Public Services

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VERN M. REDIFER, P.E., Director

May 18, 2018

David Bowen
Department of Ecology, Central Region Office
1250 West Alder Street
Union Gap, WA 98903

Re: **Lower Yakima Valley GWMA - 2018 First Quarter Report (IAA No. C 1200235)**

Dear David:

Enclosed please find one (1) copy of Yakima County's first-quarter report as required under Attachment A, Statement of Work, Agreement No. C 1200235 between the State of Washington Department of Ecology and Yakima County.

This report addresses deliverables 1.1, 1.4, and 2.2 as required under the agreement.

Deliverable 2.1, invoices, to be sent separately.

If you have any questions, please let me know.

Thank you.

Lisa H. Freund

Lisa H. Freund, Administrative Manager
Yakima County Public Services

enclosure

IAA No. C 1200235 – First Quarter 2018 Report
Lower Yakima Valley GWMA
March 31, 2018

TASK 1 - ADMINISTRATIVE FUNCTIONS
DELIVERABLES

1.1 Meeting Records

For each meeting of the GWAC, submit a copy of the agenda, minutes, attendance and public meeting notice at the end of each quarter.

Attachment [A] includes the final GWAC meeting summaries of December 7, 2017, February 15, 2018, and March 1, 2018; and the Data Collections Working Group final summaries of March 1 and 29, 2018. Data Collections was the only working group to hold meetings in this quarter.

1.4 2018 Meeting Schedule

At its December 7, 2017 meeting, the GWAC agreed to calendar two meetings per month for the first six months of 2018, with the caveat that meetings would be canceled if there wasn't sufficient material to discuss. The intent was that the GWAC would conclude its work no later than June 30. Accordingly, placeholder meetings were scheduled for the first and third Thursday of each month (except January) from 5:00 p.m. - 7:00 p.m. (January 18; February 1 and 15; March 1 and 15; April 5 and 19; May 3 and 17; and June 7 and 21, 2018). Meetings would be held at either the Yakima County Road Maintenance Shop, 1216 S. 18th Street in Yakima, the Denny Blaine Boardroom, 810 East Custer Avenue in Sunnyside and, when the Denny Blaine Boardroom was not available, Radio KDNA, 121 Sunnyside Avenue in Granger.

In the first quarter the GWAC held meetings on February 15 and March 1. Both meetings were held in Yakima. The remaining meetings were canceled due to a lack of substantive information to consider.

TASK 2 - PROGRAM FUNCTIONS
DELIVERABLES

2.2 Status Report

Submit written quarterly status reports summarizing GWAC plans, activities and work products, and describing any interlocal agreements or other contracts by the end of each quarter.

GWMA Program Development. The GWAC held two meetings in the first quarter to continue its work on the Alternatives section of the draft GWMA program, to review the second draft of the program, and to review GIS mapping and proposed locations for the purpose-built wells.

At the February 15 meeting the Alternatives list (GWMA Strategies) was further refined from previous versions. The group learned that the alternatives had been checked against Yakima County's *Comprehensive Plan – Horizon 2040 – Water Quality Goals and Objectives* for consistency. Funding strategies for proposed alternatives were introduced. Natural Resources Conservation Service (NRCS) funding was discussed. The proposed locations for purpose-built well locations were introduced to the group. The GWAC also reviewed mapping data collected on Yakima County's Geographic Information System (GIS).

GWMA Program Expenditures. In response to members' request for GWMA Program development expenditures, an itemized list was distributed at the February 15 meeting.

The "MASTER GWMA Strategies 1-29-18 vmr.xlsx," "Horizon 2040_YC Comprehensive Plan_Water Quality Goals and Objectives," the expenditures' document "GWMA LTD – 2017 12-13-17 Prelim.xlsx," and "PGG Preliminary Drill Sites 1-30" are included as Attachment [B].

GWMA Draft Program

Background. In December 2017, four draft sections of the GWMA program were released to the GWAC. Sections included the Program Index, Characterization of the Area, Sources of Nitrate and the Regulatory Environment, and Yakima County's Role in Groundwater Quality Protection. The GWAC was provided with a program comment form and asked to provide feedback by January 31, 2018. It was further explained that the "Investigations and Analysis" section had not yet been written, as the final results from the USGS well-sampling and the final draft NAA had not been completed.

At the March 1 meeting, the group reviewed the second draft of the Program, which reflected, in part, feedback provided by the group. The sections on geology, hydrogeology and typography had been completely rewritten, and more history had been added to the land-use section. In addition, appendices containing Best Management Practices recommended by the Irrigated AG and Livestock/CAFO working groups had been added. Members were urged to submit comments on the second draft by March 16. The importance of agencies responding to the "cost" and time" columns of the recommendations was emphasized so the group could set priorities more effectively when requesting money from the Legislature.

Attachment [C] includes the "Index for 3.1.2018 Program Release to GWAC," and "LYVGWMA Program JHD 02-26-18" which contains the GWMA program chapters presented to the GWAC on March 1, 2018: Introduction (Draft V2); Characterization of the Area (Draft V2); Sources of Nitrate and the Regulatory Environment (Draft V2), Yakima County's Role in Groundwater Quality Protection (Draft V2), Environmental Effects (Draft V 1) and Appendices A - F.

Working Group Activities

The Data Collections Working Group met on March 1 and 29, 2018. At the March 1 meeting, Chair Melanie Redding shared the deep soil sampling results analysis she had prepared. The group discussed the information and what kind of structure they wanted in place for examining the data and carrying forward recommendations. It was agreed that the GWMA or successor agency needed to identify the most important projects they wanted done. GWAC member Jean Mendoza felt that Melanie's presentation lacked the context of research she herself had performed. It was agreed that Jean would share her own analysis with the group.

The March 29 meeting, Jean Mendoza presented a PowerPoint presentation labeled "Analysis of the Lower Yakima Valley Groundwater Management Area Deep Soil Sampling." Following discussion, it was agreed that Ginny Stern would summarize Melanie and Jean's analyses of the deep soil sampling data with the goal of initiating discussions with stakeholder groups on changing practices. It was further suggested to contact WSU about its interest in designing a future deep soil sampling project.

Melanie Redding's supporting documents "MR_Deep Soil Sampling (DSS) in the Lower Yakima Valley GWMA" and "MR_Draft Deep Soil Sampling Analytical Analysis" are included as Attachment [D].

Jean Mendoza's supporting documents "Analysis of DSS Attachment 1 2014 03 28 Deep Soil Sampling Plan," "Analysis of DSS Attachment 2 DSS PowerPoint," "DSS Presentation to LYV GWMA Data WG," and "Soil Types and GWMA DSS" are also included as Attachment [D].

GWMA Website

The GWMA website continued to be updated in real time.

Contracts and Interlocal Agreements

Amendment Number 1 to Agreement C1600074, extending the contract between Department of Ecology and Yakima County from December 31, 2017 to December 31, 2018 was executed on January 2, 2018.

The contract between Yakima County and Pacific Groundwater Group (PGG) for Monitoring Well Installation in the amount of $147,706 was executed on January 9, 2018

Both documents are included as Attachment [E].

Attachment A

- Final GWAC meeting summary of December 7, 2017
- Final GWAC meeting summary of February 15, 2018
- Final GWAC meeting summary of March 1, 2018
- GWAC agenda and public meeting notice for February 15, 2018
- GWAC agenda and public meeting notice for March 1, 2018
- Final Data Collections Working Group summary March 1, 2018
- Final Data Collections Working Group summary March 29, 2018
- GWAC attendance roster record for February 15 and March 1

YAKIMA VALLEY GROUNDWATER MANAGEMENT AREA ADVISORY COMMITTEE (GWAC)

MEETING SUMMARY

Thursday, December 7, 2017 – 5:00 p.m. – 7:00 p.m.

Yakima County Roads Maintenance Conference Room
1216 South 18th Street, WA 98901

Note: This document is only a summary of issues and actions of this meeting. It is not intended to be a transcription of the meeting, but an overview of points raised and responses from Yakima County and Groundwater Advisory Committee members. It may not fully represent the ideas discussed or opinions given. Examination of this document cannot equal or replace attendance.

I. Call to Order: This meeting was called to order at 5:08 PM by Vern Redifer, Facilitator.

Member	Seat	Present	Absent
Stuart Turner	Agronomist, Turner and Co.,		✓
Chelsea Durfey			✓
Bud Rogers	Lower Valley Community Representative Position 1	✓	
Kathleen Rogers	Lower Valley Community Representative Position 1 (alternate)		✓
Patricia Newhouse	Lower Valley Community Representative Position 2		✓
Sue Wedam	Lower Valley Community Representative Position 2 (alternate)	✓	
Doug Simpson	Irrigated Crop Producer		✓
Jean Mendoza	Friends of Toppenish Creek	✓	
Eric Anderson	Friends of Toppenish Creek (alternate)		✓
Jan Whitefoot	Concerned Citizens of the Yakama Reservation		✓
Jim Dyjak	Concerned Citizens of the Yakama Reservation (alternate)		✓
Steve George	Yakima County Farm Bureau		✓
Frank Lyall	Yakima County Farm Bureau (alternate)	✓	
Jason Sheehan	Yakima Dairy Federation		✓
Dan DeGroot	Yakima Dairy Federation (alternate)	✓	
Ron Cowin	Roza-Sunnyside Joint Board of Control		✓
	Roza-Sunnyside Joint Board of Control (alternate)		
Laurie Crowe	South Yakima Conservation District	✓	

