Table 2-4
Summary of Changes Between LUBGWMA Synoptic Sampling Events
Second LUBGWMA Action Plan

A. Comparison of All Results From All Four Events

	1992 Event	2003 Event	2009 Event	2015 Event	Comment
number of samples	205	135	107	132	
minimum	<0.02	<0.02	<0.005	<0.005	Unaffected areas are being sampled
median	6.1	7.8	8.7	8.1	Median increased twice then decreased, showing some wells are decreasing.
average	9.2	13.0	14.7	15.3	Average consistently increased, showing increases are greater than decreases.
maximum	67.0	51.1	103.4	72.6	Same well was max in 1992, 2003, & 2009

B. Comparison of Results from 85 Wells Sampled All Four Events

85 wells sampled in all 4 events					Comment
minimum =	<0.02	<0.005	<0.005	<0.005	Unaffected areas are being sampled
median =	5.5	8.0	8.3	7.7	Median increased twice then decreased, showing some wells are decreasing.
average =	9.9	12.8	14.9	15.4	Average consistently increased, showing increases are greater than decreases.
maximum =	67	51.1	103.4	72.6	Same well was max in 1992, 2003, & 2009

The # and % of wells showing increases or decreases are not mirror images because some wells had the same concentration two events in a row.

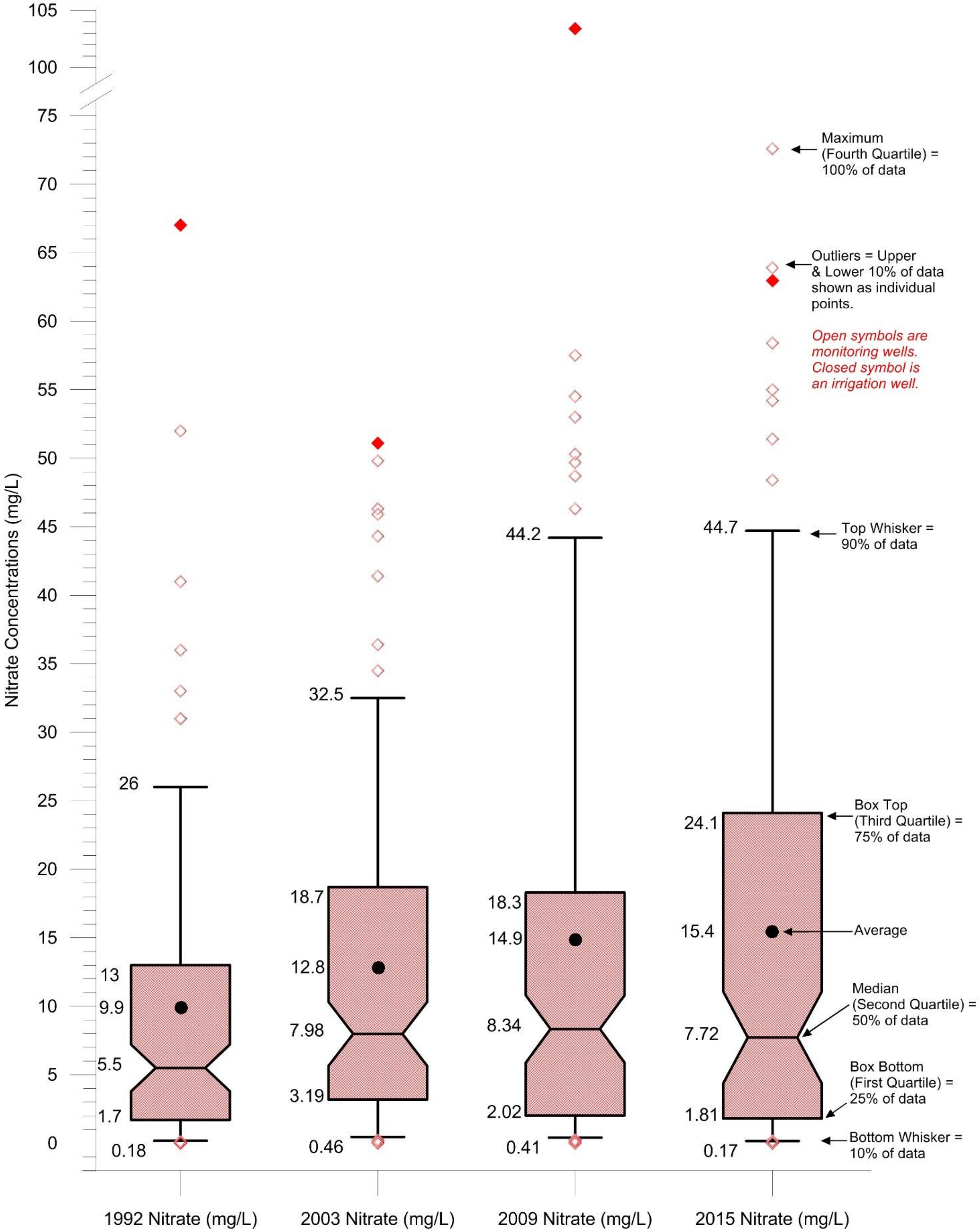
E:\LUB\Fourth Synoptic Sampling Event\[Comparison of SYnoptic Events.xlsx]Summary of Changes - All 4

Figure 2-11 is a box plot of the nitrate data from the 85 wells sampled during each of the four synoptic sampling events. When visually comparing the 1992 results to the 2015 results, it is clear that nitrate increased at these wells. Every aspect of the box plot (with one exception) shows an increase in nitrate concentration (i.e., increases in the first, second, third, and fourth quartiles as well as the top whisker and average). The exception is the bottom whisker, which is slightly lower in 2015 because detection limits are now lower. Both the Mann-Whitney Test and the Wilcoxon Signed Rank Test indicates there is a statistically significant difference between the medians of the 1992 and 2015 data sets.

When comparing 2009 to 2015 results, there are some indications of decreasing nitrate (i.e., the bottom whisker, first quartile, and second quartile are lower), but the magnitude of increases is greater than the magnitude of decreases. This is illustrated by the slight decrease in size of the bottom half of the box and the larger increase in size of the top half of the box. Neither the Mann-Whitney Test nor the Wilcoxon Signed Rank Test identified a statistically significant difference between the 2003, 2009, and 2015 medians.

These observations are consistent with the LUBGWMA well network area-wide trend, which has been increasing since 1997 but at slower rates since about 2004.

Figure 2-11
Box Plots of Data from 85 Wells Sampled in Four LUBGWMA Synoptic Events
Second LUBGWMA Area Action Plan



Synoptic Events "Implied Trends"

In an effort to relate the trends observed at the LUBGWMA well network to the wider GWMA, nitrate results from 114 wells sampled during both the first (1992) and fourth (2015) synoptic sampling events were used to calculate an "implied trend" between the two events. If the 2015 value was larger than the 1992 value then the implied trend was increasing. If the 2015 value was smaller than the 1992 value then the implied trend was decreasing. Table 2-5 shows the results of this comparison. Part A of the table quantifies the number of implied trends while Part B of the table quantifies the implied increasing and decreasing trends by magnitude.

Table 2-5 Part A shows there are more than twice as many implied increasing trends (76) as implied decreasing trends (35). There are also three implied flat trends where nitrate was not detected in either event at three wells.

Table 2-5 Part B indicates there are more implied increasing trends than implied decreasing trends, particularly among wells showing big changes. For example, when the change was less than one mg/L, the number of implied increasing trends was only slightly larger (12) than the number of implied decreasing trends (11). The ratio between 12 implied increasing trends and 11 implied decreasing trends is 1.1 (i.e., 12÷11 = 1.1). This ratio increases as the absolute value of the change increases from 1.1 for changes of less than 1 mg/L up to 13 for changes of more than 20 mg/L. The single largest increase was at a CAFO monitoring well[5]. The single largest decrease was at a UMCD monitoring well close to the bomb washout lagoon pump & treat system.

Table 2-5

Implied Trends at Wells Sampled in First and Fourth Synoptic Events

Second LUBGWMA Action Plan

A. By Direction

# Implied Increasing Trends =	76	67%
# Implied Decreasing Trends =	35	31%
# Implied Flat Trends =	3	3%
TOTAL	114	100%

B. By Magnitude	**<1 mg/L**	**1-5 mg/L**	**5-10 mg/L**	**10-20 mg/L**	**>20 mg/L**	**TOTAL**
# Implied Increasing Trends =	12	28	11	12	13	76
# Implied Decreasing Trends =	11	14	5	4	1	35
Ratio	*1.1*	*2.0*	*2.2*	*3.0*	*13*	*2.2*

The implied trends (using 2 data points between 1992 and 2015) match the Seasonal Kendall trends (using ~100 data points between September 1991 and May 2016) at 25 of the 31 LUBGWMA network wells (80%). This suggests the implied trends are a good, but not perfect, predictor of the actual trend. The implied trends at these 114 wells suggest nitrate is increasing at more wells than it is decreasing, which is consistent with observations made at the LUBGWMA well network and the food processor well networks.

Composite of Available Data

Figure 2-12 shows the nitrate concentrations at 255 wells. The figure includes the 132 wells sampled as part of the fourth synoptic sampling event plus results from 123 other wells not sampled by DEQ during the same timeframe (i.e., between November 2015 and April 2016). Most of the wells were sampled in November or December 2015.

The wells added include the remaining 15 alluvial aquifer public supply wells in the GWMA not sampled during the synoptic sampling event and 108 monitoring wells. In total, the 255 well data set includes the 17 alluvial

[5] The land surrounding the monitoring well was traditional irrigated farm ground in 1992. By 2015, the land surrounding the monitoring well was being used as part of a CAFO waste land application system.

aquifer public supply wells, 56 private domestic water supply wells, 10 irrigation wells, 171 monitoring wells, and one stock watering well. The monitoring wells include 18 wells at CAFO waste land application sites, 18 wells at the UMCD, 122 wells at food processing wastewater land application sites, 5 wells at the Finley Buttes landfill, five wells at the Boardman Bombing Range, and three wells around an old sewage lagoon near Irrigon. The data from these 255 wells were generated by DEQ, public water systems, and permitted entities.

