Lower Yakima Valley Groundwater Management Program

Volume II

Appendices

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LOWER YAKIMA VALLEY
GROUNDWATER
ADVISORY
COMMITTEE

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Volume II

Appendix A – Authority for Groundwater Management Areas

The Washington State Legislature adopted a law authorizing the identification of ground water management areas (RCW 90.44.400-440). The Department of Ecology adopted a regulation Groundwater Management Areas and Programs (Chapter 173-100 WAC), which includes a process for designation, guidelines, and criteria. GWMAs are designed to protect groundwater quality, to assure groundwater quantity, and to provide for efficient management of water resources for meeting future needs while recognizing existing water rights. The regulations adopted an approach intended to "forge a partnership between a diversity of local, state, tribal and federal interests in cooperatively protecting the state's groundwater resources."

In February 2010, the Department of Agriculture, Department of Ecology, Department of Health, Yakima County Department of Public Works, and U.S. Environmental Protection Agency published a report titled *Lower Yakima Valley Groundwater Quality, Preliminary Assessment and Recommendations Document.*[1] That preliminary assessment found that:

> "The existing studies and related water quality data indicate that nitrate and bacterial contamination of groundwater exist in the Lower Yakima Valley…Over 2,000 people in the area are exposed to nitrate over the maximum contaminant level (MCL) through their drinking water. While not all groundwater supplies have been impacted, many residents rely on private wells that are in the most vulnerable portions of the aquifer. Approximately 12 percent of domestic well users are exposed to nitrate levels in their drinking water that exceed the health-based standard of 10 mg/L."[2]

The *Preliminary Assessment* made recommendations for subsequent action, including:

- Development of a conceptual site model for the Lower Valley
- Development of a nitrogen loading model for the Yakima basin

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[1] *Lower Yakima Valley Groundwater Quality, Preliminary Assessment and Recommendations Document*, Washington State Department of Agriculture, Washington State Department of Ecology, Washington State Department of Health, Yakima County Department of Public Works, U.S. Environmental Protection Agency, Ecology Publication No. 10-10-009, February 2010. (Hereafter, "*Preliminary Assessment.*")

[2] Preliminary Assessment, p. ES 2.

- Acknowledgement of the connection between groundwater and surface water
- Determination of the sources of contamination
- Identification of agricultural operations that use flood irrigation
- Assessment of agricultural applications of nitrogen fertilizers and Best Management Practices
- Education and outreach regarding nitrates and bacteria
- Assessment of cumulative risk factoring in synergistic health effects
- Exploration of shifting residents to public water systems where feasible
- Involvement of the Yakima Health District
- Exploration of the concept of developing a groundwater management area as one potential funding option
- Development of measures of success
- Identification and implementation of appropriate enforcement actions

The *Preliminary Assessment* also identified four "needs":

1. Better characterization of vulnerable groundwater supplies.
2. Improve water quality monitoring and coordination of data that can identify trends in water quality.
3. Funding options to support lower valley initiatives to better manage potential contaminant sources and improve groundwater quality.
4. A mechanism to coordinate future efforts and implement actions that result in improved water quality.

On April 17, 2012, the Department of Ecology and Yakima County executed an Interagency Agreement. The Agreement provided funds from Ecology to the County for the formation of a Groundwater Management Area for the lower Yakima Valley as set forth in WAC 173-100. The Agreement stated that "The purpose of the GWMA is to reduce nitrate contamination in groundwater to below state drinking water standards."

Yakima County was charged by the Agreement with performing the actions of Lead Agency[3] for the development of a Groundwater Management Program, preparing a work plan, and budgeting for development of a GWMA Program.

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[3] The role of lead agency is described in WAC 173-100-080.

The lead agency shall be responsible for coordinating and undertaking the activities necessary for development of the groundwater management program. These activities shall include collecting data and conducting studies related to hydrogeology, water quality, water use, land use, and population projections; scheduling and coordinating advisory committee meetings; presenting draft materials to the committee for review; responding to comments from the committee; coordinating SEPA review; executing interlocal agreements or other contracts; and other duties as may be necessary. The lead agency shall also prepare a work plan, schedule, and budget for the development of the program that shows the responsibilities and roles of each of the advisory committee members as agreed upon by the committee. Data collection, data analysis and other elements of the program development may be delegated by the lead agency to other advisory committee members.

The contents of a GWMA Program are identified in RCW 90.44.410. Yakima County has therefore conducted studies and collected data. It has not analyzed data or drawn conclusions therefrom. Information related to hydrogeology, water quality, water use, land use, and population are included in this Program.

Washington State Law RCW 90.44.410

Requirements for groundwater management programs – review of programs.

(1) The groundwater area or sub-area management programs shall include:

(a) A description of the specific groundwater area or sub-areas, or separate depth zones within any such area or sub-area, and the relationship of this zone or area to the land use management responsibilities of county government;

(b) A management program based on long-term monitoring and resource management objectives for the area or sub-area;

(c) Identification of water resources and the allocation of the resources to meet state and local needs;

(d) Projection of water supply needs for existing and future identified user groups and beneficial uses;

(e) Identification of water resource management policies and/or practices that may impact the recharge of the designated area or policies that may affect the safe yield and quantity of water available for future appropriation;

(f) Identification of land use and other activities that may impact the quality and efficient use of the groundwater, including domestic, industrial, solid, and other waste disposal, underground storage facilities, or storm water management practices;

(g) The design of the program necessary to manage the resource to assure long-term benefits to the citizens of the state;

(h) Identification of water quality objectives for the aquifer system which recognize existing and future uses of the aquifer and that are in accordance with department of ecology and department of social and health services drinking and surface water quality standards;

(i) Long-term policies and construction practices necessary to protect existing water rights and subsequent facilities installed in accordance with the groundwater area or sub-area management programs and/or other water right procedures;

(j) Annual withdrawal rates and safe yield guidelines which are directed by the long-term management programs that recognize annual variations in aquifer recharge;

(k) A description of conditions and potential conflicts and identification of a program to resolve conflicts with existing water rights;

(l) Alternative management programs to meet future needs and existing conditions, including water conservation plans; and

(m) A process for the periodic review of the groundwater management program and monitoring of the implementation of the program.

(2) The groundwater area or sub-area management programs shall be submitted for review in accordance with the State Environmental Policy Act (SEPA).

Washington State Regulation WAC 173-100-100

Groundwater management program content.

The program for each groundwater management area will be tailored to the specific conditions of the area. The following guidelines on program content are intended to serve as a general framework for the program, to be adapted to the particular needs of each area. Each program shall include, as appropriate, the following:

(1) An area characterization section comprised of:

(a) A delineation of the groundwater area, subarea or depth zone boundaries and the rationale for those boundaries;
(b) A map showing the jurisdictional boundaries of all state, local, tribal, and federal governments within the groundwater management area;
(c) Land and water use management authorities, policies, goals and responsibilities of state, local, tribal, and federal governments that may affect the area's groundwater quality and quantity;
(d) A general description of the locale, including a brief description of the topography, geology, climate, population, land use, water use and water resources;
(e) A description of the area's hydrogeology, including the delineation of aquifers, aquitards, hydrogeologic cross-sections, porosity and horizontal and vertical

permeability estimates, direction and quantity of groundwater flow, water-table contour and potentiometric maps by aquifer, locations of wells, perennial streams and springs, the locations of aquifer recharge and discharge areas, and the distribution and quantity of natural and man-induced aquifer recharge and discharge;

(f) Characterization of the historical and existing groundwater quality;

(g) Estimates of the historical and current rates of groundwater use and purposes of such use within the area;

(h) Projections of groundwater supply needs and rates of withdrawal based upon alternative population and land use projections;

(i) References including sources of data, methods and accuracy of measurements, quality control used in data collection and measurement programs, and documentation for and construction details of any computer models used.

(2) A problem definition section that discusses land and water use activities potentially affecting the groundwater quality or quantity of the area. These activities may include but are not limited to:

(a) Commercial, municipal, and industrial discharges.

(b) Underground or surface storage of harmful materials in containers susceptible to leakage.

(c) Accidental spills.

(d) Waste disposal, including liquid, solid, and hazardous waste.

(e) Storm water disposal.

(f) Mining activities.

(g) Application and storage of roadway deicing chemicals.

(h) Agricultural activities.

(i) Artificial recharge of the aquifer by injection wells, seepage ponds, land spreading, or irrigation.

(j) Aquifer over-utilization causing seawater intrusion, other contamination, water table declines or depletion of surface waters.

(k) Improperly constructed or abandoned wells.

(l) Confined animal feeding activities.

The discussion should define the extent of the groundwater problems caused or potentially caused by each activity, including effects which may extend across groundwater management area boundaries, supported by as much documentation as possible. The section should analyze historical trends in water quality in terms of their likely causes, document declining water table levels and other water use conflicts, establish the relationship between water withdrawal distribution and rates and water level changes within each aquifer or zone, and predict the likelihood of future problems and conflicts if no action is taken. The discussion should also identify land and water use management policies that affect groundwater quality and quantity in the area. Areas where insufficient data exists to define the nature and extent of existing or potential groundwater problems shall be documented.

(3) A section identifying water quantity and quality goals and objectives for the area which (a) recognize existing and future uses of the aquifer, (b) are in accordance with water quality standards of the department, the department of social and health services, and the federal environmental protection agency, and (c) recognize annual variations in aquifer recharge and other significant hydrogeologic factors;

(4) An alternatives section outlining various land and water use management strategies for reaching the program's goals and objectives that address each of the groundwater problems discussed in the problem definition section. If necessary, alternative data collection and analysis programs shall be defined to enable better characterization of the groundwater and potential quality and quantity problems. Each of the alternative strategies shall be evaluated in terms of feasibility, effectiveness, cost, time and difficulty to implement, and degree of consistency with local comprehensive plans and water management programs such as the coordinated water system plan, the water supply reservation program, and others. The alternative management strategies shall address water conservation, conflicts with existing water rights and minimum instream flow requirements, programs to resolve such conflicts, and long-term policies and construction practices necessary to protect existing water rights and subsequent facilities installed in accordance with the groundwater management area program and/or other water right procedures.

(5) A recommendations section containing those management strategies chosen from the alternatives section that are recommended for implementation. The rationale for choosing these strategies as opposed to the other alternatives identified shall be given;

(6) An implementation section comprised of:

(a) A detailed work plan for implementing each aspect of the groundwater management strategies as presented in the recommendations section. For each recommended management action, the parties responsible for initiating the action and a schedule for implementation shall be identified. Where possible, the implementation plan should include specifically worded statements such as model ordinances, recommended governmental policy statements, interagency agreements, proposed legislative changes, and proposed amendments to local comprehensive plans, coordinated water system plans, basin management programs, and others as appropriate;

(b) A monitoring system for evaluating the effectiveness of the program;

(c) A process for the periodic review and revision of the groundwater management program.

Appendix B – Regulatory Authority

The water molecules in the ground beneath the GWMA fall within the regulatory structure of the federal Safe Drinking Water Act and Washington Department of Health regulations (as "drinking water") and Washington's Water Pollution Control Act and Water Resources Act (as "groundwater"). Those molecules' potential contribution to surface water quality makes the federal Clean Water Act and surface water authorities assigned to the Washington State Department of Ecology by the Water Pollution Control Act also apply.

Safe Drinking Water Act

The EPA has broad authority, under Section 1421 of the Safe Drinking Water Act, 42 U.S.C. 300g-1(b)(1)(A), (B), to establish national primary drinking water standards, "if the Administrator determines that . . . the contaminant may have an adverse effect on the health of persons;" "is known to occur . . . in public water systems with a frequency and at levels of public health concern;" or there is "a meaningful opportunity for health risk reduction for persons served by public water systems."

For each contaminant that the Administrator determines to regulate under subparagraph (B), the Administrator shall publish maximum contaminant level goals and promulgate, by rule, national primary drinking water regulations under this subsection (42 U.S.C. 300g-1(b)(1)(E)).

EPA sets legal limits on over 90 contaminants in drinking water. The legal limit for a contaminant reflects the level that protects human health and that water systems can achieve using the best available technology. EPA rules also set water testing schedules and methods that water systems must follow. The EPA set the maximum contaminant level for nitrate, nitrite and total nitrate, and nitrite in 40 CFR § 141.62:

Contaminant	MCL (mg/L)
(7) Nitrate	10 (as Nitrogen)
(8) Nitrite	1 (as Nitrogen)
(9) Total Nitrate and Nitrite	10 (as Nitrogen)

EPA may approve states to assume primary enforcement authority under the Safe Drinking Water Act. Washington's drinking water quality standard for nitrate is 10 milligrams per liter (mg/L), or 10 parts per million.

When drinking water in private wells contains or is likely to contain a contaminant that may present an imminent and substantial endangerment, such as nitrate, EPA may take an emergency action under the SDWA, Section 1431. EPA must first determine that the state and local authorities have not taken action to protect the health of such persons. An emergency action pursuant to SDWA Section 1431 may include any order that may be necessary to protect the health of persons, including ordering the collection of samples to investigate the sources of the contamination. In addition, where appropriate, EPA may issue orders to require the provision of alternative water supplies. EPA may also judicially enforce its orders, through action seeking civil penalties for each day of such violation. If violation of EPA's orders is "willful," EPA may seek criminal penalties of fines or imprisonment for not more than three years (42 U.S.C. § 300g-2(b)). Citizens may also seek protection of underground sources of drinking water, under 42 USC 300j-8, so as to mandate EPA regulatory or litigative action.

The EPA may also designate sole source drinking water aquifers under Section 1427 of the Safe Drinking Water Act, 42 U.S.C. 300h.

State Department of Health

The Washington State Department of Health is authorized to adopt regulations "to protect public health" (RCW 43.20.050(2)). These may include rules for Group A public water systems, as necessary, to assure safe and reliable public drinking water and to protect the public health. Those rules set requirements regarding: (i) The design and construction of public water system facilities, including proper sizing of pipes and storage for the number and type of customers; (ii) Drinking water quality standards, monitoring requirements, and laboratory certification requirements; (iii) Public water system management and reporting requirements; (iv) Public water system planning and emergency response requirements; (v) Public water system operation and maintenance requirements; (vi) Water quality, reliability, and management of existing but inadequate public water systems; and (vii) Quality standards for the source or supply, or both source and supply, of water for bottled water plants.

The DOH also sets rules for Group B public water systems, as defined in RCW 70.119A.020. These rules establish minimum requirements for the initial design and construction of a public water system and "rules and standards for prevention, control, and abatement of health hazards and nuisances related to the disposal of human and animal excreta and animal remains" (RCW 42.30.050 (2) (b), (c)).

The Department of Health requires that nitrate levels (concentrations) (as N) in Group A public water systems not exceed the maximum contaminant level ("MCL") of 10 mg/L, and that nitrite levels (concentrations) not exceed the MCL of 1 mg/L (WAC 246-290-310(3)

(Table 4)). The requirements for Group B public water systems are the same (WAC 246-291-170 (2)(b)). Nitrate and nitrite are "primary inorganic contaminants" and the MCL for nitrate and nitrite are "primary MCLs." When primary MCLs are exceeded by a public water system the water purveyor must "determine the cause of the contamination" and "take action as directed by the Department of Health" (WAC 246-290-320(1)(b)(iii)).

WAC 246-290-300 requires public water systems to sample for many contaminants, including nitrate, on a regular basis. Public water systems with nitrate levels over 10 mg/L must notify the people who receive water from them (WAC 246-290-320).

Clean Water Act

Surface water quality in Washington is regulated by the federal Clean Water Act (33 U.S.C. 1342, et seq.) and Washington's Water Quality Standards for Surface Waters (Chapter 173-201A), which are authorized by the State Water Pollution Control Act (Chapter 90.48).

The Clean Water Act makes it unlawful to discharge any pollutant from a point source into waters of the U.S. unless a National Pollutant Discharge Elimination System (NPDES) permit is obtained (33 U.S.C. 1342). The NPDES permitting authority has been delegated to the Department of Ecology (See 33 U.S.C. 1342 (b); RCW 90.48.260). The Department exercises this delegated authority, together with its authority under the Water Pollution Control Act, in issuing NPDES permits and State Waste Discharge Permits (SWDPs) (pursuant to WAC 273-226-030). Ecology's water quality standards are used to establish effluent limits in NPDES permits and SWDPs.

Ecology's water quality standards and SWDPs apply to both point source activities and nonpoint source activities. Point source activities are activities where a source of pollution can be readily distinguished, such as the industrial discharge of waste onto or into the ground. State law requires point sources to operate under permits that set conditions for discharges. These permits may be issued to a specific entity with conditions designed to protect water quality.

A "point source" is "any discernible, confined, and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture." (WAC 273-226-030 (21))

"Nonpoint sources" are more diffuse in nature. They often consist of many small pollutant sources that have a cumulative effect, like highway runoff, on-site septic systems in developed areas, and application of pesticides or nutrients in both agricultural and urban areas. Some nonpoint sources are managed through the development of siting and design standards.

Groundwater contamination may affect surface water quality. Under §303(d) of the Clean Water Act, states are required to develop lists of impaired waters. These are waters for which technology-based regulations and other required controls are not stringent enough to meet the water quality standards set by the state. The law requires that states establish priority rankings for waters on the lists and develop Total Maximum Daily Loads (TMDL) for these waters. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still safely meet water quality standards. A TMDL is generally administered by establishing limits on the discharge of pollutant materials otherwise permitted under the NPDES or state regulatory programs.

Washington's Water Pollution Control Act and Water Resources Act

Groundwater quality in Washington is regulated by the Groundwater Quality Standards (Chapter 173-200 WAC) which are authorized by the state Water Pollution Control Act (Chapter 90.48 RCW) and Water Resources Act (Chapter 90.54 RCW). Discharges to groundwater are regulated through a variety of permitting mechanisms which are authorized by the Water Pollution Control Act (Chapter 90.48. RCW). These permitting regulations include State Waste Discharge Permits, which may be issued as General Permits.

The Water Pollution Control Act, Chapter 90.48 RCW makes it "unlawful for any person to throw, drain, run, or otherwise discharge into any of the waters of this state, or to cause, permit or suffer to be thrown, run, drained, allowed to seep or otherwise discharged into such waters any organic or inorganic matter that shall cause or tend to cause pollution of such waters" (RCW 90.48.080).

The Department of Ecology (Ecology) is the primary agency in Washington State responsible for implementation of this mandate. Ecology has adopted Chapter 173-200 WAC, Water Quality Standards for Groundwaters. The standards include "water quality criteria" (numerical limits for specific contaminants that apply to all groundwaters in the state). WAC 173-200-040 (2) (Table 1) establishes that Nitrate concentrations in groundwater may not exceed 10 mg/L.

The standards apply to all groundwaters of the state that occur in a saturated zone (generally at or below the water table) or stratum beneath the surface of land or below a surface water body. The groundwater standards do not apply in the root zone of saturated soils where agricultural pesticides and nutrients have been applied at agronomic rates for agricultural purposes, but only if those contaminants will not cause pollution of groundwaters below the root zone (WAC 173-200-010(3)(a)). In other words (removing the double negative), the standards do apply in saturated root zones if pollution is caused in groundwaters below.

Ecology's water quality standards incorporate an "antidegradation policy," an otherwise existing part of state water quality law (WAC 173-200-030). This policy precludes degradation which would harm existing or future beneficial uses of groundwater (drinking water, irrigation and support of wildlife habitat). Ecology has antidegradation implementation procedures that explain what needs to be done for an antidegradation analysis. The standards provide numeric values, which must not be exceeded to protect the beneficial use of drinking water.

General permits issued by the Department of Ecology (either as a combined NPDES and SWDP or as a state only SWDP) may be issued to a group of entities with common discharge characteristics and conditions (WAC 273-226-020). Permits issued under Chapter 273-226 WAC are designed to satisfy the requirements for discharge permits under Sections 307 and 402(b) of the federal Water Pollution Control Act (33 U.S.C. §1251) and the state law governing water pollution control (Ch. 90.48 RCW) (WAC 273-226-020). If eligible, a point source must obtain general permit coverage before discharging to surface or ground waters or the point source may be found to be in violation of state or federal law for discharging without a permit.

General permits establish standards for management. General permits are issued for fixed terms not exceeding five years from the effective date. Point source facility operators must apply to Ecology for coverage under a general permit (WAC 227-226). All permittees covered under a general permit must submit a new application for coverage under a general permit or an application for an individual permit at least 90 days prior to the expiration date of the general permit under which the permittee is covered. When a permittee has made timely and sufficient application for the renewal of coverage under a general permit, an expiring general permit remains in effect and enforceable until the application has been denied, a replacement permit has been issued by Ecology, or the expired general permit has been terminated by Ecology. Coverage under an expired general permit for permittees who fail to submit a timely and sufficient application shall expire on the expiration date of the general permit (WAC 173-226-200).

A general permit may be modified, revoked and reissued, or terminated, during its term if information is obtained by Ecology which indicates that cumulative effects on the environment from dischargers covered under the general permit are unacceptable (WAC 173-226-230 (1)(d)). Ecology may require any discharger to apply for and obtain an individual permit, or to apply for and obtain coverage under another more specific general permit. Also, any interested person may petition Ecology to require a discharger authorized by a general permit to apply for and obtain an individual permit (WAC 173-226-240 (2), (3)).

Ecology may revoke, or "terminate coverage under a general permit," where terms or conditions of the general permit are violated, conditions change such that either temporary or permanent reduction or elimination of permitted discharges is required, or Ecology determines that the permitted activity endangers human health, safety, or the environment, or contributes to water or sediment quality standards violations (WAC 173-226-240 (1) (a), (c), and (d)).

Washington's Water Pollution Control Act authorizes Ecology to "bring any appropriate action, in law or equity, including action for injunctive relief . . . as may be necessary to carry out the provisions" of that Act (RCW 90.48.037), including its prohibition of the discharge of organic or inorganic matter that may cause pollution of ground or surface water (RCW 90.48.080).

Violations of maximum concentrations may be addressed by enforcement "through all legal, equitable, and other methods available to the department including, but not limited to: issuance of state waste discharge permits, other departmental permits, regulatory orders, court actions, review and approval of plans and specifications, evaluation of compliance with all known, available, and reasonable methods of prevention, control, and treatment of a waste prior to discharge, and pursuit of memoranda of understanding between the department and other regulatory agencies" (WAC 173-200-100 (3)).

If Ecology determines that a potential to pollute the groundwater exists, it may request a permit holder or responsible person to prepare and submit a groundwater quality evaluation program for its approval. Each evaluation program must be based on soil and hydrogeologic characteristics and be capable of assessing impacts on groundwater at the "point of compliance." The evaluation program approved by Ecology may include (a) groundwater monitoring for a specific activity; (b) groundwater monitoring at selected sites for a group of activities; (c) monitoring of the vadose zone; (d) evaluation and monitoring of effluent quality; (e) evaluation within a treatment process; or (f) evaluation of management practices (WAC 173-200-080 (2)). The "point of compliance" is the location where the "enforcement limit," is "measured and shall not be exceeded" (WAC 173-200-060 (1)). The "enforcement limit" is established in accordance with WAC 173-200-050.

Ecology may also designate a groundwater "special protection area" if it determines that the groundwater in an area requires "special consideration or increased protection because of one or more unique characteristics" (WAC 173-200-090 (1)). These unique characteristics are then to be taken into consideration by Ecology when regulating activities, developing regulations, guidelines and policies and when prioritizing department resources for groundwater quality protection programs (WAC 173-200-090 (2)). Characteristics to guide designation of a special protection area are set forth in the rule (WAC 173-200-090 (2)). Designation of special protection areas must be in the public interest (WAC 173-200-090 (5)(b)).

Well Construction

In Washington State, the construction of groundwater wells was first required to be reported in 1972. Consequently, the Washington State Department of Ecology (Ecology) well database includes only those wells constructed after 1972, and those wells identified in information supporting water right claims, permits or certifications predating 1972. A reasonable estimate of wells within Yakima County that are identified in Ecology's well database is 45,000. Some portion of that is located within the Groundwater Management Area.

Groundwater wells typically have a life of about 40 years. This is due to: mechanical failure, deterioration of material (primarily steel well casings), settling of casings within ground materials, change in aquifer conditions (mineralization, scale deposits within casing). In most instances, it is cheaper to drill a new well than to repair an old one (Richardson).

Not all wells have the same risk of failure, or if abandoned the same risk to the public health and welfare. Wells differ in design, construction, diameter of casing, depth of casing, depth to water, water chemistry, etc. Wells constructed pursuant to regulatory standards have less risk of failure, even if "abandoned." "Dug wells," those wells constructed by digging a pit in the ground in order to collect water near ground surface, either with or without a small-diameter casing hammered into the ground from the bottom of the pit have the greatest risk of failure and risk to the public health and welfare. In addition to potential groundwater contamination from dug wells, people and animals can fall into these wells (Richardson).

"Vaulted" wells also present a significant risk of groundwater contamination, whether in use or abandoned. A "vaulted" well is essentially a dug well with a concrete reinforcement of the sides, or bottom, of the pit, creating a "vault". Water can collect in vaults which may migrate down the well casement, or along the annulus (the circular void between the well casing and the ground material through which the well was drilled) of the well casing. Wells with casing top elevations at or near ground level (as opposed to raised above ground level), or cut off below ground level, also present risk of groundwater contamination, due to possible "overtopping" of surface contamination into the well casing. Similar risk occurs where the well casing has no cap. Otherwise properly constructed wells may present risk of groundwater contamination if they have not been "sealed." Sealing is accomplished through the infusion of bentonite clay or cement into the casing annulus for a distance sufficient to prevent surface water intrusion into the subsurface (Richardson).

Deeper wells generally have larger diameters than shallower wells. Industrial, public water system, or irrigation wells are more likely to have larger diameter wells than single-user domestic wells. Unused irrigation wells may be less likely to be discovered because of change of land use or crop choice (Richardson).

Abandoned wells or wells that have not been decommissioned are often located by purchasers of property, parties who may become liable upon foreclosure of real estate financing instruments (banks), and reviewing entities (e.g., county planning officials) when reviewing proposals for change of parcel definitions (short plats, site plans for building permits) (Richardson).

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) (Pub. L. No. 94-590, 90 Stat 2795, 42 U.S.C. §§6901 – 6987, 9001 – 9010) contains both regulatory standards and remedial provisions to achieve goals of conservation, reducing waste disposal, and minimizing the present and future threat to human health and the environment. RCRA provides a comprehensive national regulatory structure for the management of nonhazardous solid wastes (subtitle D, 42 U.S.C. §§ 6941/y-6949a) and hazardous solid wastes (subtitle C, 42 U.S.C. §§ 6921/y-6939b). "Solid waste" is defined as "any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities . . . ." 42 U.S.C. §6903(27)

Materials are discarded if they are either abandoned or recycled or are inherently waste-like. 40 C.F.R. § 261.2. Materials are "disposed" if they are discharged, deposited, injected, dumped, spilled, leaked or otherwise placed into or on land or water such that it may enter into the environment or be emitted into the air or discharged into any waters, including groundwaters 42 U.S.C. §6903(3). Agricultural wastes, including manures, crop residues, or commercial fertilizers applied to the soil in amounts greater than can be used as fertilizers or soil conditioners may be the disposal of solid waste.

Washington's Right to Farm Law

Washington State's right to farm law, RCW 7.48.300-320, was first enacted in 1979, with the purpose of protecting agricultural activities conducted on farm and forest lands from nuisance lawsuits. As a consequence, "agricultural activities conducted on farmland and forest practices, if consistent with good agricultural and forest practices and established prior to surrounding nonagricultural and nonforestry activities, are presumed to be reasonable and shall not be found to constitute a nuisance" (RCW 7.48.305 (1)). The defense does not apply however if "the activity or practice has a substantial adverse effect on public health and safety." "Agricultural activities and forest practices undertaken in conformity with all applicable laws and rules are presumed to be good agricultural and forest practices not adversely affecting the public health and safety" (RCW 7.48.305 (2)). The Yakima County Code protects the right to farm in similar terms to the state statute (Ch. 6.22, YCC).

In 2005, Washington's right to farm law was amended to provide for full recovery of costs of litigation in the defense of nuisance suits where the right to farm law was a successful defense (RCW 7.48.315).

Interagency Cooperation

Ecology and WSDA signed a Memorandum of Understanding (MOU) in 2003 to guide coordination and cooperation between the two agencies for dairies, CAFOs and other animal feeding operations. A key element of the MOU is that WSDA inspectors must provide field inspections and technical assistance to Ecology for CAFO and other AFO related water quality activities. The two agencies continue to coordinate on livestock and manure related complaints and in implementing the CAFO permit. An updated MOU was signed in 2011. The [Memorandum of Understanding (MOU)](https://ecology.wa.gov/DOE/files/6f/6f30de07-feb0-463a-958e-cf48df3a43bf.pdf) can be found at: https://ecology.wa.gov/DOE/files/6f/6f30de07-feb0-463a-958e-cf48df3a43bf.pdf. Under the MOU, Ecology is responsible to EPA for Clean Water Act compliance for AFOs and CAFOs. Ecology maintains authority under Ch. 90.48 RCW to take compliance actions on any livestock operations where human health or environmental damage has or may occur due to potential or actual discharges, for pasture or rangeland based operations, for manure spreading operations when it is determined the manure was not applied by a dairy, for non-dairy AFOs, CAFOs and permitted CAFOs, and ultimately for permitted dairies. Where compliance actions are against non-permitted dairies, Ecology recognizes WSDA as lead. When Ecology is involved in investigations and compliance actions against non-permitted dairies, they will discuss the compliance actions with WSDA to ensure that timely compliance actions are sufficient to protect human health and the environment. Ecology is responsible for the approval of best management practices used to show compliance with water quality standards. Ecology must provide available monitoring data and trend analysis for livestock-related pollutants to WSDA upon request. Ecology's TMDL process must involve WSDA as a stakeholder if livestock issues are anticipated.

The Ecology/WSDA MOU requires that both agencies provide the other all livestock-related records that either may possess as necessary to fulfill state and federal requirements for livestock under the Clean Water Act (MOU ¶ C.2), and that the two agencies will coordinate in response to public disclosure requests for AFOs, CAFOs and dairies (MOU ¶ C.4).

WSDA is responsible for implementing Ch. 90.64 RCW and is required to follow Ch. 43.05 RCW. WSDA is responsible for inspections and may initiate compliance actions on permitted dairies, but must notify Ecology if there is a discharge to waters of the state and provide a Recommendation for Enforcement. WSDA is responsible for inspections, complaint response and warning letters for all non-dairy permitted CAFOs. Ecology is responsible for complaint response for non-dairy AFOs and CAFOs but WSDA may respond for initial complaint response if resources are available and may write warning letters. WSDA must coordinate, but seldom becomes involved with Ecology when compliance actions beyond warning letters are necessary for non-dairy AFOs and CAFOs or permitted CAFOs. WSDA must enter complaint inspections and warning letters on non-permitted AFOs and CAFOs into Ecology's PARIS database.

Natural Resources Conservation Service (NRCS) offers voluntary financial and technical assistance programs to eligible landowners and agricultural producers to help them manage natural resources in a sustainable manner. Those under contract with NRCS to participate in voluntary programs must adhere to relevant standards for funded projects. Current financial assistance programs in Washington State include:

- Agricultural Management Assistance (AMA): helps agricultural producers use conservation to manage risk and solve natural resource issues through natural resources conservation.
- Conservation Stewardship Program (CSP): helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns.
- Environmental Quality Incentives Program (EQIP): provides financial and technical assistance to agricultural producers in order to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, reduced soil erosion and sedimentation or improved or created wildlife habitat.

Yakima County's Role in Groundwater Quality Protection

Yakima County's role in groundwater quality protection is enabled by Washington's Growth Management Act (GMA) and the State Environmental Policy Act (SEPA).

Growth Management Act

The GMA, primarily codified in Ch. 36.70A RCW, requires counties and cities planning under the act to adopt comprehensive plans and development regulations consistent with the GMA. The GMA establishes goals to guide the development and adoption of comprehensive plans and development regulations of those counties, like Yakima, that are required or choose to plan under RCW 36.70A.040. Relevant goals include:

(5) Encourage economic development . . . that is consistent with adopted comprehensive plans, promote economic opportunity for all citizens of this state, especially for unemployed and for disadvantaged persons, promote the retention and expansion of existing businesses and recruitment of new businesses, recognize regional differences impacting economic development opportunities, and encourage growth in areas experiencing insufficient economic growth, all within the capacities of the state's natural resources, public services, and public facilities.

(8) Maintain and enhance natural resource-based industries, including . . . agricultural . . . industries. Encourage the conservation of . . . productive agricultural lands, and discourage incompatible uses.

(10) Protect the environment and enhance the state's high quality of life, including air and water quality, and the availability of water. RCW 36.70A.020

The GMA requires that:

> Each comprehensive plan shall include a plan, scheme, or design for each of the following: A land use element designating the proposed general distribution and general location and extent of the uses of land, where appropriate, for agriculture, timber production, housing, commerce, industry, recreation, open spaces, general aviation airports, public utilities, public facilities, and other land uses. The land use element shall include population densities, building intensities, and estimates of future population growth. The land use element shall provide for protection of the quality and quantity of groundwater used for public water supplies." (RCW 36.70A.070(1))

The GMA identifies both agriculture and groundwater quality as protectable resources. GMA recognizes the importance of rural lands and rural character to Washington's economy, its people, and its environment. Rural lands and rural-based economies enhance the economic desirability of the state, help to preserve traditional economic activities, and contribute to the state's overall quality of life (RCW 36.70A.011). The statute also recognizes that, in order to retain and enhance the job base in rural areas, rural counties must have flexibility to create opportunities for business development. Rural counties must have the flexibility to retain existing businesses and allow them to expand. Not all business developments in rural counties require an urban level of services. Many businesses in rural areas fit within the definition of rural character.

When defining the county's rural element, a county should foster land use patterns and develop a local vision of rural character that will: help preserve rural-based economies and traditional rural lifestyles; encourage the economic prosperity of rural residents; foster opportunities for small-scale, rural-based employment and self-employment; permit the operation of rural-based agricultural, commercial, recreational, and tourist businesses that are consistent with existing and planned land use patterns; be compatible with the use of the land by wildlife and for fish and wildlife habitat; foster the private stewardship of the land and preservation of open space; and enhance the rural sense of community and quality of life (RCW 36.70A.070(5)).

RCW 36.70A.030 (15) defines "Rural character" as the:

"Patterns of land use and development established by a county in the rural element of its comprehensive plan:

> (a) In which open space, the natural landscape, and vegetation predominate over the built environment;
> (b) That foster traditional rural lifestyles, rural-based economies, and opportunities to both live and work in rural areas;
> (c) That provide visual landscapes that are traditionally found in rural areas and communities;

(d) That are compatible with the use of the land by wildlife and for fish and wildlife habitat;

(e) That reduce the inappropriate conversion of undeveloped land into sprawling, low-density development;

(f) That generally do not require the extension of urban governmental services; and

(g) That are consistent with the protection of natural surface water flows and groundwater and surface water recharge and discharge areas.

"Rural development" means: development outside the urban growth area and outside agricultural, forest, and mineral resource lands designated pursuant to RCW 36.70A.170. Rural development can consist of a variety of uses and residential densities, including clustered residential development, at levels that are consistent with the preservation of rural character and the requirements of the rural element. Rural development does not refer to agriculture or forestry activities that may be conducted in rural areas (RCW 36.70A.030 (16)).

"Rural governmental services" include: those public services and public facilities historically and typically delivered at an intensity usually found in rural areas, and may include domestic water systems, fire and police protection services, transportation and public transit services, and other public utilities associated with rural development and normally not associated with urban areas" (RCW 36.70A.030 (17)).

Yakima County enacted its Comprehensive Plan (*Plan 2015*) in 1997. On June 27, 2017, the Board of County Commissioners approved Ordinance 4-2017, adopting an updated Comprehensive Plan, *Horizon 2040* (Yakima County 2017). In both plans, three separate chapters – 2) Natural Setting, 5) Land Use, and 9) Utilities – include goals and policies related to water quality. *Horizon 2040*'s goals and policies are implemented through various titles of Yakima County Code. Yakima County's zoning code, YCC Title 19[3], applies to all of unincorporated Yakima County. Table 19.10.020-1 lists the zoning classifications applicable throughout the unincorporated areas. Table 19.14-1 lists which specific land uses are allowed within particular zoning districts. Each permitted use is subject to a particular level of review: Type 1 – permitted; Type 2 – administrative review; Type 3 – conditional; Type 4 – quasi-judicial review (YCC 19.30.030).

Yakima County's Agriculture (AG) Zoning District is by far the most prevalent use district in the Lower Yakima Valley, followed by the Remote/Extremely Limited Development Potential (R/ELDP) district on the ridges and along the Yakima River, Valley Rural (VR) on the Valley floor, and some Rural Transitional (RT) Zoning Districts near the cities and towns. The AG zone allows a broad array of agricultural uses under Type 1 review, including: Animal Feeding Operations, land application of soil amendments or agricultural by-products at agronomic rates. CAFOs are allowed in the AG and R/ELDP zones under Type 2 review and by Type 3 hearing review in the VR. New or expanding

CAFOs, feedlots, and other agricultural uses may be subject to environmental review under the State Environmental Policy Act (SEPA) depending upon the size of the proposal and whether the project falls below SEPA's flexible exemption thresholds.

The Growth Management Act requires counties to designate critical areas (RCW 36.70A.060(2), 170(d)). "Critical areas" include the following areas and ecosystems: (a) wetlands; (b) areas with a critical recharging effect on aquifers used for potable water; (c) fish and wildlife habitat conservation areas; (d) frequently flooded areas; and (e) geologically hazardous areas. "Fish and wildlife habitat conservation areas" do not include such artificial features or constructs as irrigation delivery systems, irrigation infrastructure, irrigation canals, or drainage ditches that lie within the boundaries of and are maintained by a port district or an irrigation district or company (RCW 36.70A.030(5). "Development regulations" may be established for critical areas so as to prohibit or refine permitted uses under existing zoning requirements (RCW 36.70A.172(1)).

As amended by Yakima County Ordinance 13-2007, the Yakima County Code now addresses regulation of land use within critical areas in Ch. 16C. Application of that chapter to agricultural activities defined in YCC 16C.01.050(3)(a) is limited due to the provisions of RCW 36.70A 700-760 (YCC Title 19 became effective October 1, 2015, replacing YCC Titles 15 and 15A, pursuant to Yakima County Ordinance 7-2013). Regulation of agricultural activities on designated agricultural and rural lands is retained in Ch. 16A. Critical areas subject to the Shoreline Management Program are addressed in YCC Ch. 16D.

RCW 36.70A.700 through .760 establish a "Voluntary Stewardship Program" (VSP) under which counties may choose to adopt a voluntary practices approach in lieu of protecting critical areas in areas used for agricultural activities through development regulations adopted under RCW 36.70A.060. Yakima County adopted the voluntary practices approach by ordinance. This approach involves the establishment of a "watershed group" to develop a "work plan to protect critical areas while maintaining the viability of agriculture in the watershed" (RCW 36.70A.720 (1)).

The Growth Management Act requires local jurisdictions to designate and protect areas with a critical recharging effect on aquifers used for potable water, or areas where a drinking aquifer is vulnerable to contamination that would affect the potability of the water (RCW 36.70A and YCC 16C.09.01 (1)).

A "critical aquifer recharge area" is an area "with a critical recharging effect on aquifers used for potable water, including areas where an aquifer that is a source of drinking water is vulnerable to contamination that would affect the potability of the water, or is susceptible to reduced recharge" (WAC 365-190-030 (3)).

Regulations of the Washington Department of Commerce provide that:

(2) The quality and quantity of groundwater in an aquifer is inextricably linked to its recharge area. Where aquifers and their recharge areas have been studied, affected

counties and cities should use this information as the basis for classifying and designating these areas. Where no specific studies have been done, counties and cities may use existing soil and surface geologic information to determine where recharge areas exist. To determine the threat to groundwater quality, existing land use activities and their potential to lead to contamination should be evaluated.

(3) Counties and cities must classify recharge areas for aquifers according to the aquifer vulnerability. Vulnerability is the combined effect of hydrogeological susceptibility to contamination and the contamination loading potential. High vulnerability is indicated by land uses that contribute directly or indirectly to contamination that may degrade groundwater, and hydrogeologic conditions that facilitate degradation. Low vulnerability is indicated by land uses that do not contribute contaminants that will degrade groundwater, and by hydrogeologic conditions that do not facilitate degradation. Hydrological conditions may include those induced by limited recharge of an aquifer. Reduced aquifer recharge from effective impervious surfaces may result in higher concentrations of contaminants than would otherwise occur (WAC 365-190-100).

Yakima County has prohibited certain uses in critical aquifer recharge areas (YCC. 16C.09.07). Currently, those limitations include:

(1) Landfills. Landfills, including hazardous or dangerous waste, municipal solid waste, special waste, wood waste and inert and demolition waste landfills;

(2) Underground Injection Wells. Class I, III and IV wells and subclasses 5F01, 5D03, 5F04, 5W09, 5W10, 5W11, 5W31, 5X13, 5X14, 5X15, 5W20, 5X28, and 5N24 of Class V wells;

(3) Wood Treatment Facilities. Wood treatment facilities that allow any portion of the treatment process to occur over permeable surfaces (both natural and manmade);

(4) Storage, Processing, or Disposal of Radioactive Substances. Facilities that store, process, or dispose of radioactive substances;

(5) Mining. Hard rock; and sand and gravel mining, unless located within the mineral resource designation; and

(6) Other Prohibited Uses or Activities:

(a)Activities that would significantly reduce the recharge to aquifers currently or potentially used as a potable water source;

(b)Activities that would significantly reduce the recharge to aquifers that are a source of significant base flow to a regulated stream.

"Susceptible Groundwater Management Areas," defined as "areas that have been designated as moderately or highly vulnerable or susceptible in an adopted groundwater management program developed pursuant to Chapter 173-100," are among those designated Critical Aquifer Recharge Areas (CARAs) (YCC 16C.09.02(3)). The Lower Yakima Valley Groundwater Management Area is currently developing such a program, but it has not yet been "adopted."

Unless the VSP work plan to protect critical areas contemplated by RCW 36.70A.720 (1) is first put in place, and adopted within the groundwater management program, those provisions of the Growth Management Act requiring establishment of development regulations within CARAs would not apply to agricultural activities within the CARA. Again, application of the critical areas aspects of the Growth Management Act to agricultural activities defined in YCC 16C.01.050(3)(a) is limited due to the provisions of RCW 36.70A 700-760.

The county commission may also "create one or more aquifer protection areas for the purpose of funding the protection, preservation, and rehabilitation of subterranean water" (RCW 36.36.020). The creation of an aquifer protection area is subject to the vote of residents within a proposed area. Fees imposed within a designated CARA may be used to address:

(1) The preparation of a comprehensive plan to protect, preserve, and rehabilitate subterranean water, including groundwater management programs adopted under Chapter 90.44 RCW. This plan may be prepared as a portion of a county sewerage and/or water general plan pursuant to RCW 36.94.030;

(2) The construction of facilities for: (a) The removal of waterborne pollution; (b) water quality improvement; (c) sanitary sewage collection, disposal, and treatment; (d) storm water or surface water drainage collection, disposal, and treatment; and, (e) the construction of public water systems;

(3) The proportionate reduction of special assessments imposed by a county, city, town, or special district in the aquifer protection area for any of the facilities described in subsection (2) of this section;

(4) The costs of monitoring and inspecting on-site sewage disposal systems or community sewage disposal systems for compliance with applicable standards and rules, and for enforcing compliance with these applicable standards and rules in aquifer protection areas created after June 9, 1988; and,

(5) The costs of: (a) Monitoring the quality and quantity of subterranean water and analyzing data that is collected; (b) ongoing implementation of the comprehensive plan developed under subsection (1) of this section; (c) enforcing compliance with standards and rules relating to the quality and quantity of subterranean waters; and (d) public education relating to protecting, preserving, and enhancing subterranean waters (RCW 36.36.040).

Yakima County's Zoning Ordinance also implements a number of *Horizon 2040*'s policies intended to reduce the number of individual wells approved in the higher density zones.

Washington State Environmental Policy Act

Washington State's Environmental Policy Act (SEPA), Chapter 43.21C RCW, requires state agencies and local governments to consider the environmental implications of potential actions. It is like the National Environmental Policy Act, enacted by Congress in 1970. Using a checklist of environmental factors, governmental officials must consider the threshold question whether a potential action has "a probable significant, adverse environmental impact" (RCW 43.21C.031 (a)). If not, an environmental assessment or determination of non-significance may be published. If so, then an environmental impact statement is required. The environmental impact disclosure process imposed by these requirements is used by local governments exercising their police power in zoning, subdivision, or other permitting actions to identify factors militating toward denial of specific development proposals or conditions that may be attached to the approval of those proposals.

When the Yakima County Planning Department receives an application for approval of a particular activity, it circulates a completed checklist of environmental factors to other governmental agencies with jurisdiction of the potential activities in order to solicit their expertise with respect to the anticipated action. Whenever those agencies suggest concerns, those concerns may be incorporated as a basis to deny or impose conditions upon approval of the proposed action.

Yakima Health District

The board of the Yakima County Health District consists of seven members, including three members of the Yakima County Board of County Commissioners and two elected officials of the cities and towns within Yakima County who are appointed by their legislative bodies and two citizens from within Yakima County with an interest in public health appointed by county commissioners (YCC 6.04.010).

The Health District approves the acceptability of site conditions for installation and construction of onsite septic systems. WAC 246-272A-0015(5) requires that the Yakima Health District prepare a written plan to provide guidance to Yakima County regarding development and management activities for all onsite septic systems within the county. At a minimum, the plan should include a description of the Yakima Health District's capacity to provide education and operation and maintenance information for all types of systems in use within the county; a description of how the local health officer will remind and encourage homeowners to complete the operation and maintenance inspection required by WAC 246-272A-0270; and, a description of its capacity to adequately fund its onsite septic system plan.

The Yakima Health District inspects about 50 percent of newly constructed wells, seeking proper bentonite or other sealing, tags, etc. It determines the GPS coordinates of each inspected well and reports the same to the Ecology.

WAC 246-272A-0015(9) authorizes the Health District to adopt its own rules for septic systems more stringent than rules adopted by the State DOH, provided that they are approved by DOH.

Regulations Pertaining to Particular Sources

Crops Supporting Livestock Operations

WSDA's regulations implementing the Dairy Nutrient Management Act, Ch. 16-611 WAC, require dairy producers to maintain records to demonstrate that applications of nutrients to crop land are within acceptable agronomic rates. Soil analysis should include annual postharvest soil nitrate nitrogen analysis; triennial soil analysis that includes organic matter; pH, ammonium nitrogen; phosphorus, potassium; and electrical conductivity. Nutrient analysis is required for all sources of organic and inorganic nutrients including, but not limited to, manure and commercial fertilizer supplied for crop uptake. Manure and other organic sources of nutrients must be analyzed annually for organic nitrogen, ammonia nitrogen, and phosphorus. WSDA conducts on-site inspections of dairies and reviews their records a minimum of every 18 months. Any significant operational change requires an updated dairy nutrient management plan. Dairies are subject to complaint inspections by WSDA, Ecology, and EPA at all times. There is no equivalent requirement for non-dairy agricultural producers.

Nutrient application records should include field identification and year of application, crop grown in each field where the application occurred, crop nutrient needs based on expected crop yield, nutrient sources available from residual soil nitrogen including contributions from soil organic matter, previous legume crop, and previous organic nutrients applied, date of applications, method of application, nutrient sources, nutrient analysis, amount of nitrogen and phosphorus applied and available for each source, total amount of nitrogen and phosphorus applied to each field each year; and the weather conditions twenty-four hours prior to and at time of application (WAC 16-611-020 (2)).

Tree Fruit and Vegetable Crops

There are no groundwater-specific regulations specifically addressing production of tree fruit and vegetable crops

Fertilizers

Bulk commercial fertilizer distributors are required by RCW 15.54.275 to be licensed. They are also required by RCW 15.54.362 to report the number of net tons of fertilizer distributed within the state during six-month periods (January to June, July to December) (annual report permitted if less than 100 tons). 220,909 tons (200,406,000 kg) of commercial fertilizer was purchased in Washington State in 2011. As the statute does not require that the report be subdivided by county, region or groundwater management area, there is no specific information with which to evaluate the amount of commercial fertilizer sold within the GWMA. “Bulk fertilizer" is commercial fertilizer distributed in a nonpackage form such as tote bags, tanks, trailers, spreader trucks, and railcars. Fertilizers are required to meet the nutrient value guaranteed by the fertilizer manufacturer. There is no requirement that agricultural producers be licensed to apply commercial or any other fertilizer. Unmanipulated animal and vegetable manures, organic waste-derived materials and biosolids are not commercial fertilizer (WAC 16-200-701).

Regulations pertaining to “chemigation” (Ch. 16-202 WAC) do not pertain to “fertigation,” the application of commercial fertilizer through irrigation water delivery systems. “Chemigation" is the application of any substance a pesticide, plant or crop protectant, or system maintenance compound applied with irrigation water (WAC 16-202-1002 (17)). All pesticide laws apply to chemigation. Pesticides cannot be applied with an open surface, gravity irrigation system unless allowed by the product label.

The Director of the Department of Agriculture may adopt regulations for the appropriate use and disposal of commercial fertilizers for the protection of groundwater (RCW 15.54.800). Although “deep percolation” (“the movement of water downward through the soil profile below a plant's effective rooting zone”) is defined by WSDA regulations, WAC 16-202-1002 (23), the regulations do not specifically prohibit deep percolation.

There are no federal, state, or local regulations specifically pertaining to the application of nitrogen-based fertilizer to agricultural crops, so long as they are applied at an agronomic rate so long as it does not pollute groundwaters below the root zone (WAC 173-200 100-(3)). Manure applied as fertilizer is a “nutrient” under Washington State’s Dairy Nutrient Management Act (Ch. 90.64 RCW) “‘Nutrient’ means any organic waste produced by dairy cows or a dairy farm operation” (RCW 90.64.010 (11)). The 2017 CAFO general permit specifically requires that application of nitrogen-based fertilizers not pollute the groundwater.

Livestock Operations

Washington’s Dairy Nutrient Management Act (DNMA) (Ch. 90.64 RCW) authorizes WSDA to “determine if a dairy-related water quality problem requires immediate corrective action under the Washington state water pollution control laws, chapter 90.48 RCW, or the Washington state water quality standards adopted under chapter 90.48 RCW” (RCW 90.64.050 (1)(d)). Dairies that are licensed to sell Grade A milk and who generate large quantities of animal waste that can pollute surface water and ground water must have an “approved” Nutrient Management Plan (NMP) on site within six months of licensing. NMP’s must be implemented within two years after licensing (RCW 90.64.026 (7)). The purpose of such plan is to prevent the discharge of livestock nutrients to surface and ground waters of the state.

The DNMA authorizes local conservation districts to “provide technical assistance to producers in developing and implementing a dairy nutrient management plan;” and to "review, approve, and certify dairy nutrient management plans that meet the minimum standards" (RCW 90.64.070 (1)(d),(e)). An employee of the South Yakima Conservation District often writes the NMP. "Approved" means the local conservation district has determined that the facility's plan to manage nutrients meets all the elements identified on a checklist established by the Washington Conservation Commission. "Certified" means the local conservation district has determined all plan elements are in place and implemented as described in the plan. To be certified, both the dairy operator and an authorized representative of the local conservation district must sign the plan. Dairies whose NPDES permits require dairy nutrient management plans need not be otherwise "certified." "Farm Plans," developed and approved by local conservation districts for farmers, must include "livestock nutrient management measures" (RCW 89.08.560). Local conservation districts also provide dairies with technical assistance and planning services with which to implement nutrient management plans.

Local Conservation Districts are authorized to provide dairies and other farms with technical assistance and planning services (RCW 89.08.560) and are required to approve and certify all NMPs. "Farm Plans" developed by conservation districts for farmers must include "livestock nutrient management measures" (RCW 89.08.560). The South Yakima Conservation District often writes the NMPs for dairy farms and later certifies them.

The primary goal of an NMP is to protect water quality from nutrient discharges. The required elements of an NMP specified by the State Conservation Commission include the collection, storage, transfer and application of manure, waste feed and litter, and any potentially contaminated runoff at the site. Plans should focus on management of nitrogen, and phosphorus as well as preventing bacteria and other pollutants, such as sediment, from reaching surface or ground water. Excess nutrients must be exported off site.

The elements of a dairy nutrient management plan may include methods and technologies of the nature prescribed by the Natural Resources Conservation Service, a department of the U.S. Department of Agriculture (RCW 90.64.026(3)).

Nutrient management plans are required to be maintained on the farm for review by WSDA inspectors. The DNMA requires that all dairies be inspected for implementation of their nutrient management plans and to ensure protection of waters of the state. Most dairies keep their NMP and associated sampling data on location.

WSDA's regulations implementing the DNMA are published at chapter 16-611 WAC. WAC 16-611-010 defines "agronomic rate" as "the application of nutrients to supply crop or plant nutrient needs to achieve realistic yields and minimize the movements of nutrients to surface and ground waters." The same section defines "Nutrient" as "any product or combination of products used to supply crops with plant nutrients including, but not limited to, manure or commercial fertilizer." The phrase "transfer of manure" is defined as "the transfer of manure, litter or process wastewater to other persons when the receiving facility is in direct control of application acreage, rate or time, and transfer rate and time.

Producers must maintain records to demonstrate that applications of nutrients to crop land are within acceptable agronomic rates. Those records should demonstrate that applications of nutrients to the land were within acceptable agronomic rates. Soil analysis should include annual postharvest soil nitrate nitrogen analysis; triennial soil analysis that includes organic matter; pH, ammonium nitrogen; phosphorus, potassium; and electrical conductivity. Nutrient analysis is required for all sources of organic and inorganic nutrients including, but not limited to, manure and commercial fertilizer supplied for crop uptake. Manure and other organic sources of nutrients must be analyzed annually for organic nitrogen, ammonia nitrogen, and phosphorus.

The Dairy Nutrient Management Act requires that manure application and transfer records, including imports or exports, be maintained by dairies that transfer ownership of manure to others. Nutrient application records should include field identification and year of application, crop grown in each field where the application occurred, crop nutrient needs based on expected crop yield, nutrient sources available from residual soil nitrogen including contributions from soil organic matter, previous legume crop, and previous organic nutrients applied, date of applications, method of application, nutrient sources, nutrient analysis, amount of nitrogen and phosphorus applied and available for each source, total amount of nitrogen and phosphorus applied to each field each year; and the weather conditions twenty-four hours prior to and at time of application. Manure transfer records, including imports or exports should include date of manure transfer, amount of nutrients transferred, the name of the person supplying and receiving the nutrients, and a nutrient analysis of manure transferred. Irrigation water management records should include field identification and the total amount of irrigation water applied to each field each year.

The elements of an NMP must include methods and technologies of the nature prescribed by the Natural Resources Conservation Service (NRCS), a department of the U.S. Department of Agriculture RCW 90.64.026(3)). NRCS provides technical assistance to farmers and other private landowners and managers. NRCS has six mission goals: 1) high quality productive soils, 2) clean and abundant water, 3) healthy plant and animal communities, 4) clean air, 5) an adequate energy supply, and 6) working farms and ranchlands.

NRCS helps landowners develop conservation plans and provides advice on the design, layout, construction, management, operation, maintenance, and evaluation of recommended, voluntary conservation practices. NRCS activities include farmland protection, upstream flood prevention, emergency watershed protection, urban conservation, and local community projects designed to improve social, economic, and environmental conditions. NRCS conducts soil surveys, conservation needs assessments, and the National Resources Inventory to provide a basis for resource conservation planning activities.

NRCS conservation practice standards contain information on why and where the practice is applied, and sets forth the minimum quality criteria that must be met during the use of that practice. State conservation practice standards are available through the Field Office Technical Guide (FOTG). NRCS believes that nutrient management for the protection of groundwater, although different on each farm, is best accomplished through best management practices beginning with those stated in Standards 590, 449 and 313.

Ch. 90.64 RCW does not require that the best management practices recommended by the NRCS be followed, but allows the use of "alternative methods and standards and specifications" of the NRCS (RCW 90.64.016 (3)). Nutrient Management Plans are required to be maintained on the farm for review by inspectors. The DNMA requires that all dairies be inspected for implementation of their Nutrient Management Plans and to ensure protection of waters of the state. Most dairies keep their NMP and associated sampling data on location.

The DNMA does not authorize the WSDA to compel nutrient management consistent with NMPs. Representatives of the WSDA state that most "enforcement" is accomplished through the "soft enforcement" efforts that the Department accomplishes through its administrative activities (visitation and advice) under its Dairy Nutrient Management Program (Prest).

Although "farm plans" are not subject to disclosure under Washington's public records law, (RCW 42.56.270 (17)), plans, records, and reports obtained by state and local agencies from dairies, animal feeding operations, and concentrated animal feeding operations not required to apply for a NPDES permit are disclosable under Washington's public records law (Ch. 42.56 RCW), but only in ranges that provide meaningful information to the public while ensuring confidentiality of business information regarding: (1) number of animals; (2) volume of livestock nutrients generated; (3) number of acres covered by the plan or used for land application of livestock nutrients; (4) livestock nutrients transferred to other persons; and (5) crop yields. The ranges of the information required to be disclosed by the public disclosure law (Ch. 42.56 RCW) are set forth in the WSDA's rules implementing that law and Ch. 90.64 RCW, WAC 16-06-210 (29).

The WSDA's mission under the DNMA is to "protect water quality from livestock nutrient discharges" and to "help maintain a healthy agricultural business climate." The WSDA encourages compliance by providing technical assistance as a first step as required by RCW 43.05, but when that is not successful the WSDA has authority under both RCW 90.64 and RCW 90.48 and has informal (warning letters and notices of correction) and formal (civil penalties and orders) enforcement tools available.

In 2013 – 2014, WSDA issued 17 notices of correction, one order, and 11 notices of penalty for discharges of pollutants to surface waters, statewide, as well as 122 warning letters and 27 notices of correction for potential to pollute (including failures in record keeping). WSDA usually begins with informal enforcement, using warning letters and notices of correction, then proceeding to formal enforcement through civil penalty or administrative order. Most penalties include a settlement process including reduction in penalty, requirements to adopt specific management practices, to abstain from discharge and collection of entire penalty in the event of non-performance.

Concentrated Animal Feeding Operations

The Clean Water Act's regulations (40 CFR, Part 122) define dairies with 700 or more animals and feedlots with 1,000 or more animals as Large Concentrated Animal Feeding Operations (CAFO). Large CAFOs are defined as point sources of water pollution if they can or do discharge to surface waters, becoming subject to the National Pollutant Discharge Elimination System (NPDES) requirement for permit. However, unlike other point sources that have continuous or regular discharges to surface waters, CAFOs are not considered to automatically have a surface water discharge. Consequently, they may be required to obtain an NPDES CAFO permit only if they have a discharge or potential to discharge. The Ecology administers the CAFO permit, decides when a facility is required to apply for a permit and is responsible for enforcing the permit.

The Washington Department of Ecology issued two CAFO permits under its general permitting authority (Chapter 173-226 WAC) in January 2017 (effective March 3, 2017) (Ecology 2017). (A National Pollutant Discharge Elimination System and State Waste Discharge General Permit for Concentrated Animal Feeding Operations (combined permit) and a State Waste Discharge General Permit (state only)). The state and combined permits regulate the discharge of pollutants such as manure, litter, or process wastewater from CAFOs into waters of the state.

The permits conditionally authorize the permittees to discharge, but only in a manner that does not cause or contribute to a violation of water quality standards. The permittees are prohibited from discharging manure, litter, feed, process wastewater, other organic by-products, or water that has come into contact with manure, litter, feed process wastewater, or other organic by-products, to surface waters of the state from the production area with a few exceptions.

The permittees must implement measures to address the pollution prevention performance objectives listed in special conditions of the permit. Livestock may not be allowed to come into contact with surface waters or conduits to surface waters. Each calendar year, the permittees must develop a field-specific nutrient budget for each land application field they will control to which they plan to apply manure, litter, process wastewater, or other organic by-products (Ecology 2017).

The permittees must have all sources of manure, litter, process wastewater, and other organic by-products sampled and analyzed prior to land application and at least twice more, spaced evenly throughout the land application season, to account for seasonal variation in nutrient concentration (e.g., dilution due to rainfall or concentration from evaporation) (Ecology 2017).

The permittees must land apply manure, litter, process wastewater, or other organic byproducts in accordance with their yearly field nutrient budgets and at the appropriate rates and times to comply with permit conditions. If the permittees generate more manure, litter, process wastewater, or other organic by-products than the land application fields available to the permittees can appropriately utilize according to their yearly field nutrient budgets, the permittees must find other avenues of appropriately utilizing the excess manure, litter, process wastewater, or other organic by-products (e.g., export, composting) (Ecology 2017).

Lands to which manure, litter, process wastewater, and other organic byproducts have been applied must be sampled in spring and fall. The permittees must manage the application irrigation water so that the amount of water applied from precipitation and irrigation does not exceed the water holding capacity in the top two feet of soil, thereby preventing the downward movement of nitrate.

The permittees must use field discharge management practices on their land-application fields to limit discharge of manure, litter, process wastewater, and other organic by-products to down-gradient surface waters or to conduits to surface or ground water.

The permittees are permitted to "export" manure, i.e., to relinquish control of how the manure is used. When exporting manure, the permittees must provide the most recent manure, litter, process wastewater, or other organic by-product nutrient analysis to the recipient as part of export. The permittees must keep records of its manure exports.

Waste Storage Facilities (Lagoons)

Under the 2017 CAFO permit, the permittee must have adequate storage space for the manure, litter, process wastewater, feed, and any other sources of pollutants on site during the storage period for the area where the CAFO is located. Lagoons and other liquid storage structures built, expanded, or having major refurbishment e.g., complete emptying and re-compaction to restore the earthen liner done after the issuance of this permit must achieve a permeability of 1×10^{-6} cm/s without consideration for manure sealing and there must be a minimum of two feet of vertical separation between the bottom of the lagoon (measured from the outside of the earthen liner) and the water table, including seasonal high water table. Lagoons must be inspected, maintained as to structure and volume, and permanently decommissioned when closed. Existing lagoons are required to be assessed.

Pens and Composting Areas

Management practices are advisable on the site of CAFO pens, such as maintaining an intact layer between the cattle and the underlying ground to inhibit leaching through the surface of the pen, changes in precipitation and evapotranspiration from season to season, and animal density rates. Particulate matter practices require that the pens maintain a certain percentage of moisture to reduce dust emissions.

Water Applications

There are no federal, state or local regulations specifically pertaining to the application of irrigation water to agricultural crops. State water law generally precludes wasting water (RCW 90.03.005). Water may only be used for "beneficial use," the opposite of which is "waste."

Residential Onsite Sewage Systems (ROSS)

"Septage" is "the mixture of solid wastes, scum, sludge and liquids pumped from within septic tanks, pump chambers, holding tanks and other OSS components" (WAC 246-271A-0010). The total nitrogen content of septage generated in the GWMA varies under individual circumstances. An area-wide average is not available.

WAC 246-272A-0270 provides that the owner of an OSS is responsible for its operation, monitoring, maintaining, repairing, altering or expanding an OSS. The owner must also assure that an evaluation of a simple gravity septic system's components happens at least once every three years and that an evaluation of all other systems occurs every year. The solids and scum must be pumped from the septic system by an approved pumper generally every three to five years or whenever necessary (EPA 2002). The septic system must not be covered by structures or impervious material. Surface drainage must be trained away from the septic system. The soil above the drain field should not be compacted by vehicles or livestock. It is advisable to inform prospective buyers about the septic system. Most septic systems are now pumped prior to transfer of title to the property.

The location, design, installation, operation, maintenance, and monitoring of OSS is regulated by Chapter 246-272A WAC. The chapter is intended to coordinate with other statutes and rules for the design of OSS under Chapter 18.210 RCW and Chapter 196-33 WAC.

A local board of health must apply to the state DOH to approve local regulations. They must be at least as stringent as the regulations of the state department WAC 246-272A-0015 (9), (10). Yakima County does not have additional regulations.

Permitting for septic systems is done by the Yakima Health District. That agency is also authorized by WAC 246-272A-0015 (5) to "develop a written plan that will provide guidance to the local jurisdiction regarding development and management activities for all OSS within the jurisdiction." The elements of the plan are listed in the WAC.

The amount of land necessary for the installation of an onsite sewage (septic) tank varies depending upon soil type. Table X in WAC 246-272A-0320 establishes the minimums. Table V in WAC 246-272A-0220 describes the soil types. A site is required to meet certain ground absorption parameters, pass a percolation test, in order to qualify for a permit to install a septic system. If the ground does not have a certain absorption rate, it does not qualify for a septic system.

TABLE 1 – (WAC 246-272A-0320) MINIMUM LAND AREA REQUIREMENT SINGLE FAMILY RESIDENCE OR UNIT VOLUME OF SEWAGE

Type of Water Supply	Soil Type (defined by WAC 246-272A-0220)					
	1	2	3	4	5	6
Public	0.5 acre 2.5 acres	12,500 sq. ft.	15,000 sq. ft.	18,000 sq. ft.	20,000 sq. ft.	22,000 sq. ft.
Individual, on each lot	1.0 acre 2.5 acres	1 acre	1 acre	1 acre	2 acres	2 acres

TABLE 2 – (WAC 246-272A-220)

Soil Type	Soil Textural Classifications
1	Gravelly and very gravelly coarse sands, all extremely gravelly soils excluding soil types 5 and 6, all soil types with greater than or equal to 90 percent rock fragments.
2	Coarse sands.
3	Medium sands, loamy coarse sands, loamy medium sands.
4	Fine sands, loamy fine sands, sandy loams, loams.
5	Very fine sands, loamy very fine sands; or silt loams, sandy clay loams, clay loams and silty clay loams with a moderate or strong structure (excluding platy structure).
6	Other silt loams, sandy clay loams, clay loams, silty clay loams.
7 Unsuitable for treatment or dispersal	Sandy clay, clay, silty clay, strongly cemented or firm soils, soil with a moderate or strong platy structure, any soil with a massive structure, any soil with appreciable amounts of expanding clays.

The minimum liquid volume for a septic tank serving a single-family residence containing three or fewer bedrooms is 900 gallons. A septic tank serving a single-family residence containing four bedrooms may be 1,000 gallons. Each bedroom after that requires an additional 250 gallons of septic capacity. The actual size of each ROSS within the GWMA is unknown.

The local health officer may require the owner of a failing OSS located within 200 feet of a public sewer service to hook up to that system WAC 246-272A-0025. Design specifications for OSS tanks are located at WAC 246-272C.

Large Onsite Sewer Systems (LOSS)

Regulations for large on-site sewage (septic) systems (LOSS) are found at WAC 264-272B. LOSS are inventoried with the Department of Ecology as UIC wells (WAC 173-218-040) under a memorandum agreement between Ecology and DOH.

Biosolids

Ecology's biosolid program is coordinated with health districts. Land application of biosolids requires pre-approval of application rates that are based upon agronomic crop requirements. Permittees receive coverage under a statewide general permit. Permit coverage is mandated for those who produce and/or land apply biosolids. Ecology's regulatory program incorporates site specific approvals with specific testing and analysis procedures, development of land application plans that prescribe specific practices and prohibitions, and a review and approval process for land application of the wastewater solids. Land application may only occur on permitted sites with pre-established buffers and setbacks.

Residential Lawn Fertilizers

There are no known laws or regulations regarding homeowner maintenance of residential lawns. There are also no known laws or regulations regarding municipal maintenance of parks or grounds.

Hobby Farms

There are no known laws or regulations regarding maintenance of animals or herbaceous material on hobby farms.

Underground Injection Wells

Part C of the federal Safe Drinking Water Act (SDWA), 42 U.S.C. §300h-3, regulates underground injection wells (UIC). Washington's UIC program is administered by the Department of Ecology. Its UIC regulations are found at WAC 173-218. The program is approved by the EPA pursuant to SDWA §1422, 40 CFR 147.2400. The program regulates the injection of fluids underground for storage, enhanced recovery, in the context of Class II, and disposal to prevent the contamination of underground sources of drinking water. Injection activities may be authorized by rule or permit. The regulations establish a non-endangerment standard designed to ensure that injected fluids do not cause or contribute to the movement of a contaminant into an underground source of drinking water if the presence of that contaminant may cause or contribute to the exceedance of a drinking water standard ("MCL") or otherwise adversely affect the health of persons (40 CFR 144.12, WAC 173-18-080).

Abandoned Wells

An "abandoned well" is one "that is unmaintained or is in such disrepair that it is unusable or is a risk to public health and welfare" (RCW 18.104.020 (1)).

Wells no longer in use are required by law to be "decommissioned" (RCW 18.104.020 (3)). WAC 173-160-381 describes the processes that must be used to decommission wells. A permit must be obtained before decommissioning may occur (RCW 18.104.030).

Appendix C – The Nitrogen Cycle

Nitrogen is a dynamic element. It exists in many forms, and undergoes many complex transformations in the environment. The aggregate of these transformations is known as the nitrogen cycle (Figure C-1). The nitrogen cycle is a series of biological processes that are influenced by climatic conditions, the physical and chemical properties of soils, and management of the land.

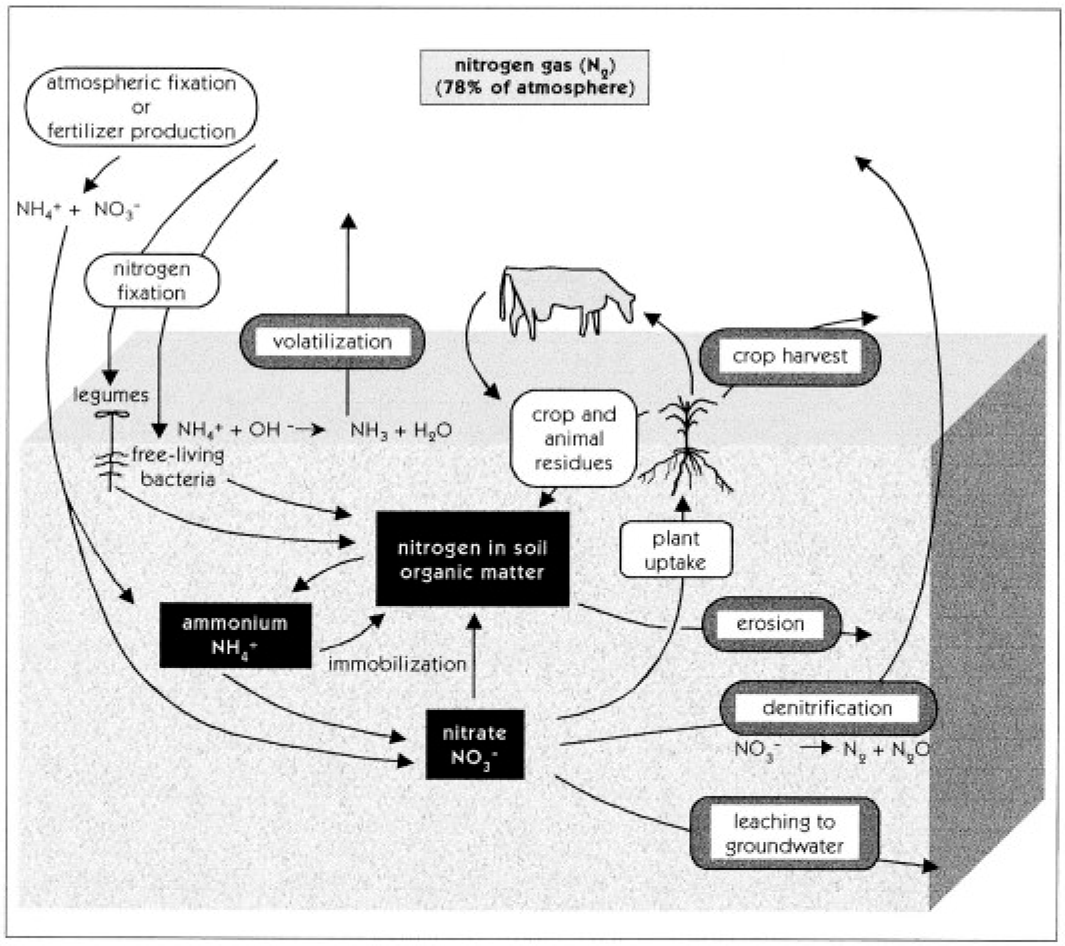


Figure C-1. Nitrogen Cycle (University of Western Australia, 2013).