Rodney Heit	South Yakima Conservation District (alternate)		✓
John Van Wingerden III	Port of Sunnyside	✓	
Rand Elliott	Yakima County Board of Commissioners	✓	
Vern Redifer	Yakima County Board of Commissioners (alternate)	✓	
Ryan Ibach	Yakima Health District)	✓	
Dr. Troy Peters	WSU Irrigated Agriculture Research and Extension Center		✓
Lucy Edmondson	U.S. Environmental Protection Agency	✓	
Nick Peak	U.S. Environmental Protection Agency (alternate)		✓
Elizabeth Sanchey	Yakama Nation		✓
Stuart Crane	Yakama Nation (alternate)	✓	
Bahr, Gary	WA Department of Agriculture	✓	
Beale, Perry	WA Department of Agriculture (alternate)		✓
Andy Cervantes	WA Department of Health	✓	
Sheryl Howe	WA Department of Health (alternate)		✓
David Bowen	WA Department of Ecology	✓	
Sage Park	WA Department of Ecology (alternate)		✓
Lino Guerra	Hispanic Community Representative		✓
Rick Perez	Hispanic Community Representative (alternate)		✓
Jessica Black	Heritage University		✓
Matt Bachmann	USGS	✓	

II. Welcome, Meeting Overview and Introductions: After the customary introductions, Vern reviewed the GWAC's timeline for completing its business. The contract between Yakima County and the Department of Ecology called for the GWAC to have its business wrapped up by the end of 2017. For a variety of reasons, this was no longer feasible. Vern and David Bowen had discussed an extension of the contract in conversations prior to the meeting. David added that Ecology would not be asking for any additional money to fund this extension. It would be paid for out of the existing GWMA budget. Items yet to be completed were 1) Nailing down the final recommended alternatives, 2) Coming to consensus, if possible, on a final draft Nitrogen Availability Assessment (NAA), 3) Letting USGS finish its well-sampling, and 4) Completion of the GWMA Program. Vern raised the question of how often the group might need to meet in 2018, but agreed to defer the question until the end of the meeting, after the group had heard some of the outstanding business.

III. Refinement of Alternatives: Jim referred the group to the last three items on Page 2 of the Draft GWMA Program's Table of Contents, which read: "Description of Alternative Actions to Address the Problem", "Discussion of Pros and Cons of Alternative Actions", and

"Recommended Actions." These terms came out of WAC 173-100-100. Jim had consolidated the list of green (group-approved) alternatives into a document about one-half to two-thirds the original length, with yellow (wait until later) items added in the "Details" section. On some future agenda, this list should be discussed, and a decision reached on final recommended alternatives. Jim felt this process may take until June.

IV. GWMA Draft Program: Jim drew members' attention to the completed first draft sections of the GWMA Program. An Excel spreadsheet for submitting comments would be made available to any group member who wanted one, with a goal of getting the editing done by March. The "Investigations and Analysis" section had not been written yet, as the final results from the USGS well-sampling and the final draft NAA had not been completed.

A member asked if anyone was working on the deep soil sampling and high-risk well questionnaires. She felt very uncomfortable looking at final alternatives without a full analysis of the data. Vern replied that Melanie Redding and Andy Cervantes were reviewing the data. Another member suggested that the alternatives the group had approved weren't dependent on data. Jim asked the group whether other alternatives could be submitted if data came in suggesting the need for them. Some members were wary of this approach without knowing what those alternatives might be. Others were more open to it. A member asked when the last USGS well tests would be ready, and Matt replied the results would be public by mid-February.

Jim asked if members had any initial reaction to the draft chapters. One member felt the "Area Characterization" was too general of an overview and needed more details. Another felt it was hard to follow with a lot of inconsistencies. Another member wanted to check with her agency on the descriptions of federal statutes contained in the "Sources of Nitrate and the Regulatory Environment" section. Another member felt there was a gap between the old history of the Lower Valley and the present day, when a great deal of nitrogen had been applied to the soil. Jim encouraged everyone with comments to request a Comments Form.

V. GIS Mapping Feedback: Vern directed the group to the GIS application unveiled at the October 19th GWAC meeting, available at http://arcg.is/1ie9mP. Before demonstrating some combinations of operational layers, he responded to some concerns that a group member who was not present at this meeting had raised with him earlier. The group member had been concerned that the total acreage irrigated by the Roza Irrigation District and the Sunnyside Valley Irrigation District exceeded the number given in the NAA as the total GWMA acreage. Vern told the group that since Roza serves areas outside the GWMA, including Terrace Heights, the figure contained in the NAA was correct.

The first layers Vern showed the group were the "Nitrate mg/l", "Groundwater Flow", and "Altitude of Groundwater Levels." This combination of features showed the location of all well samples collected in the GWMA since 2000, juxtaposed against which direction the groundwater flowed. A member of the group was concerned that the map didn't contain any of the EPA sampling, including the dairy cluster. Vern replied that this information was confidential due to agreements signed by the EPA. Another member cautioned that the groundwater flow directions depicted on the map were only true for the shallow aquifer. Deeper basalt aquifers flow differently due to tilted layers and fissures within the basalt. While most of the wells sampled were likely also shallow wells, some of them might not be. He urged the group to keep this in mind while assessing the data.

The next layers were "ROSS Density per SqMi", "RCIM: ROSS", "RCIM: LOSS", and "RCIM: COSS." Individual septic systems were depicted by dots on the map, while the density was depicted on a grid, with individual square miles of the GWMA colored according to the EPA's recommended guidelines on safe septic density levels (Green = safe, Red = unsafe, Yellow = in between). A member asked whether the red squares represented the total loading of nitrogen or availability. Vern replied that they represented availability.

The next layer was labeled "Total Availability Grid," which overlaid diamond-shaped polygons over the GWMA. These contained all the available nitrogen sources added up, and broken down by category – RCIM, Irrigated Ag, CAFO, and Lagoons. The polygons were slanted into diamond shapes to account for the direction of groundwater flow as much as possible. A group member felt the design and information was good, but that the polygons should be made smaller. Verm said he would talk with County GIS about it. Another member singled out Polygon 192 near the south end of the GWMA, which was colored red and assumed a large amount of nitrogen available from a lagoon in the area. She felt that since these particular lagoons were lined, the number should be lower.

A member who had used the application mentioned that she had a hard time differentiating among crops in the "AG: 2015 WSDA Crop Type" feature, and asked if there was a way to click a box and single out certain crops. Vern said he would talk with GIS.

There were other features Vern had wanted to show the group, but with time running out, he opted to leave them for another meeting.

VI. Committee Business: The November 2, 2017 meeting summary was approved as presented. The group moved on to discuss future meetings for 2018, and decided to provisionally schedule two meetings each month from January to June, spaced two weeks apart, with the understanding that some meetings may be cancelled if there wasn't enough material to discuss.

VII. Public Comment: There was none. The meeting adjourned at 7:01 PM.

VIII. Next Meeting: January 4, 2018.

IX. Next Steps: 1) The GWAC Member Comment Form would be made available in Excel to any member who wanted one. 2) Vern would talk with GIS about making the "Total Availability Grid" polygons smaller, and adding the ability for users to single out crops in the "2015 WSDA Crop Type" feature.

X. Meeting Summary approved by the GWAC on <u>March 1, 2018.</u>

YAKIMA VALLEY GROUNDWATER MANAGEMENT AREA ADVISORY COMMITTEE (GWAC)

MEETING SUMMARY

Thursday, February 15, 2018 – 5:00 p.m. – 7:00 p.m.

Yakima County Roads Maintenance Conference Raam
1216 South 18th Street, Yakima, WA 98901

Note: This document is anly a summary of issues and actions of this meeting. It is not intended ta be a transcription of the meeting, but an overview of points raised and responses from Yakima County and Groundwater Advisory Committee members. It may not fully represent the ideas discussed or opinions given. Examination of this document cannot equal or replace attendance.

I. Call to Order: This meeting was called to order at 5:04 PM by Vern Redifer, Facilitator.

Member	Seat	Present	Absent
Stuart Turner	Agronomist, Turner and Co.,		✓
Chelsea Durfey			✓
Bud Rogers	Lower Valley Community Representative Position 1	✓	
Kathleen Rogers	Lower Valley Community Representative Position 1 (alternate)	✓	
Patricia Newhouse	Lower Valley Community Representative Position 2		✓
Sue Wedam	Lower Valley Community Representative Position 2 (alternate)	✓	
Doug Simpson	Irrigated Crop Producer	✓	
Jean Mendoza	Friends of Toppenish Creek	✓	
Eric Anderson	Friends of Toppenish Creek (alternate)		✓
Jan Whitefoot	Concerned Citizens of the Yakama Reservation		✓
Jim Dyjak	Concerned Citizens of the Yakama Reservation (alternate)	✓	
Steve George	Yakima County Farm Bureau		✓
Frank Lyall	Yakima County Farm Bureau (alternate)	✓	
Jason Sheehan	Yakima Dairy Federation		✓
Dan DeGroot	Yakima Dairy Federation (alternate)	✓	
Ron Cowin	Roza-Sunnyside Joint Board of Control	✓	
	Roza-Sunnyside Joint Board of Control (alternate)		
Laurie Crowe	South Yakima Conservation District	✓	

Rodney Heit	South Yakima Conservation District (alternate)		✓
John Van Wingerden III	Port of Sunnyside	✓	
Rand Elliott	Yakima County Board of Commissioners	✓	
Vern Redifer	Yakima County Board of Commissioners (alternate)	✓	
Myers, Holly	Yakima Health District	✓	
Ryan Ibach	Yakima Health District (alternate)		✓
Dr. Troy Peters	WSU Irrigated Agriculture Research and Extension Center		✓
Lucy Edmondson	U.S. Environmental Protection Agency		✓
Nick Peak	U.S. Environmental Protection Agency (alternate)		✓
Elizabeth Sanchey	Yakama Nation		✓
Stuart Crane	Yakama Nation (alternate)		✓
Gary Bahr	WA Department of Agriculture	✓	
Perry Beale	WA Department of Agriculture (alternate)		✓
Andy Cervantes	WA Department of Health	✓	
Sheryl Howe	WA Department of Health (alternate)		✓
David Bowen	WA Department of Ecology	✓	
Sage Park	WA Department of Ecology (alternate)		✓
Lino Guerra	Hispanic Community Representative		✓
Rick Perez	Hispanic Community Representative (alternate)		✓
Jessica Black	Heritage University	✓	
Alexander V. Alexiades	Heritage University (alternate)		✓
Matt Bachmann	USGS	✓	

II. Welcome, Meeting Overview and Introductions: After the customary introductions and moment of silence, Vern reviewed the agenda. He noted that he would like to add an agenda item – an update on the Nitrogen Availability Assessment (NAA). He asked the group if they had any additional agenda items. There were none.

