Technical Memorandum

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Prepared for: City of Greeley

Project Title: Terry Ranch Water Supply Project Investigation Activities

Project No.: 154160

Technical Memorandum

Subject: Meadow Springs Ranch

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Section 1: Introduction

1.1 Background

Biosolids are a nutrient-rich organic material created from the biological and physical treatment of wastewater. They are the removed solids from the wastewater treatment process, which are required to meet strict state and federal standards. Biosolids contain plant nutrients and organic matter that can be used to improve soil structure and water retention, and as a slow-release fertilizer to improve production.

Farmers, land-reclamation specialists, landscapers and home gardeners have used these primarily organic materials for over seven decades in the United States. The Colorado Department of Public Health and Environment (CDPHE) and the United States Environmental Protection Agency (EPA) encourage and regulate recycling of biosolids on crop- and rangeland. Biosolids are treated to eliminate pathogens (disease-causing organisms) that may reside in wastewater. In Colorado, anerobic and aerobic digestion are most commonly used to treat and stabilize biosolids. Digestion destroys pathogens through heat and attack by beneficial microorganisms (e.g., anaerobic bacteria). Composting, heat drying, and other techniques are used to further reduce pathogens and stabilize the material.

The cost of sludge disposal led the City of Fort Collins (Fort Collins), along with many other cities around the country, to explore various methods of waste disposal. In 1984, the Fort Collins Utilities established a Resource Recovery Farm, located at the southwest corner of Prospect Road and Interstate 25, to experiment with the beneficial reuse of municipal biosolids from the wastewater reclamation facilities. At the Resource Recovery Farm, dewatered sludge was used to fertilize crops. The experiment was so successful that in 1990 Fort Collins bought the 26,000-acre Meadow Springs Ranch (MSR) near the Wyoming border to expand its sludge reclamation work.

MSR, which is owned and operated by Fort Collins Utilities, serves as the primary location for regulatory compliant land application of biosolids generated from Fort Collin's wastewater facilities. It provides Fort Collins with the ability to beneficially apply Class B biosolids produced from the Fort Collins Utilities' Mulberry Water Reclamation Facility (MWRF) and the Drake Water Reclamation Facility (DWRF). Biosolids from both WRFs are treated to meet strict state and federal standards for organic and pathogen removal, digested and dewatered at DWRF, then trucked and applied at MSR and private farmland.

In addition to serving as Fort Collins' primary land application site, MSR is actively managed to promote and achieve priorities focused on biosolids application, environmental stewardship, and cattle grazing operation. It is also rich in cultural and environmental resources, archeological artifacts, and provides a myriad of other benefits including a reintroduced population of black-footed ferrets.

Brown and Caldwell (BC) and LRE Water are summarizing applicable federal and state regulations, operations of MSR, publicly available data, and have performed a particle trace analysis to evaluate whether a potential water supply project (known as the Terry Ranch Project) would be impacted by its proximity to MSR.

1.2 Beneficial Use

Biosolids are a product of the wastewater treatment process, generated from solids removed through treatment process which are further treated physically and chemically to produce a semisolid, nutrient-rich product which can be put to beneficial use. Other than beneficial reuse by recycling as soil amendment, the only options for disposal of biosolids that meet EPA and CDPHE criteria are disposal via landfill or incineration. With incineration not being favorable because of air quality problems and limited space at

landfills, beneficial reuse is becoming the leading practice by wastewater treatment facilities. Examples of beneficial use include application to agricultural land, such as fields used for the production of food, feed and fiber crops, pasture and range land; non-agricultural land such as forests; public contact sites such as parks and golf courses; disturbed lands such as mine spoils, construction sites and gravel pits; and home lawns and gardens.

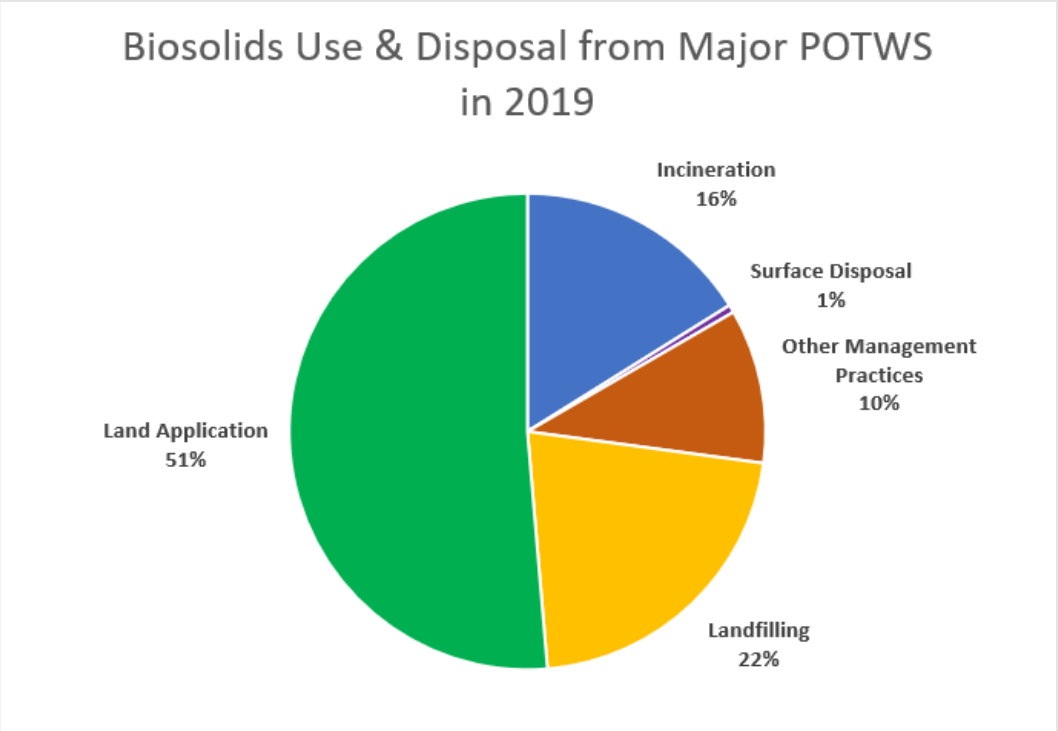

Figure 1. Biosolid Use and Disposal from Major Publicly Owned Treatment Works in 2019

Source: https://www.epa.gov/biosolids/basic-information-about-biosolids#basics

Approximately 85 percent of the biosolids generated in Colorado are recycled by land application. This compares with a U.S.-wide biosolids recycling rate of about 50 percent. In addition, 92 percent of Colorado's wastewater treatment plants recycle their biosolids[1].

