplied by the analytical laboratory. The preservation of the sample includes the refrigeration with either clean ice in sealed bags or freezer packs such as Blue Ice. The laboratory may provide freezer packs with a prepared sample kit. The laboratory will provide directions regarding shipping companies (FedEx or bus lines), and notify the laboratory of the shipment of the samples.

Packaging of the samples in a cooler must be completed so that the cooler will not be opened (such as wrapping with shipping tape and some tamper-proof tape). The samples have to be packed such that the bottles will not leak or break if the container is bumped during transit. Generally, it is recommended to seal sample bottles in Zip-lock (or similar) bags and pack clean newspaper or bubble-wrap around bottles and ice packs to prevent them from moving during transit.

8. Sampling Equipment Decontamination

First submerge pump in a clean PVC tube (or bucket) filled with a solution of Alconox (or equivalent non-phosphate cleaning product) and clean water. The Alconox solution should be prepared as directed on the label. Run the pump with the Alconox solution for a minimum of five minutes, or longer if there are solids in the tubing. Discharge of the solution should be at a location that will not impact the monitoring well or dairy operations.

Then fill tube with distilled water and run pump to rinse out the Alconox solution. Wash the exterior of pump discharge hose (pipe) with clean water.

Decontaminate the purge pump after completion of the sampling event at each monitoring well. Move to next monitoring well and repeat all steps as listed above for purging and sample preparation.

9. References For Guidance

American Society for Testing and Materials. 1999. ASTM Standards on Ground Water and Vadose Zone Investigations: Drilling, Sampling, Geophysical Logging, Well Installation and Decommissioning, Second Edition. West Conshohocken, Pennsylvania: ASTM.

Barcelona, M.J., J.P. Gibb, J.A. Helfrich, and E. E. Garske. 1985. Practical Guide for Ground-Water Sampling (ISWS Contract Report 374). Champaign, IL: Illinois State Water Survey.

Nelson, Peg. 2003. Index to EPA Test Methods, April 2003 Revised Edition, EPA 901/3-88-001 Revised. Boston: United States Environmental Protection Agency New England Region 1 Library.

Nielsen, D. M. 1991. Practical Handbook of Ground-Water Monitoring (National Ground Water Association). Boca Raton, FL: Lewis Publishers.

United States Geological Survey. (Various dates). National Field Manual for Collection of Water-Quality Data; Techniques of Water-Resources Investigations (Book 9; Chapters A1-A9). Reston, VA: USGS Water Resources—Office of Water Quality. Available online at http://pubs.water.usgs.gov/twri9A

APPENDIX E3: SOIL SAMPLING PROCEDURE FOR DAIRY AND SIMILAR SITES

Pre-sampling Requirements: Sample kits with proper containers and proper preservatives; sampling equipment (soil auger, post hole digger or shovel, plastic buckets, sample bags and labels, measuring tape); access to sample area, preferably with a moist to dry soil surface. (Avoid sampling during wet [saturated] soil conditions.)

General Health and Safety Directives:
Recommended PPE: Appropriate work attire; nitrile or latex gloves.

1. **Background**: NMED requires soil sampling to be performed at depths of 0 to 12 inches and 24 to 36 inches. These samples are analyzed for nitrate-nitrogen and total Kjeldahl nitrogen (TKN). However during this sampling event sampling and analysis need to be done per NRCS requirements that are detailed below. The Discharge Permit will have specific information for sample intervals and the sampling schedule.
   NRCS requirements are beyond NMED requirements and provide the dairy with good background soils data. Parameters needed to complete the NRCS code 590 Nutrient Management parameters include pH (saturated paste), E.C. saturated paste (in mmho/cm), organic matter (as a percent), nitrate-N (ppm), TKN (ppm), phosphorous (P), (sodium bicarbonate extractable, in ppm), water-soluble potassium (K) (in ppm), manganese (Mn), calcium (Ca), sodium (Na), copper (Cu), zinc (Zn), magnesium (Mg), iron (Fe) (all in ppm).
   NMSU has guidelines for soil sampling (Guide A-114: http://cahe.nmsu.edu/pubs/_a/a-114.html) and soil interpretations (Guide A-122: http://cahe.nmsu.edu/pubs/_a/a-122.html). NRCS Agronomy Technical Note 58 (https://www.cabq.gov/municipaldevelopment/documents/nm-nrcs-agronomy-technical-note-revised-universal-soil-loss-equation.pdf) provides instructions for use of NMSU Fertilization Interpretation Software (NRCS 590 Job sheet) and http://www.nm.nrcs.usda.gov/technical/tech-notes/agro.html once the user has obtained a proper soil test.
   Laboratories offering analysis for soils and manure for agricultural applications are different from analytical laboratories that specialize in groundwater or hazardous waste assessments. The majority of agricultural laboratory are located in the Midwest United States.
2. **Sample Locations**: Three composite samples are usually obtained for each field. Each composite sample consists of at least 15 sub-samples. A sub-sample is an individual soil core or hole at one spot in the field. Large uniform fields, such as pivots, should have one composite sample per 40 acres. The determination of the "field" limits (whether a sample represents two or smaller fields that are combined for the composite sample) needs to be known before sampling begins. Once the field has been determined, randomly select a minimum of 15 locations for the sub-samples. If you have a map available, please note their general location.
3. **Sampling Depths**: The three composite samples for each field are determined by depth: 0–12 inches (0–1 foot), 12–24 inches (1–2 foot interval), and 24–36 inches (2–3 foot interval). The 15 sub-sample locations will provide soils from each of these intervals.
4. **Sample Procedure and Procedure**: The most successful sampling containers are five-gallon plastic buckets. Three buckets, each labeled with the depth interval, provides enough volume for the soil to be collected. Metal containers are not recommended since they may add metal chips to the soil sample and change the results. Start sampling at a sub-sample location using a hand auger, a post-hole digger, or shovel. Measure the depth as you excavate so that you know when to place the sample in the appropriate bucket. Provide enough material to represent the soil interval; remember that 15 locations are to be sampled. Be careful when using a shovel to sample, since there is a tendency to make a smaller hole at depth. This may cause the deeper soil interval to be improperly represented.
   When the sub-samples for each depth interval have been collected from all 15 locations, take one of the buckets and mix the soil with a small spade or your hand. If the bucket is too small, the soil sample can be mixed in a new, clean heavy garbage bag or plastic storage container such as those made by Rubbermaid. Prepare the sample container (usually a lined paper bag or small canvas bag supplied by the laboratory) by completing the label with the dairy name, field name, date, and the depth interval. Use a gloved or clean hand to grab small portions of the soil and put it into the sample bag. Discard rocks or gravels from the soil sample. Seal the bag and proceed to the next bucket. Sample weights may be 1.5 to 2.5 pounds each.
5. **Sampling Equipment Decontamination**: Make sure that the sampling equipment is cleaned between the field composite samples. This can include a simple washing with soap and water to ensure a clean surface. Examine the sampling tools to make sure that rust or other debris is removed prior to sampling. The hand auger, shovel, or post-hole digger should be clean when a new depth is reached, but this can be done with a dry cloth or a towel wetted with potable water.

6. **Sample Handling and Shipping**: Unlike water samples, the soil samples have less stringent preservation and shipping requirements. Most agricultural soil laboratories permit shipping by a fast courier such as FedEx. The samples should be sealed in a second type of bag (one-gallon plastic Zip-lock) in the shipping container, and the samples should be packaged so that they will not rupture when dropped or tossed. Include the completed Chain-of-Custody with the samples and retain a copy for your records.
   Preservation with a chemical or refrigeration following the sample preparation is not required. However, Preservation with a chemical or refrigeration following the sample preparation is not required. However, samples should be kept dry, away from heat, and may be refrigerated if shipping is delayed several days.
   Manure Samples: Manure samples are handled with the same general procedures as soil samples. A composite sample should be obtained that represents the volume of manure that is to be land applied, hauled or composted. The sample can be placed in a laboratory-supplied container or a clean, quart Zip-lock bag. Make sure that the sample is labeled for proper identification.