Plants require nitrogen to grow. Nitrogen can be supplied to plants through the application of commercial fertilizer, animal manure or other organic wastes. The amount and type of nitrogen supplied is dependent on the source. The nitrogen forms that are immediately available for a plant to use are ammonium and nitrate. Commercial fertilizers typically contain these two forms. Manure is primarily comprised of organic nitrogen and ammonium. Organic nitrogen must first be converted to an inorganic form (either ammonium or nitrate) before it can be taken up through roots and used by plants. When plants die, the organic matter becomes part of the soil, it is converted by bacteria, used by plants, and then reverts back to organic matter.

Nitrogen Forms

Table C-1 describes the different forms of nitrogen.

Table C-1. Nitrogen Forms.

Nitrogen Form	Chemical Formula	Description
Nitrogen gas Nitrous Oxide	N_2 N_2O	The atmosphere contains 78 percent nitrogen gas. Nitrogen gas must be transformed into usable forms before it is available for plant uptake.
Organic Nitrogen	Various forms	Organic nitrogen is the dominant form of nitrogen in manure. Organic nitrogen originates in living material; it is present in animal and human wastes and decomposing plant material. Organic nitrogen is not usable by plants directly; it must first be converted to an inorganic form (ammonium, nitrate).
Ammonia	NH_3	Ammonia can be present in either a liquid or gas state. Ammonia can escape from the surface of the soil under certain conditions. Anhydrous ammonia is the basic nitrogen form found in commercial fertilizers.
Ammonium	NH_4^+	Ammonium is an inorganic form of nitrogen and is available for plant uptake. Attenuation in soils occurs through cation exchange complexes.
Nitrite	NO_2^-	Nitrite is an intermediate product in the conversion of ammonium to nitrate (nitrification). It is usually present in low quantities but is toxic to plants.
Nitrate	NO_3^-	Nitrate is an inorganic form of nitrogen and is available for plant uptake. Nitrate is very soluble in water and highly mobile.

(Killpack and Buchholz, 1993)

Nitrogen Transformation Processes

Table C-2 describes the transformations that convert nitrogen into its different forms. (Killpack and Buchholz, 1993)

Table C-2. Nitrogen Transformation Processes.

Nitrogen Process	Forms	Description
Nitrogen Fixation	$N_2 => NH_4^+$	Nitrogen fixation is the process that allows plants to convert nitrogen gas from the atmosphere into a form usable for growth. Industrial fixation is the manmade process of creating fertilizers.
Mineralization (Ammonification)	Organic nitrogen => NH_4^+	Mineralization is the conversion of organic nitrogen to ammonium. Bacteria are necessary in this process. Mineralization increases as microbial activity increases, which is directly related to soil temperature and water content.
Immobilization		Immobilization occurs when nitrate or ammonium present in the soil is used by bacteria to build proteins. These actively growing bacteria immobilize some soil N and break down soil organic matter to release N during the growing season. There is often a net gain of N during the growing season, because the additional N in the residue will be the net gain after immobilization-mineralization processes.
Nitrification	$NH_4^+ => NO_2^- NO_2^- => NO_3^-$	Nitrification is the conversion of ammonium to nitrite, and nitrite to nitrate. Nitrification is a biological process which increases rapidly in warm, wet aerobic conditions. Nitrification slows when soil temperatures decrease below 50°F.
Denitrification	$NO_3^- =>$ N gas	Denitrification is the conversion of nitrate to atmospheric forms of nitrogen. Denitrification is a bacterial process and occurs in anaerobic zones typically created by saturated soils and the presence of organic matter. Denitrifying bacteria use nitrate instead of oxygen in their metabolic process.
Volatilization	$NH_3 =>$ N gas.	Volatilization is the loss of gaseous ammonia to the atmosphere. Volatilization can occur from manure and fertilizer products containing urea. Ammonia is an intermediate form of nitrogen during the process in which urea is transformed to ammonium.

(O'Leary et al., 2002; University of Western Australia, 2013)

Processes that Affect Nitrogen Fate and Transport

Table C-3 summarizes the physical, chemical, and biological processes that result in gains and losses of nitrogen, which occur as part of the nitrogen cycle. These processes directly affect the fate and transport of nitrogen in the environment.

When nitrogen inputs to the soil system exceed outputs (crop needs), there is a possibility that excessive amounts of nitrate may leach to groundwater or runoff to surface water. Minimizing impacts to groundwater quality can be achieved through sound management practices. Understanding the characteristics of nitrogen in the environment can help efficiently manage nitrogen in land treatment systems.

Table C-3. Processes and conditions that affect nitrogen fate and transport

Nitrogen Process	Result	Description
Attenuation	Retained in soil	The effect of all processes that reduce contaminant concentrations. Ammonium is a positively charged ion which allows it to be immobilized by binding to negatively charged soil and soil organic matter. Ammonium does not move downward in soils unless all the cation exchange sites are saturated.
Leaching	Loss to groundwater	Leaching is a physical process in which nitrate moves with soil water. Nitrate is a negatively charged ion and is not attenuated by negatively charged soils particles. Nitrate is water soluble and, once it migrates below the root zone, may leach to groundwater.
Run-off	Loss to surface water	Runoff to surface water occurs when fields are frozen or saturated and nitrogen cannot infiltrate into the soil pores. Water ponds and moves downhill towards drains, ditches, or surface water.
Consumption	Loss	Consumption of nitrogen by plants and other organisms occurs while nitrogen is retained in the root zone.
Decomposition	Loss	Any portion of a plant that is left after harvest, including roots and nodules, supplies N to the soil system. When the plant material decomposes, N is released.
Precipitation	Gain	Small amounts of N are added to the soil from precipitation.
Addition of Fertilizers or Manure	Gain of N to soil	Direct additions of manure, wastewater, or commercial fertilizers to crops.
Crop Removal	Loss	Crop removal during harvest accounts for the majority of the N that leaves the soil system.
Soil Organic Matter	Gain of nitrate. Loss of organic nitrogen	Decomposition of organic matter proceeds at a slow rate and releases approximately 20 lb N/acre/year for each percent of organic matter.

(O'Leary et al., 2002; University of Western Australia, 2013)

Appendix D – Physical Basin Characteristics

The following appendix is a more detailed description of the physical basin characteristics of the Lower Yakima Valley.

Physical Basin Characteristics

The Yakima River Basin is located in south-central Washington. This area includes three Washington State Water Resource Inventory Areas (WRIA 37, 38, and 39), part of the Yakama Nation lands, three ecoregions (Cascades, Eastern Cascades, and Columbia Basin), and crosses four counties: Klickitat, Kittitas, Yakima, and Benton (USGS 2006a). Almost all of Yakima County and more than 80 percent of Kittitas County lie within the basin. About 50 percent of Benton County is in the basin. Less than 1 percent of the basin lies in Klickitat County, principally in an unpopulated upland area.

Within the Yakima Basin there are six structural sedimentary basins. The delineated sedimentary basins are (from north to south) the Roslyn, Kittitas, Selah-Wenas, Yakima (Ahtanum-Moxee), Toppenish, and Benton Sedimentary Basins. The GWMA includes only parts of the Toppenish and Benton Sedimentary Basins.

The Toppenish Sedimentary Basin is fully contained within Yakima County. It is bordered by Ahtanum Ridge to the north, Toppenish Ridge to the south, and the Benton Sedimentary Basin to the east. It is bisected by the Wapato Syncline. Only the southeastern corner of the Toppenish Sedimentary Basin, northeast of the Yakima River, is included in the GWMA boundaries.

The Benton Sedimentary Basin is bordered on the south by the Horse Heaven Hills. The northeast boundary generally follows the northern flank of the Cold Creek Syncline. The western boundary abuts the eastern boundary of the Toppenish Sedimentary Basin and a small section of the Yakima Sedimentary Basin. Only the western portion (approximately a third) of the Benton Sedimentary Basin is within the GWMA boundaries.

Geology

The primary geologic features discussed include the stratigraphic units of the Columbia River Basalt Group, the Ellensburg Formation, and the Lower Yakima Valley Fill. The structural feature known as the Yakima Fold Belt is described as well.

Columbia River Basalt Group

The Columbia River Basalt Group (CRBG) is a thick sequence of Miocene eruptive basalts estimated to be several thousand feet thick and interbedded with a few minor sedimentary strata. It overlays the basalt bedrock unit of the Yakima region. The CRBG covers an area of more than 59,000 square miles (Beeson and Tolan 1990) and spans parts of Washington, Oregon, and Idaho. It is subdivided into three primary formations: the Saddle Mountains

Basalt, the Wanapum Basalt, and the Grande Ronde Basalt (USGS 2009a; GSI 2009a, 2011). The Saddle Mountains Basalt is often exposed at the surface, with thicknesses ranging from 180 to 800 feet and averaging more than 500 feet in the Yakima Basin. The Wanapum Basalt can be over 800 feet thick. The Grande Ronde Basalt underlies the Wanapum Basalt. These formations are further subdivided into several dozen members and hundreds of flows.

The Saddle Mountains Basalt is often visible at the bounding upland ridges of the Toppenish Basin such as the Rattlesnake Mountains, Ahtanum Ridge, Toppenish Ridge, and the Horse Heaven Hills. It is made up of several flows, including the Umatilla Member, the Wilbur Creek Member, the Asotin Member (13 million years ago), the Weissenfels Ridge Member, the Esquatzel Member, the Elephant Mountain Member (10.5 million years ago), the Bujford Member, the Ice Harbor Member (8.5 million years ago), and the Lower Monumental Member (6 million years ago). The underlying Wanapum Unit averages 600 feet thick. These units are separated by the Mabton Interbed, with an average thickness of 70 feet (USGS 2009a).

Basalt is a dense rock, having a fine texture precluding identification of crystals without magnification. Basalt is resistant to erosion and weathering and is a notable cliff-forming rock. Fresh, unweathered surfaces are black or dark gray; weathered surfaces range in color from gray to reddish brown. Basalt consists principally of small crystals of calcic labradorite, pyroxene, and olivine in a dense matrix of sodic labradorite, augite, and volcanic glass. Magnetite and apatite are common accessory minerals. Calcite, siderite, zeolites, opal, and chalcedony are common in veins and vesicles in the basalt (USGS 1962).

At the end of the Miocene Epoch, approximately 5.3 million years ago, an extended plain of basaltic lava covered most of eastern Washington (USGS 1962, 2009a). The basaltic lava flows were extruded from fissures located in the eastern part of the Columbia Plateau (USGS 1962), most likely near Hells Canyon, Oregon; these extrusions probably continued intermittently into the Pliocene Epoch (5.3–2.6 million years ago), covering sedimentary deposits, forming new basins of deposition, and changing stream courses (USGS 1962). This sequence of volcanic flows resulted in the Columbia Basin Basalt Group, now underlying southeastern Washington and extending into Oregon and Idaho (USGS 1962). The individual flows range in thickness from a few feet to more than 100 feet. The total basalt thickness in the central part of the plateau is estimated to be greater than 10,000 feet (USGS 1990b), and the maximum thickness in the Yakima River basin is more than 8,000 feet (USGS 1962).

Extrusions and flows of volcanic material now within the CRBG formation occurred intermittently over millions of years. Individual flow layers range from less than 20 to more than 200 feet in thickness. Individual flows may differ considerably in thickness from place to place (USGS 1962). Enough time elapsed between extrusions to allow considerable weathering of the uppermost frothy surfaces of lava flows and to allow development of thin soil zones, which were later buried by subsequent flows (USGS 1962). Bubbles of gases emitted from the solidifying molten lava created zones of abundant gas cavities (vesicles). The vesicles are sometimes filled with secondary minerals deposited by water percolating through the rocks. The vesicles are separated from each other by the encasing solid rock, except where they have been fractured or deeply weathered (USGS 1962).

The Ellensburg Formation

At the west side of the basaltic lava plain, approximately where the present Cascade Mountains now stand, intense volcanic activity occurred before the period of basaltic lava extrusion ended. This volcanic activity was at an elevation somewhat higher than the lava plain but probably lower than the present Cascades. The debris created by this volcanic activity in those ancestral Cascade Mountains was the source of the Ellensburg Formation: sedimentary materials that were deposited upon the lava plain, transported by eastward flowing streams or aeolian processes moving ash and pumice (USGS 1962). The majority of the volcanic materials were deposited upon the lava plain after these flows ceased and the Cascades continued to rise (USGS 1962, 1999a).

The Ellensburg Formation consists of 85 to 95 percent semi-consolidated clay, silt, and sand with only 5 to 15 percent gravel and conglomerate. It often appears as sedimentary interbeds found between the various CRBG formations, members, and flow units. These interbeds vary in nature and composition, typically ranging between 1 and 100 feet thick. The color is predominantly gray, tan, and buff, although there are a few relatively thin rusty-brown sand and gravel strata. The clay and silt parts are massive at most places, but excellent bedding and shaley parting also are found. Some sand and gravel strata are cross-bedded, with thicknesses of the individual beds ranging from a few feet to more than 100 feet; strata of clay, silt, and fine sand usually are somewhat thicker than strata of the coarser materials (USGS 1962). "More than 1,000 feet of course-grained volcanoclastic sediment has accumulated over many parts of the Yakima River Basin" (USGS 1999a).

The Ellensburg Formation is mostly tough and hard, although some sand and gravel strata are weakly cemented. The silt and sand are composed chiefly of pumice, volcanic ash, quartz, and scattered feldspar and hornblende particles. Clay-size particles consist mostly of finely divided pumice and ash. The gravel contains large amounts of tuff and a distinctive purple or gray tuffaceous hornblende andesite. Cementing material is mostly argillaceous (containing clay). Minor amounts of diorite, quartzite, and various granitic and metamorphic rock types also are found locally in the gravel; basaltic fragments are rare (USGS 1962).

Lower Yakima Valley Fill

A variety of fine and coarse-grained sediments exists within the Toppenish Basin, overlying the Ellensburg Formation and included in the underlying major basalt flows (USGS 2009a). These sediments pinch out along the flanks of the ridges. They include the Touchet Beds, loess, thick alluvial sands, and gravels deposited by rivers and streams, including those within the Ellensburg Formation, and other unconsolidated and weakly consolidated valley fill comprising glacial, glacio-fluvial, lacustrine, and alluvium deposits resulting from catastrophic glacial outburst floods that inundated the lower Yakima River Basin (USGS 1962, 1990b, 1999a, 2009a).

About 16,000 years ago these glacial outburst floods created Lake Lewis, a temporary lake in what is today the Lower Yakima Valley. The waters from periodic cataclysmic floods from the glacial Lake Missoula, pluvial Lake Bonneville, and perhaps from subglacial outbursts backed up through the constriction formed by the Wallula Gap in the Horse Heaven Hills, forming the lake; water also backed up further downstream on the Columbia River between Washington and Oregon, delaying the lake's drainage. The water remained for undefined periods before draining through Wallula Gap, permitting surface loess and basalt materials collected in the flood's transit southeast from the Spokane area to settle to the lake's bottom. This settled material formed at least some of the fine-grained gravelly and sandy materials extant today on the valley bottom of the Yakima River within the GWMA (Figure 6). Lake Lewis intermittently reached an elevation of about 1,200 feet (370 m) above today's sea level before draining to the Columbia through Wallula Gap (Carson and Pogue 1996; Alt 2001; Bjornstad 2006).

The Yakima Fold Belt

The GWMA lies within the Yakima River Basin within the Yakima Fold Belt. The fold belt is a highly folded and faulted region underlain by various consolidated rocks ranging in age from the Precambrian Supereon to the Cenozoic Era's Miocene Epoch, and unconsolidated materials and volcanic rocks of the Quaternary Period's Pleistocene Epoch. Dominant geologic structures in the Yakima Fold Belt in the western part of the Columbia Plateau are long, narrow, east-west to east-southeasterly trending anticlinal ridges with intervening broad synclinal basins; the combination essentially partitions the groundwater flow system. The anticlinal ridges function as groundwater flow barriers (USGS 2009a; Vaccaro 2016).

The folding that created the anticlines and synclines within the Yakima region was the consequence of tectonic compression (McCaffrey et al. 2016), initially of the sedimentary rocks now underlying the Columbia River Basalt Group; this compression probably began during the latter part of the Cenozoic Era, during the Pliocene Epoch. The Ellensburg sedimentary material was still accumulating during this time. Earlier explanations suggested that the folding was likely related to the Cascade uplift and subsidence of the center of the lava body approaching from the southeast (Foxworthy 1962). The folding proceeded slowly enough that the Yakima River could continue to erode its channel (Union Gap) as the Ahtanum Ridge anticline rose (Foxworthy 1962). The Ahtanum Ridge and the Rattlesnake Hills are part of the same anticline (Alt and Hyndman 2007). The Toppenish Ridge is another anticline, forming the southern boundary of the Toppenish Basin.

As the folding continued, the sedimentary material previously deposited on what became the anticlinal ridges was eroded off and carried down into the centers of the synclinal basins. This process accounts in part for the great thickness of the Ellensburg formation (USGS 1962).

Groundwater Recharge

Vaccaro (2016) studied recharge in the context of water availability for potential rural residential development and identified two domains within the GWMA: Rattlesnake Hills and Mabton. The Rattlesnake Hills Domain (246 sq. mi.) includes the relevant lands south of the Moxee Drain and east and north of the Yakima River (left bank). The eastern boundary of the domain is the boundary between Yakima and Benton Counties. The Mabton Domain (40.9 sq. mi.) includes the area north of Horse Heaven Hills (defined by the ridgeline) east of the Yakama Nation boundary, south of the Yakima River and west of the Yakima–Benton county line. These two domains include the GWMA. The Rattlesnake Hills Domain was divided into two sectors: one below the Roza Irrigation District canal (Sector 1), the other above that canal (Sector 2). The Mabton Domain was not further divided (Vaccaro 2016).

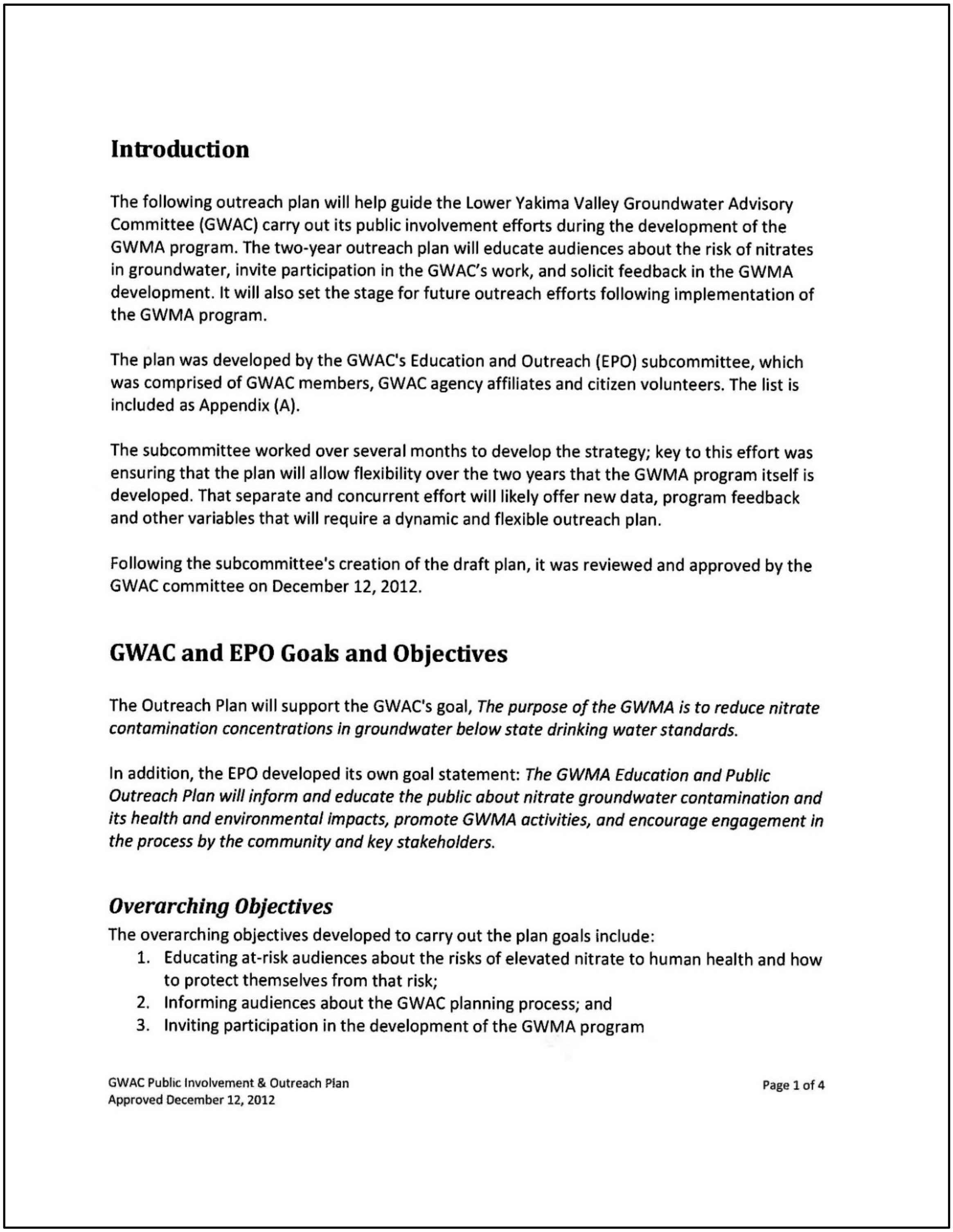
Sector 1 [of the Rattlesnake Hills Domain] (194 square miles) includes the irrigation districts present on Rattlesnake Hills such as Sunnyside Valley, Roza and Union Gap. The delivery and use of surface water in the irrigation districts provide a source of recharge (more than 10 inches per year and in some areas more than 20 inches per year (USGS 2007a) to the system. The sector includes the cities of Zillah, Sunnyside, Granger, and Grandview. Except for the northern and eastern part of the sector, the area is typified by basin fill deposits generally over 200 feet thick. That is, basin fill deposits over more than two thirds of this sector are almost everywhere greater than 200 feet, and over about one half of the sector they are greater than 400 feet. In the smaller, southeastern part of the sector, the deposits are thinner and future residential wells may need to be finished into the Saddle Mountains unit. Most of the existing wells may need to be finished in the basin fill deposits and much of the future pumpage in this sector would occur from these deposits except along the peripheral boundary with sector 2 or where the basin fill deposits thin toward the east. Future wells near the boundary between the two sectors likely would be needed to be drilled deeper than wells downslope. Groundwater-level hydrographs indicate stable water levels in these deposits. The groundwater levels for the units indicate that future withdrawals from the basin fill deposits would have minimal, if any affect, on the deeper Wanapum and Grande Ronde units.

Recharge over most of th[e] area [in the Mabton Domain north of the 700 foot water level contour for the Saddle Mountains unit [described by] Vaccaro and others (USGS 2009a)] is more than 10 inches per year because of the influence of surface water irrigation [from the Roza Irrigation District] (Vaccaro 2016).

Appendix E – Education and Public Outreach

The following plan was developed when the GWAC first formed. The committee recognized that it was critical to let affected residents know about the state of water in the Lower Yakima Valley, the potential health risks, and what they could do about it.

Outreach Plan



Introduction

The following outreach plan will help guide the Lower Yakima Valley Groundwater Advisory Committee (GWAC) carry out its public involvement efforts during the development of the GWMA program. The two-year outreach plan will educate audiences about the risk of nitrates in groundwater, invite participation in the GWAC's work, and solicit feedback in the GWMA development. It will also set the stage for future outreach efforts following implementation of the GWMA program.

The plan was developed by the GWAC's Education and Outreach (EPO) subcommittee, which was comprised of GWAC members, GWAC agency affiliates and citizen volunteers. The list is included as Appendix (A).

The subcommittee worked over several months to develop the strategy; key to this effort was ensuring that the plan will allow flexibility over the two years that the GWMA program itself is developed. That separate and concurrent effort will likely offer new data, program feedback and other variables that will require a dynamic and flexible outreach plan.

Following the subcommittee's creation of the draft plan, it was reviewed and approved by the GWAC committee on December 12, 2012.

GWAC and EPO Goals and Objectives

The Outreach Plan will support the GWAC's goal, *The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards.*

In addition, the EPO developed its own goal statement: *The GWMA Education and Public Outreach Plan will inform and educate the public about nitrate groundwater contamination and its health and environmental impacts, promote GWMA activities, and encourage engagement in the process by the community and key stakeholders.*

Overarching Objectives

The overarching objectives developed to carry out the plan goals include:

1. Educating at-risk audiences about the risks of elevated nitrate to human health and how to protect themselves from that risk;
2. Informing audiences about the GWAC planning process; and
3. Inviting participation in the development of the GWMA program

GWAC Public Involvement & Outreach Plan
Approved December 12, 2012

Page 1 of 4

Target Audiences

The EPO plan will target four larger audiences, each with its own diverse audience subsets:

1. Internal audiences
   a. Agency Leadership
   b. Policymakers & Legislative Staff
   c. Yakama Nation Leadership
2. General Public
   a. Private well users and at risk-populations in the GWMA
   b. Other residents within the GWMA
   c. Media
3. Underserved/English as a Second Language Residents
   a. Private well users and at-risk populations in the GWMA
   b. Other residents within the GWMA
   c. Spanish-Language Media
4. Special Interests
   a. Large employers in the GWMA
   b. Environmental & Ag Industry Associations
   c. Social Justice Organizations

The detailed list of the target audiences is included as Appendix (B).

Strategy

The plan will address the specific needs of the diverse target audiences by responding to 1) the information and/or educational needs of each audience; 2) providing bilingual (English and Spanish) information and 3) using audience-specific outreach tools to convey key messages. This will be accomplished through a coordinated outreach campaign using a variety of English/Spanish outreach tools: a project website, interagency networking and coordination, print materials and mailings, local media, public events and festivals.

Underserved/English As a Second Language (ESL) Audiences

The EPO will directly reach out to the underserved and ESL audiences, especially those at high risk from nitrate contamination using targeted media and outreach work. Key "messengers" include Spanish language media, large employers, women's groups, the faith community, University of Washington Pacific Northwest Agricultural Safety and Health Center (PNASH), El Projecto Bienestar, and others in the GWMA program area. They will be provided English/Spanish outreach materials and will be invited to spread the word about the program.

The EPO will seek outreach opportunities such as Cinco de Mayo festivals, Hispanic Awareness Month activities, Tribal Housing Summits, and local health care community events.

Yakama Nation and Spanish-language radio and TV will be invited to participate in outreach through public radio talk shows, PSA's and commercial ad spots.

Role of the GWAC Members in the EPO

GWAC members will also play a central role in education and outreach efforts. Members are expected to provide regular GWAC updates to their constituencies, identify and help coordinate outreach opportunities within their own organizations, and convey feedback to the EPO. They will also be invited to participate in, and to help solicit volunteers for, outreach efforts.

As the oversight body of the EPO, the GWAC will also provide ongoing guidance to the EPO through recommendations, feedback and course corrections during the development of the GWMA program.

Outreach Tools

The following is a highlight of recommended outreach tools; a comprehensive list is included as Appendix (B).

GWMA Website

The GWMA website will serve as the central clearinghouse for the GWAC and the GWMA development. It will invite audience participation in the process, offer access to educational and self-help materials, provide information exchange between the GWAC and the public, and solicit feedback on the outreach strategy and the GWMA development.

Outreach materials (correspondence, fact sheets, flyers) will direct audiences to the website, and provide an additional means for audiences to access resources and to receive updates. The website may be viewed at www.yakimacounty.us/gwma.

Bilingual educational and outreach materials

Outreach materials (flyers, posters, mailings, survey instruments) will be made available in both English and Spanish. Based on feedback from previous outreach efforts, materials will convey the plan's key messages in a simple, easy to read format.

Evaluation Measures

A consistent survey instrument will be developed and used with each audience contact (through the website, at events, etc.). The purpose will be to solicit feedback on outreach efforts and their effectiveness, and to evaluate participants' current understanding of the issues, their awareness of the GWAC and their degree of involvement with the GWMA development.

A detailed list of evaluation measures is included as Appendix (B).

Key Milestones: 2013-2014

The key milestones for the outreach plan reflect an ongoing cycle of preparation and outreach, followed by review and evaluation and a subsequent report back to the GWAC. This dynamic approach allows the strategy to remain relevant over time and under changing conditions. It also ensures that the GWAC has sufficient information to provide meaningful input, or to make course corrections or suggestions as it develops the GWMA program.

The EPO Milestones are included as Appendix (C).

(B1) Internal Audiences-Agency Leadership	OBJECTIVES	OUTREACH TOOLS	EVALUATION MEASURES
Yakima County & Benton County Health Districts Benton County Planning, Permitting, Surface Water Conservation Districts Department of Agriculture Department of Health Department of Ecology EPA Public Water Systems Cities & Towns Yakima Valley Conference of Governments	Communicate with agencies about the GWAC planning process; inform and educate stakeholders regarding nitrate contamination and its effects. Coordinate outreach efforts with other agencies to maximize effectiveness and distribution.	GWAC Agency representatives are expected to report regularly back to their respective leadership, using face-to-face meetings, fact sheets, talking points, or informal presentations on a "need to know" basis. Use internal agency venues (brown bag lunches, Ed meetings, etc.) to announce program and provide periodic updates. Frequency: semi-annually or as dictated by agency opportunities. Use agencies' existing outreach (newsletters, website:, Facebook, tweets, etc.) to announce GWAC's work and to provide updates. Use e-mail distribution list for general updates. Offer presentations and/or displays at professional conferences, annual meetings, etc. Frequency: semiannually or as dictated by agency and conference opportunities	Number of new participating agencies Number of face-to-face meetings Number of fact sheets developed Number of talking points/presentations developed Number of outreach recommendations received & implemented Amount/character of audience feedback Number of e-mail contacts received Number of updates sent via e-mail list Number and character of comments, questions, suggestions and praise. Number of agency/organization requests to be involved in GWMA Structured interviews with key stakeholders to measure understanding of issues, degree of involvement with GWMA

(B2) Internal Audiences-Policymakers & Legislative Staff	OBJECTIVES	OUTREACH TOOLS	EVALUATION MEASURES
County Commissions (Benton & Yakima) Governor's Office 13, 14, 15 & 16 Legislative District Leadership State Agency Heads (AG, Ecology, Health) Fourth Congressional District (Doc Hastings)	Keep policymakers apprised of GWAC efforts and its relevance to public health Obtain political support for GWMA at multiple leadership levels and across affiliations Cultivate policymaker support as a vehicle to obtain additional funding Develop and maintain a reputation as an effective, science-based collaborative effort to protect human health	Send introduction letters to policymakers announcing the GWAC, the GWMA program and to invite participation in the effort. Frequency: once; followed by periodic "red letter" updates, e-mails, etc. Brief leadership and/or legislative staff using face-to-face meetings supplemented with support materials (fact sheets, links to website, etc.) Frequency: once; followed by periodic updates	Number of mailings Number of e-mails Number of inquiries, or follow-up contacts initiated by policymaker or legislative staff Structured interviews with key stakeholders to measure understanding of issues, degree of involvement with GWMA Amount/quality of direct support (funding, legislative action) received

(B3) Internal Audiences-Tribal Leadership	OBJECTIVES	OUTREACH TOOLS	EVALUATION MEASURES
Yakama Nation General Council Yakima Nation Tribal Council	Keep tribal leadership apprised of the GWAC's efforts Seek to develop a collaborative outreach program between the Lower Valley GWMA and the Yakama Nation's efforts.	Provide similar policymaker outreach tools (introduction letter/fact sheet, offer to make presentations to leaderships, etc.) to Nation's GWAC representative. Frequency: as guided by Nation's GWAC representative. Provide materials and presence of the Tribal Housing Summit, Treaties, and other community events. Frequency: semiannually, or as invited to participate. Offer to provide presentations and/or materials to schools. Frequency: as invited to participate.	Similar to policymaker outreach - focus on counting and documenting outreach efforts. Number/type of invitations from tribal leadership to engage in collaborative outreach.

(B4) Target Audience- General Public	OBJECTIVES	OUTREACH TOOLS	EVALUATION MEASURES
Residents served by private wells in the GWMA. Benton and Yakima County Residents (general public) Media Healthcare Providers School Districts Higher Education	Provide information to private well users on nitrate self-help and groundwater quality protection measures. Educate public audiences about groundwater, risks of elevated nitrate to human health and the GWAC and GWMA program. Invite participation in the development of the GWMA program. Develop and maintain a reputation as an effective, science-based, non-regulatory effort to protect human health	Involve area media in events and GWAC updates using news releases, fact sheets and invitations to events. Host community water testing and education events in various target neighborhoods most likely to have high nitrate in drinking water. Frequency: 2-4 times annually. Direct mailings. Bilingual door-to-door campaign in the GWMA. Create and maintain a "groundwater message hotline" for resource and referral purposes. Create posters, fliers and table tents for distribution throughout the community and at key community events.	Amount and character of media coverage Number of community events Number of participants at events Number of drinking water samples processed Number of resident requests for assistance or follow-up Number of households contacted Number of residents requesting additional information Structured interviews with key stakeholders to measure understanding of issues, protection measures taken, degree of awareness of GWAC and/or or GWMA.

(B5) Target Audience-Underserved/English As Second Language	OBJECTIVES	OUTREACH TOOLS	EVALUATION MEASURES
Residents served by private wells in the GWMA. Benton and Yakima County Residents (general public) Spanish-language Media Healthcare & Social Service Providers School Districts Higher Education	Reach out to non-English speakers to educate and involve them in the GWAC planning efforts. Provide education on the health risks of nitrates and self-help measure's to non-English speakers through targeted media, large employers and healthcare and social service providers. Invite participation in the development of the GWMA program. Develop and maintain a reputation as an effective, science-based, non-regulatory effort to protect human health	Involve Spanish-area media in events and outreach using paid ads, PSAs, and radio talk shows. Coordinate with healthcare and social service providers, churches, U of W and Projecto Bienestar to provide education and to evaluate communication measures. Offer targeted educational outreach and community water testing at Cinco de Mayo, Hispanic awareness month festivals etc. in neighborhoods most likely to have high nitrate in drinking water. Frequency: 2-4 times annually. Direct mailings. Bilingual door-to-door campaign in the GWMA. Create and maintain a "groundwater message hotline" for resource and referral purposes. Create posters, fliers and table tents for distribution at large employers in the GWMA and throughout the community.	Amount and character of media coverage Number of community events Number of participants at events Number of drinking water samples processed Number of resident requests for assistance or follow-up Number of households contacted Number of residents requesting additional information Structured interviews with key stakeholders to measure understanding of issues, protection measures taken, degree of awareness of GWAC and/or or GWMA.

(B6) Target Audience- Special Interests	OBJECTIVES	OUTREACH TOOLS	EVALUATION MEASURES
Agricultural Groups (Dairy Federation, Farm Bureau, Fertilizer Groups, Hop Growers, Mint Growers, Irrigated Ag Producers) Centers for Disease Control (CDC) Center for Environmental Law & Policy Faith-based Groups Farm Workers Clinic Large Employers Environmental & Social Justice Organizations Women's Groups Yakama Nation	Inform targeted special interest groups of the GWAC planning process and programs. Educate targeted special interest groups about relevant measures to protect groundwater from nitrate levels that exceed drinking water standards. Provide education to targeted special interest groups on the health risks of nitrates and self-help measures. Develop and maintain a reputation as an effective, science-based, non-regulatory effort to protect human health	Distribute outreach materials (posters, fliers) to special interest groups. Offer speaker presentations at regularly scheduled meetings. Develop and maintain social media sites, e- newsletters etc. targeting special interest audiences. Network with regional dairy women and other industry representatives.	Number of materials requested and/or distributed Number of presentations requested Number of participants at events Amount/character of audience feedback Number of e- social media contacts received Number of updates sent via e-mail list Number and character of comments, questions, and praise. Structured interviews with key stakeholders to measure understanding of issues, degree of awareness of the GWMA and its purpose

Accomplishments Chronology

Lower Yakima Valley Groundwater Management Area

Education & Public Outreach Accomplishments Timeline

2012-2017

2012

1. EPO develops the Education and Public Outreach (EPO) Plan as required under WAC 173-100-090 (1) Groundwater advisory committee.
2. December 12, 2012 - GWAC approves the outreach plan; Yakima County submits it to the Department of Ecology.

*2013 - EPO Implements Education and Outreach Plan

3. EPO creates GWAC logo options for GWAC consideration.
4. March 13, 2013 - GWAC approves a GWMA logo, which is used for all subsequent outreach materials, including but not limited to the website, letterhead, news releases, outreach flyers, program banner, and billboards.
5. **Public Awareness Survey (English & Spanish).** GWAC contracts with Heritage University to conduct **bilingual** door-to-door surveys in the GWMA. EPO designs survey to gauge the public's awareness of the nitrate issue and its potential health impacts. (Work included but was not limited to creating the survey content (**English & Spanish)** and packets, mapping the areas to be surveyed, training 16 Heritage University **bilingual** students to conduct the survey, troubleshooting issues, conducting quality control of the survey methods, and entering data into a spreadsheet.)
    a. **Outreach results:** 300 Direct **Bilingual** Contacts (direct mail, in person, flyers) to households in the GWMA.
    b. 136 surveys completed
    c. **Spanish/English** news releases issued to media (pre-and post-survey).
    d. EPO issues survey results in English/**Spanish** and posts to the website.
6. **Health provider outreach.** Over 200 healthcare providers receive nitrate-related health information and a survey asking them if they have observed symptoms of methemoglobinemia in their maternal or infant patients (English).
7. July 18- Commissioner Rand Elliott and Andy Cervantes make a presentation to the Central Family Medicine Residency Program on the GWMA and nitrates.
8. September - EPO creates script for—and GWAC/EPO member Andy Cervantes participates in—an **Hispanic Affairs Commission "Connect with Your**

Government" Spanish-language statewide radio talk show to increase awareness about the GWMA

9. **December -** Commissioner Elliott gives a presentation on the GWMA, and seeks support of the upcoming well assessment survey, to the Community Advisory Board for **El Proyeto Bienestar**
10. **December-High Risk Well Assessment Survey Phase I (English/Spanish)** EPO Creates a survey instrument and develops an outreach campaign for a well assessment survey in the target area. (Wrote and released **bilingual** materials including PSA's, a direct mail piece, GWAC Chair letter to area newspapers; explored ministerial outreach to churches)
11. **GWMA website.** EPO develops and launches a community website that offers information about the committee, its meetings and information on nitrate-related topics.

*2014-

12. January-EPO issues a news release announcing the GWAC's accomplishments
13. EPO updates the website and maintains it in "real time" from its inception to the present (English)
14. EPO continues **(English/Spanish)** outreach for High Risk Well Assessment Survey Phase I

April 7 - issues an **(English/Spanish)** news release announcing that the survey deadline has been extended

15. New Mom Campaign (English/Spanish)
    a. EPO develops and obtains GWAC approval for new mom messages to be distributed in hospitals and clinics.
    b. EPO prints and distributes over 2000 English/**Spanish** new mom flyers to hospitals, clinicians and at health fairs and community events (including but not limited to Zillah Days and Granger Agricultural bilingual event)
    c. **EPO seeks and obtains partnership with the University of Washington's** Pediatric Environmental Health Specialty Unit (PEHSU) to collaborate on the New Mom campaign
        i. PEHSU conducts clinician trainings in Yakima and Lower Valley to raise clinician awareness of nitrate issue, resources and treatment
        ii. PEHSU obtains authorization to offer Continuing Education Units (CEU) to participating healthcare providers.
        iii. PEHSU creates and distributes Clinician Training video
        iv. Nitrate/new mom materials posted to PEHSU's national website
16. **GWAC educational materials**: EPO creates and obtains GWAC approval of GWAC slide deck (GWAC background information and nitrate education series); posted to website

17. **May - Deep Soil Sampling Launched.** EPO partners with Irrigated Ag working group to promote program.
18. May 2 - EPO issues a **bilingual** news release reminding households of the May 31 deadline to participate in Phase I Free Well Testing.

19. Phase I of the (English/Spanish) High Risk Well Assessment Sampling Surveys is completed (172 Total)

    a. **Outreach: Bilingual** outreach included multiple presentations to Sunnyside Workforce clients, talk show **participation** on **Spanish** (KDNA) and English radio stations, paid advertisement on **Spanish** and English-language radio, 600 **Spanish**-English direct mail pieces, and GWAC Chair editorial outreach published in area English and **Spanish** papers.

20. GWAC approves a two-year outreach budget developed by the EPO

TOTAL **$267,000**:

o Abandoned Wells	$76,000
o Educational Outreach Campaigns	$54,000
o Wellhead Risk Assessment Surveys-Phase 2	$100,000
o Redesign and Maintain GMWA Website	$12,000
o Community Outreach Surveys	$25,000

21. EPO releases the High Risk Well Assessment results.
22. EPO prints and distributes 2000 double-sided English/**Spanish** New Mom Flyers at health fairs in Prosser, Yakima and other outlets.

*2015 –

23. EPO rebuilds and launches the new GWMA website
24. High Risk Well Assessment Follow-up (English/Spanish)
    EPO communicates test results, prevention messages and GWAC information to high risk well assessment participants (171 unique mail pieces in English and **Spanish**)
25. EPO evaluates and reports back to the GWAC regarding the Phase I High Risk Well Assessment results. They agree that the data show a great need for well owners to be familiar with their wells, and to test their wells more frequently.
26. EPO announces Phase II Well Assessment survey. EPO's goal is to complete 200 sampling surveys.
    EPO agrees to use Phase I methodology for messaging in Phase II. Targets: areas of known high nitrate, areas where little nitrate data exists. Direct mail list is increased from 600 (Phase I) to 1000 in Phase II.

27. Phase II **(English/Spanish)** outreach continues. December-EPO evaluates its outreach methods (direct mail, radio advertising, flyers and newspaper coverage.) Response from survey participants indicates that direct mail is the most cost-effective method of eliciting participation. Accordingly, EPO plans a second direct-mail release in January 2016.

*2016

28. County sends 115 **(English/Spanish)** results letters to recent well assessment participants with their certified lab results and educational materials. January-350 additional household invitation letters are sent.
29. January and March-**(English/Spanish)** news releases inviting well assessment participation are released.
30. March 31-Phase II high risk well assessment survey closes.
31. April-the County mails the last round of **(English/Spanish)** results letters to the Phase II well assessment participants with their certified lab results and educational materials. The letters included **(English/Spanish)** handouts on nitrate, coliform, and private well and septic system maintenance.
32. EPO Completes Phase II of the High Risk Well Assessment Sampling Surveys (289) for a total of 466 completed surveys (Phase I-177 + Phase II- 289).
    a. **Outreach: Bilingual** outreach included multiple presentations to Sunnyside Workforce clients, talk show participation on **Spanish** and English radio stations, paid advertisement on **Spanish** and English-language radio, 600 Spanish-English direct mail pieces, and GWAC Chair editorial outreach published in area English and **Spanish** papers.
    b. **Follow-up (English/Spanish)** County communicates test results, prevention messages, septic system maintenance and GWAC information to high risk well assessment participants (289 unique mail pieces in English and **Spanish**)
33. *GWAC/EPO participate in five Spanish-language Fred Hutch-sponsored health fairs (Sunnyside, Mabton, Zillah, Granger and Toppenish) between May and August 2016. Volunteers make **bilingual**, one-on-one contact with approximately 250 lower Valley residents.
    (English/Spanish) Information on private wells, nitrate in groundwater, new mom flyers is distributed to visitors.
    Visitors are also asked to complete the GWAC's **(English/Spanish)** public survey.

Residents on private wells are offered **(English/Spanish)** nitrate test step strips for a "do-it-yourself" drinking water test. Self-addressed stamped envelopes are included with the test strips so people can return their test results directly to Yakima County.

34. EPO develops, presents and receives GWAC approval to launch a "Test Your Well" English/**Spanish billboard** campaign in the Lower Yakima Valley.

35. December - first (English/Spanish) billboard goes live in the LYV GWMA.

*2017

36. January - Second of two (English/Spanish) "Test Your Well" Billboards Goes Live

37. EPO creates, translates and posts five **(English/Spanish)** "**What You Can Do**" flyers to the GWMA website.

38. EPO Launches a (English/Spanish) "What You Can Do to Protect Well Water Campaign
(in response to wide-spread local flooding, especially in the unincorporated community of Outlook) March & April 2017

- **(English/Spanish)** "What You Can Do to Protect Well Water" flyers "(English/Spanish) and test trips distributed door-To-door in Outlook (Yakima Health District).
- **(English/Spanish)** 12,000 What You Can Do to Protect Well Water flyers inserted in the Sunnyside Daily Sun News on March 29, 2017
- **(English/Spanish)** 10,700 flyers inserted in the Spanish-language *El Sol* weekly publication on March 30, 2017
- **Spanish-language** KDNA news show participation – April 4, 2017 (Andy Cervantes and Ignacio Marquez)
- KIT interview-March 30, 2017 (Commissioner Rand Elliott)
- April 29- **(English/Spanish)** flyers (using a **Spanish-speaking EPO member)** distributed at the Sunnyside Walmart store

39. PEHSU (English/Spanish) New Mom Flyers
200 **(English/Spanish)** flyers are distributed to the Toppenish Community Hospital (restock order)

40. EPO Requests Working Groups to Complete an EPO Questionnaire
EPO asks all working groups to answer EPO's questions related to their mission, accomplishments, discoveries, target audiences and messages.
The purpose of this exercise is to help the EPO develop a short-and long-term (post adoption) Communications and Outreach Plan for the GWAC's consideration.
This information is compiled in a summary distributed to the GWAC.

41. June - EPO begins to develop its alternatives recommendations for the GWMA program.

- EPO requests GWAC assistance to identify specific messages and outreach it would like conducted.

Appendix F – Deep Soil Sampling

In 2014, the GWMA authorized a Deep Soil Sampling Initiative (DSS) to collect nitrate soil samples across a variety of irrigated agriculture activities. The project design was based on recommendations developed by the GWMA's Irrigated Agriculture Working Group and has been documented in a quality assurance project plan (PGG 2014c). The goal of the initiative was to create a "snapshot" of current soil nitrate conditions corresponding to the range of irrigated agricultural actives in the basin. By collecting generic samples from a variety of existing agricultural operations, the goal was to identify base conditions that could be used to further refine the conceptual model of irrigated agriculture's contribution of nutrients to the subsurface environment. Because participation in the initiative was voluntary and sample sites and results were anonymized, this type of assessment is qualitative, and not necessarily quantitative.

The objectives of the sampling were to provide:

- Baseline data on the nitrogen content (nitrate, ammonium, and organic matter) of soils underlying a variety of soil, crop, and irrigation systems representing a cross-section of agricultural activities.
- An initial assessment of current nitrogen and water management practices for each sampled field, along with a snapshot of soil nitrogen availability.

Programmatic goals included generating:

- Foundational information for a technically based education program and
- Insights about project design, implementation, technical challenges and costs that could guide subsequent projects.

The DSS included four rounds of sampling starting in the fall of 2014 and running through the spring of 2016. Samples were collected in the fall and spring of each year. Over the course of the two years, four rounds of sampling were conducted and 175 sites were sampled with soil collected at one foot intervals (down to six feet). All samples were analyzed for nitrate (NO_3 as N) and ammonium (NH_4 as N). Organic matter was analyzed from samples collected at one foot.

For each field sampled, a survey was to be completed that tracked:

- The amount and types of nitrogen applied over recent years,
- Types of crops with estimates of the yield, and
- Irrigation practices associated with each field.

Under the study design, grower participation was voluntary and anonymous. Each field location, data and ownership were assigned to a generic sample number. While study participants received copies of the sample results, the project data was anonymized with only generic field information being reported. Neither specific locations nor ownership data were included in the results. Each sampling round was independent of previous rounds, and unique sample numbers were assigned in each round. The DSS Sampling Plan (PGG 2014c) outlines the procedures used to coordinate the site selection, field sample collection, and laboratory reporting requirements. The work was completed under contracts with the South Yakima Conservation District (SYCD) and Landau and Associates with the bulk of the coordination and reporting under the auspices of the SYCD. The cost of sampling and analysis was paid for by the GWMA.

A complete summary of the Deep Soil Sample results are included in this appendix under Deep Soil Sampling Data. Sample results are entered by year and site/field, with each site identified by a unique ID. A summary of the field data (field survey data) is included along with the soil analysis. The 175 sample sets reflect a wide array of agricultural activities ranging from annual row crops to orchards and reflect an equally diverse set of irrigation practices. Quality Assurance and Quality Control procedures for the Initiative are outlined in the quality assurance project plan (PGG 2014c). Also included in that report are copies of the user survey (field survey), sample collection, and field analysis forms (field soil survey).

Outcomes and Challenges

The quality of information on the historical practices varied greatly over the study. Some owners were able to provide detailed information about prior year practices (over the previous 3 – 4 years) while others provided no information beyond the current year. There is a wealth of qualitative information that could be mined for further analysis, but because of the diversity of sites and impact of the limitations identified below, a comprehensive and quantitative analysis of this initial data set is not an option.

The field soil survey data appears to have been consistently collected and analyzed. Each set provided real soil nutrient information to the operator that they could use to evaluate their on-site practices; however, there are at least three factors tied to the design and operation of the initiative that limit the use of the data to make broad observations about impact of current operations across the GWMA. These limiting factors include:

- Lack of longitudinal sampling. (The same sites were not necessarily sampled repeatedly over the four rounds. If a site was sampled multiple times, the site reference, and anonymized data set obscured that fact.)
- Field survey data (user practices) were not consistently recorded. The field soil sample analysis was not explicitly tied to a completed and returned field site survey (user practices). As a result, there are sites with soil data that do not have complete survey data. Further, it is not clear that the same level of accuracy and rigor were applied to all field surveys.

- Even though the survey was voluntary, subsidized, and the public data anonymized, SYCD was faced with the challenge of recruiting participants. The public perception and fear that the collected data could be tied back to a specific site, and used in subsequent enforcement or legal challenges appears to have had a chilling effect on the volunteer pool.

None of these factors by themselves are fatal flaws, but their collective impact has limited the quantitative value of the data collected in this initial effort. However, a significant amount of data was collected and the qualitative observations speak to the original goals of the study. Two such reviews were initiated by members of the GWMA's Data Management Workgroup (Data Workgroup). These preliminary reviews were presented to the Data Workgroup, and a summary was reported to the GWAC. These presentations are included in this appendix under the section titled Analytical Data Analysis (Redding) and Analytical Data and Survey Data Analysis (Mendoza). In both Ms. Redding's and Ms. Mendoza's work, the findings are preliminary and qualitative; however, their work was able to highlight areas for discussions with the grower community, provide focus for further work, and identify opportunities for educational outreach on operational, irrigation, and fertilization practices.

Melanie Redding (Data Workgroup Chair) provided a summary of the full soil sample dataset. Her analysis focused on how nitrate values were expressed in the subsurface by depth and to a lesser extent by season. For this review, each sample site was considered a random point. She did not consider cropping or irrigation information from the field surveys and only looked at the analytical soil data. Specifically the review focused on the cumulative nitrate concentrations as they relate to average, shallow, and deep roots zones. The strength of her analysis is that it treated all sample sites as random within a geographic area. With that assumption, she was able to focus on the analytical results for each round of sampling as independent data points. This analysis did not attempt to factor in the subjective site survey data. As a result, it provided a large sample set and a snapshot of subsurface nitrate values that existed during the sample seasons. This type of analysis can be used as a base for comparison against future rounds that may be undertaken. It also highlights what current nitrate loading levels could look like at "typical" root zone levels in the GWMA.

Jean Mendoza (Data Workgroup Member and GWMA Advisory Committee member) took a different approach to reviewing the DSS data. She broke the data into spring and fall sample sets, which allowed her to combine seasonal data across the two years (fall = 2014 and 2015; spring = 2015 and 2016). This provided a larger sample set that any single year would provide. She then compared fall and spring values highlighting apparent seasonal differences. Like Ms. Redding's work, Ms. Mendoza treated all samples within a seasonal set as random. While there are likely a combination of hydrologic and operational factors that could impact seasonal soil nitrate, this initial sample set can quantify that (See discussion of limitations above). Ms. Mendoza's qualitative observations of seasonal soil nitrate levels provide a basis to begin looking at operational issues and practices that might exacerbate or mitigate subsurface nutrient levels.

Further discussions with the grower community could provide the context and understanding of "typical" operations linked to certain irrigation practices.

In her analysis, she considered gross seasonality but also looked at broad cropping and irrigation practices as potentially significant influences on the resulting soil nitrate values. Her analysis of the subset of data on fields that were double cropped and planted with triticale and corn silage shows the type of analysis that could be done in the future with targeted longitudinal samples set buttressed with consistent and complete field user data. The conclusions are qualitative because under this type of analysis, the sample sets were small and not longitudinal. The differences between sites and site-specific practices can significantly impact one data point versus another. The type of information needed to correct for those factors was not consistently captured in this initial project (DSS). With limited sample sets, it is difficult to differentiate between data points that may be outliers and those that are significant endpoints within the data set.

The analysis of the DSS data is considered informational only. Any clarification or questions can be directed to the author.

Going Forward

The work done by Ms. Redding and Ms. Mendoza provides insights into how a study like the DSS could be improved to better meet the original goals and objectives. Such work would be valuable as part of a long term GWMA program serving as a "safe" feedback mechanism to the grower community regarding the effectiveness of current management practices and their potential impact on subsurface nitrogen loading. However, any future work would need to address the limitations and challenges identified by this initial work. Specifically, some considerations include:

- Better correlation between field soil sample data and field survey data.
    - Tying soil sampling and analysis to complete and submitted field user survey.
    - Providing follow-up with users by a third party on incomplete field survey data forms.
- Tie participation and subsidies (sampling costs) to longitudinal sampling (multiple samples over time at the same site).
- Collaborate with a research organization to provide stability, expertise, and capacity to manage a multi-year program as well as detailed analysis of data as it is collected.
- Re-emphasize the "safety" and utility of the anonymized sampling protocols.

If longitudinal samples are incorporated into the study design along with more complete and consistent field survey data, the number of sample sites could be smaller and/or targeted on specific crops, cropping patters and or irrigation practices. This would expand the educational potential of the work with the agricultural community by developing a dynamic and ongoing "laboratory" that can draw attention to best management practices.

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

1001

Acres	4	10/31/2014
Soil Testing?	NO	
Test Frequency		
Irigation Type	Solid Set Above Canopy	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years		
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	8
2 ft	3
3 ft	3
4 ft	3
5 ft	5
6 ft	3
TOTAL	25
NH4-N	28
ORGANIC	1.87

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015							0						
2014	0	0	0	0	0	0	0	Pasture					
2013	0	0	0	0	0	0	0	Pasture					
2012	0	0	0	0	0	0	0	Pasture					
2011	0	0	0	0	0	0	0	Pasture					

Fertilzer Applications (#N/Acre); Cropping History

Comments: Just 4 to 5 head of Cattle

Current Crop	
Crop Year	2014
Condition	
Fair	

Soil: 18 - Cleman Very Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	6	
B	S	M	2	
C	S	M	4.2	
D	S	M	5.5	
E				

1002

Acres	50	10/29/2014
Soil Testing?	YES	
Test Frequency	Biannually	
Irigation Type	Wheel Lines	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	2	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	285
2 ft	124
3 ft	115
4 ft	
5 ft	
6 ft	
TOTAL	524
NH4-N	11
ORGANIC	2.4

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015							0						
2014	337.5	0	100	0	0	0	438	Triticale	5	Tons			
2013	112.5	0	100	0	0	0	213	Wheat	65	Bushels			
2012	0	0	0	0	0	0	0						
2011	0	0	0	0	0	0	0						

Fertilzer Applications (#N/Acre); Cropping History

Comments:

Current Crop	
Crop Year	2014
Condition	
Fair	Planned

Soil: 121 - Scoon Silt Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M		3
B	S	M		2.5
C	S	M		2
D	S	M		2
E				

1003

Acres	25	10/29/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irigation Type	Drip	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years		
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	65
2 ft	6
3 ft	3
4 ft	
5 ft	
6 ft	
TOTAL	74
NH4-N	5
ORGANIC	1.43

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015							0						
2014	0	0	50	0	0	0	50	Cherries	8	Tons			
2013	0	0	30	0	0	0	30	Cherries	4	Tons			
2012	0	0	0	0	0	0	0						
2011	0	0	0	0	0	0	0						

Fertilzer Applications (#N/Acre); Cropping History

Comments:

Current Crop	
Crop Year	2014
Condition	
Fair	

Soil: 120 - Scoon Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M		3.2
B	S	M		3.2
C	S	M		1.5
D	S	M		2.6
E				

1004

Acres	40	10/30/2014
Soil Testing?	YES	
Test Frequency		
Irigation Type	Pivot	
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	177
2 ft	79
3 ft	63
4 ft	69
5 ft	42
6 ft	50
TOTAL	480
NH4-N	16
ORGANIC	2.06

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015							0						
2014	0	0	250	0	0	0	250	Corn Silage	25	Tons	Triticale	6	Tons
2013	0	0	250	0	0	0	250	Corn Silage	25	Tons	Triticale	6	Tons
2012	0	0	250	0	0	0	250	Corn Silage	25	Tons	Triticale	6	Tons
2011	0	0	250	0	0	0	250	Corn Silage	25	Tons	Triticale	6	Tons

Fertilzer Applications (#N/Acre); Cropping History

Comments:

Current Crop	
Crop Year	2014
Condition	
Fair	

Soil: 178 - Warden Silt Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.5	
B	S	M	4.1	
C	S	M	3.2	
D	S	M	3.5	
E				

1005

Acres	15	10/30/2014
Soil Testing?	YES	
Test Frequency	Annually to Biannually	
Irigation Type	Rill Irrigation and Hand Lines w/ Impacts	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years		
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	25
2 ft	3
3 ft	3
4 ft	3
5 ft	3
6 ft	4
TOTAL	41
NH4-N	20
ORGANIC	2.21

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015							0						
2014	0	0	0	0	0	0	0	Mint	70	Lbs.			
2013	0	0	12	0	0	0	12	Corn Silage	35	Tons			
2012	0	0	12	0	0	0	12	Corn Silage	35	Tons			
2011	0	0	12	0	0	0	12	Corn Silage	35	Tons			

Fertilzer Applications (#N/Acre); Cropping History

Comments: The field has gotten manured for awhile. Solids are composted and spread as needed. Pond water is diluted down to irrigate with. No liquid sample taken.

Current Crop	
Crop Year	2014
Condition	
Good	Actual

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M		
B	S	M		
C	S	M		
D	S	M		
E				

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LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

1006

Acres	15	10/30/2014
Soil Testing?	NO	
Test Frequency		
Irrigation Type	Wheel Lines	
Irrigation Schedule	Soil Moisture Sensors	
Hour Sets	24	
Irrigation years	5	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	45
2 ft	4
3 ft	3
4 ft	3
5 ft	4
6 ft	3
TOTAL	62
NH4-N	20
ORGANIC	2.17

Fertilzer Applications (#N/Acre)								Cropping History			
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	0	0	100	0	0	0	100				
2013	0	0	100	0	0	0	100	Alfalfa	9 Tons		
2012	0	0	100	0	0	0	100	Alfalfa	10 Tons		
2011	0	0	100	0	0	0	100	Alfalfa	10 Tons		

Comments: 50 pounds of N in spring and 50 pounds of N after second cutting

Current Crop	
Crop Year	2014
Condition	
Fair	Actual

Soil: 179 - Warden Silt Loam 8-15% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, SH	M, D, D	1.5	
B	S, SH	M, M	5	5.5
C	S	M	4.5	5
D	S	M	5	5
E				

1007

Acres	7	10/30/2014
Soil Testing?	NO	
Test Frequency		
Irrigation Type	Solid Set Below Canopy	
Irrigation Schedule		
Hour Sets		
Irrigation years	10	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	3
2 ft	3
3 ft	3
4 ft	3
5 ft	
6 ft	
TOTAL	12
NH4-N	8
ORGANIC	1.09

Fertilzer Applications (#N/Acre)								Cropping History			
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	0	0	0	0	0	0	0	Crop Failure			
2013	0	0	0	0	0	0	0	Crop Failure			
2012	0	0	0	0	0	0	0	Cherries	2 Tons		
2011	0	0	0	0	0	0	0	Crop Failure			

Comments: Only leaf feed applied during crop year

Current Crop	
Crop Year	2014
Condition	
Good	Actual

Soil: 179 - Warden Silt Loam 8-15% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, SH	M, D	3.5	4
B	SH	D	1.9	1.9
C	S, SH	M, D		3
D	S, SH	M, D		3.5
E				

1008

Acres	45	10/30/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Drip	
Irrigation Schedule	Have coil moisture but use boots on ground	
Hour Sets		
Irrigation years	19	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	246
2 ft	73
3 ft	14
4 ft	3
5 ft	
6 ft	
TOTAL	336
NH4-N	37
ORGANIC	1.39

Fertilzer Applications (#N/Acre)								Cropping History			
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	0	0	0	0	0	0	0	Wine Grapes			
2013	0	0	0	0	0	0	0	Wine Grapes			
2012	0	0	0	0	0	0	0	Wine Grapes			
2011	0	0	0	0	0	0	0	Wine Grapes			

Comments: 9 acres of problem field raw manure application in adjacent acres subs into our wine grape rows

Current Crop	
Crop Year	2014
Condition	
Poor	Actual

Soil: 10 - Burke Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S	D, M, D		3.1
B	S, S	M, D	3.3	3.3
C	S	M		3
D	S, S, S	M, D, M	4	4
E				

1009

Acres	10	10/31/2014
Soil Testing?	NO	
Test Frequency		
Irrigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	99	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	12
2 ft	3
3 ft	40
4 ft	81
5 ft	
6 ft	
TOTAL	136
NH4-N	10
ORGANIC	1.64

Fertilzer Applications (#N/Acre)								Cropping History			
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	0	0	80	0	0	0	80				
2013	0	0	80	0	0	0	80	Concord Grapes	8 Tons		
2012	0	0	80	0	0	0	80	Concord Grapes	8 Tons		
2011	0	0	80	0	0	0	80	Concord Grapes	8 Tons		

Comments:

Current Crop	
Crop Year	2014
Condition	
Good	Actual

Soil: 178 - Warden Silt Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S	M, D	3.2	3.4
B	S, S	M, D	2.8	3.2
C	S, S	M, D	3.4	3.4
D	S, S	M, D		3.6
E				

1010

Acres	2	10/31/2014
Soil Testing?	NO	
Test Frequency		
Irrigation Type	Solid Set Above Canopy	
Irrigation Schedule	Routine Schedule	
Hour Sets	6	
Irrigation years		
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	50
2 ft	112
3 ft	6
4 ft	
5 ft	
6 ft	
TOTAL	168
NH4-N	17
ORGANIC	1.47

Fertilzer Applications (#N/Acre)								Cropping History			
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	0	0	0	0	0	0	0	Pasture			
2013	0	0	0	0	0	0	0	Pasture			
2012	0	0	0	0	0	0	0	Pasture			
2011	0	0	0	0	0	0	0	Pasture			

Comments: 4 to 6 Head of cattle

Current Crop	
Crop Year	2014
Condition	

Soil: 178 - Warden Silt Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M		2
B	S	M	2	2.8
C	S	M		2
D	S	M	2.6	2.6
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

1011

Acres	27	10/31/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years		
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	57
2 ft	141
3 ft	295
4 ft	269
5 ft	93
6 ft	50
TOTAL	905
NH4-N	40
ORGANIC	3.18

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield
Fertilzer Applications (#N/Acre)								Cropping History				
2016							0					
2015							0					
2014	90	0	0	0	0	0	90	Corn Silage	30	Tons		
2013	90	0	0	0	0	0	90	Wheat	110	Bushels		
2012	90	0	0	0	0	0	90	Corn Silage	30	Tons		
2011	90	0	0	0	0	0	90	Wheat	100	Bushels		

Comments

Current Crop	
Crop Year	2014
Condition	
Good	Actual

Soil	179 - Warden Silt Loam 8-15% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S, S, SH	M, M, M	3.7	4
B	S, S, SH	M, M, M	5	
C	S, S, SH, S, SH, S	M, M, M, M, M	5.5	
D	S, S, SH	M, M, M	2	2
E				

1012

Acres	10	11/4/2014
Soil Testing?	NO	
Test Frequency		
Irrigation Type	None	
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	53
2 ft	60
3 ft	102
4 ft	
5 ft	
6 ft	
TOTAL	215
NH4-N	9
ORGANIC	3.06

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield
Fertilzer Applications (#N/Acre)								Cropping History				
2016							0					
2015							0					
2014	0	0	0	0	0	0	0	Fallow				
2013	0	0	0	0	0	0	0	Fallow				
2012	0	0	0	0	0	0	0	Fallow				
2011	0	0	0	0	0	0	0	Fallow				

Comments: Fallow for last 10 years; Pre 2003 was in apples.