Biosolids that are to be beneficially used must meet federal and state requirements (and local agency, if applicable) to ensure processing, handling, land-application, and monitoring is conducted in a manner that minimizes potential risk to human health (see Section 2). The agencies regulations include treatment requirements to address pathogens and other trace elements in biosolids, and the amount that ultimately can be added to soils growing plants. The regulations also require biosolids be land applied at the appropriate sludge application rate, or agronomic rate, which is designed to provide the amount of nitrogen needed by the crop or vegetation grown on the land. Agronomic rate is dependent on crop type, geographic location, and soil characteristics.

[1] Rocky Mountain Water Environment Association (RMWEA) brochure

When applied to land at the appropriate agronomic rate, biosolids provide several benefits including nutrient addition, improved soil structure, and water reuse. Biosolids contain many beneficial chemical constituents, often in both mineral and organic forms. The principal components (nitrogen, phosphorus and organic matter) are significant in promoting plant growth and healthy soil conditions. Biosolids enrich the soil with essential nutrients and add organic matter to soil.

In Colorado, where most soils contain less than 1.5 percent organic matter, biosolids can serve as a source of organic material that improve soil tilth, water-holding capacity, structure development and stability, and air and water transport, and can ultimately decrease soil erosion potential. In fact, a study by Harris-Pierce et al. found that surface application, without subsequent incorporation of two dry tons/acre of biosolids from the Fort Collins WRFs, increased plant canopy cover of rangeland in the first and second seasons following application2. Five dry tons/acre increased plant biomass production compared to untreated control plots in just the first season. Another study, performed at Colorado State University, concluded that the concentration of soil organic matter increased from 1.3 percent prior to biosolids application to 1.9 percent following application when biosolids were applied for four growing cycles (totaling 12 dry tons of biosolids applied per acre). This represents an overall organic matter increase of 46 percent (or approximately 10 percent per application)3.

Land application of biosolids also can have economic and waste management benefits (e.g., conservation of landfill space; reduced demand on non-renewable resources like phosphorus; and a reduced demand for synthetic fertilizers). Biosolids have long been beneficially used by farmers, horticulturists, land use specialists, and the public throughout the United States and the world. The EPA and CDPHE regulate and encourage the recycling of biosolids through land application.

Section 2: Regulatory Overview

EPA and CDPHE regulatory limits applicable to beneficial use of biosolids are established based upon extensive research regarding the effects of on various pathways of exposure, including plant toxicities and adverse effects on animal and human health. Additionally, the Clean Water Act (CWA) Section 405(d)(2)(C) requires EPA to review federal biosolids (sewage sludge) standards every two years to identify additional toxic pollutants that occur in biosolids and set regulations for those pollutants if sufficient scientific evidence shows they may harm human health or the environment.

Biosolids that are land applied are divided into two classes, “Class A” and “Class B”, based upon pathogen reduction requirements. Class A biosolids are disinfected to a level that inactivates pathogens and are subject to fewer site-specific controls. If, in addition, heavy metal concentrations are sufficiently low, Class A biosolids can be used for home gardening use without further regulation; these are referred to as Class A-EQ (exceptional quality) biosolids. Class B biosolids are treated to achieve significant (e.g., 99 percent) pathogen reduction and subject to site use and access restrictions. The different classes have specified treatment requirements for pollutants, pathogens and vector attraction reduction, as well as general requirements and management practices (40 CFR Part 503). For example, Part 503 mandates pollutant limit requirements (celling concentration) specific to each Class, which are identified for each regulated pollutant by: concentration; cumulative loading rate; and annual loading rate. Similar requirements apply to

2 Harris-Pierce et al. Harris-Pierce, R.L., E.F. Redente, and K.A. Barbarick. The effect of sewage sludge application on native rangeland soils and vegetation: Fort Collins-Meadows Springs Ranch. Colorado Agricultural Experiment Station, TR93-6. 1993.

3 USEPA Region VII. Biosolids Reference Sheet - Part 2 C. https://www.epa.gov/sites/production/files/documents/handbook2.pdf

address pathogens and vector attraction reduction. The Part 503 regulation (40 CFR 503) focuses on three parameters as a basis for determining biosolids quality:

- The presence of pollutants (arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc)
- The presence of pathogens (e.g., bacteria, viruses, parasites)
- The biosolids= attractiveness to vectors (e.g., rodents, flies, mosquitos)

Regulatory management of biosolids application is designed to protect state waters, including surface- and groundwater, from harmful levels of pollutants such as metals or pathogens that may be in found in the biosolids. For example, application rates are required to be based on the nutrient requirements of the crops fertilized with biosolid material to ensure potential pollutants are beneficially used rather than washed away and potentially contaminate ground or surface water. EPA Region 8 issued a General Permit for Colorado facilities whose operations generate, treat, and/or use/dispose of sewage sludge by means of land application, landfill, and surface disposal under the National Pollutant Discharge Elimination System (NPDES). All Colorado facilities are required to apply for and to obtain coverage under the EPA General Permit (COG650000). While the EPA is the issuing agency for biosolids permits, Colorado facilities that land apply biosolids must comply with requirements of Biosolids Regulation (Regulation No. 64, Colorado Water Quality Control Commission), such as the submission of annual reports. Additionally, in Colorado, a permit issued by the CDPHE is required to apply biosolids.