III. Nitrogen Availability Assessment (NAA) Update, Gary Bahr, WSDA

Gary stated that WSDA is continuing to review the comments made on the draft NAA and to make changes based on the comments. He explained that WSDA staff has been working with WSU professors on topics including reviewing the nitrogen mineralization for the 15 identified crops and cover crops. WSU believes there may be some under- and over-mineralization for various applications (commercial fertilizer, manure compost applications). He said some items change related to nitrogen mineralization related to each crop. Based on

WSU's feedback, adjustments have been made to the low/medium/high numbers. This recalibrating should result in more accurate data.

A member commented that time and energy was spent arguing over crops that do not require additional nitrogen and that there seemed to be disagreements in the industry as to the numbers that make it dubious and call to question the ranking. Vern declared that work has not stopped and that the Department of Agriculture is taking this very seriously, making appropriate adjustments. The intent is to have the numbers finalized by April. The numbers discussed tonight are old numbers.

IV. Review and Refine Alternatives

Jim Davenport started the discussion on the refined alternatives spreadsheet. He mentioned that we have gone out to the agencies and asked for their input. When those come back we will get together with the funding group and work out those estimates. If you have an idea, please provide ASAP so we can move on. Taking some 200 alternatives, green alike and make one yellow column of details, columns to the right are factors called out in the WA Admin code (WAC). We are now in the 80 range, and 30-40 would be realistic. The information currently with WAC factors was filled in by Chris, Jim, Lisa, and Bobbie. They looked at the Yakima County Comprehensive Plan for the last column. The judgments were subjective and not quantitative. Jim would like more quantitative information. We did get a little feedback. On line 48-Update Western Fertilizer Handbook-by Western Plan Health Association, their response was that they are already doing it. He reminded the group to provide more quantitative information.

A discussion ensued regarding pursuing funding for alternatives: would requests be made directly to the Legislature, or through an agency, or by other means? It was determined that each request would be considered from various funding angles (e.g., Yakima County making a direct request to the Legislature, or Ecology making the request with Yakima County supporting and/or providing an in-kind contribution to the project, etc.). The funding "ask" would be tailored to the specific project.

Vern observed that requests would need to be reasonable and balanced. A member asked if Gary Bahr would be providing cost information from related work he had performed in Idaho. Gary replied that yes, he would provide that information.

Natural Resources Conservation Service (NRCS) Funding

Bonda Habets, State Resource Conservationist with the NRCS, was introduced. She explained the NRCS' three-year funding cycle and the available capital facilities funding through her agency. She explained how and when to make proposals: For example, NRCS may not have funding this year, however, unspent funds allocated for this year will be returned in August, and need to be expended by September 15. If an agency is prepared to make an immediate proposal in August, they might receive some of these unspent funds. She also explained the required Comprehensive Nutrient Management Plans that must be in place for certain types of funding. She added that producers typically pay 25 percent of the entire cost. In reply to a question regarding NRCS' funding source, she replied that it was allocated by Congress and administered through the US Department of Agriculture. She then described a current project – the Yakama Nation's request for funding to assist all producers within the Yakama Nation prepare Nutrient Management Plans. Vern believed this was a good example of supporting an agency and not going straight to the legislature.

Vern asked if there were any other comments on the alternatives. A member replied that he believed that the group agreed not to propose regulations (#13). Jim Davenport explained that the term "regulation" is much broader than a "just do it," and offered revised wording for the alternative. Another member added that the alternatives need measurable language to make sure people don't pollute water. Gary described a new, national Priority Watershed program (Whatcom County was identified as an example) that offers areas the opportunity to become a priority watershed. He added that Dee Carlson, the National Water Quality Initiative (NWQI) Coordinator for NRCS, was interested in talking to this group.

Another member requested that personal opinions be kept out of the alternatives spreadsheet "comments" column. In response, another member suggested that the comments field is exactly for that purpose: like the opinions expressed around this table, members should have a forum to express themselves. Beyond that opinions should be backed up by facts and data.

V. PGG Contract

Vern discussed site maps he printed, but they did not have road names so he did not bring hand-outs for everyone. The proposed purpose built wells are staked out. Vern offered to create the maps with road names that will be downloadable from the website. A member asked if land owners had been notified of the reason stakes were put out. Vern replied that they were not since they are all on publicly owned property.

A member observed that the GWAC was missing an opportunity for outreach as the proposed purpose built well locations are staked for surveying. Landowners will wonder what is going on when they see the stakes; communicating with them will build understanding and help allay concerns. Vern acknowledged the need for outreach but advised the group to wait until it's appropriate. At this point we are only at the planning stage. Once a definitive decision is made regarding the well locations, outreach can be launched. Discussion ensued regarding the definition of public right-of-way (i.e., the location of all the purpose-built wells) and courtesy to the public.

VI. GIS Mapping Results

Yakima County GIS Manager Mike Martian displayed various map layers (i.e., RCIM availability, Irrigated Ag Contributions, CAFOs (Pens and Corrals) and Lagoons).
Vern explained that each layer can be used as a tool for overarching analysis of nitrogen loading.

David Bowen clarified that the "red" squares indicated a collection of high nitrate that may or may not be reaching the [ground]water. Vern added that the study group was seeking correlations from the GIS data. The brown dots in the RCIM layer are septic systems. We are not saying septic is the problem, but we have a high density that may be adding to the problem. Theories would be considered, then they would return to the data to test the theories. He advised that there were 20 or more GIS data layers to be considered. We originally correlated high nitrogen availability to high nitrate in wells, but that theory was blown. He noted that the USGS' 2017 well sampling had not been added yet, but would be. USGS data would include well logs, and that data could be compared against Ecology's well log data. A lot of different analysis can be applied.

A member asked about the source and time span of the GIS data. Vern replied that it contains the VIRE Data (2001-02), Department of Health, USGS, and WSDA sampling. It also includes Yakima County's 2011 Nitrate Treatment Program sampling results and the GWAC's high risk well assessment survey data. The EPA data has not been added yet; although it's available on the EPA website, it is in PDF format. Vern noted he will ask Eric Winiecki for a different data format.

Matt Bachmann noted that there are complications in comparing old to new data. He observed that the USGS is gathering multiple samples (from the same wells) and in different seasons. He noted that seasonal changes in groundwater add complexity to the analysis, as does location, depth, nitrogen level, and time of year.

A member of the public voice concerns about the water table dropping, which he believes will affect nitrate concentrations. Regarding the RCIM septic system layer, was it known how many people/houses are contributing to the nitrogen load? Vern replied that he/GIS staff were using census tract data to calculate population. Approximately 26,000 people were estimated to be on septic systems in that area.

Matt Bachmann noted that the Sunnyside and Roza canals have been added to GIS. It appeared the red dots (hot spots) generally follow an East-West trending band that roughly followed the Sunnyside Canal. If so, were leaking canals contributing to nitrate concentrations? He added that groundwater contours may also influence nitrogen (or influence well depths). These are at least worth investigation.

It was asked if the group could correlate individual land use to levels of nitrogen in groundwater. Matt replied yes, but it would be very expensive and time-consuming to track. Another member asked if the group would be evaluating proposed Best Management Practices (BMPs) to this mapping. Vern replied not individually, but it is set up to measure changes over time.

VII. Committee Business: No action.

VIII. Public Comment: There was no public comment. Two GWAC members requested a more detailed Yakima County GWMA expenditure report than the document provided at the meeting. They also requested expenditure records from agencies who had provided GWMA-related work (e.g., SYCD, USGS). Vern noted he could provide all the County's information; however, requests for other agencies' expenditures would have to be made to those agencies. After discussion, another member suggested that the budget be reviewed at another meeting.

David Bowen and Gary Bahr commended the County for its work, noting that the quality of its leadership and GIS analysis are superior.

IX. The meeting adjourned at 7:19 PM.

X. Next Meeting: Thursday, March 1, 2018.

XI. Next Steps: 1) Alternatives Spreadsheet - member input is requested, particularly in the cost and funding source columns. Please provide input to Jim Davenport as soon as possible. 2) Purpose built well maps - Vern will reprint the 30 site maps with road names and distribute to the group via the web.

XII. Meeting Summary approved by the GWAC on March 1, 2018.

YAKIMA VALLEY GROUNDWATER MANAGEMENT AREA ADVISORY COMMITTEE (GWAC)

MEETING SUMMARY

Thursday, March 1, 2018 – 5:00 p.m. – 7:00 p.m.