Current Crop	
Crop Year	2014
Condition	

Soil	179 - Warden Silt Loam 8-15% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S, SH, SH, SH, SH, SH	M, D, D, D, D, D	2.3	3
B	S, SH, SH, SH	M, D, D, D	2.1	2.5
C	S, SH, SH	M, D, D	1.2	1.5
D	S, SH, SH	M, D, D	1.2	2.7
E				

1013

Acres	6	11/4/2014
Soil Testing?	NO	
Test Frequency		
Irrigation Type	Drip	
Irrigation Schedule	As Needed	
Hour Sets		
Irrigation years	10	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	68
2 ft	9
3 ft	4
4 ft	6
5 ft	
6 ft	
TOTAL	87
NH4-N	30
ORGANIC	3.09

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield
Fertilzer Applications (#N/Acre)								Cropping History				
2016							0					
2015							0					
2014	0	0	150	0	0	0	150	Pears	40	Bins		
2013	0	0	150	0	0	0	150	Pears	35	Bins		
2012	0	0	150	0	0	0	150					
2011	0	0	150	0	0	0	150					

Comments

Current Crop	
Crop Year	2014
Condition	
Fair	

Soil	178 - Warden Silt Loam 5-8% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.2	3.4
B	S	M	2.9	3.3
C	S	M	1.8	1.8
D	S	M	1.4	
E				

1015

Acres	40	11/5/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	10	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	271
2 ft	125
3 ft	266
4 ft	97
5 ft	94
6 ft	77
TOTAL	930
NH4-N	18
ORGANIC	2.26

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield
Fertilzer Applications (#N/Acre)								Cropping History				
2016							0					
2015							0					
2014	0	0	300	0	0	0	300	Corn Silage	40	Tons		
2013	0	0	300	0	0	0	300	Corn Silage	40	Tons		
2012	0	0	300	0	0	0	300	Corn Silage	40	Tons		
2011	0	0	300	0	0	0	300	Corn Silage	40	Tons		

Comments

Current Crop	
Crop Year	2014
Condition	
Good	

Soil	95 - Quincy Loamy Fine Sand 0-10% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	4.1	5.5
B	S	M	5.6	
C	S	M	4.7	
D	S	M	4.3	
E				

1016

Acres	40	11/5/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years		
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	94
2 ft	19
3 ft	27
4 ft	36
5 ft	73
6 ft	124
TOTAL	373
NH4-N	16
ORGANIC	1.71

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield
Fertilzer Applications (#N/Acre)								Cropping History				
2016							0					
2015							0					
2014	0	0	300	0	0	0	300	Corn Silage	40	Tons		
2013	0	0	300	0	0	0	300	Corn Silage	40	Tons		
2012	0	0	260	0	0	0	260	Corn Silage	40	Tons		
2011	0	0	260	0	0	0	260	Corn Silage	40	Tons		

Comments: Split Application of N

Current Crop	
Crop Year	2014
Condition	
Good	

Soil	172 - Warden Fine Sandy Loam 0-2% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.9	
B	S	M	5.4	
C	S	M	4.3	
D	S	M	3.7	
E				

Deep Soil Sampling

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE — Groundwater Management Area (GWMA)

1017

Acres		11/5/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	20	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	133
2 ft	14
3 ft	12
4 ft	14
5 ft	20
6 ft	9
TOTAL	202
NH4-N	11
ORGANIC	1.52

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	0	0	300	0	0	0	300	Corn Silage	8 Tons		
2013	0	0	300	0	0	0	300	Corn Silage	8 Tons		
2012	0	0	300	0	0	0	300	Corn Silage	8 Tons		
2011	0	0	300	0	0	0	300	Corn Silage	8 Tons		

Fertilizer Applications (#N/Acre) — Cropping History

Comments

Current Crop	
Crop Year	2014
Condition	Good — Actual

Soil: 171 - Wanser Loamy Fine Sand

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, SH, S	Dp, Dp, M, Dp	1.4	
B	S, SH, S	Dp, M, Dp	2.2	
C	S, SH, S	Dp, M, Dp	2.3	
D	S, S, SH	Dp, Dp, M	2.4	
E				

1018

Acres		11/5/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	20	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	155
2 ft	55
3 ft	32
4 ft	35
5 ft	52
6 ft	100
TOTAL	429
NH4-N	10
ORGANIC	1.64

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	0	0	300	0	0	0	300	Corn Grain	8 Tons		
2013	0	0	300	0	0	0	300	Corn Grain	8 Tons		
2012	0	0	300	0	0	0	300	Corn Grain	8 Tons		
2011	0	0	300	0	0	0	300	Corn Grain	8 Tons		

Fertilizer Applications (#N/Acre) — Cropping History

Comments

Current Crop	
Crop Year	2014
Condition	Good — Actual

Soil: 95 - Quincy Loamy Fine Sand 0-10% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, SH	M, M, M	3.6	5.5
B	S, S, SH	M, M, M	2.5	
C	S, S, SH	M, M, M	2.3	
D	S, S, SH	M, M, M	2.2	5
E				

1019

Acres	10	11/5/2014
Soil Testing?	NO	
Test Frequency		
Irrigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets	12	
Irrigation years	1	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	10
2 ft	7
3 ft	4
4 ft	5
5 ft	9
6 ft	27
TOTAL	62
NH4-N	9
ORGANIC	1.29

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	0	0	100	0	0	0	100				
2013	0	0	0	0	0	0	0	Barley	55 Bushels		
2012	0	0	0	0	0	0	0	Alfalfa	8 Tons		
2011	0	0	0	0	0	0	0				

Fertilizer Applications (#N/Acre) — Cropping History

Comments

Current Crop	
Crop Year	2014
Condition	Fair — Actual

Soil: 95 - Quincy Loamy Fine Sand 0-10% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S	M, D, D	3.5	
B	S	M	3.3	
C	S	M	4.3	
D	S, S, S	M, D, M	4.6	
E				

1020

Acres	45	11/7/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	10	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	93
2 ft	276
3 ft	208
4 ft	78
5 ft	38
6 ft	23
TOTAL	716
NH4-N	23
ORGANIC	2.32

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	0	0	100	0	0	0	100	Wheat	100 Bushels		
2013	0	0	100	0	0	0	100	Wheat	100 Bushels		
2012	0	0	300	0	0	0	300	Corn	8 Tons		
2011	0	0	300	0	0	0	300	Corn	8 Tons		

Fertilizer Applications (#N/Acre) — Cropping History

Comments

Current Crop	
Crop Year	2014
Condition	Good — Planned

Soil: 173 - Warden Fine Sandy Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S	M, M, D, M	3.4	
B	S, S, S, S	M, M, D, M	5.8	
C	S	M	4.2	
D	S	M	5.2	
E				

1021

Acres	30	11/7/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years		
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	315
2 ft	33
3 ft	99
4 ft	17
5 ft	40
6 ft	15
TOTAL	519
NH4-N	23
ORGANIC	2.15

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	0	0	100	0	0	0	100	Corn Grain	28 Bushels		
2013	0	200	100	0	0	0	300	Corn Grain	28 Bushels		
2012	0	200	0	0	0	0	200	Corn Grain	28 Bushels		
2011	0	200	0	0	0	0	200				

Fertilizer Applications (#N/Acre) — Cropping History

Comments

Current Crop	
Crop Year	2014
Condition	Fair

Soil: 172 - Warden Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S, SH	M, M, M, M, Dp	3.1	
B	S, S, SH, SH	M, M, Dp, Dp	4.1	
C	S, S, SH, SH	M, M, Dp, Dp	4.3	
D	S	M	2.4	
E				

Lower Yakima Valley Groundwater Advisory Committee — Groundwater Management Area (GWMA)

Deep Soil Sampling

1022

Acres	20	11/6/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irigation Type	Wheel Lines	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	2	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	16
2 ft	10
3 ft	17
4 ft	15
5 ft	21
6 ft	33
TOTAL	112
NH4-N	11
ORGANIC	1.53

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	0	0	100	0	0	0	100	Hay	10 Tons		
2013	0	0	100	0	0	0	100	Hay	9 Tons		
2012	0	0	100	0	0	0	100	Wheat	100 Bushels		
2011	0	0	100	0	0	0	100	Hay	8 Tons		

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	
2014	
Condition	
Fair	

Soil: 57 - Hezel Loamy Fine Sand 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S	M, M, W	3.7	
B	S, S, S	M, M, W	4.7	
C	S, S, S	M, M, W	3	
D	S, S, S	M, M, W	2.6	
E				

1023

Acres	20	11/6/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	2	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	28
2 ft	53
3 ft	152
4 ft	81
5 ft	59
6 ft	66
TOTAL	439
NH4-N	11
ORGANIC	1.19

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	75	0	300	0	0	0	375	Corn Grain	8 Tons		
2013	75	0	300	0	0	0	375	Corn Grain	8 Tons		
2012	75	0	300	0	0	0	375	Corn Grain	5 Tons		
2011	75	0	300	0	0	0	375	Corn Grain	5 Tons		

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	
2014	
Condition	
Good	Actual

Soil: 95 - Quincy Loamy Fine Sand 0-10% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.5	
B	S	M	5.1	
C	S	M	4.2	
D	S	M	3.5	
E				

1024

Acres	40	11/6/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	4	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	22
2 ft	21
3 ft	19
4 ft	34
5 ft	121
6 ft	57
TOTAL	274
NH4-N	19
ORGANIC	2.4

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	75	0	300	0	0	0	375	Corn	8 Tons		
2013	75	0	300	0	0	0	375	Corn	8 Tons		
2012	75	0	300	0	0	0	375	Corn	8 Tons		
2011	75	0	300	0	0	0	375	Corn	8 Tons		

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	
2014	
Condition	
Fair	

Soil: 95 - Quincy Loamy Fine Sand 0-10% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.3	
B	S	M	3.1	
C	S	M	2.2	
D	S	M	2.6	
E				

1025

Acres	20	11/6/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years		
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	215
2 ft	18
3 ft	13
4 ft	4
5 ft	32
6 ft	4
TOTAL	286
NH4-N	8
ORGANIC	1.34

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	0	0	180	0	0	0	180	Hops	0 Tons		
2013	0	0	180	0	0	0	180	Hops	1 Tons		
2012	0	0	180	0	0	0	180	Hops	1 Tons		
2011	0	0	140	0	0	0	140	Hops	1 Tons		

Fertilzer Applications (#N/Acre); Cropping History

Comments: Split aplication on fields; 200 lbs. N to start grow season and side dress 100 lbs throughout rest of season

Current Crop	
Crop Year	
2014	
Condition	
Fair	Actual

Soil: 95 - Quincy Loamy Fine Sand 0-10% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.8	
B	S	M	1.3	
C	S	M	1.8	
D	S	M	2.6	
E				

1026

Acres	51	11/6/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irigation Type	Rill Irrigation	
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	314
2 ft	10
3 ft	7
4 ft	7
5 ft	7
6 ft	3
TOTAL	348
NH4-N	22
ORGANIC	1.33

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014	0	0	150	0	0	0	150	Hops	1 Tons		
2013	0	0	150	0	0	0	150	Hops	1 Tons		
2012	0	0	0	0	0	0	0	Hops	1 Tons		
2011	0	0	0	0	0	0	0	Hops	1 Tons		

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	
2014	
Condition	
Fair	

Soil: 172 - Warden Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, SH	M, M	4.3	
B	S, SH	M, M	3.8	
C	S, SH	M, M	3.6	
D	S, SH	M, M	3.8	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

1027

Acres	50	11/6/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	7	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	115
2 ft	121
3 ft	99
4 ft	67
5 ft	114
6 ft	66
TOTAL	582
NH4-N	23
ORGANIC	1.94

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
	Fertilzer Applications (#N/Acre)							Cropping History			
2016							0				
2015							0				
2014	0	0	100	0	0	0	100	Alfalfa	10 Tons		
2013	0	0	300	0	0	0	300	Corn Grain	8 Tons		
2012	0	0	100	0	0	0	100	Wheat	95 Bushels		
2011	0	0	100	0	0	0	100	Wheat	120 Bushels		

Comments

Current Crop	
Crop Year	2014
Condition	
Good	Actual

Soil: 171 - Wanser Loamy Fine Sand

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, SH	D, M, M, M	4.2	
B	S	M	4.3	
C	S	M	4.5	
D	S	M	3.5	
E				

1028

Acres	25	11/7/2014
Soil Testing?	NO	
Test Frequency		
Irrigation Type	Solid Set Below Canopy	
Irrigation Schedule	Routine Schedule	
Hour Sets	12	
Irrigation years	25	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	11
2 ft	3
3 ft	3
4 ft	3
5 ft	3
6 ft	3
TOTAL	26
NH4-N	16
ORGANIC	1.39

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
	Fertilzer Applications (#N/Acre)							Cropping History			
2016							0				
2015							0				
2014	0	0	0	0	0	0	0	Apples			
2013	0	0	0	0	0	0	0	Apples			
2012	0	0	0	0	0	0	0	Apples			
2011	0	0	0	0	0	0	0	Apples			

Comments

Current Crop	
Crop Year	2014
Condition	
Poor	Planned

Soil: 143 - Starbuck-Rock Outcrop Complex 0-45% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, SH, S, SH, S, SH	M, M, M, Dp, Dp, Dp, Dp, Dp	4.3	
B	S, S, S, SH, S	M, M, M, Dp, Dp	4.2	
C	S, S, S, S, SH	M, M, M, Dp, Dp	4.2	
D	S, S, S, SH, S	M, M, Dp, Dp, Dp	4.1	
E				

1029

Acres	25	11/7/2014
Soil Testing?	NO	
Test Frequency		
Irrigation Type	Solid Set Below Canopy	
Irrigation Schedule	Routine Schedule	
Hour Sets	12	
Irrigation years	25	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	8
2 ft	3
3 ft	11
4 ft	4
5 ft	3
6 ft	3
TOTAL	32
NH4-N	10
ORGANIC	1.17

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
	Fertilzer Applications (#N/Acre)							Cropping History			
2016							0				
2015							0				
2014	0	0	0	0	0	0	0	Apples			
2013	0	0	0	0	0	0	0	Apples			
2012	0	0	0	0	0	0	0	Apples			
2011	0	0	0	0	0	0	0	Apples			

Comments

Current Crop	
Crop Year	2014
Condition	
Poor	Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, SH, SH, SH	M, M, Dp, Dp, Dp	5.5	
B	S, S, SH, SH, SH, S	M, M, Dp, Dp, Dp, M	5.9	
C	S, S, S, S, SH, SH, SH	M, M, M, M, Dp, Dp, Dp	5.2	
D	S, S, SH, SH, SH	M, M, Dp, Dp, Dp	5.1	
E				

1030

Acres	40	11/7/2014
Soil Testing?	YES	
Test Frequency	Every 4 Years	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	8	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	113
2 ft	57
3 ft	8
4 ft	6
5 ft	7
6 ft	6
TOTAL	197
NH4-N	31
ORGANIC	2.86

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
	Fertilzer Applications (#N/Acre)							Cropping History			
2016							0				
2015							0				
2014	0	0	0	0	0	0	0	Sudan Grass			
2013	0	0	0	0	0	0	0	Alfalfa	10 Tons		
2012	0	0	0	0	0	0	0	Alfalfa	10 Tons		
2011	0	0	0	0	0	0	0	Alfalfa	10 Tons		

Comments: Bio Solids applied 7 years ago, no fertilizer of any kind has been applied for 6 growing seasons. Crop advisor told producer that the Nitrogen is bound up in the first foot.

Current Crop	
Crop Year	2014
Condition	
Fair	

Soil: 66 - Kittitas Silt Loam

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	5.7	
B	S	M	5.6	
C	S	M	5.8	
D	S	M	4.9	
E				

1031

Acres	80	11/7/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years		
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	568
2 ft	601
3 ft	760
4 ft	
5 ft	
6 ft	
TOTAL	1929
NH4-N	12
ORGANIC	2.34

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
	Fertilzer Applications (#N/Acre)							Cropping History			
2016							0				
2015							0				
2014	90	0	0	0	0	0	90	Corn	5 Tons		
2013	90	0	0	0	0	0	90	Corn Grain	4 Tons		
2012	90	0	0	0	0	0	90	Wheat	70 Bushels		
2011	90	0	0	0	0	0	90	Corn Grain	4 Tons		

Comments

Current Crop	
Crop Year	2014
Condition	
Good	Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S	M, D	2.4	2.7
B	S, S	M, D	1.8	2.4
C	S, S	M, D	1.8	1.8
D	S, S	M, D	1.9	1.9
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

1032

Acres	80	11/7/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years	25	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	50
2 ft	268
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	318
NH4-N	19
ORGANIC	2.28

Fertilzer Applications (#N/Acre)								Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015							0						
2014	90	0	60	0	0	0	150	Wheat	90	Bushels			
2013	90	0	0	0	0	0	90	Corn Grain	5	Tons			
2012	90	0	0	0	0	0	90	Corn Grain	5	Tons			
2011	90	0	0	0	0	0	90	Corn Grain	4	Tons			
Comments													

Current Crop	
Crop Year	
2014	
Condition	
Good	Actual

Soil	177 - Warden Silt Loam 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S, S	M, D	1.6	2
B	S, S	M, D	1.8	1.8
C	S, S	M, D	1.5	1.7
D	S, S	M, D	1.9	1.9
E				

1033

Acres	80	11/7/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years		
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	110
2 ft	28
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	138
NH4-N	25
ORGANIC	2.96

Fertilzer Applications (#N/Acre)								Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015							0						
2014	90	0	0	0	0	0	90	Corn Grain	4	Tons			
2013	90	0	0	0	0	0	90	Wheat	100	Bushels			
2012	90	0	0	0	0	0	90	Corn Grain	5	Tons			
2011	90	0	0	0	0	0	90	Corn Grain	4	Tons			
Comments													

Current Crop	
Crop Year	
2014	
Condition	
Fair	Planned

Soil	177 - Warden Silt Loam 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1.6	2
B	S	M	2	2
C	S	M	2	2
D	S	M	2	2
E				

1034

Acres	80	11/7/2014
Soil Testing?	YES	
Test Frequency	Annually	
Irigation Type	Solid Set Above Canopy	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years	25	
Event	FALL 2014	

NO3 (#N/ACRE)	
1 ft	285
2 ft	55
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	340
NH4-N	17
ORGANIC	2.62

Fertilzer Applications (#N/Acre)								Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015							0						
2014	90	0	120	0	0	0	210	Corn Grain	5	Tons			
2013	90	0	0	0	0	0	90	Corn Grain	6	Tons			
2012	90	0	0	0	0	0	90	Corn Grain	4	Tons			
2011	90	0	0	0	0	0	90	Wheat	60	Bushels			
Comments													

Current Crop	
Crop Year	
2014	
Condition	
Good	Planned

Soil	177 - Warden Silt Loam 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1.2	1.8
B	S	M	0.9	1.4
C	S	M	1	1.5
D	S	M	1	1.7
E				

2035

Acres	40	4/28/2015
Soil Testing?	YES	
Test Frequency	Annually in Fall	
Irigation Type	Pivot	
Irrigation Schedule	Observe Crop	
Hour Sets		
Irrigation years	10	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	55
2 ft	56
3 ft	56
4 ft	103
5 ft	110
6 ft	93
TOTAL	473
NH4-N	108
ORGANIC	3.04

Fertilzer Applications (#N/Acre)								Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	0	0	434	0	0	0	434	Triticale	6	Tons			
2014	50	0	391	0	0	0	441	Triticale	6	Tons	Corn Silage	28	Tons
2013	50	0	317	0	0	0	367	Triticale	6	Tons	Corn Silage	28	Tons
2012	50	0	430	0	0	0	480	Triticale	6	Tons	Corn Silage	28	Tons
2011							0						
Comments													

Current Crop	
Crop Year	
2015	
Condition	
Good	Actual

Soil	18 - Cleman Very Fine Sandy Loam 0-2% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	4.2	
B	S	M	5.2	
C	S	M	4.5	
D	S	M	4.5	
E				

2036

Acres	33	4/28/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irigation Type	Linear Move	
Irrigation Schedule	Observe Crop	
Hour Sets		
Irrigation years	6	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	90
2 ft	47
3 ft	31
4 ft	23
5 ft	12
6 ft	6
TOTAL	209
NH4-N	65
ORGANIC	2.37

Fertilzer Applications (#N/Acre)								Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	50	0	434	0	0	0	484	Triticale	6	Tons			
2014	0	0	166	0	0	0	166	Triticale	6	Tons	Corn Silage	28	Tons
2013	0	0	434	0	0	0	434	Triticale	6	Tons	Corn Silage	28	Tons
2012	0	0	435	0	0	0	435	Triticale	6	Tons	Corn Silage	28	Tons
2011							0						
Comments													

Current Crop	
Crop Year	
2015	
Condition	
Good	Actual

Soil	18 - Cleman Very Fine Sandy Loam 0-2% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	5.5	
B	S	M	5.2	
C	S	M	4.8	
D	S	M	5.6	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

2037

Acres	38	4/28/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule	Observe Crop	
Hour Sets		
Irrigation years	10	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	50
2 ft	106
3 ft	226
4 ft	183
5 ft	149
6 ft	72
TOTAL	786
NH4-N	93
ORGANIC	1.9

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	50	0	434	0	0	0	484	Triticale	6	Tons			
2014	0	0	391	0	0	0	391	Triticale	6	Tons	Corn Silage	28	Tons
2013	0	0	434	0	0	0	434	Triticale	6	Tons	Corn Silage	28	Tons
2012	0	0	435	0	0	0	435	Triticale	6	Tons	Corn Silage	28	Tons
2011							0						

Fertilzer Applications (#N/Acre) / Cropping History

Comments

Current Crop	
Crop Year	2015
Condition	
Good	Actual

Soil: 173 - Warden Fine Sandy Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S-SH	D-M	3.2	
B	S-SH	D-M	4.3	
C	S-SH	D-M	3.5	
D	S-SH	D-M		
E				

2038

Acres	17	4/28/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Wheel Lines	
Irrigation Schedule	Observe Crop	
Hour Sets		
Irrigation years	15	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	116
2 ft	137
3 ft	108
4 ft	45
5 ft	17
6 ft	7
TOTAL	430
NH4-N	44
ORGANIC	3.46

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	40	0	0	0	0	0	40	Triticale	6	Tons			
2014	120	0	0	0	0	0	120	Triticale	6	Tons			
2013	150	0	0	0	0	0	150	Triticale	6	Tons			
2012	150	0	0	0	0	0	150	Triticale	6	Tons			
2011							0						

Fertilzer Applications (#N/Acre) / Cropping History

Comments

Current Crop	
Crop Year	2015
Condition	
Good	Actual

Soil: 140 - Sinloc Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, SH, SH	D-M, M, M	2.3	4
B	S, SH, SH	D-M, M, M	2.2	
C	S, SH, SH, SH	D-M, M, Dp, Dp	2.5	
D	S, SH, SH	D-M, M, Dp		
E				

2039

Acres	40	4/29/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule	Observe Crop	
Hour Sets		
Irrigation years	2	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	45
2 ft	104
3 ft	93
4 ft	131
5 ft	314
6 ft	360
TOTAL	1047
NH4-N	13
ORGANIC	2.12

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	198	0	0	0	0	0	198	Triticale	8	Tons			
2014	306	0	0	0	0	0	306	Alfalfa	8	Tons			
2013	216	0	0	0	0	0	216	Alfalfa	8	Tons			
2012	288	0	0	0	0	0	288	Alfalfa	8	Tons			
2011							0						

Fertilzer Applications (#N/Acre) / Cropping History

Comments

Current Crop	
Crop Year	2015
Condition	
Good	Actual

Soil: 172 - Warden Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	D-M	3.5	
B	S, SH	D-M, M	3.5	
C	S, SH, SH	D-M, M, M	4.9	
D	S, SH	D-M, M	5.6	
E				

2040

Acres	33	4/29/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Pivot	
Irrigation Schedule	Shovel Method	
Hour Sets		
Irrigation years	15	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	41
2 ft	25
3 ft	13
4 ft	36
5 ft	88
6 ft	68
TOTAL	271
NH4-N	26
ORGANIC	3.09

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	200	0	0	0	0	0	200	Triticale	9	Tons			
2014	0	0	0	0	0	0	0	Triticale	9	Tons	Corn Silage	26	Tons
2013	204	0	0	0	0	0	204	Triticale	9	Tons	Corn Silage	22	Tons
2012	200	0	0	0	0	0	200	Triticale	8	Tons	Corn Silage	25	Tons
2011							0						

Fertilzer Applications (#N/Acre) / Cropping History

Comments: LIQUID APPLIED THRU PIVOT

Current Crop	
Crop Year	2015
Condition	
Good	Actual

Soil: 172 - Warden Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, SH	D, M, M	3.6	
B	S, S, S, SH	D, M, D, M	4.8	
C	S, SH, S	D, M, M	5.9	
D	S	M	3.8	
E				

2041

Acres	72	4/29/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Pivot	
Irrigation Schedule	Shovel Method	
Hour Sets		
Irrigation years	7	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	4
2 ft	3
3 ft	3
4 ft	4
5 ft	6
6 ft	12
TOTAL	32
NH4-N	9
ORGANIC	1.46

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	0	0	0	0	0	0	0	Triticale	11	Tons			
2014	34	50	0	0	0	0	84	Triticale	7	Tons	Corn Silage	24	
2013	180	0	0	0	0	0	180	Triticale	10	Tons	Corn Silage	31	
2012	180	0	0	0	0	0	180	Triticale	10	Tons	Corn Silage	30	
2011							0						

Fertilzer Applications (#N/Acre) / Cropping History

Comments: Liquid is injected

Current Crop	
Crop Year	2015
Condition	
Good	Actual

Soil: 172 - Warden Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	D	4.5	
B	S	D	3	
C	S	D	3.6	
D	S	D		
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

2042

Field	Value	NO3 (#N/ACRE)	
Acres	18	1 ft	29
Date	4/29/2015	2 ft	28
Soil Testing?	YES	3 ft	12
Test Frequency	Annually	4 ft	7
Irrigation Type	Wheel Lines	5 ft	8
Irrigation Schedule	Soil Moisture Sensors	6 ft	5
Hour Sets	12	TOTAL	89
Irrigation years	20	NH4-N	32
Event	SPRING 2015	ORGANIC	2.03

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	0	0	0	0	0	0	0	Alfalfa	7 Tons		
2014	0	0	0	0	0	0	0	Alfalfa	2 Tons		
2013	0	0	0	0	0	0	0	Triticale	5 Tons	Sudan Grass	5 Tons
2012	0	0	0	0	0	0	0	Triticale	5 Tons	Sudan Grass	5 Tons
2011							0				

Comments: NO NITROGEN APPLIED OF ANY KIND LAST 3 YEARS

Current Crop: Crop Year 2015; Condition: Poor; Planned

Soil: 138 - Sinloc Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.7	
B	S	M	2.8	
C	S	M	3	
D	S	M	3.9	
E				

2043

Field	Value	NO3 (#N/ACRE)	
Acres	40	1 ft	32
Date	4/29/2015	2 ft	16
Soil Testing?	YES	3 ft	6
Test Frequency	Annually	4 ft	3
Irrigation Type	Wheel Lines	5 ft	13
Irrigation Schedule	Routine Schedule	6 ft	16
Hour Sets	24	TOTAL	86
Irrigation years	20	NH4-N	35
Event	SPRING 2015	ORGANIC	3.09

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	0	0	0	0	0	0	0	Alfalfa	6 Tons		
2014	0	0	0	0	0	0	0	Alfalfa	8 Tons		
2013	0	195	0	0	0	0	195	Alfalfa	4 Tons		
2012	0	0	0	0	0	0	0	Triticale	5 Tons		
2011							0				

Comments:

Current Crop: Crop Year 2015; Condition: Good; Planned

Soil: 138 - Sinloc Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S	M, Dp, W, W	1.9	
B	S, S, S	M, Dp, W	3.7	
C	S, S, S	M, Dp, W	2.6	
D	S, S, S	M, Dp, W	2.7	
E				

2044

Field	Value	NO3 (#N/ACRE)	
Acres	33	1 ft	29
Date	4/30/2015	2 ft	152
Soil Testing?	YES	3 ft	457
Test Frequency	Annually	4 ft	623
Irrigation Type		5 ft	706
Irrigation Schedule	Routine Schedule	6 ft	409
Hour Sets	24	TOTAL	2376
Irrigation years		NH4-N	31
Event	SPRING 2015	ORGANIC	3.4

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	0	0	0	0	0	0	0	Alfalfa	8 Tons		
2014	0	0	0	0	0	0	0	Alfalfa	7 Tons		
2013	0	0	0	0	0	0	0	Alfalfa	9 Tons		
2012	0	0	0	0	0	0	0	Alfalfa	6 Tons		
2011							0				

Comments: No Nutrients added during last 4 years

Current Crop: Crop Year 2015; Condition: Good; Planned

Soil: 92 - Outlook Silt Loam

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.9	
B	S	M	1.5	
C	S	M	5	
D	S	M	5.4	
E				

2045

Field	Value	NO3 (#N/ACRE)	
Acres	44	1 ft	29
Date	4/30/2015	2 ft	4
Soil Testing?	YES	3 ft	20
Test Frequency	Annually	4 ft	22
Irrigation Type	Wheel Lines	5 ft	13
Irrigation Schedule	Routine Schedule	6 ft	31
Hour Sets	24	TOTAL	119
Irrigation years	20	NH4-N	25
Event	SPRING 2015	ORGANIC	2.37

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	0	0	0	0	0	0	0	Alfalfa	8 Tons		
2014	0	0	0	0	0	0	0	Alfalfa	8 Tons		
2013	0	0	0	0	0	0	0	Alfalfa	9 Tons		
2012	0	0	0	0	0	0	0	Alfalfa	5 Tons		
2011							0				

Comments: No nutrients added since fall of 2011

Current Crop: Crop Year 2015; Condition: Good; Planned

Soil: 138 - Sinloc Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, SH, S	D, M, M, M	3.1	
B	S, S, SH, S	D, M, M, M	3	
C	S, S, SH, S	D, M, M, M	3.4	
D	S, S, SH, S, SH, S	D, M, M, M, M, M	4.7	
E				

2046

Field	Value	NO3 (#N/ACRE)	
Acres		1 ft	36
Date	4/30/2015	2 ft	88
Soil Testing?	YES	3 ft	95
Test Frequency	Annually	4 ft	70
Irrigation Type	Wheel Lines	5 ft	65
Irrigation Schedule	Routine Schedule	6 ft	72
Hour Sets	24	TOTAL	426
Irrigation years	20	NH4-N	33
Event	SPRING 2015	ORGANIC	2.67

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	0	100	0	0	0	0	100	Triticale	5 Tons		
2014	0	500	0	0	0	0	500	Triticale	5 Tons	Sudan Grass	10 Tons
2013	0	500	0	0	0	0	500	Triticale	5 Tons	Sudan Grass	10 Tons
2012	0	500	0	0	0	0	500	Triticale	5 Tons	Sudan Grass	10 Tons
2011							0				

Comments:

Current Crop: Crop Year 2015; Condition: Fair; Planned

Soil: 139 - Sinloc Silt Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, SH, S	D, M, M, M	2.9	
B	S, S, SH, S	D, M, M, M	1.8	
C	S, S, SH, S	D, M, M, M	1.9	
D	S, S, SH	D, M, M	1.3	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

2047

Acres	45	4/30/2015	NO3 (#N/ACRE)	
Soil Testing?	YES		1 ft	113
Test Frequency	Annually		2 ft	466
Irigation Type	Pivot		3 ft	913
			4 ft	951
Irrigation Schedule	Routine Schedule		5 ft	626
			6 ft	252
Hour Sets	120		TOTAL	3321
Irrigation years	10		NH4-N	21
Event	SPRING 2015		ORGANIC	3.11

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	150	0	0	0	0	0	150	Alfalfa	10 Tons		
2014	300	0	0	0	0	0	300	Alfalfa	9 Tons		
2013	300	0	0	0	0	0	300	Alfalfa	10 Tons		
2012	300	0	0	0	0	0	300	Alfalfa	6 Tons		
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	
2015	
Condition	
Fair	Planned

Soil	178 - Warden Silt Loam 5-8% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	SH, SH, SH, SH, S, SH	M, M, M, M, D, M	5.9	
B	SH, SH, SH, S	M, M, M, D	5.3	
C	SH	M	2	2
D	SH	M	2	3
E				

2048

Acres	150	4/30/2015	NO3 (#N/ACRE)	
Soil Testing?	YES		1 ft	144
Test Frequency	Annually		2 ft	73
Irigation Type	Wheel Lines		3 ft	
			4 ft	
Irrigation Schedule	Routine Schedule		5 ft	
			6 ft	
Hour Sets	12		TOTAL	217
Irrigation years	15		NH4-N	17
Event	SPRING 2015		ORGANIC	3.51

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	0	0	0	0	0	0	0	Triticale	5 Tons		
2014	0	0	0	0	0	0	0	Alfalfa	7 Tons		
2013	0	0	0	0	0	0	0	Alfalfa	7 Tons		
2012	0	0	0	0	0	0	0	Alfalfa	7 Tons		
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments: Liquid Manure was applied twice per year. Records are unavailable for #/acre of N

Current Crop	
Crop Year	
2015	
Condition	
Good	Actual

Soil	120 - Scoon Silt Loam 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1.6	1.6
B	S	M	1.4	1.5
C	S	M	1.4	1.5
D	S	M	1.7	1.8
E				

2049

Acres	35	5/3/2015	NO3 (#N/ACRE)	
Soil Testing?	YES		1 ft	84
Test Frequency	Annually		2 ft	8
Irigation Type	Pivot		3 ft	11
			4 ft	8
Irrigation Schedule	Routine Schedule		5 ft	45
			6 ft	8
Hour Sets	DAILY		TOTAL	164
Irrigation years	1		NH4-N	19
Event	SPRING 2015		ORGANIC	1.55

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	0	0	0	0	0	0	0	Corn Silage	30 Tons		
2014	0	0	50	0	0	0	50	Corn Grain	8 Tons		
2013	0	0	60	0	0	0	60	Corn Silage	8 Tons		
2012	0	0	45	0	0	0	45	Corn Silage	28 Tons		
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	
2015	
Condition	
Good	Planned

Soil	177 - Warden Silt Loam 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	4.7	
B	S	M	4.2	
C	S	M	5.9	
D	S	M	4.2	
E				

2050

Acres	55	5/3/2015	NO3 (#N/ACRE)	
Soil Testing?	YES		1 ft	18
Test Frequency	Biannually		2 ft	9
Irigation Type	Pivot		3 ft	21
			4 ft	43
Irrigation Schedule	Routine Schedule		5 ft	61
			6 ft	51
Hour Sets			TOTAL	203
Irrigation years	8		NH4-N	25
Event	SPRING 2015		ORGANIC	2.95

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	0	0	0	0	0	0	0	Triticale	8 Tons		
2014	0	0	80	0	0	0	80	Triticale	8 Tons	Corn Silage	30
2013	0	0	0	0	0	0	0	Triticale	8 Tons	Corn Silage	30
2012	0	0	45	0	0	0	45	Triticale	8 Tons	Corn Silage	30
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	
2015	
Condition	
Good	Actual

Soil	177 - Warden Silt Loam 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.2	4
B	S	M	2.7	4
C	S	M	5.3	
D	S	M	3.4	
E				

2051

Acres	50	5/3/2015	NO3 (#N/ACRE)	
Soil Testing?	YES		1 ft	14
Test Frequency	Biannually		2 ft	3
Irigation Type	Wheel Lines		3 ft	3
			4 ft	3
Irrigation Schedule	Routine Schedule		5 ft	3
			6 ft	3
Hour Sets	Daily		TOTAL	29
Irrigation years			NH4-N	25
Event	SPRING 2015		ORGANIC	2.32

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	0	0	75	0	0	0	75	Pasture			
2014	0	0	180	0	0	0	180	Pasture			
2013	0	0	150	0	0	0	150	Pasture			
2012	0	0	135	0	0	0	135	Pasture			
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	
2015	
Condition	
Good	

Soil	140 - Sinloc Silt Loam 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.4	
B	S	M	4.2	
C	S	M	4.4	
D	S	M	4.3	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE | Groundwater Management Area (GWMA)

Deep Soil Sampling

2052

Field	Value	
Acres	130	5/3/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule	Shovel Method	
Hour Sets		
Irrigation years	12	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	59
2 ft	
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	59
NH4-N	16
ORGANIC	2.16

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	0	0	0	0	0	0	0	Triticale	7	Tons			
2014	400	0	0	0	0	0	400	Triticale	6	Tons	Corn Silage	29	Tons
2013	400	0	0	0	0	0	400	Triticale	6	Tons	Corn Silage	31	Tons
2012	400	0	0	0	0	0	400	Triticale	6	Tons	Corn Silage	26	Tons
2011							0						

Fertilizer Applications (#N/Acre); Cropping History. Comments: Nutrients applied thru pivot

Current Crop — Crop Year: 2015; Condition: Good, Actual

Soil: 120 - Scoon Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	D	1	1
B	S	D	1.2	1.2
C	S	D	0.8	1
D	S	D		1
E				

2053

Field	Value	
Acres	110	5/3/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule	Shovel Method	
Hour Sets		
Irrigation years	15	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	84
2 ft	58
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	142
NH4-N	11
ORGANIC	1.59

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	0	0	0	0	0	0	0	Triticale	7	Tons			
2014	400	0	0	0	0	0	400	Triticale	6	Tons	Corn Silage	29	Tons
2013	400	0	0	0	0	0	400	Triticale	6	Tons	Corn Silage	31	Tons
2012	400	0	0	0	0	0	400	Triticale	6	Tons	Corn Silage	26	Tons
2011							0						

Fertilizer Applications (#N/Acre); Cropping History. Comments: Nutrients applied thru pivot

Current Crop — Crop Year: 2015; Condition: Good, Actual

Soil: 122 - Scoon Silt Loam 8-15% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	D	0.9	1
B	S	D	1.5	1.5
C	S	D	1.5	1.5
D	S	D	1	1
E				

2054

Field	Value	
Acres	15	5/3/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Solid Set Above Canopy	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years	15	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	133
2 ft	40
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	173
NH4-N	22
ORGANIC	2.52

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	240	0	0	0	0	0	240	Wheat	110	Bushels			
2014	200	0	0	0	0	0	200	Corn Grain	35	Bushels			
2013	200	0	100	0	0	0	300	Alfalfa	3	Tons	Corn Silage	32	Tons
2012	0	0	0	0	0	0	0	Alfalfa	9	Tons			
2011							0						

Fertilizer Applications (#N/Acre); Cropping History. Comments:

Current Crop — Crop Year: 2015; Condition: Good, Planned

Soil: 132 - Shano Lilt Loan 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2	2
B	S	M	1.9	2
C	S	M	1.9	2
D	S	M	2	2
E				

2055

Field	Value	
Acres	15	5/3/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Solid Set Above Canopy	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years	15	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	75
2 ft	
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	75
NH4-N	62
ORGANIC	4.24

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	240	0	0	0	0	0	240	Wheat	110	Bushels			
2014	200	0	0	0	0	0	200	Corn Silage	35	Tons			
2013	200	0	100	0	0	0	300	Alfalfa	2	Tons	Corn Silage	32	Tons
2012	0	0	0	0	0	0	0	Alfalfa	8	Tons			
2011							0						

Fertilizer Applications (#N/Acre); Cropping History. Comments:

Current Crop — Crop Year: 2015; Condition: Good, Planned

Soil: 120 - Scoon Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1	1
B	S	M	0.8	1
C	S	M	0.7	0.9
D	S	M	0.9	0.9
E				

2056

Field	Value	
Acres	40	5/3/2015
Soil Testing?	YES	
Test Frequency	Annually in Fall	
Irrigation Type	Wheel Lines	
Irrigation Schedule	Shovel Method	
Hour Sets	12-24	
Irrigation years	11	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	25
2 ft	151
3 ft	50
4 ft	14
5 ft	8
6 ft	10
TOTAL	258
NH4-N	21
ORGANIC	2.39

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	0	0	60	0	0	0	60	Triticale	7	Tons			
2014	0	0	50	0	0	0	50	Squash					
2013	0	0	50	0	0	0	50	Squash					
2012	0	0	0	0	0	0	0						
2011							0						

Fertilizer Applications (#N/Acre); Cropping History. Comments:

Current Crop — Crop Year: 2015; Condition: Good, Actual

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.2	
B	S	M	4.2	
C	S	M	2.5	
D	S	M	3.2	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

2057

Acres	12	5/3/2015
Soil Testing?	YES	
Test Frequency		
Irigation Type	Drip	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years		
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	37
2 ft	21
3 ft	21
4 ft	3
5 ft	
6 ft	
TOTAL	82
NH4-N	10
ORGANIC	1.03

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	0	0	0	0	0	0	0	Wine Grapes	5 Tons		
2014	0	0	0	0	0	0	0	Wine Grapes	5 Tons		
2013	0	0	0	0	0	0	0	Wine Grapes	2 Tons		
2012	0	0	0	0	0	0	0				
2011							0				

Fertilzer Applications (#N/Acre) — Cropping History

Comments: No Nutrients Applied

Current Crop	
Crop Year	2015
Condition	Fair / Planned

Soil: 132 - Shano Lilt Loan 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.6	4
B	S	M	4	4
C	S	M	3.3	3.8
D	S	M	3.7	3.7
E				

2058

Acres	35	5/3/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	15	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	119
2 ft	986
3 ft	892
4 ft	694
5 ft	407
6 ft	287
TOTAL	3385
NH4-N	16
ORGANIC	1.92

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	270	0	0	0	0	0	270	Triticale	7 Tons		
2014	342	0	0	0	0	0	342	Triticale	7 Tons	Corn Silage	25 Tons
2013	342	0	0	0	0	0	342	Triticale	7 Tons	Corn Silage	27 Tons
2012	342	0	0	0	0	0	342	Triticale	6 Tons	Corn Silage	27 Tons
2011							0				

Fertilzer Applications (#N/Acre) — Cropping History

Comments:

Current Crop	
Crop Year	2015
Condition	Good / Actual

Soil: 174 - Warden Fine Sandy Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.8	
B	S	M	4.2	
C	S, S, SH	M, M, M	3.3	
D	S, S, SH, S	M, M, M, M	4.7	
E				

2059

Acres	41	5/5/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irigation Type	Pivot	
Irrigation Schedule		
Hour Sets		
Irrigation years	1	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	33
2 ft	23
3 ft	28
4 ft	18
5 ft	
6 ft	
TOTAL	102
NH4-N	9
ORGANIC	2.83

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	0	0	40	0	0	0	40	Triticale	6 Tons		
2014	0	0	260	0	0	0	260	Corn Silage	33 Tons		
2013	0	0	200	0	0	0	200	Corn Silage	29 Tons		
2012	0	0	250	0	0	342	592	Corn Silage	31 Tons		
2011							0				

Fertilzer Applications (#N/Acre) — Cropping History

Comments:

Current Crop	
Crop Year	2015
Condition	Good / Actual

Soil: 37 - Finley Silt Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S	M, D, D	1.7	1.7
B	S, S, S, S,	M, D, D, D	2.5	4
C	S, S, S	M, D, D	1.3	1.7
D	S, S, S, S,	M, D, D, D	2.7	4
E				

2060

Acres	19	5/5/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years		
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	171
2 ft	50
3 ft	201
4 ft	24
5 ft	68
6 ft	7
TOTAL	521
NH4-N	6
ORGANIC	1.72

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	0	0	0	0	0	0	0	Mint	150 Lbs.		
2014	0	0	225	0	0	0	225	Corn Silage	30 Tons		
2013	0	0	240	0	0	0	240	Corn Silage	32 Tons		
2012	0	0	275	0	0	0	275	Mint	68 Lbs.		
2011							0				

Fertilzer Applications (#N/Acre) — Cropping History

Comments:

Current Crop	
Crop Year	2015
Condition	Good / Planned

Soil: 18 - Cleman Very Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.3	
B	S, S, S, S, S, S	M, M, M, M, Dp, M	2.6	
C	S, S, S, S, S, S	M, M, M, M, Dp, M	2.7	
D	S, S, SH, S, SH, S	M, M, M, M, M, M	1.6	
E				

2061

Acres		5/5/2015
Soil Testing?		
Test Frequency		
Irigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	5
2 ft	3
3 ft	10
4 ft	4
5 ft	
6 ft	
TOTAL	22
NH4-N	9
ORGANIC	1.78

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015	0	0	0	0	0	0	0				
2014	0	0	0	0	0	0	0				
2013	0	0	0	0	0	0	0				
2012	0	0	0	0	0	0	0				
2011							0				

Fertilzer Applications (#N/Acre) — Cropping History

Comments: No Survey Returned

Current Crop	
Crop Year	
Condition	

Soil: 125 - Scooteney Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	D	1.5	4
B	S	D	1.8	3.9
C	S	D	1.6	4
D	S	D	1.6	3.8
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

2062

Field	Value	
Acres		5/5/2015
Soil Testing?		
Test Frequency		
Irrigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	5
2 ft	6
3 ft	11
4 ft	14
5 ft	10
6 ft	
TOTAL	46
NH4-N	7
ORGANIC	0.84

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	0	0	0	0	0	0	0						
2014	0	0	0	0	0	0	0						
2013	0	0	0	0	0	0	0						
2012	0	0	0	0	0	0	0						
2011							0						

Comments: No Survey Returned

Current Crop	
Crop Year	
Condition	

Soil	95 - Quincy Loamy Fine Sand 0-10% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	D	1	4
B	S, SH	D, M	1.2	3.9
C	S	D	2.9	5.2
D	S	D	1.1	4
E				

2063

Field	Value	
Acres	69	5/5/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule		
Hour Sets		
Irrigation years	10	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	227
2 ft	337
3 ft	424
4 ft	528
5 ft	
6 ft	
TOTAL	1516
NH4-N	24
ORGANIC	3.94

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	0	306	0	0	0	0	306	Triticale	5	Tons	Corn Silage	35	Tons
2014	0	0	0	0	0	0	0	Triticale	5	Tons	Corn Silage	31	Tons
2013	0	0	0	0	0	0	0	Triticale	5	Tons	Corn Silage	31	Tons
2012	0	0	0	0	0	0	0						
2011							0						

Comments: No manure applied for last 3 years. In 2012 accidental over application of commercial nitrogen caused excess N in soil.

Current Crop	
Crop Year	2015
Condition	
Good	Planned

Soil	142 - Starbuck Silt Loam 2-15% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S, S, SH	D, D, M	3.8	4
B	S, S, SH	D, D, M	1.9	4
C	S, S, SH	D, D, M	2.6	4.1
D	S, S, SH	D, D, M	3.5	4
E				

2064

Field	Value	
Acres	30	5/5/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule	Observe Crop	
Hour Sets		
Irrigation years	10	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	52
2 ft	26
3 ft	43
4 ft	26
5 ft	
6 ft	
TOTAL	147
NH4-N	19
ORGANIC	3.21

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	324	0	0	0	0	0	324	Triticale	6	Tons	Corn Silage	35	Tons
2014	63	0	0	0	0	0	63	Triticale	6	Tons	Corn Silage	33	Tons
2013	63	0	0	0	0	0	63	Triticale	6	Tons	Corn Silage	33	Tons
2012	63	0	0	0	0	0	63						
2011							0						

Comments:

Current Crop	
Crop Year	2015
Condition	
Good	Planned

Soil	142 - Starbuck Silt Loam 2-15% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.1	4
B	S	M	3	3.9
C	S	M	3.6	4.2
D	S	M	3.6	4
E				

2065

Field	Value	
Acres	30	5/6/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Pivot	
Irrigation Schedule	Soil Moisture Sensors	
Hour Sets		
Irrigation years	15	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	213
2 ft	304
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	517
NH4-N	15
ORGANIC	2.59

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	225	0	0	0	0	0	225	Triticale	10	Tons			
2014	475	0	75	0	0	0	550	Triticale	10	Tons	Corn Silage	33	Tons
2013	475	0	100	0	0	0	575	Triticale	10	Tons	Corn Silage	35	Tons
2012	390	0	100	0	0	0	490	Triticale	12	Tons	Corn Silage	33	Tons
2011							0						

Comments:

Current Crop	
Crop Year	2015
Condition	
Good	Actual

Soil	132 - Shano Lilt Loan 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S, S	M, D	2	2
B	S, S	M, D	1.9	1.9
C	S	M	2	2
D	S	M	2	2
E				

2066

Field	Value	
Acres	155	5/8/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Pivot	
Irrigation Schedule	Soil Moisture Sensors	
Hour Sets		
Irrigation years	9	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	44
2 ft	182
3 ft	193
4 ft	
5 ft	
6 ft	
TOTAL	419
NH4-N	24
ORGANIC	3.23

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	200	0	0	0	0	0	200	Triticale	8	Tons			
2014	450	0	0	0	0	0	450	Triticale	8	Tons	Corn Silage	30	Tons
2013	425	0	0	0	0	0	425	Triticale	9	Tons	Corn Silage	29	Tons
2012	450	0	50	0	0	0	500	Triticale	7	Tons	Corn Silage	26	Tons
2011							0						

Comments:

Current Crop	
Crop Year	2015
Condition	
Good	Actual

Soil	120 - Scoon Silt Loam 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	D-M	2	2
B	S	D-M	2	2
C	S	D-M	2.8	2.9
D	S	D-M	1.6	1.7
E				

Deep Soil Sampling

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE — Groundwater Management Area (GWMA)

2067

Acres	83	5/8/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Pivot	
Irrigation Schedule	Soil Moisture Sensors	
Hour Sets		
Irrigation years	7	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	19
2 ft	97
3 ft	197
4 ft	115
5 ft	40
6 ft	27
TOTAL	495
NH4-N	18
ORGANIC	1.56

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	0	0	90	0	0	0	90	Triticale	7	Tons			
2014	180	0	200	0	0	0	380	Triticale	7	Tons	Corn Silage	32	Tons
2013	180	0	200	0	0	0	380	Triticale	10	Tons	Corn Silage	31	Tons
2012	20	0	200	0	0	0	220	Triticale	7	Tons	Corn Silage	25	Tons
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	2015
Condition	Good
	Actual

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S, S, S, S, S	), D-M, M, D-M, M, M, D-M, M	5.3	
B	S, S, S, S, S, S	D, D-M, M, D-M, M, M	3.9	
C	S, S, S, S, S, S	D, D-M, M, D-M, M, D-M	4.1	
D	S, S, S, S, SH, S, S, S, S	)-M, M, D-M, M, D-M, M, D-M	5.3	
E				

2068

Acres	75	5/8/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Pivot	
Irrigation Schedule	Soil Moisture Sensors	
Hour Sets		
Irrigation years	9	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	7
2 ft	35
3 ft	137
4 ft	115
5 ft	
6 ft	
TOTAL	294
NH4-N	13
ORGANIC	1.71

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	250	0	0	0	0	0	250	Triticale	7	Tons			
2014	0	0	75	0	0	0	75	Triticale	7	Tons	Corn Silage	31	Tons
2013	240	0	150	0	0	0	390	Triticale	7	Tons	Corn Silage	31	Tons
2012	250	0	175	0	0	0	425	Triticale	7	Tons	Corn Silage	29	Tons
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	2015
Condition	Good
	Actual

Soil: 58 - Hezel Loamy Fine Sand 2-15% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S,	D, M, M, M	3	4
B	S	M	3	4
C	S	M	2.5	4
D	S	M	3	4
E				

2069

Acres	83	5/8/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Linear Move	
Irrigation Schedule	Routine Schedule 1 inch every 3 to 4 days	
Hour Sets		
Irrigation years	10	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	24
2 ft	9
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	33
NH4-N	22
ORGANIC	2.17

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	0	0	0	0	0	0	0	Alfalfa	8	Tons			
2014	164	0	0	0	0	0	164	Alfalfa	7	Tons	Corn Silage	35	Tons
2013	0	315	70	0	0	0	385	Triticale	12	Tons	Corn Silage	35	Tons
2012	0	0	150	0	0	0	150	Triticale	12	Tons			
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	2015
Condition	Good
	Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2	2
B	S	M	1	1
C	S	M	2	2
D	S	M	1.9	1.9
E				

2070

Acres	110	5/8/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Linear Move	
Irrigation Schedule	Routine Schedule 1 inch every 3 to 4 days	
Hour Sets		
Irrigation years	10	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	37
2 ft	26
3 ft	63
4 ft	83
5 ft	51
6 ft	38
TOTAL	298
NH4-N	9
ORGANIC	0.98

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	60	0	100	0	0	0	160	Triticale	15	Tons			
2014	60	135	100	0	0	0	295	Triticale	15	Tons	Corn Silage	35	Tons
2013	0	0	270	0	0	0	270	Triticale	15	Tons	Corn Silage	35	Tons
2012	0	132	0	0	0	0	132	Triticale	15	Tons	Corn Silage	35	Tons
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments: Commercial N put through pivot throughout the year.

Current Crop	
Crop Year	2015
Condition	Good
	Actual

Soil: 19 - Cleman Very Fine Sandy Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S	M, D, D	6	
B	S, S, S, S,	M, D, D, D	5.8	
C	S	M	5.8	
D	S	M	5.6	
E				

2071

Acres	35	5/8/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years		
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	41
2 ft	68
3 ft	31
4 ft	36
5 ft	77
6 ft	100
TOTAL	353
NH4-N	16
ORGANIC	1.34

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	150	0	0	0	0	0	150	Alfalfa	10	Tons			
2014	150	0	80	0	0	0	230	Corn Silage	35	Tons			
2013	150	0	0	0	0	0	150	Alfalfa	10	Tons			
2012	150	0	100	0	0	0	250	Triticale & Grass	22	Tons			
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	2015
Condition	Good
	Planned

Soil: 58 - Hezel Loamy Fine Sand 2-15% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2	4
B	S	M	3	4
C	S	M	3	4
D	S	M	4	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

2072

Acres	40	5/8/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Wheel Lines	
Irrigation Schedule	Routine Schedule	
Hour Sets	12	
Irrigation years		
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	39
2 ft	20
3 ft	21
4 ft	15
5 ft	21
6 ft	24
TOTAL	140
NH4-N	19
ORGANIC	1.03

Fertilzer Applications (#N/Acre)							
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total
2016							0
2015	45	0	0	0	0	0	45
2014	100	0	0	0	0	0	100
2013	150	0	0	0	0	0	150
2012	100	0	0	0	0	0	100
2011							0

Comments

Cropping History					
Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
Alfalfa	10	Tons			
Alfalfa	9	Tons			
Grass	21	Tons			
Grass	20	Tons			

Current Crop	
Crop Year	
2015	
Condition	
Good	Planned

Soil: 58 - Hezel Loamy Fine Sand 2-15% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3	3.2
B	S	M	3.5	3.5
C	S	M	6	
D	S	M	3	3
E				

2073

Acres	120	5/8/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years		
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	36
2 ft	35
3 ft	31
4 ft	38
5 ft	
6 ft	
TOTAL	140
NH4-N	27
ORGANIC	2.42

Fertilzer Applications (#N/Acre)							
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total
2016							0
2015	150	0	80	0	0	0	230
2014	150	0	100	0	0	0	250
2013	150	0	100	0	0	0	250
2012	150	0	0	0	0	0	150
2011							0

Comments

Cropping History					
Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
Alfalfa	10	Tons			
Alfalfa	9	Tons			
Alfalfa	10	Tons			
Alfalfa	10	Tons			

Current Crop	
Crop Year	
2015	
Condition	
Good	Planned

Soil: 179 - Warden Silt Loam 8-15% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S	M, M, D	3.2	3.4
B	S, S, S	M, M, D	2.4	2.9
C	S, S, S	M, M, D	3.3	3.5
D	S, S, S	M, M, D	3.1	3.9
E				

2074

Acres	20	5/8/2015
Soil Testing?	Yes	
Test Frequency	Annually	
Irrigation Type	Wheel Lines	
Irrigation Schedule	Soil Moisture Sensors	
Hour Sets		
Irrigation years		
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	75
2 ft	55
3 ft	68
4 ft	97
5 ft	94
6 ft	26
TOTAL	415
NH4-N	26
ORGANIC	2.51

Fertilzer Applications (#N/Acre)							
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total
2016							0
2015	0	0	0	0	0	0	0
2014	177	0	0	0	0	0	177
2013	177	0	0	0	0	0	177
2012	106	0	0	0	0	0	106
2011							0

Comments

Cropping History					
Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
Alfalfa	8	Tons			
Alfalfa	8	Tons			
Alfalfa	8	Tons			

Current Crop	
Crop Year	
2015	
Condition	
Good	

Soil: 37 - Finley Silt Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	6	
B	S	M	3.7	
C	S	M	3.4	
D	S, S, SH, H	M, M, M, M	2.6	4.5
E				

2075

Acres	30	5/8/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Big Gun	
Irrigation Schedule	Shovel Method	
Hour Sets		
Irrigation years		
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	160
2 ft	40
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	200
NH4-N	55
ORGANIC	2.72

Fertilzer Applications (#N/Acre)							
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total
2016							0
2015	0	0	0	0	0	0	0
2014	130	0	0	0	0	0	130
2013	30	0	0	0	0	0	30
2012	0	0	0	0	0	0	0
2011							0

Comments: Nutrients applied with injector

Cropping History					
Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
Triticale	10	Tons			
Corn Silage	25	Tons			
Triticale	2	Tons			
Sudan Grass	7	Tons			

Current Crop	
Crop Year	
2015	
Condition	
Good	Actual

Soil: 40 - Finley Silt Loam 8-15% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1	1
B	S	M	2	2
C	S	M	1.5	1.5
D	S, EH	M, M	1.2	2
E				

2076

Acres	37	5/8/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years		
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	182
2 ft	87
3 ft	150
4 ft	73
5 ft	248
6 ft	30
TOTAL	770
NH4-N	14
ORGANIC	1.49

Fertilzer Applications (#N/Acre)							
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total
2016							0
2015	0	0	0	0	0	0	0
2014	0	0	200	0	0	0	200
2013	0	0	200	0	0	0	200
2012	0	0	200	0	0	0	200
2011							0

Comments

Cropping History					
Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
Mint	150	Lbs.			
Corn Silage	28	Tons			
Corn Silage	33	Tons			
Corn Silage	35	Tons			

Current Crop	
Crop Year	
2015	
Condition	
Good	Planned

Soil: 18 - Cleman Very Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2	
B	S	M	2	
C	S	M	1.5	
D	S	M	1.5	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

2077

Acres	40	5/8/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Pivot	
Irrigation Schedule	Observe Crop	
Hour Sets		
Irrigation years	14	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	26
2 ft	22
3 ft	26
4 ft	25
5 ft	35
6 ft	41
TOTAL	175
NH4-N	16
ORGANIC	1.81

Fertilzer Applications (#N/Acre)								Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	0	0	0	0	0	0	0	Triticale	8	Tons			
2014	0	0	100	0	0	0	100	Triticale	6	Tons	Corn Silage	35	Tons
2013	0	0	100	0	0	0	100	Triticale	6	Tons	Corn Silage	35	Tons
2012	0	0	100	0	0	0	100						
2011							0						
Comments													

Current Crop	
Crop Year	
2015	
Condition	
Good	Planned

Soil	95 - Quincy Loamy Fine Sand 0-10% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3	
B	S	M	4	
C	S	M	3	
D	S	M	2	
E				

2078

Acres	40	5/8/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Pivot	
Irrigation Schedule	shovel method	
Hour Sets		
Irrigation years	14	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	49
2 ft	89
3 ft	86
4 ft	156
5 ft	172
6 ft	111
TOTAL	663
NH4-N	27
ORGANIC	2.62

Fertilzer Applications (#N/Acre)								Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	0	0		0	0	0	0	Triticale	8	Tons			
2014	0	0	100	0	0	0	100	Triticale	6	Tons	Corn Silage	35	
2013	0	0	100	0	0	0	100	Triticale	6	Tons	Corn Silage	35	
2012	0	0	100	0	0	0	100						
2011							0						
Comments													

Current Crop	
Crop Year	
2015	
Condition	
Good	Planned

Soil	32 - Esquatzel Silt Loam 0-2%Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S	M, Dp, M	2.5	
B	S, S, S	M, Dp, M	2	
C	S, S, S, S, S	M, Dp, M, W, M	2.2	
D	S, S, S	M, Dp, W	1.5	
E				

2079

Acres	55	5/8/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule	Visual in spring; routine in summer	
Hour Sets		
Irrigation years	20	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	9
2 ft	66
3 ft	127
4 ft	173
5 ft	98
6 ft	108
TOTAL	581
NH4-N	17
ORGANIC	2.62

Fertilzer Applications (#N/Acre)								Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	20	0	0	0	0	0	20	Triticale	8	Tons			
2014	20	0	250	0	0	0	270	Triticale	8	Tons	Corn Silage	30	Tons
2013	20	0	200	0	0	0	220	Triticale	8	Tons	Corn Silage	30	Tons
2012	20	0	200	0	0	0	220	Triticale	8	Tons	Corn Silage	30	Tons
2011							0						
Comments													

Current Crop	
Crop Year	
2015	
Condition	
Good	Actual

Soil	172 - Warden Fine Sandy Loam 0-2% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S, S, SH, S, S, SH	M, M, M, M, M, M	3.5	
B	S, S, SH	M, M, M	5.1	
C	S, S, SH	M, M, M	5.8	
D	S, S, S, SH, S, SH	M, M, M, M, M, M	5.2	
E				

2080

Acres	104	5/8/2015
Soil Testing?	YES	
Test Frequency	Annually	
Irrigation Type	Pivot	
Irrigation Schedule	Visual in spring; routine in summer	
Hour Sets		
Irrigation years	15	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	15
2 ft	15
3 ft	27
4 ft	44
5 ft	
6 ft	
TOTAL	101
NH4-N	17
ORGANIC	2.63

Fertilzer Applications (#N/Acre)								Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	35	0	0	0	0	0	35	Triticale	8	Tons			
2014	35	0	250	0	0	0	285	Triticale	8	Tons	Corn Silage	30	Tons
2013	35	0	200	0	0	0	235	Triticale	8	Tons	Corn Silage	30	Tons
2012	35	0	200	0	0	0	235	Triticale	8	Tons	Corn Silage	30	Tons
2011							0						
Comments													

Current Crop	
Crop Year	
2015	
Condition	
Good	Actual

Soil	172 - Warden Fine Sandy Loam 0-2% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1.5	4
B	S	M	2	2
C	S	M	1.5	2
D	S	M	1.5	2
E				

2081

Acres	13	5/8/2015
Soil Testing?	YES	
Test Frequency	Biannually	
Irrigation Type	Rill Irrigation and hand line	
Irrigation Schedule	Routine Schedule	
Hour Sets	12	
Irrigation years	10	
Event	SPRING 2015	

NO3 (#N/ACRE)	
1 ft	75
2 ft	48
3 ft	40
4 ft	42
5 ft	32
6 ft	24
TOTAL	261
NH4-N	35
ORGANIC	2.45

Fertilzer Applications (#N/Acre)								Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	0	0	0	0	0	0	0	Triticale	7	Tons			
2014	457	0	0	0	0	0	457	Triticale	7	Tons	Corn Silage	29	Tons
2013	403	0	0	0	0	0	403	Triticale	7	Tons	Corn Silage	29	Tons
2012	367	0	0	0	0	0	367						
2011							0						
Comments	N split applications; Rill used for corn in July and August. Hand lines rest of year.												

Current Crop	
Crop Year	
2015	
Condition	
Good	Planned

Soil	18 - Cleman Very Fine Sandy Loam 0-2% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.5	
B	S	M	3.5	
C	S	M	3	
D	S	M	4	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

2082

Acres	57 — 5/8/2015
Soil Testing?	YES
Test Frequency	Biannually
Irrigation Type	Rill Irrigation and hand line
Irrigation Schedule	Routine Schedule
Hour Sets	12
Irrigation years	10
Event	SPRING 2015

NO3 (#N/ACRE)	
1 ft	41
2 ft	22
3 ft	55
4 ft	70
5 ft	58
6 ft	74
TOTAL	320
NH4-N	25
ORGANIC	3.36

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015	0	0	0	0	0	0	0	Triticale	7	Tons			
2014	370	0	0	0	0	0	370	Triticale	7	Tons	Corn Silage	29	Tons
2013	414	0	0	0	0	0	414	Triticale	7	Tons	Corn Silage	29	Tons
2012	571	0	0	0	0	0	571						
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments: N split applications; Rill used for corn in July and August. Hand lines rest of year.

Current Crop	
Crop Year	2015
Condition	Good — Planned

Soil: 32 - Esquatzel Silt Loam 0-2%Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, SH	M, Dp	1.8	
B	S, SH	M, Dp	2.5	
C	S, SH	M, Dp	2.8	
D	S, SH	M, Dp	2.5	
E				

3083

Acres	8 — 10/13/2015
Soil Testing?	YES
Test Frequency	Once per Year
Irrigation Type	Wheel-line
Irrigation Schedule	Shovel Method
Hour Sets	
Irrigation years	20
Event	FALL 2015

NO3 (#N/ACRE)	
1 ft	417
2 ft	412
3 ft	118
4 ft	72
5 ft	77
6 ft	22
TOTAL	1118
NH4-N	56
ORGANIC	2.96

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Triticale	10	Tons			
2015	0	100	0	0	0	0	100	Barley	3	Tons	Barley Hay	2	Tons
2014	150	0	0	0	0	0	150	Alfalfa	10	Tons			
2013	150	0	0	0	0	0	150	Alfalfa	10	Tons			
2012	0	0	0	0	0	0	0						
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments: In spring the liquid manure is about 9 pounds per 1000 gallons. During irrigation season water is blended down to under 1 pound per 1000 gallons.

Current Crop	
Crop Year	2016
Condition	Good — Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, SH	M,M	1.2	
B	S, S, SH	M, Dp, M	1.8	
C	S, SH, SH	M, M, Dp	1.5	
D	S, SH, SH	M, M, DP	2.2	
E				

3084

Acres	55 — 10/13/2015
Soil Testing?	NO
Test Frequency	Not in last two years
Irrigation Type	Wheel-line
Irrigation Schedule	Soil Moisture Sensors
Hour Sets	24
Irrigation years	1
Event	FALL 2015

NO3 (#N/ACRE)	
1 ft	14
2 ft	5
3 ft	3
4 ft	3
5 ft	6
6 ft	5
TOTAL	36
NH4-N	30
ORGANIC	2.72

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	0	0	0	0	0	0	0	Pasture	2	Tons			
2014	0	0	200	0	0	0	200	Triticale	8	Tons	Corn Silage	27	Tons
2013	0	0	200	0	0	0	200	Triticale	8	Tons	Corn Silage	28	Tons
2012	0	0	200	0	0	0	200						
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments: Nutrients applied in spring.

Current Crop	
Crop Year	2015
Condition	Good — Actual

Soil: 176 - Warden Silt Loam 0 to 2 percent slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S	M, Dp	3	
B	S, S, S	M, Dp, Dp	0.8	
C	S, S, S	M, Dp, Dp	0.6	
D	S, SH	M, Dp	0.6	
E				

3085

Acres	20 — 10/14/2015
Soil Testing?	YES
Test Frequency	Twice per year
Irrigation Type	Solid Set Above Canopy
Irrigation Schedule	Soil Moisture Sensors
Hour Sets	24
Irrigation years	3
Event	FALL 2015

NO3 (#N/ACRE)	
1 ft	110
2 ft	108
3 ft	73
4 ft	80
5 ft	266
6 ft	108
TOTAL	745
NH4-N	10
ORGANIC	1.56

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Triticale	10	Tons			
2015	0	113	300	0	0	0	413	Corn Silage	30	Tons			
2014	0	0	100	0	0	0	100	Grapes	9	Tons			
2013	0	0	100	0	0	0	100	Grapes	8	Tons			
2012	0	0	0	0	0	0	0						
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments:

Current Crop	
Crop Year	2016
Condition	Good — Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M		
B	S	M	0.9	
C	S	M	0.7	
D	S	M		
E				

3086

Acres	38 — 10/14/2015
Soil Testing?	YES
Test Frequency	Twice per year
Irrigation Type	Pivot
Irrigation Schedule	check the field
Hour Sets	
Irrigation years	15
Event	FALL 2015

NO3 (#N/ACRE)	
1 ft	139
2 ft	30
3 ft	33
4 ft	56
5 ft	47
6 ft	29
TOTAL	334
NH4-N	14
ORGANIC	1.76

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Triticale	8	Tons			
2015	20	0	225	0	0	0	245	Triticale	8	Tons	Corn Silage	25	Tons
2014	60	0	225	0	0	0	285	Triticale	8	Tons	Corn Silage	25	Tons
2013	60	0	225	0	0	0	285	Triticale	8	Tons	Corn Silage	25	Tons
2012	0	0	0	0	0	0	0						
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments:

Current Crop	
Crop Year	2016
Condition	Good — Planned

Soil: 178 - Warden Silt Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S	M, D, D	2	
B	S, S, S	M, D, D	1.5	
C	S, S, S	M, D, D	1.2	
D	S, S, S	M, D, D	1.5	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

3087

Field	Value
Acres	15
Date	10/14/2015
Soil Testing?	YES
Test Frequency	Once per Year
Irrigation Type	Wheel-line
Irrigation Schedule	Routine Schedule
Hour Sets	24 one time a month
Irrigation years	10
Event	FALL 2015

NO3 (#N/ACRE)	
1 ft	31
2 ft	12
3 ft	26
4 ft	44
5 ft	19
6 ft	6
TOTAL	138
NH4-N	7
ORGANIC	2.11

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	0	0	0	0	0	0	0	Alfalfa	10 Tons		
2015	0	266	0	0	0	0	266	Alfalfa	10 Tons		
2014	0	266	0	0	0	0	266	Sudan Grass	10 Tons	Triticale	10 Tons
2013	0	266	0	0	0	0	266	Sudan Grass	10 Tons	Triticale	10 Tons
2012	0	0	0	0	0	0	0				
2011							0				

Comments:

Current Crop: Crop Year 2016; Condition: Good, Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, SH	M, D, M, M	2.2	
B	S, S, S	M, D, M	1.8	
C	S, S	M, D	2.5	5
D	S, S	M, D	2.1	4
E				

3088

Field	Value
Acres	10
Date	10/14/2015
Soil Testing?	NO
Test Frequency	N/A
Irrigation Type	Rill Irrigation
Irrigation Schedule	Routine Schedule
Hour Sets	1x per month
Irrigation years	100
Event	FALL 2015

NO3 (#N/ACRE)	
1 ft	65
2 ft	11
3 ft	22
4 ft	9
5 ft	24
6 ft	6
TOTAL	137
NH4-N	24
ORGANIC	2.27

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	0	0	0	0	0	0	0				
2015	0	0	0	0	0	0	0	Alfalfa	9 Tons		
2014	0	0	0	0	0	0	0	Alfalfa	8 Tons		
2013	0	0	0	0	0	0	0	Alfalfa	7 Tons		
2012	0	0	0	0	0	0	0	Alfalfa	8 Tons		
2011							0				

Comments: No nutrients applied last 5 years

Current Crop: Crop Year 2015; Condition: Good, Actual

Soil: 18 - Cleman Very Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, SH, SH	D, Dp, W	3.3	
B	S, SH, SH	D, Dp, W	5.3	
C	S, SH, SH	D, Dp, W	1.4	
D	S, SH, SH	D, Dp, W	1.9	
E				

3089

Field	Value
Acres	20
Date	10/14/2015
Soil Testing?	YES
Test Frequency	Once per Year
Irrigation Type	Wheel-line
Irrigation Schedule	Routine Schedule
Hour Sets	24 twice a month
Irrigation years	1
Event	FALL 2015

NO3 (#N/ACRE)	
1 ft	207
2 ft	276
3 ft	290
4 ft	166
5 ft	130
6 ft	80
TOTAL	1149
NH4-N	29
ORGANIC	2.49

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	0	0	0	0	0	0	0	Alfalfa	9 Tons		
2015	100	0	0	0	0	0	100	Barley	4 Tons		
2014	100	0	0	0	0	0	100	Corn Grain	6 Tons		
2013	100	0	0	0	0	0	100	Corn Grain	6 Tons		
2012	0	0	0	0	0	0	0				
2011							0				

Comments: Manure application in spring

Current Crop: Crop Year 2016; Condition: Good, Planned

Soil: 139 - Sinloc Silt Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S, S	M, Dp, Dp, Dp, Dp	2.8	
B	S, S, S, S, S	M, Dp, Dp, Dp, Dp	3	
C	S, S, S, S, S	M, Dp, Dp, Dp, Dp	2.7	
D	S, S, S,	M, Dp, Dp	1.8	
E				

3090

Field	Value
Acres	33
Date	10/14/2015
Soil Testing?	YES
Test Frequency	Twice per year
Irrigation Type	Wheel-line
Irrigation Schedule	Routine Schedule
Hour Sets	24
Irrigation years	25
Event	FALL 2015

NO3 (#N/ACRE)	
1 ft	51
2 ft	28
3 ft	25
4 ft	42
5 ft	40
6 ft	33
TOTAL	219
NH4-N	36
ORGANIC	2.29

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	0	0	0	0	0	0	0	Alfalfa	9 Tons		
2015	0	350	0	0	0	0	350	Triticale	10 Tons	Sudan Grass	6 Tons
2014	0	350	0	0	0	0	350	Triticale	9 Tons	Sudan Grass	7 Tons
2013	0	350	0	0	0	0	350	Triticale	10 Tons	Sudan Grass	7 Tons
2012	0	0	0	0	0	0	0				
2011							0				

Comments:

Current Crop: Crop Year 2016; Condition: Fair, Planned

Soil: 140 - Sinloc Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S	M, Dp	1.9	
B	S, S	M, Dp	1.8	
C	S, S	M, Dp	1.6	
D	S, S	M, Dp	1.1	
E				

3091

Field	Value
Acres	45
Date	10/15/2015
Soil Testing?	YES
Test Frequency	Once per Year
Irrigation Type	Pivot
Irrigation Schedule	Routine Schedule
Hour Sets	5 day sets
Irrigation years	10
Event	FALL 2015

NO3 (#N/ACRE)	
1 ft	86
2 ft	43
3 ft	46
4 ft	56
5 ft	19
6 ft	4
TOTAL	254
NH4-N	25
ORGANIC	2.41

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	150	0	0	0	0	0	150	Alfalfa	9 Tons		
2015	300	0	0	0	0	0	300	Alfalfa	8 Tons		
2014	300	0	0	0	0	0	300	Alfalfa	9 Tons		
2013	300	0	0	0	0	0	300	Alfalfa	10 Tons		
2012	0	0	0	0	0	0	0				
2011							0				

Comments: Split applications - 150 lbs thru pivot point in spring, 150 lbs thru pivot point in fall

Current Crop: Crop Year 2016; Condition: Fair, Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	6	
B	S	M	6	
C	S	M	4	4
D	S	M	2.5	4
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

3092

Acres	36	10/15/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irrigation Type	Wheel-line	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years	20	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	22
2 ft	8
3 ft	9
4 ft	3
5 ft	3
6 ft	3
TOTAL	48
NH4-N	14
ORGANIC	2.15

	Fertilzer Applications (#N/Acre)							Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Alfalfa	8	Tons			
2015	0	0	0	0	0	0	0	Alfalfa	8	Tons			
2014	0	0	0	0	0	0	0	Alfalfa	7	Tons			
2013	0	0	0	0	0	0	0	Alfalfa	9	Tons			
2012	0	0	0	0	0	0	0						
2011							0						

Comments: No nutrients have been added since 2012

Current Crop	
Crop Year	
2016	
Condition	
Good	Planned

Soil	138 - Sinloc Fine Sandy Loam 0-2% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S, S	M, Dp	2	
B	S, S, S	M, Dp, Dp	1.8	
C	S, S, S, S	M, Dp, Dp, Dp	2	
D	S, S, S	M, Dp, Dp	2	
E				

3093

Acres	80	10/15/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets	Check the soil	
Irrigation years	6	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	16
2 ft	3
3 ft	3
4 ft	4
5 ft	6
6 ft	7
TOTAL	39
NH4-N	19
ORGANIC	1.63

	Fertilzer Applications (#N/Acre)							Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Alfalfa	10	Tons			
2015	0	0	50	0	0	0	50	Alfalfa	10	Tons			
2014	0	0	50	0	0	0	50	Alfalfa	10	Tons			
2013	0	0	50	0	0	0	50	Alfalfa	10	Tons			
2012	0	0	0	0	0	0	0						
2011							0						

Comments: N is applied in the spring

Current Crop	
Crop Year	
2016	
Condition	
Good	Planned

Soil	177 - Warden Silt Loam 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S	M, M, Dp, Dp	1.8	
B	S, S, S, S	M, M, Dp, Dp	1.9	
C	S, S, S, S	M, M, Dp, Dp	2	
D	S, S, S, S	M, M, Dp, Dp	1.5	
E				

3094

Acres	35	10/15/2015
Soil Testing?	YES	
Test Frequency	Twice per year	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets	Check Soil	
Irrigation years	16	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	467
2 ft	644
3 ft	776
4 ft	726
5 ft	576
6 ft	565
TOTAL	3754
NH4-N	50
ORGANIC	2.85

	Fertilzer Applications (#N/Acre)							Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	190	0	0	0	0	0	190	Triticale	7	Tons			
2015	320	0	0	0	0	0	320	Triticale	8	Tons	Corn Silage	27	Tons
2014	360	0	0	0	0	0	360	Triticale	7	Tons	Corn Silage	27	Tons
2013	342	0	0	0	0	0	342	Triticale	7	Tons	Corn Silage	25	Tons
2012	0	0	0	0	0	0	0						
2011							0						

Comments: Liquid manure is applied twice a year. Split Application. In current year, only 1 application has occurred.