APPENDIX F: EXAMPLE OF NMED GROUND WATER DISCHARGE PERMIT

NEW MEXICO

ENVIRONMENT DEPARTMENT

Ground Water Quality Bureau

1190 Saint Francis Drive / PO Box 5469
Santa Fe, NM 87502-5469
Phone (505) 827-2900 Fax (505) 827-2965
www.env.nm.gov

GROUND WATER QUALITY BUREAU

DISCHARGE PERMIT – RENEWAL
EXISTING DAIRY FACILITY with a LAND APPLICATION AREA
Issued under 20.6.2 and 20.6.6 NMAC

Facility Name:	Happy Cow Dairy
Discharge Permit No:	DP-123
Facility Location:	
County:	
Permittee Name:	
Mailing Address:	
Permitting Action:	Renewal
Source Classification:	Agriculture- Dairy
Permit Issuance Date:	
Permit Expiration Date:	
NMED Permit Contact:	
Telephone Number/Email:	

____

for

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PART A GENERAL INFORMATION

A100 Introduction

A. The New Mexico Environment Department (NMED) issues this Discharge Permit Renewal (Discharge Permit), **DP-123**, to the Permittee pursuant to the New Mexico Water Quality Act (WQA), NMSA 1978, §§ 74-6-1 through 74-6-17, and the New Mexico Ground and Surface Water Protection Regulations, 20.6.2 NMAC and the Supplemental Permitting Requirements for Dairy Facilities (Dairy Rule), 20.6.6 NMAC. NMED's purpose in issuing this Discharge Permit is to control the discharge of water contaminants from the Happy Cow (dairy facility) for the protection of groundwater and those segments of surface water gaining from groundwater inflow, for present and potential future use as domestic and agricultural water supply and other uses, and to protect public health.

B. The Permittee is discharging up to 180,000 gallons per day (gpd) of effluent from the Happy Cow Dairy. This discharge or leachate may move directly or indirectly into groundwater of the State of New Mexico which has an existing concentration of 10,000 milligrams per liter (mg/L) or less of total dissolved solids (TDS) within the meaning of 20.6.2.3104 and 20.6.2.3101(A) NMAC. These discharges may contain water contaminants or toxic pollutants elevated above the standards of 20.6.2.3103 NMAC in compliance with the terms and conditions of this Discharge Permit.

C. The Permittee is authorized to discharge water contaminants pursuant to this Discharge Permit which contains requirements authorized or specified by the Dairy Rule on condition that the Permittee complies with the Dairy Rule and this Discharge Permit, which are enforceable by NMED.

A101 Terms of Permit Issuance

A. **Permit Duration** - Pursuant to WQA 74-6-5(I) and 20.6.2.3109(H) NMAC, the term of a Discharge Permit shall be for the fixed term of **five years** from the effective date of the Discharge Permit.

B. **Permit Fees** – As a discharge permit associated with a dairy facility, the Permittee shall remit an annual permit fee payment equal to one-tenth of the applicable permit fee from table 1 of 20.6.2.3114 NMAC on the first occurrence of August 1 after the effective date of this Discharge Permit, and annually thereafter until expiration or termination of this Discharge Permit [20.6.6.9(A) NMAC].

C. **Permit Renewal** - To renew this Discharge Permit, the Permittee shall submit, in accordance with 20.6.6.10 NMAC, an application and any associated fees for renewal, renewal and modification, or renewal for closure at least one year before the discharge permit expiration date, unless closure of the facility is approved by NMED before that date.

D. **Transfer of Ownership** - This Discharge Permit is being issued to the Permittee as identified in **Section A100** above. In accordance with 20.6.6.8 NMAC, the Permittee, any listed owner(s) of record, and any [other] holder(s) of an expired discharge permit are responsible for complying with the conditions listed herein and the Dairy Rule. If during the duration of this Discharge Permit a change in the list of responsible persons is required, transfer of ownership shall be completed in accordance with 20.6.6.34 NMAC as described further in Item D of **Part C101** of this Discharge Permit.

A102 Applicable Regulations

A. **Scope** - This Discharge Permit applies solely for the regulation of process wastewater or stormwater generated as a result of dairy facility operations and does not include regulation of domestic wastewater at the facility [20.6.6.20(Y) NMAC]. Domestic wastewater generated at the facility is treated or disposed of pursuant to 20.7.3 NMAC and LW permit #s RO050041, RO160129, RO020091, and RO130030.

B. The Permittee is discharging from a facility that meets the definition of "dairy facility." 20.6.2.3000 through 20.6.2.3114 NMAC and Part 20.6.6 NMAC (Dairy Rule) apply to discharges specific to dairy facilities and their operations.

C. The discharge from the dairy facility is not subject to any of the exemptions of 20.6.2.3105 NMAC.

D. Groundwater quality as observed in on-site monitoring wells is subject to the criteria of 20.6.2.3101 and 20.6.2.3103 NMAC unless otherwise specified in this Discharge Permit.

E. Complying with the applicable requirements of 20.6.2 and 20.6.6 NMAC does not relieve a dairy facility's owner, operator or Permittee from complying with the requirements of other applicable local, state and federal regulations or laws.

A103 Additional Information Requirements

A. The Permittee shall have 120 days from the effective date of this Discharge Permit (by **May 28, 2022**) to submit all the necessary information to comply with 20.6.6.10 and 20.6.6.12 NMAC.

B. NMED requires the following sections of the application form for renewal be completed, and the form shall be signed by the Permittee and notarized prior to submission:

1. Part II.B.2 and II.B.5, provide storage capacities of Runoff East, Runoff West, and Runoff South, as pursuant to 20.6.6.12.H(2) NMAC.

A104 Facility: Physical Description

C. This dairy facility meets the definition of "existing facility."

D. This dairy facility is located at 123 Happy Cow Dairy Rd.

C. This dairy facility is comprised of the following wastewater system components as identified in the application dated August 28, 2018 and the administrative record (which includes the original Discharge Permit which was issued on February 18, 1991 and subsequently renewed on July 25, 1997, and renewed and modified on March 25, 2005, as of the effective date of this Discharge Permit:

2. Wastewater impoundments:

   a. **Settling Impoundment 1** - a synthetic lined retention impoundment used to collect and store both wastewater and stormwater prior to land application. Settling Impoundment 1 is centrally located at the facility, situated east of Settling Impoundment 2 and Storage Lagoon 2. Constructed in June 2005, with a current storage capacity of 2.9 Ac-ft and lined with 40 mil HPDE.

   b. **Settling Impoundment 2** - a synthetic lined retention impoundment used to collect and store both wastewater and stormwater prior to land application. Settling Impoundment 2 is centrally located at the facility, situated between of Settling Impoundment 1 and Storage Lagoon 2. Constructed in June 2005, with a current storage capacity of 2.9 Ac-ft and lined with 40 mil HPDE.

   c. **Storage Impoundment 1** - a synthetic lined retention impoundment used to store both wastewater and stormwater prior to land application. Storage Impoundment 1 is centrally located at the facility, situated north of Storage Impoundment 2. Constructed in June 2005, with a current storage capacity of 17.3 Ac-ft and lined with 40 mil HPDE.

   d. **Storage Impoundment 2** - a synthetic lined retention impoundment used to store both wastewater and stormwater prior to land application. Storage Impoundment 2 is centrally located at the facility, situated west of Settling Impoundment 2 and south of Storage Impoundment 1. Constructed in June 2005, with a current storage capacity of 17.6 Ac-ft and lined with 40 mil HPDE.

3. Stormwater impoundments:

   a. **Runoff East** – an unlined retention impoundment used to store stormwater prior to transfer to a settling impoundment. Runoff East is centrally located at the facility, at the southeast corner of the corral. Constructed prior to 2006, Runoff East has an unknown storage capacity.

   b. **Runoff West** – an unlined retention impoundment used to store stormwater prior to transfer to a settling impoundment. Runoff West is centrally located at the facility, due south of the corral. Constructed in prior to 2006, Runoff West has an unknown storage capacity.

   c. **Runoff South** – an unlined retention impoundment used to store stormwater prior to transfer to a settling impoundment. Runoff South is located immediately east of the corral. Constructed in prior to 2006, Runoff South has an unknown storage capacity.

4. Fields within the land application area:

   a. **Field 1** – 119 acres located at the northeast corner of the facility. Field 1 has been actively receiving wastewater discharge since prior to 2007. Wastewater is applied by a center pivot.

   b. **Field 2** – 127 acres located at the west boundary of the facility. Field 2 has been actively receiving wastewater discharge since prior to 2007. Wastewater is applied by a center pivot.

   c. **Field 3** – 67 acres located at the southwest corner of the corrals. Field 3 has been actively receiving wastewater discharge since prior to 2007. Wastewater is applied by a center pivot.

   d. **Field 4** – 101 acres and is located at the center east boundary of the facility. Field 4 has been actively receiving wastewater discharge since prior to 2005. Wastewater is applied by a linear roll sprinkler.

These system components are identified as potential sources of groundwater contamination. A list of all wastewater system components authorized to discharge under this Discharge Permit is provided in **Section B100**.