2.1 Federal

The federal regulation governing the management of biosolids is 40 CFR Part 503 and is based on the 1987 CWA amendments that directed EPA to research and promulgate regulations for use and disposal of sewage sludge. EPA issued 40 CFR Part 503, Standards for the Use or Disposal of Sewage Sludge (Biosolids Rule), to establish general management requirements, pollutant limits, management practices and operational standards for the use and disposal of sewage sludge (biosolids), and address requirement of Section 405(d) of the CWA which requires EPA to:

- Establish numeric limits and management practices that protect public health and the environment from the reasonably anticipated adverse effects of chemical and microbial pollutants during the use or disposal of sewage sludge.
- Review sewage sludge regulations every two years to identify any additional pollutants that may occur in biosolids, and then set regulations for those pollutants if sufficient scientific evidence shows they may harm human health or the environment.

40 CFR Part 503 was developed based on a multi-pathway risk assessment used by EPA for evaluating and setting limits to manage pollutants in biosolids, to provide a comprehensive risk-based rule that protects the public health and the environment from reasonably anticipated adverse effects of pollutants that may be present in biosolids (sewage sludge).

EPA uses risk assessments to characterize the nature and magnitude of health risks to humans and ecological receptors from chemical contaminants and other stressors, that may be present. While there are many definitions of the word risk, EPA considers risk to be the chance of harmful effects resulting from exposure to a physical, chemical, or biological environmental stressor that can induce an adverse response. 40 CFR 503 was developed based on the results of risk assessments to identify what, if any, risks were associated with the use or disposal of biosolids via land application, surface disposal, or incineration. In conducting the risk assessment and ongoing standards reviews, EPA engages states and tribes, risk managers, scientists, and members of the biosolids community regarding foreseeable science and

implementation issues, to identify exposure pathways and develop data and tools used for analyzing and characterizing risk.

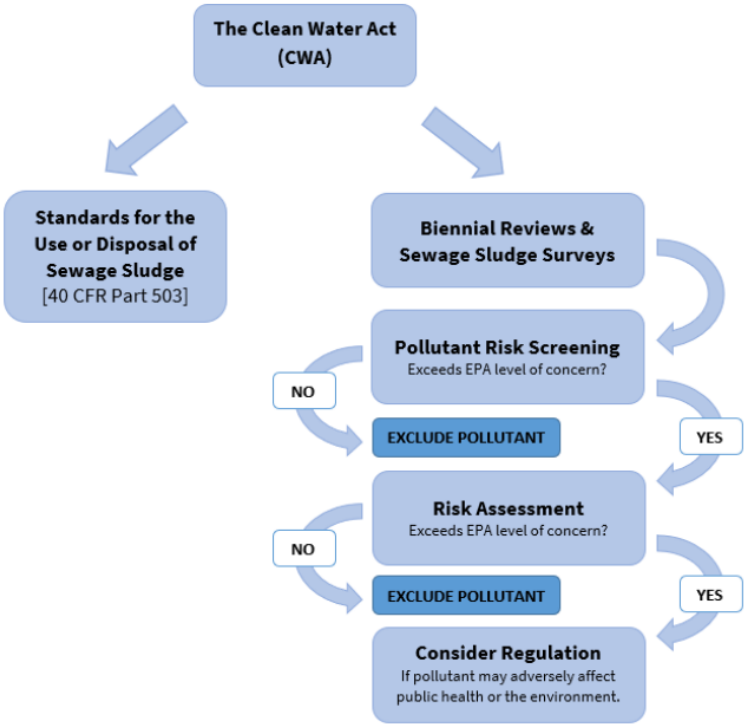

Figure 2. Clean Water Act Section 405(d) Requirements

After reviewing over 200 specific compounds and elements from an initial candidate list of thousands, EPA targeted at least 22 constituents for a formal risk assessment to examine the quantities of the metals and chemicals in biosolids, their toxicity, routes of potential exposure to humans and the environment. Based on the results of its risk assessment, EPA identified and set numeric limits for the nine trace elements (heavy metals), which have high enough potential risk to require monitoring, primarily to protect against toxic effects to plants and entry into the food chain4. These nine trace elements include arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc. EPA also mandated that treatment facilities use at least one of several alternative technologies to significantly decrease or eliminate levels of pathogens in biosolids.

According to the CWA requirements, EPA reviews sewage sludge regulations every 2 years to identify any additional pollutants that may occur in biosolids and then sets regulations for those pollutants if sufficient scientific evidence shows they may harm human health or the environment. EPA identifies pollutants found in biosolids through open literature reviews and sewage sludge surveys in order to assess their potential risk to public health and the environment.

The EPA sewage sludge surveys are conducted to identify the presence of pollutants in biosolids and assess concentrations of pollutants using samples taken from wastewater treatment plants (WWTP) around the nation. This information is used in assessing potential risk from pollutants found in biosolids to human

[4] EPA, A Guide to the Biosolids Risk Assessments for the Part 503 Rule (1995).

health and the environment. EPA will screen those pollutants found in biosolids to identify which pollutants do not pose a risk and which exceed EPA's levels of concern. The pollutant risk screening process increases EPA's ability to invest more resources into pollutants that potentially present greater risk to human health and the environment.