Current Crop	
Crop Year	
2016	
Condition	
Good	Planned

Soil	175 - Warden fine silty loan 8 to 15 percent slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2	
B	S	M	1.8	
C	S	M	1.6	
D	S	M	1	
E				

3095

Acres	75	10/15/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irrigation Type	Pivot	
Irrigation Schedule	Only 1 irrigation to sprout triticale	
Hour Sets		
Irrigation years		
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	60
2 ft	90
3 ft	140
4 ft	178
5 ft	
6 ft	
TOTAL	468
NH4-N	17
ORGANIC	1.92

	Fertilzer Applications (#N/Acre)							Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Triticale	10	Tons			
2015	0	0	0	0	0	0	0	Triticale		Tons	Corn Silage		Tons
2014	0	0	0	0	0	0	0	Triticale		Tons	Corn Silage		Tons
2013	0	0	0	0	0	0	0	Triticale		tons			
2012	0	0	0	0	0	0	0						
2011							0						

Comments: This field has had a history of manure application for double cropping. The property changed ownership and application records and yield records were not available.

Current Crop	
Crop Year	
2016	
Condition	
Good	Planned

Soil	57 - Hezel Loamy Fine Sand 0-2% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S	M, M, Dp	1.4	
B	S, S, S	M, M, Dp	0.8	4
C	S, S	M, Dp	0.9	4
D	S, S, S	M, M, Dp	2.8	4
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

3096

Acres	16	10/16/2015
Soil Testing?	YES	
Test Frequency	Twice per year	
Irrigation Type	Wheel-line	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	2	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	27
2 ft	8
3 ft	10
4 ft	17
5 ft	47
6 ft	19
TOTAL	128
NH4-N	44
ORGANIC	2.06

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Triticale	9	Tons			
2015	0	0	0	0	0	0	0	Triticale	7	Tons	Sudan Grass	7	Tons
2014	0	0	251	0	0	0	251	Triticale	8	Tons	Sudan Grass	7	Tons
2013	0	225	0	0	0	0	225	Triticale	7	Tons	Corn Silage	24	Tons
2012	0	0	0	0	0	0	0						
2011							0						

Fertilizer Applications (#N/Acre); Cropping History

Comments: No nutrients applied in 2015

Current Crop	
Crop Year	2016
Condition	
Good	Planned

Soil: 95 - Quincy Loamy Fine Sand 0-10% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S, S, S	M, M, M, M, Dp, M	2.9	
B	S, S, S, S, S	M, M, Dp, M, Dp	3	
C	S, S, S, S, S, S, S, S	M, M, M, Dp, M, Dp, M, Dp	2.4	
D	S, S, S, S, S, S	M, M, M, Dp, M, Dp	3	
E				

3097

Acres	60	10/16/2015
Soil Testing?	YES	
Test Frequency	Twice per year	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets	Check Soil	
Irrigation years	7	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	336
2 ft	363
3 ft	335
4 ft	263
5 ft	113
6 ft	64
TOTAL	1474
NH4-N	28
ORGANIC	2.18

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Triticale	9	Tons			
2015	0	0	0	170	0	0	170	Triticale	9	Tons	Corn Silage	28	Tons
2014	0	0	0	170	0	0	170	Triticale	9	Tons	Corn Silage	28	Tons
2013	0	0	0	170	0	0	170	Triticale	9	Tons	Corn Silage	28	Tons
2012	0	0	0	0	0	0	0						
2011							0						

Fertilizer Applications (#N/Acre); Cropping History

Comments: Bio solids applied in spring

Current Crop	
Crop Year	2016
Condition	
Good	Planned

Soil: 95 - Quincy Loamy Fine Sand 0-10% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, SH, S, S	M, M, M, M, M, M	1.4	
B	S, S, S, SH, S, S	M, M, M, M, M, M	1.1	
C	S, S, SH, S, S	M, M, M, M, M	1.5	
D	S, S, S, SH, S, S	M, M, M, M, M, M	1.7	
E				

3098

Acres	35	10/16/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irrigation Type	Wheel-line	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years	20	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	35
2 ft	11
3 ft	16
4 ft	12
5 ft	24
6 ft	15
TOTAL	113
NH4-N	40
ORGANIC	1.46

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	0	0	100	0	0	0	100	Wheat	9	Tons			
2014	0	0	100	0	0	0	100	Wheat	9	Tons	Sudan Grass	4	Tons
2013	0	0	100	0	0	0	100	Wheat	9	Tons	Sudan Grass	4	Tons
2012	0	0	0	0	0	0	0						
2011							0						

Fertilizer Applications (#N/Acre); Cropping History

Comments:

Current Crop	
Crop Year	2015
Condition	
Good	Actual

Soil: 172 - Warden Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.5	
B	S	M	2.1	
C	S	M	2.3	
D	S	M	2.8	
E				

3099

Acres	40	10/16/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets	Check the Soil	
Irrigation years	30	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	179
2 ft	151
3 ft	77
4 ft	54
5 ft	90
6 ft	56
TOTAL	607
NH4-N	15
ORGANIC	1.65

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	0	0	200	0	0	0	200	Corn Silage	28	Tons			
2014	0	0	200	0	0	0	200	Corn Silage	28	Tons			
2013	0	0	200	0	0	0	200	Corn Silage	28	Tons			
2012	0	0	0	0	0	0	0						
2011							0						

Fertilizer Applications (#N/Acre); Cropping History

Comments:

Current Crop	
Crop Year	2015
Condition	
Fair	Actual

Soil: 32 - Esquatzel Silt Loam 0-2%Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S, S	D, M, M, M, M	2	
B	S, S, S, S, S	D, M, M, M, M	2	
C	S, S, S, S, S, S	D, M, M, M, M, M	2.4	
D	S, S, S, S, S	D, M, M, M, M	2.2	
E				

3100

Acres	35	10/18/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irrigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets	Check the soil	
Irrigation years		
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	79
2 ft	41
3 ft	68
4 ft	76
5 ft	61
6 ft	27
TOTAL	352
NH4-N	22
ORGANIC	1.4

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	0	0	200	0	0	0	200	Corn Silage	30	Tons			
2014	0	0	200	0	0	0	200	Corn Silage	30	Tons			
2013	0	0	200	0	0	0	200	Corn Silage	30	Tons			
2012	0	0	0	0	0	0	0						
2011							0						

Fertilizer Applications (#N/Acre); Cropping History

Comments:

Current Crop	
Crop Year	2015
Condition	
Good	Actual

Soil: 174 - Warden Fine Sandy Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.4	
B	S	M	3.3	
C	S	M	3.3	
D	S	M	3.7	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

3101

Acres	20
Date	10/18/2015
Soil Testing?	YES
Test Frequency	Once per Year
Irrigation Type	Wheel-line
Irrigation Schedule	Routine Schedule
Hour Sets	12
Irrigation years	20
Event	FALL 2015

NO3 (#N/ACRE)	
1 ft	54
2 ft	9
3 ft	5
4 ft	7
5 ft	22
6 ft	18
TOTAL	115
NH4-N	46
ORGANIC	2.38

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	0	0	0	0	0	0	0	Grazing Pasture					
2014	0	0	0	0	0	0	0	Grazing Pasture					
2013	0	0	60	0	0	0	60	Grazing Pasture					
2012	0	0	0	0	0	0	0	Grazing Pasture					
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Current Crop	
Crop Year	2015
Condition	Good

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.4	
B	S	M	1.3	
C	S	M	1.3	
D	S	M	1.8	
E				

Comments: 120 mature milking cows 6 hours a day

3102

Acres	55
Date	10/18/2015
Soil Testing?	YES
Test Frequency	Twice per year
Irrigation Type	Pivot
Irrigation Schedule	Routine Schedule
Hour Sets	Check the soil
Irrigation years	7
Event	FALL 2015

NO3 (#N/ACRE)	
1 ft	46
2 ft	17
3 ft	13
4 ft	52
5 ft	
6 ft	
TOTAL	128
NH4-N	27
ORGANIC	2.89

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Alfalfa	10	Tons			
2015	10	0	0	0	0	0	10	Alfalfa	10	Tons			
2014	0	0	0	0	0	0	0	Triticale	8	Tons	Sudan Grass	6	Tons
2013	0	0	0	0	48	0	48	Corn Silage	29	Tons	Triticale	8	Tons
2012	0	0	0	0	0	0	0						
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Current Crop	
Crop Year	2016
Condition	Good / Planned

Soil: 32 - Esquatzel Silt Loam 0-2%Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1.3	4
B	S	M	1	4
C	S	M	1.2	4
D	S	M	1.8	4
E				

Comments: The 8 ton per acre compost application = 48 lbs of N applied per acre; No nutirents applied in 2014.

3103

Acres	65
Date	10/20/2015
Soil Testing?	NO
Test Frequency	N/A
Irrigation Type	Wheel-line
Irrigation Schedule	Sprinklers
Hour Sets	24
Irrigation years	25
Event	FALL 2015

NO3 (#N/ACRE)	
1 ft	12
2 ft	4
3 ft	7
4 ft	5
5 ft	7
6 ft	3
TOTAL	38
NH4-N	19
ORGANIC	1.73

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	30	0	0	0	0	0	30	Grass hay	2	Tons	Cows		
2014	30	0	0	0	0	0	30	Grass hay	2	Tons	Cows		
2013	30	0	0	0	0	0	30	Grass hay	2	Tons	Cows		
2012	30	0	0	0	0	0	30	Grass hay	2	Tons	Cows		
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Current Crop	
Crop Year	2015
Condition	Good / Actual

Soil: 178 - Warden Silt Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S, S, S	M, M, M, M, M, M	1.9	
B	S, S, S, SH, S, S, S	M, M, M, M, M, M, M	1.9	
C	S, S, S, S, S, S	M, M, M, M, M, M	1.8	
D	S, S, S, S, S	M, M, M, M, M	2.5	
E				

Comments: Split application; 15 lbs N per Acre in Spring, 15 lbs N per Acre in fall

3104

Acres	80
Date	10/20/2015
Soil Testing?	NO
Test Frequency	N/A
Irrigation Type	Wheel-line
Irrigation Schedule	Routine Schedule
Hour Sets	24
Irrigation years	20
Event	FALL 2015

NO3 (#N/ACRE)	
1 ft	17
2 ft	3
3 ft	3
4 ft	3
5 ft	
6 ft	
TOTAL	26
NH4-N	28
ORGANIC	2.42

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	30	0	0	0	0	0	30						
2014	30	0	0	0	0	0	30	Grass Hay	2	Tons	Cows		
2013	30	0	0	0	0	0	30	Grass Hay	2	Tons	Cows		
2012	30	0	0	0	0	0	30	Grass Hay	2	Tons	Cows		
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Current Crop	
Crop Year	2015
Condition	Fair / Just Graz

Soil: 120 - Scoon Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	SH, SH, SH, SH	M, M, Dp, Dp	2.2	3.2
B	SH, SH	M, M	2.9	3.1
C	SH, SH, SH	M, M, Dp	2.3	3
D	SH, SH, SH	M, M, Dp	2.2	3.6
E				

Comments: Split application; 15 lbs N per Acre in Spring, 15 lbs N per Acre in fall; Because of drought, no hay was made in the 2015 Season. Only 100 beef cows in August grazed off pasture.

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

3105

Acres	20	10/21/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irrigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets	Check soil	
Irrigation years	30	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	371
2 ft	58
3 ft	18
4 ft	9
5 ft	20
6 ft	68
TOTAL	544
NH4-N	67
ORGANIC	1.83

Fertilzer Applications (#N/Acre)							
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total
2016	0	0	0	0	0	0	0
2015	0	200	0	0	0	0	200
2014	0	200	0	0	0	0	200
2013	0	200	0	0	0	0	200
2012	0	0	0	0	0	0	0
2011							0

Cropping History					
Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
Triticale	10	Tons			
Corn Silage	30	Tons			
Corn Silage	25	Tons			
Corn Silage	28	Tons			

Current Crop	
Crop Year	
2016	
Condition	
Good	Planned

Soil: 18 - Cleman Very Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, FI, FI, FI	M, Dp, Dp, Dp	1.4	
B	S, FI, FI, FI, S	M, Dp, Dp, Dp, M	1.7	
C	S, FI, FI, FI, FI, FI	M, Dp, Dp, Dp, Dp, Dp	1.3	
D	S, FI, FI, FI, FI, FI	M, Dp, Dp, Dp, Dp, Dp	1.3	
E				

Comments: Nutrients applied in the spring; Note irrigation - uses Rill on Corn and Wheel-line for triticale

3106

Acres	35	10/21/2015
Soil Testing?	YES	
Test Frequency	Twice per year	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets	Check Soil	
Irrigation years	14	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	316
2 ft	445
3 ft	465
4 ft	248
5 ft	256
6 ft	222
TOTAL	1952
NH4-N	15
ORGANIC	0.95

Fertilzer Applications (#N/Acre)							
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total
2016	150	0	0	0	0	0	150
2015	300	0	0	0	0	0	300
2014	300	0	0	0	0	0	300
2013	300	0	0	0	0	0	300
2012	0	0	0	0	0	0	0
2011							0

Cropping History					
Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
Triticale	10	Tons			
Triticale	9	Tons	Corn Silage	37	Tons
Triticale	8	Tons	Corn Silage	41	Tons
Triticale	10	Tons	Corn Silage	36	Tons

Current Crop	
Crop Year	
2016	
Condition	
Good	Planned

Soil: 32 - Esquatzel Silt Loam 0-2%Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S, FI, FI	M, M, M, M, M, M	1.4	
B	S, S, S, S, FI, FVI	M, M, M, M, M, M	3.2	
C	S, S, S, S, FI, FVI	M, M, M, M, M, M	3.4	
D	S, S, S, S, VFI	M, M, M, M, M	3.1	
E				

Comments: Split application 150 lbs N in Spring 150 lbs N in Fall

3107

Acres	35	10/21/2015
Soil Testing?	YES	
Test Frequency	Twice per year	
Irrigation Type	Pivot	
Irrigation Schedule	Blank	
Hour Sets		
Irrigation years	10	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	96
2 ft	70
3 ft	164
4 ft	182
5 ft	120
6 ft	44
TOTAL	676
NH4-N	22
ORGANIC	2.48

Fertilzer Applications (#N/Acre)							
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total
2016	0	0	0	0	0	0	0
2015	127	0	0	0	0	0	127
2014	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0
2011							0

Cropping History					
Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
Triticale	10	Tons			
Corn Silage	26	Tons			

Current Crop	
Crop Year	
2016	
Condition	
Fair	Planned

Soil: 138 - Sinloc Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, FI, S	M, M, M, Dp	3.2	
B	S, S, FI, S	M, M, M, Dp	2.8	
C	S, S, FI, S	M, M, M, Dp	3.2	
D	S, S, FI, S	M, M, M, Dp	3.3	
E				

Comments: Only one year of history available, but there is a known history of annual manure application

3108

Acres	24	10/21/2015
Soil Testing?	YES	
Test Frequency	Twice per year	
Irrigation Type	Pivot	
Irrigation Schedule	Watch the corn	
Hour Sets		
Irrigation years	10	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	311
2 ft	465
3 ft	612
4 ft	684
5 ft	247
6 ft	264
TOTAL	2583
NH4-N	27
ORGANIC	2.66

Fertilzer Applications (#N/Acre)							
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total
2016	21	0	0	0	0	0	21
2015	82	0	150	0	0	0	232
2014	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0
2011							0

Cropping History					
Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
Triticale	10	Tons			
Triticale	8	Tons	Corn Silage	28	Tons

Current Crop	
Crop Year	
2016	
Condition	
Fair	Planned

Soil: 138 - Sinloc Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S	M, M	2.5	
B	S, FI, S, S	M, M, M, M	3.4	
C	S, FI, VFI, S	M, M, M, M	1.4	
D	S, FI, VFI, FI, S	M, M, M, M, M	3	
E				

Comments: 82 lbs N thru pivot onto triticale in spring, 150 N thru pivot for corn crop. Only one year history available but field has had a history of annual manure application.

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE — Groundwater Management Area (GWMA)

Deep Soil Sampling

3109

Acres	36	10/21/2015
Soil Testing?	YES	
Test Frequency	Twice per year	
Irigation Type	Wheel Lines	
Irrigation Schedule	Blank	
Hour Sets		
Irrigation years	10	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	82
2 ft	60
3 ft	223
4 ft	238
5 ft	56
6 ft	100
TOTAL	759
NH4-N	12
ORGANIC	1.48

Fertilzer Applications (#N/Acre)								Cropping History			
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	31	0	0	0	0	0	31	Triticale	10 Tons		
2015	29	0	150	0	0	0	179	Triticale	8 Tons	Corn Silage	29 Tons
2014	0	0	0	0	0	0	0				
2013	0	0	0	0	0	0	0				
2012	0	0	0	0	0	0	0				
2011							0				

Comments: All nutrients applied thru the pivot. Only one year history available, but field has a known history of having manure applied on a annual basis.

Current Crop	
Crop Year	2016
Condition	
Good	Planned

Soil: 174 - Warden Fine Sandy Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	4.5	
B	S	M	2.6	
C	S	M	3.5	4
D	S	M	3.8	4
E				

3110

Acres	32	10/22/2015
Soil Testing?	YES	
Test Frequency	Twice per year	
Irigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets	Check soil	
Irrigation years	11	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	93
2 ft	100
3 ft	125
4 ft	154
5 ft	283
6 ft	413
TOTAL	1168
NH4-N	34
ORGANIC	2.19

Fertilzer Applications (#N/Acre)								Cropping History			
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	100	0	0	0	0	0	100	Triticale	11 Tons		
2015	280	0	60	0	0	0	340	Triticale	12 Tons	Corn Silage	38 Tons
2014	300	0	125	0	0	0	425	Triticale	11 Tons	Corn Silage	34 Tons
2013	280	0	50	0	0	0	330	Triticale	12 Tons	Corn Silage	30 Tons
2012	0	0	0	0	0	0	0				
2011							0				

Comments: Split application of liquid manure, half in fall and half in spring

Current Crop	
Crop Year	2016
Condition	
Good	Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, FI	M, M, M	4.9	
B	S, S, FI	M, M, M	3.5	
C	S, S, FI	M, M, M	4.3	
D	S, S, FI, S	M, M, M, M	4.2	
E				

3111

Acres	40	10/22/2015
Soil Testing?	YES	
Test Frequency	Twice per year	
Irigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets	check soil	
Irrigation years	10	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	35
2 ft	45
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	80
NH4-N	24
ORGANIC	1.59

Fertilzer Applications (#N/Acre)								Cropping History			
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	170	0	0	0	0	0	170	Triticale	10 Tons		
2015	300	0	0	0	0	0	300	Triticale	12 Tons	Corn Silage	18 Tons
2014	300	0	0	0	0	0	300	Triticale	18 Tons	Corn Silage	30 Tons
2013	300	0	75	0	0	0	375	Triticale	15 Tons	Corn Silage	33 Tons
2012	0	0	0	0	0	0	0				
2011							0				

Comments: Split application of liquid manure 150 lbs in fall 150 lbs in spring

Current Crop	
Crop Year	2016
Condition	
Good	Planned

Soil: 121 - Scoon Silt Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, HA	M, M	1.2	1.6
B	S, HA	M, M	1.1	1.1
C	S, HA	M, M	1.2	1.5
D	S	M	0.9	1
E				

3112

Acres	66	10/22/2015
Soil Testing?	YES	
Test Frequency	Twice per year	
Irigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets	check soil	
Irrigation years	8	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	39
2 ft	73
3 ft	87
4 ft	95
5 ft	47
6 ft	38
TOTAL	379
NH4-N	22
ORGANIC	1.87

Fertilzer Applications (#N/Acre)								Cropping History			
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	75	0	0	0	0	0	75	Triticale	10 Tons		
2015	75	0	85	0	0	0	160	Triticale	12 Tons	Corn Silage	36 Tons
2014	75	0	40	0	0	0	115	Triticale	10 Tons	Corn Silage	32 Tons
2013	75	0	0	0	0	0	75	Triticale	11 Tons	Corn Silage	30 Tons
2012	0	0	0	0	0	0	0				
2011							0				

Comments: Liquid manure fall application on triticale commerical N side dress with corn planting

Current Crop	
Crop Year	2016
Condition	
Good	Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.4	
B	S	M	1.7	
C	S	M	3.4	
D	S	M	2.2	5.7
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

3113

Acres	74	10/22/2015
Soil Testing?	YES	
Test Frequency	Twice a Year	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets	Check Soil	
Irrigation years	8	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	49
2 ft	150
3 ft	308
4 ft	308
5 ft	340
6 ft	280
TOTAL	1435
NH4-N	19
ORGANIC	1.71

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Alfalfa	10	Tons			
2015	75	0	0	0	0	0	75	Alfalfa	10	Tons			
2014	75	0	0	0	0	0	75	Triticale	10	Tons	Alfalfa	4	Tons
2013	75	0	45	0	0	0	120	Triticale	11	Tons	Corn Silage	30	Tons
2012	75	0	0	0	0	0	75						
2011							0						

Fertilizer Applications (#N/Acre); Cropping History

Comments: Liquid manure fall application

Current Crop	
Crop Year	2016
Condition	Good / Planned

Soil: 178 - Warden Silt Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, Fl, Si	M, M, M, M, M	6	
B	S, S, S, Fi, S, S	M, M, M, M, M, M	5.2	
C	S, S, S	M, M, M	5	5
D	S, S, S	M, M M	4	4
E				

3114

Acres	36	10/22/2015
Soil Testing?	YES	
Test Frequency	Once a Year - Fall	
Irrigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets	8-Day Rotation	
Irrigation years	100	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	131
2 ft	22
3 ft	36
4 ft	18
5 ft	28
6 ft	31
TOTAL	266
NH4-N	10
ORGANIC	1.55

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	0	100	0	0	0	0	100	Corn Silage	34	Tons			
2014	0	150	0	0	0	0	150	Corn Silage	35	Tons			
2013	0	200	0	0	0	0	200	Corn Silage	31	Tons			
2012	0	0	0	0	0	0	0	Corn Silage	27	Tons			
2011							0						

Fertilizer Applications (#N/Acre); Cropping History

Comments:

Current Crop	
Crop Year	2015
Condition	Good / Actual

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, Fl, S, S, L	D, M, M, M, M, M	1.8	
B	S, S, Fl, L, Fl, L, S, L	D, M, M, M, M, M, M, M	3.3	
C	S, S, Fl, S, Fl	D, M, M, M, M	2.4	
D	S, S, S, L, S, Fl	D, M, M, M, M, M	3.4	
E				

3115

Acres	40	10/22/2015
Soil Testing?	YES	
Test Frequency	Twice per year	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	10	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	82
2 ft	90
3 ft	149
4 ft	111
5 ft	192
6 ft	195
TOTAL	819
NH4-N	14
ORGANIC	1.67

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	150	0	0	0	0	0	150	Triticale	10	Tons			
2015	300	0	0	0	0	0	300	Triticale	10	Tons	Sorgummilo	18	Tons
2014	300	0	0	0	0	0	300	Triticale	18	Tons	Corn Silage	30	Tons
2013	300	0	75	0	0	0	375	Triticale	14	Tons	Corn Silage	33	Tons
2012	0	0	0	0	0	0	0						
2011							0						

Fertilizer Applications (#N/Acre); Cropping History

Comments: Split application of liquid manure, 150 lbs N in spring, 150 lbs N in fall

Current Crop	
Crop Year	2016
Condition	Good / Planned

Soil: 179 - Warden Silt Loam 8-15% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, Fl, S	M, M, M	1.9	4
B	S, Fl, S, Fl, S, Fl	M, M, M, M, M, M	3.2	
C	S, S, Fl, S, Fl, VFl, S	M, M, M, M, M, M, M	2.9	
D	S, S, Fl, S, S, S, VFl	M, M, M, M, M, M, M	2.5	
E				

3116

Acres	30	10/25/2015
Soil Testing?	YES	
Test Frequency	One a Year	
Irrigation Type	Rill Irrigation	
Irrigation Schedule	Look at Crop and Soil	
Hour Sets		
Irrigation years	65	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	271
2 ft	489
3 ft	113
4 ft	56
5 ft	55
6 ft	49
TOTAL	1033
NH4-N	23
ORGANIC	3.04

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	50	0	150	0	0	0	200	Corn Grain	180	Bushels			
2014	50	0	150	0	0	0	200	Corn Grain	180	Bushels			
2013	50	0	150	0	0	0	200	Corn Grain	180	Bushels			
2012	0	0	0	0	0	0	0	Corn Silage	25	Tons			
2011							0						

Fertilizer Applications (#N/Acre); Cropping History

Comments:

Current Crop	
Crop Year	2015
Condition	Good / Actual

Soil: 176 - Warden Silt Loam 0 to 2 percent slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1.9	
B	S	M	2.2	
C	S	M	3.7	
D	S	M	2.7	
E				

3117

Acres	36	10/25/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irrigation Type	Solid Sets	
Irrigation Schedule	Blank	
Hour Sets		
Irrigation years	5	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	51
2 ft	301
3 ft	573
4 ft	400
5 ft	
6 ft	
TOTAL	1325
NH4-N	9
ORGANIC	1.67

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Grapes	6	Tons			
2015	0	0	0	0	0	0	0	Grapes	6	Tons			
2014	0	0	0	0	0	0	0	Grapes	9	Tons			
2013	0	0	0	0	0	0	0	Grapes	6	Tons			
2012	0	0	0	0	0	0	0						
2011							0						

Fertilizer Applications (#N/Acre); Cropping History

Comments: This is an organic grape vineyard. We use vetch legume with triticale as a cover crop and the vetch does nitrogen fixing.

Current Crop	
Crop Year	2015
Condition	Fair / Actual

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S	D, M, M	3.9	4
B	S, S, S	D, M, M	3.6	4
C	S, S, S, S, S	D, M, M, M, M	2.3	4
D	S, S, S, S, S	D, M, M, M, M	1.8	4
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE — Groundwater Management Area (GWMA)

Deep Soil Sampling

3118

Acres	45	10/25/2015
Soil Testing?	NO	
Test Frequency	N/A	
Irrigation Type	Solid Sets	
Irrigation Schedule	Check the soil	
Hour Sets		
Irrigation years	25	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	87
2 ft	51
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	138
NH4-N	14
ORGANIC	3.06

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	0	0	70	0	0	0	70	Apples	53	Bins			
2014	0	0	50	0	0	0	50	Apples	55	Bins			
2013	0	0	50	0	0	0	50	Apples	50	Bins			
2012	0	0	0	0	0	0	0	Apples	50	Bins			
2011							0						

Fertilzer Applications (#N/Acre) — Cropping History

Comments

Current Crop	
Crop Year	2015
Condition	Good

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	D	1.8	1.8
B	S	D	1.8	1.8
C	S	D	1.9	1.9
D	S	D	1.7	1.7
E				

3119

Acres	15	10/25/2015
Soil Testing?	YES	
Test Frequency	Every 2 Years	
Irigation Type	Solid Sets	
Irrigation Schedule	Check Soil	
Hour Sets		
Irrigation years	10	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	20
2 ft	213
3 ft	260
4 ft	213
5 ft	559
6 ft	580
TOTAL	
NH4-N	11
ORGANIC	1.49

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	0	0	50	0	0	0	50	Grapes	10	Tons			
2014	0	0	50	0	0	0	50	Grapes	6	Tons			
2013	0	0	50	0	0	0	50	Grapes	4	Tons			
2012	0	0	0	0	0	0	0	Grapes	10	Tons			
2011							0						

Comments: Previous farmer 40 years ago had a history of excessive nitrogen application according to current farmer

Current Crop	
Crop Year	2015
Condition	Good Actual

Soil: 179 - Warden Silt Loam 8-15% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, FI	M, M, D	5.3	5.8
B	S, S	M, M	3.2	4
C	S, S	M, M	3.3	3.8
D	S, S, FI, L	M, M, M, M	3	4
E				

3120

Acres	35	10/25/2015
Soil Testing?	YES	
Test Frequency	Every Other Year	
Irigation Type	Solid Sets	
Irrigation Schedule	Check soil	
Hour Sets		
Irrigation years	10	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	13
2 ft	143
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	156
NH4-N	12
ORGANIC	1.35

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	0	0	50	0	0	0	50	Grapes	10	Tons			
2014	0	0	50	0	0	0	50	Grapes	8	Tons			
2013	0	0	50	0	0	0	50	Grapes	4	Tons			
2012	0	0	0	0	0	0	0	Grapes	10	Tons			
2011							0						

Comments

Current Crop	
Crop Year	2015
Condition	Good Actual

Soil: 180 - Warden Silt Loam 15-30% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1.4	1.4
B	S	M	1.8	2
C	S	M	1.6	1.9
D	S	M	1.1	2
E				

3121

Acres	40	10/25/2015
Soil Testing?	YES	
Test Frequency	Twice per year	
Irigation Type	Pivot	
Irrigation Schedule	Soil Moisture Sensors	
Hour Sets		
Irrigation years	17	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	275
2 ft	193
3 ft	162
4 ft	137
5 ft	202
6 ft	272
TOTAL	1241
NH4-N	32
ORGANIC	2.91

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Triticale	8	Tons			
2015	0	0	0	0	0	0	0	Triticale	7	Tons	Corn Silage	29	Tons
2014	137	0	0	0	0	0	137	Triticale	7	Tons	Corn Silage	29	Tons
2013	293	0	0	0	0	0	293	Triticale	7	Tons	Corn Silage	29	Tons
2012	0	0	0	0	0	0	0						
2011							0						

Comments: No nutrients applied in 2015. 2013 split application - 117 pounds in Spring and 176 pounds in fall.

Current Crop	
Crop Year	2016
Condition	Good Planned

Soil: 139 - Sinloc Silt Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.2	
B	S	M	1.5	
C	S	M	4.5	
D	S	M	4.6	
E				

3122

Acres	80	10/25/2015
Soil Testing?	YES	
Test Frequency	Twice per year	
Irigation Type	Wheel-line	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years	30	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	101
2 ft	20
3 ft	14
4 ft	3
5 ft	16
6 ft	4
TOTAL	158
NH4-N	23
ORGANIC	2.07

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Triticale	8	Tons			
2015	0	0	215	0	0	0	215	Triticale	9	Tons	Corn Silage	25	Tons
2014	0	0	60	0	0	0	60	Corn Silage	28	Tons			
2013	0	0	140	0	0	0	140	Corn Silage	30	Tons			
2012	0	0	0	0	0	0	0						
2011							0						

Comments: Comment on Sprinklers - For triticale sprinkles 24 hour sets for corn move ditches every 2 hours. Rill forever sprinklers started 5 years ago. Rill for corn, sprinklers for triticale.

Current Crop	
Crop Year	2016
Condition	Good Planned

Soil: 32 - Esquatzel Silt Loam 0-2%Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, FI, FI, FI, S	M, M, Dp, W, M	1.2	
B	S, FI, FI, FI, S	M, M, Dp, W, M	1.1	
C	S, FI, FI, FI, S	M, M, Dp, W, M	1.4	
D	S, FI, FI, FI, S	M, M, Dp, W, M	1.1	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

3123

Acres	40	10/25/2015
Soil Testing?	YES	
Test Frequency	Once a Year	
Irrigation Type	Rill Irrigation	
Irrigation Schedule	Every 8 days	
Hour Sets		
Irrigation years	100	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	435
2 ft	27
3 ft	74
4 ft	31
5 ft	99
6 ft	28
TOTAL	694
NH4-N	47
ORGANIC	2.28

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	200	0	0	0	0	0	200	Corn Silage	30	Tons			
2014	200	0	0	0	0	0	200	Corn Silage	26	Tons			
2013	200	0	0	0	0	0	200	Corn Silage	27	Tons			
2012	0	0	0	0	0	0	0	Corn Silage	26	Tons			
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments: Every year

Current Crop	
Crop Year	
2015	
Condition	
Fair	Actual

Soil: 178 - Warden Silt Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S	M, M, M, W	2.4	
B	S, S, S	M, M, W	2.4	
C	S, S, S	M, M, W	2.6	
D	S, S, S	M, M, W	1.6	
E				

3124

Acres	20	10/25/2015
Soil Testing?	NO	
Test Frequency	N/A	
Irrigation Type	Rill/Surface Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets	6x a year water	
Irrigation years		
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	13
2 ft	6
3 ft	3
4 ft	4
5 ft	4
6 ft	6
TOTAL	36
NH4-N	81
ORGANIC	2.95

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	17	0	0	0	0	17	Pasture					
2015	0	17	0	0	0	0	17	Pasture					
2014	0	17	0	0	0	0	17	Pasture					
2013	0	17	0	0	0	0	17	Pasture					
2012	0	17	0	0	0	0	17	Pasture					
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments: Only manure is from cows - .42 lbs of N per day per animal pair; 40 pair year around

Current Crop	
Crop Year	
2015	
Condition	
Fair	

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, FI	M, M, Dp-W	1	
B	S, S, FI	M, M, Dp-W	3.4	
C	S, S, FI	M, M, Dp-W	2.6	
D	S, S, FI, FI	M, M, M, Dp-W	1.8	
E				

3125

Acres	35	10/25/2015
Soil Testing?	NO	
Test Frequency	N/A	
Irrigation Type	Wheel-line	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years	16	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	8
2 ft	4
3 ft	3
4 ft	
5 ft	
6 ft	
TOTAL	15
NH4-N	20
ORGANIC	0.9

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Alfalfa	10	Tons			
2015	0	0	210	0	0	0	210	Alfalfa	10	Tons			
2014	0	0	210	0	0	0	210	Alfalfa	9	Tons			
2013	0	0	210	0	0	0	210	Alfalfa	10	Tons			
2012	0	0	0	0	0	0	0						
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments: Split application of N to the field

Current Crop	
Crop Year	
2015	
Condition	
Fair	

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S	M, M, M	1.6	3
B	S, L, S	M, M, M	3.1	3.1
C	S, S, FI, S	M, M, M, M	2	2
D	S, S, FI, S	M, M, M, M	1.6	2
E				

3126

Acres	16	10/27/2015
Soil Testing?	YES	
Test Frequency	Twice per year	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets	Check soil	
Irrigation years	1	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	246
2 ft	104
3 ft	92
4 ft	126
5 ft	134
6 ft	140
TOTAL	842
NH4-N	30
ORGANIC	1.91

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	40	0	0	0	0	0	40	Triticale	10	Tons			
2015	160	0	80	0	0	0	240	Triticale	10	Tons	Corn Silage	37	Tons
2014	40	0	0	0	0	0	40	Alfalfa	9	Tons			
2013	40	0	0	0	0	0	40	Alfalfa	10	Tons			
2012	0	0	0	0	0	0	0						
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments: Split application of commercial N

Current Crop	
Crop Year	
2016	
Condition	
Good	Planned

Soil: 18 - Cleman Very Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S	M, M, Dp, W	2.7	
B	S, S, S, S	M, M, Dp, W	2.5	
C	S, S, S, S	M, M, Dp, W	1.7	
D	S, S, S, S	M, M, Dp, W	2	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

3127

Acres		10/27/2015
Soil Testing?	Blank	
Test Frequency	N/A	
Irigation Type	Wheel-line	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years		
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	34
2 ft	22
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	56
NH4-N	13
ORGANIC	2.27

	Fertilzer Applications (#N/Acre)							Cropping History			
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	0	0	0	0	0	0	0	Alfalfa	Tons		
2015	40	0	0	0	0	0	40	Alfalfa	9 Tons		
2014	40	0	0	0	0	0	40	Alfalfa	10 Tons		
2013	40	0	0	0	0	0	40	Alfalfa	8 Tons		
2012	0	0	0	0	0	0	0				
2011							0				

Comments: Liquid manure applied thru wheel lines to field in Spring

Current Crop	
Crop Year	2016
Condition	
Good	

Soil: 173 - Warden Fine Sandy Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1.8	2
B	S	M	1.3	2
C	S	M	1.6	2
D	S	M	1	1
E				

3128

Acres	30	10/28/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years		
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	257
2 ft	11
3 ft	22
4 ft	10
5 ft	95
6 ft	
TOTAL	395
NH4-N	12
ORGANIC	1.61

	Fertilzer Applications (#N/Acre)							Cropping History			
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	0	0	0	0	0	0	0	Corn Silage	35 Tons		
2015	0	0	100	0	0	0	100	Corn Silage	35 Tons		
2014	0	0	0	0	0	0	0	Corn Silage	Tons		
2013	0	0	0	0	0	0	0	Corn Silage	Tons		
2012	0	0	0	0	0	0	0				
2011							0				

Comments: Records were not available for yield of year 14 and 13 also fertilizer records were not available for year 14 or 13

Current Crop	
Crop Year	2015
Condition	
Good	Actual

Soil: 174 - Warden Fine Sandy Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S	M, M, Dp	0.6	5
B	S, S, S	M, M, Dp	0.9	4
C	S, S, S, S, S	M, M, Dp, M, Dp	1.3	
D	S, S, S	M, M, Dp	1.4	5.2
E				

3129

Acres	30	10/28/2015
Soil Testing?	YES	
Test Frequency	Once a Year	
Irigation Type	Rill Irrigation	
Irrigation Schedule	check soil	
Hour Sets		
Irrigation years	30	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	28
2 ft	8
3 ft	17
4 ft	6
5 ft	7
6 ft	3
TOTAL	69
NH4-N	22
ORGANIC	2.49

	Fertilzer Applications (#N/Acre)							Cropping History			
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	0	0	0	0	0	0	0				
2015	0	0	300	0	0	0	300	Mint	190 Lbs.		
2014	0	0	300	0	0	0	300	Mint	165 Lbs.		
2013	0	0	300	0	0	0	300	Mint	165 Lbs.		
2012	0	0	0	0	0	0	0	Mint	165 Lbs.		
2011							0				

Comments: 150 in Spring another 150 after cutting

Current Crop	
Crop Year	2015
Condition	
Good	Actual

Soil: 32 - Esquatzel Silt Loam 0-2%Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S	M, M, M, M	2.5	
B	S, S, S	M, M, M	2	
C	S, S, S, S, S	M, M, M, M, Dp	1.4	
D	S, S, S, S, S	M, M, M, M, Dp	1.1	
E				

3130

Acres	16	10/28/2015
Soil Testing?	NO	
Test Frequency	N/A	
Irigation Type	Hand-line	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years	3	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	18
2 ft	7
3 ft	6
4 ft	3
5 ft	
6 ft	
TOTAL	34
NH4-N	10
ORGANIC	1.91

	Fertilzer Applications (#N/Acre)							Cropping History			
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	0	0	0	0	0	0	0	Alfalfa	10 Tons		
2015	0	0	0	0	0	0	0	Alfalfa	10 Tons		
2014	0	0	0	0	0	0	0	Alfalfa	11 Tons		
2013	0	0	0	0	0	0	0	Alfalfa	10 Tons		
2012	0	0	0	0	0	0	0				
2011							0				

Comments: This farm applied 20 tons of manure per acre in Fall of 2011 before alfalfa was planted. It was on est. 200 lbs of N applied per acre. When not in alfalfa it is a rill irrigated corn field.

Current Crop	
Crop Year	2016
Condition	
Good	Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1.6	4
B	S	M	1.4	4
C	S	M	4	4
D	S	M	3.3	4
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

3131

Acres	35	10/28/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irrigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	100	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	97
2 ft	25
3 ft	33
4 ft	14
5 ft	12
6 ft	11
TOTAL	192
NH4-N	58
ORGANIC	2.72

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Corn Silage	30	Tons			
2015	0	250	100	0	0	0	350	Corn Silage	30	Tons			
2014	0	60	100	0	0	0	160	Corn Silage	30	Tons			
2013	0	0	100	0	0	0	100	Corn Silage	30	Tons			
2012	0	0	0	0	0	0	0						
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments: All nutrients applied in Spring

Current Crop	
Crop Year	
2015	
Condition	
Good	Actual

Soil: 138 - Sinloc Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S	M, M, Dp, Dp	1.5	
B	S, S, S, S, S	M, M, Dp, Dp, Dp	1.2	
C	S, S, S, S, S, S	M, M, Dp, Dp, M, Dp	2.1	
D	S, S, S, S	M, M, Dp, Dp	2.8	
E				

3132

Acres	20	10/28/2015
Soil Testing?	YES	
Test Frequency	Once a Year	
Irrigation Type	Rill Irrigation	
Irrigation Schedule	Check soil	
Hour Sets		
Irrigation years	100	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	308
2 ft	43
3 ft	78
4 ft	14
5 ft	43
6 ft	8
TOTAL	494
NH4-N	13
ORGANIC	1.78

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	0	100	100	0	0	0	200	Corn Silage	28	Tons			
2014	0	100	100	0	0	0	200	Corn Silage	30	Tons			
2013	0	100	100	0	0	0	200	Corn Silage	25	Tons			
2012	0	100	100	0	0	0	200	Corn Silage	27	Tons			
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments: All nutrients applied in spring

Current Crop	
Crop Year	
2015	
Condition	
Fair	Actual

Soil: 58 - Hezel Loamy Fine Sand 2-15% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S	D, M	3.1	4
B	S, S, S	D, M, M	2.8	
C	S, S, S	D, M, M	3.1	
D	S, S, S	D, M, M	3.2	
E				

3133

Acres	30	10/28/2015
Soil Testing?	YES	
Test Frequency	Once a Year	
Irrigation Type	Rill Irrigation	
Irrigation Schedule	Check soil	
Hour Sets		
Irrigation years	100	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	170
2 ft	97
3 ft	53
4 ft	24
5 ft	67
6 ft	59
TOTAL	470
NH4-N	16
ORGANIC	1.9

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0						
2015	0	100	100	0	0	0	200	Corn Silage	24	Tons			
2014	0	100	100	0	0	0	200	Corn Silage	27	Tons			
2013	0	100	100	0	0	0	200	Corn Silage	32	Tons			
2012	0	100	100	0	0	0	200	Corn Silage	27	Tons			
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments: All nutrients applied in spring

Current Crop	
Crop Year	
2015	
Condition	
Fair	Actual

Soil: 58 - Hezel Loamy Fine Sand 2-15% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S, S, S, S	M, M, M, M	2.6	
B	S, S, S	M, M, M	1.8	
C	S, S, S	M, M, M	2.9	
D	S, S, S, S, S	M, M, M, M, Dp	1.6	
E				

3134

Acres	30	10/29/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irrigation Type	Pivot	
Irrigation Schedule	Shovel	
Hour Sets		
Irrigation years	3	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	10
2 ft	14
3 ft	76
4 ft	74
5 ft	46
6 ft	48
TOTAL	268
NH4-N	11
ORGANIC	1.42

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	0	0	0	0	0	0	0	Mint	200	Lbs.			
2015	0	0	80	0	0	0	80	Mint		Lbs.			
2014	0	0	180	0	0	0	180	Corn	35	Bushels			
2013	0	0	180	0	0	0	180	Corn Grain	8	Tons			
2012	0	0	0	0	0	0	0						
2011							0						

Fertilzer Applications (#N/Acre); Cropping History

Comments: Yield for 2015 not recorded

Current Crop	
Crop Year	
2016	
Condition	
Good	Planned

Soil: 57 - Hezel Loamy Fine Sand 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.3	4
B	S	M	2.5	4
C	S	M	2	4
D	S	M	2.1	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

3135

Acres	28	10/29/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irigation Type	Pivot	
Irrigation Schedule	Observe Crop	
Hour Sets		
Irrigation years	3	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	225
2 ft	233
3 ft	219
4 ft	125
5 ft	
6 ft	
TOTAL	802
NH4-N	20
ORGANIC	2.14

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	0	0	0	0	0	0	0	Corn Grain	28 Tons		
2015	0	50	200	0	0	0	250	Corn Silage	28 Tons		
2014	0	0	250	0	0	0	250	Corn Grain	7 Tons		
2013	0	0	200	0	0	0	200	Corn Grain	7 Tons		
2012	0	0	0	0	0	0	0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments: Previously commercial N was broadcast on by now it is applied thru the growing season thru the pivot

Current Crop	
Crop Year	2015
Condition	Good / Actual

Soil: 57 - Hezel Loamy Fine Sand 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1.2	4
B	S	M	1.5	4
C	S	M	1.1	3.2
D	S	M	1.3	4
E				

3136

Acres	15	10/29/2015
Soil Testing?	Blank	
Test Frequency	N/A	
Irigation Type	Rill Irrigation	
Irrigation Schedule	Blank	
Hour Sets		
Irrigation years	50	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	50
2 ft	6
3 ft	4
4 ft	3
5 ft	10
6 ft	8
TOTAL	81
NH4-N	20
ORGANIC	1.85

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	0	0	0	0	0	0	0	Mint	Lbs.		
2015	0	0	300	0	0	0	300	Mint	185 Lbs.		
2014	0	0	300	0	0	0	300	Mint	195 Lbs.		
2013	0	0	300	0	0	0	300	Mint	180 Lbs.		
2012	0	0	0	0	0	0	0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments: 150 in spring, fly on 50lbs June 1st, July 10 add

Current Crop	
Crop Year	2016
Condition	

Soil: 173 - Warden Fine Sandy Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.4	
B	S	M		
C	S	M	2	
D	S	M		
E				

3137

Acres	5	10/29/2015
Soil Testing?	NO	
Test Frequency	N/A	
Irigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	50	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	56
2 ft	3
3 ft	7
4 ft	3
5 ft	7
6 ft	3
TOTAL	79
NH4-N	71
ORGANIC	1.75

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	0	0	0	0	0	0	0	Mint	188 Lbs.		
2015	0	0	300	0	0	0	300	Mint	188 lbs		
2014	0	0	300	0	0	0	300	Mint	188 Lbs.		
2013	0	0	300	0	0	0	300	Mint	188 Lbs.		
2012	0	0	0	0	0	0	0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments:

Current Crop	
Crop Year	2016
Condition	Good / Planned

Soil: 173 - Warden Fine Sandy Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.4	
B	S	M	2.4	
C	S	M	2.1	
D	S	M	1.9	
E				

3138

Acres	30	10/29/2015
Soil Testing?	NO	
Test Frequency	N/A	
Irigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets	Check soil to start	
Irrigation years	100	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	15
2 ft	3
3 ft	7
4 ft	4
5 ft	43
6 ft	4
TOTAL	76
NH4-N	12
ORGANIC	0.84

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	0	0	0	0	0	0	0	Grapes	15 Tons		
2015	0	0	75	0	0	0	75	Grapes	11 Tons		
2014	0	0	75	0	0	0	75	Grapes	18 Tons		
2013	0	0	75	0	0	0	75	Grapes	12 Tons		
2012	0	0	0	0	0	0	0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments: Field has been in grapes since 1949

Current Crop	
Crop Year	2016
Condition	Good / Planned

Soil: 176 - Warden Silt Loam 0 to 2 percent slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2	4
B	S	M	2.2	4
C	S	M	1.8	
D	S	M	2.6	4
E				

3139

Acres	60	10/29/2015
Soil Testing?	NO	
Test Frequency	N/A	
Irigation Type	Solid Sets	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years	10	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	5
2 ft	6
3 ft	30
4 ft	32
5 ft	
6 ft	
TOTAL	73
NH4-N	10
ORGANIC	1.13

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	0	0	0	0	0	0	0	Grapes	15 Tons		
2015	0	0	75	0	0	0	75	Grapes	11 Tons		
2014	0	0	75	0	0	0	75	Grapes	18 Tons		
2013	0	0	75	0	0	0	75	Grapes	12 Tons		
2012	0	0	0	0	0	0	0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments:

Current Crop	
Crop Year	2016
Condition	Good / Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.6	4
B	S	M	1.8	4
C	S	M	1.7	4
D	S	M	3.2	4
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE Groundwater Management Area (GWMA)

Deep Soil Sampling

3140

Acres	20	10/29/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irigation Type	Drip	
Irrigation Schedule	once system is on rotate thru year	
Hour Sets		
Irrigation years	15	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	300
2 ft	4
3 ft	40
4 ft	17
5 ft	127
6 ft	5
TOTAL	493
NH4-N	22
ORGANIC	1.42

Fertilzer Applications (#N/Acre)							
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total
2016	0	0	0	0	0	0	0
2015	0	0	200	0	0	0	200
2014	0	0	200	0	0	0	200
2013	0	0	200	0	0	0	200
2012	0	0	0	0	0	0	0
2011							0

Comments

Cropping History				
Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield
Hops	2	Tons		
Hops	1	Tons		
Hops	1	Tons		
Hops	1	Tons		

Current Crop	
Crop Year	
2016	
Condition	
Good	Planned

Soil	177 - Warden Silt Loam 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.4	
B	S	M	2.5	
C	S	M	2.7	
D	S	M	2	
E				

3141

Acres	20	10/29/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irigation Type	Drip	
Irrigation Schedule	once system is on rotate thru year	
Hour Sets		
Irrigation years	15	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	950
2 ft	59
3 ft	596
4 ft	57
5 ft	1344
6 ft	1204
TOTAL	4210
NH4-N	22
ORGANIC	2.25

Fertilzer Applications (#N/Acre)							
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total
2016	0	0	0	0	0	0	0
2015	0	0	200	0	0	0	200
2014	0	0	200	0	0	0	200
2013	0	0	200	0	0	0	200
2012	0	0	0	0	0	0	0
2011							0

Comments

Cropping History				
Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield
Hops	2	Tons		
Hops	1	Tons		
Hops	1	Tons		
Hops	1	Tons		

Current Crop	
Crop Year	
2016	
Condition	
Good	Planned

Soil	32 - Esquatzel Silt Loam 0-2%Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2	
B	S	M	2.8	
C	S	M	2.1	5
D	S	M	2.2	4
E				

3142

Acres	20	10/29/2015
Soil Testing?	YES	
Test Frequency	Once per Year	
Irigation Type	Drip	
Irrigation Schedule	once system is on rotate thru year	
Hour Sets		
Irrigation years	15	
Event	FALL 2015	

NO3 (#N/ACRE)	
1 ft	820
2 ft	44
3 ft	149
4 ft	56
5 ft	
6 ft	
TOTAL	1069
NH4-N	12
ORGANIC	1.85

Fertilzer Applications (#N/Acre)							
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total
2016	0	0	0	0	0	0	0
2015	0	0	200	0	0	0	200
2014	0	0	200	0	0	0	200
2013	0	0	200	0	0	0	200
2012	0	0	0	0	0	0	0
2011							0

Comments

Cropping History				
Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield
Hops	2	Tons		
Hops	2	Tons		
Hops	2	Tons		

Current Crop	
Crop Year	
2016	
Condition	
Good	Planned

Soil	32 - Esquatzel Silt Loam 0-2%Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.1	4
B	S	M	2.9	4
C	S	M	3.1	4
D	S	M	2.8	4
E				

4143

Acres	20	4/26/2016
Soil Testing?	YES	
Test Frequency	Yearly	
Irigation Type	Drip	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	5	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	129
2 ft	290
3 ft	174
4 ft	66
5 ft	30
6 ft	9
TOTAL	698
NH4-N	13
ORGANIC	1.46

Fertilzer Applications (#N/Acre)							
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total
2016			0				0
2015			75				75
2014			100				100
2013			100				100
2012							0
2011							0

Comments

Cropping History				
Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield
Apples	16.1	Tons		
Apples	2.1	Tons		
None				
None				

Current Crop	
Crop Year	
2016	
Condition	
Fair	Planned

Soil	177 - Warden Silt Loam 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.4	
B	S	M	1.8	
C	S	M	2.6	4
D	S	M	1.4	
E				

4144

Acres	20	4/26/2016
Soil Testing?	YES	
Test Frequency	Annually	
Irigation Type	Micro Sprinklers	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	8	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	33
2 ft	20
3 ft	17
4 ft	
5 ft	
6 ft	
TOTAL	70
NH4-N	16
ORGANIC	1.93

Fertilzer Applications (#N/Acre)							
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total
2016			60				60
2015			75				75
2014			100				100
2013			100				100
2012							0
2011							0

Comments

Cropping History				
Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield
Cherries	60	Tons		
Cherries	66.3	Tons		
Cherries	68	Tons		
Cherries	33	Tons		

Current Crop	
Crop Year	
2016	
Condition	
Fair	Planned

Soil	177 - Warden Silt Loam 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S,S,SH,S	M	2.6	3
B	S,SH	M	1.9	2
C	S,SH,S	M	2.5	2.5
D	S,SH	M	1.6	1.8
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

4145

Acres	35	4/26/2016
Soil Testing?		
Test Frequency		
Irrigation Type	Wheel Lines	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	15	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	13
2 ft	4
3 ft	3
4 ft	3
5 ft	
6 ft	
TOTAL	23
NH4-N	22
ORGANIC	1.54

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016			0				0						
2015			0				0	Alfalfa	9	Tons			
2014			0				0	Alfalfa	7	Tons			
2013			200				200	Wheat	145	Bushels			
2012							0						
2011							0						

Current Crop	
Crop Year	2016
Condition	
Good	Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	4	4
B	S	M	3.2	4
C	S	M,M,M,D	3.9	4
D	S	M,M,D,M	4	4
E				

Comments:

4146

Acres		4/27/2016
Soil Testing?		
Test Frequency		
Irrigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	35
2 ft	
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	35
NH4-N	9
ORGANIC	1.64

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014							0				
2013							0				
2012							0				
2011							0				

Current Crop	
Crop Year	
Condition	

Soil: 120 - Scoon Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1	1.1
B	S	M	0.9	0.9
C	S	M	0.9	1
D	S	M	0.7	0.9
E				

Comments: Survey Was not Returned

4147

Acres		4/27/2016
Soil Testing?		
Test Frequency		
Irrigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	54
2 ft	51
3 ft	96
4 ft	197
5 ft	323
6 ft	
TOTAL	
NH4-N	13
ORGANIC	1.82

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014							0				
2013							0				
2012							0				
2011							0				

Current Crop	
Crop Year	
Condition	

Soil: 121 - Scoon Silt Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	3.1	3.5
B	S	M	5	5
C	S	M	2.2	3.5
D	S	M	1.9	2.8
E				

Comments: Survey was not returned

4148

Acres		4/27/2016
Soil Testing?		
Test Frequency		
Irrigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	41
2 ft	39
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	80
NH4-N	36
ORGANIC	2.95

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014							0				
2013							0				
2012							0				
2011							0				

Current Crop	
Crop Year	
Condition	

Soil: 121 - Scoon Silt Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1.4	1.4
B	S	M	1.1	1.2
C	S	M	1.3	1.3
D	S	M	0.9	0.9
E				

Comments: Survey was not returned

4149

Acres	35	4/27/2016
Soil Testing?	YES	
Test Frequency	Two times per year	
Irrigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	1	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	122
2 ft	59
3 ft	67
4 ft	42
5 ft	67
6 ft	175
TOTAL	532
NH4-N	17
ORGANIC	1.58

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0	Corn Silage	25	Tons			
2015							0	Corn Silage	26.5	Tons			
2014							0	Corn Silage	29	Tons	Triticale	9	Tons
2013							0	Corn Silage	23	Tons			
2012							0						
2011							0						

Current Crop	
Crop Year	2016
Condition	
Fair	Planned

Soil: 140 - Sinloc Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S,S,SH,S	M	0.5	
B	S,HA,S,S,	M	1.7	5
C	S,SH,S,S,S	M	1.8	
D	S,SH,S	M	1.6	
E				

Comments: Page two of survey not available

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

4150

Acres	40	4/27/2016
Soil Testing?	YES	
Test Frequency	Two times per year	
Irigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	2	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	189
2 ft	109
3 ft	148
4 ft	200
5 ft	178
6 ft	91
TOTAL	915
NH4-N	22
ORGANIC	2.04

Fertilzer Applications (#N/Acre)								Cropping History					
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0	Corn Silage	25	Tons			
2015							0	Corn Silage	26.5	Tons			
2014							0	Corn Silage	29	Tons	Triticale	9	Tons
2013							0	Corn Silage	23	Tons			
2012							0						
2011							0						

Comments: Page two of survey not available

Current Crop	
Crop Year	
2016	
Condition	
Fair	Planned

Soil	32 - Esquatzel Silt Loam 0-2%Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S,S,SH	D,M,Dp	1.3	
B	S,S,SH	D,M,Dp	0.9	
C	S,S,SH	D,M,Dp	1.3	
D	S,S,SH	D,M,Dp	1	
E				

4151

Acres	8	4/27/2016
Soil Testing?	NO	
Test Frequency		
Irigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	37
2 ft	10
3 ft	6
4 ft	4
5 ft	5
6 ft	3
TOTAL	65
NH4-N	16
ORGANIC	1.19

Fertilzer Applications (#N/Acre)								Cropping History			
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014							0				
2013							0				
2012							0				
2011							0				

Comments: No tillage practices. This area has never been farmed or irrigated. Sample taken to see if nitrates were present to ground that has never been farmed in the low lying area of the Outlook area and close to the Granger Drain.

Current Crop	
Crop Year	
Condition	

Soil	140 - Sinloc Silt Loam 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	5.1	
B	S	M	4.4	
C	S	M	4.2	
D	S	M	3.8	
E				

4152

Acres	40	4/28/2016
Soil Testing?	YES	
Test Frequency	Once per year	
Irigation Type	Pivot	
Irrigation Schedule	Soil Moisture Sensors - 1st year	
Hour Sets		
Irrigation years	4	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	25
2 ft	106
3 ft	319
4 ft	279
5 ft	256
6 ft	219
TOTAL	1204
NH4-N	26
ORGANIC	2.63

Fertilzer Applications (#N/Acre)								Cropping History				
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield
2016							0	Alfalfa	72	Bushels		
2015							0	Alfalfa	8	Tons		
2014							0	Alfalfa	8	Tons		
2013							0	Alfalfa	8	Tons		
2012							0					
2011							0					

Comments: 2016 crop yield is from first cutting. No nutrients applied from 2013 thru 2016.

Current Crop	
Crop Year	
2016	
Condition	
Fair	Actual

Soil	140 - Sinloc Silt Loam 2-5% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1.5	
B	S	M	5.2	
C	S	M	3.3	
D	S	M	6	
E				

4153

Acres	20	4/28/2016
Soil Testing?	YES	
Test Frequency		
Irigation Type	Wheel Lines	
Irrigation Schedule		
Hour Sets		
Irrigation years	15	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	17
2 ft	9
3 ft	21
4 ft	21
5 ft	5
6 ft	10
TOTAL	83
NH4-N	17
ORGANIC	2.62

Fertilzer Applications (#N/Acre)								Cropping History				
Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield
2016							0	Alfalfa				
2015							0	Alfalfa green cho	20	Tons		
2014							0	Alfalfa green cho	20	Tons		
2013							0	Alfalfa green cho	10	Tons		
2012							0					
2011							0					

Comments: No nutrients applied 2013 thru 2016.

Current Crop	
Crop Year	
2016	
Condition	
Good	

Soil	178 - Warden Silt Loam 5-8% Slopes			
Hole	Consistency	Moisture	Roots	Refusal
A	S,S,S,L	M,M,D,D	4.8	
B	S,S,S,L	M,M,D,D	3.9	4
C	S,S,S,L	M,M,D,D		4
D	S	M	3	3
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

4154

Acres	20	4/28/2016
Soil Testing?	YES	
Test Frequency	Yearly	
Irigation Type	Drip	
Irrigation Schedule	Routine Schedule - visual	
Hour Sets		
Irrigation years	13	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	157
2 ft	345
3 ft	100
4 ft	9
5 ft	11
6 ft	4
TOTAL	626
NH4-N	14
ORGANIC	1.99

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016			200				200	Hops	1.0 Tons		
2015			200				200	Hops	1.5 Tons		
2014			150				150	Hops	1.5 Tons		
2013			150				150	Hops	1.5 Tons		
2012							0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	2016
Condition	
Good	Planned

Soil: 176 - Warden Silt Loam 0 to 2 percent slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S,SH,S,S,S	M	4	
B	S	M	3	
C	S,S,S,L,S,L,S	M,M,M,D,M,D,M		
D	S,SH,S	M		
E				

4155

Acres	18	4/28/2016
Soil Testing?	YES	
Test Frequency	Yearly	
Irigation Type	Drip	
Irrigation Schedule	Routine Schedule - visual	
Hour Sets		
Irrigation years	30	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	71
2 ft	76
3 ft	35
4 ft	21
5 ft	17
6 ft	18
TOTAL	238
NH4-N	6
ORGANIC	1.23

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016			150				150	Hops	1.2 Tons		
2015		140					140	Hops	1 Tons		
2014			200				200	Hops	1 Tons		
2013			200				200	Hops	1 Tons		
2012							0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	2016
Condition	
Good	Planned

Soil: 176 - Warden Silt Loam 0 to 2 percent slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S,FI,S	M	3.1	
B	S,FI,S,FI	M,M,M,Dp	2.3	
C	S,FI,S	M	2.6	
D	S,FI,S	M	4.3	
E				

4156

Acres	20	4/28/2016
Soil Testing?	YES	
Test Frequency	yearly	
Irigation Type	Drip	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	4	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	84
2 ft	174
3 ft	110
4 ft	21
5 ft	59
6 ft	63
TOTAL	511
NH4-N	10
ORGANIC	1.22

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016			150				150	Hops	1.5 Tons		
2015			200				200	Hops	1 Tons		
2014			200				200	Hops	1 Tons		
2013			200				200	Hops	1 Tons		
2012							0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments

Current Crop	
Crop Year	2016
Condition	
Good	Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S,FI,S,VFI,FI	M,M,M,M,W	3.7	
B	S,VFI,S,FI	M,M,M,W	1.5	
C	S,S,FI	M,M,W	5.2	
D	S,S,S,FI	M.M.M.W	4	
E				

4157

Acres	36	4/29/2016
Soil Testing?	YES	
Test Frequency	Once each fall	
Irigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets	24	
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	123
2 ft	166
3 ft	157
4 ft	123
5 ft	97
6 ft	66
TOTAL	732
NH4-N	18
ORGANIC	2.08

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016			150				150	Corn Silage	35 Tons		
2015			190				190	Corn Silage	36.7 Tons		
2014			225				225	Corn Silage	32 Tons		
2013			240				240	Corn Silage	30 Tons		
2012							0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments: Started irrigating using a pump back system 3 years ago. In 2016 irrigated almost exclusively with tail water. Adding soil moisture probes this year.

Current Crop	
Crop Year	2016
Condition	
Good	Planned

Soil: 18 - Cleman Very Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.5	
B	S	M	2.6	
C	S	M	3.4	
D	S	M	3.3	
E				

4158

Acres	76	4/29/2016
Soil Testing?	YES	
Test Frequency	Annual in fall	
Irigation Type	Pivot	
Irrigation Schedule	Soil Moisture Sensors	
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	12
2 ft	5
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	17
NH4-N	38
ORGANIC	2.18

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	85		240				325	Corn Silage	35 Tons		
2015			240				240	Corn Silage	37 Tons	Triticale	6.4 Tons
2014			225				225	Corn Silage	29 Tons	Triticale	8.6 Tons
2013			300				300	Corn Silage	37 Tons	Triticale	6.4 Tons
2012							0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments: Plan on adding more moisture probes and base station; Hiring an agronomist.

Current Crop	
Crop Year	2016
Condition	
Good	Planned

Soil: 37 - Finley Silt Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	D,M	1	1
B	S	D,M	1	1.8
C	S	D,M	1	1
D	S	D,M	1	1.3
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

4159

Acres	40	4/29/2016
Soil Testing?	YES	
Test Frequency	Annually in fall	
Irigation Type	Pivot	
Irrigation Schedule	Soil Moisture Sensors	
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	34
2 ft	16
3 ft	36
4 ft	27
5 ft	7
6 ft	9
TOTAL	129
NH4-N	40
ORGANIC	2.41

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	60		240				300	Corn Silage	35	Tons			
2015			240				240	Corn Silage	37.4	Tons	Triticale	5.3	Tons
2014			238				238	Corn Silage	29	Tons	Triticale	6.6	Tons
2013			250				250	Corn Silage	28	Tons	Triticale	8.1	Tons
2012							0						
2011							0						

Comments: Plan on adding more moisture sensors and hiring an agronomist.

Current Crop	
Crop Year	
2016	
Condition	
Good	Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2	
B	S	M	2.4	4
C	S	M	5.2	
D	S	M	2	4
E				

4160

Acres		4/29/2016
Soil Testing?		
Test Frequency		
Irigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	9
2 ft	
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	9
NH4-N	19
ORGANIC	1.79

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014							0				
2013							0				
2012							0				
2011							0				

Comments: No survey returned

Current Crop
Crop Year
Condition

Soil: 37 - Finley Silt Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1	1
B	S	M	1	1
C	S	M	1	1
D	S	M	1	1
E				

4161

Acres	75	4/29/2016
Soil Testing?	YES	
Test Frequency	Twice each year	
Irigation Type	Pivot	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	25	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	66
2 ft	9
3 ft	6
4 ft	5
5 ft	8
6 ft	8
TOTAL	102
NH4-N	39
ORGANIC	2.59

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016	140		120				260	Triticale	9	Tons			
2015	0		217				217	Triticale	12	Tons	Corn Silage	30	Tons
2014	250		150				400	Triticale	12	Tons	Corn Silage	28	Tons
2013	200		150				350	Triticale	10	Tons	Corn Silage	30	Tons
2012							0						
2011							0						

Comments: Manure applications for 2013 and 2014 were split - half in spring and half in fall

Current Crop
Crop Year
Condition

Soil: 173 - Warden Fine Sandy Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S,S,F	M,M,D	4.1	
B	S,S,S,F,S	M,M,M,D,M	2.5	
C	S,S,S,S,F	M,M,D,M,D	4.4	
D	S	M,M,M,D,M	5.6	
E				

4162

Acres		4/29/2016
Soil Testing?		
Test Frequency		
Irigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	14
2 ft	4
3 ft	3
4 ft	3
5 ft	3
6 ft	63
TOTAL	30
NH4-N	30
ORGANIC	1.66

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014							0				
2013							0				
2012							0				
2011							0				

Comments: No Survey Returned

Current Crop
Crop Year
Condition

Soil: 173 - Warden Fine Sandy Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S,F,S,S,F	M	5.6	
B	S,F,S,F	M	3.8	
C	S,F,S,F	M	3.3	
D	S,S,F,S	M	5.1	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE
Groundwater Management Area (GWMA)

Deep Soil Sampling

4163

Acres		4/29/2016
Soil Testing?		
Test Frequency		
Irigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	11
2 ft	5
3 ft	13
4 ft	4
5 ft	38
6 ft	3
TOTAL	74
NH4-N	19
ORGANIC	1

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014							0				
2013							0				
2012							0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments: No Survey Returned

Current Crop	
Crop Year	
Condition	

Soil: 141 - Sinloc Silt Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S,FI,L,L	M,D,D,D	3.9	
B	S,FI	M,D	4	
C	S,FI	M,D	4	
D	S,FI	M,D	3.4	
E				

4164

Acres		4/29/2016
Soil Testing?		
Test Frequency		
Irigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	6
2 ft	3
3 ft	3
4 ft	5
5 ft	16
6 ft	14
TOTAL	47
NH4-N	12
ORGANIC	1.54

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014							0				
2013							0				
2012							0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments: No Survey Returned

Current Crop	
Crop Year	
Condition	

Soil: 18 - Cleman Very Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M,M,D,M	4	
B	S	M,M,D,M	4.3	
C	S	M,M,D,M	2.6	
D	S	M,M,D,M	3.2	
E				

4165

Acres		4/29/2016
Soil Testing?		
Test Frequency		
Irigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	4
2 ft	51
3 ft	4
4 ft	4
5 ft	6
6 ft	
TOTAL	69
NH4-N	10
ORGANIC	1.47

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014							0				
2013							0				
2012							0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments: No Survey Returned

Current Crop	
Crop Year	
Condition	

Soil: 18 - Cleman Very Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S,S,FI,FI	M	3.3	4.6
B	S,S,FI,FI	M	3.3	4
C	S,S,FI	M	3.8	4
D	S	M	3.6	4
E				

4166

Acres		5/3/2016
Soil Testing?	YES	
Test Frequency	Twice per year	
Irigation Type	Sprinklers	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	1	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	27
2 ft	9
3 ft	11
4 ft	16
5 ft	23
6 ft	21
TOTAL	107
NH4-N	31
ORGANIC	1.45

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	180						180	Triticale	10 Tons		
2015							0	Grapes			
2014							0	Grapes			
2013							0	Grapes			
2012							0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments:

Current Crop	
Crop Year	2016
Condition	Good Actual

Soil: 95 - Quincy Loamy Fine Sand 0-10% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	D,M,M	1.7	
B	S	D,M,M	1.2	
C	S	D,M,M	2.1	
D	s	D,M,M	1.9	
E				

4167

Acres	20	5/3/2016
Soil Testing?	YES	
Test Frequency	Twice each year	
Irigation Type	Rill Irrigation - furrow	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	97
2 ft	81
3 ft	88
4 ft	13
5 ft	
6 ft	
TOTAL	279
NH4-N	68
ORGANIC	1.39

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016	240						240	Corn Silage	30 Tons		
2015	280						280	Corn Silage	30 Tons	Triticale	8 Tons
2014							0				
2013							0				
2012							0				
2011							0				

Fertilzer Applications (#N/Acre); Cropping History

Comments:

Current Crop	
Crop Year	2016
Condition	Good Actual

Soil: 172 - Warden Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S,S,S,SH	D,M,D,M	1.8	4
B	S,S,S,SH	D,M,D,M	1.5	4
C	S,S,S,SH	D,M,D,M	1.1	4
D	S,S,SH	D,M,M	1.2	4
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

4168

Acres		5/3/2016
Soil Testing?		
Test Frequency		
Irrigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	52
2 ft	
3 ft	
4 ft	
5 ft	
6 ft	
TOTAL	52
NH4-N	21
ORGANIC	3.2

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014							0				
2013							0				
2012							0				
2011							0				

Comments: No survey returned

Current Crop	
Crop Year	
Condition	

Soil: 121 - Scoon Silt Loam 5-8% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	D	0.8	1
B	S	D	0.6	1.1
C	S	D	1.1	1.1
D	S	D	0.4	1
E				

4169

Acres	35	5/4/2016
Soil Testing?	YES	
Test Frequency	Once each year	
Irrigation Type	Drip	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	10	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	191
2 ft	377
3 ft	285
4 ft	82
5 ft	37
6 ft	7
TOTAL	979
NH4-N	16
ORGANIC	1.91

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016			20				20	Hops	1 Tons		
2015			20		30		50	Hops	1 Tons		
2014			20		30		50	Hops	0.8 Tons		
2013			20		100		120	Hops	0.9 Tons		
2012							0				
2011							0				

Comments:

Current Crop	
Crop Year	
2016	
Condition	
Good	Planned

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1.2	
B	S	M		
C	S	M	0.7	
D	S	M	0.8	
E				

4170

Acres	20	5/4/2016
Soil Testing?	YES	
Test Frequency	Once each year	
Irrigation Type	Rill Irrigation	
Irrigation Schedule		
Hour Sets		
Irrigation years	10	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	134
2 ft	98
3 ft	46
4 ft	25
5 ft	52
6 ft	19
TOTAL	374
NH4-N	34
ORGANIC	2.04

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0	Corn Silage	18 Tons		
2015							0	Corn Silage	20.5 Tons		
2014							0	Corn Silage	19 Tons		
2013							0	Corn Silage	17 Tons		
2012							0				
2011							0				

Comments: Applied one cover of liquid manure 2013 through 2016. One cover of solid Manure 2014. Don't know the amount of N applied.