A105 **Facility: Documented Hydrogeologic Conditions**

A. Groundwater most likely to be affected at this dairy facility is at a depth of approximately 50 feet and had a pre-discharge total dissolved solids concentration of 720 milligrams per liter.

B. Data collected from on-site monitoring wells document groundwater contamination attributed to one or more wastewater system components at this dairy facility. Groundwater quality standards for *total dissolved solids (TDS), chloride, and nitrate nitrogen (NO3-N)* have been exceeded according to the criteria of 20.6.2.3101 and 20.6.2.3103 NMAC. Pursuant to 20.6.6.27.A, the Permittee shall submit a corrective action plan within 120 days following the effective date of this Discharge Permit (by **May 28, 2022**) to address *exceedances of TDS, chloride, and NO3-N in multiple monitoring wells for multiple years*. The corrective action plan shall be prepared in accordance with the requirements of **Section B104** of this Discharge Permit and shall describe any repairs made to address the cause of the exceedances, and propose source control measures and a schedule for implementation. The implementation schedule shall include a schedule of all proposed corrective action activities and the date that corrective action will be completed. Please include all Abatement wells and their continued use or status. Additionally, the corrective action plan shall contain provisions to continue to supply clean water to downgradient receptors in a manner like the current abatement plan. NMED shall approve or disapprove the corrective action plan within 60 days of receipt. Once the corrective action plan is approved abatement requirements pursuant to 20.6.2.4000-4115 NMAC may be suspended during the term of this discharge permit.

C. There are no perennial surface waters existing within the bounds of the facility. The closest surface water system to the facility is the Pecos River, approximately 4.25 miles to the east. Thirteenmile Draw, an ephemeral creek, flowed across Field 2, but ended south of the Field 3.

PART B FACILITY SPECIFIC REQUIREMENTS

B100 Facility: Authorized Discharge

A. The Permittee is authorized to discharge water contaminants as part of facility operations subject to the following requirements:

1. The Permittee is authorized to discharge up to 180,000 gpd of wastewater from the production area. Wastewater is collected in two cinder block sumps at the two milking parlors and in the calf hutch sump and is pumped via PVC pipe to a concrete mixing sump and then to an incline screen solids separator. Wastewater is them pumped to two synthetically lined settling impoundments and two synthetically lined lagoons for storage. Wastewater is pumped via underground PVC pipe and land applied by center pivot and linear roll sprinkler irrigation to up to 414 acres of irrigated cropland under cultivation.
2. Pursuant to 20.6.6.11 (C)(2) NMAC, the permittee shall submit lease or other agreement with Adrian and Rosalinda Reyes of 135 E Calusa (parcel number 4-1420-742-315-030-00000) within 90 days following the effective date of this Discharge Permit (**by April 28, 2022**).
3. The Permittee is authorized to use the following impoundments for the following purposes in accordance with 20.6.6.20(B) NMAC:
   a. **Settling Impoundment 1** – authorized to receive wastewater and stormwater for collection prior to land application. This impoundment exists as of the effective date of this Discharge Permit.
   b. **Settling Impoundment 2** – authorized to receive wastewater and stormwater for collection prior to land application. This impoundment exists as of the effective date of this Discharge Permit.
   c. **Storage Impoundment 1** – authorized to receive wastewater and stormwater for storage prior to land application. This impoundment exists as of the effective date of this Discharge Permit.
   d. **Storage Impoundment 2** – authorized to receive wastewater and stormwater for storage prior to land application. This impoundment exists as of the effective date of this Discharge Permit.
   e. **Runoff East** – authorized to receive stormwater storage prior to transfer into a lined impoundment. This impoundment exists as of the effective date of this Discharge Permit. Stormwater collected in the Runoff East impoundment shall be transferred to Storage Impoundment 1 or 2 as soon as practicable, and in no case more than 14 days after the subject storm event.

f. **Runoff West** - authorized to receive stormwater storage prior to transfer into a lined impoundment. This impoundment exists as of the effective date of this Discharge Permit. Stormwater collected in the Runoff West impoundment shall be transferred to Storage Impoundment 1 or 2 as soon as practicable, and in no case more than 14 days after the subject storm event.

g. **Runoff South** - authorized to receive stormwater storage prior to transfer into a lined impoundment. This impoundment exists as of the effective date of this Discharge Permit. Stormwater collected in the Runoff South impoundment shall be transferred to Storage Impoundment 1 or 2 as soon as practicable, and in no case more than 14 days after the subject storm event.

4. NMED authorizes the Permittee to apply wastewater and stormwater to fields within the land application area in accordance with 20.6.6.21(B, C and I) NMAC. The land application area is comprised of the following fields for a total land application area of 414 acres.

   a. **Field 1** – authorized by the last Discharge Permit, prior to the effective date of the Dairy Rule (December 31, 2011), to receive wastewater and/or stormwater and has received wastewater and/or stormwater as of the effective date of this Discharge Permit.

   b. **Field 2** – authorized by the last Discharge Permit, prior to the effective date of the Dairy Rule (December 31, 2011), to receive wastewater and/or stormwater and has received wastewater and/or stormwater as of the effective date of this Discharge Permit.

   c. **Field 3** – authorized by the last Discharge Permit, prior to the effective date of the Dairy Rule (December 31, 2011), to receive wastewater and/or stormwater and has received wastewater and/or stormwater as of the effective date of this Discharge Permit.

   d. **Field 4** – authorized by the last Discharge Permit, prior to the effective date of the Dairy Rule (December 31, 2011), to receive wastewater and/or stormwater and has received wastewater and/or stormwater as of the effective date of this Discharge Permit.

B. This Discharge Permit authorizes only those discharges specified herein. Any unauthorized discharges, such as spills or leaks must be reported to NMED in a corrective action conducted pursuant to by 20.6.2.1203 NMAC.

C. The Permittee shall provide written notice to NMED regarding any changes to the status of wastewater discharges at the facility in accordance with 20.6.6.20.A NMAC as summarized in **Table B1** below:

Table B1
NMED Required Notification for Authorized Discharge

Activity	Notification of Estimated Date	Verification of Actual Date
Cessation of wastewater discharge	Not required	Within 30 days of cessation of discharge
Recommencement of Discharge	Minimum 30 days prior to recommencement	Within 30 days of recommencement

B101 <u>**Facility: Existing System Controls**</u>

A. The Permit requires the following existing system controls at this dairy facility as described below:

1. **Impoundments** - The Permittee shall maintain operations of the existing impoundment(s) as listed in **Section A104** above in accordance with conditions listed in **Table B2** to achieve compliance with the Dairy Rule. The wastewater impoundment system shall be designed to achieve compliance with the storage capacity requirements of 20.6.6.17(D) NMAC.
2. **Flow Meters** - The dairy facility was existing as of the effective date of the Dairy Rule (December 31, 2011) and measures the volume of (1) wastewater discharged from the production area and (2) wastewater and stormwater discharged to the land application area using the following flow meters:
    a. **Dairy 1 Sump Meter** - located at the southeast corner of the sump to measure the volume of wastewater discharged from the production area to Settling Impoundment 1.
    b. **Calf Sump Meter** - located at the north of the calf hutch area to measure the volume of wastewater discharged from the production area to Settling Impoundment 1.
    c. **Separator Meter** - located east of the lagoon system at the separator sump to measure the volume of stormwater flowing from the separator to the impoundment system.
    d. **Land Application Meter** - located at the west of Storage Impoundment 2 to measure the volume of wastewater discharged from Storage Impoundment 2 to the land application areas.
3. **Manure Solids Separator** - The dairy facility was existing as of the effective date of the Dairy Rule (December 31, 2011) and employs [the following] manure solids separation systems:

a. **Manure Solids Separator** - an inclined-screen solids separator, located at the east side of Settling Impoundment 1.

4. **Monitoring Wells** - The dairy facility was existing as of the effective date of the Dairy Rule (December 31, 2011) and uses [the following] monitoring wells to supply data representative of groundwater quality:

a. **MW-1** – hydrologically downgradient of decommissioned wastewater impoundment and located approximately 280 feet south of the corral.

b. **MW-3** – hydrologically upgradient of the facility and located northwest of the commodity area. The well is in the perched aquifer. MW-3 was reported damaged in July 2018 and has not reported data since then. NMED gave approval to plug and abandon MW-3 on May 20, 2020.

c. **MW-4** – hydrologically downgradient of Field 1 and located southeast of Field 1. The well is in the perched aquifer.

d. **MW-6** – hydrologically downgradient of Storage Impoundment 2 and located adjacent east of Storage Impoundment 2. The well is in the perched aquifer.

e. **MW-7** - hydrologically downgradient of Settling Impoundment 1 and located approximately 65 feet south of Settling Impoundment 1. The well is in the perched aquifer.