Figure 2-12
Composite of Available Nitrate Data in the LUBGWMA
Second LUBGWMA Action Plan

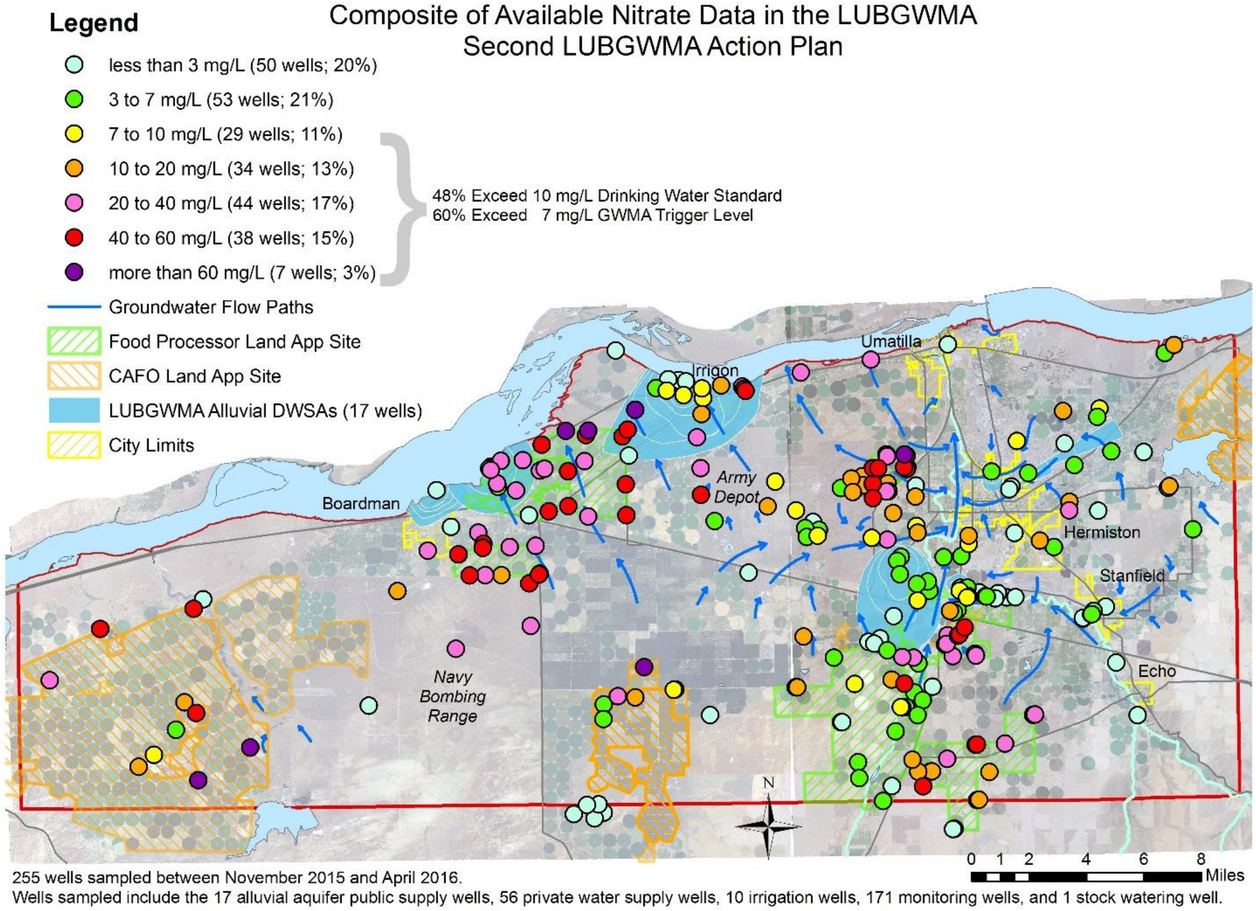


Figure 2-12 shows 48% of the 255 wells exceeded the 10 mg/L nitrate drinking water standard and 60% exceeded the 7 mg/L GWMA trigger level. The higher nitrate concentrations at monitoring wells than domestic wells observed in the Fourth Synoptic Sampling Event data described above is also evident in this composite data set.

It is noteworthy that 17 wells supply water to 12 alluvial aquifer Public Water Systems in the LUBGWMA. During the timeframe of the fourth LUBGWMA Synoptic Sampling Event, four wells (24%) exceed the GWMA Trigger Level. Four of the 12 Public Water Systems (33%) have exceeded the 10 mg/L drinking water standard at least once since 2011.

2.4.6 Summary and Conclusions of Previous Sampling Events

An evaluation of the groundwater nitrate sampling conducted in the LUBGWMA by public entities and permitted facilities discussed above indicate:

- Nitrate concentrations exceed the 7 mg/L GWMA trigger level, as well as the 10 mg/L federal drinking water standard in many area wells,
- Nitrate concentrations are higher in monitoring wells located where nitrogen-rich waste is land applied than at private domestic drinking water wells,
- Nitrate trends are increasing at more wells than they are decreasing,
- Increasing trends are generally steeper than decreasing trends,
- The first LUBGWMA Action Plan's goal of a decreasing nitrate trend throughout the GWMA by 2009 was not met.

These conclusions are summarized again below for the respective sampling events.

Reconnaissance Sampling

The Reconnaissance Sampling conducted from July 1990 through September 1991 documented the area-wide nitrate contamination, elevated levels of total dissolved solids, and scattered pesticide/industrial chemical detections. The highest nitrate concentration detected was 76 mg/L from an irrigation well located within a center pivot field. Approximately 24% of the 205 wells sampled contained more than 10 mg/L nitrate. The median nitrate concentration was 4.25 mg/L.

LUBGWMA Well Network (aka Bi-Monthly Well Network)

With some modifications to the frequency of sample collection and wells to be sampled, the LUBGWMA well network has been sampled continuously since September 1991. Most of the wells in the network are private domestic wells with some irrigation wells also included.

The first LUBGWMA Action Plan called for this well network to be the source of information to be used to gauge GWMA nitrate trends through 2009. By the end of 2009, seven of the 38 wells were no longer being sampled leaving 31 wells still being sampled. The trend analysis of nitrate data from this network indicated over twice as many wells showed increasing trends (15 of 31 wells) than decreasing trends (7 of 31 wells). When viewed by magnitude, there were more small, medium, and large increasing trends than small, medium, and large decreasing trends. The average slope of the small *decreasing* trends was steeper than the average slope of the small *increasing* trends (suggesting improving water quality at wells showing small changes). However, the average slope of the medium and large *increasing* trends was steeper than the average slope of the medium and large *decreasing* trends (suggesting worsening water quality at wells showing medium and large changes). The average nitrate concentration exceeded the 10 mg/L nitrate drinking water standard at 10 of the 31 wells (32%). The average nitrate concentration exceeded the 7 mg/L GWMA trigger level in 12 of the 31 wells (39%). The area-wide trend calculated with this data set was increasing at 0.018 ppm/year.

A second trend analysis was conducted in late 2016 using data through May 2016. The trend analysis indicated fewer statistically insignificant trends and more statistically significant trends. The analysis also showed there were still more increasing trends than decreasing trends but the spread was less than before (increasing trends went from 15 to 16; decreasing trends went from 7 to 10). As was the case with the first analysis, when viewed by magnitude, there were more small, medium, and large increasing trends than small, medium, and large decreasing trends. Again, as was the case with the first analysis, the average slope of the small *decreasing* trends was steeper than the average slope of the small *increasing* trends (suggesting improving water quality at wells showing small changes). Again, as was the case with the first analysis, the average slope of the medium and large *increasing* trends was steeper than the average slope of the medium and large *decreasing* trends (suggesting worsening water quality at wells showing medium and large changes).

The area-wide trend calculated with this data set was 0.0024 ppm/yr. Eliminating the most recent year of data and re-running the analysis multiple times shows the area-wide trend has been consistently increasing since enough data has been collected to calculate a trend (i.e., 1998). The slope of the trend line consistently decreased in magnitude (but remained increasing) until about 2004. Since 2004, the trend line continues some reduction in slope while also fluctuating, but remains slightly increasing.

The average nitrate concentration at the 31 long-term wells exceeded the 10 mg/L nitrate drinking water standard at 32% of these wells. The average nitrate concentration exceeded the 7 mg/L GWMA trigger level in 45% of these wells. In other words, the percentage of wells exceeding the drinking water standard did not change but the percentage of wells exceeding the GWMA trigger level increased. It is noteworthy that the average nitrate concentration increased at 17 wells, decreased at nine wells, and did not change at five wells.

Based on data collected from the LUBGWMA well network, it is concluded that nitrate concentrations are increasing more than they are decreasing, and that the overarching goal of reducing nitrate concentrations below 7 mg/L has not been met.

Food Processor Permitted Facility Well Networks

At the time of the first LUBGWMA Action Plan, the only permitted facilities with groundwater monitoring well networks were three landfills, the UMCD's bomb washout lagoon, and several food processor waste land application sites. None of the four CAFOs identified in the first Action Plan had comprehensive groundwater monitoring programs.

One of the first LUBGWMA Action Plan goals was "improving groundwater quality trends for nitrate" at the food processor land application sites by the end of 2001, the end of 2005, and the end of 2009. A trend analysis was done at food processor land application sites during each of these timeframes to evaluate that specific Action Plan goal.

Results of the first trend analysis indicate 64% (i.e., 72 of the 113 wells) analyzed from the 10 sites were increasing, 7% were decreasing, 3% were flat, and 27% were statistically insignificant.

Results of the second trend analysis indicate 58% (i.e., 74 of the 127) analyzed from the 12 sites were increasing, 20% decreasing, 0% flat, and 22% statistically insignificant.

Results of the third trend analysis indicate 54% (i.e., 61 of the 113 wells) from the 12 sites were increasing, 20% decreasing, 1% flat, and 25% statistically insignificant.

Conclusions from all three trend analyses included that nitrate was increasing at most wells, and at most sites. Therefore, the measure of Action Plan success calling for decreasing trends at these sites was not met.

Synoptic Sampling Events

LUBGWMA synoptic sampling events were conducted in 1992, 2003, 2009, and 2015. The most recent synoptic sampling event included 132 wells, mostly domestic drinking water wells and monitoring wells at permitted facilities that land apply nitrogen-rich waste. Nitrate results ranged from non-detectable (i.e., < 0.005 mg/L) to 72.6 mg/L with a median of 8.06 mg/L and an average of 15.3 mg/L. The nitrate concentration exceeded the 10 mg/L drinking water standard in 44% of the wells. As a whole, monitoring wells exhibited higher nitrate concentrations (19.3 mg/L average) than domestic wells (10.7 mg/L average).

Eighty-five wells have been sampled in all four events. Some wells show non-detectable amounts of nitrate in each event, indicating that some unaffected areas are being sampled. The median concentration increased twice then decreased, suggesting some wells are recently decreasing in nitrate concentration. However, the average concentration of these 85 wells consistently increased over time, suggesting more wells are consistently increasing in nitrate concentration. The median of nitrate concentrations from these wells in 1992 is statistically lower than during 2003, 2009, or 2015. These observations are consistent with the LUBGWMA well network area-wide trend, which has been increasing since 1997 but at slower rates since about 2004.

The trend "implied" by comparing two data points between 1992 and 2015 appears to be a good, but not perfect, predictor of the actual trend. The implied trends at 114 wells sampled in 1992 and 2015 suggest nitrate is increasing more than it is decreasing, particularly among wells showing big changes. These observations are consistent with the more statistically robust conclusions made from the LUBGWMA well network and the food processor well networks.