40 CFR Part 503 standards include the frequency of monitoring and recordkeeping requirements and contains limits for pollutants in land-applied biosolids. In addition, the rule establishes a ceiling concentration for the regulated pollutants and limits for cumulative and annual pollutant loading rates: the cumulative rate is the maximum amount of regulated pollutants that can be applied to an area of land. The annual rate is the maximum amount of a pollutant that can be applied to a unit area of land during a 365-day period. Land application must also comply with protections for endangered species, and appropriate precautions must be taken to prevent biosolids applications to frozen, snow-covered or flooded land from entering surface waters or wetlands unless specifically permitted under the CWA. The generator of biosolids is responsible for sampling for metals, pathogens and (where applicable) vector attraction reduction and the land applier is responsible for verifying that the biosolids application does not exceed the agronomic rate, and identifying the amount of nitrogen needed by the crop or vegetation grown on the land to minimize the amount of nitrogen passing into the ground water.

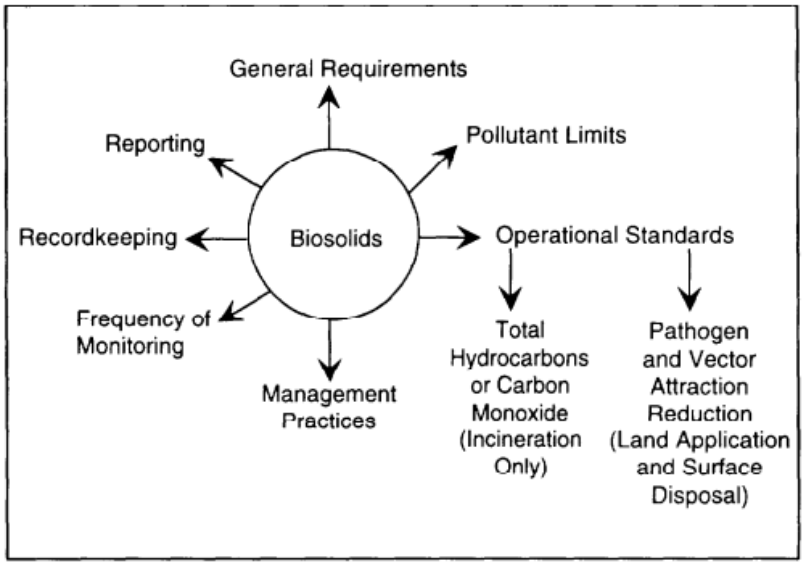

Figure 3. Overview of the 40 CFR Part 503 Biosolids Rule Requirements

The EPA risk-based biosolids regulations limit the amount of biosolids that may be applied to the land to ensure that metal concentrations on biosolids-amended soils do not exceed safe levels. Trace chemicals that on occasion have been identified in biosolids have not been found in environmentally or toxicologically significant amounts; and, the trace amounts of these substances that may be present typically bind to soil constituents, limiting human exposure5. Industrial pretreatment programs required under the CWA also reduce or eliminate many hazardous chemicals entering the treatment facility from the municipal sewer system. The goal of the Pretreatment Program is to prevent the introduction of pollutants into publicly owned

[5] R.Y. Surampalli et al., Long-term Land Application of Biosolids—A Case Study, 57 Water Sci. and Tech 345, 349 (2008) (finding "the cumulative metal loading rates after 10 years of biosolids application were far less than USEPA limits")

treatment works (POTWs) which will pass through or interfere with the operation of a POTW, including use and disposal of biosolids. These pre-treatment programs reduce pollutants such as metals from industrial or commercial sources, allowing wastewater treatment facilities the ability to meet the biosolids regulations. The federal regulations require application of biosolids and in ways that minimize risk of leaching of nutrients or other constituents to groundwater or runoff to nearby surface water.

Some examples of required management practices to protect human health and the environment include:

- Agronomic Rate: limits the amount of applied biosolids to the amount needed to meet the nitrogen requirement of the crop grown.
- Setbacks: prohibiting application of biosolids within 10 meters from waterbodies; and
- Biosolids Management Plan Land Application Plans: based upon site-specific conditions and data (e.g., soil types, water tables, and climate).

2.2 State

To further strengthen oversight and safety of the practice, Colorado has implemented its own land application program complementary to EPA. The CDPHE regulates the quality and use of biosolids through its Biosolids Management Program. That program includes enforcement, facility inspection and land application site inspection and individual land application site approval. Colorado conducts inspections of both facilities and land application sites. The State receives and reviews the annual reports and enters data into the EPA Biosolids Data Management System (BDMS). CDPHE also administers and enforces the National Pretreatment Program that the Clean Water Act mandates.

In Colorado, the Water Quality Control Division (WQCD) regulates land application of biosolids. Colorado utilizes general NPDES-type permits to regulate end use and disposal. Land application sites are permitted by the state using separate, site-specific permits. Approvals are issued on a site by site basis as “Notices of Authorization for the Use and Distribution of Biosolids” (Notices of Authorization), which focus on management, monitoring and reporting requirements which are unique to the State’s Biosolids Regulations, while the broader requirements which flow from the federal Part 503 regulations will be integrated into a Colorado Pollutant Discharge Elimination System (CPDS) permit. The Colorado Biosolids Regulation (No. 64) establishes requirements, prohibitions, standards and concentration limitations on the use of biosolids as a fertilizer and/or organic soil amendment in a manner so as to protect the public health and prevent the discharge of pollutants into state waters. The regulations apply to any domestic wastewater treatment works withdrawing, treating and/or applying biosolids for beneficial use. Notices of Authorization are not issued if they would allow a violation of any water quality standards promulgated by the State of Colorado for surface or groundwater, or would violate a control regulation.

A CPDS Biosolids permit issued by WQCD through Biosolids regulation 5 CCR 1002-64 is required for beneficial use of biosolids. Requirements of biosolids program include the following four:

1. File a Letter of Intent with the CDPHE.
2. Meet all CDPHE requirements regarding trace elements and pathogens.
3. Apply biosolids at “agronomic rates.”
4. Develop a soil-management program that includes periodic soil and plant sampling and analyses.