B. A total of 5 monitoring wells are documented at or near this dairy facility. All facility monitoring wells are subject to the facility-specific monitoring requirements outlined in **Section B102** as well as any general monitoring requirements outlined in **Table C1** of this Discharge Permit:

B102 **Facility: Conditions for Operation**

A. **Impoundment(s)** - The Permittee shall manage all impoundments at the dairy facility in accordance with 20.6.6 NMAC and the conditions summarized in **Table B2** below.

Table B2
Impoundment(s)

Engineering, Surveying and Construction and/or Improvements
a) None required.
Operations and Maintenance of All Impoundments
b) Maintain operation of the following existing impoundments in compliance with this section: **Settling Impoundment 1, Settling Impoundment 2, Storage Impoundment 1, and Storage Impoundment 2.**
c) Maintain the existing wastewater storage impoundment system to contain the maximum daily discharge volume of 180,000 gpd authorized by this Discharge Permit for a minimum period of 21 days to accommodate when land application is not feasible, while preserving two feet of freeboard as required by 20.6.6.17(D) NMAC. [20.6.6.21(A)NMAC]
d) Maintain impoundments to prevent conditions which could affect the structural integrity of the impoundments and associated liners in accordance with 20.6.6.20(P) NMAC.
e) Repair or replace the faulty pipe(s) or fixture(s) within 72 hours of discovery of an unauthorized discharge. [20.6.6.20(Q) NMAC]
Inspection and Monitoring All Impoundments
f) Visually inspect impoundments and surrounding berms on a monthly basis to ensure proper condition and control vegetation growing around the impoundments in a manner that is protective of the liners. [20.6.6.20(P) NMAC]

Table B2
Impoundment(s)

g) Visually inspect pipes and fixtures on a weekly basis for evidence of leaks or failure. In areas where pipes and fixtures cannot be visually inspected because they are buried, visually inspect the area directly surrounding the features for evidence of leaks or failure (e.g., saturated surface soil, surfacing wastewater, etc.). [20.6.6.20(Q) NMAC]
h) Estimate or measure the volume of all wastewater discharged to the wastewater or combination wastewater/stormwater impoundment(s) using flow meters. [20.6.6.24(C)NMAC]
i) Annually collect representative wastewater samples from impoundments used to store wastewater prior to land application in accordance with 20.6.6.25(C) NMAC and analyze for nitrate as nitrogen, total Kjeldahl nitrogen, chloride, total sulfur and total dissolved solids pursuant to 20.6.6.24(B) NMAC.
Recordkeeping and Reporting All Impoundments
j) Report any unauthorized discharges to NMED pursuant to 20.6.2.1203 NMAC.
k) Unless otherwise specified in this Discharge Permit, submit all monitoring information quarterly as part of the required Quarterly Monitoring Report in accordance with the general reporting schedule listed in Table C1 of this Discharge Permit.
l) Report wastewater sample results to NMED annually as part of the next scheduled Quarterly Monitoring Report. [20.6.6.25(C) NMAC]
m) Notify NMED within 24 hours of discovery of any observed impoundment condition(s) that may impact the structural integrity of a berm or liner or that may result in an unauthorized discharge. [20.6.6.20(P) NMAC]
n) Maintain written records at the dairy facility of all facility inspections including repairs and replacements.

B. **Land Application Area Management** - The Permittee shall manage all land application areas at the dairy facility in accordance with 20.6.6 NMAC and the conditions summarized in **Table B3** below.

Table B3
Land Application Area Management

Engineering and Surveying
a) Any irrigation or supply wells located within the land application area shall have a surface pad constructed in accordance with the recommendations of 19.27.4.29(G) NMAC and a permanent well cap or cover pursuant to 19.27.4.29(I) NMAC. [20.6.6.21(N) NMAC]
Operations and Maintenance All Land Application Areas
b) Land apply wastewater and/or stormwater uniformly to all fields within the land application area as authorized in **Section B100** and a planned rate consistent with an approved **NMP**. [20.6.6.21(B) NMAC]
c) Land apply wastewater and/or stormwater **only** to field(s) within the land application area receiving fresh irrigation water. Wastewater and/or stormwater are intended as sources of crop nutrients and shall not be used as a primary source to meet the water consumptive needs of a crop.
d) Land apply, as required, manure solids and composted material to the land application area in accordance with an approved **NMP**. [20.6.6.20(S) NMAC]
e) As required, blend wastewater with fresh water using any of the methods provided in 20.6.6.21(D) NMAC.
f) Minimize ponding within the land application area. [20.6.6.21(B) NMAC]

Table B3
Land Application Area Management

g) Remove crops from fields within the land application area by mechanical harvest in a manner consistent with an approved **NMP** [20.6.6.21(J) NMAC]
h) Crops may be grazed prior to and between mechanical harvests and nitrogen removal, however, nitrogen removal credit cannot be taken for grazing activities unless a grazing plan is developed and submitted as part of an approved **NMP**.
i) Utilize flow meters (**Table B6**) installed on one or more discharge or transfer line(s) to monitor and record the volume of wastewater and/or stormwater distributed to the land application area. [20.6.6.21(G and H) NMAC]
j) Per 20.6.6.21(L) NMAC, utilize and maintain backflow prevention devices as summarized in **Table B7** of this Discharge Permit.
Inspection and Monitoring All Land Application Areas
k) Perform routine soil sampling in each field within the land application area in accordance with 20.6.6.25(K and L) NMAC. Report analytical results and provide a map depicting the soil sampling locations within each field annually to NMED as part of the **Quarterly Monitoring Report** due **May 1**. • For fields currently receiving or having received wastewater, collect soil samples annually regardless of whether the field is cropped, remains fallow, or has recently received wastewater or stormwater.
l) Annually collect a sample of irrigation water supplied from each well or a group of physically connected wells and analyze for nitrate as nitrogen and total Kjeldahl nitrogen, pursuant to 20.6.6.24(B)NMAC. Report results to NMED as part of the **Quarterly Monitoring Report** due **May 1**. If the results are consistent for the first **five years** of annual sampling, sampling frequency may be reduced to once every other year. [20.6.6.25(E) NMAC]
m) Collect and analyze a composite sample of plant material representative of each type of crop harvested from each field in the land application area over the course of the year in accordance with 20.6.6.25(I) NMAC. The Permittee may use the most recent book values included in the NMSU/NRCS 590 jobsheet or data obtained from the USDA PLANTS Database as an alternative method to estimate the nitrogen concentration of harvested crops. Report results to NMED as part of the next scheduled **Quarterly Monitoring Report**.
n) Annually collect a composite sample to calculate actual nitrogen content values of on-site manure solids or estimate the nitrogen content of the manure solids applied to each field of the land application area at 25 pounds/ton. [20.6.6.25(D) NMAC] Collect and analyze sample in accordance with the requirements listed in 20.6.6.25(D) NMAC: Report results to NMED as part of the next scheduled **Quarterly Monitoring Report**.
Recordkeeping and Reporting All Land Application Areas
o) Submit annual updates to the approved **NMP** to NMED as part of the **Quarterly Monitoring Report** due **May 1**. [20.6.6.21(I) NMAC]
p) If blending, maintain an accurate written record of the volume of fresh water added to the wastewater to properly calculate the overall volume of wastewater applied under an approved **NMP**.
q) Maintain and submit land application data sheets (LADS) for each authorized field within the land application area in accordance with 20.6.6.25(G) NMAC. Submit completed sheets or a statement that land application did not occur to NMED as part of each **Quarterly Monitoring Report**.
r) Maintain a log recording for fluid volume(s) being land applied that includes the following: • date and location of each discharge • flow meter readings immediately prior to and after each discharge

Table B3
Land Application Area Management

• calculated total volume of each discharge reported in gallons and acre-feet
s) Submit a copy of the current log to NMED as part of each **Quarterly Monitoring Report**. [20.6.6.25(B) NMAC]
t) Maintain a log recording for all additional fertilizers applied to each field within the land application area that includes the following: • date of fertilizer application • type and form of fertilizer • fertilizer analysis • amount of fertilizer applied (pounds/acre) to each field • amount of nutrients applied (pounds/acre) to each field
u) Submit a copy of the current log to NMED as part of each **Quarterly Monitoring Report**. [20.6.6.25(F) NMAC]
v) Maintain an inspection log on-site regarding maintenance of land application infrastructure. Provide log to NMED upon request. [20.6.6.21(K) NMAC]
w) Estimate the annual volume of fresh water applied to each field within the land application area: Report results to NMED as part of the **Quarterly Monitoring Report** due **May 1**. [20.6.6.25(E) NMAC]
x) Per 20.6.6.25(H) NMAC, submit crop yield documentation and plant and harvest dates of each crop grown to NMED as part of the next scheduled **Quarterly Monitoring Report**.
y) Per 20.6.6.25(J) NMAC, submit a nitrogen removal summary report to NMED as part of the next scheduled **Quarterly Monitoring Report**.