Current Crop	
Crop Year	
2016	
Condition	
Good	

Soil: 177 - Warden Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M,M,Dp	2.5	
B	S	M,M,Dp	2.8	
C	S	M,M,Dp	2.9	
D	S	M,M,Dp,Dp	2.7	
E				

4171

Acres		5/4/2016
Soil Testing?		
Test Frequency		
Irrigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	29
2 ft	6
3 ft	16
4 ft	22
5 ft	29
6 ft	27
TOTAL	129
NH4-N	13
ORGANIC	1.3

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014							0				
2013							0				
2012							0				
2011							0				

Comments: No Survey Returned

Current Crop	
Crop Year	
Condition	

Soil: 95 - Quincy Loamy Fine Sand 0-10% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	4.3	
B	S	M	4.5	
C	S	M	4.4	
D	S	M	3.6	
E				

4172

Acres		5/4/2016
Soil Testing?		
Test Frequency		
Irrigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	25
2 ft	11
3 ft	3
4 ft	3
5 ft	3
6 ft	19
TOTAL	64
NH4-N	15
ORGANIC	2.02

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield	Crop 2	Crop 2 Yield
2016							0				
2015							0				
2014							0				
2013							0				
2012							0				
2011							0				

Comments: No Survey Returned

Current Crop	
Crop Year	
Condition	

Soil: 92 - Outlook Silt Loam

Hole	Consistency	Moisture	Roots	Refusal
A	S	M,M,Dp	1.7	
B	S	M,M,Dp	1.2	
C	S	M,M,Dp		
D	S	M,M,Dp	1.4	
E				

LOWER YAKIMA VALLEY GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA)

Deep Soil Sampling

4173

Field	Value	
Acres		5/4/2016
Soil Testing?		
Test Frequency		
Irrigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	141
2 ft	541
3 ft	311
4 ft	121
5 ft	
6 ft	
TOTAL	1114
NH4-N	24
ORGANIC	2.64

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0						
2015							0						
2014							0						
2013							0						
2012							0						
2011							0						

Comments: No Survey Returned

Current Crop	
Crop Year	
Condition	

Soil: 91 - Outlook Fine Sandy Loam

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	2.7	4.3
B	S	M	2.1	4
C	S	M	1.8	4
D	S	M	1.5	3.9
E				

4174

Field	Value	
Acres	16	5/4/2016
Soil Testing?	YES	
Test Frequency	Once each year	
Irrigation Type	Drip	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	1	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	117
2 ft	142
3 ft	29
4 ft	11
5 ft	27
6 ft	8
TOTAL	334
NH4-N	11
ORGANIC	0.81

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016		140					140	Hops	1	Tons			
2015							0	Grapes					
2014							0	Grapes					
2013							0	Grapes					
2012							0						
2011							0						

Comments:

Current Crop	
Crop Year	2016
Condition	Fair / Planned

Soil: 125 - Scooteney Silt Loam 2-5% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M	1.7	
B	S	M	1.4	
C	S	M		4
D	S	M	2.1	4
E				

4175

Field	Value	
Acres	10	5/4/2016
Soil Testing?	YES	
Test Frequency	Once each year	
Irrigation Type		
Irrigation Schedule		
Hour Sets		
Irrigation years		
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	427
2 ft	766
3 ft	664
4 ft	242
5 ft	281
6 ft	169
TOTAL	2549
NH4-N	12
ORGANIC	0.69

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0	Asparagus					
2015							0	Asparagus					
2014							0	Asparagus					
2013							0	Asparagus					
2012							0						
2011							0						

Comments: No nutrients applied for at least the last 3 years. No manure applied for over 10 years. Field gets subby when SVID canal fills up in spring and dries out when canal shuts off.

Current Crop	
Crop Year	2016
Condition	Good

Soil: 18 - Cleman Very Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M,Dp,Dp,w,w	1	
B	S	Dp,Dp,Dp,W	1.2	
C	S	Dp,Dp,Dp,W	0.9	
D	S	Dp,Dp,Dp,W	1.1	
E				

4176

Field	Value	
Acres	20	5/4/2016
Soil Testing?	YES	
Test Frequency	Once each year	
Irrigation Type	Rill Irrigation	
Irrigation Schedule	Routine Schedule	
Hour Sets		
Irrigation years	100	
Event	SPRING 2016	

NO3 (#N/ACRE)	
1 ft	36
2 ft	233
3 ft	160
4 ft	172
5 ft	143
6 ft	54
TOTAL	798
NH4-N	16
ORGANIC	1.12

Year	Liquid Manure	Solid Manure	Com.	Bio	Comp	Other	Total	Crop 1	Crop 1 Yield		Crop 2	Crop 2 Yield	
2016							0	Asparagus					
2015							0	Asparagus					
2014							0	Asparagus					
2013							0	Asparagus					
2012							0						
2011							0						

Comments: No nutrients applied for at least the last 3 years. No manure applied for over 10 years. Field gets subby when SVID canal fills up in spring and dries out when canal shuts off.

Current Crop	
Crop Year	2016
Condition	Good

Soil: 18 - Cleman Very Fine Sandy Loam 0-2% Slopes

Hole	Consistency	Moisture	Roots	Refusal
A	S	M,M,W,W,W	1.3	
B	S	M,M,W,W,W	1.2	
C	S	Dp,M,W,W,W	0.8	
D	S	Dp,M,W,W,W	0.9	
E				

Analytical Data Analysis

Analysis of the deep soil analytical data was conducted by Melanie Redding, chair of the data workgroup.

Deep Soil Sampling (DSS)
In the Lower Yakima Valley GWMA

Melanie Redding, Hydrogeologist,
Washington State Department of Ecology
May, 2018

Deep Soil Sampling was conducted in the Lower Yakima Valley. This effort was initiated and funded by the Groundwater Management Area Committee. Sample sites were selected voluntarily and all locations remain anonymous. Samples were collected from 175 fields at one foot intervals down to six feet below land surface, and these samples were collected over four seasons (fall 2014, spring 2015, fall 2015, and spring 2016). All samples were analyzed for nitrate (NO_3 as N), ammonium (NH_4 as N) and organic matter from samples collected at the one foot depth.

Limitations of Data

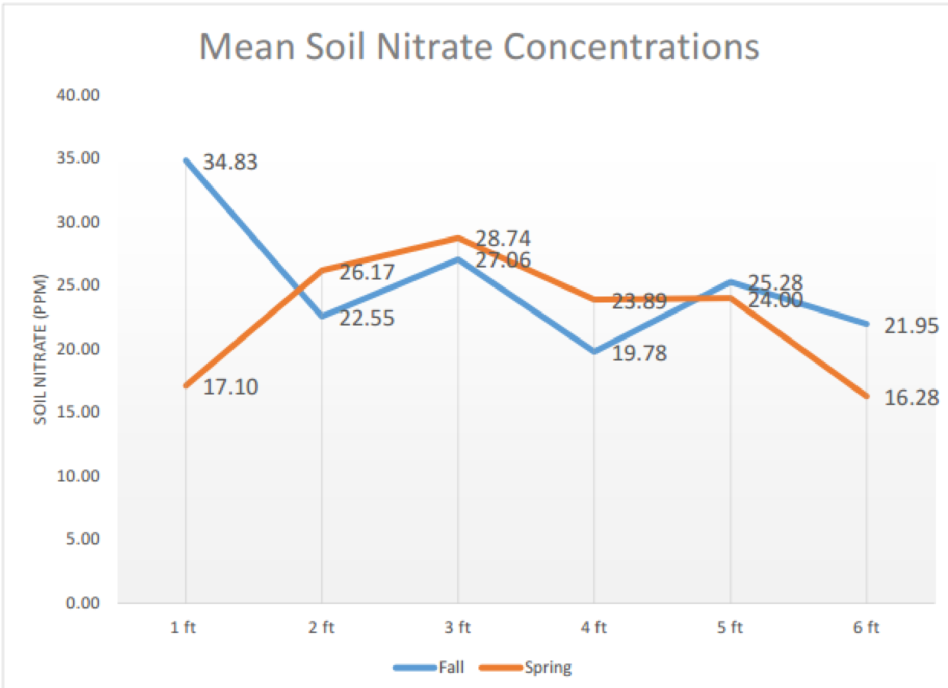
- Since all locations are anonymous it is not possible to determine if a site was sampled more than once during the project.
- Survey data was also collected at the time of sampling, including amount of nitrogen applied over recent years, type of nitrogen, type of crops grown, irrigation practices, and crop yield.
- At a recent GWAC meeting, it was decided not to use crop survey data collected for the Nitrogen Availability Assessment since there were questions about its accuracy. Since it is impossible to validate anonymous survey data, this data was omitted from the evaluation process.
- This evaluation focuses only on the analytical data and not the survey data.
- There is no way to determine trends over time, how nitrate is moving through the soil column, or how different sources of nitrogen affect residual soil nitrate.
- This information cannot be extrapolated to be representative of the entire Lower Yakima Valley.
- This data represents a snapshot in time.
- Quality Assurance – assure all data used is credible.
    - The ammonium data collected in the Fall 2015 had an RPD of 55% for the sample with lower ammonium concentrations. PGG cautions that during this sampling event lower concentration ammonium results may be biased high.

Fall vs. Spring

<u>Mean soil nitrate concentrations for all fall samples compared to all spring samples</u>.

- Two lines are closely aligned for all depths except in the first foot.
- The first foot spring soil nitrate is an average of 18 ppm lower than fall soil nitrate.
- The differences for all other depths are between 1 ppm and 6 ppm.

Figure 1.



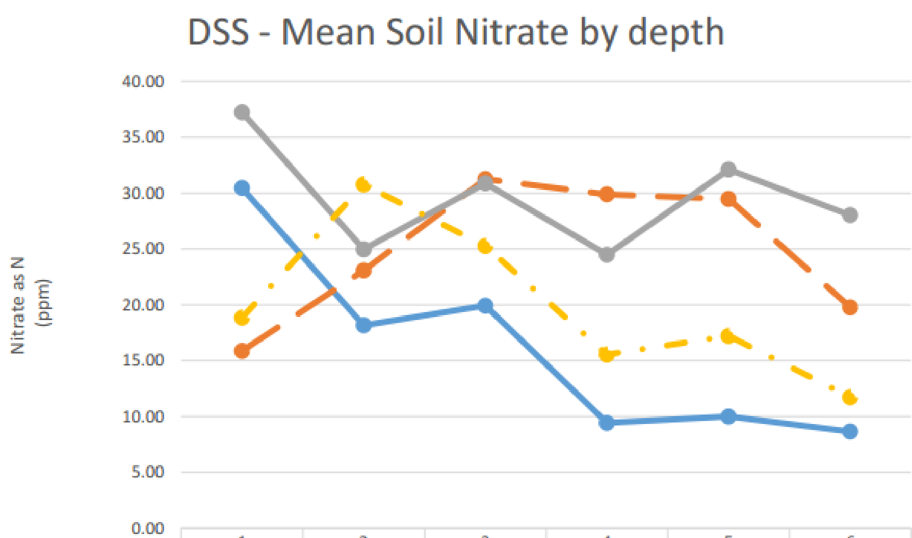
	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	Total Cumulative
Fall	34.83	22.55	27.06	19.78	25.28	21.95	130.15
Spring	17.10	26.17	28.74	23.89	24.00	16.28	111.26
difference	17.74	-3.62	-1.68	-4.11	1.28	5.67	18.89

mean ppm (parts per million)

Mean soil nitrate concentrations for each depth are compared for each sampling event (fall 2014, spring 2015, fall 2015, and spring 2016).

- Fall 2014
  - The mean for all depths is ≤ 30 ppm.
  - The shape of both Fall lines are similar, but 2014 is consistently lower than 2015.
  - The highest mean concentration occurs within the 1 foot sample.
  - The lowest mean concentration for all sampling events occurs in the fall 2014 in the 6 ft depth.
  - Within the 1 foot sample, the means of both fall samples are close to twice the concentration of both the spring mean concentrations.
- Spring 2015
  - The mean for all depths is ≤ 31 ppm.
  - The highest mean concentration occurs with the 1 foot sample.
- Fall 2015
  - The highest mean of all sampling events and all depths occurred in the fall 2015 in the 1 foot depth at 37 ppm.
  - The mean is elevated (≥ 30 ppm) in the 1 foot, 3 foot, and 5 foot depths.
- Spring 2016
  - The mean for all depths ≤ 30 ppm.

Figure 2.



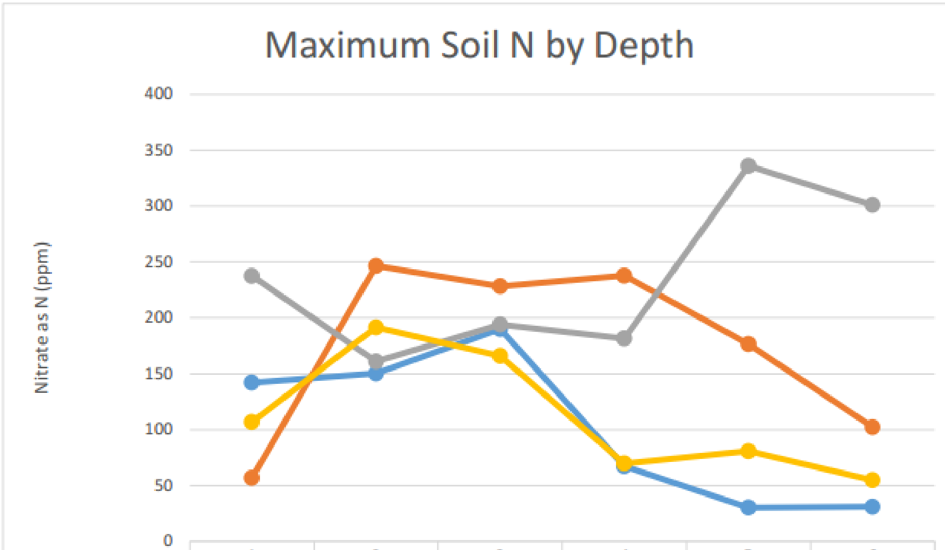
	1	2	3	4	5	6
FALL 2014	30.45	18.16	19.93	9.43	10.00	8.64
SPRING 2015	15.86	23.08	31.25	29.88	29.48	19.77
FALL 2015	37.24	24.96	30.88	24.49	32.11	28.03
SPRING 2016	18.84	30.77	25.27	15.54	17.21	11.73

<u>Maximum soil nitrate concentration for each depth compared for each sampling event</u>.

- Fall 2014
  - The maximum concentrations are elevated (≥ 30 ppm) for all depths. These values range from 190 ppm at the 3 foot depth to 30 ppm in the 5 and 6 foot depths.
  - There are no consistent patterns with the fall maximum concentrations or the spring maximum concentrations.
  - The maximum fall concentrations were both greater than the spring maximum concentrations in the 1st foot sample.
  - Collectively, it appears that concentrations are elevated in the 2 foot and 3 foot samples (150 to 250 ppm).
- Spring 2015
  - The maximum concentrations are elevated (≥ 30 ppm) for all depths.
- Fall 2015
  - The maximum concentrations are elevated (≥ 30 ppm) for all depths ranging from 161 ppm to 336 ppm.

- Fall 2015 had the highest measured soil nitrate value during this study of 336 ppm in the 5 foot sample.
- Spring 2016
    - The maximum concentrations are elevated (≥ 30 ppm) for all depths.

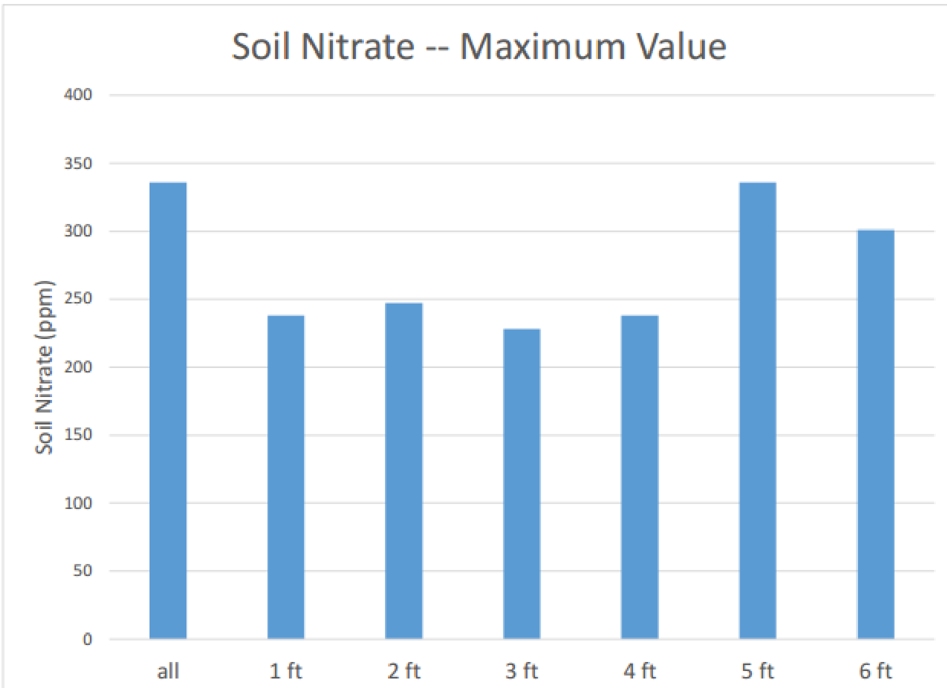
Figure 3.



	1	2	3	4	5	6
FALL 2014	142	150.25	190	67.25	30.25	31
SPRING 2015	56.75	246.5	228.25	237.75	176.5	102.25
FALL 2015	237.5	161	194	181.5	336	301
SPRING 2016	106.75	191.5	166	69.75	80.75	54.75

<u>The maximum soil nitrate concentration</u> for each depth exceeded 200 ppm. Every depth had a maximum soil nitrate concentration which exceeded 200 ppm. The maximum concentrations were greatest in the 5 ft (336 ppm) and 6 ft (301 ppm).

Figure 4.

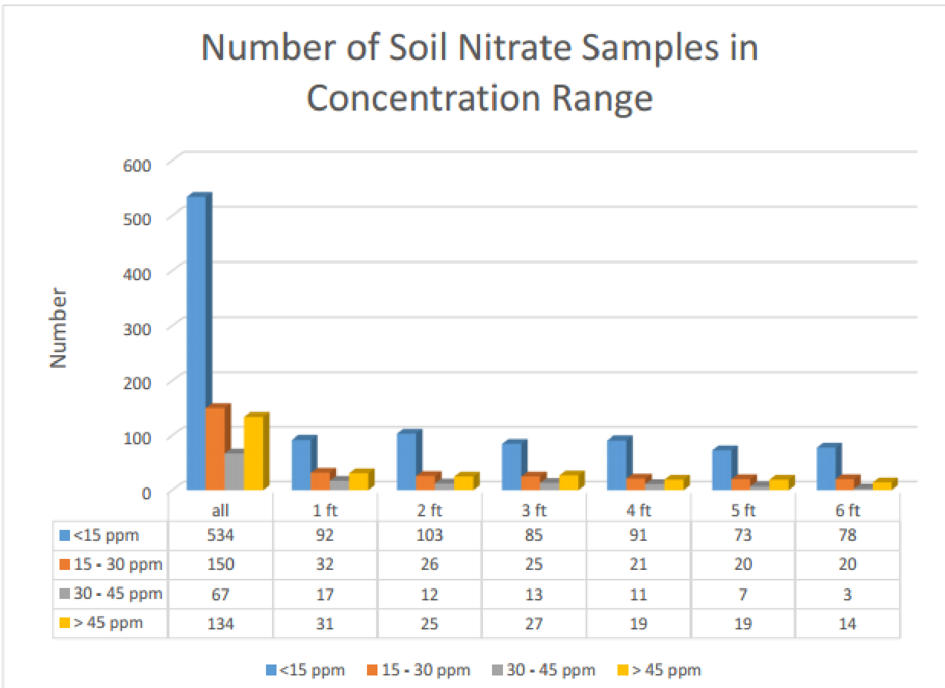


Depth

<u>The number of soil nitrate which are in four different concentration brackets; < 15 ppm, 15 – 30 ppm, 30 – 45 ppm, and > 45 ppm</u>. This graph compares all depths. The first set of bars in figure 5 represents the entire data set.

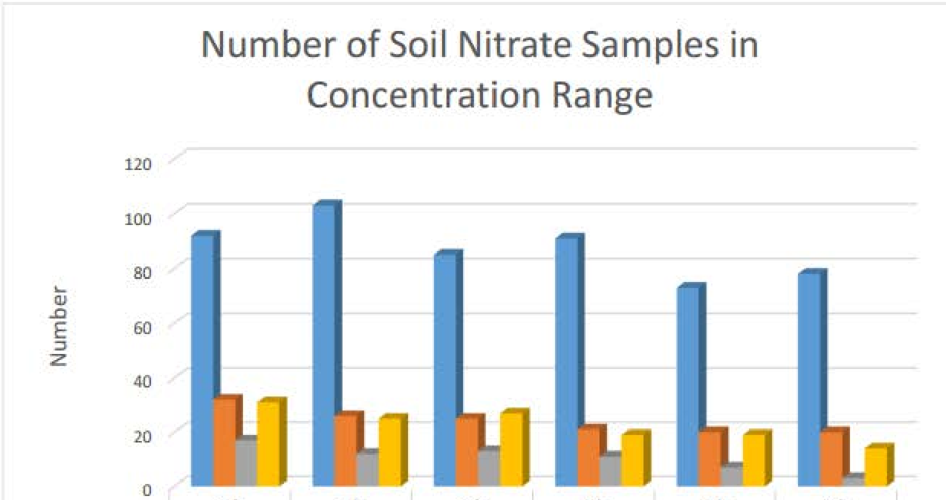
- The majority of soil nitrate samples were < 15 ppm for the entire data set and for each depth.
- All depths had soil nitrate samples which were in the 30 – 45 ppm and > 45 ppm ranges.

Figure 5.



	all	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft
<15 ppm	534	92	103	85	91	73	78
15 - 30 ppm	150	32	26	25	21	20	20
30 - 45 ppm	67	17	12	13	11	7	3
> 45 ppm	134	31	25	27	19	19	14

Figure 6.



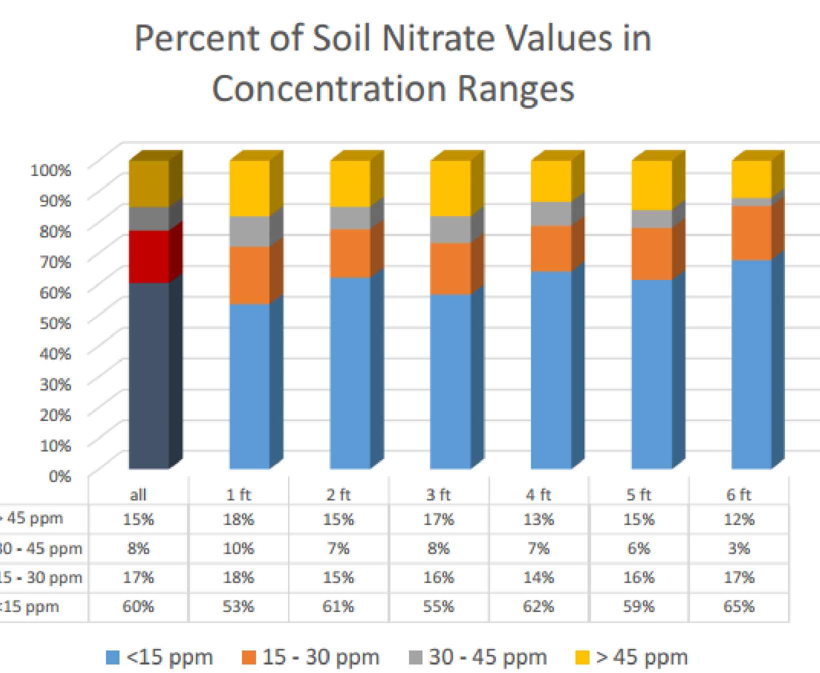
	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft
<15 ppm	92	103	85	91	73	78
15 - 30 ppm	32	26	25	21	20	20
30 - 45 ppm	17	12	13	11	7	3
> 45 ppm	31	25	27	19	19	14

<15 ppm 15 - 30 ppm 30 - 45 ppm > 45 ppm

Figure 7 shows the percent of soil nitrate samples that occurred in each of the concentration categories for each depth. The first bar represents the entire data set.

- Again, this figure illustrates that 60% of all soil samples had nitrate concentrations < 15 ppm.
- And 23% of all soil samples were > 30 ppm.
- The percentages are fairly consistent across all depths.
    - < 15 ppm ranged from 53% to 65%
    - > 30 ppm ranged from 28% to 15%

Figure 7.



	all	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft
> 45 ppm	15%	18%	15%	17%	13%	15%	12%
30 - 45 ppm	8%	10%	7%	8%	7%	6%	3%
15 - 30 ppm	17%	18%	15%	16%	14%	16%	17%
<15 ppm	60%	53%	61%	55%	62%	59%	65%

Distribution by sampling event and depth

These figures show the concentration distribution for each depth for each sample. The first four graphs are divided by sampling event. The last graph has all samples collectively. These graphs allow a comparison of where the highest and lowest nitrate concentrations are found for each sample.

Figure 8.

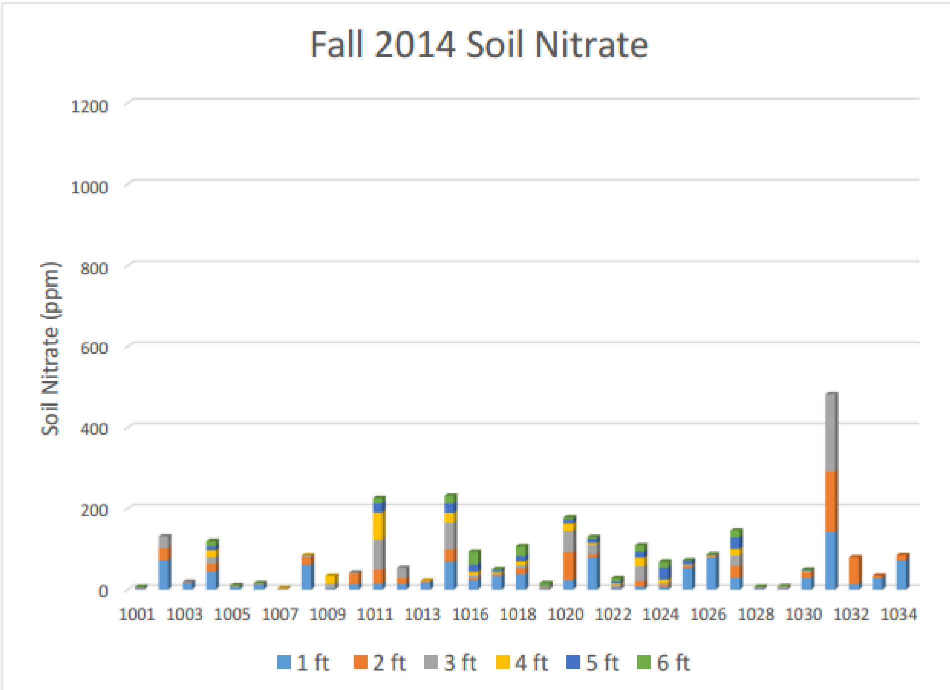
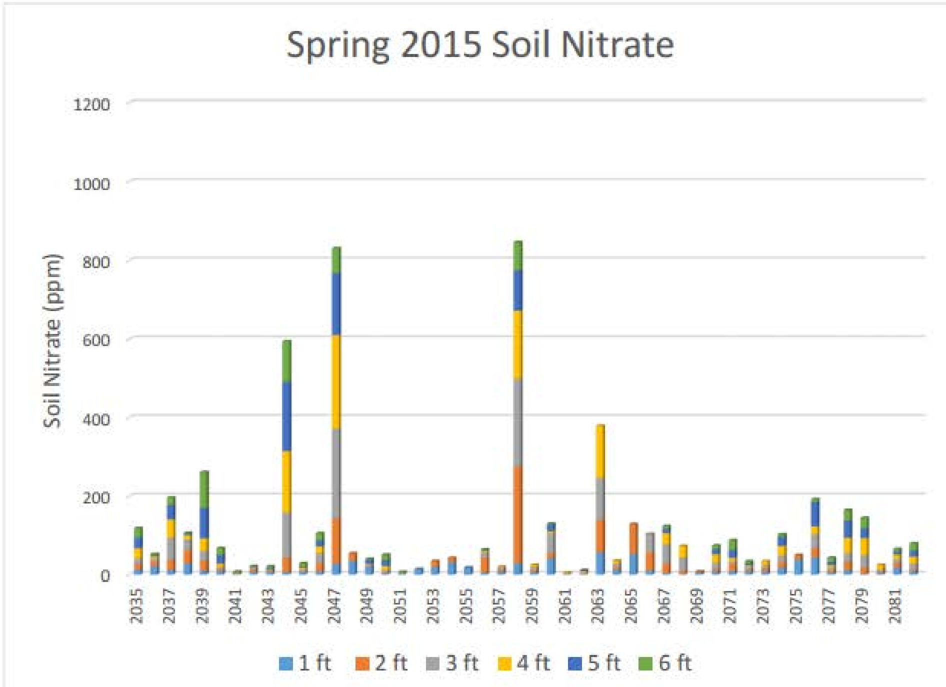


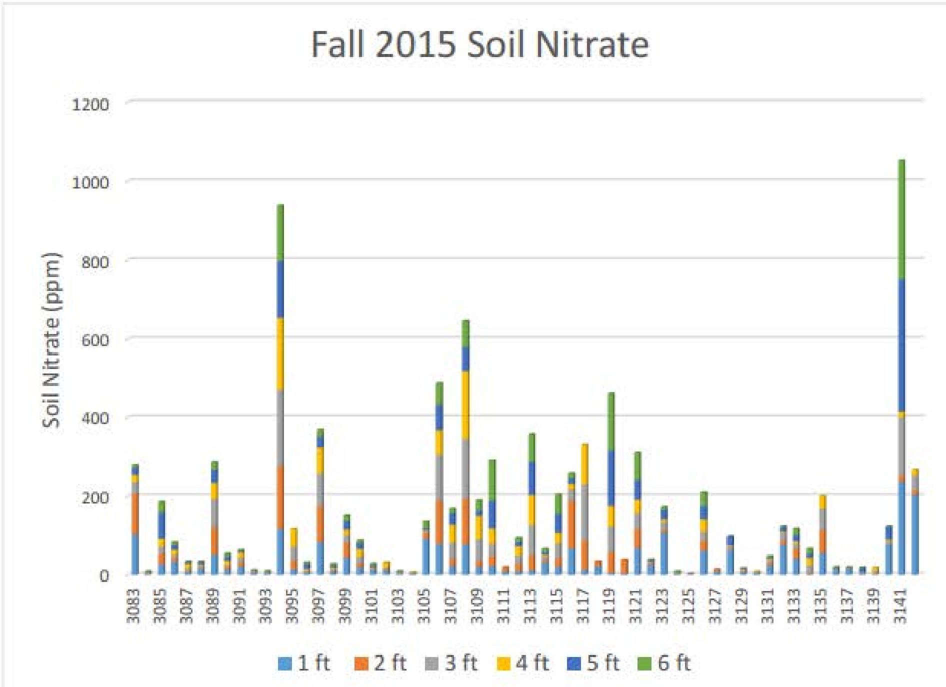
Figure 9.



Spring 2015 Soil Nitrate
Soil Nitrate (ppm)
1200
1000
800
600
400
200
0
2035
2037
2039
2041
2043
2045
2047
2049
2051
2053
2055
2057
2059
2061
2063
2065
2067
2069
2071
2073
2075
2077
2079
2081
1 ft
2 ft
3 ft
4 ft
5 ft
6 ft

11

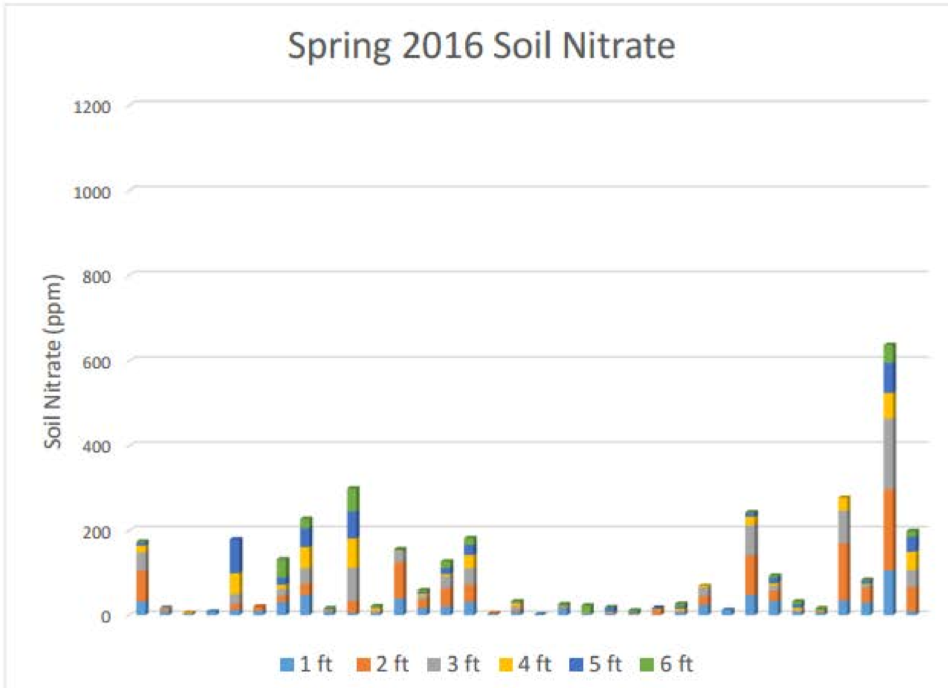
Figure 10.



Fall 2015 Soil Nitrate
Soil Nitrate (ppm)
1200
1000
800
600
400
200
0
3083
3085
3087
3089
3091
3093
3095
3097
3099
3101
3103
3105
3107
3109
3111
3113
3115
3117
3119
3121
3123
3125
3127
3129
3131
3133
3135
3137
3139
3141
1 ft
2 ft
3 ft
4 ft
5 ft
6 ft

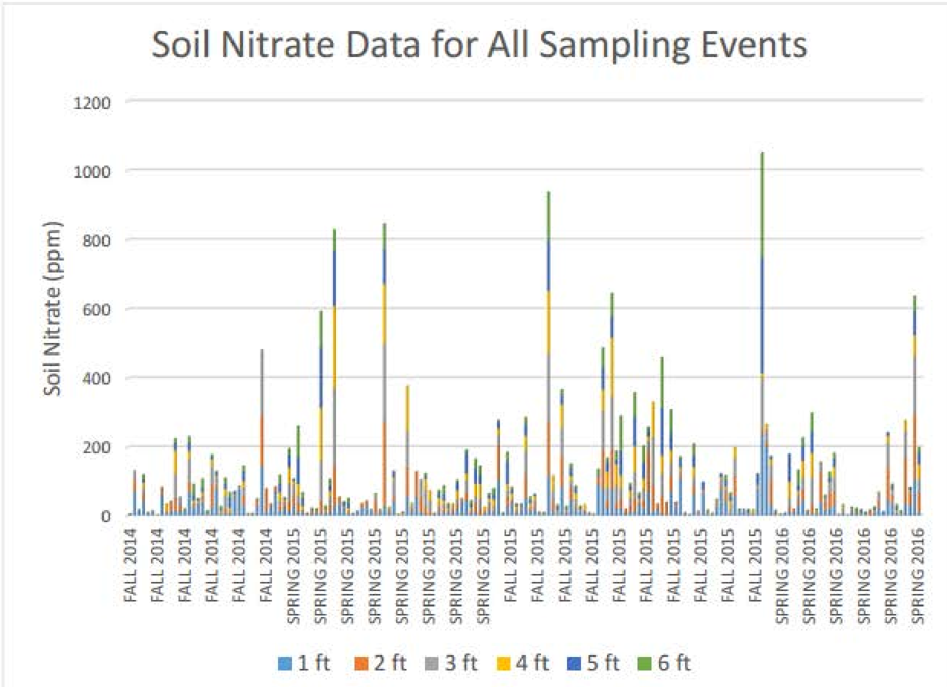
12

Figure 11.


Spring 2016 Soil Nitrate
1200
1000
800
600
400
200
0
Soil Nitrate (ppm)
1 ft
2 ft
3 ft
4 ft
5 ft
6 ft

13

Figure 12.



Soil Nitrate Data for All Sampling Events
Soil Nitrate (ppm)
1200
1000
800
600
400
200
0
FALL 2014
FALL 2014
FALL 2014
FALL 2014
FALL 2014
FALL 2014
SPRING 2015
SPRING 2015
SPRING 2015
SPRING 2015
SPRING 2015
SPRING 2015
SPRING 2015
SPRING 2015
FALL 2015
FALL 2015
FALL 2015
FALL 2015
FALL 2015
FALL 2015
FALL 2015
FALL 2015
FALL 2015
FALL 2015
SPRING 2016
SPRING 2016
SPRING 2016
SPRING 2016
SPRING 2016
SPRING 2016
1 ft
2 ft
3 ft
4 ft
5 ft
6 ft

14

Nitrate relative to the root zone

Figure 13.

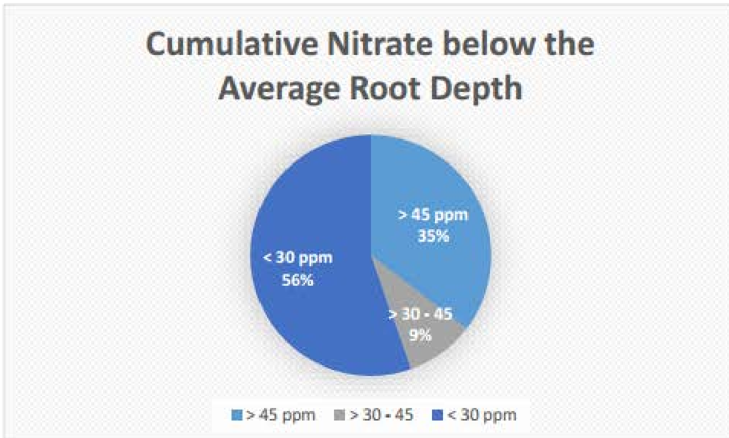


Figure 14.

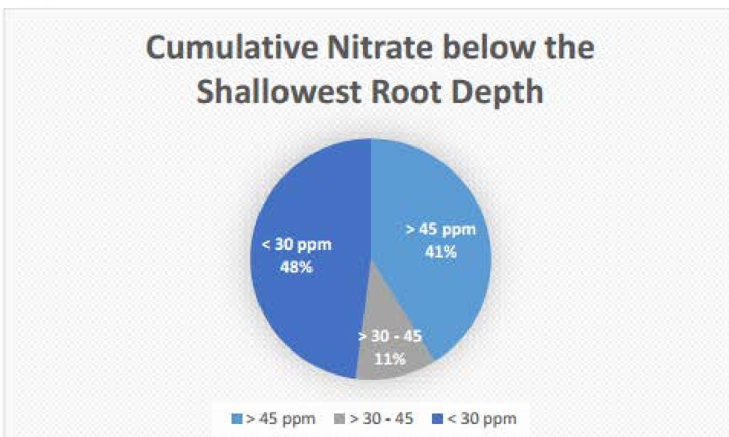
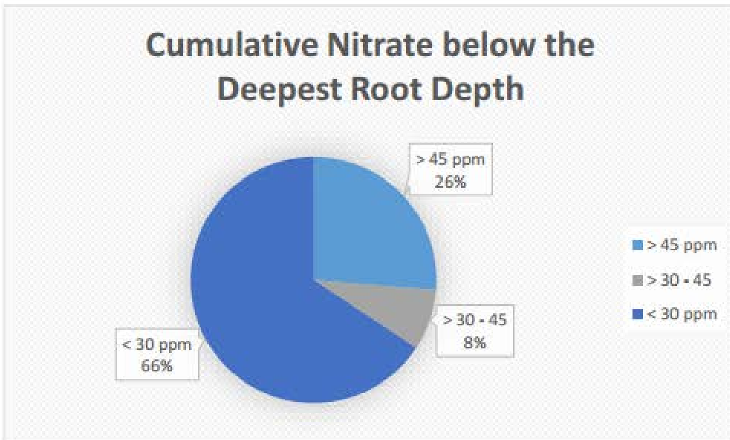


Figure 15.


Cumulative Nitrate below the Deepest Root Depth
> 45 ppm
26%
> 30 - 45
8%
< 30 ppm
66%
> 45 ppm
> 30 - 45
< 30 ppm

Summary Statistics

	Soil Nitrate (NO3 as N) (ppm)						
	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	Total Cumulative
	FALL 2014						
mean	30.45	18.16	19.93	9.43	10.00	8.64	85.73
median	17.00	7.00	3.88	3.50	8.00	5.75	68.50
max	142.00	150.25	190.00	67.25	30.25	31.00	482.25
min	0.75	0.75	0.75	0.75	0.75	0.75	3.00
n	33.00	33.00	30.00	25.00	21.00	21.00	33.00
Δ	141.25	149.50	189.25	66.50	29.50	30.25	479.25
	SPRING 2015						
mean	15.86	23.08	31.25	29.88	29.48	19.77	119.69
median	10.25	10.88	11.63	10.50	14.50	8.63	59.38
max	56.75	246.50	228.25	237.75	176.50	102.25	846.25
min	1.00	0.75	0.75	0.75	0.75	0.75	5.50
n	48.00	46.00	40.00	39.00	31.00	30.00	48.00
Δ	55.75	245.75	227.50	237.00	175.75	101.50	840.75
	FALL 2015						
mean	37.24	24.96	30.88	24.49	32.11	28.03	155.00
median	20.13	10.50	12.38	13.00	11.75	7.50	83.50
max	237.50	161.00	194.00	181.50	336.00	301.00	1052.50
min	1.25	0.75	0.75	0.75	0.75	0.75	3.75
n	60.00	60.00	56.00	55.00	47.00	46.00	59.00
Δ	236.25	160.25	193.25	180.75	335.25	300.25	1048.75
	SPRING 2016						
mean	18.83824	30.76613	25.26724	15.54464	17.21	11.72826	99
median	9.75	12.75	9	5.25	7.25	4.75	32.25
max	106.75	191.5	166	69.75	80.75	54.75	637.25
min	1	0.75	0.75	0.75	0.75	0.75	2.25
n	34	31	29	28	25	23	33
Δ	105.75	190.75	165.25	69	80	54	635

Sites where all concentrations are < 30 ppm			
	number	total	percent
Fall 2014	16	33	48%
Spring 2015	29	48	60%
Fall 2015	29	60	48%
Spring 2016	20	34	59%

Sites where the cumulative nitrate ≥200 ppm			
	number	total	percent
Fall 2014	3	33	9%
Spring 2015	5	48	10%
Fall 2015	16	60	27%
Spring 2016	5	34	15%

Sites where ≥45 ppm is present			
	number	total	percent
Fall 2014	10	33	30%
Spring 2015	11	48	23%
Fall 2015	25	60	42%
Spring 2016	9	34	26%

Additionally, there are 4 sites where soil nitrate concentrations exceeded 45 ppm at all depths.

And there are 6 sites where soil nitrate concentrations exceeded 30 ppm at all depths.

Site		Soil Nitrate (NO3 as N)						
		ppm						
ID	Time	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	Total Cumulative
1001	FALL 2014	2	0.75	0.75	0.75	1.25	0.75	6.25
1002	FALL 2014	71.25	31	28.75				131
1003	FALL 2014	16.25	1.5	0.75				18.5
1004	FALL 2014	44.25	19.75	15.75	17.25	10.5	12.5	120
1005	FALL 2014	6.25	0.75	0.75	0.75	0.75	1	10.25
1006	FALL 2014	11.25	1	0.75	0.75	1	0.75	15.5
1007	FALL 2014	0.75	0.75	0.75	0.75			3
1008	FALL 2014	61.5	18.25	3.5	0.75			84
1009	FALL 2014	3	0.75	10	20.25			34
1010	FALL 2014	12.5	28	1.5				42
1011	FALL 2014	14.25	35.25	73.75	67.25	23.25	12.5	226.25
1012	FALL 2014	13.25	15	25.5				53.75
1013	FALL 2014	17	2.25	1	1.5			21.75
1015	FALL 2014	67.75	31.25	66.5	24.25	23.5	19.25	232.5
1016	FALL 2014	23.5	4.75	6.75	9	18.25	31	93.25
1017	FALL 2014	33.25	3.5	3	3.5	5	2.25	50.5
1018	FALL 2014	38.75	13.75	8	8.75	13	25	107.25
1019	FALL 2014	2.5	1.75	1	1.25	2.25	6.75	15.5
1020	FALL 2014	23.25	69	52	19.5	9.5	5.75	179
1021	FALL 2014	78.75	8.25	24.75	4.25	10	3.75	129.75
1022	FALL 2014	4	2.5	4.25	3.75	5.25	8.25	28
1023	FALL 2014	7	13.25	38	20.25	14.75	16.5	109.75
1024	FALL 2014	5.5	5.25	4.75	8.5	30.25	14.25	68.5
1025	FALL 2014	53.75	4.5	3.25	1	8	1	71.5
1026	FALL 2014	78.5	2.5	1.75	1.75	1.75	0.75	87
1027	FALL 2014	28.75	30.25	24.75	16.75	28.5	16.5	145.5
1028	FALL 2014	2.75	0.75	0.75	0.75	0.75	0.75	6.5
1029	FALL 2014	2	0.75	2.75	1	0.75	0.75	8
1030	FALL 2014	28.25	14.25	2	1.5	1.75	1.5	49.25
1031	FALL 2014	142	150.25	190				482.25
1032	FALL 2014	12.5	67					79.5
1033	FALL 2014	27.5	7					34.5
1034	FALL 2014	71.25	13.75					85

ID	Time	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	Total Cumulative
2035	SPRING 2015	13.75	14	14	25.75	27.5	23.25	118.25
2036	SPRING 2015	22.5	11.75	7.75	5.75	3	1.5	52.25
2037	SPRING 2015	12.5	26.5	56.5	45.75	37.25	18	196.5
2038	SPRING 2015	29	34.25	27	11.25	4.25	1.75	107.5
2039	SPRING 2015	11.25	26	23.25	32.75	78.5	90	261.75
2040	SPRING 2015	10.25	6.25	3.25	9	22	17	67.75
2041	SPRING 2015	1	0.75	0.75	1	1.5	3	8
2042	SPRING 2015	7.25	7	3	1.75	2	1.25	22.25
2043	SPRING 2015	8	4	1.5	0.75	3.25	4	21.5
2044	SPRING 2015	7.25	38	114.25	155.75	176.5	102.25	594
2045	SPRING 2015	7.25	1	5	5.5	3.25	7.75	29.75
2046	SPRING 2015	9	22	23.75	17.5	16.25	18	106.5
2047	SPRING 2015	28.25	116.5	228.25	237.75	156.5	63	830.25
2048	SPRING 2015	36	18.25					54.25
2049	SPRING 2015	21	2	2.75	2	11.25	2	41
2050	SPRING 2015	4.5	2.25	5.25	10.75	15.25	12.75	50.75
2051	SPRING 2015	3.5	0.75	0.75	0.75	0.75	0.75	7.25
2052	SPRING 2015	14.75						14.75
2053	SPRING 2015	21	14.5					35.5
2054	SPRING 2015	33.25	10					43.25
2055	SPRING 2015	18.75						18.75
2056	SPRING 2015	6.25	37.75	12.5	3.5	2	2.5	64.5

2057	SPRING 2015	9.25	5.25	5.25	0.75			20.5
2058	SPRING 2015	29.75	246.5	223	173.5	101.75	71.75	846.25
2059	SPRING 2015	8.25	5.75	7	4.5			25.5
2060	SPRING 2015	42.75	12.5	50.25	6	17	1.75	130.25
2061	SPRING 2015	1.25	0.75	2.5	1			5.5
2062	SPRING 2015	1.25	1.5	2.75	3.5	2.5		11.5
2063	SPRING 2015	56.75	84.25	106	132			379
2064	SPRING 2015	13	6.5	10.75	6.5			36.75
2065	SPRING 2015	53.25	76					129.25
2066	SPRING 2015	11	45.5	48.25				104.75
2067	SPRING 2015	4.75	24.25	49.25	28.75	10	6.75	123.75
2068	SPRING 2015	1.75	8.75	34.25	28.75			73.5
2069	SPRING 2015	6	2.25					8.25
2070	SPRING 2015	9.25	6.5	15.75	20.75	12.75	9.5	74.5
2071	SPRING 2015	10.25	17	7.75	9	19.25	25	88.25
2072	SPRING 2015	9.75	5	5.25	3.75	5.25	6	35
2073	SPRING 2015	9	8.75	7.75	9.5			35
2074	SPRING 2015	18.75	13.75	17	24.25	23.5	6.5	103.75
2075	SPRING 2015	40	10					50
2076	SPRING 2015	45.5	21.75	37.5	18.25	62	7.5	192.5
2077	SPRING 2015	6.5	5.5	6.5	6.25	8.75	10.25	43.75
2078	SPRING 2015	12.25	22.25	21.5	39	43	27.75	165.75
2079	SPRING 2015	2.25	16.5	31.75	43.25	24.5	27	145.25
2080	SPRING 2015	3.75	3.75	6.75	11			25.25

2081	SPRING 2015	18.75	12	10	10.5	8	6	65.25
2082	SPRING 2015	10.25	5.5	13.75	17.5	14.5	18.5	80

	> 30 ppm
	> 45 ppm
	> 200 ppm cumulative

ID	Time	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	Total Cumulative
3083	FALL 2015	104.25	103	29.5	18	19.25	5.5	279.5
3084	FALL 2015	3.5	1.25	0.75	0.75	1.5	1.25	9
3085	FALL 2015	27.5	27	18.25	20	66.5	27	186.25
3086	FALL 2015	34.75	7.5	8.25	14	11.75	7.25	83.5
3087	FALL 2015	7.75	3	6.5	11	4.75	1.5	34.5
3088	FALL 2015	16.25	2.75	5.5	2.25	6	1.5	34.25
3089	FALL 2015	51.75	69	72.5	41.5	32.5	20	287.25
3090	FALL 2015	12.75	7	6.25	10.5	10	8.25	54.75
3091	FALL 2015	21.5	10.75	11.5	14	4.75	1	63.5
3092	FALL 2015	5.5	2	2.25	0.75	0.75	0.75	12
3093	FALL 2015	4	0.75	0.75	1	1.5	1.75	9.75
3094	FALL 2015	116.75	161	194	181.5	144	141.25	938.5
3095	FALL 2015	15	22.5	35	44.5			117
3096	FALL 2015	6.75	2	2.5	4.25	11.75	4.75	32
3097	FALL 2015	84	90.75	83.75	65.75	28.25	16	368.5
3098	FALL 2015	8.75	2.75	4	3	6	3.75	28.25
3099	FALL 2015	44.75	37.75	19.25	13.5	22.5	14	151.75
3100	FALL 2015	19.75	10.25	17	19	15.25	6.75	88
3101	FALL 2015	13.5	2.25	1.25	1.75	5.5	4.5	28.75
3102	FALL 2015	11.5	4.25	3.25	13			32
3103	FALL 2015	3	1	1.75	1.25	1.75	0.75	9.5
3104	FALL 2015	4.25	0.75	0.75	0.75			6.5
3105	FALL 2015	92.75	14.5	4.5	2.25	5	17	136
3106	FALL 2015	79	111.25	116.25	62	64	55.5	488
3107	FALL 2015	24	17.5	41	45.5	30	11	169
3108	FALL 2015	77.75	116.25	153	171	61.75	66	645.75
3109	FALL 2015	20.5	15	55.75	59.5	14	25	189.75
3110	FALL 2015	23.25	25	31.25	38.5	70.75	103.25	292
3111	FALL 2015	8.75	11.25					20
3112	FALL 2015	9.75	18.25	21.75	23.75	11.75	9.5	94.75
3113	FALL 2015	12.25	37.5	77	77	85	70	358.75
3114	FALL 2015	32.75	5.5	9	4.5	7	7.75	66.5
3115	FALL 2015	20.5	22.5	37.25	27.75	48	48.75	204.75
3116	FALL 2015	67.75	122.25	28.25	14	13.75	12.25	258.25
3117	FALL 2015	12.75	75.25	143.25	100			331.25
3118	FALL 2015	21.75	12.75					34.5
3119	FALL 2015	5	53.25	65	53.25	139.75	145	
3120	FALL 2015	3.25	35.75					39
3121	FALL 2015	68.75	48.25	40.5	34.25	50.5	68	310.25
3122	FALL 2015	25.25	5	3.5	0.75	4	1	39.5
3123	FALL 2015	108.75	6.75	18.5	7.75	24.75	7	173.5

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3124	FALL 2015	3.25	1.5	0.75	1	1	1.5	9
3125	FALL 2015	2	1	0.75				3.75
3126	FALL 2015	61.5	26	23	31.5	33.5	35	210.5
3127	FALL 2015	8.5	5.5					14
3128	FALL 2015	64.25	2.75	5.5	2.5	23.75		98.75
3129	FALL 2015	7	2	4.25	1.5	1.75	0.75	17.25
3130	FALL 2015	4.5	1.75	1.5	0.75			8.5
3131	FALL 2015	24.25	6.25	8.25	3.5	3	2.75	48
3132	FALL 2015	77	10.75	19.5	3.5	10.75	2	123.5
3133	FALL 2015	42.5	24.25	13.25	6	16.75	14.75	117.5
3134	FALL 2015	2.5	3.5	19	18.5	11.5	12	67
3135	FALL 2015	56.25	58.25	54.75	31.25			200.5
3136	FALL 2015	12.5	1.5	1	0.75	2.5	2	20.25
3137	FALL 2015	14	0.75	1.75	0.75	1.75	0.75	19.75
3138	FALL 2015	3.75	0.75	1.75	1	10.75	1	19
3139	FALL 2015	1.25	1.5	7.5	8			18.25
3140	FALL 2015	75	1	10	4.25	31.75	1.25	123.25
3141	FALL 2015	237.5	14.75	149	14.25	336	301	1052.5
3142	FALL 2015	205	11	37.25	14			267.25

ID	Time	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	Total Cumulative
4143	SPRING 2016	32.25	72.5	43.5	16.5	7.5	2.25	174.5
4144	SPRING 2016	8.25	5	4.25				17.5
4145	SPRING 2016	3.25	1	0.75	0.75			5.75
4146	SPRING 2016	8.75						8.75
4147	SPRING 2016	13.5	12.75	24	49.25	80.75		
4148	SPRING 2016	10.25	9.75					20
4149	SPRING 2016	30.5	14.75	16.75	10.5	16.75	43.75	133
4150	SPRING 2016	47.25	27.25	37	50	44.5	22.75	228.75
4151	SPRING 2016	9.25	2.5	1.5	1	1.25	0.75	16.25
4152	SPRING 2016	6.25	26.5	79.75	69.75	64	54.75	301
4153	SPRING 2016	4.25	2.25	5.25	5.25	1.25	2.5	20.75
4154	SPRING 2016	39.25	86.25	25	2.25	2.75	1	156.5
4155	SPRING 2016	17.75	19	8.75	5.25	4.25	4.5	59.5
4156	SPRING 2016	21	43.5	27.5	5.25	14.75	15.75	127.75
4157	SPRING 2016	30.75	41.5	39.25	30.75	24.25	16.5	183
4158	SPRING 2016	3	1.25					4.25
4159	SPRING 2016	8.5	4	9	6.75	1.75	2.25	32.25
4160	SPRING 2016	2.25						2.25
4161	SPRING 2016	16.5	2.25	1.5	1.25	2	2	25.5
4162	SPRING 2016	3.5	1	0.75	0.75	0.75	15.75	7.5
4163	SPRING 2016	2.75	1.25	3.25	1	9.5	0.75	18.5
4164	SPRING 2016	1.5	0.75	0.75	1.25	4	3.5	11.75

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4165	SPRING 2016	1	12.75	1	1	1.5		17.25
4166	SPRING 2016	6.75	2.25	2.75	4	5.75	5.25	26.75
4167	SPRING 2016	24.25	20.25	22	3.25			69.75
4168	SPRING 2016	13						13
4169	SPRING 2016	47.75	94.25	71.25	20.5	9.25	1.75	244.75
4170	SPRING 2016	33.5	24.5	11.5	6.25	13	4.75	93.5
4171	SPRING 2016	7.25	1.5	4	5.5	7.25	6.75	32.25
4172	SPRING 2016	6.25	2.75	0.75	0.75	0.75	4.75	16
4173	SPRING 2016	35.25	135.25	77.75	30.25			278.5
4174	SPRING 2016	29.25	35.5	7.25	2.75	6.75	2	83.5
4175	SPRING 2016	106.75	191.5	166	60.5	70.25	42.25	637.25
4176	SPRING 2016	9	58.25	40	43	35.75	13.5	199.5

QA synopsis:

Nitrate:

Blind samples were submitted to the soils analytical lab with each round of sampling. Two samples were selected; one with a known nitrate concentration between 10 and 15 mg/Kg, and the other greater than 50 mg/Kg. All analyzed results were within the +/- 20% relative percent difference as specified in the QAPP.

Organic Matter and Ammonium:

Blind samples were submitted to the soils analytical lab with each round of sampling. There were evaluation criteria specified in the QAPP. Pacific Groundwater Group states in their evaluations of the blind sampling:

Although bias is suggested by the larger RPD percentage (in some cases) for ammonium and organic matter, these results are explained by the unavoidable variability which naturally occurs. This variability can occur due to heterogeneity which is typically present in soils. Further the North American Proficiency Testing (NAPT) program standards are median values calculated from analyses performed by multiple labs, therefore some lab and natural variabili6ty in the samples is expected and is statistically documented by the NAPT program. Natural variability may also occur in association with sample handling practices. A RPD of +/- 20% is typically used by labs for laboratory standard samples, with theoretically have no natural variability. Therefore, it is reasonable to expect that these samples which have natural variability could have RPDs that exceed +/- 20%.

Qualified soil data:

The ammonium data collected in the Fall 2015 had an RPD of 55% for the sample with lower ammonium concentrations. PGG cautions that during this sampling event lower concentration ammonium results may be biased high.

Analytical Data and Survey Data Analysis

Jean Mendoza evaluated the entire data set including the analytical data and the survey data collected from the farmer. She also conducted a second evaluation specifically focusing on fields planted in triticale.

Lower Yakima Valley Deep Soil Sampling Summary Analysis

By Jean Mendoza

August 2017

Between the fall of 2014 and the spring of 2016 the Lower Yakima Valley (LYV) Groundwater Management Area (GWMA) conducted four rounds of deep soil sampling (DSS) on agricultural land in the GWMA target area. All fields were voluntarily submitted and anonymously recorded. Soil sampling was done under contract by the South Yakima Conservation District and Landau Associates.

Purposes of the DSS as stated in *Deep Soil Sampling Plan Lower Yakima Valley Groundwater Management Area, March 2014* were:

1) Providing baseline data regarding the nitrogen content (nitrate, ammonium, and organic matter) of soils underlying a variety of soil, crop, and irrigation systems that represent a cross-section of agricultural activities.
2) Provide an initial assessment of current nitrogen and water management practices in place today and in the past.
3) Provide information regarding availability of soil nitrogen to crops.
4) Provide the foundation for a technically based education program.
5) Provide information about project design, practical realities, time requirements and costs that can be used in developing subsequent project scopes.

There has been no analysis of the collected data. This summary is an attempt by one member of the GWMA advisory committee to begin that process. This summary indicates that analysis is possible for a limited number of crops – triticale, alfalfa & corn silage. These were the majority of the crops in the study – 60% of crops in fall samplings and 78% of crops in spring samplings.

Summary of Data Parameters

There is a difference between the nitrate levels in the soil samples from the fall testing and the spring testing. This could be due to winter moisture that drives nitrates downward in the soil column. It could be due to differences in the fields and nature of the crops that were tested in each season.

Table 1. Average Nitrate Levels for Fall & Spring DSS

Seasonal Averages	1 Ft #N/Acre	2 Ft #N/Acre	3 Ft #N/Acre	4 Ft #N/Acre	5 Ft #N/Acre	6 Ft #N/Acre	Total #N/Acre	Ammonia #N/Acre	Organic Matter
Fall (N = 93)	135.33	89.55	107.95	78.75	101.52	87.26	531.78	22.7	2.01%
Spring (N = 82)	68.39	104.7	114.94	95.57	96	64.92	448.41	23.8	2.13%

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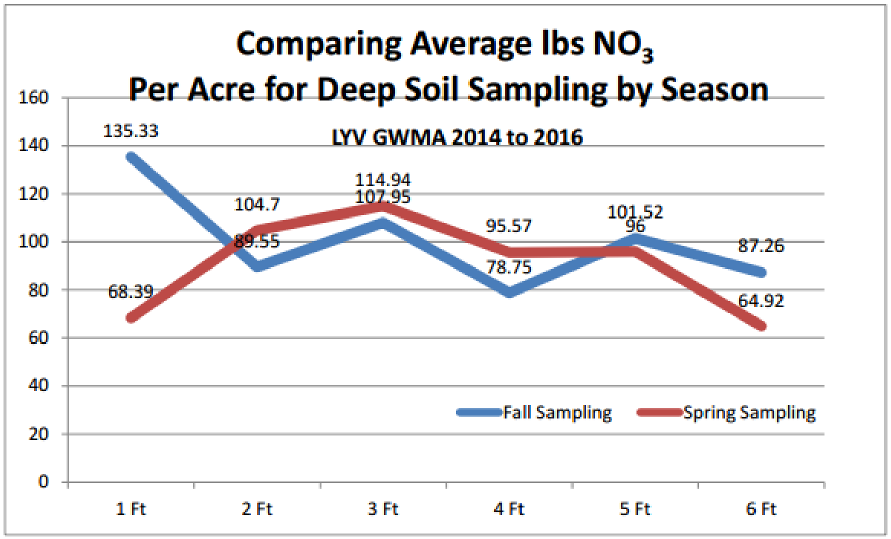
Graph 1.



There are results for 93 fields in the fall sampling and 82 fields in the spring sampling for a total of 175. Part or all of the survey results are missing for 17 of the sites in the spring 2016 study. Analysis by crop, crop yield, fertilizations practices and irrigation type for the 2016 spring testing was calculated for those samples with available information. Soil information was available for all samples.

Average acreage per field was 34.23 acres for the fall testing and 45.61acres for the spring testing.

Total acreage: According to the Washington State Department of Agriculture (WSDA) there are about 96,380 acres of land in agriculture in the GWMA target area. Survey results were obtained for 6,091 acres or 6% of those fields. Acreage was missing for 3 of the fields in the fall samplings and 16 fields in the spring samplings. We do not know if any fields were tested twice and we do not know the locations of the fields.

Soil testing had been done by 74% of the growers in the fall survey and 99% of the growers in the spring survey with 3 unknown in the fall and 15 unknown in the spring. Those fields that were not routinely tested had lower nitrate levels. This indicates that many farmers know where they should be testing.

Irrigation types were:

- Rill = 21 fields or 23% for fall sampling and 7 fields or 11% for spring sampling with 17 unknown in the spring
- Sprinkler = 66 fields or 73% for fall sampling and 51fields or 78% for spring sampling with 17 unknown in the spring
- Drip = 5 fields or 3% for fall samplings and 7 fields or 11% for spring sampling with 17 unknown in the spring
- No irrigation = 1 field or 1% for the fall sampling

Crop history was provided for the past four to five years for most fields. Some fields were planted in only one crop throughout that time period while others were planted with multiple crops. This complicates the analysis. Unless otherwise stated the crop listed for each sample and analysis is the most recently harvested crop under the category *Crop #1* in the DSS spreadsheets. Remember that previous crops impact the nitrogen levels in soils.

Percentage of crops in the DSS is described below in Table 2. WSDA's percentage of crops in the GWMA target area is in parentheses. WSDA data is taken from Attachment 2, *Summary of Proposed Allocation Process.* Most DSS fields in triticale were double cropped in silage corn. Perhaps WSDA only counted triticale as a crop when it was the only crop on a field. This would account for WSDA's low estimate of land in triticale.

Table 2. Percentage of Crops in the LYV GWMA DSS

Fall	% of Crops in the Sampling	N	Spring	% of Crops in the Sampling	N
Triticale	22% (WSDA 1%)	20	Triticale	46% (WSDA 1%)	31
Alfalfa	15% (WSDA 7%)	14	Alfalfa	19% (WSDA 7%)	13
Corn Silage	14% (WSDA 19% for silage + grain)	13	Corn Silage	12% (WSDA 19% for silage + grain)	8
Corn Grain	10% (WSDA 19% for silage + grain)	9	Hops	7% (Hops 5%)	5
Grapes	6% (WSDA 11%)	6	Asparagus	3% (WSDA 1%)	2
Hops	5% (WSDA 5%)	5	Mint	3% (WSDA 1%)	2
Mint	5% (WSDA 1%)	5	Wheat	3% (WSDA 2%)	2
Pasture	5% (WSDA 6%)	5	Apples	1% (WSDA 17%)	1
Wheat	4% (WSDA 2%)	4	Cherries	1 % (WSDA 7%)	1
Apples	3% (WSDA 17%)	3	Pasture	1% (WSDA 6%)	1
Hay	3% (WSDA 1%)	3	Wine Grapes	1% (WSDA 5%)	1
Cherries	2% (WSDA 7%)	2	None	1%	1
Barley	1% (WSDA < 1%)	1			
Fallow	1%	1			
Pears	1% (WSDA 4%)	1			
Sudan Grass	1% (WSDA 1%)	1			
Wine Grapes	1% (WSDA 5%)	1			
Double Crop	24%	22	Double Crop	46%	31
Multiple Crops	30%	28	Multiple Crops	25%	17

Based on these numbers it is possible to draw limited conclusions regarding triticale, alfalfa and corn silage for the fields in this data set of voluntary samples. This descriptive analysis begins on page 8. Statistical analysis for significance begins on page 37.

Fertilization Practices were:

- Liquid Manure = 29 fields (31%) for fall sampling and 36 fields (55%) for spring
- Solid Manure = 18 fields (19%) for fall sampling and 10 fields (15%) for spring
- Commercial Fertilizer = 59 fields (63%) for fall sampling and 36 fields (55%) for spring sampling
- Biosolids = 1 field (1%) for fall sampling and 0% for spring sampling
- Compost = 2 fields (2%) for fall sampling and 0% for spring sampling
- Other = 3 fields (3%) for fall sampling and 1 field (2%) for spring sampling
- 23 fields or 25% of the fall sampling received more than one type of fertilizer
- 23 fields or 35% of the spring sampling received more than one type of fertilizer

Leaching estimates were obtained using the *Capacity of the Most Limiting Layer to Transmit Water (Ksat)* classifications found on the Natural Resource Conservation Services (NRCS) *Soils Website* at https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.

Ksat soil classes for this analysis were:

- Very Low to Moderately Low =5 fields or 5% for fall, 9 fields or 11% for spring and 14 fields or 8% overall
- Moderately High to High = 78 fields or 84% for fall, 68 fields or 83% for spring and 146 fields or 83% overall.
- High to Very High = 10 fields or 11% for fall, 15 fields or 6% for spring and 25 fields or 9% overall

See Attachment 3 for a listing of the soil types and classifications in the DSS. None of the sampled fields fell into other classes.

Most frequent soil types listed in the DSS spread sheet were:

Fall –

- Warden Silt Loam 2-5% Slopes (Moderately High to High) – 24% (22)
- Quincy Loamy Fine Sand 0-10% Slopes (Moderately High to High) – 9% (8)
- Warden Silt Loam 5-8% Slopes (Moderately High to High) – 9% (8)
- Ezquatel Silt Loam 0-2% Slopes (Moderately High to High) – 8% (7)
- Warden Silt Loam 8-15% Slopes (Moderately High to High) – 6% (6)

Spring –

- Warden Silt Loam 2-5% Slopes (Moderately High to High) – 15% (12)
- Cleman Very Find Sandy Loam 0-2% Slopes (Moderately High to High) – 12%(10)
- Warden Fine Sandy Loam 0-2% Slopes (Moderately High to High) – 7%(6)
- Scoon Silt Loam 2-5% Slopes (Very Low to Moderately Low) – 6% (5)
- Sinloc Silt Loam 2-5% Slopes (Moderately High to High) – 6% (5)

Deep Soil Sampling Plan

Prior to implementation of the LYV GWMA DSS planners from the Irrigated Ag Work Group presented the advisory committee with an estimated breakdown of categories for the GWMA target area. (Attachment 2 – *Summary of Proposed Allocation Process*) These groupings were:

1. Crops by root depths:
   - More than 4 Ft – alfalfa, asparagus, tree fruits & hops ~42% of total crops
   - 2.5 Ft to 4 Ft – corn, wheat, grains/triticale, sorghum/Sudan, pasture, grapes ~54% of total crops
   - Less than 2.5 Ft – mint ~1% of total crops
   - Miscellaneous ~3% of total crops

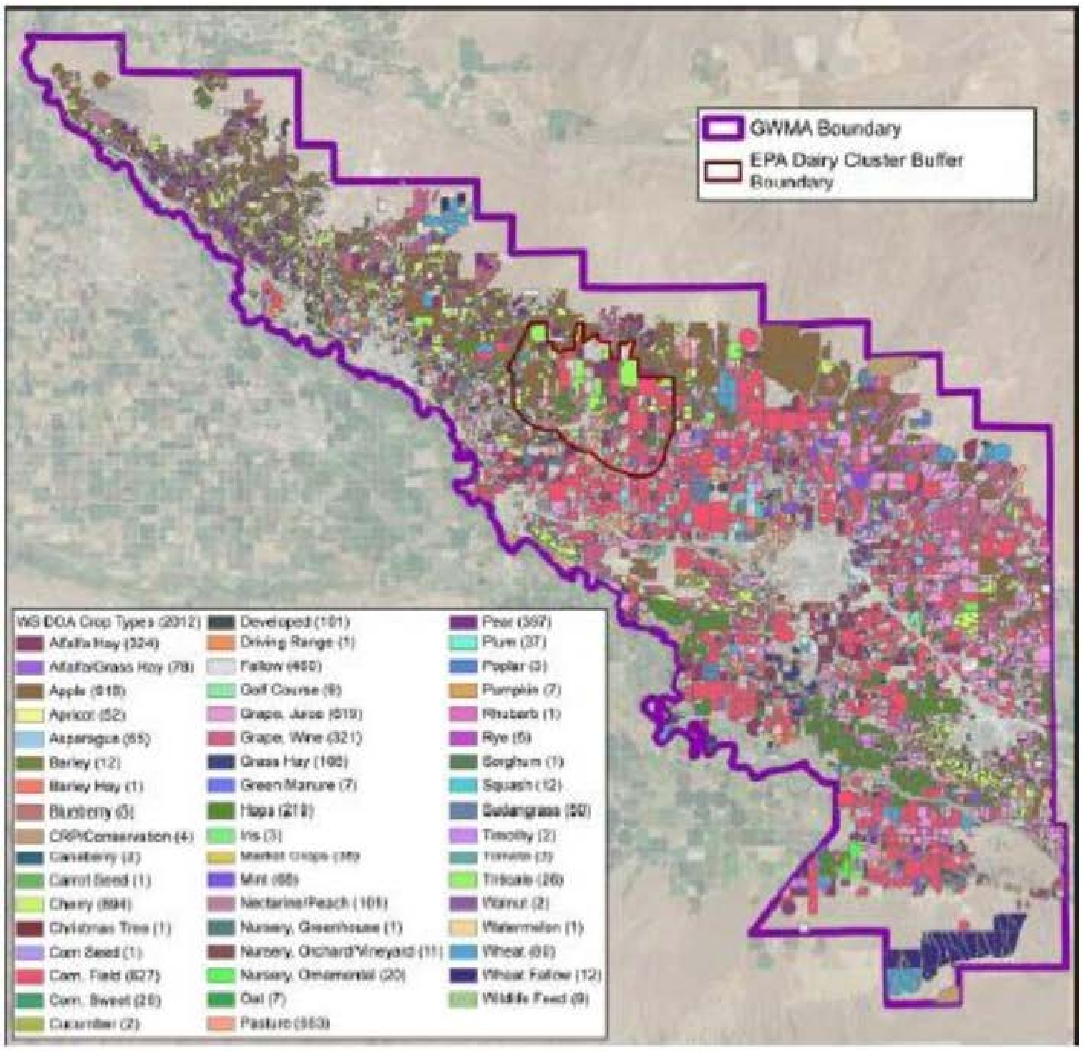
2. Irrigation Types
   - None, none + anything, unknown ~6% of area irrigation
   - Drip, micro sprinkler, drip + anything ~13% of area irrigation
   - Sprinklers, sprinklers + anything, hand ~63% of area irrigation
   - Flood, rill, rill + sprinkler ~ 16% of area irrigation

3. Leaching Potentials (percentages unknown)
   - Low
   - Medium
   - High
   - Possibly a fourth category – medium to high

The plan was to calculate total acreage for each of 36 to 96 categories and to rank categories according to acreage. Analysists would determine which categories were most prevalent in the GWMA target area. They would sample 6 fields from each of the most prevalent, 4 fields from each of the next highest grouping and 3 fields from each of the next highest grouping. There would be no sampling from approximately half of the combinations with low prevalence.