Yakima County Roads Maintenance Conference Room
1216 South 18th Street, Yakima, WA 98901

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Frank Lyall	Yakima County Farm Bureau (alternate)	✓	
Jason Sheehan	Yakima Dairy Federation	✓	
Dan DeGroot	Yakima Dairy Federation (alternate)	✓	
Ron Cowin	Roza-Sunnyside Joint Board of Control	✓	
	Roza-Sunnyside Joint Board of Control (alternate)		
Laurie Crowe	South Yakima Conservation District	✓	

Rodney Heit	South Yakima Conservation District (alternate)		✓
John Van Wingerden III	Port of Sunnyside	✓	
Rand Elliott	Yakima County Board of Commissioners	✓	
Vern Redifer	Yakima County Board of Commissioners (alternate)	✓	
Myers, Holly	Yakima Health District		✓
Ryan Ibach	Yakima Health District (alternate)		✓
Dr. Troy Peters	WSU Irrigated Agriculture Research and Extension Center		✓
Lucy Edmondson	U.S. Environmental Protection Agency	✓	
Nick Peak	U.S. Environmental Protection Agency (alternate)		✓
Elizabeth Sanchey	Yakama Nation		✓
Stuart Crane	Yakama Nation (alternate)	✓	
Gary Bahr	WA Department of Agriculture		✓
Perry Beale	WA Department of Agriculture (alternate)	✓	
Andy Cervantes	WA Department of Health	✓	
Sheryl Howe	WA Department of Health (alternate)		✓
David Bowen	WA Department of Ecology	✓	
Sage Park	WA Department of Ecology (alternate)		✓
Lino Guerra	Hispanic Community Representative	✓	
Rick Perez	Hispanic Community Representative (alternate)		✓
Jessica Black	Heritage University	✓	
Alexander V. Alexiades	Heritage University (alternate)		✓
Matt Bachmann	USGS		✓

II. **Welcome, Meeting Overview and Introductions:** The meeting was called to order at 5:00 pm. After the customary introductions, Vern reviewed the agenda. The meeting summaries from December 7th, 2017 and February 15th, 2018 were approved as presented by the GWAC. A member brought up the "No Action" scenario described in WAC 173-100, and asked what progress had been made in assessing that. There was some discussion on how it was difficult to make projections into the future based on constantly changing agricultural practices, and whether the existing past data was voluminous enough to make reliable projections.

III. **Second Draft of the GWMA Program:** Jim Davenport thanked group members for their feedback on the first draft of the GWMA program, and drew their attention to the revised and expanded second draft. The sections on geology, hydrogeology, and topography had been completely rewritten, and more history had been added to the land use section. In addition, appendices containing best management practices recommended by the Irrigated

Ag and Livestock/CAFO working groups had been added at the end. The entire document would be made available to the group electronically. The full list of Best Management Practices had not been included in the draft. Jim asked members if they wanted this to be part of the final document, but no decision was reached. Jim urged members to get any comments they might have to him by March 16th.

IV. Consider & Discuss Potential Recommendations: Jim Davenport directed the group's attention to the spreadsheet of strategies derived from last year's meetings. Particularly, he emphasized the importance of agencies responding to the "Cost" and "Time" columns with their estimates so the group could set priorities more effectively when requesting money from the legislature.

Some members asked whether regulations were being considered as part of the strategies list. Jim replied that any alternatives with new regulations were rejected by the group last year. Members pointed out that the language in some strategies suggests a regulatory approach, for example, #13 says "WSDA: Adopt regulations listing Lower Yakima Valley GWMA-specific BMPs", #15 says "Improve composting regulations", and #s 21-30 have language about "Limit" and "Require". Another member passed out materials, one of which was titled "Vital Elements of a GWMA", arguing for more attention to volatization and atmospheric deposition. While it would be possible, if the GWAC were to come to consensus, to recommend changes of existing regulations, state agencies are often reluctant to do so because once you open up one rule, you've potentially opened others. Ecology posited that the best way to notify agencies about the need for regulatory updates was to write up a white paper identifying specific problems and solutions.

A member raised concerns about #46, "Develop and implement Nutrient Management Plans" for irrigated agriculture, wondering how this would be enforced given the way the law is currently written for dairy operations. Another member was concerned about #5, "Develop educational materials that could be elected by instructors at 8-12 levels about aquifer protection, groundwater and best management practices", observing that teachers are already being asked to incorporate a lot of different materials into their lesson plans.

A member recalled that the GWAC had agreed not to proceed with proposed strategies and recommendations until cost data is available, so as to better prioritize solutions. Jim Davenport expressed concerns that Ecology might not certify the program if it did not have cost data, and urged agencies to forward on their best estimates in the next 60 days.

V. Purpose-Built Wells: Vern stated that the County is still working on the purpose-built well maps. At present, staff is busy identifying county right-of-way along the proposed sites. A member asked whether the group would get to 30 wells as planned. Vern wasn't sure, but the way the contract is being discussed is to do a minimum of 20 wells, and then ask for prices on the rest. If it was too expensive to do all 30 wells, they would be dropped from the list, starting with #30, then #29, etc. Members also asked about the USGS wells, which Vern was waiting for approval from USGS to share. Regarding analysis of the purpose-built wells, USGS had offered to analyze the data using their methods for $75,000 with a $10,000 match.

VI. Program Expenditures: Following up on the February 15 GWAC meeting, Vern asked if anyone wanted to discuss the group's expenditures in more detail. A member wanted to know more information on how the various contract dollars went. Vern offered to show the invoices from the various contracts to the member. He advised that the easiest way would be to set up an appointment to come in and review the invoices and ask questions of staff as needed.

VII. Public Comment: A member of the audience suggested that with the contraction of farm prices in the Midwest, it would only be a matter of time before those trends carried over to the Northwest, with a concurrent decline in commercial fertilizer purchased, and less nitrate application. Long-term, as more farmland develops into residential property, the amount of fertilizer will decline as well. He also felt that effective regulations depend on trust between regulators and the regulated, and that onerous regulations do not allow for that trust to develop.

VIII. Next Meeting: April 5, 2018.

IX. Next Steps: 1) The March 15th GWAC Meeting was cancelled for lack of subject matter that would be ready to discuss. 2) The Second Draft GWMA Program will be made available to members electronically. Members will send their comments to Jim Davenport by March 16th. 3) Agency representatives will get cost and time estimates on the GWMA Strategies to Jim Davenport before the next GWAC meeting.

X. Meeting Summary approved by the GWAC on May 3, 2018.

LOWER YAKIMA VALLEY

GROUNDWATER ADVISORY COMMITTEE

Groundwater Management Area (GWMA):
The purpose of the GWMA is to reduce nitrate contamination concentrations in groundwater below state drinking water standards

Meeting Time and Location

Thursday, February 15, 2018 5:00 p.m. – 7:00 p.m.

Yakima County Road Maintenance Conference Room
1216 South 18th Street
Yakima, WA 98901

Agenda

Time	Topic	
5:00 – 5:10 p.m.	Welcome, Meeting Overview and Introductions: • Committee members • Others attending the meeting	Vern Redifer, Facilitator
5:10 – 5:55 p.m.	Review and Refine Alternatives	Jim Davenport
5:55 – 6:00 p.m.	PGG Contract	Vern Redifer
6:00 – 6:30 p.m.	GIS Mapping Results What's been collected and learned	Jim Davenport
6:30 – 6:40 p.m.	Committee Business • Approve the December 7, 2017 GWAC Meeting Summary • Confirm 2018 Meeting Calendar	Vern
6:40 – 6:45 p.m.	Public Comment	
6:50 p.m.	Adjourn	

Committee Members

Stuart Turner, agronomist, Chelsea Durfey (alternate)	Turner and Co.
Bud Rogers, Kathleen Rogers (alternate)	Lower Valley Community Representative Position 1
Patricia Newhouse, Sue Wedam (alternate)	Lower Valley Community Representative Position 2
Doug Simpson	Irrigated Crop Producer
Dr. Jessica Black	Heritage University
Jean Mendoza, Eric Anderson (alternate)	Friends of Toppenish Creek
Jan Whitefoot, Jim Dyjak (alternate)	Concerned Citizens of the Yakama Reservation
Steve George, Frank Lyall (alternate)	Yakima County Farm Bureau
Jason Sheehan, Dan DeGroot (alternate)	Yakima Dairy Federation
Ron Cowin	Sunnyside-Roza Joint Board of Control
Laurie Crowe, Rodney Heit (alternate)	South Yakima Conservation District
John Van Wingerden III, (alternate)	Port of Sunnyside
Rand Elliott, Vern Redifer (alternate)	Yakima County Commission
Holly Myers, Ryan Ibach (alternate)	Yakima Health District
Dr. Troy Peters	WSU Irrigated Agriculture Research and Extension Center
Lucy Edmondson, Nick Peak (alternate)	U.S. Environmental Protection Agency
Elizabeth Sanchey, Stuart Crane (alternate)	Yakama Nation
Gary Bahr, Perry Beale (alternate)	Washington Department of Agriculture
Andy Cervantes, Sheryl Howe (alternate)	Washington Department of Health
David Bowen, Sage Park (alternate)	Washington Department of Ecology
Lino Guerra, Rick Perez (alternate)	Hispanic Community Representative
Matt Bachmann	U.S. Geological Survey

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- Treat one another with civility
- Respect each other's perspectives
- Listen actively
- Participate actively

- Honor time frames
- Silence electronic devices during meetings
- Speak from interests, not positions.

Preliminary 2018 Meeting Dates:

February 15	April 5
March 1	April 19
March 15	May 3
	May 17
	June 7
	June 21

Meeting Materials:

Name	Date Provided	From
2017_12_07_2017 GWAC Meeting Draft Summary	12/11/2017 & 2/8/2018	Lisa.freund@co.yakima.wa.us
Meeting Agenda	2/8/2018	Lisa.freund@co.yakima.wa.us
GWMA Strategies 1-29-18 vmr.xlsx	2/8/2018	Lisa.freund@co.yakima.wa.us
GWMA LTD – 2017 12-13-17 Prelim.xlsx	2/8/2018	Lisa.freund@co.yakima.wa.us
No Working Groups have met since the last GWAC meeting on December 7.	N/A	N/A

D0003

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Yakima County
Notice of Public Meeting
Lower Yakima Valley
Groundwater Advisory
Committee

NOTICE IS HEREBY GIVEN that Yakima County is holding a public meeting of the Lower Yakima Valley Groundwater Advisory Committee on **Thursday, February 15, 2018, at 5:00 PM at Yakima County Road Maintenance Conference Room, 1216 South 18th Street, Yakima, WA 98901** pursuant to Chapter 173-100-080 WAC Ground Water Management Areas and Programs.

For Additional Information

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For more information about the meeting, please contact Lisa Freund, Yakima County Public Services Administrative Manager at 574-2300.