C. **Stormwater Management -** The Permittee shall manage stormwater at the dairy facility in accordance with 20.6.6 NMAC and the conditions summarized in **Table B4** below.

Table B4
Stormwater Management

Engineering and Surveying
a) Within 120 days of effective date of this Discharge Permit (by **May 28, 2022**), submit a survey providing volumes (capacities) of Runoff East, Runoff West, and Runoff South, as pursuant to Section H(2) of 20.6.6.12 NMAC.
b) If applicable to the Proposed Runoff Ponds, prior to initiating improvements or repairs to an existing impoundment, submit for approval (as part of the design plans and specifications) a temporary wastewater or stormwater management plan to be implemented during the improvement phase. [20.6.6.17(C) NMAC] The plan shall include, at a minimum: • A description of how on-going stormwater collection will be handled and disposed of during improvement • A description of how solids and wastewater or stormwater within the impoundment will be removed and disposed of prior to beginning improvement • A schedule for implementation through completion of the project

Table B4
Stormwater Management

If the plan proposes temporary use of a location for the discharge of wastewater not authorized by this effective Discharge Permit, the Permittee shall request temporary permission to discharge from NMED.
Operations and Maintenance
c) Implement stormwater management by observing the facility for the presence of standing liquid after every precipitation event as follows: [20.6.2.3109 NMAC] • Maintain stormwater conveyance [20.6.6.20(H) NMAC] • Divert stormwater to minimize stormwater ponding and infiltration. [20.6.6.20(H) NMAC] • Maintain diversions for facility stormwater run-on and run-off to prevent ponding within areas used for manure and compost stockpiling [20.6.6.20(S) NMAC] d) Apply stormwater to fields within the land application area in accordance with **Table B3** of this Discharge Permit. e) Transfer stormwater collected in unlined stormwater impoundments to the wastewater impoundments as soon as practicable, and in no case more than 14 days after the subject storm event, in accordance with 20.6.6.20(I) NMAC. Operational pumps shall be available on-site at all times to enable transfer.
Inspection and Monitoring
f) Visually inspect all facility pipes and fixtures on a weekly basis for evidence of leaks or failure. [20.6.6.20(Q) NMAC]
Recordkeeping and Reporting
g) None required.

D. **Manure Solids Separator** - The Permittee shall employ manure solids separation at the dairy facility in accordance with 20.6.6.20(F) NMAC and the conditions summarized in **Table B5** below.

Table B5
Manure Solids Separator

Engineering and Surveying
a) None required.
Operations and Maintenance
b) Regularly remove all manure solids (and any composted material) from the separation system(s) for appropriate disposal per 20.6.6.20(S) NMAC. c) Collect and contain all manure solids and leachate generated from those solids as part of the manure solids separation system on an impervious surface prior to disposal.
Inspection and Monitoring
d) None required.
Recordkeeping and Reporting
e) None required.

E. **Flow Meters** – Pursuant to 20.6.6.20 and 20.6.6.21 NMAC, the Permittee shall employ a flow metering system that uses flow measurement devices (flow meters) to measure the volume(s) of 1) wastewater discharged from the production area and 2) wastewater and stormwater transferred and land applied at the dairy facility. All flow meters employed at a dairy facility shall be managed in accordance with 20.6.6 NMAC and the conditions listed in **Table B6** below.

Table B6
Flow Meters

Engineering and Surveying
a) None required.
Operations and Maintenance
b) The following flow meter(s) are approved for continued use in compliance with 20.6.6.20(J) NMAC: **Calf Sump Meter, Dairy 1 Sump Meter, Dairy 3 sump Meter, Separator Meter, and Land Application Meter.**
c) All flow meters shall be calibrated in accordance with the manufacturer's requirements prior to installation or reinstallation following repair. [20.6.6.20(J) NMAC]
Inspection and Monitoring
d) Using flow meter(s) installed on the discharge line, directly measure the volume of all wastewater discharged to the impoundments authorized to contain wastewater. [20.6.6.20(N) NMAC]
e) Using flow meter(s) installed on the discharge line(s), directly measure the volume of all wastewater or combination wastewater/stormwater discharged to each field within the land application area. Record readings immediately prior to and after each discharge and calculate the total volume of each discharge in both gallons and in acre-feet. [20.6.6.25(A) NMAC]
f) Visually inspect flow meters on a weekly basis for evidence of malfunction. If a visual inspection indicates a flow meter is not functioning to measure flow, the Permittee shall initiate repair or replacement of the meter within seven days of discovery. [20.6.6.20(O) NMAC]
Recordkeeping and Reporting
g) Maintain copies of the manufacturer's certificate of calibration and the manufacturer's recommended maintenance schedule at the facility.
h) Record of meter readings at intervals not to exceed monthly. The average daily discharge volume for each recording interval shall be calculated by dividing the difference between the meter readings by the number of days between meter readings. [20.6.6.24(C)NMAC]
i) Record meter readings (without adjustments or deductions) and submit in the **Quarterly Monitoring Report** [20.6.6.20(N) NMAC]. Include the date, time and units of each measurement, and calculations for the average daily volumes of wastewater discharged to the impoundments, reported in gallons per day. [20.6.6.24(C)NMAC]
j) For meters requiring repair, submit a report to NMED on the quarter following the repair that includes a description of the malfunction, a statement verifying the repair, and a copy of the manufacturer's or repairer's certificate of calibration.
k) For meters requiring replacement, submit a report to NMED on the quarter following the replacement that includes plans for the device pursuant to 20.6.6.17(C) NMAC, a copy of the manufacturer's certificate of calibration, and a copy of the manufacturer's recommended maintenance schedule.

F. **Backflow Prevention Device(s)** - Per 20.6.6.21 NMAC, the Permittee shall protect all water wells used within a land application distribution system from contamination by wastewater or stormwater backflow by installing and maintaining backflow prevention methods or devices. The backflow prevention system(s) employed at a dairy facility shall be managed in accordance with the conditions listed in **Table B7** below.

Table B7
Backflow Prevention

Engineering and Surveying
a) None required.
Operations and Maintenance
b) Maintain all backflow prevention methods or devices in compliance with 20.6.6.21(L) NMAC.
c) Repair or replace a malfunctioning check valve device within 30 days of discovery, and use of all wastewater supply lines associated with the check valve device shall cease until repair or replacement has been completed. [20.6.6.21(M) NMAC]
Inspection and Monitoring
d) Inspect each check valve device monthly when the well is in operation. [20.6.6.21(M) NMAC]
Recordkeeping and Reporting
e) Submit annually copies of the inspection and maintenance records for each check valve device associated with the backflow prevention program for the previous year to NMED as part of the **Quarterly Monitoring Report** due **May 1**. [20.6.6.21(M) NMAC]

G. **Monitoring Well(s)** - Per 20.6.6.23.A NMAC, a Permittee is required to install a sufficient number of monitoring wells at appropriate depths and locations to monitor groundwater quality upgradient of a dairy facility and hydrologically downgradient of each source of groundwater contamination: wastewater, stormwater, and combination wastewater/stormwater impoundments, and fields within the land application area. The approved groundwater monitoring well system at a dairy facility is detailed in **Table B8** below.