In order to determine the percentage of GWMA land in each category someone would use the WSDA map of GWMA area crops below and search the NRCS Web Soils site to determine soil type for each parcel. These calculations were apparently not done.

Map 1. WSDA Crop Map for the GWMA Target Area



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Comparison of the Plan with the Collected DSS Data

For purposes of this comparison the number of categories is reduced to 27 possible combinations: (Irrigation = 3) x (Crops = 3) x (Leaching = 3).

Irrigation

The plan states there is rill irrigation on 16% of the target area. 19% of the fields in the study had rill irrigation

The plan states there is sprinkler irrigation on 63% of the fields in the target area. 74% of the fields in the study had sprinkler irrigation

The plan states there is drip irrigation on 13% of the fields in the target area. 7% of the fields in the study had drip irrigation

There is no irrigation on 6% of the fields in the target area and about 1% of the fields in the study had none. That category is omitted in this analysis of the DSS

Crops by Rooting Depth

The plan states that 1% of the crops in the target area have roots < 2.5 Ft deep. About 5% of the fields in the study had crops (mint) in this category

The plan states that 54% of the crops in the target area have roots 2.5 Ft to 4 Ft. About 66% of the fields in the study had crops in this category.

The plan states that 42% of the crops in the target area have roots > 4 Ft. About 29% of the fields in the study had crops in this category

Analysis of DSS by crops is complicated by double cropping. Most of the DSS fields planted in triticale and corn silage were double cropped. Double cropping was done on 24% of the fields in the fall soil sampling and 46% of the crops in the spring soil sampling

Crops in the DSS are not always typical of the crops grown in the area. For example 2.5% of the fields in the DSS were planted in apples but 19% of the cropland in the area is actually planted in apples according to the WSDA. For example 17% of the fields in the DSS were planted in alfalfa but 7% of the cropland in the area is actually planted in alfalfa according to the WSDA. The composition of the > 4 Ft root depth group in the DSS includes both of these crops and is especially not typical of the area.

Leaching Potential

In the collected data the DSS leaching potential categories were:

- Very low to moderately low – 6% of fields
- Moderately high to high – 84% of fields
- High to very high – 10% of fields

We do not know the actual percentages of leaching categories in the GWMA target area.

Results for Most Prevalent Categories in the DSS

The DSS gathered data for 15 out of the 27 categories.

Table 3. LYV GWMA DSS Categories with Soil Testing Results

Irrigation	Root Depth	Leaching Potential	Number of fields in the DSS	% of DSS Fields
Rill	< 2.5 Ft	Moderately High, Moderately High to High	6	4%
Rill	2.5 Ft to 4 Ft	Moderately High, Moderately High to High	19	12%
Rill	2.5 Ft to 4 Ft	High to Very High	1	1%
Rill	> 4 Ft	Moderately High, Moderately High to High	3	2%
Rill	> 4 Ft	High to Very High	1	1%
Sprinkler	< 2.5 Ft	Moderately High, Moderately High to High	2	1%
Sprinkler	2.5 Ft to 4 Ft	Very Low to Moderately Low	8	5%
Sprinkler	2.5 Ft to 4 Ft	Moderately High, Moderately High to High	65	40%
Sprinkler	2.5 Ft to 4 Ft	High to Very High	12	7%
Sprinkler	> 4 Ft	Moderately High, Moderately High to High	31	19%
Sprinkler	> 4 Ft	High to Very High	2	1%
Drip	2.5 Ft to 4 Ft	Very Low to Moderately Low	1	1%
Drip	2.5 Ft to 4 Ft	Moderately High, Moderately High to High	1	1%
Drip	> 4 Ft	Very Low to Moderately Low	1	1%
Drip	> 4 Ft	Moderately High, Moderately High to High	9	6%

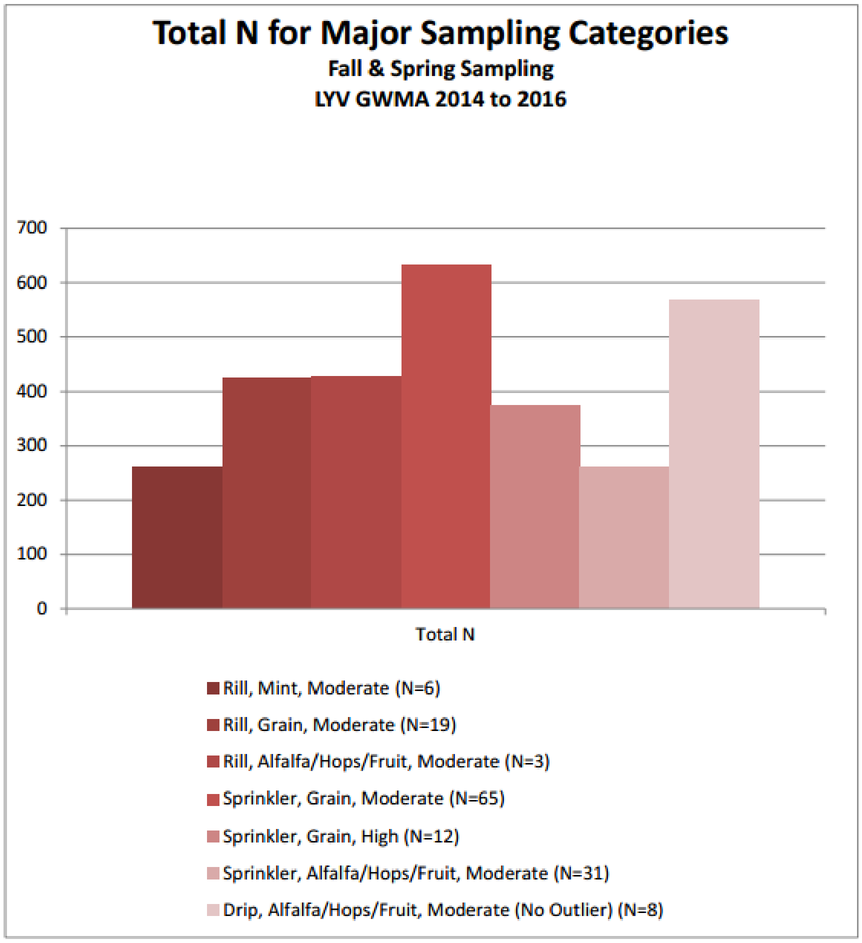
Here are the average readings for nitrates in the soil for the categories with more than three samples. The bar graph that follows shows the calculated total nitrogen for these major groups. Note that early refusal of the auger results in fewer samples and a lower total N. For this reason the category "Sprinkler, Grain, Low" was omitted from the bar graph since that grouping had no measurements below 3 ft.

Table 4. Average NO_3 Levels by Sampling Category for LYV GWMA DSS

Category	1 FT	2Ft	3 Ft	4 Ft	5 Ft	6 Ft	Total N
Rill, Mint, Moderate (N=6)	85.33	26.17	63.67	18.67	57.17	9.17	260.17
Rill, Grain, Moderate (N=19)	157.95	74.42	69.74	47.37	52.88	33.69	425.16
Rill, Alfalfa/Hops/Fruit, Moderate (N = 3)	138.33	84.67	63	62.67	58	21	427.67
Sprinkler, Grain, Low (N=8)	92.88	80.83	103.67		Early Refusal		
Sprinkler, Grain, Moderate (N=65)	101.09	130.69	145.08	124.88	111.7	102.77	631.43
Sprinkler, Grain, High (N=12)	102.5	61.5	89.1	60	62.67	50.44	373.08
Sprinkler, Alfalfa/Hops/Fruit, Moderate (N = 31)	60.83	35.72	53.56	53.67	65.67	37.75	260.72
Drip, Alfalfa/Hops/Fruit, Moderate with Outlier (N = 9) *	287.44	168.56	164.67	36.56	217.86	187.57	972.44
Drip, Alfalfa/Hops/Fruit, Moderate without Outlier (N = 8)	204.63	182.25	110.75	34	30.17	18.17	567.75

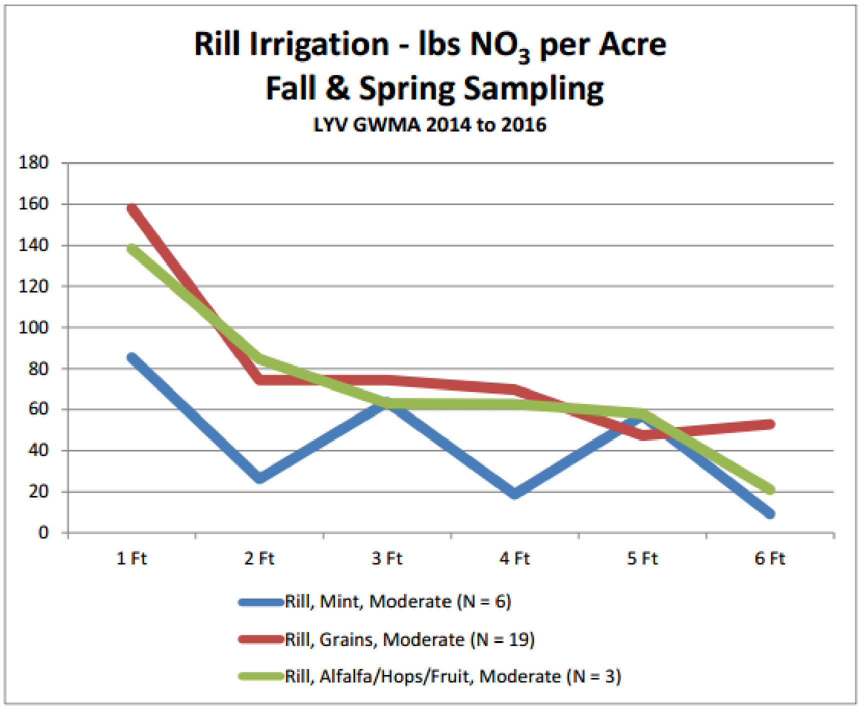
* Field #3141 had extremely high nitrate levels at the 5 ft and 6 ft levels. At this depth the readings cannot be explained by the parameters in the study. This field was excluded from the analysis on this page, but not from later analyses.

Graph 2. Total Nitrogen for Major Sampling Categories LYV GWMA DSS



Following are graphs that provide easy viewing of common factors in the 15 groupings.

Graph 3.



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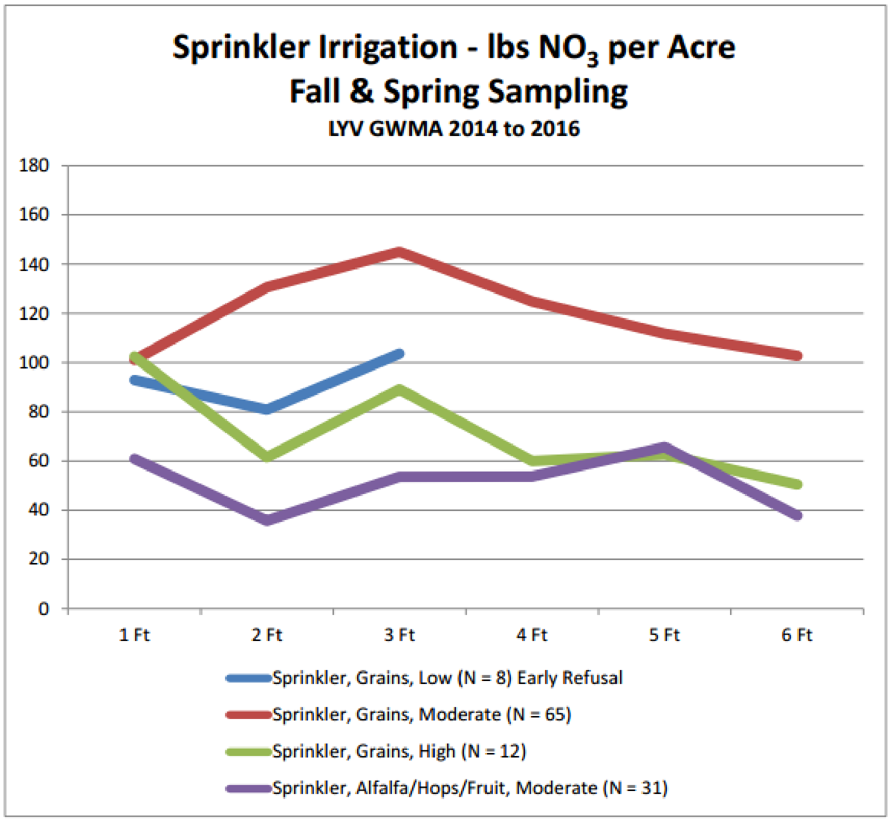
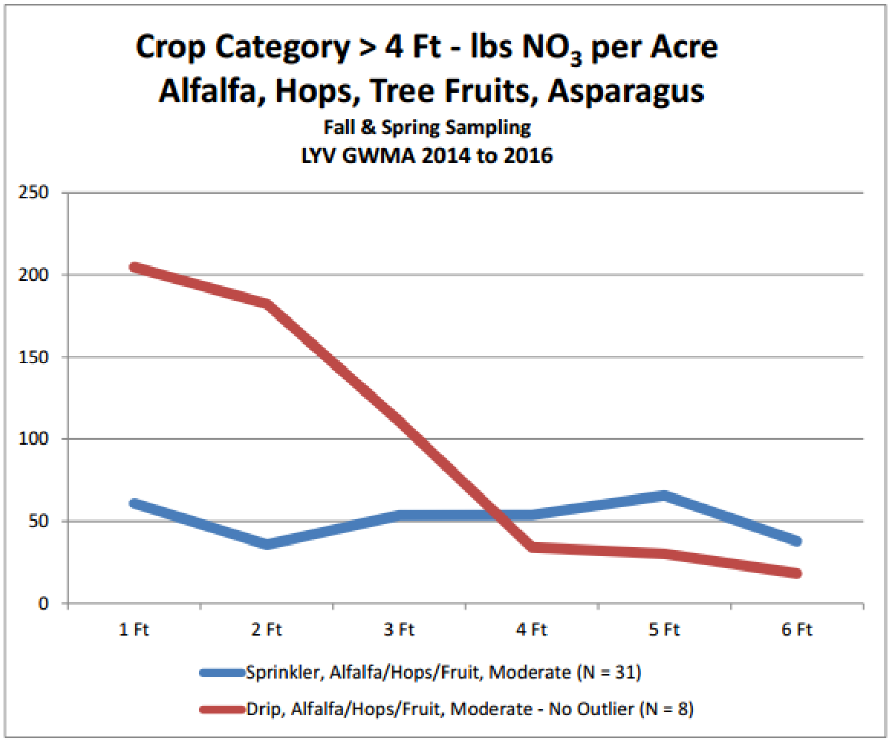
Graph 4.



Sprinkler Irrigation - lbs NO_3 per Acre
Fall & Spring Sampling
LYV GWMA 2014 to 2016
180
160
140
120
100
80
60
40
20
0
1 Ft
2 Ft
3 Ft
4 Ft
5 Ft
6 Ft
Sprinkler, Grains, Low (N = 8) Early Refusal
Sprinkler, Grains, Moderate (N = 65)
Sprinkler, Grains, High (N = 12)
Sprinkler, Alfalfa/Hops/Fruit, Moderate (N = 31)

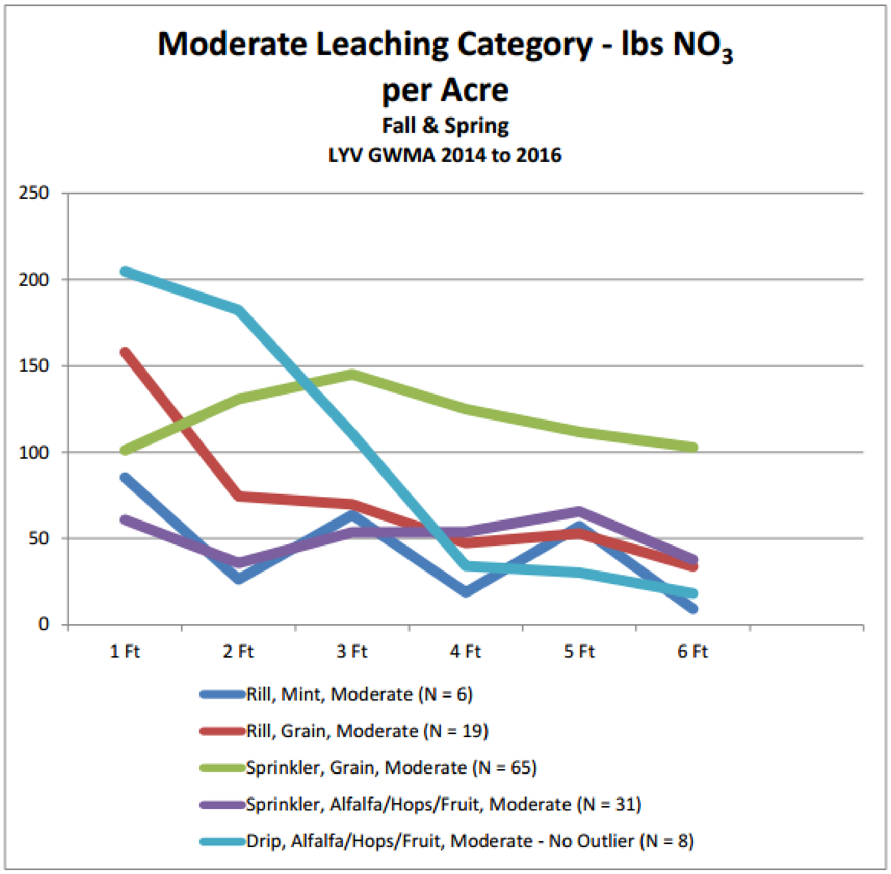
12

Graph 5.



Note change in scale

Graph 6.



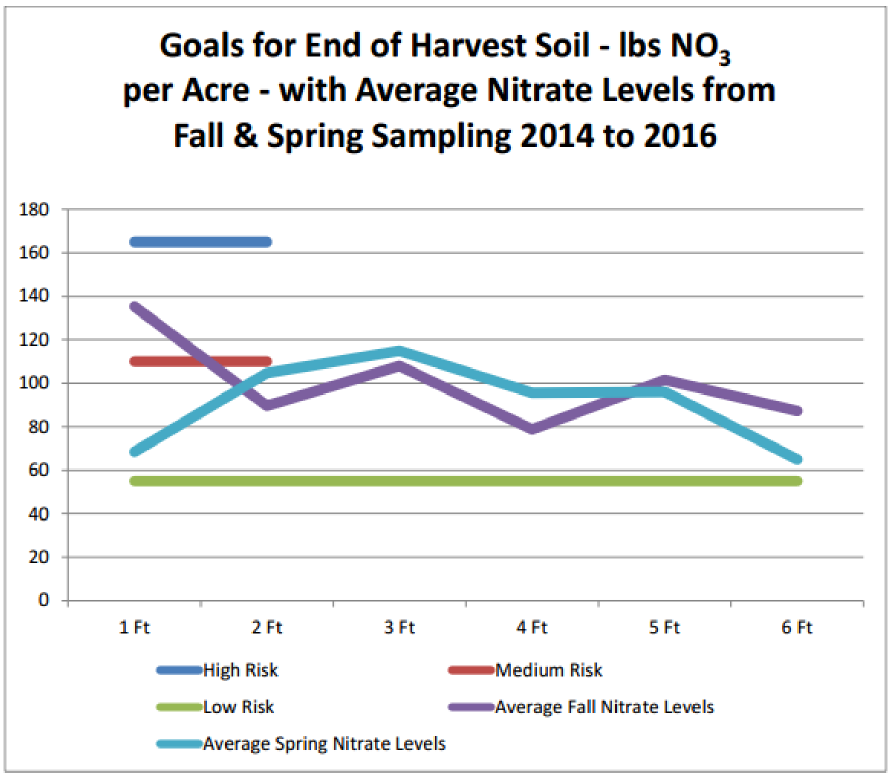
Descriptive Analysis of the DSS Data

Based on the number of samples available certain groupings of data in the DSS lend themselves to limited analysis. In the pages that follow there is discussion of data for the crops: alfalfa, alfalfa + other, triticale & corn silage. There is limited discussion of other crops: grapes, hops, mint, grain corn, & wheat. There is analysis of the impact of double cropping, fertilizer practices and root depth. This study is not sufficiently sophisticated to analyze combinations of factors. The results apply only to the data in the DSS and should only be applied to the entire GWMA target area with caution. Spring and fall data collections are analyzed separately in most of the analyses that follow.

DSS Goals: Suggested goals for end of harvest soil testing at the two foot level in Eastern Washington can be adapted from the WA State General NPDES permit for Concentrated Animal Feeding Operations. (Ecology, 2017). According to this document there is low risk when end of harvest nitrate levels at two feet are < 55 # per acre, medium risk when levels are 55# per acre to 110 # per acre, high risk when levels are 110 # per acre to 165 # per acre and very high risk when levels are > 165 # per acre.

Here is a graphic representation with the average nitrate levels from fall and spring DSS testing in the LYV GWMA target area:

Graph 7.



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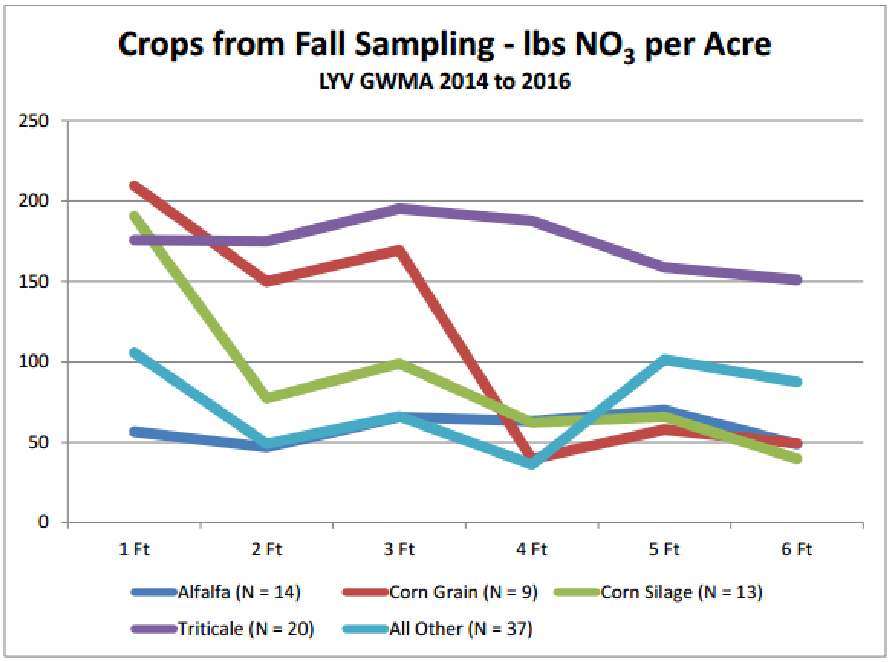
Major Categories: The majority crops in the fall sampling were triticale (n=20), alfalfa (n = 14), corn silage (n=13), corn grain (n=9) and all others (n=37). The majority crops in the spring sampling were triticale (n=31), unknown (n=15), alfalfa (n=13), corn silage (n=8) and all others (n=15).

Graph 8.



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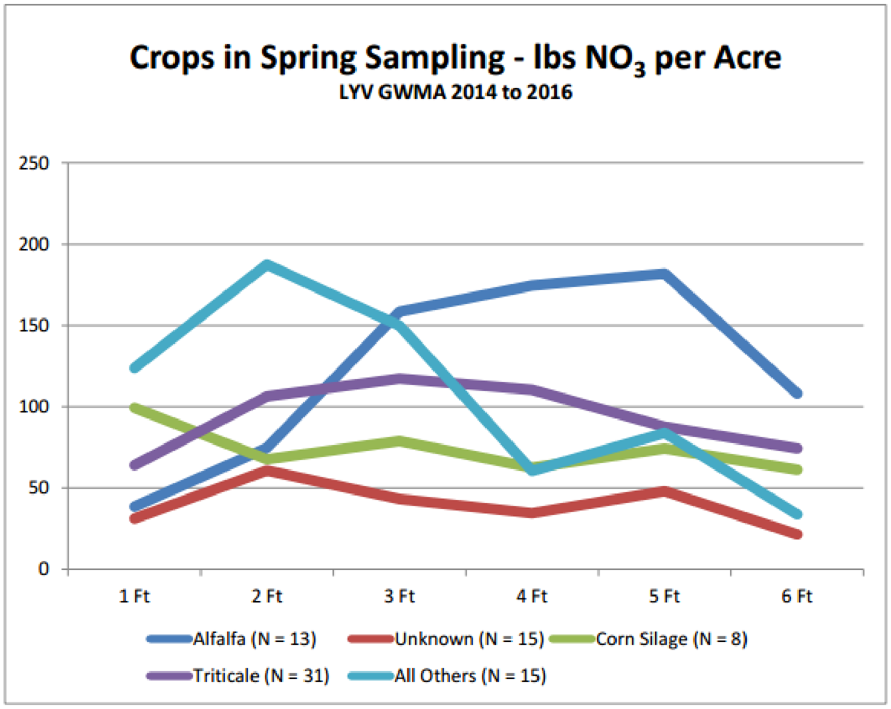
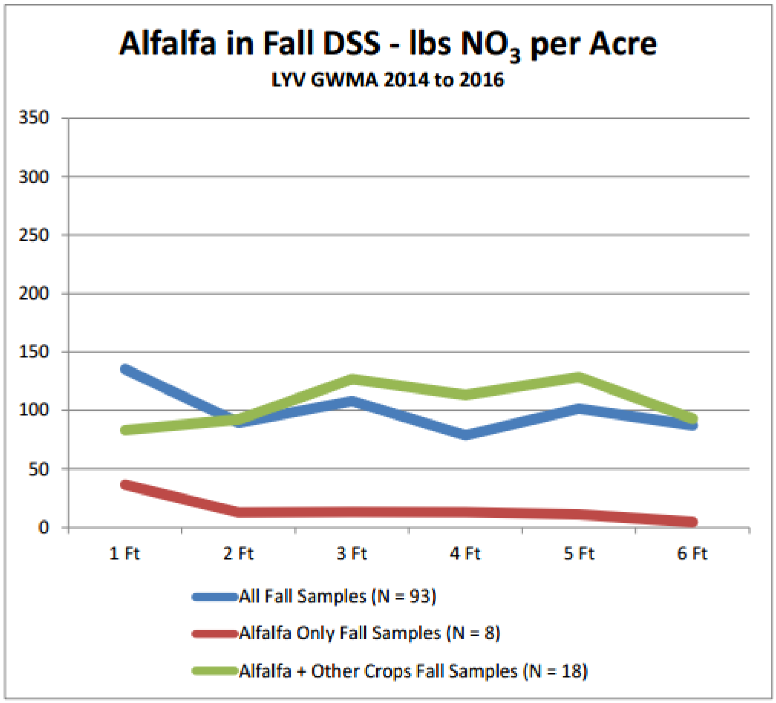
Graph 9.



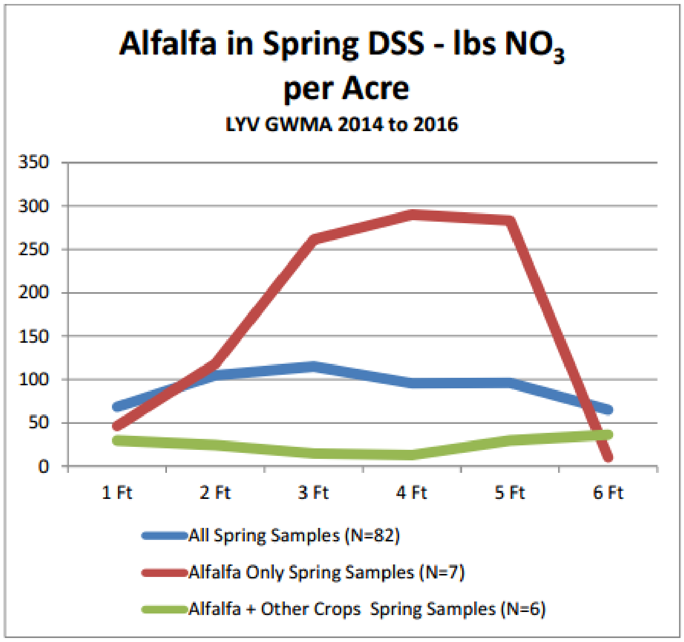
Alfalfa: Analysis of the data for alfalfa from the fall samplings strongly suggests that when alfalfa is the only crop planted on a field for several years, then nitrate levels tend to be low. When other crops are rotated onto the field then nitrate levels tend to be higher. Fertilization practices naturally have a strong influence.

Graph 10.



But when the alfalfa data from spring sampling is analyzed there are surprises. The spring alfalfa fields have much higher nitrate levels than the combined fields for all spring sampling. Alfalfa only fields have higher nitrates than the fields with alfalfa plus multiple other crops in the spring sampling.

Graph 11.



A closer look at the spring "alfalfa only" data provides a clue. There are some extreme values in fields #2044, #2047 and #4152. The range of values for these fields is huge.

Table 5. Spring Sampling: Alfalfa = Only Crop

Field ID	1 FT	2Ft	3 Ft	4 Ft	5 Ft	6 Ft	Total	Ammonia	Organic
2045	29	4	20	22	13	31	119	25	2.37
2047	113	466	913	951	626	242	3321	21	3.11
2073	36	35	31	38			140	27	2.42
2074	75	55	68	97	94	26	415	26	2.51
4152	25	106	319	279	256	219	1204	26	2.63
2044	29	152	457	623	706	409	2376	31	3.4
4153	17	9	21	21	5	10	83	17	2.62
Averages	46.29	118.14	261.29	290.14	283.33	10	1094	24.7	2.72

According to the DSS spreadsheets for the fields with high nitrate levels:

- No irrigation type is listed for #2044 but it is likely sprinkler. Soil testing is done annually. "No nutrients have been applied during last four years." Crop yield is slightly less than average at 7.5 tons per acre. Soil type is Outlook Silt Loam with a moderately high to high Ksat. Rooting depth averages 3.7 ft with a range of 1.5 ft to 5.4 ft
- Irrigation is pivot sprinkler for #2047. Soil testing is done annually. This field received 300#/acre of N from liquid manure in 2012, 2013, & 2014 and 150#/acre of N from liquid manure in 2015. Average crop yield was 8.75 tons per acre. Soil type is Warden Silt Loam 5-8% slopes with moderately high to high Ksat. Average rooting depth is 3.8 ft with a range of 2ft to 5.9 ft.
- Irrigation is pivot sprinkler for #4152 and moisture sensors had been in place for a year. Soil testing is done annually. "No nutrients applied from 2013 thru 2016". Average crop yield was 8 tons per acre. Soil type is Sinloc Silt Loam 2-5% slopes with a moderately high to high Ksat. Rooting depth averaged 4 ft with a range of 1.5 ft to 6 ft.

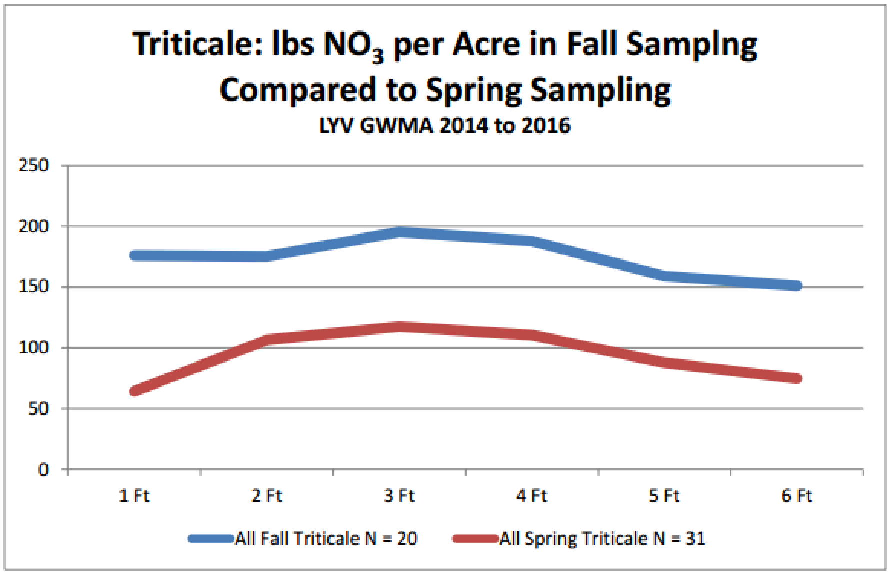
For the fields with low nitrate levels:

- Irrigation is by wheel lines on field #2045. Soil testing is done annually. "No nutrients applied since fall of 2011." Crop yield is slightly less than average at 7.5 tons per acre. Soil type is Sinloc Fine Sandy Loam 0-2% slopes with moderately high to high Ksat. Rooting depth averaged 3.55 ft with a range of 3 ft to 4.7 ft.
- Irrigation is by pivot sprinkler on field #2073. Soil testing is done twice a year. The field received 150# of N per acre from liquid manure in 2012, 2013, 2014 & 2015. Crop yield was 9.75 tons per acre. Soil type is Warden Silt Loam 8-15% slopes with moderately high to high Ksat. Rooting depth averaged 3 ft with a range of 2.4 ft to 3.3 ft. There was refusal of the auger at < 4 ft at all four bore holes.
- Irrigation is by wheel lines on field #2074. Soil testing is done annually and soil moisture sensors are used. The field received 106 #N per acre in 2012 and 177 #N per acre in 2013 & 2014 from liquid manure. Crop yield averages 8 tons per acre. Soil type is Finley Silt Loam 0-2% slopes with high Ksat. Rooting depth averages 3.9 ft with a range of 2.6 ft to 6 ft.
- Irrigation is by wheel lines on field #4153. Soil testing is done annually. "No nutrients applied 2013 thru 2016." Crop yield averages 16.7 tons of green chop per year. Soil type is Warden Silt Loam 5-8% slopes with moderately high to high Ksat. Rooting depths average 3.9 ft with a range of 3 ft to 4.8 ft.

This information is insufficient to explain the great differences in nitrate levels.

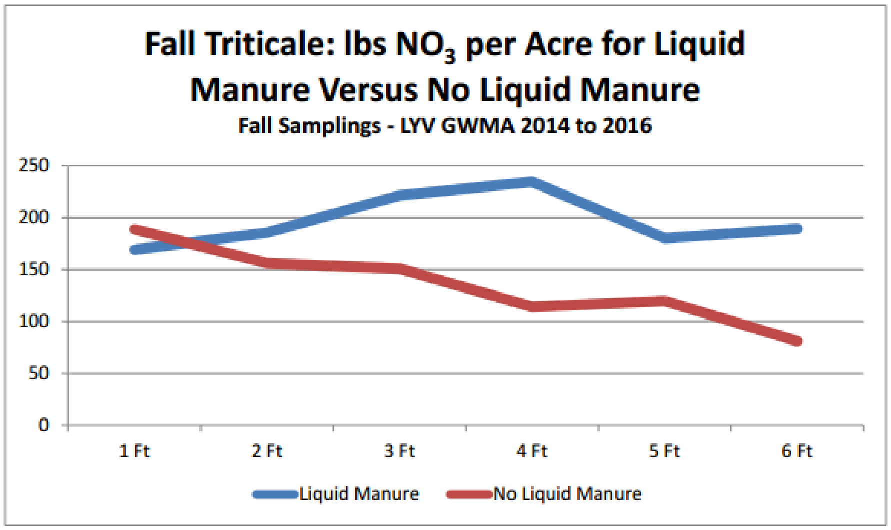
Triticale: Most of the fields planted in triticale are double cropped with corn silage. For purposes of analysis the fields in which triticale is listed as the most recently harvested crop in the *Crop #1* category are considered. Nitrate levels from triticale fields were higher during the fall sampling than during the spring sampling. Overall nitrate levels tended to peak at a depth of 3 ft.

Graph 10.

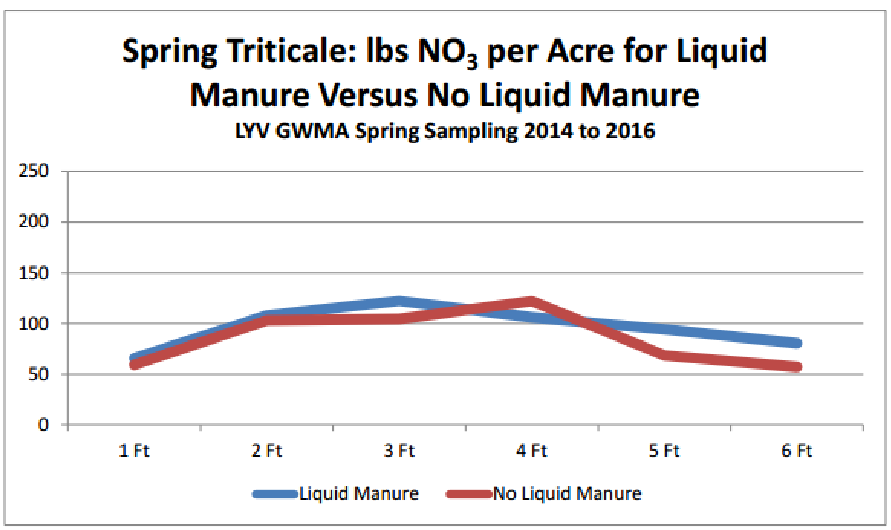


In the fall sampling triticale fields that received liquid manure tended to have higher nitrate levels than those that did not.

Graph 11.

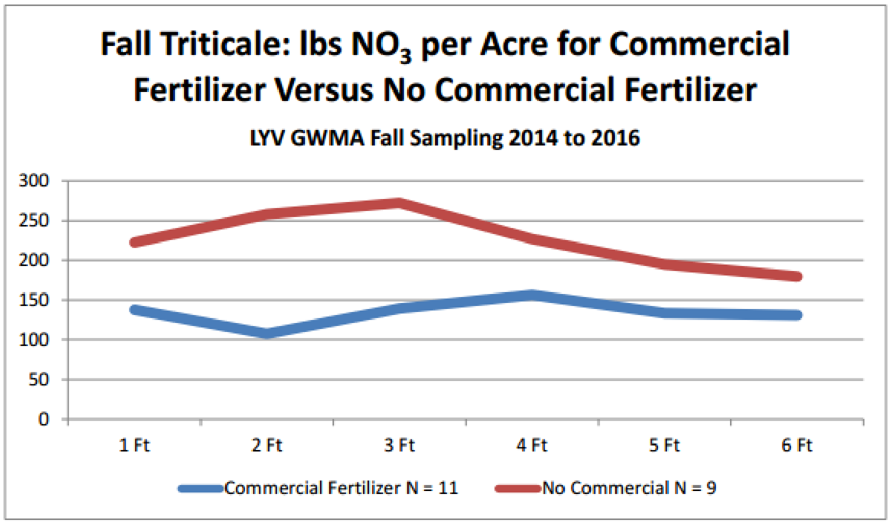


Graph 12.

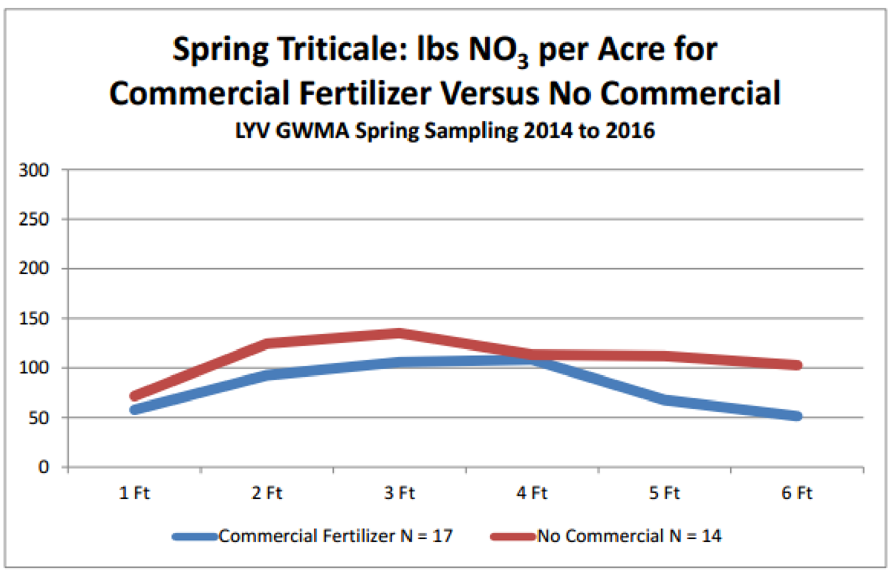


Triticale fields that received commercial fertilizer tended to have lower nitrate levels than those that did not.

Graph 13.



Graph 14.



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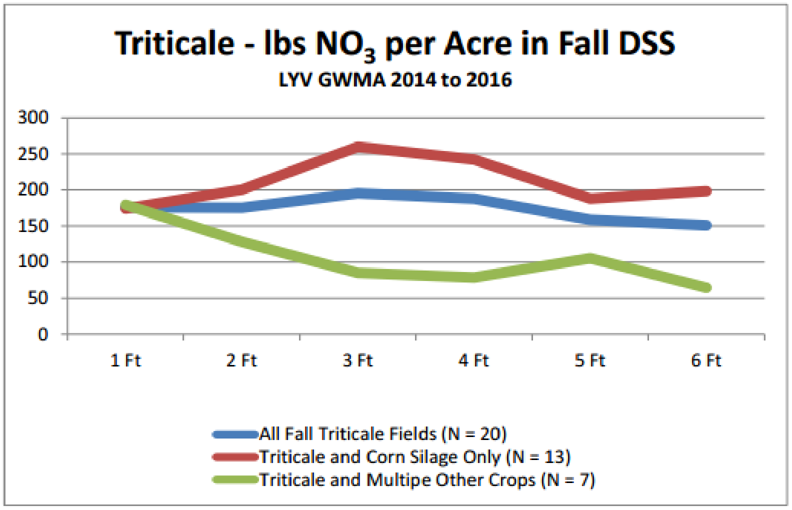
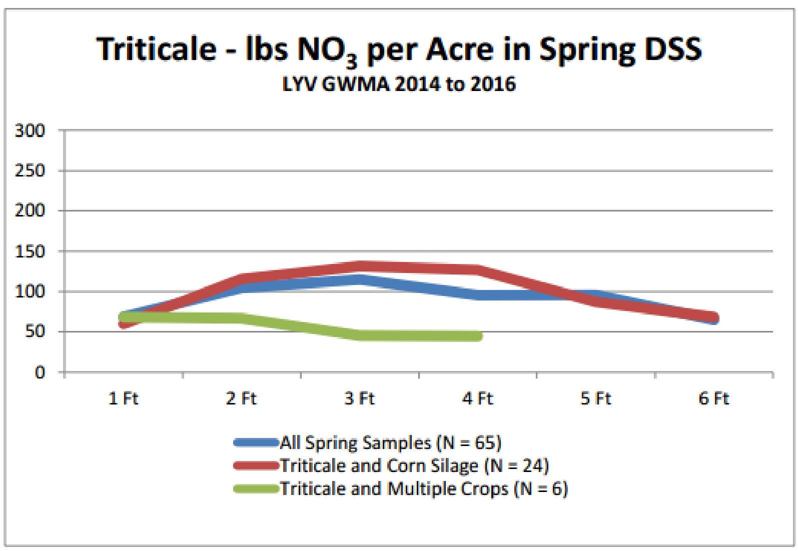
Fields planted only in triticale and corn silage tended to have higher nitrate levels than fields planted in triticale plus multiple other crops.

Graph 15.

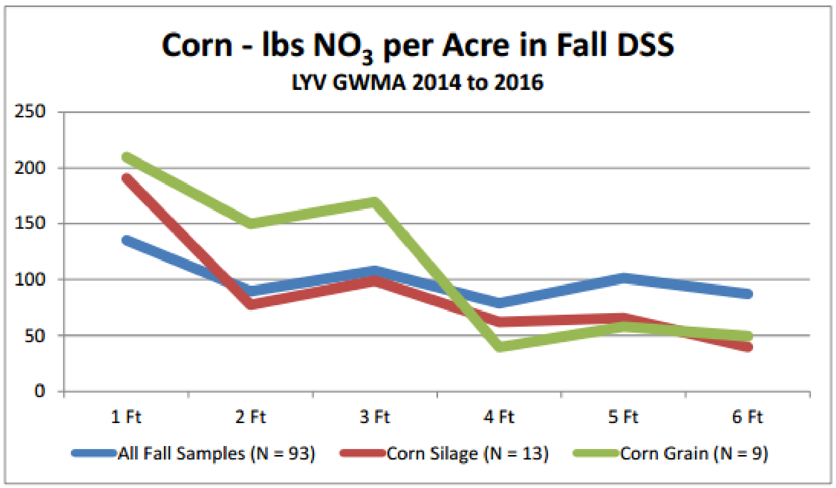


Graph 16.

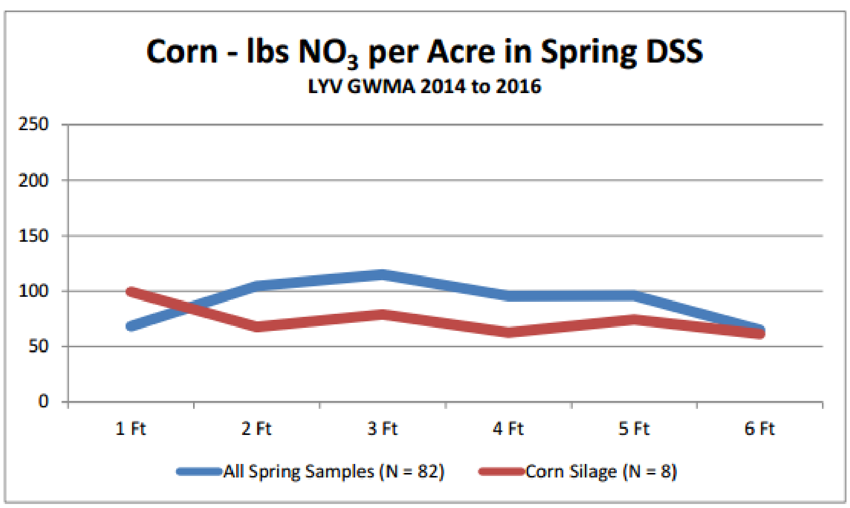


Corn: Both grain corn and silage corn fields were sampled in the fall. Only silage corn was sampled in the spring. Except for the first foot silage corn had lower nitrate levels than the average of all crops in both fall and spring. The fields described below had corn as the most recently harvested crop in the *Crop #1* category of the spreadsheets.

Graph 17.



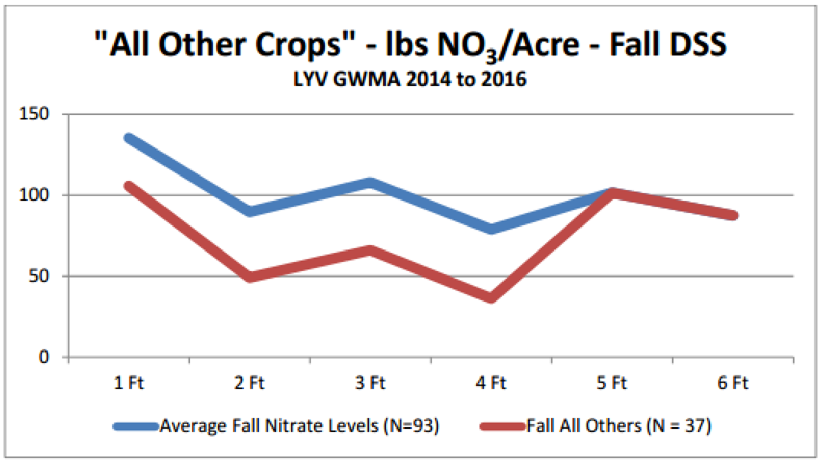
Graph 18.



"All Other Crops": This includes first listed crops other than alfalfa, corn and triticale.

Fall Sampling: There were 37 fields out of 93 for this category in the fall samplings. Crops were: apples (3), barley (1), cherries (2), fallow (1), grapes (6), hay (3), hops (5), mint (5), pasture (5), pears (1), Sudan grass (1), wheat (3), and wine grapes (1)

Graph 19.



Here are the nitrate levels at depths for those fall DSS crops with more than 2 samples. There was refusal before six feet for 17 out of 37 fields so total nitrogen is not included. There were potential outliers.

Table 6. NO_3 Levels for "All Other" Crops for LYV GWMA Fall Sampling

	N	1 FT	2Ft	3 Ft	4 Ft	5 Ft	6 Ft	Ammonia	Organic
"All Other"	37	105.68	49.11	66.03	36.13	101.43	87.43	21.76	1.86
Apples	3	35.33	19	7	3.5	3	3	13.33	1.87
Cherries	2	34	4.5	3	3			6.5	1.26
Grapes *	6	19.33	111.5	182	146	301	292	10.67	1.35
Hay	3	15	5.67	9	7.67	14	18	19.33	1.89
Hops *	5	519.8	27	161	28.2	377.5	304	17.2	1.64
Mint	5	33.8	6.8	21.4	17.8	14.6	13.2	28.8	1.944
Pasture	5	27.8	27	4	4.25	9.25	8	40.4	2.28
Wheat	3	59.33	185	112	45	31	19	27.33	2.02

Possible Outliers are included in the table. These extreme values strongly influence the averages:

The potential outliers are

Grapes:

- Field #3117 is a 37 acre grape field with solid set irrigation. Soil testing is done annually. "This is an organic grape vineyard. No fertilizer is applied. We use vetch legume with triticale as a cover crop and the vetch does nitrogen fixing." Crop yield averages 6.75 tons per year. Soil type is Warden Silt Loam 2-5% slopes with moderately high to high Ksat.
- Field #3119 is a 15 acre grape field with solid set irrigation. Soil testing is done every two years. No fertilizer is applied. "Previous farmer 40 years ago had a history of excessive nitrogen application according to current farmer." Crop yield averages 7.5 tons per acre. Soil type is Warden Silt Loam 8-5% slopes with moderately high to high Ksat.

Hops:

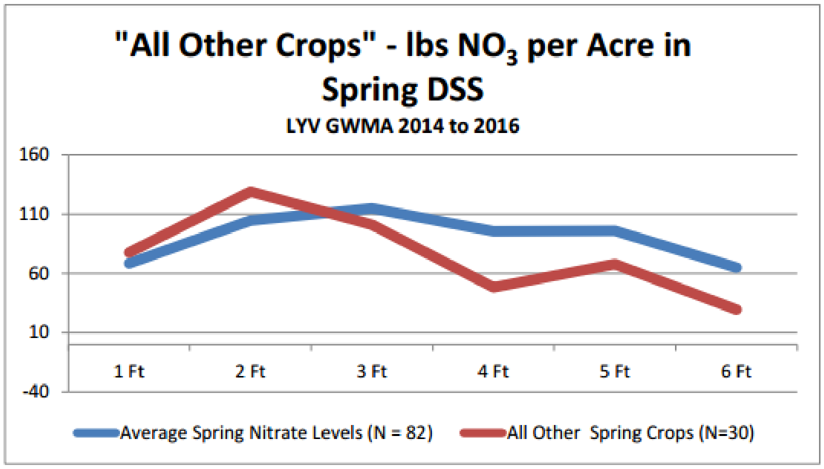
- Field #3141 is a 20 acre hop field with drip irrigation. Soil testing is done annually. 200# N per acre of commercial fertilizer was applied in 2013, 2014 & 2015. Crop yield averages 1.25 tons per acre. Soil type is Esquatzel Silt Loam 0-2% slopes with moderately high to high Ksat.

Table 7. NO_3 Levels: Potential Outliers for "All Other" Crops in LYV GWMA Fall Sampling

Field #	1 FT	2Ft	3 Ft	4 Ft	5 Ft	6 Ft	Total	Ammonia	Organic
3117	51	301	573	400			1325	9	1.67
3119	20	213	260	213	559	580	1845	11	1.49
3141	950	59	596	57	1344	1204	4210	22	2.25

Spring Sampling: There were 30 out of 82 fields in this category for the spring samplings. Crops were: apples (1), asparagus (2), cherries (1), hops (5), mint (2), pasture (1), wheat (2), wine grapes (1) and unknown (15)

Graph 20.



Here are the nitrate levels at depths for those spring DSS crops with more than 2 samples. There was refusal before six feet for 14 out of 30 fields so total nitrogen is not included. There were potential outliers.

Table 8. NO_3 Levels for "All Other" Crops for LYV GWMA Spring Sampling

	N	1 FT	2Ft	3 Ft	4 Ft	5 Ft	6 Ft	Ammonia	Organic
All Other Crops	30	77.5	129.04	101.04	48.17	67.85	29.47	16.87	1.75
Asparagus *	2	231.5	499.5	412	207	212	111.5	14	0.91
Hops	5	124	223	111.8	28.8	30.2	20	11.4	1.43
Mint	2	176.5	68.5	175.5	48.5	158	18.5	10	162.63
Wheat	2	104	40					42	3.38
Unknown	15	31.2	60.83	43.27	34.64	48.11	21.5	16.87	1.79

Potential outliers were Fields # 4175 & 4176. These are the only asparagus fields in the DSS and should not be considered typical of asparagus in the area.

- Field # 4175 is a 10 acre asparagus field. The irrigation type is not identified and soil testing is done annually. "No nutrients applied for at least the last three years. No manure applied for over 10 years. Field gets subby when SVID canal fills up in spring and dries out when canal shuts off." No crop yield is recorded. Soil type is Cleman Very Fine Sandy Loam 0-2% slopes with moderately high to high Ksat.
- Field #4176 is a 20 acre asparagus field with rill irrigation. Soil testing is done annually. "No nutrients applied for at least the last three years. No manure applied for over 10 years. Field gets subby when SVID canal fills up in spring and dries out when canal shuts off." No crop yield is recorded. Soil type is Cleman Very Fine Sandy Loam 0-2% slopes with moderately high to high Ksat.

Here are the nitrate levels for the asparagus fields:

Table 9. Asparagus fields in the LYV GWMA Spring DSS

Field #	1 FT	2Ft	3 Ft	4 Ft	5 Ft	6 Ft	Total	Ammonia	Organic
4175	427	766	664	242	281	169	2549	12	0.69
4176	36	233	160	172	143	54	798	16	1.12
Average	231.5	499.5	412	207	212	111.5	1673.5	14	0.91

Here are the nitrate levels for the fields in which crops were unknown for the Spring DSS. There was early refusal on 9 out of 15 fields in this group.

Table 10. Fields with Unknown Crop in Spring DSS

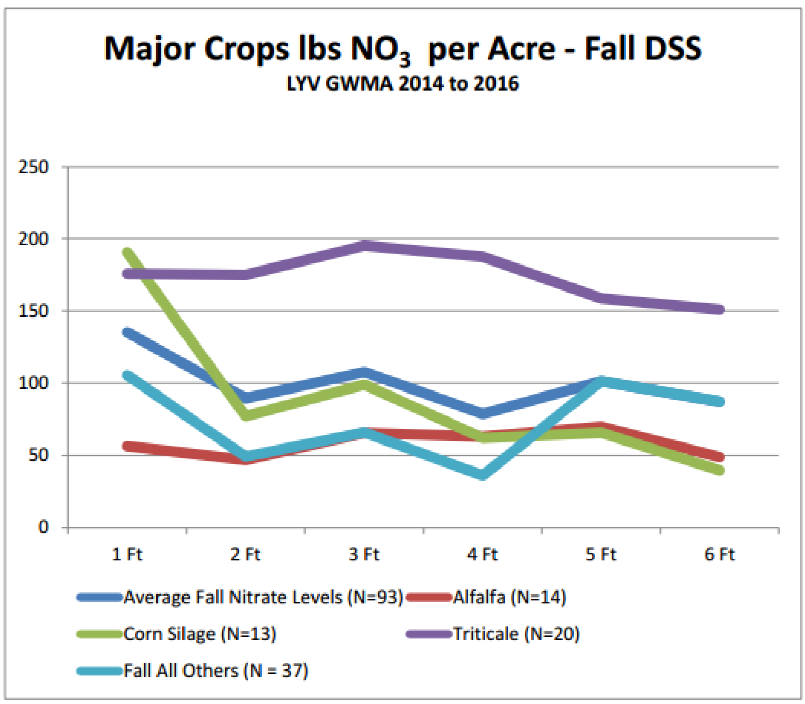
Field #	1 FT	2Ft	3 Ft	4 Ft	5 Ft	6 Ft	Total	Ammonia	Organic
2061	5	3	10	4			22	9	1.78
2062	5	6	11	14	10		46	7	0.84
4146	35						35	9	1.64
4147	54	51	96	197	323		721	13	1.82
4148	41	39					80	36	2.95
4151	37	10	6	4	5	3	65	16	1.19
4160	9						9	19	1.79
4162	14	4	3	3	3	63	30	30	1.66
4163	11	5	13	4	38	3	74	19	1
4164	6	3	3	5	16	14	47	12	1.54
4165	4	51	4	4	6		69	10	1.47
4168	52						52	21	3.2

4171	29	6	16	22	29	27	129	13	1.3
4172	25	11	3	3	3	19	64	15	2.02
4173	141	541	311	121			1114	24	2.64
Average	31.2	60.83	43.27	34.64	48.11	21.5	170.47	16.87	1.79

Comparison of Major Crops for Fall & Spring DSS:

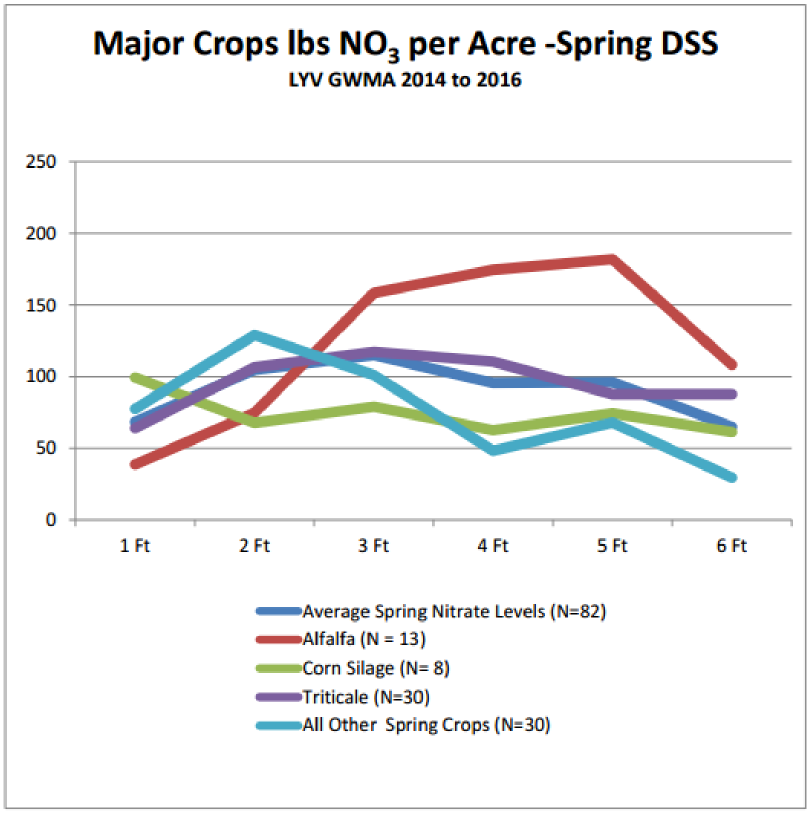
Below are graphs that compare average nitrate levels for all crops to nitrate levels for: alfalfa, corn silage, triticale, and all other crops for the fall and spring DSS.

Graph 21.



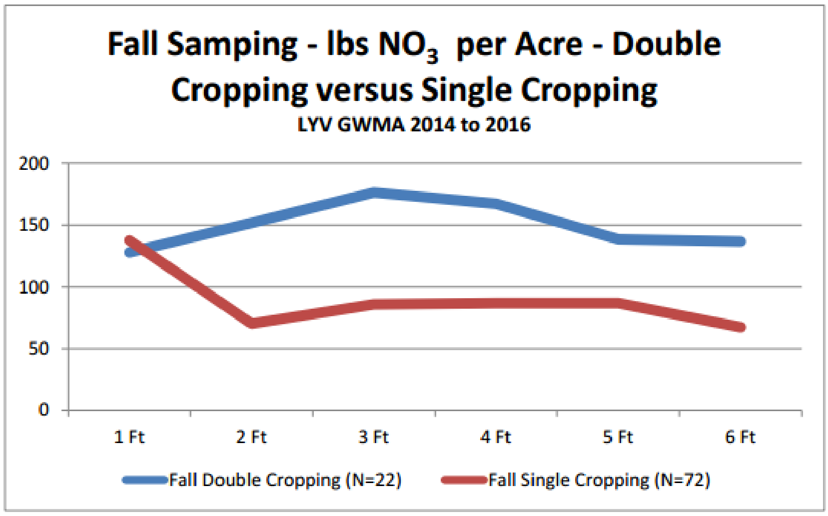
30

Graph 22.

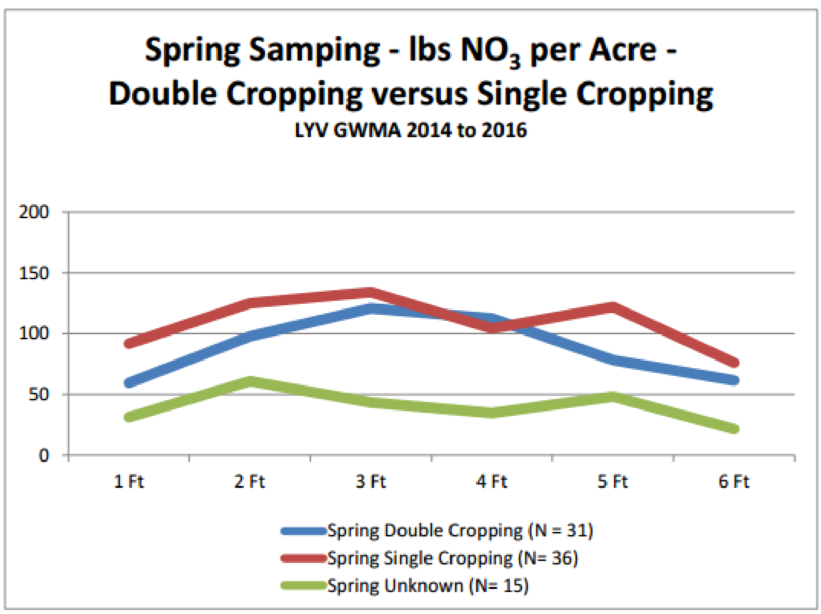


Double Cropping: This practice shows higher nitrate levels than single cropping in the fall sampling and general lower levels in the spring sampling. The 15 samples without cropping information for spring sampling complicate the analysis.

Graph 23.



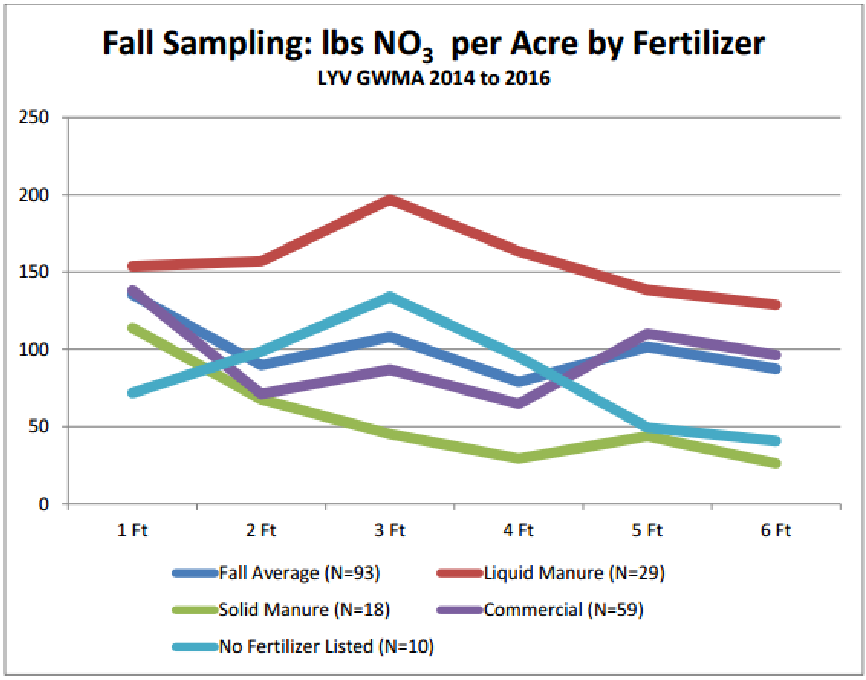
Graph 24.



32

Type of Fertilizer: For the fall sampling (N=93) there were fairly clear differences in nitrate levels for the various fertilizer types.

Graph 25. Fall Sampling by Fertilizer Type



There were 29 fields (31%) that received liquid manure. These fields had the highest percentage of organic matter. They were most likely to be double cropped and most likely to use sprinkler irrigation. Soil testing was highest for this group.

There were 18 fields (19%) that received solid manure. These fields had the highest ammonia levels and second highest levels of organic matter. They had the most rill irrigation and were least likely to receive sprinkler irrigation.

There were 59 fields (63%) that received commercial fertilizer. These fields had the lowest percentage of organic matter and were least likely to receive more than one type of fertilizer.

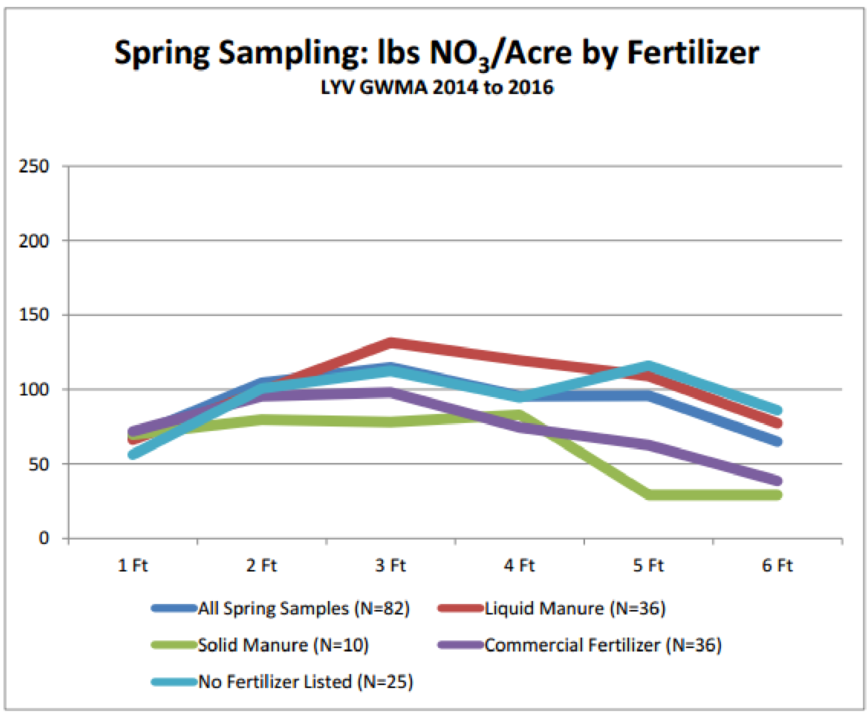
There were 10 fields (11%) with no fertilizer listed. These fields had the lowest ammonia levels and second lowest levels of organic matter. Soil testing was only done on half of these fields, the lowest percentage of all.

Table 11. Analysis of Fertilizer Types for Fall Sampling – LYV GWMA DSS

	NH_3 #/ac Average	Organic Matter	Double Cropped	Rill Irrigation	Sprinkler Irrigation	Soil Testing	> 1 Type Fertilizer
Fall Total N = 93	22.7	2.01%	24%	23%	71%	75%	
Liquid = 29	24.62	2.28%	38%	12%	88%	90%	55%
Solid N = 18	32.33	2.15%	28%	39%	61%	78%	50%
Commercial N = 59	20.27	1.9%	20%	26%	67%	80%	37%
None listed N = 10	15.5	1.94%	20%	10%	80%	50%	

For the spring sampling (N=82) nitrate levels were close together at shallow levels and spread out at deeper levels.

Graph 26. Spring Sampling by Fertilizer Type



There were 36 fields (44%) that received liquid manure. 18 of these fields also received commercial fertilizer. All had soil testing. These fields had the highest ammonia levels and the highest percentage of organic matter. They were most likely to be double cropped and had the highest percentage of sprinkler irrigation.

There were 10 fields (12%) that received solid manure. In contrast to the fall soil sampling these fields with solid manure had the lowest ammonia levels and the lowest levels of organic matter. They were least likely to be double cropped, least likely to receive sprinkler irrigation and most likely to receive drip irrigation. 60% received other additional fertilizers.

There were 36 fields (44%) that received commercial fertilizer. 18 of these fields also received liquid manure. These fields had the second highest ammonia levels and the second highest levels of organic matter.

There were 25 fields with no documented fertilizers. This includes fifteen fields with no survey data returned. These fields had the lowest levels of ammonia and organic matter.

Table 12. Analysis of Fertilizer Types for Spring Sampling – LYV GWMA DSS

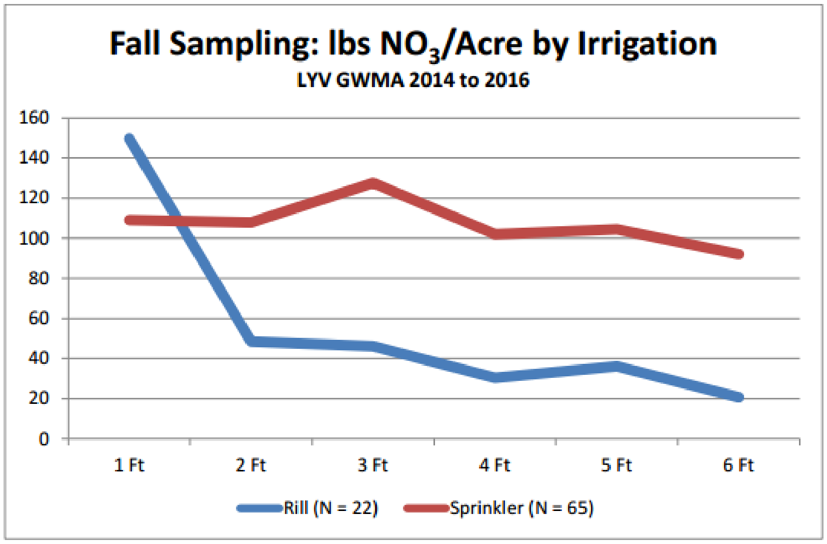
	NH_3 lbs/ac	Organic Matter	Double Cropped	Rill Irrigation	Sprinkler Irrigation	Drip Irrigation	Soil Testing	> 1 Type Fertilizer
Spring Total N = 82	23.8	2.13%	46%	10%	76%	10%	99%	35%
Liquid N = 36	30.86	2.36%	69%	8%	92%	0%	100%	56%
Solid N = 10	20.8	2.07%	50%	10%	70%	20%	100%	60%
Commercial N = 36	26.28	2.21%	56%	8%	78%	14%	97%	58%
None Listed N = 25	18.44	1.85%	4%					

Type of Irrigation: One field in the 93 fall samples received no irrigation. Five fields received drip irrigation and that analysis was complicated by early refusals and the fact that two fields had extremely high and unusual nitrate readings. For this reason drip irrigation is not included in the fall analysis.