Colorado’s biosolids regulations are more restrictive than the federal Part 503 rule in areas such as setback requirements for surface waters and public and private wells, public access restrictions, slope restrictions, depth to groundwater, soil conditions, winter prohibition, and nutrient restrictions. Colorado’s pathogen, vector attraction reduction limits, and pollutant limits are the same as Part 503. However, Colorado requires additional monitoring at Class B land application sites and soil tests required prior to the initial application

and on an annual basis thereafter. The WQCD Permit requires analysis of the treatment facility sludge (biosolids) prior to disposal or beneficial reuse, for the presence of toxic pollutants listed in 40 CFR 122 Appendix D Table III (NPDES Application Testing Requirements) at least once per year. Also, Colorado requires testing of soil for all of the Part 503 metals prior to the initial application and once every five years thereafter. The Permit requires specific sample collection and analysis procedures; reporting results of these routine monitoring activities, annual reporting of pretreatment routine monitoring results. Because groundwater is a "water of the state," in Colorado, some biosolids land application requires five feet (the depth of the principal root zone) from the surface to groundwater. Land application sites are inspected regularly by the state, and by a county inspector in some counties.

Section 3: Facility Overview

3.1 History and Location

Fort Collins Utilities has had a long history of land application of biosolids. MWRF was constructed in 1948 and DWRF was constructed in 1966. Biosolids from both plants for the first few decades were dried onsite and disposed of at various land application sites around Fort Collins (nearby parks and agricultural land) or trucked in liquid form and applied to farmland. In the late 1970's growth of the service area put too much pressure on the biosolids disposal system and led to a biosolids management plan and the subsequent purchase of Fort Collins' own beneficial reuse facility. The Resource Recovery Farm (Farm) became a base for the biosolids management program starting in 1983 through a construction grant from the EPA. The Farm was 377 acres and was located on the southwest side of Interstate 25 and Prospect Road and provided Fort Collins a location for beneficial reuse of the biosolids. The Farm was composed of an underground piping network that would inject biosolids below the surface. Approximately 220 acres of the Farm was reserved for corn production for animal feed and the biosolids were used to fertilize these crops. The remaining biosolids were disposed of on neighboring wheat farms. In 1985, a corporation announced the construction of a new brewery in Fort Collins and they helped to fund an aerated windrow composting facility at the Farm to account for the additional biosolids that would be produced as a result of the high strength waste delivered to DWRF. The composting facility was completed in 1988. Additionally, in1988, liquid biosolids were no longer applied and a drier biosolids cake was applied from this point forward. As stated in the 1994 Master Plan, from 1990 to 1993, 7 to 24 percent of Fort Collins' biosolids production was applied on the Farm in the spring while offsite disposal on other private farms (mostly wheat) provided disposal of 58 to 84 percent of the biosolids. The remaining 8 to 18 percent was composted at the covered aerated windrow composing facility. The resulting compost satisfied the pathogen reduction requirements, and the finished product was approved for general distribution.

In the late 1980s and early 1990s, Fort Collins Utilities studied options to address the EPA's promulgation of biosolids regulations, Part 503. Concerns included the existing Farm's long-term capacity for cumulative metals loading at the high fertilizer application rates, development pressures in the area of the Farm, the insecurity and lack of control associated with the dependence of local farmers for part of the disposal, and high costs for farmland application. The results of these internal studies found that rangeland application for biosolids reuse was a long term, economical, and environmentally sound disposal option. Subsequently, Fort Collins purchased the 18,130 acres of the MSR in 1990 and leased another 7,550 acres totaling 25,680 acres. The 7,550 acres were later purchased by Fort Collins in 1994.