Table B8
Groundwater Monitoring Wells

Engineering and Surveying
a) To achieve compliance with the facility monitoring requirements set forth in this Discharge Permit and the Dairy Rule, the Permittee shall submit a written proposal describing which existing monitoring wells will be utilized as 1) an upgradient well and 2) a well downgradient. This proposal must be submitted for review and approval by NMED within 60 days following the effective date of this Discharge Permit (by **March 29, 2022**). The proposal shall designate the locations of all monitoring wells required by this Discharge Permit. The proposal shall include, at a minimum, the following information: • A map showing the proposed location of the monitoring well(s) from the boundary of the source it is intended to monitor

Table B8
Groundwater Monitoring Wells

• A statement describing groundwater flow direction beneath the facility, and documentation and/or data supporting the determination All proposed monitoring well locations shall be approved by NMED. [NMSA 1978, § 74-6-5.D, 20.6.2.3109(B) NMAC]
Operations and Maintenance
b) Operate and maintain the following facility groundwater monitoring well(s) in compliance with 20.6.6.23(A) NMAC and this section of this Discharge Permit: ***MW-1, MW-4, MW-6, MW-7.*** c) Verify all facility monitoring wells are permanently identified in accordance with 20.6.6.23(C) NMAC.
Inspection and Monitoring
d) Perform quarterly groundwater sampling in accordance with 20.6.6.23(F) NMAC to comply with the required monitoring reporting schedule listed in **Table C1**. e) Analyze collected groundwater sample(s) according to the methods listed in 20.6.6.24(B)and 20.6.2.3107(B) NMAC. Pursuant to 20.6.6.24(B)NMAC, sample constituents that require analysis and reporting to NMED include: nitrate as nitrogen, total Kjeldahl nitrogen, chloride, sulfate and total dissolved solids. [20.6.6.23(G) NMAC] f) Prior to the expiration date of this Discharge Permit, NMED shall have the option to perform one downhole inspection of each monitoring well identified in this Discharge Permit. NMED shall establish the inspection date and provide at least 60 days' notice to the Permittee by certified mail. The Permittee shall have any existing dedicated pumps removed at least 48 hours prior to NMED inspection to allow adequate settling time of any sediment agitated as a result of pump removal. g) Should a facility not have existing dedicated pumps, but decide to install pumps in any of the monitoring wells, NMED shall be notified at least 90 days prior to pump installation so that a downhole well inspection can be scheduled prior to pump placement. [20.6.2.3107 NMAC]
Recordkeeping and Reporting
h) A **Quarterly Monitoring Report** shall be filed with NMED in accordance with the general reporting schedule listed in **Table C1**. Each **Quarterly Monitoring Report** shall contain, at a minimum, the following information: [20.6.6.23(G) NMAC] • Facility map with location and number of each well in relation to the contamination source it is intended to monitor • Depth-to-shallowest groundwater measurements • Field parameter measurements and parameter stabilization log • Analytical results (including the laboratory quality assurance and quality control summary report) • Groundwater elevation contour maps utilizing elevation contours of 2 ft or less in accordance with 20.6.6.23(L) NMAC

B103 **Facility: Conditions for Closure**

A. The Permittee shall comply with the requirements of 20.6.6.30 NMAC and shall submit to NMED all information or documentation required by the applicable portions of 20.6.6.30 NMAC.

B. Within 180 days of the effective date of this Discharge Permit (by **July 27, 2022**), the Permittee shall properly plug and abandon the following existing monitoring wells in accordance with 20.6.6.30(C) NMAC.

1. **MW-3**, located at the commodities area southwest of Field 1

Well[s] shall be plugged and abandoned in pursuant to 19.27.4 NMAC and 20.6.6.30(C) NMAC and in accordance with NMED's *Monitoring Well Construction and Abandonment Guidelines* and any other applicable local, state, and federal regulations. Documentation describing the plug and abandonment procedures, including photographic documentation, shall be presented in a **Well Abandonment Report**. The **Well Abandonment Report** shall be submitted to NMED within 60 days of completion of well plugging activities.

C. For permanent closure, the following closure actions shall be completed upon permanent cessation of wastewater discharge:

1. Notify NMED of closure plans within 30 days of cessation.
2. Provide NMED with a **Disposal Plan** for closure activities: Implement **Disposal Plan** upon NMED approval.
3. Remove all manure solids and compost from surface areas.
4. Empty all facility impoundments of wastewater within 6 months of cessation.
5. Empty all facility impoundments of stormwater within 1 year of cessation.
6. Complete removal of manure solids from wastewater impoundments within 2 years of cessation
7. Perforate or remove impoundment liner(s), as applicable, re-grade impoundments with clean fill, and blend area with surrounding surface topography to prevent ponding within 2 years of cessation
8. Dispose all wastes according the approved **Disposal Plan**.

9. Perform post-closure monitoring at all facility monitoring wells for a minimum of eight consecutive groundwater sampling events to confirm that the standards of 20.6.2.3103 NMAC are not exceeded and the total nitrogen concentration in groundwater is less than or equal to 10 mg/L. If monitoring results show a failure of one or both of these conditions, the Permittee shall implement contingency requirements pursuant to 20.6.6.27 NMAC (**Section B103**).

B104 **Facility: Contingency Plan**

A. In the event NMED or the Permittee identifies any failures of the Discharge Permit or system not specifically noted herein, NMED may require the Permittee to develop for NMED approval a contingency or corrective action plan and schedule to cope with the failure(s) [20.6.2.3107.A(10) NMAC].

B. Facility conditions that will invariably require Permittee action under one or more contingency plans include:

1. **Exceedance of groundwater quality standards** – Constituent concentration(s) in one or more groundwater samples collected from a monitoring well intended to monitor contamination sources at a dairy facility including impoundments exceed (1) one or more of the groundwater standards of 20.6.2.3103 NMAC and (2) reported constituent concentration(s) in one or more groundwater samples collected from the upgradient monitoring well for four consecutive quarters.
2. **Ineffective groundwater monitoring well(s)** – One or more monitoring well(s) required by 20.6.6.23 NMAC are (1) not located hydrologically downgradient of the contamination source(s) intended to monitor, (2) not completed pursuant to 20.6.6.23 NMAC or (3) contains insufficient water to monitor groundwater quality effectively.
3. **Exceedance(s) of permitted maximum daily discharge volume** - The maximum daily discharge volume authorized by this Discharge Permit is exceeded by more than ten percent for any four average daily discharge volumes within any 12-week period.
4. **Insufficient impoundment capacity** - A survey, capacity calculations, or settled solids thickness measurements indicate an existing impoundment is not capable of meeting the capacity requirements required by 20.6.6.17(D) NMAC.
5. **Inability to maintain required freeboard**- A minimum of two feet of freeboard cannot be preserved in one or more wastewater impoundment(s).
6. **Impoundment(s) structural integrity compromised** - Any damage to the berms or the liner of an impoundment or any condition that exists that may compromise the structural integrity of the impoundment.
7. **Spills, leaks, unauthorized discharge** – Any spill or release that is not authorized under this Discharge Permit.

C. If a contingency or corrective action plan is required, the Permittee shall comply with the requirements of 20.6.2.1203 and 20.6.6.27 NMAC, and shall submit to NMED all information or documentation required by the applicable portions of 20.6.2.1203 and 20.6.6.27 NMAC.

The Permittee may be required to abate water pollution pursuant to 20.6.2.4000 through 20.6.2.4115 NMAC, should the corrective action plan not result in compliance with the standards and requirements set forth in 20.6.2.4103 NMAC.

PART C GENERAL CONDITIONS

C100 Introduction

A. NMED has reviewed the discharge permit application for the proposed renewal and has determined that the provisions of the Dairy Rule and applicable groundwater quality standards will be met in accordance with this Discharge Permit. General conditions for all Discharge Permits issued by the Ground Water Quality Bureau pursuant to NMAC 20.6.2 as well as specific conditions as applied to the operation and maintenance of a dairy facility with use of a land application area pursuant to 20.6.6 NMAC are summarized on **Table C1**. Unless otherwise specified in Parts A or B of this Discharge Permit, both the general discharge permit conditions (as listed in this part) and facility-specific conditions as listed in **Part B** are mandated to assure continued compliance.

Table C1
General Discharge Permit Conditions for a Dairy Facility:
Existing with a Land Application Area

Engineering and Surveying
a) Comply with the requirements of 20.6.6.17 NMAC and submit to NMED all information or documentation required by the applicable portions of 20.6.6.17 NMAC.
Operations and Maintenance
b) Comply with the requirements of 20.6.6.20 and 20.6.6.21 NMAC, and submit to NMED all information or documentation required by the applicable portions of 20.6.6.20 and 20.6.6.21 NMAC.
c) Operate in a manner such that standards and requirements of 20.6.2.3101 and 20.6.2.3103 NMAC are not violated.
d) Manage disposal of all manure solids and composted material generated at the facility in accordance with 20.6.6.20(S) NMAC.
e) Repair or replace compromised pipe(s) or fixture(s) within 72 hours of discovery. [20.6.6.20(Q) NMAC]
f) Manage all animal mortalities at the facility in compliance with 20.6.6.20(W) NMAC.
Inspection and Monitoring
g) **Wastewater** - Comply with the requirements of 20.6.6.24 and 20.6.6.25 NMAC, and submit to NMED all information or documentation required by the applicable portions of 20.6.6.24 and 20.6.6.25 NMAC.
h) **Stormwater** - Comply with the requirements of 20.6.6.24 and 20.6.6.25 NMAC, and submit to NMED all information or documentation required by the applicable portions of 20.6.6.24 and 20.6.6.25 NMAC.
i) **Groundwater** - Comply with the requirements of 20.6.6.23 NMAC and submit to NMED all information or documentation required by the applicable portions of 20.6.6.23 NMAC.
j) Visually inspect all facility pipes and fixtures on a weekly basis for evidence of leaks or failure. [20.6.6.20(Q) NMAC]
Recordkeeping and Reporting