Results from the synoptic sampling events indicate nitrate concentrations remain above the GWMA Trigger Level in many wells, and that nitrate concentrations are increasing more than they are decreasing.

Composite of Available Data

Nitrate concentrations (from late 2015 through early 2016) available from all known data sources were compiled into one map. The wells include the 132 wells sampled during the Fourth Synoptic Sampling Event plus 108 monitoring wells and the remaining 15 alluvial aquifer public supply wells in the GWMA not already sampled. These results show that 48% of the 255 wells exceeded the 10 mg/L nitrate drinking water standard and 60% exceeded the 7 mg/L GWMA trigger level. The higher nitrate concentrations at monitoring wells than domestic wells observed in the Synoptic Sampling Event data is also evident in this composite data set.

2.5 Statistical Approach

As part of an ODA Fertilizer Research Grant awarded to the LUBGWMA Irrigated Agriculture Sub-Committee in 2012, an OSU statistician conducted a review of the statistical methods used to evaluate nitrate trends in the LUBGWMA and the conclusions drawn from those analyses. The appendix of this document includes a summary of the statistician's recommendations along with DEQ's response, a discussion of some complexities that can affect how groundwater nitrate data are interpreted, and a discussion of the revised statistical approach to be used to evaluate groundwater nitrate trends in the future. Readers interested in the full discussion are encouraged to read the report and response, which are available upon request.

2.5.1 Complexities Affecting Interpretation of Groundwater Nitrate Data

Beyond imperfections in the statistical foundation of groundwater monitoring networks, groundwater nitrate data can be difficult to interpret due to natural spatial and temporal variability in nitrate concentrations. Some of this difficulty is because nitrogen is continually cycled in the environment, and the heterogeneous nature of contaminant transport in soil and rock materials. For example, nitrification and denitrification processes may alternate in time and space based on changing soil moisture conditions and the amount of organic matter present in soils. Similarly, the porosity of soil and rock materials is complex and affects the movement of contaminants through soil; with relatively slow movement through small pores in the lower conductivity materials and more rapid, preferential flow through larger pores, macropores, and along structural planes.

Spatial variability of nitrate concentrations and trends has been attributed by Alley (1993) to several factors including the nitrogen cycle and biogeochemical processing, variable sources of nitrogen in the environment, and temporal changes in source and delivery. The nitrate concentration observed at any well will reflect a complex interaction of the land uses and nitrogen sources in areas of differing recharge characteristics, the nature and thickness of material over the aquifer, the hydraulic properties of the surface materials and aquifer, the three-dimensional groundwater flow system, and possible related stratification of solutes (either because of chemical properties, flow system effects, denitrification, or temporal changes in loading). With stratification of solutes and/or the non-uniform, preferential flow of water and contaminants, even subtle differences in the depth of the open portion of a well can make a major difference in nitrate concentrations. In fact, large variability in nitrate concentrations in groundwater is the rule, not the exception, particularly in areas where variable thickness of an aquitard overlies an aquifer (Alley, 1993). Even nearby wells may show seasonal variations that are out of phase, because of differences in the time of arrival of the "seasonal changes" to a well. Given these effects, the time frame over which sampling is carried out, or repeated, in a given area can also affect the apparent nature of these variations (Alley, 1993).

2.5.2 Summary of Revised Statistical Approach

Given the limitations of the available well networks, and general complexities in interpreting groundwater nitrate data from a regional groundwater monitoring network, this second LUBGWMA Local Action Plan calls for conclusions regarding regional groundwater nitrate concentrations and trends to rely on multiple lines of evidence from multiple sources of information including, but not limited to the LUBGWMA well network, synoptic sampling events, wells at permitted facilities, public supply wells, and other publicly available data. It is recognized that the statistical robustness will likely vary between data sources and between the methods of data analysis. More weight will be given to data sources and methods of data analysis that are more robust (e.g., groundwater quality data collected and analyzed following industry-recognized quality assurance / quality control procedures, and industry-recognized statistical techniques).

3.0 Sources and Solutions

This chapter provides a summary of the factors that are potentially impacting groundwater quality in the Lower Umatilla Basin and the methods that can be used to protect groundwater quality for the benefit of the entire region. It is organized into sub-sections according to the six major focus areas addressed by the LUBGWMA Committee and Sub-Committees. These six focus areas include:

- Irrigated Agriculture
- Land Application of Food Processing Industrial Process Wastewater
- Rural, Open, and Green Spaces
- Confined Animal Feeding Operations
- Livestock Operations
- Public Water Systems

Each sub-section consists of an overview, inventory of potential contaminant sources, and goals, objectives, strategies, and actions. The overview describes how a particular land use or activity is potentially impacting and/or is impacted by nitrate. In the case of public water supplies, other potential contaminants identified in the Source Water Assessments completed by DEQ and DHS are also considered. The inventory of potential sources catalogs the activities associated with each focus area that may be impacting groundwater quality. The Public Water Supply section identifies all the potential sources of groundwater contamination within a portion of the Drinking Water Supply Areas for those systems.

The core elements of each sub-section are the goals, objectives, strategies, and actions that the GWMA Committee recommends as the optimal ways to address the problem of nitrate groundwater contamination in the region. Most of the recommendations are specific to a particular interest and source category. Other recommendations suggest actions that cut across all land uses and interest groups, such as erecting signs along major roadways to inform people that they are entering a drinking water supply area.

Each interest category has goals with specific strategies under each goal. Each strategy then contains detailed actions on how to implement the strategy. Each goal has one or more objectives. The following definitions provide a guide to understanding the differences between these four components:

Goal: An ultimate aim or aspiration

Strategy: Conceptual means to achieve a goal

Action: Specific procedures, processes, and activities to accomplish strategies, and ultimately, the goal

Objective: Measurable, longer-term ways to determine if the goals are being achieved.

Responsible Entity: Local, State or Private Sector entity with primary responsibility for implementing an action

Schedule: Timeline for completion of Action

3.1 Irrigated Agriculture

3.1.1 Overview

Irrigated agriculture is the largest user of fertilizer nitrogen in the Lower Umatilla Basin and, at approximately 180,000 acres, is the single largest land-use by type within the LUBGWMA. Nitrogen used in irrigated agriculture has been a contributing source of nitrate input into the region's groundwater. Widespread irrigation water management and use of nutrient management guidelines in fertilizer use and application on agricultural lands is the most effective method of groundwater protection. This Local Action Plan recognizes that coupling groundwater protection objectives with irrigation water and fertilizer input efficiencies will achieve mutually inclusive beneficial goals. This in turn will enhance agronomic competitiveness and groundwater protection will decrease externalized costs of nitrate treatment for drinking water in the LUBGWMA.

In this arid climate with sandy soils of low organic matter, it is essential to supply crops with nutrients and water for maximum agronomic yield. The technology used to deliver water to crops in the Basin has advanced from gravity-fed flood irrigation to computer-controlled pressurized systems designed to maximize energy and water application efficiency. Similarly, nutrient management practices have advanced over the past few decades and many growers use precision techniques to maximize nutrient use efficiency and apply nutrients and irrigation water at the right time, location, type and rates.

Best Management Practices (BMPs) for nutrient management focus on implementing the 4Rs of agronomic practice (right rate, timing, placement & source or type) to minimize irrigation water and fertilizer movement of nitrogen below the root zone during the growing and winter seasons. Agronomic rates of nitrogen applied in accordance with the timing, amount, and placement of crop nitrogen demand will minimize the build-up of inorganic nitrogen that contributes to winter leaching events. The use of winter cover crops can also minimize movement of nitrogen deeper into the soil profile.

Due to the unique soils and growing environment in the region, practices developed in other regions may need to be modified before adoption in the Basin. Area specific procedures should be continually evaluated and improved to account for not only the climate and soils present in the LUBGWMA, but common crops and rotational systems as well. A failure to appropriately manage the application of agricultural resources through ongoing research and technical assistance increases the likelihood of negative environmental impacts. In the case of nitrogen fertilization, mismanagement can result in nitrate contamination of groundwater.

To minimize the leaching of nitrogen from irrigated agriculture, *both* irrigation and nutrient management must be considered and managed. Components of the soil-water balance that can be controlled should be managed to minimize winter leaching and runoff (e.g. managing field capacity through deficit irrigation, frequent light irrigation, etc.).

All nitrogen applied to the soil (including ammonium and organic forms) will eventually be subject to transformation to nitrate (except for volatilization losses). The total transformation of organic to inorganic nitrogen may take a few weeks to a few years, depending on the nature of the organic waste. Nitrate moves readily with water in the soil profile and can reach groundwater if not taken up by crops or denitrified/volatilized. Other forms of nitrogen are less mobile. Organic or inorganic nitrogen applications that (on average) exceed crop nitrogen uptake (plus loss to gaseous emissions of denitrification and volatilization) will accumulate inorganic nitrogen in the soil, which will be susceptible to leaching in nitrate form. Additionally, root systems are not spatially uniform and cannot perform with perfect uptake efficiency. Soil nitrogen that moves below the root zone cannot be taken up by crops and will eventually leach to groundwater as nitrate. Denitrification may help to reduce nitrate loading to groundwater under some conditions. (Hermason, et.al.)

3.1.2 Potential Sources of Nitrate from Irrigated Agriculture

Potential sources of nitrate in irrigated agriculture include:

- Inorganic commercially manufactured fertilizer products
- Organic residues such as soil organic matter, previous crop residues and manures/compost
- Atmospheric nitrogen fixed by soil microbiology
- Irrigation source water

Each of these potential sources is discussed below.

3.1.2.1 Inorganic Commercially Manufactured Fertilizer

The three common forms of nitrogen in commercial fertilizer are Urea-N, Ammoniacal-N (Ammonia/Ammonium), and Nitrate-N. Many fertilizer products contain a blend of two or all three of the different forms of nitrogen. Urea is the most chemically complex of the three forms and it has very limited availability to plants. When in contact with moist soil, it is hydrolyzed to ammonium (NH_4^+). Ammonium is then either taken up by plant roots or soil microorganisms, attached to negatively charged soil colloids or converted to ammonia gas (NH_3) in which state it is vulnerable to loss to the atmosphere. Ammonium can also be oxidized by soil biology during nitrification to form nitrate (NO_3^-), a compound that is also readily utilized by plants but is much more susceptible to leaching deeper into the soil with irrigation or precipitation. Each of these forms of nitrogen have distinct chemical characteristics that affect their potential loss to the environment, whether it's through volatilization to the atmosphere from the soil surface or being carried out of the root zone with water.

Many commercial forms of nitrogen are now available with treatments that reduce the rate of conversion from one form of nitrogen to another. This may dramatically reduce the amount of nitrogen available for leaching or volatility at any given time. Knowing which form(s) of nitrogen a fertilizer contains is the first step in determining how and when it should be applied to insure that it is available to the growing crop and less available for loss to the environment.