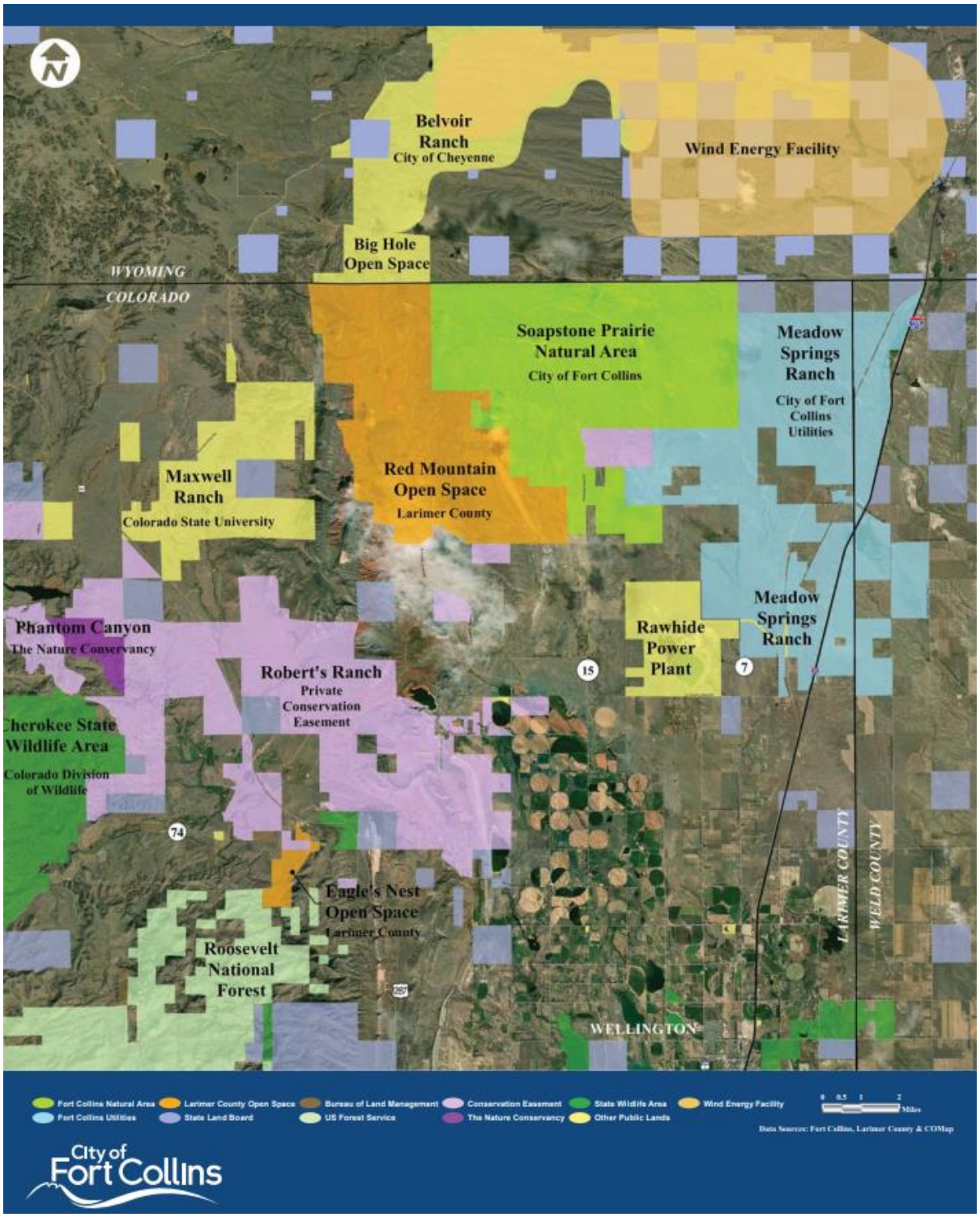

Figure 4. Meadow Springs Ranch

In 1993, a demonstration phase started at the Ranch to monitor the effectiveness of biosolids reuse. Three cells on the ranch were used as demonstration cells for the next 6 years. The goal of the demonstration study was to monitor:

- Optimal sludge application rates
- Optimal sludge composition
- Ground water impacts
- Surface water impacts
- Air quality impacts
- Human health and environmental risks
- Wildlife impacts
- Wetland identification
- Endangered species identification
- Cultural heritage zones
- Exclusion zones
- Operational and facility requirements

The demonstration phase was a success and details can be found in the 1999 Master Plan Update. No negative impacts to wildlife, the environment, soils, surface water, or groundwater were observed. In addition, the biosolids can be used beneficially as a fertilizer and soil conditioner and as shown in the vegetative studies completed in 1992-1993 (CDM 1994) an application rate of 2-5 tons/acre provides significant vegetative growth without promoting the growth of undesirable plants. This increased vegetation increases the productivity of the land as a Ranch and provides better habitat for wildlife. As a result, FCU sold the previous Resource Recovery Farm and centralized the biosolids operations at the Ranch starting in 2000. Also, in 2000, 40 acres were sold to the U.S. Department of Interior for a black-footed ferret facility. After 2000 another 3 land purchases were made, totaling another 960 acres creating the 26,600-acre MSR that exists today.

3.2 Land Uses

MSR cattle operations is leased to the Natural Fort Grazing Association. Annual grazing plans are determined with the expertise of local Natural Resources Conservation Service (NRCS). Groundwater delivered from on-site wells is provided to livestock for watering.

The ranch is also a habitat for the pronghorn antelope and the site for the National Black-Footed Ferret Conservation Center. The utility works with the U.S. Fish and Wildlife Service and the Colorado Parks and Wildlife department to reestablish the ferrets, a species related to badgers and weasels that is native to the area but on the endangered species list. It's the first and only project of its kind in the country. Utilities staff routinely sample soil and groundwater to determine best management practices on rangeland. Wildlife experts have determined that reintroducing an endangered species, such as the black-footed ferret, into rangeland with biosolids applications is not detrimental to the animals or the success of the program.

In addition, prairie dog populations (black-footed ferrets' main food source) at Soapstone Prairie and Meadow Springs Ranch have been managed to support the ferret reintroduction in partnership with the U.S. Fish and Wildlife Service and Colorado Parks and Wildlife.

3.3 Operation

Fort Collins began land-applying at the ranch in 2001 after 10 years of careful study in collaboration with Colorado State University, the EPA and CDPHE. One hundred percent of Fort Collins Utilities biosolids are applied on the MSR. According to Fort Collins' website, Fort Collins currently produces approximately 2,355 metric dry tons of biosolids per year (more than 579 semi-truck loads) and applies biosolids at a rate of 2.8 tons/acre. Ten to twelve semi-trailer loads of biosolids are trucked from the DWRF to MSR each week. The biosolids are unloaded at a staging area within a predetermined and permitted site and directly land applied by using a wet spreader equipped with flotation tires for minimal impact on vegetation, as well as a tractor with spreading trailer; a front-end loader is used to load the spreaders. The wet spreader uses a side discharge that spreads the solids out 70-80 feet. One load covers 1.34 acres; the application rate is calculated at about 3 to 4 dry tons per acre. The staff also makes sure the ranch is using all its water rights, interacts with the public and assesses forage to determine how many animals to pasture.

According to information provided by Fort Collins for a recent editorial in Treatment Plant Operator Magazine which spotlighted the award-winning biosolids program6, "The city's Water Reclamation and Biosolids Division includes an industrial pretreatment program, mechanical and electrical maintenance, plant operations, technical services and resource recovery staff. An on-site pollution control laboratory and SCADA engineering team ensure accurate process control decisions and smooth operations. The Drake and Mulberry Water Reclamation Facilities have a combined design capacity of 29 million gallons per day (mgd) and combined average flow of 19 to 20 mgd. Both use a three-stage biological nutrient removal process followed by UV disinfection (WEDECO - a Xylem Brand). All solids are treated and stabilized at the Drake facility using four mesophilic anaerobic digesters to generate Class B biosolids. Only three digesters operate at any time; the other is reserved for use during maintenance and cleaning. A pair of Centrisys/CNP centrifuges yield cake at 19 percent solids." Depending on the extent of dewatering or drying, the solids content of biosolids can range from less than 5 percent to more than 90 percent.