Table C1
General Discharge Permit Conditions for a Dairy Facility:
Existing with a Land Application Area

k) Maintain written records at the dairy facility of any inspection(s), repairs and maintenance conducted on facility infrastructure as related the wastewater management system.
l) Generate monitoring reports that contain monitoring data and information collected pursuant to the Dairy Rule and as described in applicable sections of this Discharge Permit.
m) Retain required records for a minimum period of 10 years from the date of any sample collection, measurement, report or application in accordance with 20.6.6.33 NMAC.
n) Unless otherwise identified in this Discharge Permit, submit monitoring reports to NMED quarterly according to the following schedule: [20.6.6.24(A) NMAC] • January 1 through March 31 (first quarter) – report due by **May 1** • April 1 through June 30 (second quarter) – report due by **August 1** • July 1 through September 30 (third quarter) – report due by **November 1** • October 1 through December 31 (fourth quarter) – report due by **February 1**
o) Provide written notice to NMED regarding any changes to the presence of lactating cows at the facility to achieve compliance with 20.6.6.20(A) NMAC as follows: • Verify with NMED within 30 days of the actual removal/reintroduction
p) Within 90 days of any addition or change to the dairy facility which affect one or more items listed in 20.6.6.20(U) NMAC, update and resubmit a facility map pursuant to 20.6.6.17(C) NMAC. [20.6.6.20(V) NMAC]

C101 **Legal**

A. Nothing in this Discharge Permit shall be construed in any way as relieving the Permittee of the obligation to comply with all applicable federal, state, and local laws, regulations, permits or orders [20.6.2 NMAC].

B. Pursuant to 20.6.2.3109 NMAC, NMED reserves the right to require a Discharge Permit Modification in the event NMED determines that the requirements of 20.6.2 NMAC are being or may be violated or the standards of 20.6.2.3103 NMAC are being or may be violated. NMED may require more stringent requirements to protect groundwater quality if a determination that structural controls and/or management practices approved under this Discharge Permit are not protective of groundwater quality. NMED may require the Permittee to implement abatement of water pollution and remediate groundwater quality.

C. Any violation of the requirements and conditions of this Discharge Permit, including any failure to allow NMED staff to enter and inspect records or facilities, or any refusal or failure to provide NMED with records or information, may subject the Permittee to a civil enforcement action. Pursuant to WQA 74-6-10(A) and (B), such action may include a compliance order requiring compliance immediately or in a specified time, assessing a civil penalty, modifying or terminating the Discharge Permit, or any combination of the foregoing; or an action in district court seeking injunctive relief, civil penalties, or both. Pursuant to WQA 74-6-10(C) and 74-6-10.1, civil penalties of up to $15,000 per day of noncompliance may be assessed for each violation of the WQA 74-6-5, the WQCC Regulations, or this Discharge Permit, and civil penalties of up to $10,000 per day of noncompliance may be assessed for each violation of any other provision of the WQA, or any regulation, standard, or order adopted pursuant to such other provision. In any action to enforce this Discharge Permit, the Permittee waives any objection to the admissibility as evidence of any data generated pursuant to this Discharge Permit. [74-6-10 WQA, 74-6-10.1 WQA]

D. Pursuant to WQA 74-6-10.2(A-F), NMED shall assess criminal penalties for any person who knowingly violates or knowingly causes or allows another person to:

1. Make any false material statement, representation, certification or omission of material fact in an application, record, report, plan or other document filed, submitted or required to be maintained under the WQA;
2. Falsify, tamper with or render inaccurate any monitoring device, method or record required to be maintained under the WQA; or
3. Fail to monitor, sample or report as required by a permit issued pursuant to a state or federal law or regulation, is subject to felony charges and shall be sentenced in accordance with the provisions of 31-18-15 NMSA 1978.

E. The Permittee shall notify the proposed transferee in writing of the existence of this Discharge Permit and include a copy of this Discharge Permit with the notice in accordance with 20.6.2.3111 NMAC, prior to the transfer of any ownership, control, or possession of this permitted facility or any portion thereof. The transferee(s) shall notify NMED, in writing, of the date of transfer of ownership and provide contact information for the new owner(s) pursuant to 20.6.6.12(B) NMAC. Submit to NMED notification of the transfer within 30 days of the ownership transfer date. [20.6.6.34 NMAC]

F. Pursuant to WQA 74-6-5(o), the Permittee has a right to appeal the conditions and requirements as outlined in this Discharge Permit through filing a petition for review before the WQCC. Such petition shall be in writing to the WQCC within thirty (30) days of the receipt of this Discharge Permit. Unless a timely petition for review is made, the decision of NMED shall be final and not subject to judicial review.

C102 General Inspection and Entry Requirements

A. Nothing in this Discharge Permit shall limit in any way the inspection and entry authority of NMED under the WQA, the WQCC Regulations, or any other applicable law or regulation. [20.6.2.3107 NMAC, 74-6-9(B) & (E) WQA]

B. The Permittee shall allow the Secretary or an authorized representative, upon the presentation of credentials, to [20.6.2.3107.D NMAC, 74-6-9(B) & (E) WQA]:

1. Enter at regular business hours or at other reasonable times upon the Permittee's premises or other location where records must be kept under the conditions of this Discharge Permit, or under any federal or WQCC regulation.

2. Inspect and copy, during regular business hours or at other reasonable times, any records required to be kept under the conditions of this Discharge Permit, or under any federal or WQCC regulation.
3. Inspect, at regular business hours or at other reasonable times, any facility, equipment (including monitoring and control equipment or treatment works), practices or operations regulated or required under this Discharge Permit, or under any federal or WQCC regulation.
4. Sample or monitor, at reasonable times for the purpose of assuring compliance with this Discharge Permit or as otherwise authorized by the WQA, any effluent, water contaminant, or receiving water at any location before or after discharge.

C103 **<u>General Record Keeping and Reporting Requirements</u>**

A. The Permittee shall maintain a written record of the following:

1. Amount of wastewater, effluent, leachate or other wastes discharged pursuant to this Discharge Permit. [20.6.2.3107.A NMAC]
2. Operation, maintenance, and repair of all facilities/equipment used to treat, store or dispose of wastewater; to measure flow rates, to monitor water quality, or to collect other data required by this Discharge Permit. Per 20.6.2.3107.A NMAC, this record shall include:
   a. Repair, replacement or calibration of any monitoring equipment
   b. Repair or replacement of any equipment used in the Permittee's waste or wastewater treatment and disposal system.
3. Any spills, seeps, and/or leaks of effluent, and of leachate and/or process fluids not authorized by this Discharge Permit. [20.6.2.3107.A NMAC]

B. The Permittee shall maintain at its facility a written record of all data and information related to field measurements, sampling, and analysis conducted pursuant to this Discharge Permit. The following information shall be recorded and shall be made available to NMED upon request:

1. The dates, exact place and times of sampling or field measurements;
2. The name and job title of the individuals who performed each sample collection or field measurement;
3. The date of the analysis of each sample;
4. The name and address of the laboratory and the name and job title of the person that performed the analysis of each sample;
5. The analytical technique or method used to analyze each sample or take each field measurement;
6. The results of each analysis or field measurement, including raw data;
7. The results of any split sampling, spikes or repeat sampling; and

8. A description of the quality assurance (QA) and quality control (QC) procedures used.

C. The Permittee shall furnish to NMED, within a reasonable time, any documents or other information which it may request to determine whether cause exists for modifying, terminating and/or renewing this Discharge Permit or to determine compliance with this Discharge Permit. The Permittee shall also furnish to NMED, upon request, copies of documents required to be kept by this Discharge Permit. [20.6.2.3107.D NMAC, 74-6-9(B) & (E) WQA]

C104 Modifications and/or Amendments

A. The Permittee shall notify NMED of any changes to the Permittee's wastewater treatment and disposal system, including any changes in the wastewater flow rate or the volume of wastewater storage, or of any other changes to operations or processes that would result in any significant change in the discharge of water contaminants. The Permittee shall obtain NMED's approval, as a modification to this Discharge Permit pursuant to 20.6.2.3109(E, F, or G) NMAC, prior to any increase in the quantity discharged, or any increase in the concentration of water contaminants discharged, above those levels approved in this Discharge Permit [20.6.2.3107.C NMAC].