3.1.2.2 Organic Residues

Residue from the previous crop, soil organic matter and manures, or composts applied to the soil are all sources of nitrogen that can potentially be converted to nitrate by soil biological processes.

Much of the nitrogen present in animal manures and composts is tied up in organic compounds and as such, is not immediately available for either utilization by plants or loss to the environment. The second most abundant form of nitrogen in manure is ammonium, which, like ammonium in inorganic commercial fertilizers, is susceptible to high volatile loss as ammonia gas if mismanaged during application. Very little of the nitrogen in manures and composts is in the nitrate form. The fraction of total nitrogen in these products that mineralizes and becomes available is typically highest during the first growing season after application and the rate of additional mineralization rapidly diminishes during subsequent years.

The amount and type of plant residue remaining after the harvest of the previous crop is an important consideration in nitrogen management. Residues high in carbon and low in total nitrogen, such as the chaff and straw of small grain crops, contribute relatively little nitrogen to the next crop. They can utilize a significant portion of the available soil nitrogen in the process of decomposition resulting in a seasonal "tie-up" of soil nitrogen. Conversely, green crop residues such as those from potatoes, peas, or other fresh vegetables where the majority of the plant's lush vegetative material remains in the field, can contain higher levels of total nitrogen and typically decompose faster than high carbon residues. Therefore, they potentially contribute substantial levels of crop available nitrogen to the soil.

In addition to residue contributions from the previous crop and any manures or composts that may be added as fertilizer, nitrogen can also come from soil organic matter. This organic nitrogen pool within the soil is complex and heavily influenced by soil texture, environmental conditions, and agronomic practices. As a result, organic matter levels can vary significantly from region to region and from farm to farm within an area. Soils with higher organic matter levels will release more mineralized nitrogen each cropping season than low organic matter soils.

3.1.2.3 Atmospheric Nitrogen

Another way that nitrogen can be introduced to a cropping system is through the incorporation of leguminous crops into the crop rotation. Legumes are a family of plants that bear root nodules containing nitrogen fixing bacteria and include such crops as peas, beans, alfalfa, and clover. When these plants die, their root nodules break down, releasing the nitrogen they contained back into the soil for potential use by the following crop. In addition to the bacteria living symbiotically with legumes, there are other free-living soil bacteria that can also fix atmospheric nitrogen. However, their abundance in a field is greatly influenced by the management practices that are used by the farmer. As a result, their presence may be highly variable.

3.1.2.4 Irrigation Water

Depending upon the source, irrigation water can contain high amounts of nitrogen. Unlike most of the other sources of nitrogen discussed, fresh irrigation water contains mainly nitrate. Irrigation water can easily move through the soil profile with the water it arrives with and is readily taken up by plants as soon as it reaches the root zone. Water with a nitrate concentration of 10 milligrams per liter (mg/L) supplies ~2.26 pounds of nitrogen per acre for every inch of water applied, which is enough to supply 60-70 lbs/acre nitrogen during the typical potato growing season. Sampling irrigation water for nitrate at the beginning of the season and crediting the amount against fertilizer application is required to avoid over applying nitrogen fertilizer.

Precipitation and irrigation water that does not transpire or evaporate becomes either runoff or infiltrates into the ground or both. From the water that infiltrates, a part is used to replenish the soil moisture and any excess is lost as drainage water or deep percolation at the bottom of the soil. This is called field capacity of the soil. When field capacity of the soil is exceeded, water passes through the soil becoming drainage water or deep percolation to groundwater (Hermanson, et.al.).

The Lower Umatilla Basin (LUB) region has sandy soils, which have a relatively low field capacity. The difference in volumetric water content between field capacity and wilting point is less in sandy soils (as compared to a silty loam). The optimal range for balancing irrigation and groundwater protection is smaller and requires robust data capture and decision-making. Crop water use early in the spring is less because of lower evapotranspiration (ET) demand during cooler temperatures and early crop growth stages. The management of irrigation water as a solute transport mechanism is a key component of the agronomic practice that will achieve groundwater protection in the LUB. For a brief introduction to soil water best management principles and practices in Nebraska, please see: https://youtu.be/YULwrICaB1Y

3.1.3 Irrigated Agriculture's Goals, Objectives, Strategies and Actions

Oregon's 1989 Groundwater Quality Protection Act (Act) [ORS 468B.160] requires programs to be established to prevent groundwater quality degradation through the use of best management practices (BMPs).

The goals for irrigated agriculture within the LUBGWMA are focused on continuing to reduce nitrate contributions to groundwater from agricultural systems, while maintaining the economic viability of those systems in the Basin. In addition to implementing BMPs, growers and the agencies responsible to address groundwater issues need strategies to evaluate and continuously improve BMPs, as well as a way to track the extent of BMP implementation. This includes ongoing research evaluating BMP effectiveness, a voluntary BMP documentation and certification program that recognizes growers' existing BMP practices, and improves upon BMP practices throughout the Basin.

Oregon State University (OSU) Hermiston Agricultural Research & Extension Center (HAREC) and Oregon ODA will support limiting nitrogen loss to groundwater during agronomic practice by:
1.) Evaluating and documenting current BMPs,
2.) Identifying possibilities for improvement in current BMP systems through research in the effectiveness of practices that prevent root zone winter leaching events,

3.) Providing updated technical and educational outreach to growers on effective nitrogen and irrigation management strategies, while continuing to fund research into new methodologies and requirements for crop irrigation and fertilization that prevent leaching below the root zone.
4.) Updating and implementing Willow Creek and Umatilla Agricultural Water Quality Management Area Plans

The goals of the Irrigated Agricultural Sub Committee of the LUBGWMA are:

Goal 1: Procure funding for a United States Geological Survey (USGS) to study, characterize, and develop a comprehensive groundwater and hydrology transport model for the Lower Umatilla Basin.

Goal 2: Procure funding to develop and market a voluntary BMP certification program to inventory and document the extent of BMP implementation in the basin.

Goal 3: Research, catalog, and publish on the effectiveness of current agronomic best management practices (BMPs) in reducing nitrate contamination of groundwater.

Goal 4: Create and maintain an online list of reference materials which recommend best management practices and strategies to reduce nitrate loading for targeted crops and conditions in the Lower Umatilla Basin, as well as materials associated with soil health, conservation, and sustainable farming practices.

Goal 5: Determine what monitoring methods and frequencies are most efficient and effective at helping growers manage in-season water and fertility resources for crops commonly grown in the Basin. Continue to fund research, education, and outreach to improve and encourage the adoption of agronomic BMPs by growers within the Basin

Goal 6: Develop criteria for achieving GWMA repeal in ORS 468B.188 "*Repeal of declaration of groundwater management area*".

Goal 7: Create an Interagency Task Force to achieve groundwater management goals of the irrigated agricultural community.

Goal 8: Evaluate the feasibility of a nitrogen mass-balance model and biogeochemical research projects that would spatially identify nitrogen loading in support of Goal 9.

Goal 9: Evaluate the feasibility of re-defining the LUBGWMA into smaller sections based upon land use, a USGS hydrogeology transport, model and possibly a nitrogen mass-balance model.

Goal Strategies and Actions

Goal 1: Procure funding for a United States Geological Survey (USGS) to study, characterize, and develop a comprehensive groundwater & hydrology transport model for the Lower Umatilla Basin.

Strategy 1.1
Develop the data, information, and understanding necessary to make informed management decisions regarding groundwater in the Umatilla Basin.

Actions

- Develop, test, and refine a conceptual transport model of the hydrologic system of the Umatilla Basin.
- Describe the hydrologic system through reports and presentations that promote a common understanding of the groundwater resource within the Umatilla Basin.
- Construct numerical models that accurately represent the hydrologic system and can be used as tools to evaluate the effects of proposed management alternatives (for example, future droughts or floods due to changing rainfall patterns).
- Use the hydrologic models to identify optimal management alternatives based on specific quantity and quality management objectives of water resources.

Responsible Entity: DEQ, GWMA Committee stakeholders, USGS
Schedule: 2025

Goal 2: Procure funding to develop and market a voluntary BMP certification program and/or other comprehensive strategies that would inventory, document, and market the extent of BMP implementation in the basin and identify and address opportunities for improvement.

Strategy 2.1
Develop nutrient best management practice & guidelines and irrigation water best management practice and guidelines. Facilitate farm-scale implementation of the nutrient and irrigation water best management practices guidelines. Support activities and share resources to achieve goals and objectives of reducing and eliminating in-season and winter leaching of nitrate to groundwater.

Actions
State, local, and non-profit cooperators such as Salmon Safe, Oregon State University, Umatilla County and Morrow SWCDs, Oregon Department of Agriculture, and others to conduct research, develop recommendations, and incorporate research results into the design and implementation of a voluntary BMP certification program that promotes:

- Increased market visibility and access through development of a BMP groundwater protection standard within existing Salmon Safe (or other) certification and labeling.
- Develop recommended nutrient and irrigation water management guidelines for crops.
- Develop crop specific recommendations for fertilizer rates, types, placement and timing for achieving maximum economic yields for the top five irrigated crops (by acreage) grown in the LUB based on standard cropping practices.
- Develop soil-water field capacity model for the predominantly occurring soils in the LUB. Based upon maximum economic yields and LUB soils, develop crop specific recommendations for irrigation rates, type, timing, and placement.
- Develop and implement data capture and decision making at the field scale based on right rate, type, timing, and placement of fertilizer and irrigation water.
- Deep soil testing for tracking effectiveness of fertilizer and irrigation water management techniques.
- Recommendations for requisite field scale instrumentation, analytical data collection, monitoring methods, and default values (N source/losses, water meters, soil moisture, ET, etc.) that support active management of nitrogen and water inputs to LUB soils.
- Develop pre-season nutrient & water management plans coupled with post-season (winter) evaluation.
- Crediting the different sources of nitrogen that crops may use beneficially.
- Update & develop tools and services to provide recommendations and data for irrigation water and fertilizer management, including weather and soil moisture data collection and distribution.
- Conversion to more efficient irrigation systems.
- Recommend fertilizer source, rate, placement, timing of application, and economically realistic crop yield goals.

- Procedures for crediting the various sources of nitrate including inorganic fertilizers, organic sources, residual soil nitrogen, and irrigation water.
- Recommendations on soil and tissue sampling to reduce uncertainty about crop nutrient needs.
- Recommendations regarding the efficient use of irrigation systems and uniform application of irrigation water for all crops.
- Recommendations to manage for all crops in the rotation and not focus on one crop.
- Schedule maintenance leaching to minimize groundwater impact.
- Promote cropping systems to manage nitrate movement. These systems may include the use of second crops, cover crops, and deep-rooted crops to recover and/or store nitrogen that would otherwise pass the crop root zone.
- Recommend methods, approaches, and reporting that supports data interpretation of actively managed nitrogen and water inputs into the vadose zone of LUB soils that achieve maximum economic yield while decreasing groundwater impacts.