If you are a person with a disability who needs any accommodation in order to participate in this program, you may be entitled to receive certain assistance at no cost to you. Please contact the ADA Coordinator at Yakima County no later than forty-eight (48) hours prior to the date service is needed.

Yakima County ADA Coordinator
128 N. 2nd Street, Room B27
Yakima, WA 98901
(509) 574-2210
7-1-1 or 1-800-833-6384
(Washington Relay Services for deaf and hard of hearing)

PUBLISH: DAILY SUN NEWS
February 7, 2018

Affidavit of Publication

STATE OF WASHINGTON
ss.
County of Yakima

Roger Harnack, being first duly sworn on oath deposes and says that he is the Publisher of the DAILY SUN NEWS, a daily newspaper.

That said newspaper is a legal newspaper and it is now and has been for more than six months prior to the date of publications hereinafter referred to, published in the English language continually as a daily newspaper in the city of Sunnyside, YAKIMA County, Washington, and it is now and during all of said time printed in an office maintained at the afforesaid place of publication of said newspaper, and that the said Daily Sun News was on the 4th Day of April, 1969 approved as a legal newspaper by the Superior Court of said Yakima County.

That the annexed is a true copy of a LEGAL PUBLICATION
Yakima County Public Services
2/15 Meeting

published in regular issues (and not in supplemental forms) of said newspaper once each week for a period of 1 consecutive issue(s) commencing 02/07/18 and ending on 02/07/18, both dates inclusive, and that such newspaper was regularly distributed to its subscribers during all of said period. That the full amount of the fee charged for the foregoing publication is the sum of $52.50, amount has been paid in full, at the rate of $7.75 per column inch per insertion.

Subscribed and sworn to before me 02/07/18

Debbie Guerrero

Notary Public in and for the State of Washington

030110-00000

DEBBIE GUERRERO
COMMISSION EXPIRES
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PUBLIC
JUNE 17, 2020
STATE OF WASHINGTON

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YAKIMA WA 98901

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AMOUNT PAID
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YAKIMA HERALD REPUBLIC

Affidavit of Publication

STATE OF WASHINGTON,)
)
COUNTY OF YAKIMA)

Danielle Rogers, being first duly sworn on oath deposes and says that she/he is the Accounting clerk of Yakima Herald-Republic, Inc., a daily newspaper. Said newspaper is a legal newspaper approved by the Superior Court of the State of Washington for Yakima County under an order made and entered on the 13th day of February, 1968, and it is now and has been for more than six months prior to the date of publication hereinafter referred to, published in the English language continually as a daily newspaper in Yakima, Yakima County, Washington. Said newspaper is now and has been during all of said time printed in an office maintained at the aforesaid place of publication of said newspaper.

That the annexed is a true copy of a:
Yakima County Notice of Public Meeti

it was published in regular issues (and not in supplement form) of said newspaper once each day and for a period of 1 times, the first insertion being on 02/07/2018 and the last insertion being on 02/07/2018

	Yakima Herald-Republic	02/07/18
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and the such newspaper was regularly distributed to its subscribers during all of the said period. That the full amount of the fee charged for the foregoing publication is the sum of $116.16

Danielle R

Accounting Clerk

Sworn to before me this 7th day of, February 2018

Lisa M. Dripps

Notary Public in and for the
State of Washington,
residing at Yakima

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Yakima County

Notice of Public Meeting
Lower Yakima Valley
Groundwater Advisory
Committee

NOTICE IS HEREBY GIVEN that Yakima County is holding a public meeting of the Lower Yakima Valley Groundwater Advisory Committee on **Thursday, February 15, 2018, at 5:00 PM at Yakima County Road Maintenance Conference Room, 1216 South 18th Street, Yakima, WA 98901** pursuant to Chapter 173-100-080 WAC Ground Water Management Areas and Programs.

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Yakima County ADA Coordinator
128 N. 2nd Street, Room B27
Yakima, WA 98901
(509) 574-2210
7-1-1 or 1-800-833-6384
(Washington Relay Services for deaf and hard of hearing)

Dated this **Monday, February 5, 2018**

(792929) February 7, 2018

Courtesy of Yakima Herald-Republic

Meeting Time and Location

Thursday, March 1, 2018 5:00 p.m. – 7:00 p.m.

Yakima County Road Maintenance Conference Room
1216 South 18th Street
Yakima, WA 98901

Agenda

Time	Topic	
5:00 – 5:10 p.m.	Welcome, Meeting Overview and Introductions: • Committee members • Others attending the meeting	Vern Redifer, Facilitator
5:10 – 5:30 p.m.	Distribute latest draft of the GWMA Program	Jim Davenport
5:30 – 6:30 p.m.	Consider & Discuss Potential Recommendations	Jim Davenport
6:30 – 6:40 p.m.	Committee Business • Approve the December 7, 2017 & February 15, 2018 GWAC Meeting Summaries • Confirm 2018 Meeting Calendar • Program Expenditures	Vern
6:40 – 6:45 p.m.	Public Comment	
6:50 p.m.	Adjourn	

Committee Members

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Patricia Newhouse, Sue Wedam (alternate)	Lower Valley Community Representative Position 2
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- Speak from interests, not positions.

2018 Meeting Dates:

February 15
March 1
March 15

April 5
April 19
May 3
May 17
June 7
June 21

Meeting Materials:

Name	Date Provided	From
2018_02-15 GWAC Meeting Draft Summary_v1	2/22/2018	Lisa.freund@co.yakima.wa.us
Meeting Agenda	2/22/2018	Lisa.freund@co.yakima.wa.us
Copy of MASTER GWMA Strategies 1-29-18 vmr	2/22/2018	Lisa.freund@co.yakima.wa.us
Index for Program Released to the GWAC - March 1, 2018	2/22/2018	Lisa.freund@co.yakima.wa.us
No final Working Group summaries at this time.	N/A	N/A
GWMA Program Draft Chapters - To Be Distributed at the Meeting		
Introduction (Draft V2)	3/1/2018	
Characterization of the Area (Draft V2)	3/1/2018	
Sources of Nitrate and the Regulatory Environment (Draft V2)	3/1/2018	
Yakima County's Role in Groundwater Quality Protection (Draft V2)	3/1/2018	
Environmental Effects (Draft V1)	3/1/2018	
Appendices A - F	3/1/2018	

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YAKIMA HERALD-REPUBLIC

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STATE OF WASHINGTON,)
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COUNTY OF YAKIMA)

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That the annexed is a true copy of a:
Yakima County Notice of Public Meeti

it was published in regular issues (and not in supplement form) of said newspaper once each day and for a period of 1 times, the first insertion being on 02/21/2018 and the last insertion being on 02/21/2018

	Yakima Herald-Republic	02/21/18
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Danielle R

Accounting Clerk

Sworn to before me this 21st day of February 2018

Lisa M. Dripps

Notary Public in and for the
State of Washington,
residing at Yakima

LISA M DRIPPS
NOTARY
My Comm. Expires
April 05, 2021
PUBLIC
STATE OF WASHINGTON

Yakima County

Notice of Public Meeting
Lower Yakima Valley
Groundwater Advisory
Committee

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128 N. 2nd Street, Room B27
Yakima, WA 98901
(509) 574-2210
7-1-1 or 1-800-833-6384
(Washington Relay Services for deaf and hard of hearing)

Dated this **Tuesday, February 20, 2018**

(795652) February 21, 2018

D0003

DAILY SUN
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Sunnyside, WA 98944
Phone (509) 837-4500
Fax (509) 837-6397

WE
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Notice of Public Meeting
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Groundwater Advisory
Committee

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To learn more about the Lower Yakima Valley Groundwater Management Area, the Groundwater Advisory Committee, and its goals and objectives, please see the Lower Yakima Valley Groundwater Management Area on the County webpage at: http://www.yakimacounty.us/gwma/

For more information about the meeting, please contact Lisa Freund, Yakima County Public Services Administrative Manager at 574-2300.

If you are a person with a disability who needs any accommodation in order to participate in this program, you may be entitled to receive certain assistance at no cost to you. Please contact the ADA Coordinator at Yakima County no later than forty-eight (48) hours prior to the date service is needed.

Yakima County ADA Coordinator
128 N. 2nd Street, Room B27
Yakima, WA 98901
(509) 574-2210

7-1-1 or 1-800-833-6384 (Washington Relay Services for deaf and hard of hearing)

Dated this Tuesday, February 20, 2018

PUBLISH: DAILY SUN NEWS
February 21, 2018

Affidavit of Publication

STATE OF WASHINGTON
ss.
County of Yakima

Roger Harnack, being first duly sworn on oath deposes and says that he is the Publisher of the DAILY SUN NEWS, a daily newspaper.

That said newspaper is a legal newspaper and it is now and has been for more than six months prior to the date of publications hereinafter referred to, published in the English language continually as a daily newspaper in the city of Sunnyside, YAKIMA County, Washington, and it is now and during all of said time printed in an office maintained at the afforesaid place of publication of said newspaper, and that the said Daily Sun News was on the 4th Day of April, 1969 approved as a legal newspaper by the Superior Court of said Yakima County.

That the annexed is a true copy of a LEGAL PUBLICATION
Yakima County Public Services
FC3463–100–120

published in regular issues (and not in supplemental forms) of said newspaper once each week for a period of 1 consecutive issue(s) commencing 02/21/18 and ending on 02/21/18, both dates inclusive, and that such newspaper was regularly distributed to its subscribers during all of said period. That the full amount of the fee charged for the foregoing publication is the sum of $52.50, amount has been paid in full, at the rate of $7.75 per column inch per insertion.