All process Biosolids from MWRF are conveyed via the interceptor to the DWRF where they are mixed with the rest of the DWRF influent. At DWRF, primary sludge and scum are cleaned by the sludge strain press and then conveyed to four anaerobic digesters for stabilization. Intermediate sludge and waste activated sludge are thickened in the dissolved air floatation thickener (DAF) before being sent to the digesters. Ferric chloride is added to the digesters to reduce hydrogen sulfide levels during the anaerobic digestion process. It is also possible to add ferric to the centrifuges for struvite control. Assorted polymers are added to the DAFT and centrifuges to enhance the thickening and dewatering processes. Digested solids are dewatered via centrifuge, and the Class B biosolids are transported to the Meadow Springs Ranch biosolids facility where they are land applied. A Class B biosolids product is produced from the solids treatment process. The degree and level of treatment required, and effluent limitations are outlined in Permit #CO-26425 for the Mulberry WRF and Permit #CO-0047627 for the Drake WRF.

A nine-person team is dedicated to the biosolids operation with five resource recovery specialists staffing the ranch: a resource recovery chief, responsible for the operation; two resource recovery technicians; and one in charge of biosolids hauling. Application sites are determined by ranch staff. Then each plot is mapped using GPS and, weather permitting, truckloads are deposited directly on the land. Testing and all biosolids

[6] Treatment Plant Operator Magazine. Pervasive Excellence - Some Clean-Water Plants Have Trouble Finding Land to Apply Their Biosolids. That's Not the Case for This Colorado City. Editorial written by Jim Force and published in November 2020. https://www.tpomag.com/editorial/2020/11/some-clean-water-plants-have-trouble-finding-land-to-apply-their-biosolids-thats-not-the-case-for-this-colorado-city

practices have been directed by members of the biosolids management program team. The cross-functional team meets once a month, paying attention to the whole biosolids value chain. They review the impact of pretreatment and the effects of cake application on the environment. Team members also monitor metals, nitrogen and phosphorus, establish standard operating procedures, provide training and set goals such as feed rates to the digesters and percent solids coming off the centrifuges. They maintain contact with jurisdictional emergency response teams for quick response if anything were to happen during transportation or on the ranch.

Section 4: Summary of Biosolids Data and Operating Statistics

4.1 Monitoring

Fort Collins monitors the nutrient and metals in the biosolids, soil and groundwater in accordance the State and Federal regulations. There are 11 groundwater wells on the ranch. Publicly available data was reviewed using the EPA Enforcement and Compliance History Online (ECHO) website. The ECHO biosolids facility report for MSR showed three-year compliance history for the site, by quarter. During this three-year compliance history, there were no identified violations at this facility. ECHO also identifies if there are any Informal or Formal Enforcement Actions within the last five years, for which none were identified.

The following data was available for 2018 and 2019 through ECHO

- January 2019 summary of soil sample results for metals
- Biosolids composition data from DWRF for 2018 and 2019
- Biosolids pollution concertation data from 2018 and 2019

Data confirmed no exceedances for any parameters were observed during 2018 and 2019 sampling. Parameters evaluated in 2018 and 2019 included those identified within Part 503 regulation (40 CFR 503): zinc, selenium, nickel, molybdenum, mercury, lead, copper, cadmium, and arsenic. The MSR data are available to the public and can be accessed through ECHO at the following website: https://echo.epa.gov/biosolids-facility-report?id=COL047627.

The award-winning Fort Collins Utilities biosolids program follows quality procedures in applying Class B material on the MSR. Fort Collins Utilities has a Certified Management Program which received a prestigious Platinum-level accreditation from the National Biosolids Partnership in 2019. The MSR is the only facility in Colorado, and one of only approximately 20 in the country to receive the accreditation at the time. The EPA-founded National Biosolids Partnership advances environmentally sound biosolids promote biosolids best management practices. Platinum Level Partnering (Partnership) organization's programs have been verified by a third-party certification audit process based on the ISO 14001 standard. Fort Collins Utilities also received the Biosolids Management Award from the Rocky Mountain Water Environment Association (RMWEA). Additionally, all Fort Collins WRFs are certified under the ISO 14001 international environmental management standard. Fort Collins Utilities has won commendations for its environmentally sound practices and continuous improvements that exceed regulatory requirements and protect public health, including a Gold Partnership in the Environmental Leadership Program from the CDPHE, a Platinum Peak Performance Award from the National Association of Clean Water Agencies, and RMWEA awards in sustainability and safety.

4.2 Contaminants of Emerging Concern

Contaminants of emerging concern (CECs) is a term used to describe pollutants that have been detected in water bodies, that may cause ecological or human impacts and typically are not regulated under current environmental regulations. Two such contaminants that have been discussed by the state of Colorado in recent months are perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS), which belong to a broader group of chemicals known as Per- and polyfluoroalkyl substances (PFAS). On July 14, 2020, the WQCD adopted a policy that develops a translation level for the narrative standard of no toxics in toxic amounts for PFAS compounds, as well as some "parent" compounds that may degrade into these PFAS compounds being addressed (Policy 20-1 Policy for Interpreting the Narrative Water Quality Standards for Per- and Polyfluoroalkyl Substances (PFAS)). These translation levels will be ultimately implemented into permits for wastewater (industrial and municipal) and construction dewatering permits. Currently, no standard exists for PFAS, including PFOA and PFOS, in Colorado. Additionally, Policy 20-1 does not apply to biosolids. As new CECs become exposed, it will be imperative to implement adaptive management into any source water protection approach.

Section 5: Upper Laramie Aquifer Recharge Area

The simulated outcrop, or recharge area, of the Upper Laramie Aquifer near Terry Ranch is depicted on Figure 5. This is the portion of the Upper Laramie formation that is exposed at the surface and where natural recharge can enter the aquifer. Also shown on the figure is the prevailing groundwater flow direction, which is from northwest to southeast. The groundwater flow gradient, or slope of the potentiometric surface, is highest near the recharge area at 0.017 ft/ft and shallows to 0.006 ft/ft near the southwestern corner of Terry Ranch.