Responsible Entity: Salmon Safe, Oregon State University, Oregon Department of Agriculture, Umatilla County and Morrow SWCDs, DEQ.
Schedule: 2020

Strategy 2.2
Apply for available Western SARE grants to fund a voluntary BMP certification program and BMP research. Continue to apply for DEQ 319 funding when it is available.

Actions
- Communicate with Oregon DEQ about the availability of 319 funding opportunities.
- Work with State and local cooperators such as Oregon Department of Agriculture, Umatilla County and Morrow SWCDs, Oregon State University, and others to help design and implement a voluntary BMP certification program and BMP research grant proposals.

Responsible Entity: DEQ, Oregon State University, Oregon Department of Agriculture, Umatilla County and Morrow SWCDs.
Schedule: 2020

Strategy 2.3
Seek out and apply for new and upcoming sources of funding for a voluntary BMP certification program and BMP research grant proposals.

Actions
- Perform periodic searches for new funding opportunities.
- Work with State and local cooperators such as Oregon Department of Agriculture, Umatilla County and Morrow SWCDs, Oregon State Universit,y and others to help design and implement a voluntary BMP certification program.

Responsible Entity: Oregon State University, Oregon Department of Agriculture, Umatilla County and Morrow SWCDs.
Schedule: 2020

Strategy 2.4
Distribution of new educational and promotional materials on Basin BMPs to grower groups within the Basin during the roll-out of a voluntary BMP certification program.

Actions

- Evaluate materials currently disseminated at public forums for growers. Work with professional service providers, local conservation districts, and OSU to develop new materials to present new technologies and information.

Responsible Entity:	Oregon State University, Oregon Department of Agriculture, Umatilla County and Morrow SWCDs.
Schedule:	2020

Goal 3: Oregon State University researches, catalogs and publishes an evaluation of the effectiveness of current agronomic best management practices (BMPs) in reducing nitrate contamination of groundwater. Research, catalog and evaluate current BMPs that reduce nitrate loss to groundwater. Identify and develop a comprehensive system of irrigation and fertilization practices based on the agronomic practice of the 4Rs (right source, right amount, right timing, right placement) that will improve upon the current level of BMP effectiveness to prevent winter and in-season leaching events.

Strategy 3.1
Monitor in-season and winter soil moisture and soil-test nitrogen across time on a center-pivot irrigated field within the Basin that is being managed with typical BMPs for the crops grown.

Actions

- Monitor crop nitrogen removal, soil nitrate accumulation, and nitrate leaching for several years.
- Implement a lysimeter study project measuring nitrate losses from fields in areas with improved fertilizer management. Soil water samples from existing and newly placed lysimeters are collected once a month for two years, and analyzed by a laboratory to determine levels of nitrate and phosphorus leaching below the crop rooting zones in fields using precision agriculture and other innovative fertilizer management practices.
- Monitor soil moisture and soil nitrogen content pre-plant, during the cropping season and post-harvest (winter) to assess the potential for having pushed nitrate below the root zone.
- Document pre-plant soil test nitrogen, in season nitrogen fertilization, and remaining post-harvest soil test nitrogen.
- Compare common methods of soil moisture monitoring to evaluate whether irrigation management effectiveness is influenced by the type and/or frequency of generated data.
- Update and unify all fertilizer rate application tables for the recommended agronomic rate of nitrogen addition to the soil that is needed to produce maximum economic yield, while minimizing adverse environmental effects. The recommended agronomic rate must account for nitrogen available to the crop throughout the growing season from all sources such as mineralization of organic residues and soil organic matter, residual inorganic nitrogen in the rooting zone, and nitrogen from irrigation water or other sources.

Responsible Entity:	Oregon State University
Schedule:	2020

Strategy 3.2
Characterize physical variability across the same field and assess the effects of that variability on water and nitrate movement given a uniform application of both resources across the field.

Actions

- Grid sample the field for soil textural analysis to determine areas where deeper percolation is likely to occur.

- Analyze elevation and slope data for the field looking for areas where run-off and/or ponding are likely to occur.
- Make visual observations of the field during irrigation looking for wet and dry areas as the soil surface dries out.
- Monitor subsurface moisture movement in areas identified as having abnormal wetting and drying patterns compared to the average of the field.

Responsible Entity: Oregon State University
Schedule: 2020

Goal 4: Oregon State University evaluates existing nutrient management publications and as necessary, adds to its publication catalog of agronomic best management practices to reduce nitrate loading to groundwater. Create and maintain an online list of reference materials that recommend management practices and strategies to reduce nitrate loading for targeted crops and conditions in the Lower Umatilla Basin as well as materials associated with soil health, conservation, and sustainable farming practices.

Objectives: Maintain a high level of BMP understanding, adoption, and voluntary certification among growers within the Basin.

Strategy 4.1
Utilize a cooperative agency such as Umatilla County, Morrow SWCDs, or OSU Extension to host a webpage for growers to access that would be able to link them to resources on crop specific fertility information, soil and water conservation practices, irrigation management technology and strategies, crop water use curves, etc.

Actions

- Catalog and publish all agronomic BMPs that ensure groundwater protection.
- Create a "Groundwater Protection & Agronomic Factor" (GPAF) scoring system, that incorporates groundwater protection and agronomic viability, and apply a GPAF score to each cataloged BMP published by OSU.
- Update the BMP catalog and GPAF scoring on an annual basis.
- Utilizing the GPAF scores, create a standardized suite of BMPs that represent an economically achievable baseline of BMP implementation for growers across the Basin. Provide this standard suite of BMPs to a voluntary BMP certification program that involves active outreach to growers. Active outreach includes recognizing existing BMP performance and improving upon BMP performance.
- Contact potential project partners about the project and determine their willingness and ability to help.
- Compile a list of reference material that can be organized and posted to the webpage.
- Periodically update webpage content.
- Provide a means for growers or industry professionals to suggest additional materials.
- Perform outreach to inform local growers that this source of information exists and is easily accessed.

Responsible Entity: Oregon State University
Schedule: 2020

Goal 5: Oregon State University Agricultural Extension Office in partnership with Oregon Department of Agriculture determines what monitoring methods and frequencies that are most efficient and effective at helping growers manage in season water and fertility resources for crops commonly grown in the Basin. Continue to support research, education, and outreach to improve upon and encourage the adoption of agronomic BMPs by growers within the Basin.

Objectives: Help growers obtain the most cost effective BMPs that can be used to make in season irrigation and fertilization management decisions and determine if different methods of monitoring may be appropriate for different crops. Keep BMP information up to date through research and adaptive management. Answer any questions concerning new crops and technologies.

Strategy 5.1
Instrument a field with multiple styles of soil moisture monitoring devices that provide for variable sampling frequencies and cost.

Actions
- Contract with local service professionals to install, maintain, and read moisture monitoring devices.
- Collect and compare data sets.
- Assess grower confidence in the data and their ability to make management decisions from it.
- Evaluate total costs of data generation for each style of device.

Responsible Entity: Oregon State University
Schedule: 2020

Strategy 5.2
Compare irrigation practices across common Basin crops and evaluate whether certain types of moisture monitoring devices may be more appropriate than others for certain types of crops.

Actions
- Work with local professional service providers to determine common irrigation practices and quantify the variability of those practices across crop types.
- Conclude whether there is a strong correlation between crop type and irrigation management.
- Assess variables such as irrigation frequency, root zone depth, and seasonal water and fertilizer requirements for different Basin crops. Determine if specific soil moisture monitoring devices are more appropriate than others for specific crops.
- Promote and certify the use of the most appropriate BMP technology for each crop.

Responsible Entity: Oregon State University
Schedule: 2020

Goal 6: Develop criteria for achieving GWMA repeal in ORS 468B.188 “*Repeal of declaration of groundwater management area*”.

Objectives: Objectives include development of criteria for achieving ORS 468B.188. The objectives outlined in ORS 468B.188 are partially achieved through the existence of this revised local action plan.

Responsible Entity: GWMA Committee
Schedule: 2020

Goal 7: Interagency Task Force to achieve groundwater management goals of the irrigated agricultural community.

Objectives: The objective of the structured Interagency Task Force is to coordinate between ODA, ODEQ, OWRD, OSU, and OHA to achieve groundwater management goals of the irrigated agricultural community and basin stakeholders. Success will include interagency consensus, direct liaison authority, coordinating authorities, channels, terms of commitment, and MOAs or MOUs that support policy, legitimacy, defined purpose, authorities, leadership parameters, functional protocols, unified effort, centralized planning and direction, decentralized execution, and management of resources.

Responsible Entity: GWMA Committee
Schedule: 2020

Goal 8: Evaluate the feasibility of a nitrogen mass-balance model and biogeochemical research projects that would spatially identify nitrogen loading in support of Goal 9.

Objectives: Conduct a nitrogen mass-balance model and biogeochemical research projects that would spatially identify nitrogen loading.

Responsible Entity: GWMA Committee, OSU, EPA
Schedule: 2020

Goal 9: Evaluate the feasibility of re-defining the LUBGWMA into smaller sections based upon land use, a USGS hydrogeology transport model, and possibly a nitrogen mass-balance model that incorporates source loading isotopic signatures.

Objectives: Re-define the LUBGWMA into smaller sections based upon land use, a USGS hydrogeology transport model and possibly a nitrogen mass-balance model.

Responsible Entity: GWMA Committee
Schedule: 2020

3.2 Land Application of Food Processing Industrial Process Wastewater

3.2.1 Overview

Food processing facilities generate large volumes of nutrient rich process water as part of their daily operations. These facilities are one of the few sources of nitrate to groundwater that are already under direct regulatory requirements. These facilities are required to obtain National Pollution Discharge Elimination System (NPDES) or Water Pollution Control Facilities (WPCF) permits from the state to discharge waste water to waters of the state or land apply waste water. Originally, food processors land applied their waste water to limited areas, during all seasons, and at amounts exceeding crop needs. These activities contributed to local nitrate-nitrogen groundwater contamination. Today, DEQ's regulatory waste discharge permit system are designed to reduce nitrate loading to the groundwater and will continue to do so.

3.2.2 Inventory of Sources

Historically, the food processing industry did not apply process water at agronomic rates. Their main emphasis was process water disposal in order to avoid nuisance conditions such as, odor, flies, and truck traffic problems. Neither the industry nor DEQ considered the impact of process water application on groundwater quality. The focus was preventing run off from the application fields. Once the impact of the process water disposal practices were realized, modification to the process water disposal practices began. DEQ worked with the facilities to modify the industry's facility process water discharge permits to protect groundwater quality.

3.2.3 Food Processing Wastewater Goals, Objectives, Strategies, and Actions

Implementation of this plan will rely on current permitting practices of DEQ with input from the food processing industry. The industry will address the intent of the laws and regulations established for groundwater protection. The industry will continue to follow their permit conditions and requirements and meet or exceed all requirements. Additionally, the industry is committed to continued use of the Operation, Monitoring, and Management (OMM) strategy developed through the permitting process. DEQ and food processors will jointly be responsible for implementation of this component.