Subscribed and sworn to before me 02/21/18

Notary Public in and for the State of Washington

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DEBBIE GUERRERO
COMMISSION EXPIRES
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JUNE 17, 2020
STATE OF WASHINGTON

Data Collection, Characterization, Monitoring

Charge from Groundwater Management Area Advisory Committee

Working Group Members

Melanie Redding (Chair); Andres Cervantes; Bob Stevens; Charles (Pony) Ellingson; David Bowen; Chelsea Durfey; Dave Cowan; Doug Simpson; Elizabeth Sanchey; Frank Lyall; Ginny Stern; Jaclyn Hancock; Jan Whitefoot; Jean Mendoza, John Van Wingerden, Kevin Lindsey; Laurie Crowe; Lino Guerra; Mike Shuttleworth; Ralph Fisher; Ron Cowin; Scott Stephen; Steve Swope; Stuart Turner; Dr. Troy Peters

Meetings/Calls Dates

Meeting: Thursday, March 1, 2018, 1:00-3:00 PM
Call Number: 509-574-2353 pin: 2353#

Participants

Present: Melanie Redding (Chair), Vern Redifer, Jim Davenport, Jean Mendoza, Sage Park, Steve George, Michael Martian, Andy Cervantes, Dave Bowen*, Margaret Drennan*, Chris Saunders, Patty LeBlanc (County support staff) *via phone

Key Discussion Points

Update on Role of Data Working Group:

The meeting was called to order at 1:03pm. The main purpose of the meeting was to discuss the Deep Soil Sampling data analysis. Additionally, Jim and Vern asked for time on the agenda to discuss GIS data. After the customary introductions, Jim explained that there was a lot of data that had been compiled by GIS on maps that had been displayed at the last few GWAC meetings, but currying lessons from it would require creative minds looking for patterns or anomalies for which we don't have an explanation. The point was to give future lead entities and members of the public a tool to use in understanding nitrates' presence in the GWMA, and how best to apply action to mitigate high nitrate levels.

As an example, the last time Vern talked with GIS and USGS, they noticed what seemed to be a band of high-testing wells. After some examination, they discovered that they seemed to follow the Sunnyside Valley Irrigation District canal. Vern mapped a one-mile buffer strip on the north and south sides of the canal, and found that average and median nitrate levels inside the band were significantly higher than nitrate levels outside, suggesting that aging water infrastructure might be contributing towards driving nitrates into the ground. These results might also be coincidental, but that's why it's important to have a group scrutinize these questions, with the goal of coming up with a list of areas that demand further study.

A member commented that it was hard to provide input without seeing the map. Vern agreed, saying his purpose at this meeting was to let the group know where things were at, and to suggest the possibility of future meetings to study the data and suggest areas in need of further study. Discussion ensued on whether an outside statistician should be brought in to examine the data on the maps as an alternative to having the Data Working Group look it over. Melanie and Vern preferred to have the group look over the information. They hoped a meeting could be arranged at the end of the month with Matt Bachmann and others present and fully realized maps printed off for examination.

Deep Soil Sampling Results Analysis:

Melanie presented the group with an analysis she had performed of the deep soil sampling results after the December GWAC meeting. She emphasized that the data she was presenting was only an analysis of the analytical data, not the survey data, and it was not meant to draw firm conclusions, but rather to make observations about the data that had been collected. The results had not been tied to specific crops, given the difficulty in obtaining statistically valid populations of fields sampled, and the skepticism some group members had expressed as to the accuracy of survey results in calculating nitrogen application. The first page of her handout titled "Deep Soil Sampling (DSS) in the Lower Yakima Valley GWMA" had a bullet-pointed list of the limitations of the data.

The second handout was titled "Deep Soil Sampling Analytical Data Analysis", which contained a number of charts and graphs. On page 2 was a graph titled "Mean Soil Nitrate Concentrations". Melanie observed that of the fields which were sampled, the mean nitrate levels in the first foot of soil were twice as high in the fall as opposed to spring. Jim had some concerns about the randomness of the data sites collected, but other group members felt that the results could still be useful in pointing to the need for further study. The results of the deep soil sampling described only what was happening on the fields which were sampled, and could not be extrapolated to the rest of the Lower Valley.

Page 3 contained similar information, which broke down the results of the fields sampled by year. In both 2014 and 2015, mean fall nitrate levels in the first foot of soil were twice the levels they were in the ensuing spring seasons. In the fall of 2014, mean nitrate levels declined from 30 ppm in the first foot, to 9 ppm in the 6th foot. Group members observed that it would make sense for nitrate levels to be higher in the fall if the SVID hypothesis about summer irrigation waters driving nitrates was correct. The problem is that the locations of the soil samples are confidential. Discussion ensued on the feasibility of constructing a study of nitrate levels during the 2015 drought compared to the wet year of 2016. Instinctively, there would seem to be a clear connection, but members brought up factors such as some irrigation districts having senior water rights and others not, and the long crop planning timeframe. Farmers plan next year's crop in the fall, but those with junior water rights don't find out their water allotment until March.

Page 4 contained a graph depicting the maximum soil nitrate concentrations for the fields sampled by depth and season. All of them were over 30 ppm, with the highest levels being above 300 ppm five and six feet deep in the fall of 2015. Melanie also pointed to the first foot of soil, where the maximum levels for fall were greater than the spring concentrations.

Melanie took the group back to the first handout on page 5, where tables had been put together breaking down the fields sampled into nitrate concentration categories. About 48 percent of sites tested had concentrations below 30 ppm in the fall of 2014 and 2015, compared to 60 percent in the spring of 2015 and 59 percent in the spring of 2016. There were a total of 29 fields (17%) where the cumulative soil nitrate from all sampled depths was greater than 200 ppm.

Returning to the second handout, page five held a bar graph with the maximum value soil nitrate concentrations broken down by soil depth. The numbers were highest at the five and six-foot depth. These numbers included both fall and spring. Page 6 depicted the number of soil nitrate samples by different concentration ranges according to soil depth. Low-end concentrations below 15 ppm were the largest categories at all depths, although there were significant percentages of sites over 30 ppm as well. This information was captured in percentage terms on page 8. A member wanted to know whether we knew the root zone at these sites. Melanie replied that it would be interesting to tie this into the data.

The group discussed what kind of structure they wanted in place for examining the data and carrying forward recommendations. A member noted that there are a lot of grants out there, and staff at WSU looking for research projects, but first, the GWMA or its successor agency would need to identify the most important projects they wanted done.

Melanie asked the group to send her any further ideas. Jean thought the findings Melanie presented lacked the context of Jean's research on the subject. Jean had previously analyzed the Deep Soil Sampling data (both the analytical and survey data) and sent this analysis to the GWAC in July 2017. No action was taken by the GWAC on Jean's work. This analysis focused on triticale, corn, and alfalfa, crops where there were larger sample sizes. Jean found cause for concern that individuals might take the information on the charts and graphs and extrapolate them onto crops where the irrigation and nitrogen application methods were very different. Vern and Jim suggested that Jean could present her findings at the next GWAC meeting and see if there was a way to combine her data with Melanie's. Jean agreed to forward a copy of her research to Melanie and other members of the group.

The group discussed the various limitations on the data available so far, and where they would like to see more information in addition to the canals issue. A group member felt that eventually, they would need to collect some non-anonymous samples in order to effectively monitor watering and nitrate applications at the same sites at regular intervals throughout the seasons. The presence of organic matter in the soil layer was another topic of interest.

The meeting adjourned at 3:05pm.

Resources Requested

Recommendations for GWAC

Deliverables/Products Status

Proposed Next Steps

The Data Working Group will meet again on March 29th to discuss the GIS well mapping.

The root zones of fields will also be looked at in relation to nitrate levels with regards to the Deep Soil Sampling.

Jean will send the group her analysis of the deep soil sampling results.

Data Collection, Characterization, Monitoring

Charge from Groundwater Management Area Advisory Committee

Working Group Members

Melanie Redding (Chair); Andres Cervantes; Bob Stevens; Charles (Pony) Ellingson; David Bowen; Chelsea Durfey; Dave Cowan; Doug Simpson; Elizabeth Sanchey; Frank Lyall; Ginny Stern; Jaclyn Hancock; Jan Whitefoot; Jean Mendoza, John Van Wingerden; Laurie Crowe; Lino Guerra; Mike Shuttleworth; Ralph Fisher; Ron Cowin; Scott Stephen; Steve Swope; Stuart Turner; Dr. Troy Peters

Meetings/Calls Dates

Meeting: Thursday, March 29, 2018, 1:00-3:00 PM
Call Number: 509-574-2353 pin: 2353#

Participants

Present: Melanie Redding (Chair), Vern Redifer, Jean Mendoza, Steve George, David Bowen, Ginny Stern, Stuart Turner, Andy Cervantes, Gary Bahr*, Chris Saunders, Star Betancourth (Yakima County support staff)

Key Discussion Points

The meeting convened at 1:00pm. After the customary introductions, Jean Mendoza presented via PowerPoint a document labeled "Analysis of Lower Yakima Valley Groundwater Management Area Deep Soil Sampling".

Deep Soil Sampling Analysis & Discussion:

Jean began by setting the stage. When the deep soil sampling began, the group had a lot of ideas for how the data could be used, and was hoping for a statistically valid representation of fields.

Slides 2 and 3 of the analysis contained the following conclusions:

- 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. (See Attachment 2)
    - o Data was gathered for 15 out of 27 categories.
    - o Only 7 categories had six or more samples
    - o One category had 3 samples
    - o Two categories had 2 samples
    - o 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.

Discussion ensued on some of the limitations of the data, and what they suggested for future areas of study. Outlier results should be tested again in the future, with the permission of the owner, to see how the outcomes compare. Slide 9 described how crop history was provided for the past four to five years in most fields, and how fields which had been planted with multiple crops made it difficult to assess how much the current crop being grown there was contributing to nitrate levels.