Nitrate levels for the 65 fields that received sprinkler irrigation remained around 100 lbs per acre at all levels while the readings for the 22 fields that received rill irrigation rapidly declined after 1 foot.

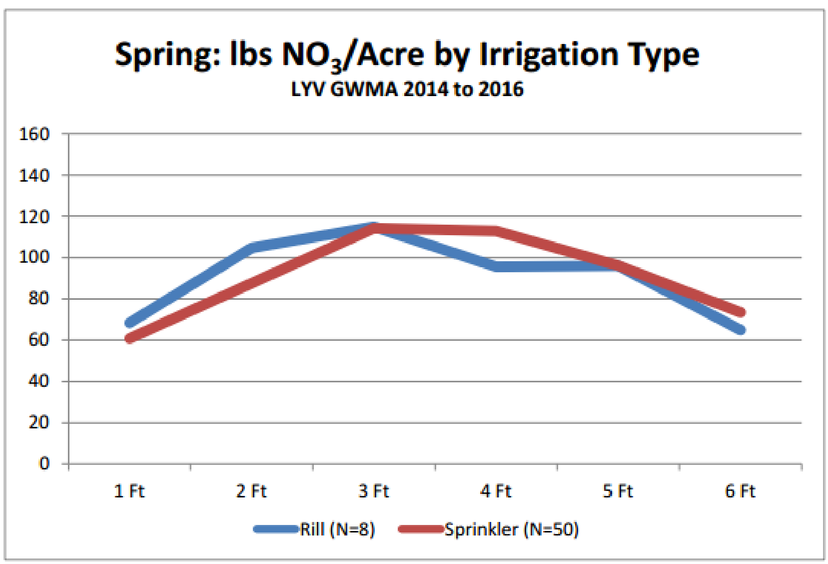
There were 2 fields that had both rill and sprinkler irrigation. They were placed in the rill category according to the DSS plan.

Graph 27.



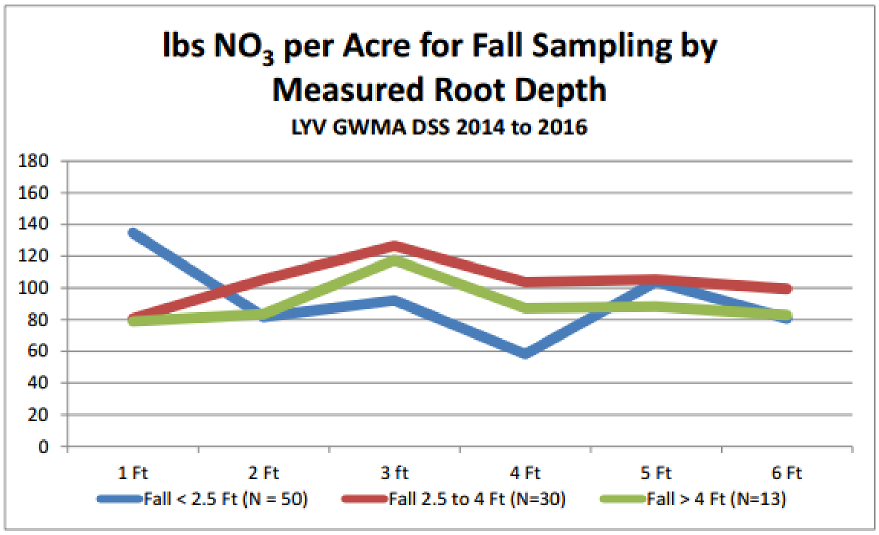
For clarity only rill and sprinkler irrigation for spring sampling are presented here.

Graph 28.



Measured Root Depth: The teams that gathered the soil samples measured root depths on each sampled field. This makes possible a comparison of nitrate levels based on how deep the root of crops penetrated the soil. This is not the same as grouping root depth by crops.

Graph 29.



Graph 30.

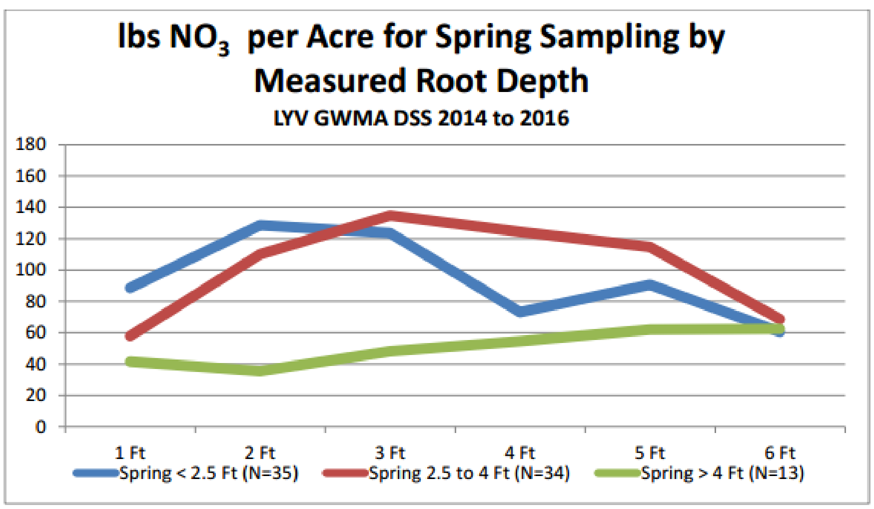


Table 13. NO_3 Levels by Measured Root Depths for Fall & Spring DSS

	Fall 2014 & 2015		Average N by Measured Root Depths						
Group	N	1 FT	2 Ft	3 Ft	4 Ft	5 Ft	6 Ft	Ammonia	Organic
< 2.5 Ft	50	134.72	81.76	92.02	58.15	103.91	80.63	35.46	2.06%
2.5 to 4 Ft	30	160.8	105.2	126.63	103.57	105.23	99.32	17.67	1.87%
> 4 Ft	13	78.92	83.38	117.54	87.08	88.17	82.83	23.69	2.12%
	Spring 2015 & 2016		Average N by Measured Root Depths						
Group	N	1 FT	2 Ft	3 Ft	4 Ft	5 Ft	6 Ft	Ammonia	Organic
< 2.5 Ft	35	88.6	128.63	123.64	73.1	90.6	60.5	23.23	2.21%
2.5 to 4 Ft	34	57.85	110.06	134.88	124.47	114.68	68.54	21.79	2.1%
> 4 Ft	13	41.54	35.46	48.08	54.54	62	62.46	30.62	2.03%

The measured root depths are different from the classification of root depths according to crop type. There is a full range of crops in each category of measured root depths. For example the category < 2.5 feet in the fall sampling included fields planted in triticale, corn, pasture, alfalfa, grapes, barley, mint, apples, grass hay, hops, and pears.

Note the lower nitrate levels for samples where the roots extend to deeper levels.

Statistical Analysis

Another way to look at the data is to describe the sampling at different soil depths. For the sake of brevity this paper only looks at the 2 Ft and 4 Ft depths. Two feet is the approved level for deep soil testing in Ecology's newly released CAFO General Permit. Four feet is below the root depth for most crops in the DSS and consequently estimates nitrate available for leaching.

The analyses that follow look at the results of soil testing at these levels from a statistical perspective. Previous graphing shows apparent differences in nitrate levels with respect to crops, irrigation, fertilizers and leaching factors. The Student T-test is used here to determine whether those differences have statistical significance. The calculations are based on whether a factor is present or not present. There is no attempt to measure complex associations.

Two Foot Analysis

Table14. Characteristics of Risk Levels at Two Foot Sampling Depths (Low Risk is < 55 lbs NO_3/Acre, Medium Risk/High Risk is 55 lbs NO_3/Acre to 165 lbs NO_3/Acre, Very High Risk is > 165 lbs NO_3/Acre)

		Low Risk	Medium/High Risk	Very High Risk
N		96	47	27
Irrigation				
	Rill	19 (20%)	6 (13%)	3 (11%)
	Sprinkler	62 (65%)	35 (74%)	18 (67%)
	Drip	4 (4%)	4 (9%)	4 (15%)
	Unknown/None	12 (12%)	2 (4%)	2 (7%)
Crops				
	Alfalfa	19 (20%)	6 (13%)	2 (7%)
	Apples	3 (3%)		1 (4%)
	Asparagus			2 (7%)
	Barley	1 (1%)		
	Cherries	3 (3%)		
	Corn Grain		2 (4%)	2 (7%)
	Fallow		1 (2%)	
	Corn Silage		9 (19%)	2 (7%)
	Grapes	3 (3%)	1 (2%)	2 (7%)
	Hay	3 (3%)		
	Hops	4 (4%)	3 (6%)	3 (11%)
	Mint	6 (6%)	1 (2%)	
	Pasture	5 (5%)	1 (2%)	
	Pears	1 (1%)		
	Sudan Grass		1 (2%)	
	Triticale	19 (20%)	21 (45%)	10 (37%)
	Wheat	2 (2%)		2 (7%)
	Wine Grapes	1 (1%)	1 (2%)	
	Unknown	11 (11%)		1 (4%)
	Double Crop	26 (27%)	15 (32%)	10 (37%)

Fertilizer				
	Liquid Manure	29 (30%)	22 (47%)	12 (44%)
	Solid Manure	17 (18%)	8 (17%)	3 (11%)
	Commercial	54 (56%)	26 (55%)	13 (52%)
	Biosolids			1 (4%)
	Compost	2 (2%)		
	Unknown/None		7 (15%)	5 (19%)
Leaching				
	Low	5 (5%)	4 (9%)	1 (4%)
	Moderate	78 (81%)	39 (83%)	25 (93%)
	High	13 (14%)	4 (9%)	1 (4%)

A. Irrigation Types: Analysis using the Student T-test at the 2 foot soil testing depth finds no statistically significant difference in nitrate levels for different types of irrigation except that rill irrigation is associated with lower nitrate levels at the $p < .10$ level of significance.

Rill Irrigation: The average nitrate level at two feet for fields that received rill irrigation is 61.67 lbs per acre. The average nitrate level at two feet for fields with documented irrigation type that did not receive rill irrigation is 102.66 lbs per acre. *The t-value is -1.41917. The p-value is .078941. The result is not significant at p < .05 but it is significant at p < .10.*

B. Crops by Category from DSS Plan: Analysis using the Student T-test was performed for crops at the < 2.5 ft root depth, 2.5 to 4 ft root depth, > 4 ft root depth, > 4 ft root depth minus alfalfa, for alfalfa, corn silage and triticale. Soil tests for fields with no documented crops were omitted from the calculations. Most results were not statistically significant. Here are the noteworthy results.

< 2.5 Ft Root Depth: The average nitrate level at two feet for this category was 24.43 lbs per acre (N=7). The average nitrate level for all other categories was 102.58 lbs per acre. *The t-value is -1.34184. The p-value is .090799. The result is not significant at p < .05 but it is significant at p < .10.*

Alfalfa: The average nitrate level at two feet for alfalfa was 60.30 lbs per acre. The average nitrate level for all other crops was 107.11 lbs per acre. *The t-value is -1.47226. The p-value is .071482. The result is not significant at p < .05 but it is significant at p < .10.*

Triticale: The average nitrate level at two feet for triticale was 133.90 lbs per acre. The average nitrate level for all other crops was 83.01 lbs per acre. *The t-value is 1.98851. The p-value is .024252. The result is significant at $p < .05$.*

C. Fertilizer: It appears that the type of fertilizer impacts nitrate levels at two feet.

a. Looking at all 170 samples with results at two feet the Student T-test tells us that the higher levels of nitrates seen with application of liquid manure are significant.

Liquid M: The average nitrate level at two feet for fields that received liquid manure is 125.57 lbs per acre. The average level for fields that did not receive liquid manure is 79.24 lbs per acre. *The t-value is 1.94819. The p-value is .026529. The result is significant at $p < .05$.*

Commercial: The average nitrate level for fields that received commercial fertilizer is 80.18 lbs per acre. The average nitrate level for fields that did not receive commercial fertilizer is 116.49 lbs per acre. *The t-value is -1.56554. The p-value is .059669. The result is not significant at $p < .05$ but it is significant at $p < 0.10$.*

Differences in nitrate levels for other fertilizer types are not significant for this data set.

b. If we leave out the fields with no documented fertilizer applications and look only at the 135 samples known to receive fertilizer the Student T-test tells us that, at two feet, the higher levels of nitrates seen with application of liquid manures and the lower levels seen with application of commercial fertilizer are significant.

Liquid M: The average nitrate level at two feet for fields that received liquid manure is 125.57 lbs per acre. The average nitrate level for fertilized fields that did not receive liquid manure is 67 lbs per acre. *The t-value is 2.39048. The p-value is .009114. The result is significant at $p < .05$.*

Commercial: The average nitrate level at two feet for fields that received commercial fertilizer is 80.18 lbs per acre. The average nitrate level for fertilized fields that did not receive commercial fertilizer is 126.78 lbs per acre. *The t-value is -1.73592. The p-value is .042447. The result is significant at $p < .05$.*

D. Leaching Categories: 142 out of the 170 fields (84%) with data at two feet had soils in the moderate to moderately high Ksat category. This makes analysis of leaching less certain. This data showed no significant differences in nitrate levels for the three leaching categories except for a possible mild effect at the $p < .10$ level of significance.

Moderate: The average nitrate value at the two foot level for fields with moderately high to high Ksat soils was 103.93 lbs per acre. The average nitrate level for fields not in that category was 58.29 lbs per acre. *The t-value is 1.46704. The p-value is .072118. The result is not significant at p < .05 but it is significant at p < .10.* Note that both low to moderately low and high to very high fields had lower nitrate levels than moderately high to high. The graph is dome shaped and not a straight line.

Four Foot Analysis

Table15. Characteristics of Risk Levels at Four Foot Sampling Depths (Low Risk is < 55 lbs NO_3/Acre, Medium Risk/High Risk is 55 lbs NO_3/Acre to 165 lbs NO_3/Acre, Very High Risk is > 165 lbs NO_3/Acre)

		Low Risk	Medium/High Risk	Very High Risk
N		89	34	24
Irrigation				
	Rill	21 (23%)	6 (18%)	2 (8%)
	Sprinkler	52 (59%)	23 (68%)	19 (79%)
	Drip	7 (8%)	4 (12%)	
	Unknown/None			3 (13%)
Crops				
	Alfalfa	16 (18%)	3 (9%)	4 (21%)
	Apples	2 (2%)	1 (3%)	
	Asparagus			2 (8%)
	Barley	1 (1%)		
	Cherries	1 (1%)		
	Corn Grain	4 (4%)	2 (6%)	
	Corn Silage	13 (15%)	5 (15%)	2 (8%)
	Grapes	2 (2%)	1 (3%)	2 (8%)
	Hay	3 (3%)		
	Hops	7 (8%)	3 (9%)	
	Mint	5 (6%)	2 (6%)	
	Pasture	5 (6%)		
	Pears	1 (1%)		
	Sudan Grass	1 (1%)		
	Triticale	16 (18%)	15 (44%)	12 (50%)

	Wheat	1 (1%)	1 (3%)	
	Wine Grapes	2 (2%)		
	Unknown	9 (10%)	1 (3%)	1 (4%)
	Double Crop	19 (21%)	13 (38%)	12 (50%)
Fertilizer				
	Liquid Manure	20 (23%)	17 (50%)	11 (46%)
	Solid Manure	20 (23%)	5 (15%)	1 (4%)
	Commercial	47 (53%)	16 (47%)	8 (33%)
	Biosolids	2 (2%)		1 (4%)
	Compost			
	Unknown/None	10 (11%)	1 (3%)	9 (38%)
Leaching				
	Low	2 (2%)		1 (4%)
	Moderate	76 (85%)	30 (88%)	22 (92%)
	High	11 (12%)	4 (12%)	1 (4%)

A. Irrigation Type: Analysis using the Student T-test at the 4 foot level finds a statistically significant association between sprinkler irrigation and higher nitrate levels and a statistically significant association between rill irrigation and lower nitrate levels.

Rill Irrigation: The average nitrate reading at 4 feet for fields that receive rill irrigation was 40.3 lbs per acre. The average reading for fields that did not receive rill irrigation was 98.54 lbs per acre. *The t-value is -1.92605. The p-value is .028124. The result is significant at $p < .05$.*

Sprinkler Irrigation: The average nitrate reading at 4 feet for fields that receive sprinkler irrigation was 106.59 lbs per acre. The average reading for fields that did not receive sprinkler irrigation was 37.66 lbs per acre. *The t-value is 2.54584. The p-value is .006025. The result is significant at $p < .05$.*

Drip Irrigation: The average nitrate reading at 4 feet for fields that receive drip irrigation was 30.45 lbs per acre. The average reading for fields that did not receive drip irrigation was 90.42 lbs per acre. *The t-value is -1.29622. The p-value is .098581. The result is not significant at $p < .05$ but it is significant at $p < .10$.*

B. Crops: Analysis using the Student T-test was performed for crops at the < 2.5 ft root depth, 2.5 to 4 ft root depth, > 4 ft root depth, > 4 ft root depth minus alfalfa, for alfalfa, corn silage and triticale. Soil tests for fields with no documented crops were omitted from the calculations. The only statistically significant results were for triticale.

Triticale: The average nitrate level at four feet for triticale was 142.81 lbs per acre. The average nitrate level at four feet for all other crops was 66.46 lbs per acre. The t-value is 2.75448. The p-value is .003348. The result is significant at $p < .05$.

Unusually high nitrate levels at four feet for a few alfalfa fields complicate the analysis.

C. Fertilizer: The data suggests that the type of fertilizer impacts nitrate levels at four feet.

a. Looking at all 147 samples that had data at 4 feet the Student T-test tells us that the higher levels of nitrates seen with application of liquid manure are significant. There may be a more modest reduction of nitrate levels with solid manure and commercial fertilizer.

Liquid M: The average nitrate level at four feet for fields that received liquid manure is 139.65 lbs per acre. The average for fields that did not receive liquid manure is 60.61 lbs per acre. *The t-value is 3.08855. The p-value is .001206. The result is significant at p < .05.*

Solid M: The average nitrate level at four feet for fields that received solid manure is 47.85 lbs per acre. The average for fields that did not receive solid manure is 94.7 lbs per acre. *The t-value is -1.45353. The p-value is .074119. The result is not significant at p < .05 but it is significant at p < .10.*

Commercial: The average nitrate level at four feet for fields that received commercial fertilizer is 68.19 lbs per acre. The average for fields that did not receive commercial fertilizer is 108.79 lbs per acre. *The t-value is -1.64521. The p-value is .051047. The result is not significant at p < .05 but it is significant at p < .10.*

b. Looking only at the 117 samples that had data at 4 feet and received fertilizer, the Student T-test tells us that the increased nitrate levels associated with liquid manure and the decreased nitrate levels associated with commercial fertilizer are significant.

Liquid M: The average nitrate level at four feet for fields that received liquid manure is 139.65 lbs per acre. The average for fertilized fields that did not receive liquid manure is 45.71 lbs per acre. *The t-value is 3.4706. The p-value is .000366. The result is significant at p < .05.*

Solid M: The average nitrate level at four feet for fields that received solid manure is 47.85 lbs per acre. The average for fertilized fields that did not receive solid manure is 94.65 lbs per acre. *The t-value is -1.40234. The p-value is .081753. The result is not significant at p < .05 but it is significant at p < .10.*

Commercial: The average nitrate level at four feet for fields that received commercial fertilizer is 68.19 lbs per acre. The average for fertilized fields that did not receive commercial fertilizer is 120.39 lbs per acre. *The t-value is -1.74448; p-value is .041874. The result is significant at $p < .05$.*

D. Leaching: There were no statistically significant differences in the nitrate levels at four feet for the three leaching categories in this study.

Conclusion

This summary of the LYV GWMA DSS concludes that:

- There are differences between spring and fall deep soil testing results
- There was unequal coverage of the various combinations of irrigation practices, crop types and leaching factors.
  - Data was gathered for 15 out of 27 categories.
  - Only 7 categories had six or more samples
  - One category had 3 samples
  - Two categories had 2 samples
  - Five categories had only one sample.
- Sixty five of 175 samples or 37% fell into the category of sprinkler irrigation, 2.5 ft to 4 ft crops and moderately high to high Ksat
- There were fields with extreme values that would ideally be re-tested. Those fields are #'s 3141, 2044, 2047, 4152, 3117, and 3119.
- The two asparagus samples, #'s 4175 and 4176 may not be representative of that crop
- The range of values for alfalfa is huge and suggests a need for further study
- The range of values for hops is large and suggests a need for further study
- Over half of the fields planted in triticale are at medium to high risk for leaching nitrate to the groundwater
- Double cropping is associated with higher nitrate levels
- In this data set rill irrigation is more protective of the groundwater than sprinkler irrigation
- Application of liquid manure is significantly more likely to result in high nitrate levels
- There is more soil testing on fields with higher nitrate levels.
- There are wide ranges in values for many of the crops in this data set.
- Some of the project purposes were not achieved in this round of DSS. Baseline data for many of the crops and conditions is still lacking. However there is adequate information to proceed with recommendations regarding triticale and application of liquid manure.

References

Lower Yakima Valley Groundwater Management Area (2014) *Deep Soil Sampling Plan Lower Yakima Valley Groundwater Management Area.* (Attachment 1)

Lower Yakima Valley Groundwater Management Area (2013) *PP Summary of Proposed Allocation Processes.* (Attachment 2)

WA State Dept. of Agriculture (2017*) Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area*. Available in draft form only.

WA State Dept. of Ecology (2017) *Concentrated Animal Feeding Operation General National Pollutant Discharge Elimination System and State Waste Discharge General Permit.* Available at
http://www.ecy.wa.gov/programs/wq/permits/cafo/docs/01182017CombinedPermit.pdf

WA State Dept. of Ecology (2017) *Concentrated Animal Feeding Operation State Waste Discharge General Permit.* Available at
http://www.ecy.wa.gov/programs/wq/permits/cafo/docs/01182017StatePermit.pdf

Lower Yakima Valley Groundwater Management Area Deep Soil Sampling Analysis of Fields Planted in Triticale/Corn Silage

By Jean Mendoza

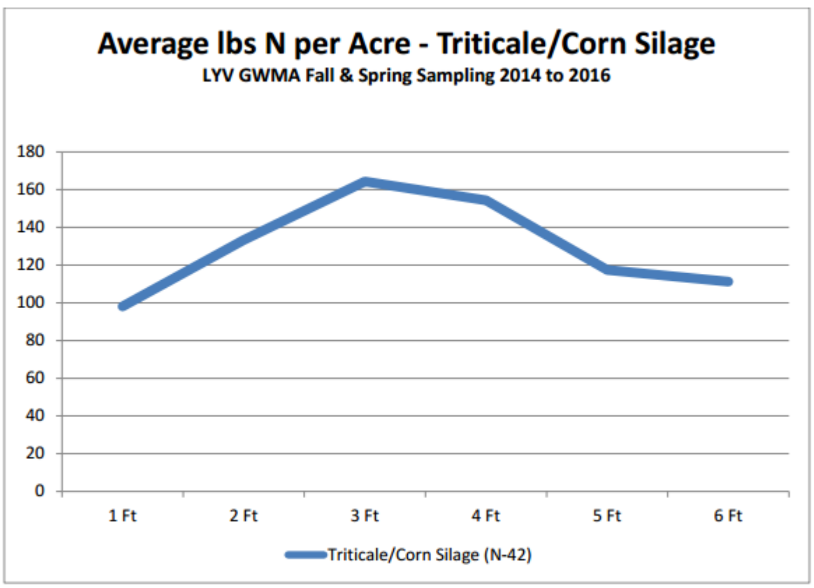
July 2017

Between the fall of 2014 and the spring of 2016 the Lower Yakima Valley (LYV) Groundwater Management Area (GWMA) contracted with the South Yakima Conservation District and Landau Associates to perform four rounds of deep soil sampling (DSS) on agricultural land in the GWMA target area. All fields were voluntarily submitted and anonymously recorded. 24% of the fields (42 out of 175) were double cropped in Triticale/Corn Silage (40) or Triticale/Sudan Grass (2). This is the largest number for any crop in the DSS and lends itself to a more detailed study.

Overview of the Data

Below is a graph that depicts the nitrate levels in lbs of nitrate (NO_3) per acre at depths by one foot increments.

Graph 1.



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The average field was 55.5 acres. Soil testing was done on all fields. Testing was done twice a year for 27 of the fields (64%) and annually for 15 of the fields (36%). There was rill irrigation on one field, rill & sprinkler irrigation on two fields and sprinkler irrigation only on thirty nine fields.

Liquid manure was applied to 31 of the fields (74%), solid manure to 5 of the fields (12%), commercial fertilizer to 26 (of the fields 62%) and bio-solids to 1 of the fields (2%). More than one type of fertilizer was used on 22 of the fields (52%).

The capacity of the most limiting layer to transmit water (Ksat) classifications were "very low to moderately low" on 4 of fields (10%), "moderately high to high" on 34 of fields (81%), and "high to very high" on 4 of fields (9%).

There was early refusal of the soil drilling equipment on one field at 2 feet, four more at 3 feet, one more at 4 feet and six more at 5 feet. Early refusal was more likely in the soils classified as very low to moderately low leaching.

Average root depth was 2.87 feet and the median was 2.85. The range for root depths was 1 ft to 5.8 ft.

Data Analysis for Triticale/Corn Silage

Table 1. Nitrate in lbs per Acre for Triticale/Corn Silage

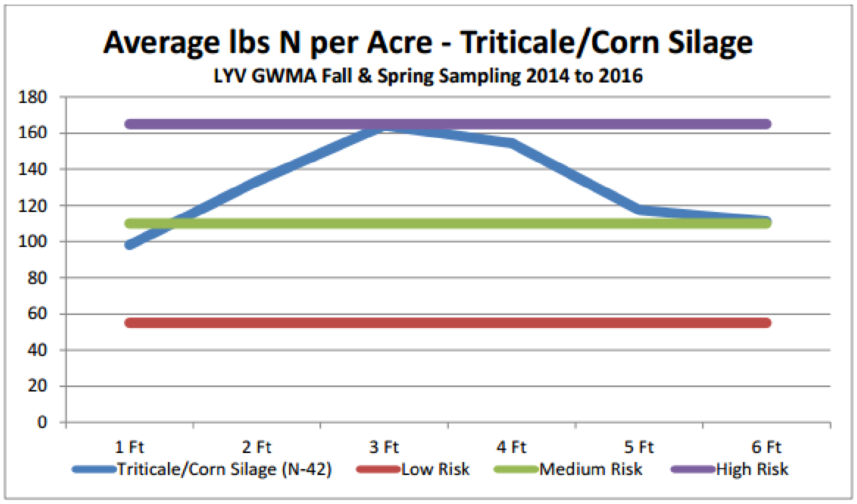
	1 FT	2Ft	3 Ft	4 Ft	5 Ft	6 Ft	Total	NH_3	Organic
Average (lbs/acre)	98.07	133.24	164.3	154.36	117.43	111.2	668.5	29	2.25
Median (lbs/acre)	57	60	87	89	60	66	356.5	24	2.18
Range (lbs/acre)	4 to 467	3 to 986	3 to 892	3 to 726	6 to 576	4 to 565	17 to 3754	9 to 108	0.95 to 3.94
Early Refusal (ft)	0	1	5	6	12	12			

The median is much less than the average at all depths. The data has a positive skew.

The sampling shows that there are high nitrate levels at depths where the crops no longer take up the nitrate for plant use. In other words, there is significant leaching to the aquifer from fields planted in triticale/corn silage.

One way to look at the data is to determine how many fields have nitrate levels above the risk levels that were defined by Ecology (2017) for the CAFO General Permits. According to that document there is low risk when nitrate levels at two feet are < 55 lbs per acre, medium risk when levels are 55lbs per acre to 110 lbs per acre, high risk when levels are 110 lbs per acre to 165 lbs per acre and very high risk when levels are > 165 lbs per acre. The average level of nitrate in this study was in the high risk range for all levels except one foot.

Graph 2.



Analysis at the Two Foot Level

Another way to analyze the material is to look at the two foot level where most nutrient management plan decision making is done for Eastern Washington. Numbers in the table below were sorted by size for the two foot level. There were 19 samples in the low risk category (< 55 lbs/acre), 14 samples in the medium risk category (55lbs/acre to 110 lbs/acre), none in the high risk category (110 lbs/acre to 165 lbs/acre) and 9 samples in the very high risk category (>165lbs/acre).

Table 2.

Field ID #	1 FT lbs/ac	2Ft lbs/ac	3 Ft lbs/ac	4 Ft lbs/ac	5 Ft lbs/ac	6 Ft lbs/ac	Total lbs/ac	Ammonia lbs/ac	Organic Matter
Very High Risk		N = 9 (21%)							
2058	119	986	892	694	407	287	3385	16	1.92%
3094	467	644	776	726	576	565	3754	50	2.85%
3108	311	465	612	684	247	264	2583	27	2.66%
3106	316	445	465	248	256	222	1952	15	0.95%
3097	336	363	335	263	113	64	1474	28	2.18%
2063	227	337	424	528			1516	24	3.94%
2065	213	304					517	15	2.59%
3121	275	193	162	137	202	272	1241	32	2.91%
2066	44	182	193				419	24	3.23%
Medium Risk		N = 14 (33%)							
2037	50	106	226	183	149	72	786	93	1.9%
3110	93	100	125	154	283	413	1168	34	2.19%
2067	19	97	197	115	40	27	495	18	1.56%
3115	82	90	149	111	192	195	819	14	1.67%
3095	60	90	140	178			468	17	1.92%
2078	49	89	86	156	172	111	663	27	2.62%
2046	36	88	95	70	65	72	426	33	2.67%
4167	97	81	88	13			279	68	1.39%
1004	177	79	63	69	42	50	480	16	2.06%
3112	39	73	87	95	47	38	379	22	1.87%
2079	9	66	127	173	98	108	581	17	2.62%
3109	82	60	223	238	56	100	759	12	1.48%
2053	84	58					142	11	1.59%
2035	55	56	56	103	110	93	473	108	3.04%
Low Risk		N = 19 (45%)							
2081	75	48	40	42	32	24	261	35	2.45%
2036	90	47	31	23	12	6	209	65	2.37%
3111	35	45					80	24	1.59%
2068	7	35	137	115			294	13	1.71%
3086	139	30	33	56	47	29	334	14	1.76%
2070	37	26	63	83	51	38	298	9	0.98%
2064	52	26	43	26			147	19	3.21%
2040	41	25	13	36	88	68	271	26	3.09%
2082	41	22	55	70	58	74	320	25	3.36%

4

2077	26	22	26	25	35	41	175	16	1.81%
3122	101	20	14	3	16	4	158	23	2.07%
4159	34	16	36	27	7	9	129	40	2.41%
2080	15	15	27	44			101	17	2.63%
2050	18	9	21	43	61	51	203	25	2.95%
4161	66	9	6	5	8	8	102	39	2.59%
3096	27	8	10	17	47	19	128	44	2.06%
4158	12	5					17	38	2.18%
2041	4	3	3	4	6	12	32	9	1.46%
2052	59						59	16	2.16%

These nitrate values do not conform to a normal curve but statistical analyses can be done by plotting log values for the nitrate levels. This normalizes the data and tells us that 95% of the nitrate levels at 2 feet for the fields in this study will lie between 4.2 lbs per acre and 815.2 lbs per acre. This is a very large range. There are 2 out of 41 values in the study that lie outside the 95 percentile range. They are 3 lbs per acre at the low end and 986 lbs per acre at the high end.

Analysis of Irrigation Practices found that most samples (89% to 100%) used sprinkler. There is a small trend for lower risk fields to use rill irrigation but the numbers are not large enough to prove statistical significance. :

Table 3. Irrigation Practices and Risk Levels for Triticale/Corn Silage

	Low Risk	Medium/High Risk	Very High Risk	All Samples
Rill	2 (11%)	1 (7%)	0 (0%)	3 (7%)
Sprinkler	17 (89%)	13 (93%)	9 (100%)	39 (93%)
Drip	0 (0%)	0 (0%)	0 (0%)	0 (0%)

There were no dose dependent relationships for ammonia or organic matter and risk

Table 4. Average Ammonia & Organic Matter Levels for Triticale/Corn Silage

	Low Risk	Medium/High Risk	Very High Risk	All Samples
Ammonia	26.16	35.00	25.67	28.27
Organic Matter	2.25	2.04	2.58	2.32

Note: Field #2035 in the Medium Risk category had an unusually high ammonia level of 108 #/acre

There were no clear trends regarding crop yields and risk categories:

Table 5. Crop Yield for Triticale & Corn Silage in Different Risk Levels

	Low Risk	Medium Risk	Very High	All Samples
Average of Most Recent Crop Yields for Triticale in Tons	8.14 T	8 T	8.22 T	8.11 T
Average of Most Recent Crop Yields for Corn Silage in Tons	29.39 T	31.25 T	30.22 T	30.15 T

There were no clear trends regarding impact of fertilizer type for these crops:

Table 6. Percentage of Fields that Received Major Types of Fertilizer for Triticale/Corn

	Low Risk	Medium Risk	Very High Risk	All Samples
Liquid Manure	15 (79%)	10 (71%)	6 (86%)	31 (74%)
Solid Manure	3 (16%)	1 (7%)	1 (14%)	5 (12%)
Commercial Fertilizer	12 (63%)	10 (71%)	4 (57%)	26(62%)
Biosolids	0 (0%)	0 (0%)	1 (14%)	1(2%)
Unknown	0 (0%)	1 (7%)	0 (0%)	1 (2%)
More Than One Type	10 (53%)	8 (57%)	4 (44%)	22 (52%)

There were no clear trends regarding soil type and leaching potential for these crops:

Table 7. Soil Categories and Risk Levels for Triticale/Corn Silage

	Low Risk	Medium Risk	Very High Risk	All Samples
Low to Moderately Low	2 (11%0	1 (7%)	1 (11%)	4 (10%)
Moderate to High Ksat	14 (74%)	13 (93%)	7 (78%)	34 (81%)
High to very High Ksat	3 (16%)	0 (0%)	1 (11%)	4 (10%)

The major conclusion from analysis of data at the two foot level is that over half of the fields in this study are at medium to very high risk for leaching to the groundwater.

Analysis Based on Median Levels at One Foot Intervals

Another way to analyze the data is to look at median levels of nitrate in lbs per acre at each level of testing. Half of all fields in a data set are above the median level and half are below the median level. The data in this study is skewed positively, meaning that median values are lower than average values. In this study half of nitrate levels were above:

a. 57 lbs per acre at one foot

b. 60 lbs per acre at two feet

c. 87 lbs per acre at three feet

d. 89lbs per acre at four feet

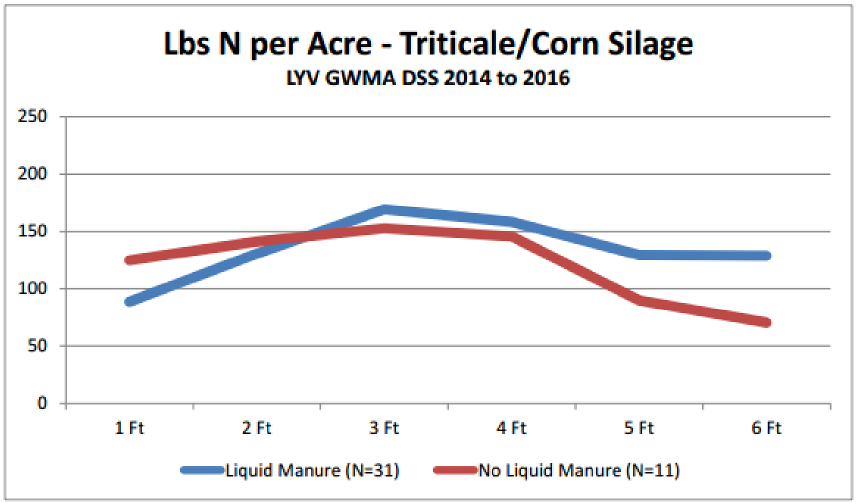
e. 60#lbs per at five feet

f. 66 lbs per acre at six feet.

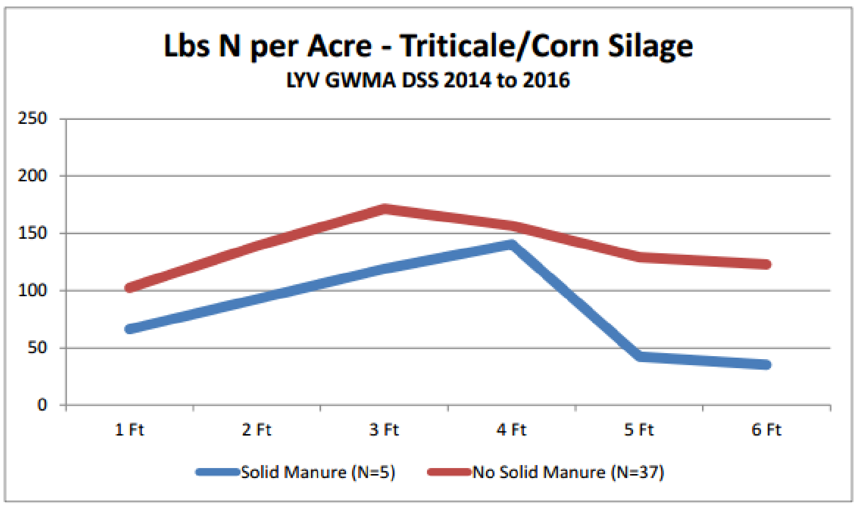
Types of Fertilizers

Analysis of the DSS as a whole indicates that nitrate levels are higher when liquid manure is applied to the fields. Application of solid manure, on the other hand, is associated with lower nitrate levels. The graphs below describe nitrate levels for triticale/corn silage fields based on yes or no for application of each major class of fertilizer. 52% of the fields received more than one type of fertilizer and this practice was associated with a reduction in nitrate levels.

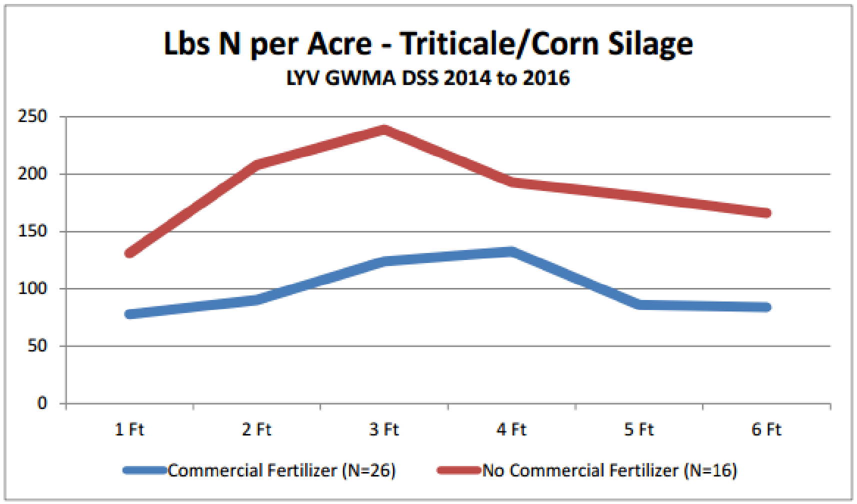
Graph 3. Fields that Received Liquid Manure and Those That Did Not



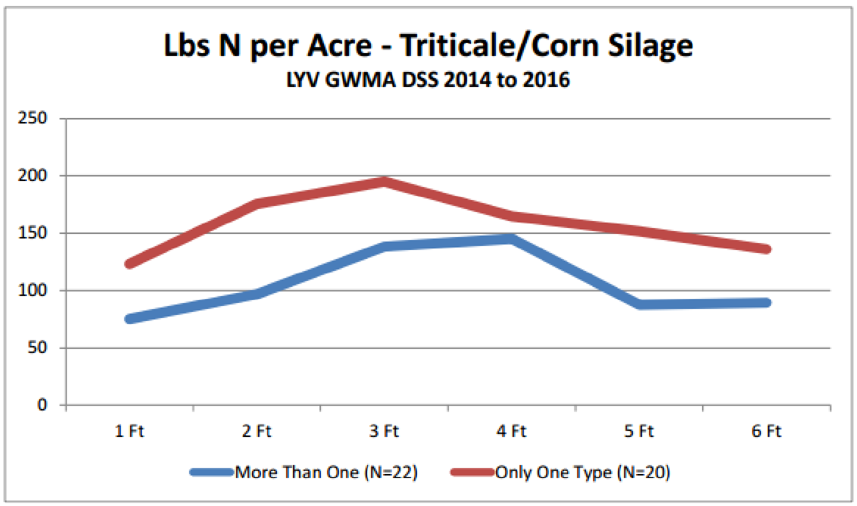
Graph 4. Fields that Received Solid Manure and Those That Did Not



Graph 5. Fields That Received Commercial Fertilizer and Those That Did Not



Graph 6. Fields That Received More Than One Type of Fertilizer or Did Not

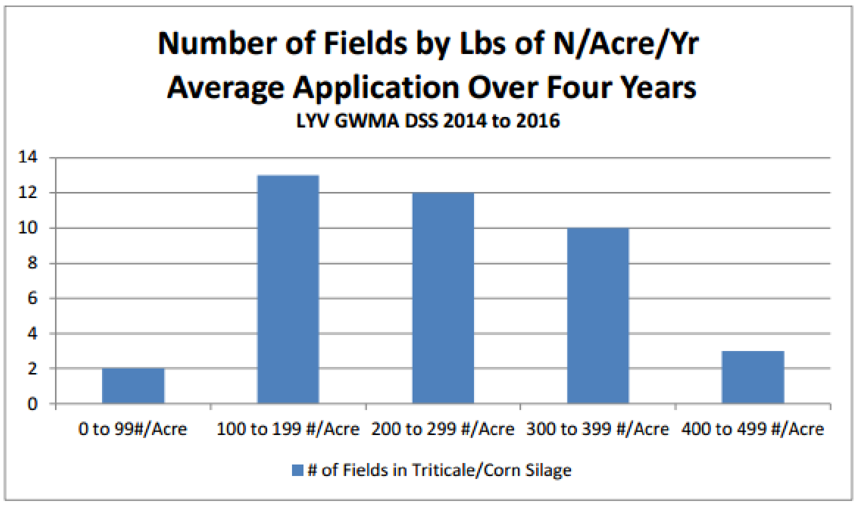


Could this indicate that farmers who apply more than one type are more thoughtful about fertilizer applications?

Amount of Fertilizer

DSS surveys asked farmers how much nitrogen they applied in lbs N per acre to the sampled fields. Average application over four years was calculated for each field and the number of fields with application of 0 to 99lbs, 100 to 199 lbs, 200 to 299 lbs, 300 to 399 lbs and 400 to 499 lbs was counted.

Graph 7. Range of Fertilizer Application Rates to Triticale/Corn Silage Fields in DSS



According to the WSDA Nitrogen Loading Assessment (2017) and the recommendations of members of the GWMA Irrigated Ag Work Group the average uptake of nitrogen for corn silage is 270 #/acre. The uptake by triticale ranges from a low of 190 lbs per acre to a high of 210 lbs per acre. This indicates that most farmers in the DSS apply less than the recommended amounts of nitrogen to triticale/corn silage fields.

Some fields received high amounts of nitrogen fertilizer in single years. For example, Field # 2065 received 575lbs of N per acre in 2013; Fields # 2066 received 500 lbs of N per acre in 2012; Field # 2046 received 500 lbs of N per acre in three out of four years.

There is a clear upward trend in nitrogen application related to level of risk: On average fields in the low risk level received 211 lbs N per acre; those in the medium to high level received 250 lbs N per acre and those in the very high level received 258 lbs per acre.

Table 8. Average Nitrogen Application at Different Risk Levels

	Low Risk	Medium/High Risk	Very High Risk	All Samples
Average N Application in lbs per Acre	211.45	249.92	258.25	237.06
Range of Average N Applications in lbs per Acre	31.25 – 379.75	105 to 436	170 to 391.25	31.25 – 436

Relationships can be examined by looking at the ratio of Total Nitrogen to Average Applied Nitrogen. Calculated Total Nitrogen is the sum of measurements at all six foot levels. Therefore those samples with early refusal were deleted from this analysis. The average ratios of Total Nitrogen to average Applied Nitrogen - were:

Very High Risk: 11.82 (Range = 7.44 to 20.42)

Medium to High Risk: 3.22 (Range = 1.10 to 7.23)

Low Risk: 1.52 (Range = 0.29 to 6.50)

References

WA State Dept. of Agriculture (2017*) Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area*. Available in draft form only.

WA State Dept. of Ecology (2017) *Concentrated Animal Feeding Operation General National Pollutant Discharge Elimination System and State Waste Discharge General Permit.* Available at
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http://www.ecy.wa.gov/programs/wq/permits/cafo/docs/01182017StatePermit.pdf

Errata

Towards the end of this analysis it was noted that two of the fields were planted in Sudan grass as well as the Triticale/Corn Silage combination. This could impact the data. The fields planted in Sudan grass were # 2046 and # 3096.

Appendix G – Best Management Practices Recommended by Irrigated Agriculture Work Group

Best Management Practices for Irrigated Cropland
OB = objective; MT = management target; BMP = best management practice
The IAWG has reviewed the list of BMPs compiled by HDR that could be implemented on irrigated cropland activities which may provide protections to nitrate (N) leaching to groundwater. These include irrigation practices, cropping practices, and N source management (type, quantity, and timing). The IAWG believes that the core BMPs to reduce negative impacts to ground water are 1) managing nutrient inputs to ensure that the 4R's are utilized (right amount, the right source, the right timing, and the right location) (accounting for all sources including soil amendments, compost, biosolids, manure and commercial fertilizer) and 2) irrigation water management. The IAWG felt that these two BMPs had the greatest potential to reduce the problem. They are also beneficial to all parties. The IAWG believes the BMPs included in the table below will not replace the core BMPs above but may provide additional proctections to ground water. The BMPs listed in the table below have a range of applicability in the Lower Yakima Valley GWMA. Some are potentially very effective, some moderately effective, and some that have no applicability in this GWMA. The comments in the right hand column are a compilation of input from the IAWG and are intended to provide the GWAC with some sense of the effectiveness of the BMPs as they would apply to this specific GWMA. The IAWG emphasized that the BMPs are voluntary, not always suited to a particular farm, and still require the judgment of the farm operator to achieve the desired results.

Management Target	Best Management Practices	References	Work Group Comments
MT 1.1.1 Perform irrigation system evaluation and monitoring	BMP 1.1.1.1 Conduct irrigation system performance evaluation	EM 4885 – IP 2.01.03; PNW 293; EM4828	More practical to preform routine maintenance and observe uniformity of coverage.
	BMP 1.1.1.2 Install and use flow meters or other measuring devices to track water volume applied to each field at each irrigation	EM 4885 – IP 2.01.01	Meters not practical; soil moisture sensing devices are used effecively - even required in some cases, to monitor and schedule irrigation.
	BMP 1.1.1.3 Conduct pump performance tests	EM 4885 – IP 2.01.02	Relatively simple and easy to do. Requires an ultrasonic flow meter and pressure gage.
MT 1.1.2 Improve irrigation scheduling	BMP 1.1.2.1 Use weather based irrigation scheduling	EM 4885 – IP 2.01.05, 2.01.06	This is one of the most practical way to help solve the issues. It is now free and easy to do. (http://weather.wsu.edu/is)
	BMP 1.1.2.2 Use plant-based irrigation scheduling	EM 4885 – IP 2.01.05, 2.01.06; EM4821; EB1513	Time consuming to do, unless there are automated sensors. Research is still being done in this area. It is not easy or very accurate.
	BMP 1.1.2.3 Measure soil moisture content to guide irrigation timing and amount	EM 4885 – IP 2.01.05, 2.01.06; PNW0475	Soil moistures sensors are expensive and data-interpretation requires assistance.
	BMP 1.1.2.4 Avoid heavy pre-plant or fallow irrigations		Depends on definition of "heavy"
MT 1.1.3 Improve surface gravity system design and operation	BMP 1.1.3.1 Convert to surge irrigation	EM 4885 – IP 2.02.03; EM4826	A good idea, but requires a certain field setup. Most people who have tried surge, migrate back to conventional rill irrigation. Better to encourage to conversion to sprinkler or drip.
	BMP 1.1.3.2 Use high flow rates initially, then cut back to finish off the irrigation	EM 4885 – IP 2.02.10; EM4828	Good idea, but difficult to implement unless irrigation delivery can be variable.
	BMP 1.1.3.3 Reduce irrigation run distances and decrease set times	EM 4885 – IP 2.02.04; EM4828	Good, but increases labor and equipment costs
	BMP 1.1.3.4 Increase flow uniformity among furrows (e.g., compaction furrows)	EM 4885 – IP 2.02.02	Encourange use of PAM
	BMP 1.1.3.5 Grade fields as uniformly as possible	EM 4885 – IP 2.02.05, 2.02.05	Good but within constraints of topography.
	BMP 1.1.3.6 Where high uniformity and efficiency are not possible, convert to drip, center pivot, or linear move systems	EM 4885 – IP 2.01.08	Good

MT 1.1.4 Improve sprinkler system design and operation	BMP 1.1.4.1 Monitor flow and pressure variations throughout system	EM 4885 – IP 2.03.02	Good idea on district scale (they already do much of this), but logging pressure and flow variation is not cost-effective for individual growers.
	BMP 1.1.4.2 Repair leaks and malfunctioning sprinklers, follow manufacturer recommended replacement intervals	EM 4885 – IP 1.00.05, 2.03.03	Power companies often have monitary energy savings incentives for repair of irrigation systems.
	BMP 1.1.4.3 Operate sprinklers during the least windy periods	EM 4885 – IP 2.03.05	For the most part not possible when water delivered by a major irrigation entitiy.
	BMP 1.1.4.4 Reduce distance between lateral lines or alternate lateral line location over successive irrigations	EM 4885 – IP 2.03.04, 2.03.06	Requires additional moves (labor $) and sometimes additional hardware (e.g. an additional wheel line). Get a good design!
	BMP 1.1.4.5 When pressure variation is excessive, use flow control or pressure regulating nozzles	EM 4885 – IP 2.03.02	Good.
MT 1.1.5 Improve micro-irrigation system design and operation	BMP 1.1.5.1 Use appropriate lateral hose length to improve uniformity	EM 4885 – IP 2.04.02	Good. i.e. get a good and appropriate irrigation system design.
	BMP 1.1.5.2 Check for clogging potential and prevent or correct clogging	EM 4885 – IP 2.04.03	Good and necessary for good crop yields and uniformity.
MT 1.1.6 Make other irrigation infrastructure improvements	BMP 1.1.6.1 Installation of subsurface drains	EM 4885 – IP 5.01.01	Good. When necessary.
	BMP 1.1.6.2 Backflow prevention	EM 4885 – IP 6.00.03, EB1722	Required by law if chemigating.

MT 1.2.1 Modify crop rotation	BMP 1.2.1.1 Grow cover crops	EM 4885 – IP 5.01.01	Good in areas where they are not water limited. Probably not cost effective.
	BMP 1.2.1.2 Include deep-rooted or “nitrogen scavenger” crop species in annual crop rotations	PNW513	Good.
	BMP 1.2.1.3 Grow more crops per year (double cropping)	Bul 869	Utilize extra cropping to utilize excess nutrients on soil
	BMP 1.2.1.4 Include perennial crop rotation	PNW513	Encourage crop rotation
MT 1.2.2 Monitor crops	BMP 1.2.2.1 Monitor crop performance for each field including yield, nitrogen content, estimate of nitrogen removed from field versus remaining in field	NRCS Part 651. Ch. 13, Appendix 13B	Great
MT 1.3.1. Improve rate, timing, and placement of N fertilizers	BMP 1.3.1.1 Adjust nitrogen fertilization rates based on soil nitrate testing	EM 4885 – IP 3.02.01	Great
	BMP 1.3.1.2 Adjust timing of nitrogen fertilization based on plant tissue analysis	EM 4885 – IP 3.02.03	Good.
	BMP 1.3.1.3 Apply nitrogen fertilizer in small multiple doses rather than single large dose	EM 4885 – IP 3.02.05	Great - use fertigation
	BMP 1.3.1.4 Measure nitrate content of irrigation water and adjust fertilizer accordingly	EM 4885 – IP 3.02.02	Very little N in irrigation water. More in rainfall, but that is negligible in the Yakima River Basin.
	BMP 1.3.1.5 Use low rates of foliar nitrogen instead of higher rates applied		This is an OK method for micro-nutrients, but not for macro-nutrients.

MT 1.3.1. Improve rate, timing, and placement of N fertilizers	BMP 1.3.1.6 Vary nitrogen application rates within large fields according to expected needs (precision agriculture)	Peters and Davenport	Good.
	BMP 1.3.1.7 When fertilizing in surface gravity systems, use delayed injection procedures		Chemigating with surface gravity systems is not recommended
	BMP 1.3.1.8 Develop a nitrogen budget that includes crop nitrogen harvest removal, supply of nitrogen from soil, and other inputs	CSU-XCM-173	Good.
	BMP 1.3.1.9 Use controlled release fertilizers, nitrification inhibitors, and urease inhibitors	EM 4885 – IP 3.02.06	Good.
	BMP 1.3.1.10 Assess the risk of contamination of ground and surface water due to fertilizer leaching or runoff	EM 4885 – IP 3.01.01	Good.
	BMP 1.3.1.11 Maintain records of all soil, tissue, and water tests, cropping rotations, yields, and applications (dates, material, method, results)	CSU-XCM-173	Good.
	BMP 1.3.1.12 Develop realistic yield goals	EM 4885 – IP 3.02.07	Good.

MT 1.3.2. Improve rate, timing, and placement of animal manure applications	BMP 1.3.2.1 Apply moderate rates of manure and compost, and use materials with high nitrogen content (inorganic fertilizer) to meet the peak nitrogen demand		Good.
	BMP 1.3.2.2 Incorporate solid manure immediately to decrease ammonia volatilization loss	EM 4885 – IP 3.03.05	Good.
	BMP 1.3.2.3 When applying liquid manure in surface gravity irrigation systems, use the delayed injection procedure to improve application uniformity		Not recommended
	BMP 1.3.2.4 Use quick test methods to monitor dairy lagoon water nitrogen content immediately before and during application, and adjust application rate accordingly		By law, dairies are required to test manure once in the spring prior to the first application.
	BMP 1.3.2.5 Develop a nitrogen budget that includes crop nitrogen harvest removal, supply of nitrogen from manure, and other inputs	CSU-XCM-173; USU 2010	Good.
	BMP 1.3.2.6 Calibrate solid manure and compost spreaders	EM 4885 – IP 3.03.01; NRCS Part 651. Ch. 13, Appendix 13A	Good.
	BMP 1.3.2.7 Ensure uniformity of application with manure	EM 4885 – IP 3.03.07	Good.
	BMP 1.3.2.8 Do not apply manure to frozen ground, especially sloping fields	EM 4885 – IP 3.03.08	Good. Although this is a surface runoff issue, not a groundwater issue.
	BMP 1.3.2.9 Test manure or other organic by-product materials for nutrient content	EM 4885 – IP 3.02.04; NRCS Part 651. Ch. 13, Appendix 13B	Great
	BMP 1.3.2.10 Use synchronized rate nutrient application of lagoon water to reduce or eliminate the need for fertilizer	NDESC 2005 (II)	

MT 1.3.3. Use fertilizer guides to determine and apply appropriate fertilizer amounted.	BMP 1.3.3.1 Follow recommendations of Fertilizer Guide: Home Vegetable Gardens, Irrigated Central Washington	FG0052	Good.
	BMP 1.3.3.2 Follow recommendations of Fertilizer Guide: Irrigated Alfalfa Central Washington	FG0003	All FG need to be looked at to make sure they are not outdated.
	BMP 1.3.3.3 Follow recommendations of Fertilizer Guide: Irrigated Asparagus	FG0012	Good.
	BMP 1.3.3.4 Follow recommendations of Fertilizer Guide: Irrigated Field Beans for Central Washington	FG0005	Good.
	BMP 1.3.3.5 Follow recommendations of Fertilizer Guide: Irrigated Field Corn for Grain or Silage	FG0006	Good.
	BMP 1.3.3.6 Follow recommendations of Fertilizer Guide: Irrigated Hops for Central Washington	FG0011	Good.
	BMP 1.3.3.7 Follow recommendations of Fertilizer Guide: Irrigated Mint Central Washington	FG0008	Good.
	BMP 1.3.3.8 Follow recommendations of Fertilizer Guide: Irrigated Peas for Central Washington	FG0033	Good.

MT 1.3.3. Use fertilizer guides to determine and apply appropriate fertilizer amounted.	BMP 1.3.3.9 Follow recommendations of Fertilizer Guide: Irrigated Small Grains, Central Washington	FG0009	Good.
	BMP 1.3.3.10 Follow recommendations of Fertilizer Guide: Irrigated Sudangrass Pasture or Silage	FG0036	Good.
	BMP 1.3.3.11 Follow recommendations of Fertilizer Guide: Irrigated Vineyards for Entire State	FG0013	Good.
	BMP 1.3.3.12 Follow recommendations of Fertilizer Guide: Ornamentals, Entire State Except Central Irrigated Washington	FG0049	Does not pertain to Irrigated AG
	BMP 1.3.3.13 Follow recommendations of Fertilizer Guide: Vegetable and Flower Gardens, Except Irrigated Central Washington	FG0050	Does not pertain to Irrigated AG
	BMP 1.3.3.14 Follow recommendations of Fertilizer Guide: Improved Pasture, Hay, Eastern Washington	FG0037	Good.
	BMP 1.3.3.15 Follow recommendations of Fertilizer Guide: Grass Seed for Eastern Washington	FG0038	Good.

MT 1.3.3. Use fertilizer guides to determine and apply appropriate fertilizer amounted.	BMP 1.3.3.16 Follow recommendations of Fertilizer Guide: Barley for Eastern Washington	FG0029	Good.
	BMP 1.3.3.17 Follow recommendations of Fertilizer Guide: Soil Samples/Orchards	FG0028C	Good.
	BMP 1.3.3.18 Follow recommendations of Fertilizer Guide: Instructions for Tree Fruit Leaf Nutrient Analysis	FG0028E	Good.
	BMP 1.3.3.19 Follow recommendations of Fertilizer Guide: Peas and Lentils for Eastern Washington	FG0025	Good.
	BMP 1.3.3.20 Follow recommendations of Fertilizer Guide: Lawns, Playfields and Other Turf, East and Central Washington	FG0024	Good.

MT 1.4.1 Avoid fertilizer material and manure spills during transport, storage, and application	BMP 1.3.4.1 Do not overfill trailers or tanks. Cap or cover loads.	EM 4885 – IP 4.01.06	Good
	BMP 1.3.4.2 When transferring fertilizer, take care not to allow materials to accumulate on the soil		Good.
	BMP 1.3.4.3 Maintain all fertilizer storage facilities and protect them from the weather		Good.

MT 1.4.1 Avoid fertilizer material and manure spills during transport, storage, and application	BMP 1.3.4.4 Clean up fertilizer spills promptly		Good.
	BMP 1.3.4.5 Shut off fertilizer applicators during turns and use check valves		Good.
	BMP 1.3.4.6 Maintain proper calibration of fertilizer application equipment	EM 4885 – IP 3.03.01	Good.
	BMP 1.3.4.7 Create a buffer around wellheads from fertilizer and manure storage, handling, and application	EM 4885 – IP 6.00.02	Good.
	BMP 1.3.4.8 Distribute rinse water from fertilizer application equipment throughout field		Good.
	BMP 1.3.4.9 Avoid manure spills/discharges during transport, storage, and application		Good.
	BMP 1.3.4.10 Prevent back siphonage/flow of chemicals or nutrients down a well after injection	EM 4885 – IP 6.00.03, EB1722	Required by law.
	BMP 1.3.4.11 Identify and properly seal all abandoned and improperly constructed wells	EM 4885 – IP 6.00.04	Good.

Appendix H – Best Management Practices Recommended by Livestock/CAFO Work Group

NRCS Standards Recommended by Livestock/CAFO Work Group

Title	Revision Date
Amendments for Treatment of Agricultural Wastes (591) Standard	1/27/2014
Anaerobic Digester (366) Standard	1/11/2011
Animal Mortality Facility (316) Standard	1/11/2011
Composting Facility (317) Standard	1/11/2011
Dam (402) STANDARD	2/25/2013
Diversion (326) STANDARD	2/25/2013
Feed Management (592) Standard	1/15/2013
Filter Strip (393) Standard	2/11/2015
Heavy Use Area Protection (561) Standard	2/12/2015
Monitoring Well (353) Standard	2/11/2015
Nutrient Management (590) Standard	2/18/2014
Pond Sealing or Lining, Bentonite Sealant (521C) Standard	11/4/2015
Pond Sealing or Lining, Compacted Clay Treatment (521D) Standard	11/4/2015
Pond Sealing or Lining, Flexible Membrane (521A) STANDARD	2/25/2013
Pond Sealing or Lining, Soil Dispersant (521B) Standard	11/4/2015
Pumping Plant (533) Standard	2/12/2015
Roof Runoff Structure (558) STANDARD	2/12/2015
Short Term Storage of Animal Waste and By Products (318) – National NRCS Standard http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1263507.pdf	
Solid/Liquid Waste Separation Facility (632) Statement of Work	1/11/2008
Sprinkler System (442) Standard	11/4/2015
Stream Crossing (578) Standard	2/12/2015
Vegetative Treatment Area (635) Standard	1/29/2016
Waste Facility Closure (360) STANDARD	2/25/2013
Waste Recycling (633) STANDARD	2/25/2013
Waste Separation Facility (632) STANDARD	1/27/2014
Waste Storage Facility (313) Standard	2/11/2015
Waste Transfer (634) Standard	2/12/2015
Waste Treatment (629) Standard	2/12/2015
Waste Treatment Lagoon (359) Standard	2/25/2013
Water Well (642) Standard	2/12/2015
Well Decommissioning (351) Standard	2/11/2015
Groundwater Testing (355) Standard	2/11/2015

Appendix I – Comprehensive List of Alternative Management Strategies

The Groundwater Management Committee first made a list of approximately 300 potential alternatives, incorporating working group recommendations, ideas raised in working group conversations and reviews of scientific and environmental literature.