Goal 1: Assess and adopt best management practices for land application.

Goal 2: Minimize site conditions and land application practices that increase the chance of leaching nitrate to groundwater.

Goal Strategies and Actions

Goal 1: Assess and adopt best management practices for land application.

Objective: Assess current OMM and land application practices and compare them to current BMPs of other land application sites in the area.

Strategy: Review current practices and collaborate with other applicants and DEQ to develop a standardized way of applying food processor waste.

Actions: Review and adopt Irrigated Agriculture’s action plan items, including participation in a voluntary BMP certification program.

Responsible Entity: DEQ and WPCF permit holders who land apply food processing wastewater.

Schedule: As Irrigated Ag evaluates and adopts practices lined out in its section of the Action Plan.

Actions: Review OMM and current practices and compare to other food processors/WPCF permit holders to create a more standard application process with DEQ and permit holders.

Responsible Entity: DEQ and WPCF permit holders who land apply food processing wastewater.
Schedule: Within one year of Action Plan adoption for existing fields and prior to land application at new sites.

Goal 2: Minimize site conditions and land application practices that increase the chance of leaching nitrate to groundwater.

Objective: Identify and minimize site conditions and land application practices that increase the chance of leaching nitrate to groundwater.

Strategy: Evaluate site conditions and land application practices to identify conditions or practices that increase the chance of leaching nitrate to groundwater.

Actions: Evaluate site conditions (e.g., soil type, soil moisture variability, NRCS's Nitrate Leaching Potential http://websoilsurvey.nrcs.usda.gov/app/) and identify fields or portions of fields with high nitrate leaching potential. Evaluate land application practices (e.g., crop selection, crop rotation, fertilization practices (including form, placement, and timing), and irrigation practices (including method, timing, and soil moisture movement beneath the root zone).

Responsible Entity: DEQ and WPCF permit holders who land apply food processing wastewater
Schedule: Within one year of Action Plan adoption for existing fields, and prior to land application at new sites.

Goal 3: Develop nitrogen mass balance model for the LUBGWMA.

Objective: Model nitrogen budget and transport

Strategy: Model nitrogen budget and transport

Actions: Evaluate site conditions (e.g., soil type, soil moisture variability, NRCS's Nitrate Leaching Potential http://websoilsurvey.nrcs.usda.gov/app/) and identify fields or portions of fields with high nitrate leaching potential. Evaluate land application practices (e.g., crop selection, crop rotation, fertilization practices (including form, placement, and timing), and irrigation practices (including method, timing, and soil moisture movement beneath the root zone).

Responsible Entity: DEQ and WPCF permit holders who land apply food processing wastewater
Schedule: Within one year of Action Plan adoption for existing fields, and prior to land application at new sites.

3.3 Rural, Open, and Green Spaces (ROGs)

3.3.1 Overview

Oregon's 1989 Groundwater Quality Protection Act (Act) [ORS 468B. 184 (1) (f)] requires amendments to affected city or county comprehensive plans and land use regulations (in accordance with the schedule and requirements of periodic review set forth in ORS chapter 197) to address identified groundwater protection and management concerns.

Additionally, Oregon's 1989 Groundwater Quality Protection Act [ORS 468B.187] requires, *within 120 days after the department accepts the final action plan*, each agency of the group that is responsible for implementing all or part of the plan *shall adopt rules* necessary to carry out the agency's duties under the action plan.

This portion of the Local Action Plan is focused on activities that take place in residential areas (lawns, gardens, pastures, domestic wells and septic systems), parks and other open space (city parks, walking paths, and golf courses), and agricultural areas smaller than 40 acres (row crops, hobby farms, livestock and pastures). These sub areas will outline the Goals, Objectives, Strategies, and Actions that will achieve success. A new category has been added to address agricultural practices that happen on small acreages of less than 40 acres on land not zoned for Exclusive Farm Use (EFU).

For this Second Local Action Plan the Residential, Open, and Green Spaces (ROGs) Subcommittee, formally the Rural Residential Subcommittee, have updated the list of contributing sources to reflect what has been learned and to have a broader application beyond residential, to include open and green spaces as well.

To assist readers of this Second Local Action Plan the following definitions, specific to this Action Plan Section, are included:

Rural: lands zoned for rural residential use, including rural residential, farm residential, rural service center, or other pertinent use zones, in north Morrow County and west Umatilla County; lands within the urban growth boundary of Boardman, Irrigon, Umatilla, Hermiston, Echo, and Stanfield, particularly those lands that have ongoing agricultural uses; lands within those same cities for the purposes of land application of chemicals to public lands that are considered open or green space; and any residential use that includes yards and gardens.

Open Space: lands that are generally owned by a public entity that may have public access, but are not maintained with a lawn or other plantings that would require watering and maintenance. Examples might be land owned by the Army Corps of Engineers along the Columbia River in either Umatilla or Morrow County, or land owned by the Bureau of Reclamation that has portions of the Hermiston walking path installed on it.

Green Space: lands that are generally owned by a public entity that may have public access, and that are maintained with a lawn and other plantings that would require watering and maintenance. Examples might include school or city sports complexes, golf courses, cemeteries, or city parks.

It should be noted that this Local Action Plan does not address the impacts to groundwater quality that events such as flooding may have. Other community plans would address these events and may include information about how to manage environmental impacts. Both Umatilla and Morrow Counties have adopted Natural Hazard Mitigation Plans that address flooding and other natural hazards.

3.3.2 Sources of Nitrates from Residential, Open and Green Space

The principle activities that may contribute nitrate to groundwater include septic systems, lawn and garden practices, conditions of wells, small irrigated operations, and pasture management. The following continuing sources of nitrites and nitrates are addressed within this Local Action Plan:

- Improperly sited, installed or maintained septic systems;
- Density of installed septic systems;
- Wells and their construction, location and leakage;
- Over fertilization of landscaped areas including yards, gardens, and open spaces including parks, play and school grounds;
- Small (less than 40 acres) irrigated operations that are not located on lands zoned for Exclusive Farm Use; and
- Pasture management as an alternative to animal density.

3.3.2.1 Septic System Installation and Maintenance

The standard household septic system is not designed to effectively treat waste water for nitrates. Properly operating systems deliver amounts of nitrate in the range of 50 to 60 mg/L to the soil profile above the groundwater table. Under certain soils, denitrification takes place, however, treatment in the basin's soils are limited because of its sandy, porous nature. Septic systems that have been improperly installed or are not maintained contribute to the movement of nitrite and nitrate to groundwater.

Septic Systems are found throughout the Lower Umatilla Basin Groundwater Management Area (LUB GWMA) outside of the Urban Growth Boundary of city limits. Significant concentrations of septic systems can be found alongside and within urban growth boundaries and in areas where exception lands, otherwise known as lands zoned for rural residential, commercial or industrial uses, have seen significant development. A growing trend is the requirement for the installation of septic systems using Advanced Treatment Technology, often referred to as ATTs. A variety of factors can trigger this requirement, including shallow water tables, limited treatment area based on soil types, and other locational factors.

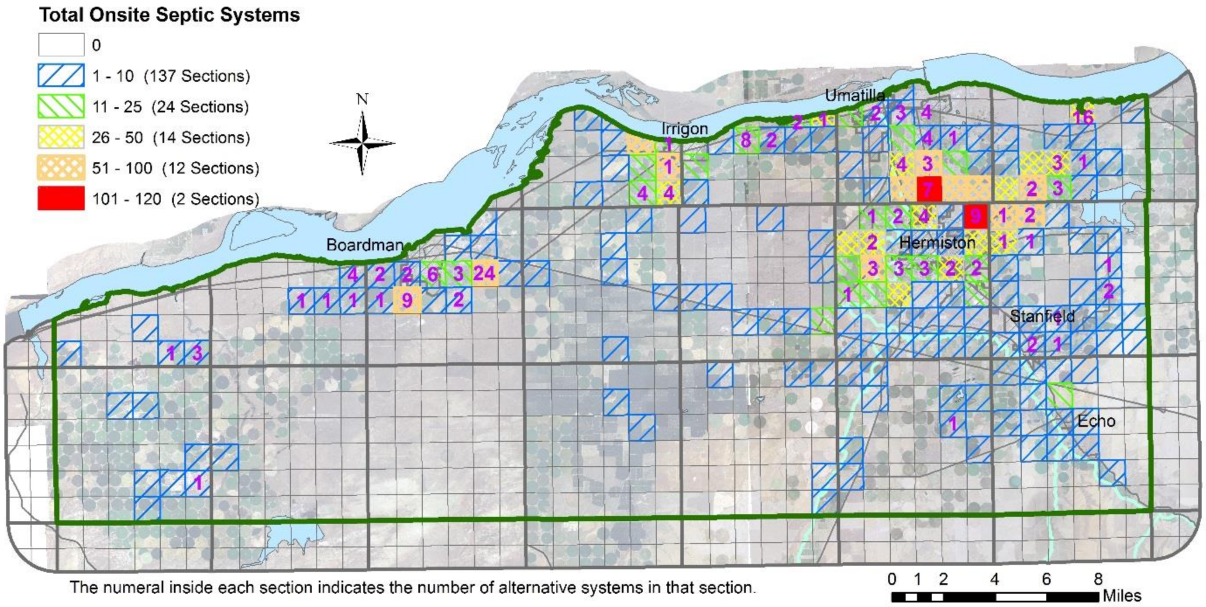
3.3.2.2 Septic System Density

Generally, this source of nitrate is not a concern from a regional perspective when the volume of wastewater is relatively small compared to the volume of groundwater. However, there is a regional concern when the density or clustering of septic systems exceeds the dilution capabilities of the groundwater system or a local concern when a drinking water well is located too close to a septic system drain field. In some areas of the LUB GWMA, septic system density or clustering affects groundwater quality.

Figure X shows the density of onsite septic systems in the LUBGWMA. The numerals indicate how many alternative systems have been installed within that square mile. The conditions that required the installation of alternative systems are summarized as follows:

- Boardman area: where the permanent water table is shallow and/or where the effective soil depth is shallow. Some denials occur west of Boardman due to a shallow water table.
- Irrigon area: in pockets where the permanent water table is shallow, and where lots are small.
- Irrigon to Umatilla: where the permanent water table is shallow. There have been some denials due to a shallow water table.
- Hat Rock area: where the effective soil depth is shallow (i.e., where bedrock is shallow), and where lots are small.
- Hermiston area: where lots are small. Historically there have been some areas of high water table but this condition is seen less often since flood irrigation has decreased.

Figure X
Onsite Septic System Density
Lower Umatilla Basin Groundwater Management Area



This map was created using information from the DEQ Eastern Region Onsite Application Database. Information entered into the database starting in 1990 includes such things as owner, location, system type, inspection dates, installer, and fees.