Slide 10 contained a table outlining the percentages of crops in the deep soil sampling. Triticale had contributed 22 percent of the fall samples and 46 percent of the spring samples, although triticale amounted to only one percent of the fields in the Lower Valley, according to the WSDA's 2005 survey. A more recent survey by WSDA had put the estimated acreage for triticale at 10,780. Slide 19 contained work plan estimates of irrigation practices compared with what the study did, and found that 74 percent of fields sampled used sprinkler irrigation compared to 63 percent in the original work plan. Rill irrigation came in at 19 percent, compared to 16 percent in the work plan. Slide 23 contained a table with numbers from each sampling category, broken down by irrigation method and crop type. Slides 24-28 contained graphs illustrating the data. Rill irrigation showed low nitrate levels below the 1-foot level on the sites sampled, while sprinkler irrigation showed higher levels at the 2-4-foot depth. Drip irrigation showed high nitrate levels for crops with a 4-ft root depth like alfalfa, hops and fruit at the first two feet, and then declined sharply afterwards. Based on the number of samples available, certain groups of data lent themselves to limited analysis, such as alfalfa, triticale and corn silage, double-cropping, fertilizer practices, and root depth.

Slide 30 contained suggested goals for end-of-harvest soil testing at the 2-foot level in Eastern Washington based off of the Department of Ecology's CAFO permit, which described 55 pounds per-acre as "low-risk", and above 110 pounds-per-acre as "high-risk". Slides 33-52 contained graphs illustrating nitrate levels at one-foot intervals going down to six feet, broken down by irrigation method, crop type, fertilizer type, and season. There were 60 slides in Jean's presentation. In the interests of time, she stopped at slide 44.

Members discussed how best to utilize the data Jean had brought forward. Ginny expressed concern about using average numbers given the diversity of results within the samples, and offered that perhaps expressing the values in mode and median terms would be more useful. Vern stated that the main reason the deep soil sampling efforts had fallen short in obtaining people to volunteer their fields was a lack of incentive. A future sampling program would probably need to offer some amount of monetary incentive to participate. Group members would have to give further thought to what might be reasonable to ask in return for that incentive. One group member thought it might be worthwhile to roll any incentives into the Voluntary Stewardship Program.

Some members expressed a willingness to present an analysis of the deep soil sampling results at horticulture and grape grower trade shows, as long as there was a pre-packaged delivery for specific groups. It would be important to present the information in a way that got the attention of the target audience, gave them something meaningful to do, and a vehicle for them to do it with. Ginny agreed to dig further into the numbers and produce a summary of what Jean and Melanie had produced. Gary Bahr agreed to talk with staff at WSU about their interest in pursuing a research project in the future aimed at filling in some of the gaps in the current data in order to meet the original project goals, and offering incentives for grower participation.

The meeting adjourned at 3:14pm.

Resources Requested

Recommendations for GWAC

Deliverables/Products Status

Proposed Next Steps

Ginny Stern will summarize Melanie and Jean's analyses of the deep soil sampling data with the goal of initiating discussions with stakeholder groups on changing practices. Gary Bahr will contact WSU about their interest in designing a future deep soil sampling project.

GWAC Attendance Roster

Member	15-Feb-2018	1-Mar-2018
Stuart Turner	Absent	Absent
Chelsea Durfey (alternate)	Absent	Absent
Bud Rogers	Present	Present
Kathleen Rogers (alternate)	Present	Present
Patricia Newhouse	Absent	Present
Sue Wedam (alternate)	Present	Absent
Doug Simpson	Present	Absent
Jean Mendoza	Present	Present
Eric Anderson (alternate)	Absent	Absent
Jan Whitefoot	Absent	Absent
Jim Dyjak (alternate)	Present	Present
Steve George	Absent	Present
Frank Lyall (alternate)	Present	Present
Jason Sheehan	Absent	Present
Dan DeGroot (alternate)	Present	Present
Ron Cowin	Present	Present
Laurie Crowe	Present	Present
Rodney Heit (alternate)	Absent	Absent
John Van Wingerden	Present	Present
Rand Elliott	Present	Present
Vern Redifer	Present	Present
Holly Myers	Present	Absent
Ryan Ibach (alternate)	Absent	Absent
Dr. Troy Peters	Absent	Absent
Lucy Edmondson	Absent	Present
Peter Contreras/Nick Peak (alter	Absent	Absent
Elizabeth Sanchey	Absent	Absent
Stuart Crane (alternate)	Absent	Present
Gary Bahr	Present	Absent
Perry Beale (alternate)	Absent	Present
Andy Cervantes	Present	Present
Sheryl Howe (alternate)	Absent	Absent
David Bowen	Present	Present
Sage Park (alternate)	Absent	Absent
Lino Guerra	Absent	Present
Rick Perez (alternate)	Absent	Absent
Jessica Black	Present	Present
Alexander V. Alexiades (alternate	Absent	Absent
Matt Bachmann	Present	Absent

Attachment B

- MASTER GWMA Strategies, 1-29-18
- Horizon 2040_YC Comprehensive Plan – Water Quality Goals and Objectives
- GWMA LTD -2017, 12-13-17 Prelim
- PGG Preliminary Drill Sites, 1-30-18

	sort	To Whom	Strategy	Details	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs	Comments
1	**Abandoned Wells**	Legislature	Permit the repair or decommissioning of wells by general contractors, rather than exclusively by well-drillers, so as to diminish costs of decommissioning.		F	E	None	None	One year	Easy (Research statute and recommend language.)	Consistent with NS-8.2, 9.2, 9.8, 9.10, UT-4, 6.1, 6.5, 7.2, 8, 12.5, 13.1	
2	**Abandoned Wells**	DOE, Yakima Health District	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 decommissioning. Provide some form of protection for self-reporting of abandoned or improperly decommissioned wells.	F	Unknown	Plan: Cheap Implementation: Expensive	Legislature	Any	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	
3	**Aquifer Protection**	Yakima County	Postpone decision on creation of an aquifer protection area till a later date when more information is known.		Feasible	Not Effective	No current administrative costs to postponing decision	None	Any	Easy	Inconsistent with NS-8.2, 9.1, 9.2, 9.4, 9.5, 9.6, 9.8, 9.10, UT-4, 6.1, 6.5, 7.2, 8, 12.5, 13.1	
4	**Aquifer Protection**	Yakima County	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		Feasible	Effective	Administrative costs; Higher costs for operations that have to comply	County General Fund	One year	Controversial	Consistent with NS-9.2, 9.3, 9.10	
5	**Aquifer Protection**	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	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	
6	**Atmosphere**	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.	Ask CAA	Ask CAA	Ask CAA	Ask CAA	Ask CAA	Ask CAA	Consistent with NS-3.1, 3.2, 3.3, 8.1	
7	**Atmosphere**	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.	EPA: The Community Multiscale Air Quality Modeling System (CMAQ) can be used to model nitrogen emissions and the atmospheric deposition of nitrogen in the Yakima Valley.	EPA: Feasible	EPA: Effective	EPA: Ongoing work now, not costly	EPA: Agency budgets	EPA: 2018	EPA: Not difficult	Consistent with NS-3.1, 3.2, 3.3, 8.1	
8	**Atmosphere**	WSDA	Establish a monitoring system for compliance with NRCS Standard 317 on new composting facilities at Washington dairies (phased in for existing facilities).		Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	
9	**Atmosphere**	WSDA, SYCD	Encourage prompt incorporation of manures and fertilizers after application to cropland where appropriate.		Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	
10	**Atmosphere**	WSDA, SYCD	Discourage broadcast application of manures to cropland.		Ask WSDA & SYCD	Ask WSDA & SYCD	Ask WSDA & SYCD	Ask WSDA & SYCD	Ask WSDA & SYCD	Ask WSDA & SYCD	Ask WSDA & SYCD	**Steve George**: Broadcasting manure is one of the most common practices of applying manure and has no more detrimental effect to groundwater than other types of applications. Broadcast application is a form that can be used on growing crops that would include apples, hops and other established crops. It would also include applications to open ground in preparation to grow a crop, no different than applying commercial fertilizers. It would be better to recommend "When making fertilizer applications, apply at agronomic rates."
11	**Atmosphere**	WSDA, SYCD	Encourage application of manures and fertilizers by surface banding.	Banding, "dribbling," "stripping" of liquid fertilizers, https://fluidfertilizer.org/wp-content/uploads/2016/05/22P14-18.pdf	Ask WSDA, SYCD	Ask WSDA, SYCD	Ask WSDA, SYCD	Ask WSDA, SYCD	Ask WSDA, SYCD	Ask WSDA, SYCD	Ask WSDA, SYCD	**Steve George**: over all concerns about this rec. Should this be "subsurface" banding? This is going to have limited use depending on the crop. Wouldn't it be better to say "Implement application strategies that reduce N volatilization?" This could then include the use of anti volatilization products such as Agritain or the use of Super U and deal with both manure and commercial fertilizer.
12	**Public Health**	PEHSU, Washington State 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	Ask PEHSU, DOH, YHD	Legislature	2019 Session	Not difficult	Consistent with NS-9.10	