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	**Proposed by**	**Feasibility**	**Effectiveness**	**Cost**	**Proposed funding**	**Time**	**Difficulty to implement**	**Degree of consistency with local comprehensive plans and water management programs**
Remediation								
Pump, treat and reinject groundwater	WGD	not feasible, treatment area too large	not effective because of 3-dimensional size of treatment area	excessive				
Pump-and-fertilize. Use existing (or new) agricultural water wells to remove nitrate-contaminated groundwater and "treat" the water by using it to irrigate crops which will take up the nitrogen concentration in the irrigation water (presumes the existence of a proper nutrient management plan for the irrigated acreage).	JD							
Fill irrigation ditches with water and let it sit there to leak into groundwater. Use groundwater recharge as a means to dilute nitrate concentrations in the groundwater.	WGD						irrigation district canal maintenance in winter, increased personnel?, irrigation district compensation, relation to water rights? problem of freezing of flow meters in laterals, interaction with Bureau of Reclamation	
Drill new 1,500 foot wells to replace contaminated wells .	WGD			$12 million				
Regionalize and connect users to a larger system with reliable quality water.—pipe connection to an existing system	WGD							
Blend better quality water with contaminated water to reduce nitrate concentrations	JD	works for larger community systems with more than one water source.						
Construct a potable water line from nearby developed area into deadhead water stations at central rural location (permit potable water collection at deadhead water stations).	JD							
Discontinue use of shallow wells. Rebuild, repair or replace poorly constructed wells.	WGD							
Remediate local nitrate contamination hotspots only .	JD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Administration/Lead Agency--Yakima County?								
Identify or create of an organization (Lead Entity) responsible for implementation and oversight of the LYV GWMA Groundwater Management Plan and acquisition of stable funding to support their activities. Potential entities include, Yakima County, South Yakima Conservation District (SYCD), Yakima County Health District, Washington State Department of Agriculture (WSDA), Ecology, and/or a yet to be formed entity.	L/C WG							
Implement an Adaptive Management Plan utilizing data collected, progress made, or lack of progress to inform the community on adjustments that need to be implemented. Plan could incorporate availability of technology, education and outreach, tracking exports, land use regulations, treatment systems, and other changes to inform decision makers regarding management changes necessary for a successful program.	L/C WG							
Let the lead agency determine who will do monitoring. Possible assignment of long-term monitoring after 2017 to Yakima Health District.	WGD							
Inform livestock operators and facilitate a dialogue with representatives of the regulatory agencies, other agricultural producers, and the general public through a public information/education program to protect the quality of the area groundwater resource. Information and incentives provided to Lower Yakima Valley agricultural operators will expedite implementation of BMPs.	L/C WG							
Collect, analyze, and interpret data to track water quality improvement progress, nutrients generated, applied, or exported, which will inform the implementation of an Adaptive Management Plan within the LYV GWMA.	L/C WG							
Focus implementation of analyzed data based on information and data included in the Nitrogen Loading Assessment, Soil Sampling Program, Ambient Groundwater Monitoring Plan, USGS Reports, and other similar scientifically based publications.	L/C WG							
Increase education and outreach efforts by improving the availability of technical assistance to develop nutrient management plans for all livestock industries. Assist industry trade organizations to enhance their local efforts to bring information to their members. Help increase livestock operator awareness of the need for procedures for proper management of animal wastes and wastewater. Potential funding sources include industry, government, educational institutions, grants, industry associations, etc...	L/C WG							
Cooperate with the WCC and WSDA in their efforts to document regulatory compliance for dairies within the GWMA that are completing and implementing Dairy Nutrient Management Plans (DNMP). Explore the possibility of disclosing non-proprietary data produced through the DNMP process.	L/C WG							
Further develop a local forum for disseminating information and facilitating technical exchange regarding BMPs for livestock management and groundwater protection. Endorse and distribute materials by all effective means that will educate the public about the facts of livestock waste management and the science of groundwater protection.	L/C WG							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	**Proposed by**	**Feasibility**	**Effectiveness**	**Cost**	**Proposed funding**	**Time**	**Difficulty to implement**	**Degree of consistency with local comprehensive plans and water management programs**
Quantify the nutrient value and rate of release of nitrate from livestock waste under various Lower Yakima Valley conditions to become part of the nutrient management guidelines.	L/C WG							
Voluntary development and implementation of NMPs by operations not already required to hold permits or a DNMP as an effective means of environmental protection.	L/C WG							
Allocate cost share funding or other funding assistance to operators implementing environmental protection measures.	L/C WG							
Develop strategies for marketing the economic, fertilizer value, and soil enhancing properties of appropriate application of manure and other livestock wastes.	L/C WG							
Provide Yakima County fiscal support to maintain its GIS data base on the GWMA over time.	JD							
Overlay GIS density maps reflecting different sources of nitrogen in order to geographically indicate the total density from all sources.	JD							
Map those areas that can tolerate more nitrogen application and areas that are more vulnerable to its application.	JD							
Use USGS particle tracking model to indicate where groundwater moves faster (permeability).	WGD							
Assess groundwater contamination potential, making use of the available information on soils, geology, and groundwater in order to identify those areas that are the most vulnerable to contamination. These areas may be closer to surface water, areas where recharge is faster or more frequent, or areas where shallow soils overlie soluble bedrock. Identify strategies "upstream" of sensitive areas to reduce contributions of nitrate sources.	WGD							
Enact County ordinances that would affect the problem grower.	WGD						Difficult to enforce.	
Maintain the County's GWMA website.	WGD							
Create an aquifer protection area.	WGD	Requires vote of people within protection area		Generates tax revenue				
Consider the enactment of a county ordinance addressing the density of segments of nitrate producing agricultural activity within the areas currently zoned as agricultural within the GWMA.	WGD		Prospective application					
Consider creation of subcategories of agricultural zoning, limiting density in those areas where soils are more permeable or groundwater moves faster.	WGD		Prospective application					
Consider "overlay" zoning ordinance adding special groundwater conservancy restrictions to otherwise conventionally zoned properties. Uses consumptive of groundwater quality resources are precluded or more generally regulated. Uses that are not consumptive of groundwater quality resource are permitted. Specific limitations might include limitations of water use, drainage, development density, septic use.	JD		Prospective application					

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Define "conditional uses" that can be allowed after assurance that groundwater resources would not be damaged.	JD		Prospective application					
Consider a county ordinance concerning overapplication of manure.	WGD		Prospective application				Difficult to enforce	
Create county ordinance limiting total number or density of cows or dairies (lid).	WGD		Prospective application				Difficult to enforce	
Adopt a LYC GWMA or county-wide CAFO ordinance	L/C WG (no consensus in WG)	Lengthy public process to create a CAFO Ordinance. Uncertain outcomes and timing. Too much uncertainty to rely on this option for the plan at this time. The county might consider legislative action as an alternative if public outreach, voluntary compliance, implementation of identified BMP's, and other efforts are not						
Establish a quota system through zoning regulations establishing how much nitrogen could be applied (based on agronomic rates for individual crop types) within fixed zones.	WGD		Prospective application				Difficult to enforce	
Consider density limitations, building codes for farm structures, development standards for farm activities.	WGD		Prospective application					
Regulate crop mix to weight more toward nitrogen-light crops--	JD						Difficult to enforce	

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	**Proposed by**	**Feasibility**	**Effectiveness**	**Cost**	**Proposed funding**	**Time**	**Difficulty to implement**	**Degree of consistency with local comprehensive plans and water management programs**
Consider limitation of septic systems (therefore building permit) where soil filtration rate is high, where housing density is already big, where nitrate concentration is already great downstream of the septic plume	JD	Applied admnistratively, requires GIS mapping of soil zones					Growers view as governmental interference with economic choice if nitrogen-heavy crops generate better returns	
Property tax for properties with onsite septic systems, waived in the case of proper inspection and pumping	JD							
Protect Critical Aquifer Recharge Areas	WGD							
Require bonding as prerequisite to permitting of livestock operations so as to assure financial capability for clean up in the instance of bankruptcy or other economic failure.	GWACD							
Measure the effects of GWAC program on Yakima County economics.	WGD							
Establish a more interactive and frequent relationship between Yakima County and NRCS.	WGD							
Education								
Develop post GWAC education and outreach campaign	EPO							
Broaden the pool of people GWMA is educating or communicating with.	EPO							
Maintain a public education program regarding nitrate pollution and health risk over a 5-10 year period. Provide all materials distributed to the public in English and Spanish.	EPO							
Billboard campaign – urging well testing	EPO							
Create 1 FTE Bilingual Outreach Coordinator Position to implement a post-adoption outreach campaign (EPO meeting summary 8/1/2014 & proposed to GWAC 8/21/14 - voted low priority)	EPO	Low	Unknown	$83,000 annually		1 FTE	Requires clear, measurable outcomes[1], a "home" agency to house, provide oversight, and to measure effectiveness; and ongoing funding.	
Develop a K-12 education program about groundwater and best management practices--mobile program visiting schools.	EPO							
Employ/enlist college students to conduct surveys, consider outreach methodologies as part of classwork to assist with GWMA education	EPO							
Educate the public, particularly in towns, about lawn and garden nitrogen applications' contribution to nitrate concentrations	EPO							
Educate private well owners: Re: protect your family; know who's at risk; test your well regularly.	EPO							
Private well owners' responsibility to protect WQ	EPO							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	**Proposed by**	**Feasibility**	**Effectiveness**	**Cost**	**Proposed funding**	**Time**	**Difficulty to implement**	**Degree of consistency with local comprehensive plans and water management programs**
Publish public information about proper septic system construction and operation	EPO							
Advise the public that GWMA is looking for abandoned wells. Wellhead protection education	EPO							
Offer incentives for property owners to identify and properly abandon wells.	EPO							
Offer incentives to drill deeper wells for homeowners served by shallow, poorly constructed, poorly located wells.	EPO							
Offer incentives to connect households on private wells near community water systems to connect to a community water system. (Nitrate Treatment Pilot Program-June 2011)	EPO							
Provide a resource hotline (as proposed by RCIM on 8/2014)	EPO							
Prepare a fact sheet/develop outreach campaign to growers that explains agronomic rates – applying nutrients at the right time/right place/right amount	EPO							
Study report outreach: Show/Identify how much nitrogen is left after nutrient uptake in crops.	EPO							
Encourage commodity groups to provide education on water management and fertilizer use through regular meetings.	EPO							
Outreach targeted to small farm/hobby farm/rachettes manure management	EPO							
Educate irrigation users on the consequences of too much irrigation.	EPO							
Inform farmers about technological improvements in irrigation that permit easier management of water, descriptions of specific improved technology, and economic viability of technological advancements .	EPO							
Enlist advocacy groups/Farm Bureau/federations/associations to host workshops/informational meetings regarding GWMA education goals and partnerships in success	EPO							
Make presentations at trade shows, communicate with agricultural consultants who have positive relationships with farmers suggesting that they change practices	EPO							
Partner with UW Pediatric Environmental Health Specialty Unit (PEHSU) to continue training local healthcare providers to recognize and address Nitrate risk in their patients (pregnant women and infants up to six months)	EPO	Feasible	Effective	Up to $30,000 annually (.25 FTE; + translation, printing, coordination)	Unknown	.25 FTE	Coordinate partnership through either DOH or YHD	
Advise the public that GWMA is looking for abandoned wells	WGD							
Encourage commodity groups to provide education on water management and fertilizer use through regular meetings	WGD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Research and Data Collection								
Use both method-based measurement and performance-based measurement.	WGD							
Establish performance objectives against which monitoring data can be compared--number of at risk wells, BMP implementation, funding success, reduction in number of underperforming farming practices	JD							
Implement Ambient Groundwater Monitoring Plan	GWAC	Feasable						
Implement Drinking Water Quality Monitoring Plan	GWAC	Feasable						
Establish a fund and plan to analyze data collected in ambient water quality monitoring and drinking water well monitoring programs. Study short-term seasonal variations in nitrate concentrations over next year or two--addresses how changes in nutrient application over the agricultural cycle affects things. Study long-term trends that develop over several years--to track whether the overall picture is getting better, whether changes recommended by GWMA are having impact.	WGD							
Use hydro-geologically directed monitoring well placement to detect cause/effect remediation opportunities.	JD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Building from the WSDA's Nitrogen Availability Assessment, develop a Nitrogen Loading Assessment for all agricultural, residential and commercial properties, using newly collected data. Hire a technical consultant to conduct a literature review to determine the most relevant information and accurate factors for use in the Nitrogen Loading Assessment. Periodically repeat the grower survey used in the Nitrogen Availability Assessment to compare against the currently established data. Collect data on how many acres in the GWMA are fertilized in various crops with manure and how many with commercial fertilizer. Update and monitor the percentage of acreage in various crops, particularly silage corn and field corn. Study effect of contribution of nitrogen from cover crops used to form mulch. Determine acreage for triticale. Discover commercial fertilizer tonnage for Yakima County and/or for GWMA. Explore how much nitrogen leaches into groundwater from drains and wasteways. Study atmospheric deposition more comprehensively. Understand the difference between plant uptake and plant removal of nitrogen.	WGD, JD							
Get fertilizer loading numbers per crop type. Get economic engine factors per crop type. Determine crop/fertilizer utility ratios. Consider economic benefit of various crop type categories. Consider agricultural usage categories (e.g., field crop, row crop, vineyard, orchard, dairy. Determine amount of land appropriate for each, and location best for each given soil, climate, effect upon groundwater, etc. Ensure adequate supply of each in order to permit opportunity of market choice.	JD							
Recommend that the Yakima Health District or Yakima County continue the High Risk Well Assessment (survey to identify outreach messaging related to health risks and well sampling) periodically over a 5-10 year period. Collect more information on wells known to have high nitrate concentrations, perhaps identifying whether the concentration is self-caused	WGD							
Conduct recurrent drinking water testing where drinking water standards have previously been exceeded.	JD							
Design and implement pilot studies focusing on innovative farm techniques which reduce nitrogen loading to crops and monitor results for future expansion of findings.	JD							
Explore whether nitrate leaching is greater with vetch amended soil or commercial fertilizer amended soil. The results of one study indicate that vetch nitrogen, in comparison to fertilizer nitrogen, leads to lower concentrations of soil inorganic nitrogen and greater immobilization of added nitrogen in soil organic matter. This would reduce the potential for nitrate leaching.	JD							
Recommend that WSU Extension Service update Appendices A and B of the Washington Irrigation Guide.	WGD							
Recommend that Western Fertilizer Handbook, Western Plant Health Association, Ninth Edition (2002) be updated.	WGD							
Fund professional adaptation of Utah Fertilizer Guide for Washington State http://extension.usu.edu/files/publications/publication/AG_431.pdf	JD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Washington State Department of Agriculture								
Develop Nitrogen Loading Assessment as provided in Research and Data Collection above.	WGD							
Summarize the DNMP reporting and provide information that would disclose the amount of manure the CAFO's in the GWMA created and where it was distributed.	WGD							
Review and evaluate the WSDA Dairy Nutrient Management Program inspection protocols to assist in determining if additional resources should be allocated and identify any areas for improvement of the inspections themselves.	L/C WG							
Add staff to WSDA to oversee Dairy Nutrient Management Plans and complaints regarding manure spills.	WGD							
Promote on-going research for managing animal nutrients.	WGD							
Southern Yakima Conservation District								
Ask SYCD for projected plan to expand fiscal and administrative capacity	JD							
Fund post GWMA education and outreach through Conservation District	WGD							
Put request for $$$ for SYCD in State Conservation Commission budget	WGD							
Enhance engineering expertise (personnel) within Conservation District--none there or at NRCS	WGD							
Charge dairies for Conservation District preparation of Dairy Nutrient Management Plans	WGD							
Recommend funding for Southern Yakima Conservation District review of Dairy Nutrient Management Plans	WGD							
Provide better funding and more staffing for Conservation District: hard money funding, increase property tax assessment, create exceptions to taxation for demonstrated testing and monitoring.	WGD							
Develop water sorption graph or chart. List volumes of water applied, soil types, absorption/compaction rates, depths to water, pre-season and post-season appropriate moisture levels.	JD							
US Geological Survey								
Use USGS Particle Tracking Model	WGD							
Use USGS particulate tracking model to identify targets of education	WGD							
USGS Particle Tracking Model Overview--potentially combined with MT3D MODFLOW application to the vadose Zone	WGD							
Yakima Health District								
Study potential nitrate contamination attributable to improperly operated septic systems. Consider restoration/retrofit of older septic systems through incentives or county property tax breaks.	WGD							
Drill deeper water wells further from septic drain systems	WGD							
Require builders to demonstrate that septic system design will not add to nitrogen loading problem as condition of construction	WGD							
Publish and distribute homeowner guide on how to use septic systems	WGD							
Department of Ecology								

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Publish the Department of Ecology's lists of certified laboratories that can test private wells for nitrates and pathogens and Ecology's providing funding to low income, private well users, in order to conduct this testing.	WGD							
Encourage an increase in the number and availability of soil testing laboratories.	JD							
Make grants that complement projects related to non-point source pollution.	WGD							
Provide grant funding for well decommissioning.	WGD							
Search for abandoned wells.	WGD							
Send a postcard to 10 % of known property owners on record having a well asking about knowledge of older wells.	WGD							
Compare Google Earth to Yakima County GIS images to determine building changes and thus possible well usage changes. Focus first on hotspot high density areas in GWMA. Ground truth suspected problem wells.	WGD							
Educate realtors and banking industry about disclosure of abandoned wells in property transfers.	WGD							
Educate public regarding liability of an ill-secured well.	WGD							
Provide some form of protection for self-reporting of abandoned or improperly decommissioned wells.	WGD							
Seek legislative change on requirements for well decommissioning, making them cheaper.	WGD							
Amend RCW 18.104.055 to dedicate a portion of "notice of intent" fees to a fund to be used by Ecology (or Health) for the proper decommissioning of wells in those cases where DOE (or Health) determines that such publicly-funded action is necessary in the public interest to protect or enhance the quality of public health ("infirmity" of the public health).	JD							
Amend authority of Department of Ecology to gain access to properties where manure is spread outside land subject to nutrient management plans	WGD							
Residential, Commercial, Industrial, Municipal								
Encourage municipalities within the GWMA to extend municipal sewer systems within urban growth areas and retire ROSS and LOSS.	RCIM WG							
Encourage connection of residences within urban growth zones to sewer systems extended by municipalities.	RCIM WG							
Encourage the development of group septage-management or treatment systems in areas outside urban growth zones where the density of residential development could exacerbate the effect of multiple OSS on groundwater quality.	RCIM WG							
Establish or maintain ongoing, extended funding necessary for the Yakima County Department of Public Services and Yakima Health District to actively participate in water quality improvement, testing, monitoring, scientific data analysis, and infrastructure development.	RCIM WG							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)							
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Request Yakima County Public Services to perform an engineering study of locations outside urban growth areas where there is rural residential medium to high density OSS and the nitrate concentration is greater than the state water quality standard where community water systems could feasibly be constructed in lieu of individual water wells.	RCIM WG							
Request Yakima County Public Services to perform an engineering study of locations outside urban growth areas where there is rural residential medium to high density OSS and the nitrate concentration is greater than the state water quality standard where community waste water systems could feasibly be constructed in lieu of individual on-site septic systems.	RCIM WG							
Request that the Yakima Health District prepare a plan, as required and described by WAC 246-272A-0015, giving primary emphasis on educational programs for operation and maintenance of existing on-site septic systems (OSS), reserving a determination regarding the advisability of the establishment of regulatory or enforcement programs until data is available from the GWMA's monitoring well system.	RCIM WG							
Request the Yakima Health District to consider the nitrate density element when approving proposed septic systems, including those technologies verified by the U.S. EPA's Environmental Technology Verification Program, for reducing the nutrient nitrogen in domestic wastewater discharged from OSS, including fixed film trickling filter biological treatment, media filter biological treatment, and submerged attached-growth biological treatment.	RCIM WG							
Recommend that soil testing be performed below at least two ROSS drain fields (one with a shallow water table, one with a deeper water table) in high density areas to analyze nitrogen loads as the septage approaches the water table.	RCIM WG							
Request that the State Department of Health determine, prior to issuing or reissuing LOSS permits, that all employee counts are regularly reported, so that the LOSS will continue to operate as designed.	RCIM WG							
Recommend that the State Department of Health consider not approving additional LOSS or otherwise require an effective nitrate removal system.	RCIM WG							
Request that the Department of Ecology analyze the trends of nitrate data contained within reports required by NPDES and SDWA permits.	RCIM WG							
Educate the public regarding the importance of the integrity of wells, particularly those without a well log, and fund and encourage periodic well inspection by the Yakima Health District or professional well engineers.	RCIM WG							
Require that site inspections for possible abandoned wells be performed before building permits are issued for properties that are proposed to be redeveloped after prior development of domestic, agricultural or industrial uses.	RCIM WG							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)							
Action	**Proposed by**	**Feasibility**	**Effectiveness**	**Cost**	**Proposed funding**	**Time**	**Difficulty to implement**	**Degree of consistency with local comprehensive plans and water management programs**
Request that the Department of Ecology develop a plan for finding and decommissioning abandoned wells in the next 12 months, using the LYVGWMA as a pilot project.	RCIM WG							
Permit the repair or decommissioning of wells by general contractors, rather than exclusively by well-drillers, so as to diminish costs of decommissioning.	RCIM WG							
Assist hobby farmers to locate ROSS drain fields on their property so as to avoid animal farming over the drain field.	RCIM WG							
Request the county include the EPO flyer on OSS maintenance in correspondence with GWMA home owners for 5 years. i.e. tax bills, property transfers.	RCIM WG							
Make facility process improvements in waste treatment and food processing plants to reduce nitrogen and total discharge volume.	JD							
Replace aging sewer system infrastructure and ensure proper system maintenance to reduce nitrate leaching.	JD							
Require new developments to address impacts on groundwater quality through permitting review of "site plan review criteria."	JD							
Technology								
Identify and support opportunities, including educational research institutions, for private, public, and industry investment in technology specific to addressing nitrate contamination in groundwater.	L/C WG							
AKART--industry can't keep up with technology, required if performance already meets performance standards?	WGD							
AKART problems--does standard mandate installation of new technologies even when existing ones accomplish the measured objective	WGD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	**Proposed by**	**Feasibility**	**Effectiveness**	**Cost**	**Proposed funding**	**Time**	**Difficulty to implement**	**Degree of consistency with local comprehensive plans and water management programs**
Require nitrogen reducing technologies for onsite septic systems:	WGD			estimated installation costs $20,000, yearly operational costs about $1,500, recirculating sand filters, carbon systems, old system retrofits cost $5,000-7,000 per system				
Explore public investment in waste to energy technology	WGD							
Promote new products that are found through research	WGD							
Promote markets for those products	WGD							
Use commodity group "check off" money for research and development	WGD							
BMPs								
Inform farmers of those BMPs prioritized by Livestock/CAFO and Irrigated Agriculture Work Groups from HDR list to reflect greatest effectiveness in nitrate reduction	WGD							
Determine who implements the BMP and who monitors it and the time frame in which to measure/monitor it--problem with available expertise, timing, installation cost	WGD							
Identify and publish a list of poor management practices. Recommend that they be terminated or avoided.	JD							
Establish a BMP monitoring well network. Monitor BMP performance and effectiveness with the monitoring well network first, then monitor water quality.	Bowen: Having a monitoring plan for the BMP's in place is part of the work the GWAC is required to do.							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	**Proposed by**	**Feasibility**	**Effectiveness**	**Cost**	**Proposed funding**	**Time**	**Difficulty to implement**	**Degree of consistency with local comprehensive plans and water management programs**
Livestock								
Recommend that dairies and CAFOs use those Best Management Practices contained within Attachment B to the Livestock/CAFO Work Group's Report to GWAC	L/C WG	Feasable	GWAC has not reached consensus that pursuing this recommendation alone would accomplish Goals # 1, 2.					
Encourage the WSDA and Conservation Districts to continue education and outreach to livestock operators about impacts and practices related to compliance with relevant State and federal requirements for groundwater protection, particularly addressing those not currently acting in good faith toward that objective.	L/C WG	Feasability depends upon available resources		2 additional FTE's cost ?	Industry, government, private or public research and development, foundations, and industry associations.			
Implement an Education and Outreach Program (EOP) informing producers of Best Management Practices (BMP's) including increased funding for the DNMP assistance program.	L/C WG							
Create and maintain a central depository of public information online, as part of an Education and Outreach Program (EOP) informing producers of the nitrate issue, community impacts, and Best Management Practices (BMP's).	L/C WG				Industry, government, private or public research and development, foundations, and industry associations.			
Increase funding for the local Conservation District and Natural Resources Conservation Service (NRCS) so that assistance programs for nutrient management planning, engineering, cost share, and loan funds are more available.	L/C WG				Industry, government, private or public research and development, foundations, and industry associations.			
Streamline current enforcement activities so as to improve customer service and protocols, increase clarity of process, escalate enforcement for facilities not following management practices, identify methods to discourage repeatedly unfounded complaints, and improve overall transparency.	L/C WG							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)							
Action	Proposed by	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs
Collect data to track water quality improvement progress and nutrients generated, applied, or exported within the LYV GWMA. Generate data through soil testing, Ambient Groundwater Monitoring Plan implementation - including purpose built and existing wells, sampling of liquid and solid waste to be field applied, composted, or exported, the CAFO General Permit, and tracking nutrients applied by non-dairy operations.	L/C WG							
Support and advocate private, public, and industry investment in technology, including at research institutions, specific to addressing nitrate contamination in groundwater, especially where it creates improvements for the public good.	L/C WG							
Require more complete disclosure of Dairy Nutrient Management Plans.	WGD							
Incentivize technology and management of fertilizers and manures.	WGD							
Install separation systems--separate liquids from solids.	WGD							
Use anaerobic digestion in waste storage lagoons	WGD			Very expensive				
Install liners in liquid waste storage lagoons.	WGD							
Install impervious surfaces beneath silage/feed storage.	WGD							
Revise WAC 246-203-130 so that it defines "health hazard" and "nuisance" and includes specific and enforceable requirements designed to protect human health.	WGD, JD							
Compost more manure	WGD							
Improve composting regulations	WGD							
Provide underlying soils information to each livestock opeeration so that individual evaluations can be made.	JD							
Remove wastes from barnyards and other areas of animal concentrations and frequently convey them to waste storage or treatment facilities.	JD							
Prevent contaminants from flowing into wells by ensuring that the external areas around well casings are properly sealed and that wastes are kept the recommended distance from wells.	JD							
Entrain water (as rain or snow-melt) collected from roofs away from animal pen or manure collection facilities.	JD							
Drain low areas where ponds accumulate to collect and manage waste waters.	JD							
Treat manure supply in excess of that which can reasonably be applied as nutrient to agricultural lands as a "waste" product. Apply waste management strategies including land disposal at designated site, incineration, centralized waste-to-energy facility.	JD							
Create a state CAFO Siting Team, composed of representatives of relevant state agencies with support from USGS, to which the county commission could refer proposed CAFO sitings or expansions. The CAFO Siting Team would provide a recommended site suitability determination, based upon a predetermined scoring system, including description of environmental risk factors and mitigation strategies.	WSDA, Gary Bahr							
Amend Dairy Nutrient Management Act to extend WSDA's authority t land application acreage with which dairy facilities contract pursuant to nutrient management plans.	JD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
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Support and advocate private, public, and industry investment in technology, including at research institutions, specific to addressing nitrate contamination in groundwater, especially where it creates improvements for the public good.	L/C WG							
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Treat manure supply in excess of that which can reasonably be applied as nutrient to agricultural lands as a “waste” product. Apply waste management strategies including land disposal at designated site, incineration, centralized waste-to-energy facility.	JD							
Create a state CAFO Siting Team, composed of representatives of relevant state agencies with support from USGS, to which the county commission could refer proposed CAFO sitings or expansions. The CAFO Siting Team would provide a recommended site suitability determination, based upon a predetermined scoring system, including description of environmental risk factors and mitigation strategies.	WSDA, Gary Bahr							
Amend Dairy Nutrient Management Act to extend WSDA’s authority t land application acreage with which dairy facilities contract pursuant to nutrient management plans.	JD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)							
Action	**Proposed by**	**Feasibility**	**Effectiveness**	**Cost**	**Proposed funding**	**Time**	**Difficulty to implement**	**Degree of consistency with local comprehensive plans and water management programs**
Irrigated Agriculture								
Anecdotal results of deep soil sampling carried out by SYCD with farmers with pre-existing relationship with SYCD were informative. Word-of-mouth reporting within farmer community greatly increased acres sampled. Establish a multi-year deep soil sampling program where farmers subscribe for a duration with pre-determined fiscal remuneration for completed sampling. Cost share with farmer. Farmer to provide checklist indicating performance with BMPs. Test throughout growing year, in order to observe effects of fertilization throughout year. Share data with public.	WGD			Expensive	Federal or State			
Do deep soil sampling on fields within GWMA that apply biosolids.	WGD							
Make shallow (1, 2, 3 foot) soil testing reports prerequisites for funding, lending or building permits.	WGD							
Hire soil scientists to do publicly funded "spot auditing" soil checks for feedback to farmers and fertilizer sellers.	JD							
Incentivize development and provide information about improvements made in nutrient management and agronomic rate application of fertilizer by specific developing technologies	JD							
Commission the creation of a data assembly software that could receive, translate, assemble and analyze the data produced by agricultural equipment technology manufactured by different agricultural equipment manufacturers, so as to permit integration of data per field, crop or enterprise.	WGD, Doug Simpson							
Monitor nitrate concentrations of irrigation water at headgates.	JD							
Stimulate news coverage of progress in irrigation technology.	WGD							
Land acquisition—purchase properties with greatest nitrate contribution and retire uses that generate nitrate.	JD							
Incentives—provide credit against county real property tax for investment in source abatement.	WGD							
Develop farmer-specific irrigation water use programs including collection of data, records of irrigation management, education of farmer regarding new processes and technology.	WGD							
Create irrigation management plans (similar to nutrient management plans) for farms over a minum size and provide financial assistance for implemented plans.	WGD							
Encourage advanced irrigation management. Recognizing that there is significant cost involved in changing an irrigation system, look for strategic opportunities in the area where the use of more advanced irrigation management systems could have the greatest benefit for reducing nitrogen impacts to groundwater. One example of advanced irrigation management is electronic sensor irrigation water management (IWM). Identify federal, state and local incentive programs, such as grants, and low interest loans, to facilitate a transition to more advanced irrigation management in those areas	EPA Region 10							
Provide funding for a mobile irrigation lab to assess the efficiency of current or advised irrigation practices, either through a singular lab or component parts.	WGD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	**Proposed by**	**Feasibility**	**Effectiveness**	**Cost**	**Proposed funding**	**Time**	**Difficulty to implement**	**Degree of consistency with local comprehensive plans and water management programs**
Provide financial assistance for 1) conversions from rill irrigation to sprinkler or drip irrigation, 2) installation of flow meters and moisture meters to reflect over-irrigation, high water table, drought conditions, 3) the cost of hiring third party sampling , measuring equipment, personnel or self-test kits, 4) management of sprinkler systems so they do not drive nutrients past the root system.	WGD							
Establish a voluntary irrigation management cost-share program with SYCD. Data shared with public.	WGD							
Manage sprinkler systems so they do not drive nutrients past the root system.	WGD							
Advise farmers of the relative propensity of wheel lines, center pivots, and drip lines to cause leaching.	JD							
Use available techniques to determine how much and when irrigation is needed instead of irrigating according to a prearranged schedule.	JD							
Schedule water and nitrogen application according to the need for optimal crop yields.	JD							
Analyze irrigation practices to discover whether frequency or volume creates greater propensity for leaching.	JD							
Identify and decommission abandoned agricultural irrigation wells.	JD							
Upgrade irrigation districts' open, earthen or concrete delivery laterals and head ditches to PVC pipe.	JD							
Route irrigation-return flow through a constructed managed wetland to reduce concentrations of nutrients and suspended sediment.	JD							
Add polyacrylamide (PAM) to irrigation water.	JD							
Install effective backflow prevention devices on supply lines of water supplied from groundwater wells to avoid backflow from chemigation.	JD							
Structure irrigation water pricing by volume per acre used with preference for lower volume use.	JD							
Improve micro-irrigation system design and operation.	JD							
Recommend that irrigation districts be authorized to condition delivery of irrigation water on irrigation practices consistent with agronomic rate of application of water.	WGD							
Require irrigated agriculture nutrient management plans. Record the source and type of fertilizer and number of acres fertilized with each.	WGD							
Establish water use "domains" (zones) to apply water use constraints, or well construction design constraints, for agricultural uses.	JD							
Develop and implement Nutrient Management Plans (NMPs) for all producers (those that apply manure and those that apply synthetic fertilizer that include annual soil testing for phosphorus and nitrogen and which follow available guidance (i.e. Land Grant University) for developing appropriate land application rates for phosphorus and nitrogen. These NMPs can identify site specific conservation practices that are, or will be, implemented to minimize the transport of phosphorus or nitrogen to surface and ground waters. NMPs that are "adaptive" -- adjusted based on annual soil tests, the types of crops grown, and other site or field specific factors – allow producers to adjust their plans and practices as new information becomes available.	EPA Region 10							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	**Proposed by**	**Feasibility**	**Effectiveness**	**Cost**	**Proposed funding**	**Time**	**Difficulty to implement**	**Degree of consistency with local comprehensive plans and water management programs**
Provide funding for nutrient management education or information distribution.	WGD							
Make Nutrient Management Plan records available upon Department of Agriculture determination of potential excessive application of nutrients.	JD							
Incentivize investment in crops that require less fertilization, or which take up greater amounts of nitrogen.	JD							
Distribute information to farmers on what can happen with applied manure, what should be applied and reasonable, agronomic rates of application.	WGD							
Integrate use of animal waste and synthetic fertilizer, balancing nutrient application amounts so as to maximize crop production and full nitrogen uptake.	JD							
Track nutrients and their application regardless of the end user, including commercial fertilizer.	L/C WG		Nutrients from animal waste are tracked now while in the control of dairy operations. Once those nutrients are transferred to a third party no further regulation exists.					
Keep track of synthetic fertilizer sales.	WGD							
Avoid fertilizer material and manure spills during transport, storage, and application.	WGD							
Use effective application schedules, placement, rate and time of application and speed of release for specific crop requirements.	JD							
Where possible, apply nitrogen through to plant-specific root zone means, rather than broadcast application.	JD							
Identify areas with highly permeable and susceptible soils where fertilization and pesticide application should be most carefully managed.	JD							
Amend Yakima County Code 16C.09.070 to include excess fertilizer application to list of prohibited uses within critical aquifer recharge areas.	WGD							
Amend the list of prohibited uses under the Critical Aquifer Recharge Area ordinance 16C.09.070 (6) to include "activities that would add nutrients to the soil column beyond those amounts that can be taken up within a reasonable time by plant materials." Or perhaps, activities inconsistent with NCRS Code 590	JD							
Inform farmers that fertilization and supplemental irrigation beyond the optimum rate will not necessarily produce better yields or higher profits without serious side effects.	WGD							
Develop an approach for data collection of volume and location of manure application off dairy sites.	WGD							
Place areawide limitation on number of acres where manure can be spread as fertilizer. Require permit to spread manure as fertilizer. Allow market in permits. Allow dairies to own permits which could be leased to other agricultural properties.	JD							

Alternative land and water use management strategies for reaching program goals and objectives per WAC 172-100-100(4)		Evaluation Criteria per WAC 173-100-100 (4)						
Action	**Proposed by**	**Feasibility**	**Effectiveness**	**Cost**	**Proposed funding**	**Time**	**Difficulty to implement**	**Degree of consistency with local comprehensive plans and water management programs**
Intermittent fallowing (leaving lands dormant) to reduce both natural plant nitrogen and fertilizer nitrogen additions to the soil.	JD							
Refrain from tilling under herbaceous remnants of prior crops, reducing plant nitrogen contributions to soil column.	JD							
No Action								
Consider costs of health risks to families from nitrate exposures, costs incurred by growers and producers of various recommendations, costs of bottled water, costs to connect to public sewage systems, cost for WSDA to monitor DNMP, costs of soil sampling	WGD							

Appendix J – Consensus List of Potential Recommendations

The Groundwater Management Committee first made a list of approximately 300 potential alternatives, incorporating working group recommendations, ideas raised in working group conversations and reviews of scientific and environmental literature. The GWAC first applied a consensus screen in order to reduce the large list of alternatives to those potential recommendations with which no one would disagree. This produced a shorter list of 83 potential recommendations to be evaluated by the criteria established by WAC 173-100-100 (4).

GWAC members responded to a request to evaluate the draft recommendations, placing a value of -3 to +3 on each draft recommendation. The results were totaled. A unanimous consensus could not be obtained that the outcome of this method represented the consensus of the GWAC regarding its recommendations. The GWAC membership took a recorded vote at its May 17, 2018 meeting whether to recommend all draft recommendations which had received a total score greater than zero. The GWAC voted 17 to 1, 1 not voting, to recommend those draft recommendations. They appear as "Recommended Actions in Volume I." Those draft recommendations obtaining a total value of zero or less are also presented in Volume I.

	Recommend To:	Recommendation	Details	Feasible?	Effective?	Cost?	Proposed funding?	Time?	Difficult to implement?	Consistent with local comprehensive plans and water management programs?
	Education									
1	DOH, Yakima Health District, Lead Agency	Develop a health-risk education and outreach campaign	Establish a public education program regarding nitrate pollution and health risk over a 5-10 year period. Broaden the pool of people GWMA is educating or communicating with. Provide all materials distributed to the public in English and Spanish. Provide education about concepts that people can understand.Billboard campaign – urging well testing. Partner with UW Pediatric Environmental Health Specialty Unit (PEHSU) to continue training local healthcare providers to recognize and address Nitrate risk in their patients (pregnant women and infants up to six months)	Feasible	Effective	\$50K; \$100K (5 Year plan)	Ecology, Legislature	2019 Session	Not difficult	Consistent with NS-9.10
2	Yakima Health District	Publish and distribute homeowner guide on how to maintain septic systems		Feasible	Effective	Part of previous item cost.	Ecology, Legislature	2019 Session	Easy	Consistent with NS-9.6
3	OSPI, ESD 105	Develop educational materials that could be elected by instructors at 8-12 levels about aquifer protection, groundwater and best management practices.		Feasible	Effective depending on use	\$10K. Contract with educational consultant; see what materials/models out there already	County General Fund	One year	Difficult to fit into curriculum	Consistent with NS-9.6, 9.10
4	Lead Agency	Develop an urban and hobby agriculturalist education and outreach campaign.	Provide information targeted to small farm/hobby farm/ranchettes about manure management. Publish public information about proper septic system construction and operation. Educate the public, particularly in towns, about lawn and garden nitrogen applications' contribution to nitrate concentrations. Recommend against farming around a water well	Feasible	Not Effective, based on prior efforts	\$30 K	Legislature	2019 Session	Easy	Consistent with NS-8.2
5	WCC, WSU Extention, DOE, SYCD, WSDA, Lead Entity, Ag Industry Associations	Develop a post-GWAC agricultural producer education and outreach campaign. Create a broad-based advocacy group (e.g., regulatory agencies, AG industry associations such as the Farm Bureau, Dairy Federation, hop growers, wine grape growers and producers) to carry out the educational components. . Create a central repository (e.g., website) of agricultural information that provides technical assistance to growers and producers, provides education on nitrate, and identifies BMPs specific to each local agricultural industry. Address consequences of too much irrigation. Technological improvements in irrigation that permit easier management of water. Descriptions of specific improved technology. Economic viability of technological advancements BMP implementation, irrigation water management, soil nutrient management and manure management and application.	Elements could include: encourage commodity groups to provide education on water management and fertilizer use through regular meetings; distribute information to producers on what can happen with applied nitrogen, what should be applied and reasonable, agronomic rates of application; encourage agencies and subject matter experts to make presentations at trade shows; ask agricultural consultants to share the latest BMP developments with their clients; increase livestock operators' awareness of the need for procedures for proper management of animal wastes and wastewater; provide producers with information on funding sources (e.g., industry, government, educational institutions, industry associations etc.) that will improve their ability to apply BMPs; enlist partners (Farm Bureau/federations/associations) to host workshops/informational meetings regarding GWMA goals and recommendations.	Feasible	Effective	DOE: \$100 K /yr; SYCD; \$100 K / yr, WSDA \$50-100 K / yr	Operating budgets	2019 Session	Ask WCC, WSU	Consistent with NS-9.10
6	SYCD, WCC	Establish a local forum for disseminating information and facilitating technical exchange regarding BMPs for irrigated agriculture and livestock management and groundwater protection.	Prepare a fact sheet/develop outreach campaign to growers that explains agronomic rates, applying nutrients at the right time/right place/right amount. Endorse and distribute materials that will educate producers about the facts related to all fertilizer types, including livestock waste and the science of groundwater protection.	Feasible	Effective depending on attendance	Included in above item	Operating budgets	2019 Session	Easy	Consistent with NS-9.10
7	WSDA, SYCD	Inform farmers of those BMPs prioritized by Livestock/CAFO and Irrigated Agriculture Work Groups to reflect greatest effectiveness in nitrate reduction.	Focus implementation of BMPS based on information and data included in the Nitrogen Availability Assessment, Soil Sampling Program, Ambient Groundwater Monitoring Plan, USGS Reports, and other similar scientifically based publications. GWMA: Publish lists as appendices to GWMA Program. WSDA: Adopt a llist Lower Yakima Valley GWMA-specific BMPs; Determine who implements each BMP and who monitors it. Determine the time frame in which to measure/monitor each BMP. SYCD: provide farmer-specific consultation.	Feasible	Effective	Included in above item	Operating budgets	2019 Session	Easy	Consistent with NS-9.6
8	WSDA, SYCD	Encourage appropriate use of surface banding ("dribblling," "stripping" of liquid fertilizer, "broadcasting" or prompt incorporation of manures and fertilizers after application to cropland..	broadcast is effective for corn, alfalfa, triticale. Incorporation should occur within 24 hours.	Ask WSDA	Effective	Included in above item	Operating budgets	2019 Session	Ask WSDA	Ask WSDA
9	WSDA, SYCD	Continue to provide underlying soils information to individual livestock operations, provide same for all irrigated agriculture	So that individual property owners can evaluate contamination potential., already in DNMP process	Feasible, info available from NRCS	Effective	Current service of NRCS, SYCD	None	N/A	Easy	Consistent with NS-9.10

	Recommend To:	Recommendation	Details	Feasible?	Effective?	Cost?	Proposed funding?	Time?	Difficult to implement?	Consistent with local comprehensive plans and water management programs?
		Administrative								
1	DOE, Lead Agency, Yakima Health District	Establish or maintain ongoing, extended funding necessary for the Yakima County Department of Public Services and Yakima Health District to actively participate in water quality improvement, testing, monitoring, scientific data analysis, and infrastructure development.	Collect data to track water quality improvement progress and nutrients generated, applied, or exported within the LYV GWMA. Generate data through soil testing, Ambient Groundwater Monitoring Plan implementation - including purpose built and existing wells, sampling of liquid and solid waste to be field applied, composted, or exported, the CAFO General Permit, and tracking nutrients applied by non-dairy operations. Collect, analyze, and interpret data to track water quality improvement progress, nutrients imported, generated, applied, or exported, which will inform the implementation of an Adaptive Management Plan within the LYV GWMA.	Feasible	Effective	DOE $250 K yr. Other cost included in other itemized recommendations	DOE: State operating budget; YHD paid by applicant	2019 Session	Easy	
2	Washington Conservation Commission	Fund SYCD, through State Conservation Commission budget, for projected educational, administrative, nutrient management planning, engineering, cost share, and lending activities.		Feasible,	Effective	Cost included in other itemized recommendations	State operating budget	2019 Session	Easy	
3	SYCD, WSDA	Monitor changes occurring in agricultural operations. Evaluate whether those changes positively affect improvement in groundwater quality.	Requires cooperation of producers & landowners, multi-year effort to account for crop rotation, dry vs. wet years, changing technology, decades to monitor groundwater quality change. WSDA: prepare report to Legislature and Department of Ecology.	Feasible	Effective	$100 K at SYCD; $50 K at WSDA	WCC Operating Budget; WSDA Operating Budget	2019 Session	Requires cooperation of producers	Consistent with NS-9.10
4	Lead Agency	Establish a Lead Agency reponsible for implementation and oversight of the LYV GWMA Groundwater Management Plan and acquisition of stable funding to support their activities.	Administration of Groundwater Quality Program. Administer funds and distribute to other entities by subcontract. Maintain Yakima County's GWMA website. Maintain a GIS data base on the GWMA.	Feasible	Effective	$100 K / yr	Legislature	2019 Session	Not difficult	Consistent with NS-9.10
5	Lead Agency	Perform an engineering study of water supply alternatives.	Possible alternatives: 1) Discontinue use of contaminated shallow wells. Build new 1,500 foot community wells. 2) Rebuild, repair or replace poorly constructed wells. 3) Construct a potable water line from nearby developed area into deadhead water stations at central rural location (permit potable water collection at deadhead water stations). 4) Offer incentives to drill deeper wells or connect households on private wells near community water systems to connect to a community water system. (Nitrate Treatment Pilot Program-June 2011).	Feasible	Effective	$100 K	Legislature	2019 Session	Not difficult	Consistent with NS-9.10, UT-1.1-1.7, 3.1, 3.5, 6.5
6	Lead Agency	Adopt and Implement an Adaptive Management Plan	Utilizing data collected, progress made, or lack of progress, to inform the community on adjustments that need to be implemented. Plan would incorporate necessary adjustments to availabley of technology, education and outreach, tracking exports, land use regulations, treatment systems, and other changes to inform decision makers regarding management changes necessary for a successful program.	Feasible	Effective	$100 K / yr	Legislature	Continuous, 2018-2030	Not difficult, depends on funding	Consistent with NS-9.10
7	EPA, DOE, WSDA	Streamline current regulatory enforcement activities	Improve customer service and protocols, increase clarity of process, escalate enforcement for facilities not following management practices, identify methods to discourage repeatedly unfounded complaints, and improve overall transparency.	Feasible	Effective	$ 0 - $ 300 K / yr, WSDA $100 K	Legislature	2019 Session	Not difficult	Consistent with NS-9.10
8	DOE, WSDA	Improve composting regulations (statutory)	Unclear as to particular reguations proposed	Yes	Potentially effective. .	$50 K	Legislature	2019	Unceertain	Consistent with NS-9.2 , 9.6, 9.10
9	DOE	Inspect, monitor and regulate stockpiled manures.	Coordinate with WSDA. Currently being done; currently required as part of dairy nutrient management plans	Feasible	DOE:	$0 (part of current work)	NA	2018	Not difficult	Consistent with NS-9.2 & 9.4 & 9.10
10	DOE	Review applications for and issue exemptions for agricultural composting operations in a manner that protects public health and the environment, as required by state rules and regs		Feasible	Currently being done	$0 (part of current work)	NA	2018	Not difficult	Consistent with NS-9.2 & 9.6 & 9.10
11	DOE	Provide assistance to local departments of health regarding the regulation of agricultural composting operations		Feasible	Currently being done	$0 (part of current work), 1/4 FTE/yr	NA	2018	Not difficult	Consistent with NS-9.2 & 9.6 & 9.10
12	DOE	Analyze the trends of nitrate data contained within reports required by NPDES and SWD permits.		Feasible	Currently being done	$0 (part of current work), 1/4 FTE/yr	NA	2018	Not difficult	

	Recommend To:	Recommendation	Details	Feasible?	Effective?	Cost?	Proposed funding?	Time?	Difficult to implement?	Consistent with local comprehensive plans and water management programs?
13	DOE,	Develop a plan for finding and decommissioning abandoned wells in the next 12 months, using the LYVGWMA as a pilot project.	Educate the public regarding liability of an ill-secured well, and the importance of the integrity of wells, particularly those without a well log. Educate realtors and banking industry officials about disclosure of abandoned wells in property transfers. Compare Google Earth to GIS images to determine where building or usage changes indicate possible well usage changes. Focus first on hotspot high density areas in GWMA. Ground truth suspected problem wells. Offer incentives, for property owners to identify and properly abandon wells. Offer grant funding to Yakima Health District or professional engineers for well inspections and to assist in abandoned well decomissioning. Provide some form of protection for self-reporting of abandoned or improperly decommissioned wells.	Feasible	Unknown	$30-50 K / yr	Legislature	Two years	Difficult	Consistent with NS-8.2, 9.2, 9.8, 9.10, UT-4, 6.1, 6.5, 7.2, 8, 12.5, 13.1
14	DOE	Require facility process improvements in waste treatment and food processing plants to reduce nitrogen and total discharge volume.	Addressed by Department of Ecology General Permit for Food Processing, specific problems can be addressed through "special protection areas, " WAC 173-200-090.	Difficult, in general, feasible in specific	Uncertain	$20 K administrative cost. Costly to fruit processing facilities	DOEOperating Budget, Private	2019	Requires amendment to state Water Pollution Control Act (RCW 90.48)?	
15	DOE, EPA	Study the relationship between nitrogen emissions and atmospheric deposition of reactive nitrogen. Develop a model that predicts what percentage of emissions return to the GWMA area as atmospheric deposition.		Feasible, but inconsequential	Not effective, has deminimus impact on problem	Cost disproprotionate to benefit		2019-2122	Possible	Consistent with NS-3.1, 3.2, 3.3, 8.1
16	WDOH	Determine, prior to issuing or reissuing LOSS permits, that all employee counts are regularly reported.	So that the LOSS will continue to operate as designed.	Feasible, already being done	Effective	$0 part of current work	DOH operating budget	2018	Easy	Consistent with NS-9.3 & 9.4
17	WDOH	Revise WAC 246-203-130 (keeping of animals)	So that it includes specific and enforceable requirements designed to protect human health.	Feasible	Effective	$200K	Legislature	2019 Session	Not difficult	Consistent with NS-9.10
18	WSDA	Design and implement pilot studies focusing on innovative farm techniques which reduce nitrogen loading to crops and monitor results..		Feasible	Effective	$ 25 K	WSDA operating budget			
19	WSDA	Document and publish regulatory compliance for dairies within the GWMA that are completing and implementing Dairy Nutrient Management Plans (DNMP).	Explore the possibility of disclosing non-proprietary data produced through the DNMP process. Summarize the DNMP reporting and provide information that would disclose the amount of manure the CAFO's in the GWMA create and where it is distributed.	Feasible	Effective	$ 50 K	WSDA / DNMP operating budget	2018	Easy	Consistent with NS-9.10
20	DOE, Yakima Regional Clean Air Agency, WSDA	Estimate emissions of reactive nitrogen - gaseous nitrogen oxides (NO_x), ammonia (NH_3), nitrous oxide (N_2O), the anion nitrate, NO_3^- -from animal agriculture, manure and fertilizer applications in the Lower Yakima Valley. Use this to inform the nitrogen balance data base for the GWMA area and refine estimates of atmospheric deposition.	Use this to inform the nitrogen balance data base for the GWMA area and refine estimates of atmospheric deposition.	Not Feasible CAA Not Willing		"big and expensive"				Consistent with NS-3.1, 3.2, 3.3, 8.1
21	WSDA	Establish a monitoring system for compliance with NRCS Standard 317 on new composting facilities at Washington dairies (phased in for existing facilities).		Feasible but inconsequential	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA
22	Yakima Health District	Issue permits for agricultural composting operations, to appropriately inspect composting operations and to enforce regulations that protect public health and the environment, as required by state rules and regs.		Feasible, requires authorization from County Board of Health	Effective	$10K, depends upon number of composting facilities	Legislature, balance funded by permit applicant.	2019	Not difficult	Consistent with NS-9.2 & 9.6 & 9.10
23	Yakima Health District	Require new developments outside towns to address potential impacts on groundwater quality	Through permitting review of site plan criteria.	Feasible	Effective	Approx. $25-50 K Costly for developer & purchaser	Developer/ purchaser	Decades	Requires BOCC approval	Consistent with NS-8.2
24	Yakima Health District	Study potential nitrate contamination attributable to improperly operated septic systems.	Consider restoration/retrofit of older septic systems through incentives or county property tax breaks. Require nitrogen reducing technologies for onsite septic systems where appropriate. Assist hobby farmers to locate ROSS drain fields on their property so as to avoid animal farming over the drain field.	Feasible	Effective	$700 per applicant for system repair permit application fee. 100 applicants subsidezed = $70K; subsidize cost of reconstruction = $500K	permit applicant	2020	Not difficult	Consistent with NS-9.2 & 9.3 & 9.10
25	Yakima Health District	Issue permits for agricultural composting operations, to appropriately inspect composting operations and to enforce regulations that protect public health and the environment, as required by state rules and regulations.		Uncertain	Uncertain	Cost would be charged to permittee	Perrmit applicant	?	?	Consistent with NS-9.2 & 9.6 & 9.10
26	Yakima County Building Department	Require new developments to address potential impacts on groundwater quality. Limit new development utilizing septic system where soil filtration rate is high, where housing density is already big, where nitrate concentration is already great downstream of the septic plume. Consider the nitrate density element (# of systems per-area) when approving proposed septic systems in order to reduce the nutrient nitrogen in domestic wastewater discharged from OSS.	Recommendations for conditions on issuance of building permits. Determine "density" evaluation criteria. Including those technologies verified by the U.S. EPA's Environmental Technology Verification Program: fixed film trickling filter biological treatment, media filter biological treatment, and submerged attached-growth biological treatment. Recommend use of anaerobic digestion in waste storage lagoons as a best management practice.	Feasible; Not Feasible for YHD, Would need authorization from County Board of Health. Feasible for YC Planning	Effective	Approx. $10-50 K; Costly for developer & purchaser. $410 per applicant for septic permit from YHD; Building permit application fee	Developer / purchaser / permit applicant	Decades	Requires BOCC approval. Requires knowledge of specific area soils and current septic densities.	Consistent with NS 8.2; NS-9.2 & 9.3 & 9.10; Inconsistent with NS-9.7

	Recommend To:	Recommendation	Details	Feasible?	Effective?	Cost?	Proposed funding?	Time?	Difficult to implement?	Consistent with local comprehensive plans and water management programs?
		Data Collection and Monitoring								
1	DOE, DOH	Establish time-based performance objectives against which well-monitoring data can be compared. Establish criteria by which to measure whether performance of nitrate reduction strategies is successful.	E.g., number of at risk wells, BMP implementation, funding success, reduction in number of underperforming farming practices. Use both method-based measurement and performance-based measurement.	Feasible, depends upon immediacy of expectations	Effective in measuring attainment of objectives	DB: $200-250K / Yr; GS 25 K, 1/4 FTE	DOE, DOH Operating Budget	2019 Session	Difficult; need to define timeframe for water quality improvement	Consistent with NS-9.10
2	Yakima County Public Works	Install Ambient Groundwater Monitoring Wells	Monitoring well construction: Monitoring well data collection:	Feasible	Effective	$700,000 in hand, balance uncertain;	Balance from DOE Capital Budget	2019 Session	Already designed, to be installed before 12/31/18	
3	YHD	Collect data from Ambient Groundwater Monitoring Wells	Study short-term seasonal variations in nitrate concentrations over next year or two.--addresses effects of changes in nutrient application over the agricultural cycle. Study long-term trends that develop over several years--to track whether time-based performance objectives are being met.	Feasible	Effective	$20K / year	DOE Operating Budget			
4	Irrigation Districts	Monitor nitrate concentrations of irrigation water at headgates.	Report nitrate concentrations annually to Department of Ecology	Feasible	Effective	$30 K	Ratepayers or DOE grant	2019	Ditch-rider expense	
5	USGS	Contract with USGS to collect data from water well system per 2017		Feasible	Effective	$300K				
6	USGS	Contract with USGS to do particle tracking model study to indicate where groundwater moves faster (permeability).	USGS Particle Tracking Model Overview--potentially combined with MT3D MODFLOW application to the vadose Zone	Feasible, already exists	Unknown	$50K Agency Memo only, $500 + K for 5-year study	Legislature	2019 Session	Easy	
7	WSDA, DOE, Lead Agency	Assess Nitogen Loading. Building from the WSDA's Nitrogen Availability Assessment, develop a Nitrogen Loading Assessment for all agricultural, residential and commercial properties, using newly collected data.	Hire a technical consultant to conduct a literature review to determine the most relevant information and accurate factors for use in the Nitrogen Loading Assessment. Periodically repeat the grower survey used in the NAA to compare against currently established data. Collect data on how many acres in the GWMA are fertilized in various crops with manure and/or commercial fertilizer. Update and monitor the percentage of acreage in various crops, particularly silage corn and field corn. Study effect nitrogen contribution from cover crops. Determine acreage for triticale. Discover commercial fertilizer tonnage for Yakima County and/or for GWMA. Explore how much nitrogen leaches into groundwater from drains and wasteways. Study atmospheric deposition more comprehensively. Understand the difference between plant uptake and plant removal of nitrogen. Ask EPA to use its CMAQ model, or other tools, to estimate emissions of reactive nitrogen - gaseous nitrogen oxides (NOx), ammonia (NH3), nitrous oxide (N2O), the anion nitrate, NO3,- from animal agriculture, manure and fertilizer applications.. Use this to inform the nitrogen balance data base and refine estimates of atmospheric deposition.	Feasible	Dependent upon completion of NAA & GWAC resolution of course of action	WSDA $1 million. DOE $250 K	WSDA, DOE Operating Budget	Dependent upon completion of NAA & GWAC resolution of course of action	Dependent upon completion of NAA & GWAC resolution of course of action	Consistent with NS-9.10
		Water								
1	WSU	Provide funding to WSU for a mobile irrigation lab to assess the efficiency of current or advised irrigation practices, either through a singular lab or component parts.	Inform farmers of the relative propensity of wheel lines, center pivots, and drip lines to cause leaching and that fertilization and supplemental irrigation beyond the optimum rate will not necessarily produce better yields or higher profits without serious side effects.. Advise re corn and triticale water practices.	Feasible	Effective	Approx. $100 K / yr (IAWG)	WSU Operating Budget	2019 Session	Not difficult	Consistent with NS-9.10, 12.1, 12.2, 12.4
2	SYCD, WSDA, WSU	Create Irrigation Management Plans (similar to Nutrient Management Plans) for farms over a minimum size and provide financial assistance for implemented plans.	Use available techniques to determine how much and when irrigation is needed instead of irrigating according to a prearranged schedule. Analyze irrigation practices to discover whether frequency or volume creates greater propensity for leaching. Manage sprinkler systems so they do not drive nutrients past the root system. Improve micro-irrigation system design and operation. Schedule water and nitrogen application according to the need for optimal crop yields. Monitor the timing of application of fertilizers to fields and how much water was then applied.	Difficult	Effective	WCC $200 K / yr; SYCD $200 K / yr	WCC , WSU Operating Budgets	2019 Session	Difficult, plans are property-specific,	Consistent with NS-9.10, 12.1, 12.2, 12.3
3	WSU, SYCD, WSDA, WCC	Encourage advanced irrigation management. Integrate management of synthetic/organic fertilizers and application of water	Recognizing that there is significant cost involved in changing an irrigation system, look for strategic opportunities where the use of more advanced irrigation management systems could have the greatest benefit for reducing nitrogen impacts to groundwater. One example of advanced irrigation management is electronic sensor irrigation water management (IWM). Identify federal, state and local incentive programs (like EQIP), such as grants, and low interest loans, to facilitate a transition to more advanced irrigation management in those areas. Provide financial assistance for 1) conversions from rill irrigation to sprinkler or drip irrigation, 2) installation of flow meters and moisture meters to reflect over-irrigation, high water table, drought conditions, 3) the cost of hiring third party sampling , measuring equipment, personnel or self-test kits, 4) management of sprinkler systems so they do not drive nutrients past the root system. Establish a voluntary irrigation management cost-share program from which data may be shared with the public.	Feasible	Effective	$25 million (18 K acres of rill irrigation in GWMA @ $3 K / acre, split 50/50 with landowner) $36 million @ $4 K / acre.	Identify federal, state and local incentive programs (like EQIP), such as grants, and low interest loans, financial assistance	Short & Long-Term		Consistent with NS-9.10

	Recommend To:	Recommendation	Details	Feasible?	Effective?	Cost?	Proposed funding?	Time?	Difficult to implement?	Consistent with local comprehensive plans and water management programs?
		Public Works								
1	Municipalities	Provide funding for municipalities to replace aging sewer system infrastructure and ensure proper system maintenance to reduce nitrate leaching.	Municipalities need to estimate costs and system integration.	Feasible	Effective	$10 million	Congress, Infrastructure Bill	Decades	Requires upgrades to meet all current standards	Consistent with UT-1.3, 1.6, 11.5, 11.6, 11.7
2	Lead Agency	Encourage municipalities within the GWMA to extend municipal sewer systems within urban growth areas and retire ROSS and LOSS., alternatively extend public water systems. Encourage connection of residences within urban growth zones to sewer systems extended by municipalities		Feasible	Effective	$5 million	Congress, Infrastructure Bill	Decades	Hasn't been accomplished to date	Consistent with UT-1.3, 1.6, 11.5, 11.6, 11.7
		Research and Development								
1	EPA, DOE	Identify and support opportunities, including educational research institutions, for private, public, and industry investment in technology specific to addressing nitrate contamination in groundwater.	EPA & DOE construct a LYVGWMA Program for coordinated implementation.	Feasible	Effective	$100-250 K / yr	Agency budgets	2018	Easy	
2	WSDA	Identify and support opportunities, including education research institutions for private, public and industry investment in technology and management of fertilizers and manures, including separation of solid and liquid wastes.	WSDA construct LYVGWMA administrative program.	Feasible	Effective	$1.75-$4 million, WSDA $10 million	WSDA Capital Budget	2018	Easy	
3	USDOE, USDOA	Explore investment in animal and agricultural waste to energy technology	Explore state of technology, economic viability, return on investment (national corporate research & development/ governmental incentives)	Feasible	Effective	Included in item above	Congress, Energy Bill	2020	Easy	Consistent with NS-9.10
4	WSU Extension Service	Continue research of water management with application of agricultural nutrients.	Develop water sorption graph or chart. List volumes of water applied, soil types, infiltration rates, water holding capacity, absorption/compaction rates, depths to water, pre-season and post-season appropriate moisture levels, evapotranspiration rates.	Feasible	Effective	$250 K	WSU Operating Budget	Five years	Continuous effort	
5	WSU, Producers	Integrate use of animal waste and synthetic fertilizer.	Research chemical integration of animal waste and synthetic ferlizers with objective of balancing nutrient application amounts in order to maximize crop production and full nitrogen uptake.	Feasible	Effective	$250 K	Private, WSU Operating Budget	Ongoing, 2019 Session	Not difficult, but requires knowledge of soil chemistry	Consistent with NS-9.10
6	WSDA, WSU	Quantify the nutrient value and rate of release of nitrate from livestock waste under various Lower Yakima Valley conditions to become part of nutrient management guidelines.		Feasible	Effective	$500 K. $100 K	WSDA, WSU Operating Budgets	2019 Session	Difficult without knowledge of sub-area soil chemistry and moisture information	Consistent with NS-9.10
7	WSDA	Develop strategies for marketing the economic, fertilizer value, and soil enhancing properties of appropriate application of manure and other livestock wastes.		Feasible	Effective	$25 K	WSDA Operating Budghet	2019 Session	Ask WSDA	Consistent with NS-9.10
8	WCC	Identify and support opportunities, including education research institutions for private, public and industry investment in technology and management of fertilizers and manures, including separation of solid and liquid wastes.		Feasible	Effective	$1 million	WCC Capital Budget	2019 Session	Not difficult	
9	Legislature	Require Commodity Commissions to dedicate "check off" money for research and development in water quality technology and practices.	include in funding alternatives for technology R & D	Feasible	Effective	Portion of other estimates above.	CC Members	2019	Research CC statutes	
10	USDOE, USDOA	Explore investment in animal and agricultural waste to energy technology	Explore state of technology, economic viability, return on investment (national corporate research & development/ governmental incentives)	Feasible	Effective	$1 million	Congress	2020	Easy	Consistent with NS-9.10
11	SYCD, WSDA, WSU, Private Industry, Producers	Educate producers regarding aplication of nutrients at Agronomic Rate	Develop technologies and provide information about improvements made in nutrient management and agronomic rate application of fertilizer by specific developing technologies.	Feasible	Effective	Dependent on technologies included in combined education recommendation GB $500,000	Private, Legislature	Ongoing, 2019 Session	Dependent on technologies	Consistent with NS-9.10

	Recommend To:	Recommendation	Details	Feasible?	Effective?	Cost?	Proposed funding?	Time?	Difficult to implement?	Consistent with local comprehensive plans and water management programs?
		Agriculture								
1	NRCS, DOE	Provide financial assistance for implementation of Irrigation Management Plans.	1) conversions from rill irrigation to sprinkler or drip irrigation, 2) installation of flow meters and moisture meters to reflect over-irrigation, high water table, drought conditions, 3) the cost of hiring third party sampling , measuring equipment, personnel or self-test kits, 4) management of sprinkler systems so they do not drive nutrients past the root system.	Feasible	Effective	$ 1 million one time ($250 K x 4; NRCS EQIP program limited to $450 K per farmer unless new Farm Bill authorization)	Congress (Farm Bill), DOE Capital Budget	2019 Session	Doable	Consistent with NS-9.10, 12.1, 12.2, 12.4
2	DOE, WSDA	Make grants and allocate cost share funding or other funding assistance to people implementing environmental protection measures affecting groundwater quality.	Assign personnel to investigate which environmental protection measures utilized by irrigated agriculturalists and livestock/dairy producers have positive influence on groundwater quality and explore means to share costs of implementing such measures. (Coordinated DOE, WSDA, Conservation District program). See NRCS Environmental Stewardship Program (2012).Also WCC, Voluntary Stewardship Program (Bill Isler), USDA Rural Community Assistance Group environmental program	Feasible	Effective, depending upon definition of "environmental measures"	DOE: $1 million, WSDA: $500 K	DOE, WSDA Capital Budget	2019 Session	Difficult, dependent on interagency communication & relationships with producers	Consistent with NS-9.6, 9.10
3	SYCD, Producers	Develop and implement Nutrient Management Plans for all farmers.	Mandatory or Voluntary. Farming operations currently are not required to hold permits or a prepare a Nutrient Management Plan.	Feasible	Effective	SYCD $200 K, on farm costs born by producer	WCC Operating Budget	Recurrent/ Annual	Not difficult	Consistent with NS-9.10
4	WSDA	Amend the Dairy Nutrient Management Act to extend WSDA's authority to manure application on properties other than those owned by dairies, provide more complete disclosure of Nutrient Management Plans.		Feasible	Effective	$200 K / yr	WSDA Operating Budget	2019 Session	Requires legislative approval	Consistent with NS-9.10. Inconsistent with NS-7.64. (Mutually inconsistent provisions.)
5	SYCD	Establish a multi-year deep soil sampling program where farmers subscribe for a duration with pre-determined fiscal remuneration for completed sampling. Cost share with farmer. Farmer to provide checklist indicating performance with BMPs. Test throughout growing year, in order to observe effects of fertilization throughout year. Share data with public.	Farmers would subscribe for a duration with pre-determined fiscal remuneration for completed sampling. Cost share with farmer. Farmer would provide checklist indicating performance with BMPs. Testing would occur throughout growing year, in order to observe effects of fertilization throughout year. Data grossly accumulated would be shared with public without attribution to individual farmers. Anecdotal results of deep soil sampling carried out by SYCD with farmers with pre-existing relationship with SYCD were informative. Word-of-mouth reporting within farmer community greatly increased acres sampled.	Feasible	Effective	$250 K / year for 5 years to finance extensive deep soil sampling program;	WCC Operating Budget	2019 Session	How to share data is unresolved, public distribution may limit participation by producers & landowners	Consistent with NS-9.10
6	WSDA	Complete NRCS Technical Note 23 inspections on all waste storage ponds (lagoons) within the GWMA boundaries.		Feasible	Ask WSDA	WSDA $20 K	WSDA Operating Budget	2019 Session	Ask WSDA	Unknown
7	Producers	Make capital improvements	Install liners in liquid waste storage lagoons. Install impervious surfaces beneath silage storage.	Feasible	Effective	$10 million	Cost-share/ producers & WSDA (Legislature)	2019	Feasible	Consistent with NS-9.10
8	Legislature	Make shallow (1, 2, 3 foot) soil testing reports prerequisites for funding, lending or building permits.	In the nature of Phase I Environmental Audits. Makes nitrate-related information/data available for water quality management.	Feasible	Effective	$2 k / per mit application	Private	2019	Amend GMA (RCW 36.70A)	

Appendix K – Recommendations Received From Public Comment

These recommendations consolidated in this appendix came out of the public comments. In many instances the exact wording from the comment letter was used, however some were edited for length.

During the Program creation process, the GWAC met for 6 years, spending many hours drafting, analyzing, and voting on potential recommended actions for the program. Some of the items in this appendix have previously been discussed by the GWAC, however all items have been included as documentation for future use.

Recommendations Related to Dairies or Large Farming:

All agriculture (including hops, mint, row crops, tree fruit, grapes) should be required to take annual soil samples and have a written nutrient management plan plus inspections.

Encourage adoption of irrigation and nutrient management practices.

Create means for all agriculture to work together.

Create a cost share program for earthen lagoons.

Recommendations Related to Ongoing Data:

The Departments of Ecology, Agriculture and Conservation Commission, as well as Yakima County, the Yakima County Health District and the Southern Yakima Conservation District should not regard the investigation of groundwater contamination in the Lower Yakima Valley as a fait accompli, but rather as a fait ab initio.

Results from the next steps in the U.S. Geological Survey work could be useful to implementing the GWMA program. The next phase would be to conduct a reverse-loading analysis based on the 2015 particle tracking study, to estimate how much reduced nitrogen loading would need to occur to decrease nitrate concentrations in downgradient residential wells to meet the drinking water maximum contaminant level. These findings could be used to refine and focus efforts to implement the final GWMA program in the coming years.

The Washington State Conservation Commission awarded competitive grants for demonstration projects statewide to test various technological approaches to recapture or recycle nutrients, including one in the Yakima Valley. The results of these projects could be useful in the implementation phase.

Use new information from research, data gathering, and technology demonstration projects nationwide pertaining to both understanding the nature of groundwater contamination and strategies to reduce it.

Collect nitrate data from domestic wells as a substitute for monitoring wells. Collection of additional data, including hydrogeological and water quality data should focus on areas with identified deeper nitrate contamination, with a goal of identifying potential conduits to deeper aquifer zones.

Seek to broadly and proportionately represents the affected community.

Duly authorized governmental agencies and duly elected public officers are charged with a public duty to execute those rules and regulations currently in effect, and exercise those powers with which they are currently authorized, notwithstanding that they are not recommended by public interest groups.

Neither the final draft of the Lower Yakima Valley Groundwater Advisory Committee's Program, nor the recommendations contained therein, are limiting upon the choices available to the public at large or governmental agencies with relevant jurisdiction.

The Washington hop commission funded a WSU, three year, deep sampling to 6 ft. in 23 hop yards from 1990-1992. This study showed the variability between spring and fall sampling and explained some of the reasons why this happens. It also demonstrated how variable management practice can effect soil test nitrate over time. Take this into account.

Ensure that QAPPs are developed for any new work that includes data collection.

Overlay historical nitrate levels against farming practices over the same time and the population growth of the area of both livestock and people. If this long term (more than a decade) historic data is not available, perhaps a trend or timeline should be established prior to making broad decisions.

Recommendations Related to Public Outreach and Education:

Send a mass mailing to all residents located outside of public water supply service areas within the Lower Yakima Valley. The mailing would explain the problem of nitrates in shallow groundwater, and that it is of particular danger to expecting mothers and infants. The mailing would provide a telephone number for free testing of their well water for nitrates.

Use Spanish-language radio educational information as an outreach tool.

Provide education on double cropping and agronomic application of nitrogen

Recommendations Related to Gathering Additional Data:

Assign staff dedicated to collection of water samples from domestic wells for nitrate analysis. The staff should be able to respond to requests to sample within one week of a telephone request. Households with infants or expecting mothers (or women of childbearing age) would be bumped to the top of the list. Shallower wells should be given a higher priority than deeper wells. The sampling staff would maintain a database, including available well construction information.

A higher percentage of the committee be comprised of members who reside in the affected GWMA area so as to more accurately represent their community and neighbors' best interests.

Because of potential negative effects on fish and fish habitat, ammonia (NH_3) should be investigated in irrigation return flows to surface waters. Arid area waters tend to be more alkaline than those in wetter areas, and NH_3 toxicity to aquatic organisms increases as pH increases. (EPA Quality Criteria for Water, 1986 as updated). If initial investigations do not indicate a problem, no further monitoring should be required.

Consideration should be given to supplemental funding to include nitrogen analysis of groundwater samples from Superfund/MTCA site monitoring wells within the study area. This would potentially increase the number of available data points within the study area at a very modest increase in cost.

Information not provided to the GWAC but obtainable from the Washington State

Department of Agriculture should be analyzed:
a. Growth in agricultural use intensity (density/acre, acreage fanned, production volume)
b. Amount of chemical fertilizer sold or used within GWMA
c. Report of dairy nutrient management plan information on distribution of manure (see RCW 90.64.026(3), RCW 42.56.270(7), WAC 16-06-210(29))
d. Nitrogen Loading Assessment (as distinguished from Nitrogen Availability Assessment, see: June 19, 2014, August 21, 2014, October 16, 2014, and December 18, 2014 GWAC meeting summaries; Yakima County/Department of Agriculture Interagency Agreement

Information not provided to the GWAC but obtainable from the Department of Ecology should be analyzed:
a. Report on enforcement of RCW groundwater standards
b. Report on effect of large scale water usage on groundwater quality

Identify or analyze information about the amount of chemical fertilizers sold or distributed to managers of orchards and crops, or applied to orchards and crops within the study area.

Reflect the often-expressed view/opinion within the Advisory Committee that the effect of groundwater contamination in the Lower Yakima Valley influences the lives and health of human demographic groups disproportionately. Study or describe the socioeconomic effect of groundwater contamination within the study area upon on future generations. Both effects should be studied.

Correlate the economic benefit derived from the private small industrial, agricultural, urban/suburban residential sector sources' activity within the study area with the economic costs likely to be incurred by the public remedial, corrective, educational, or regulatory activities responding to the problem. Quantify the economic value of the natural resource (groundwater) consumed through contamination (an unmeasured and undocumented expense incurred as part of the private small industrial, agricultural, and urban/suburban residential sectors' entrepreneurial enterprise). Study this relationship in order to determine correlate costs of remediation, if any, with the economic benefits of groundwater consumption.

Evaluate the causal relationship, if any, between the method and volumes of water applied to the ground surface (either generally or at specifically identifiable locations, or the volume of groundwater stored within the ground, within the studied area, and the extent, location or degree of groundwater contamination within the studied area or at specific contaminated wells.

Evaluate the correlation, if any, of the location, volume or movement of surface water within lined or unlined artificial conveyance systems (irrigation canals) with the extent, location or degree of groundwater contamination within the studied area.

Correlate changes in concentration, density, intensity, or use of source-related activities within the studied area with changes, if any, in the extent, location or degree of groundwater contamination within the studied area.

Analyze specific deep soil sampling data collected from known locations. Collect more deep soil sampling data, with data collection sites located, and that data analyzed.

Analyze trends in well data from Valley Institute for Research and Education Report (2002), Nitrate Pilot Project Well Samples, LVYGWMA High Risk Well Assessment Well Samples, and USGS 2017 Well Testing Data. Analyze trends in this data.

Identify plausible hypotheses of causation, transmission, or accumulation of contaminant between categorical sources and contamination events or locations. These hypotheses should be stated and explored.

Describe the processes of hydrogeologic or chemical transmission or accumulation of contaminant in the area of contamination. These processes should be more completely explored and described.

Investigate or analyze the geologic and hydrogeologic properties of denser locations of contaminated wells (“hotspots). These should be investigated and analyzed.

Investigate or analyze the plausible causal relationship between specifically identifiable sources and specific contamination events. These should be investigated and analyzed.

Explore the correlation, if any, between specific land use types and proximate water supply contamination events.

Address the specific land use regulations, or other regulation types, that might use, rectify, ameliorate or otherwise alter the general or specific contamination condition within the study area.

Address the effect of generic or specific sources on the protection of areas with “critical recharging effect on aquifers used for potable water or areas where a drinking aquifer is vulnerable to contamination that would affect the potability of the water” as designated by Yakima County pursuant to the Growth Management Act or otherwise (RCW 36.70A; WAC 365-190-030 (3); and YCC 16A, 16C), as “environmentally sensitive or special areas” as contemplated by WAC 197-1l-330(2)(e)(i), WAC 197-11-305 (l)(a), WAC 197-1l-908(l)(b) and the Growth Management Act. These effects should be described and analyzed.

Explore the strategy of taxation on the use or sale of materials containing chemical constituents common to known constituents of groundwater contamination as a means of source reduction.

Explore the strategy of usage limitations, imposed through land use regulation, on the nature, density, or intensity of use (analogous to limitations on industrial development).

Recommend any remedial action. Remedial actions should be studied.

Evaluate the costs or implications of inaction. These should be evaluated.

Locate and evaluate any past nitrate studies done for this area, specifically an unspecified study done approximately 40-50 years previous.

Use scientific data from additional sources, including: Collaborative work carried out by local, state and federal agencies in 2010, “Lower Yakima Valley Groundwater Quality.” Data from other scientific studies are also available. Quality-assured/quality controlled available data. A few examples to draw upon include:

- United States Geological Survey (USGS): “Particle tracking for selected groundwater wells in the lower Yakima River Basin, Washington,” 2015. The USGS assessed nitrate sources in specific geographic areas within the GWMA with groundwater contamination and identified associated likely nitrogen source areas, https://pubs.er.usizs.izov/publication/sir20155149

- The EPA: "Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington," 2013 contains soil information such as permeability data from lagoons, and nitrogen concentrations in manured dairy crop fields, https://www.epa.izov/wa/lower-yakima-vallevgroundwater
- Since a Consent Order was signed with three Lower Yakima Valley dairies in 2013, these dairies have made great strides in reducing the amount of nitrogen accumulating in their fields. In reports submitted under the EPA Consent Order and approved Quality Assurance Project Plan (QAPP), there are several years of biannual data from fields prior to the AOC-required limitations of field applications of manure and the subsequent transition to the present conditions. These dairies are also providing post-harvest data that can inform soil concentration estimates in the draft GWMA Plan. https://www.epa.gov/wa/lower-vakima-valley-groundwater

Study proportional impact of all sources of nitrate so as not to overly burden one group over another without knowing their respect impacts to groundwater nitrates.

Study scientific evidence of impacts related to regulations on farmers and dairymen.

Recommendations Related to Monitoring Wells:

Maintain a longitudinal record of measurements taken from groundwater monitoring wells so as to document trends in improvement or worsening of the present condition.

Map the "horizon" of analysis of monitoring well measurements from the groundwater monitoring well system (an undulating plane established by points (elevations) at each monitoring well, with the intervening spaces being calculated with reference to influence from proximate point data) should be mapped. This might indicate how the measured horizon intersects with the geologic regimes already known (theoretically) to exist within the study area.

Introduce some sort of non-pollutive tracer in selected monitoring wells in order to ascertain whether that tracer expresses itself in other monitoring wells. This may be possible due to the density and location of monitoring wells within the study area. This may provide information helpful in establishing direction of groundwater flow (albeit at a rather surficial elevation).

Test monitoring wells whether the nitrates are coming from human waste or from animals and commercial fertilizer.

Place some wells around the town of Outlook to determine whether the nitrates are coming from people or agriculture.

In addition to randomly placed monitoring wells, consideration should be given to more intensive targeted monitoring at and around "hot spots" as changes in N concentrations (improvements and further degradation) will be particularly important in those areas.

Include wells in the urban growth areas.

Wells deemed anomalies to be discontinued.

Recommendations Related to Providing Resources:

Identify locations for household collection of free drinking water at each community in the Lower Yakima Valley. Once a household water supply well has been tested, the owner or resident would be provided with a document allowing them to pick up free drinking water (a reasonable weekly allotment could be calculated).

Begin a grant program for replacement of impacted shallow domestic wells. Such grants could be applied for by homeowners that have a shallow wells with nitrates above cleanup levels. Prioritization of grant recipients should be based on needs of the applicant. A fund for this grant can be contributed to by taxpayers and groundwater polluters. This recommendation would require legislative action.

Formation of rural PUD Water Districts for replacement water supplies, particularly in "hot spots" within the GWMA.

Use recirculating sand filters in areas where high density of ROSS.

Coordinate with DOH on WAC 246-272A-015 (5) which states "shall develop a written plan that will provide guidance to the local jurisdiction regarding development and management activities for all OSS within the jurisdiction".

Recommendations Related to Additional Regulations:

Drinking water wells required depth of greater than one hundred feet deep.

Onsite Sewage Systems (OSS) should be controlled by the county and a plan that is required by WAC 246-272A-015(5) should be developed by the Health Department for OSS.   I would recommend that any parcel that requests an OSS permit that is less than 20 acres (just under High Density standards) should have an OSS that is designed to reduce the nitrogen flow in its effluent.

Recommendations Related to Additional Approaches:

Provide greater focus on eliminate exposure pathways.

Make providing drinking water to affected the top priority.