This map contains information from January 1990 through December 2015.
A total of 2,367 onsite systems (including 182 alternative systems) were installed during these 26 years.

Alternative systems are required at locations when a high water table, minimal soil depth, poor soil type, and/or small lot size prevent a standard system. Alternative systems include capping fill systems, pressure distribution systems, and sand filters. Most areas requiring alternative systems could be more vulnerable to groundwater contamination.

Since the first Action Plan was adopted, the Oregon Department of Environmental Quality (DEQ) initiated changes within the Oregon Statewide Planning Program to assure that rural residential lot sizes are 10 acres in size with significantly higher standards to acquire development at lot sizes of two acres.

3.3.2.3 Wells and their Construction, Location and Leakage

Contaminated water moving down a well casing from land surface to groundwater or moving between aquifer units via well bores could contribute to or exacerbate the nitrate contamination problem. Many basin wells were constructed before strict seal requirements came into effect. Improperly sealed wells can facilitate water movement, possibly carrying contaminants from land surface to the groundwater or between aquifer units. The following link is to applicable Oregon Administrative Rules for well construction: http://arcweb.sos.state.or.us/pages/rules/oars_600/oar_690/690_210.html. This link is to the Oregon Water Resources Department and Oregon Health Authority's "Water Well Owner's Handbook": http://www.oregon.gov/owrd/pubs/docs/Well_Water_Handbook.pdf

Locating a septic system or other contamination source too close or up gradient from a poorly sealed well may cause the well to capture contaminated water and allow contaminated water to move further into the aquifer or between aquifers. Well construction and protection of the wellhead is essential to preserving the integrity of the well and the well water.

3.3.2.4 Landscaped Areas: Lawns, Gardens, Open Spaces, Parks, Play and School Grounds

Landscaping, lawn, and garden activities on the basin's sandy soils can deliver nitrate to the groundwater through over-fertilizing and watering; by poor timing of fertilizing and watering; and by not understanding the causes of landscape, lawn and garden problems. Golf courses, large school grounds or parks, and residential management of lawns and gardens can all become sources of increased nitrate in groundwater by many activities. Watering too much or too long after fertilization can simply wash the applied fertilizer past the root systems of the plants and into the groundwater.

3.3.2.5 Small Irrigated Operations

Small irrigated agricultural or hobby farm operations on the basin's sandy soils can deliver nitrate to the groundwater much in the same way as what happens with landscaped areas described above. For the purposes of this Second Local Action Plan, this section focuses on areas where agriculture or hobby farm operations may be happening, but the land is not zoned for Exclusive Farm Use. This may be within city limits, an urban growth boundary or other areas zoned for residential development.

3.3.2.6 Pasture Management

Pasturing animals on small acreages can degrade groundwater if not managed properly. Allowing excess manure to build up in a pasture will allow nutrients to accumulate in the soil making them available to leach when irrigation or precipitation occurs. Exceeding the carrying capacity of a pasture can enable animals to over-graze grasses reducing their ability to utilize manure for plant growth. This leads to an accumulation of nitrates and other chemicals, which is then available for leaching to groundwater. Improperly storing manure where precipitation or irrigation water is allowed to percolate through the manure will leach nutrients into the groundwater.

3.3.3 Goals, Objectives, Strategies, and Actions

The primary goal is to reduce nitrate in groundwater throughout the LUBGWMA. The objectives, strategies, and actions are mechanisms to achieve the goal. Success is measured by the actions of achieving the goal. The following ROGS goals are used to attain the primary goal:

Goal 1: Achieve an increased level of knowledge and cooperation around groundwater quality resulting in reduction of nitrate levels.

Goal 2: Reduce nitrate concentrations by implementing best practices in residential, open and green space areas.

Goal 3: Reduce the nitrate concentration from septic systems.

Goal 4: Reduce the potential for contamination of wells; conduct analytical testing for nitrates in domestic wells and educational outreach to domestic well owners on point-of-use treatment options.

Goal 5: Provide technical support for local governing bodies to adopt rules in accordance with Oregon statute.

Goal Strategies and Actions

Goal 1: Achieve an increased level of knowledge and cooperation around groundwater quality resulting in reduction of nitrate levels.

Objectives:

- Increased knowledge with owners and renters of homes, developers, businesses and other facilities within the LUBGWMA
- Increased knowledge of land use planning agencies and state agencies concerning the impacts to the LUBGWMA
- Provide technical support for local governing bodies

Strategy 1.1 Compile information from the industry or regulatory agencies and provide education.

Actions

- Information gathered can be compiled into a single brochure or broader information packet that can be used by the Oregon DEQ, county planning departments and appropriate city planning staffs to better inform citizens or potential citizens about groundwater quality.
- Offer workshops for realtors on groundwater quality concerns and provide continuing education credits.
- Identify funding and offer a free drinking water well nitrate testing program.
- Implement a project that looks at what types of messages resonate with rural residents to get their drinking water wells tested or treated. The project will gather baseline data on community awareness of local groundwater contamination in specific geographic areas in the GWMA. The results from this study will help the GWMA Committee, DEQ staff, and others better understand constituents' needs, create the appropriate communication tools, and encourage beneficial practices.
- Create and implement a school age program for delivery within the LUBGWMA. Topics should include, but not be limited to, the following: what not to put down your drain, how to have your drinking water tested, and how to maintain a healthy lawn.
- Integrate a groundwater quality component into the local area watershed curriculum initiative and other educational forums (such as: 4H, FAA and Scouts).

Responsible Entity: Morrow County and Umatilla County
Schedule: 2020

Strategy 1.2 Provide information to the public about groundwater quality.

Actions

- Develop appropriate articles and newsletters for local publication and media outlets. Emphasize and encourage the adoption of recommended practices to reduce nitrogen loading to the groundwater.
- Submit a monthly press release to local newspapers, publish a biannual newsletter and submit articles to the Ruralite magazine (written by various agency personnel and active citizens).

Responsible Entity: Morrow County and Umatilla County
Schedule: 2020

Strategy 1.3 Provide the rural residential community with information and alternatives on how to develop property while protecting groundwater quality.

Actions

- Establish an educational/outreach program and material for the region.
- Encourage local area libraries to house information.
- Develop bilingual outreach material for the Hispanic community.

Responsible Entity: Morrow County and Umatilla County
Schedule: 2020

Strategy 1.4 Offer technical support to elected officials, city and county staff, and citizens' advisory groups about the GWMA and associated issues.

Actions

- Provide workshops, briefing sheets, meeting speakers, and other educational tools for local policy-makers and those implementing the policies.
- Coordinate with local partners to include relevant GWMA-related information on their websites.

Responsible Entity: Morrow County and Umatilla County

Schedule: 2020

Strategy 1.5 Identify organizations, both locally, across the region and state, and nationally that have expertise in this or related areas and utilize their knowledge and materials to benefit the LUBGWMA and assist with implementing this and other portions of the Local Action Plan.

Actions

- Oregon DEQ, County Planning Departments and Commissions, and affected cities lead identification of amendments to city or county comprehensive plans and land use regulations to assist county planning commissions, departments and the development community in addressing the groundwater quality impacts of future development.

Responsible Entity: Oregon DEQ, Morrow County and Umatilla County
Schedule: 2020

Goal 2: Reduce nitrate concentrations by implementing best practices in residential, open and green space areas

Objectives:

- Increase knowledge by providing education about elevated nitrates and the causes
- Implementation of best management practices

Strategy 2.1 Perform outreach and education about best practices to reduce nitrate leaching from residential, open and green space activities

Actions

- Educate and inform landscapers and yard maintenance companies, owners and operators of large public open and green space, and residents generally about best management practices concerning watering, fertilizing and general management of these areas.
- Measure via a survey or other instrument the knowledge of residents about the application of fertilizers at the correct agronomic rate for the plants being fertilized as well as the amount and times of water needed to maintain a healthy landscape, lawn or garden.
- Assist landowners to know about and encourage pasture nutrient, and irrigation management practices for long term viability and to prevent possible groundwater contamination.

Responsible Entity: Morrow County SWCD and Umatilla County SWCD
Schedule: 2020

Strategy 2.2 Assist owners of medium and large animals to better understand the impacts of animals on groundwater and how proper nutrient, manure and irrigation water management can be beneficial to clean drinking water and their environment.

Actions

- Assist landowners to follow general grazing accepted pasture management practices to avoid over grazing of pastures. Include pasture maintenance and renovation, pasture rotation and winter grazing management.
- Assist landowners to practice proper manure management techniques which include the proper collection, storage of manure, waste water control and application techniques.
- Assist landowners to know about and implement measures to minimize wastewater by providing dry manure storage facilities and diverting surface runoff.
- Outreach through animal feed suppliers and veterinarians.
- Morrow and Umatilla County Planning Departments and affected cities amend their animal density

requirements toward a pasture management system that could allow for more animals if certain conditions are met. Document and map if possible.

Responsible Entity: Morrow County SWCD and Umatilla County SWCD
Schedule: 2020

Strategy 2.3 Umatilla County and Morrow Soil and Water Conservation Districts, the OSU Master Gardener Program, County Planning Departments, County weed managers or supervisors, and the Cities within the LUBGWMA work cooperatively to educate and inform.

Actions

- Provide homeowners and others managing open or green space information about causes of different plant problems, including watering and fertilizing, available to them that is regionally specific with references to available assistance.
- Organize information and develop an educational outreach program on methods and alternatives to properly maintain landscaping, lawns and gardens to prevent leaching nutrients to the groundwater.
- Identify programs currently offered by and through the Umatilla County or Morrow SWCD that could be expanded into the LUBGWMA and determine if there are incentives involved.
- Reengage the cities within the LUBGWMA relative to both residential impacts and the impacts from public lands.
- Engage the OSU Master Gardener Program utilizing their organization, meetings and outreach efforts to the benefit of the residents within the LUBGWMA.

Responsible Entity: Umatilla County and Morrow Soil and Water Conservation Districts, the OSU Master Gardener Program, County Planning Departments, County weed managers or supervisors, and the Cities within the LUBGWMA
Schedule: 2020

Goal 3: Reduce the nitrate concentration from septic systems

Objectives:

- Proper installation and continued maintenance of septic systems to reduce the movement of nitrite and nitrate to groundwater.
- Through amendments to city or county comprehensive plans and land use regulations, address developments proposals with high densities or clusters of installed septic systems and the negative impacts of allowing new areas with increased septic density.
- All low or moderate income residents within high risk areas of the GWMA have access to financial assistance for analytical testing and treatment technologies that reduce nitrate exposure in drinking water.
- Identify impacts to septic systems from various sources, including but not limited to, cancer treatment and other drugs, and misinformed use of septic treatment products. Introducing these other components or compounds into the septic system impacts the proper operation of the system.

Strategy 3.1 Provide ongoing education and information to address groundwater quality and other effects of improperly installed or maintained systems.