B. The Permittee shall file plans and specifications with NMED for the construction of a wastewater system and for proposed changes that will change substantially the quantity or quality of the discharge from the system. The Permittee shall file plans and specifications prior to the commencement of construction. Changes to the wastewater system having a minor effect on the character of the discharge shall be reported as of January 1 and June 30 of each year to NMED. [20.6.2.1202 NMAC]

Part D MISCELLANEOUS

D100 Supporting On-Line Documents

A. Copies of the following documents can be downloaded from NMED's web site under Forms.

https://www.env.nm.gov/forms/

1. Notice of Intent to Discharge
2. Application for a New Discharge Permit (dairy facility only)
3. Application for Discharge Permit Renewal and/or Modification (dairy facility only)
4. Application for Discharge Permit Renewal for Closure (dairy facility only)

D101 Definitions

A. "**abatement plan**" means a description of any operational, monitoring, contingency and closure requirements and conditions for the prevention, investigation and abatement of water pollution, and includes Stage 1, Stage 2, or Stage 1 and 2 of the abatement plan, as approved by the secretary

B. "**commission**" means:

1. the New Mexico water quality control commission (WQCC), or
2. NMED, when used in connection with any administrative and enforcement activity

C. "**dairy facility**" means the production area and the land application area, where the discharge and associated activities will or do take place

D. "**Dairy rule**" means 20.6.6 NMAC, as amended

E. "**NMED**", "**agency**", or "**division**" means the New Mexico Environment Department or a constituent agency designated by the **commission**

F. "**discharge permit**" means a discharge plan approved by NMED

G. "**discharge permit modification**" means a change to the requirements of a discharge permit that result from a change in the location of the discharge, a significant increase in the quantity of the discharge, a significant change in the quality of the discharge; or as required by the secretary

H. "**discharge permit renewal**" means the re-issuance of a discharge permit for the same, previously permitted discharge

I. "**discharge plan**" means a description of any operational, monitoring, contingency, and closure requirements and conditions for any discharge of effluent or leachate which may move directly or indirectly into groundwater

J. "**discharge site**" means the entire site where the discharge and associated activities will take place

K. "**discharge volume**" means the measured daily volume of wastewater actually discharged within the production area. This definition does not include the volume of wastewater discharged to a land application area (if applicable).

L. "**disposal**" means to abandon, deposit, inter or otherwise discard a fluid as a final action after its use has been achieved

M. "**existing dairy facility**" means a dairy facility that is currently discharging, or has previously discharged and has not been issued a notice from NMED verifying that closure and post-closure monitoring activities have been completed

N. "**fluid**" means material or substance which flows or moves whether in a semisolid, liquid, sludge, gas, or any other form or state

O. "**flow meter**" means a device used to measure the volume of water, wastewater or stormwater that passes a particular reference section in a unit of time

P. "**freeboard**" means the vertical distance between the elevation at the lowest point of the top inside edge of the impoundment and the design high water elevation of the water level in the impoundment

Q. "**groundwater**" means interstitial water which occurs in saturated earth material and which is capable of entering a well in sufficient amounts to be utilized as a water supply

R. "**impoundment**" means any structure designed and used for storage or disposal by evaporation of wastewater, stormwater, or a combination of both wastewater and stormwater. A multiple-cell impoundment system having at least one shared berm or barrier whose smallest cells have a cumulative constructed capacity of 10 percent or less of the constructed capacity of the largest cell shall be considered a single impoundment for the purposes of the Dairy Rule. A wastewater or stormwater transfer sump or a solids settling separator is not an impoundment

S. "**manure**" means an agricultural waste composed of excreta of animals, and residual bedding materials, waste feed or other materials that have contacted excreta from such animals

T. "**maximum daily discharge volume**" means the total daily volume of wastewater (expressed in gallons per day) authorized for discharge by a discharge permit. This definition does not include the volume of wastewater discharged to a land application area (as applicable)

U. "**owner of record**" means an owner of property according to the property records of the tax assessor in the county in which the discharge site is located at the time the application was deemed administratively complete

V. "**permittee**" means a person who is issued or receives by transfer a discharge permit for a dairy facility or, in the absence of a discharge permit, a person who makes or controls a discharge at a dairy facility.

W. "**production area**" means that part of the animal feeding operation that includes the following: the animal confinement areas; the manure, residual solids and compost storage areas; the raw materials storage areas; and the wastewater and stormwater containment areas. The animal confinement areas include but are not limited to open lots, housed lots, feedlots, confinement barns, stall barns, free stall barns, milkrooms, milk centers, cowyards, barnyards, hospital pens and barns, and animal walkways. The manure, residual solids and compost storage areas include, but are not limited to, storage sheds, stockpiles, static piles, and composting piles. The raw materials storage areas include, but are not limited, to feed silos, silage storage areas, feed storage barns, and liquid feed tanks. The wastewater and stormwater containment areas include, but are not limited to, settling separators, impoundments, sumps, run-off drainage channels, and areas within berms and diversions which prohibit uncontaminated stormwater from coming into contact with contaminants

X. "**responsible person**" means a person who is required to submit a discharge permit or who submits a discharge permit

Y. "**secretary**" or "**director**" means the secretary of the New Mexico Environment Department or the director of a constituent agency designated by the **commission**

Z. "**spillway**" means a structure used for controlled releases from an impoundment designed to receive stormwater, in a manner that protects the structural integrity of the impoundment

AA. "**stormwater**" means direct precipitation and run-off that comes into contact with water contaminants within the production area of a dairy facility

BB. "**TDS**" means total dissolved solids as determined by the "calculation method" (sum of constituents), by the "residue on evaporation method at 180 degrees" of the "U.S. geological survey techniques of water resource investigations," or by conductivity, as the secretary may determine

CC. "**toxic pollutant**" means a water contaminant or combination of water contaminants in concentration(s) which, upon exposure, ingestion, or assimilation either directly from the environment or indirectly by ingestion through food chains, will unreasonably threaten to injure human health, or the health of animals or plants which are commonly hatched, bred, cultivated or protected for use by man for food or economic benefit; as used in this definition injuries to health include death, histopathologic change, clinical symptoms of disease, behavioral abnormalities, genetic mutation, physiological malfunctions or physical deformations in such organisms or their offspring; in order to be considered a toxic pollutant a contaminant must be one or a combination of the potential toxic pollutants listed below and be at a concentration shown by scientific information currently available to the public to have potential for causing one or more of the effects listed above; any water contaminant or combination of the water contaminants in the list below creating a lifetime risk of more than one cancer per 100,000 exposed persons is a toxic pollutant. The list of **toxic pollutants** recognized by NMED can be found in 20.6.2.7(T) NMAC.

DD. "**unauthorized discharg**e" means a release of wastewater, stormwater or other substances containing water contaminants not approved by a discharge permit

EE. "**wastewater**" means water, that has come into contact with water contaminants as a result of being directly or indirectly used in the operations of a dairy facility including, but not limited to, the following: washing, cleaning, or flushing barns or other roof-covered production areas; washing of animals; spray-cooling of animals (except in open lots); and cooling or cleaning of feed mills and equipment. Wastewater does not include overflow from the drinking water system or stormwater unless overflow or stormwater that is collected is comingled with wastewater, or it comes into contact with water contaminants as a result of being directly or indirectly used in dairy facility operations

FF. "**wastes**" means sewage, industrial wastes, or any other liquid, gaseous or solid substance which will pollute any waters of the state

GG. "**water**" means all water including water situated wholly or partly within or bordering upon the state, whether surface or subsurface, public or private, except private waters that do not combine with other surface or subsurface water

HH. "**water contaminant**" means any substance that could alter if discharged or spilled the physical, chemical, biological or radiological qualities of water; "**water contaminant**" does not mean source, special nuclear or by-product material as defined by the Atomic Energy Act of 1954

II. "**water pollution**" means introducing or permitting the introduction into water, either directly or indirectly, of one or more water contaminants in such quantity and of such duration as may with reasonable probability injure human health, animal or plant life or property, or to unreasonably interfere with the public welfare or the use of property

D102 **Acronyms**

CQA.. construction quality assurance
CQC.. construction quality control
DP.. discharge permit
FEMA.. federal emergency management administration
FIRM.. flood insurance rate map
gpd.. gallon per day
mg/L.. milligram per liter
NMAC.. New Mexico Administrative Code
NMED.. New Mexico Environment Department
NMP.. Nutrient Management Plan
NMSA.. New Mexico Statutes Annotated
TDS.. total dissolved solids
WQA.. New Mexico Water Quality Act
WQCC.. Water Quality Control Commission

April 2025 Las Cruces, NM