LRE conducted a particle trace analysis using its MODFLOW groundwater flow model of the Upper Laramie Aquifer to estimate the length of time it would take for natural recharge originating near Meadow Springs Ranch to reach the Terry Ranch wells. As shown on Figure 5, the model estimates that it would take approximately 1,400 years for natural recharge at this location to reach the southwestern boundary of Terry Ranch near WWR-5.

Section 6: Risk Impacts to Groundwater Quality

Considering the slow groundwater travel times in the Upper Laramie Aquifer, surface activities such as biosolids spreading in the aquifer's recharge area to the west of Terry Ranch pose very little risk to groundwater quality underlying the Property. The particle trace analysis is inherently conservative, meaning that it does not take into account the other physical, chemical, and biological processes (dispersion, diffusion, sorption, degradation, and attenuation) that can occur as a contaminant is transported within the aquifer. These processes tend to reduce the concentration of a substance over its migration path, or potentially remove it from the groundwater entirely (e.g., sorption or precipitation).

The most effective means to protect groundwater quality at Terry Ranch is to limit surface activities on the Property, particularly in the southeastern portion where groundwater levels are shallowest, and to ensure that wells are properly constructed and sealed. Properly constructed wells with surface seals will prevent contaminants at the ground surface from entering the aquifer and screened portion of the well.

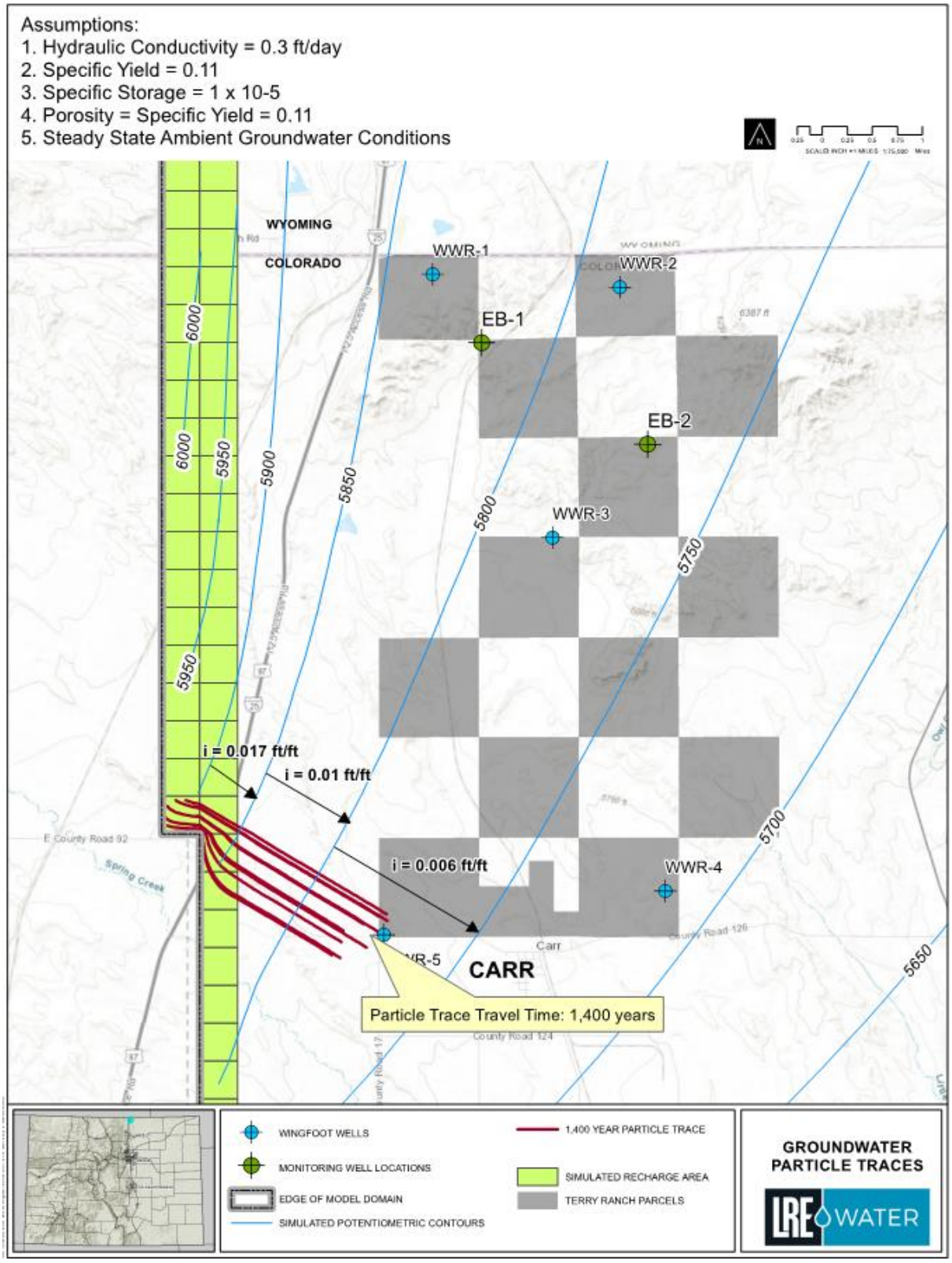

Figure 5. Groundwater Particle Traces

Section 7: Recommendations

For source water assessment and protection (SWAP) plans, each state has their own guidance7. It is recommended that Greeley incorporate SWAP into future phases of design to protect groundwater quality. Adaptive management will be an important consideration of the SWAP to minimize and mitigate impacts to the source water as the area around Terry Ranch continues to develop, or if new CECs are discovered that need to be evaluated further.

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