Actions

- Take into consideration the location of existing wells, septic systems, and other possible contamination sources before siting a septic system.
- Encourage periodic inspections and replacement or upgrading of septic systems to meet current standards.
- Encourage routine maintenance of septic systems to extend the useful life of the system and minimize groundwater impacts.

- Use information obtained by surveying septic system pumpers to determine what type of information septic system owners need to improve maintenance of their systems.
- Use information from complaints or through other developed mechanisms to determine failing or impaired septic systems.
- Through amendments to city or county comprehensive plans and land use regulations, consideration should be given to the use of Alternative Treatment Technologies
- Provide information to drug stores and pharmacies about impacts of drugs on septic systems and wastewater treatment facilities. Develop and implement prescription drug take back programs

Responsible Entity: Morrow County and Umatilla County
Schedule: 2020

Strategy 3.2 Morrow and Umatilla County Planning Departments adopt and implement Comprehensive Plan policy statements or other land use measures and rules that implement and maintain a seven to ten acre rural residential parcel size when new lands are converted from resource to non-resource, particularly residential, use.

Actions

- Amend Land Use Plans and Codes to incorporate groundwater concerns and incorporate groundwater quality as criteria in land use review of development proposals.
- Through amendments to city or county comprehensive plans and land use regulations, develop solutions for county and city governments to use to address the cumulative impacts of clustered and high-density septic systems when planning for and reviewing developments.

Responsible Entity: Morrow County and Umatilla County
Schedule: 2020

Strategy 3.3 Facilitate the use of financial incentives to encourage the use of technologies that reduce nitrate contributions from septic systems to groundwater.

Actions

- Promote utilization of Clean Water Loans offered through DEQ to make repairs more affordable.
- Explore options to make use of the State Revolving Loan Fund to finance grants and loans to low- and moderate-income residents for installations or upgrades to meet an approved nitrate reduction standard.
- Investigate the possibilities of using current or new state income tax or county property tax credits or deductions for individuals who install onsite wastewater systems that meet an approved nitrate reduction standard, similar to the idea of a tax credit for water conserving appliances.
- Network with local, state, and federal agencies that provide financial assistance for home rehabilitation and water-quality-protection to ensure that septic system enhancement is an allowable use of those funds.

Responsible Entity: Oregon DEQ, Morrow County and Umatilla County
Schedule: 2020

Strategy 3.4 Minimize septic system wastewater loadings that could create a groundwater quality problem.

Actions

- Utilize septic system density map, hydrogeology, the current built environment overlaid with current zoning.
- Investigate possible methods for determining where in the LUBGWMA high densities of septic systems, in conjunction with soil types and other limiting factors, are likely to have an adverse impact on groundwater quality.

- Complete amendments to city or county comprehensive plans and land use regulations to guide future land use decisions for zone changes, subdivisions or other land use actions that would decrease wastewater loading.

Responsible Entity: Morrow County and Umatilla County
Schedule: 2020

Goal 4: Reduce the potential for contamination of wells and conduct analytical testing for nitrates in domestic wells and educational outreach to domestic well owners on point-of-use treatment options.

Strategy 4.1 Provide nitrate analytical testing and point-of-use treatment options information to owners and users of wells. Provide information to well drillers, realtors, landscapers and yard maintenance companies concerning various aspects of well construction and maintenance

Actions

- Implement nitrate analytical testing for domestic wells in Morrow and Umatilla County.
- Provide educational outreach to domestic well users regarding point-of-use nitrate treatment options.
- Assure that older wells with poor construction or known leakage are repaired.
- Assure that new wells are installed in such a way as to avoid creating new problems relative to a wells construction, location, or leakage.
- Work with the Oregon Water Resources Department (OWRD), the Oregon Drinking Water Program, and city and county planning departments to provide information
- Construct and repair wells to prevent possible contamination from the surface and the concern about the use of sand points.
- Encourage owners of older wells to get their well casings and seals inspected to ensure that no leakage is occurring.
- Take into consideration the location of existing wells, septic systems, and other possible contamination sources before siting a well
- Locate potential liquid or solid contaminates away from well heads or provide barriers to prevent well contamination.
- When using chemigation provide anti back siphoning devices to prevent contamination of the well and groundwater through back siphoning of chemigation tanks.
- Repair wells that are commingling alluvial and basalt aquifers so contamination in one aquifer does not contaminate another.

Responsible Entity: Morrow County and Umatilla County, OHA, OWRD,
Schedule: 2020

Strategy 4.2 Facilitate the use of financial incentives to encourage proper abandonment or repair of wells

Actions

- Work with Oregon Water Resources Department and Oregon's Drinking Water Program to identify grants and make available loans to improve well construction and repair problem wells.
- Create an incentives program that would encourage owners of problem wells to address the situation.
- Request increased inspection of wells by OWRD and take necessary steps to support the agency in doing this.
- Agency cooperation to identify needs and risks of the LUBGWMA.

Responsible Entity: Oregon (OWRD), Morrow County and Umatilla County
Schedule: 2020

Goal 5: Provide technical support for local governing bodies to adopt rules in accordance with Oregon statute.

Provide technical support for rule making by city or county comprehensive plans and land use regulations that incorporate groundwater concerns and incorporate groundwater quality as criteria in land use review of development proposals.

Responsible Entity: Oregon DEQ, Morrow County and Umatilla County
Schedule: 2020

3.4 Confined Animal Feeding Operations (CAFOs)

3.4.1 Overview

An animal feeding operation (AFO) is the holding of animals; including, cattle, sheep, or other animals; in buildings, pens, or lots where the surface has been treated to support animals in wet weather. A confined animal feeding operation (CAFO) that confines animals for more than four months in a year and has a disposal system for liquid waste or a wastewater control facility is required to obtain a permit from ODA (see Table 1 in either the Oregon CAFO National Pollutant Discharge Elimination System General Permit or the Oregon CAFO Water Pollution Control Facilities General Permit). Any reference to “CAFO” in this Local Action Plan refers to an AFO that is required to obtain a permit in the state of Oregon.

Currently there are ten operating CAFO facilities in the LUBGWMA. Each facility operates under a water quality permit jointly issued by DEQ and ODA and each facility is inspected at minimum of once per year to ensure compliance. Of these ten facilities, four are cow dairies and six are cattle feedlots. Cumulatively these CAFOs also manage approximately 42,000 acres of crop and pasture land in the LUBGWMA.

3.4.2 Potential Sources of Nitrate from CAFOs

Primary source are nitrogen from animal manure and process wastewater. Secondary sources are synthetic fertilizer and irrigation water.

CAFOs in the Basin are a source of nitrogen from the animal manure and process wastewater generated at the feeding operation. If these sources are not properly managed, excess nitrate from the manure and process wastewater may leach into groundwater. The CAFO permit requires that an ODA-approved Animal Waste Management Plan (AWMP) be developed and implemented, which must describe the facility’s best management practices (BMPs) to store, handle, and utilize manure. CAFOs are required to meet state design standards for impoundments and surfaces where manure liquids and solids will be stored to prevent discharge or leaching of nutrients. The land application of manure and nutrients at CAFOs is regulated and must be applied at or below agronomic rates; and they are required to manage irrigation (manure liquids and fresh water) to prevent runoff and leaching of soluble nutrients (NO^{3-} and NO^{2-}). Also, CAFOs in the basin are required to make records of crops planted, total manure nutrients applied to each field and total additional synthetic fertilizers applied.

Goal 1: Collect, contain, treat and/or store manure and process wastewater at CAFOs in a manner that is protective of groundwater.

Goal 2: Beneficially utilize nutrients at CAFOs and prevent leaching of nutrients to groundwater.

Goal 3: Keep current with CAFO BMPs and provide CAFO education outreach.

Goal Strategies and Actions

3.4.3 Goals, Objectives, Strategies and Actions:

Goal 1: Collect, contain, treat and/or store manure and process wastewater at CAFOs in a manner that is protective of groundwater.

Objective 1: In each 4-year period, CAFOs in the LUB GWMA will have an average annual routine inspection compliance rating of at least 90%.

Strategy 1.1: Surface Water Management. Precipitation, or water, that comes in contact with potential pollutant sources at CAFOs continues to be collected, contained and/or treated. Additionally, CAFOs may incorporate facility management techniques that will divert clean surface water and stormwater runoff away from the production area facilities where they can come in contact with manure and stored feed products.

Actions:

- CAFO operators inspect and maintain their systems that collect, contain and/or treat surface and stormwaters that have come into contact with potential pollutants sources at their facility (CAFO permit requires this).
- CAFO operators with fresh water diversion systems inspect and maintain the diversion structures (CAFO permit requires this).

Responsible Entity: CAFO Operators
Schedule: Ongoing; these actions are already required and being implemented

Strategy 1.2. Wastewater Conveyance and Storage Management. Surface and groundwater protection measures for wastewater management include lagoons, evaporative ponds, and conveyance facilities that direct, catch and hold manure, process wastewater and runoff waters that come in contact with manure or feed stores. These facilities allow the capture, management, and storage of manure, process wastewater, and runoff water.

Actions:

- ODA and the CAFO permit will continue to require CAFOs to operate with an approved AWMP that includes a list of planned structural improvements. Newly proposed manure handling structures requires ODA approval prior to constructing.
- CAFOs planning to construct new lagoons, solid storage, and wastewater conveyance facilities submit design plans to ODA for review and receive ODA approval prior to construction.
- ODA reviews design plans for new lagoons, solid storage and wastewater conveyance facilities to ensure that they are designed and constructed in accordance with current state standards to minimize leakage of stored wastewater. ODA may request that DEQ assist in these reviews.
- Existing lagoons and wastewater conveyance facilities meet state design standards for storing wastes, leachates and effluent. All manure and process wastewater structures must be operated and maintained to deliver the designed water quality protections.
- CAFOs follow their operation and maintenance plan in their ODA-approved AWMP when cleaning out sediments from lagoons and holding ponds to prevent damage to the seals or structures, which could result in leakage.

Responsible Entity: CAFO Operators
Schedule: Ongoing; these actions are already required and being implemented

Strategy 1.3. Management of Solid Storage Areas and Feed yard Surfaces. Studies have shown that concentrating animals in a small area produces a surface seal of compacted organic matter and soil that inhibits movement and leaching of effluent through the seal of feed yard surfaces. Anaerobic conditions can also be created in the seal, which will assist in the denitrification process. New pens, manure storage, and feed storage areas are designed and constructed according to state design standards to minimize groundwater issues.

Actions:

- CAFOs store manure in designated locations identified in the ODA-approved AWMP and in a manner that minimizes impact to surface and groundwater.
- CAFOs maintain the surface seal while removing manure and shaping the feedlot pens.
- CAFOs direct runoff to adequately constructed effluent storage or treatment facilities.

Responsible Entity: CAFO Operators
Schedule: Ongoing; these actions are already required and being implemented