	sort	To Whom	Strategy	Details	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs	Comments
13	**Best Management Practices**	GWMA, 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 regulations listing 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	Zero	Zero	Ask SYCD	Easy	Consistent with NS-9.6	**Steve George:** Concern as it promotes the adoption of BMP REGULATIONS. I do not support this as written and do not feel that it is necessary at this time.
14	**Best Management Practices**	Yakima Health District	Recommend against farming around a water well.		Feasible	Effective	Ask YHD	Ecology, Legislature	Minimal	Easy	Consistent with NS-9.6, 9.10	
15	**Composting**	Ecology, WSDA	Improve composting regulations		Ask WSDA, Ecology	Ask WSDA, Ecology	Ask WSDA, Ecology	Ask WSDA, Ecology	Ask WSDA, Ecology	Ask WSDA, Ecology	Consistent with NS-9.2 , 9.6, 9.10	
16	**Composting**	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.		Ask YHD	Ask YHD	Ask YHD	Ask YHD	Ask YHD	Ask YHD	Consistent with NS-9.2 & 9.6 & 9.10	
17	**Composting**	DOE, Yakima Health District	Inspect, monitor and regulate stockpiled manures.		Ask DOE	Ask DOE	Ask DOE	Ask DOE	Ask DOE	Ask DOE	Consistent with NS-9.2 & 9.4 & 9.10	
18	**Composting**	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.		Ask YHD	Ask YHD	Ask YHD	Ask YHD	Ask YHD	Ask YHD	Consistent with NS-9.2 & 9.6 & 9.10	**Steve George:** Ag composting should be exempt, this would require legislative change
19	**Composting**	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		Ask DOE	Ask DOE	Ask DOE	Ask DOE	Ask DOE	Ask DOE	Consistent with NS-9.2 & 9.6 & 9.10	**Steve George:** same as #18
20	**Composting**	DOE	Provide assistance to local departments of health regarding the regulation of agricultural composting operations		Ask DOE	Ask DOE	Ask DOE	Ask DOE	Ask DOE	Ask DOE	Consistent with NS-9.2 & 9.6 & 9.10	
21	**Domestic Waste Management**	Yakima Health District, Yakima County Building Department	Limit septic system developments where soil filtration rate is high, where housing density is already big, where nitrate concentration is already great downstream of the septic plume.	Recommendations for conditions on issuance of building permits.	Ask YHD	Ask YHD	Ask YHD	Ask YHD	Ask YHD	Ask YHD	Consistent with NS-9.2 & 9.3 & 9.10	**Steve George:** Change wording from "Where housing density is already big" to "Where housing density is already at or above the EPA's definition of high density." Use of the word "big" is not descriptive enough.
22	**Domestic Waste Management**	Yakima Health District, Yakima County Building Department	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.	Ask YHD	Ask YHD	Costly to landowner	Ask YHD	Ask YHD	Ask YHD	Consistent with NS-9.2 & 9.3 & 9.10	
23	**Domestic Waste Management**	Yakima Health District	Publish and distribute homeowner guide on how to maintain septic systems		Feasible	Effective	Ask YHD	Ecology, Legislature	Ask YHD	Easy	Consistent with NS-9.6	
24	**Domestic Waste Management**	Yakima Health District, Yakima County Building Department, County Planning	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.	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.	Ask YHD, Building, Planning	Ask YHD, Building, Planning	Ask YHD, Building, Planning	Ask YHD, Building, Planning	Ask YHD, Building, Planning	Requires BOCC approval	Consistent with NS-9.2 Inconsistent with NS-9.7	
25	**Domestic Waste Management**	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.	Ask DOH	Ask DOH	Ask DOH	Ask DOH	Ask DOH	Ask DOH	Consistent with NS-9.3 & 9.4	
26	**Domestic Waste Management**	Legislature	Require facility process improvements in waste treatment and food processing plants to reduce nitrogen and total discharge volume.		Difficult	Uncertain	Costly to fruit processing facilities	Private		Requires amendment to state Water Pollution Control Act (RCW 90.48)		
27	**Domestic Waste Management**	Legislature	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	Expensive	Congressional, Legislature	Decades	Requires upgrades to meet all current standards		
28	**Domestic Waste Management**	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	Marginal	Private	Years	Amend GMA (RCW 36.70A)		
29	**Domestic Waste Management**	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	Ask EPA & DOE	Agency budgets	2018	Easy		
30	**Domestic Waste Management**	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	Ask WSDA	Agency budget	2018	Easy		
31	**Funding**	Legislature	Fund, DOE, WSDA, and Lead Agency activities put in place pursuant to these recommendations.	Prepare fiscal request for legislature.	Feasible	Effective	Ask agencies	Operating budget	2019 Session	Difficult but essential		

	sort	To Whom	Strategy	Details	Feasibility	Effectiveness	Cost	Proposed funding	Time	Difficulty to implement	Degree of consistency with local comprehensive plans and water management programs	Comments
32	**Funding**	Legislature, Ecology, Lead Agency, Yakima Health District, USGS	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	Ask WCC	State operating budget	2019 Session	Easy		
33	**Funding**	Legislature, 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	Ask WCC	State operating budget	2019 Session	Easy		
34	**Funding**	Legislature	Require Commodity Commissions to dedicate "check off" money for research and development in water quality technology and practices.		Feasible	Effective	Estimate R&D needs	CC Members	2019	Research CC statutes		**Steve George:** Most commissions are small. They need a grant program to tap into, similar to the CDs. Commissions will not agree to be mandated on where they spend their research dollars, but they likely would agree to secure a grant to work on a specific project. There is already a template in place that many commissions tap into obtaining grant dollars from the Washington State Commission on Pesticide Registration. A slight change in the mandate of the Pesticide Commission could include allow them to distribute funds for environmental issues as well.
35	**Groundwater Quality Monitoring**	Lead Agency, Yakima Health District, USGS	Implement an Ambient Groundwater Monitoring Plan	Monitoring well construction: Lead Agency; Monitoring well data collection: Yakima Health District, USGS. 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.	Feasible	Effective	$700,000 in hand, balance uncertain	Legislature	2019 Session	Already designed, to be installed before 12/31/18		
36	**Groundwater Quality Monitoring**	Lead Agency, Yakima Health District, USGS, EPA	Implement a Drinking Water Quality Monitoring Plan	Data collection, Yakima Health District, USGS. Study short-term seasonal variations in nitrate concentrations over next year or two--addressing how changes in nutrient application over the agricultural cycle affects things. Collect more information on wells known to have high nitrate concentrations, perhaps identifying whether the concentration is self-caused. 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. Where drinking water wells have had a comprehensive site assessment and exceed the Maximum Contaminant Level (MCL) for nitrate, investigate the cause and consider sampling additional wells or use of groundwater monitoring wells, upgradient and downgradient, to assess the source of the nitrate.	Feasible, underway	Effective	Ask USGS	Legislature	2019 Session	Easy		
37	**Groundwater Quality Monitoring**	USGS	Use USGS particle tracking model 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	Ask USGS	Legislature	2019 Session	Easy		**Steve George:** I'm not a fan of the USGS particle tracking modeling and do not feel that pursuing it is cost effective for the GWMA.
38	**Groundwater Quality Monitoring**	DOE	Analyze the trends of nitrate data contained within reports required by NPDES and SWD permits.		Ask DOE	Ask DOE	Ask DOE	Agency budget	2019	Ask DOE		
39	**Groundwater Quality Monitoring**	Irrigation Districts	Monitor nitrate concentrations of irrigation water at headgates.	Report nitrate concentrations annually to Department of Ecology	Feasible	Effective	Ask IDs	Ratepayers or DOE grant	2019	Ditch-rider expense		**Steve George:** Not sure why monitoring N at the irrigation headgate is cost effective. Source would need to be return flows, which Roza would not have much of. Does SVID have return flows come into the main canal from Roza water? Seems like a waste of time for irrigation dist staff as it would be a small amount, if any. I would think monitoring the drains would be a better indicator.
40	**Irrigated *Agriculture***	WSDA, SYCD, WSU, WCC	Continue education and outreach to agriculture operators about impacts and practices related to *compliance with relevant State and federal* requirements for groundwater protection.	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 .	Feasible	Effective if operators *are receptive*	Ask WSDA, SYCD, WSU, *WCC*	Legislature, operating *budget*	2019	Easy		
41	**Irrigated Agriculture**	WSU Extension Service	Update Appendices A and B of the Washington Irrigation Guide.		Feasible	Effective	Ask WSU	Legislature	2019	Already researched, not yet published		
42	**Irrigated Agriculture**	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	Ask WSU	Legislature	Five years	Continuous effort		
43	**Irrigated Agriculture**	WSU, SYCD, WSDA, WCC	Encourage advanced irrigation management.	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	Substantial	Identify federal, state and local incentive programs (like EQIP), such as grants, and low interest loans, financial assistance	Short & Long-Term			

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44	**Irrigated Agriculture**	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		Expensive to establish, costly to producer	Legislature	2019 Session	Difficult, plans are property-specific,	Consistent with NS-9.10, 12.1, 12.2, 12.3	
45	**Irrigated Agriculture**	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	Expensive	Congressional, Legislature	2019 Session	Dependent on funding	Consistent with NS-9.10, 12.1, 12.2, 12.4	
46	**Irrigated Agriculture**	Producers	Develop and implement Nutrient Management Plans.	Voluntary. Farming operations currently are not required to hold permits or a DNMP.	Feasible	Effective	Unknown	Producer	Recurrent/ Annual	Not difficult	Consistent with NS-9.10	
47	**Irrigated Agriculture**	Producers	Use effective fertilizer application procedures for specific crop requirements.	Determine schedules, placement, rate and time of application and speed of release. Where possible, apply nitrogen to plant-specific root zone, rather than broadcast application. Refrain from tilling under herbaceous remnants of prior crops, reducing plant nitrogen contributions to soil column.	Feasible	Effective	Saves Money	Producer	Recurrent/ Annual	Not difficult	Consistent with NS-9.10	
48	**Irrigated Agriculture**	Western Plant Health Association	Update Western Fertilizer Handbook, Western Plant Health Association, Ninth Edition (2002)		Ask WPHA	Ask WPHA	Ask WPHA	Ask WPHA	Ask WPHA	Ask WPHA	Consistent with NS-9.10, 12.3	
49	**Irrigated Agriculture**	Legislature	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.	Feasible	Effective	Approx. $100,000 (IAWG)	Legislature	2019 Session	Not difficult	Consistent with NS-9.10, 12.1, 12.2, 12.4	
50	**Both Irrigated Agriculture and Livestock**	Ag Industry Associations, DOE, SYCD, WSDA, WSU, Yakima County	Develop a post-GWAC agricultural producer education and outreach campaign	1. 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. 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. 2. 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.	Feasible	Depends upon approach	Expensive in totality	Legislature	2019 Session	Dependent on specific approach	Consistent with NS-9.10	
51	**Both Irrigated Agriculture and Livestock**	Legislature, DOE, WSDA, Washington State DOH	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.	Feasible	Effective	$5 million (est)	Legislature	2019 Session	Difficult, dependent on interagency communication & relationships with producers	Consistent with NS-9.6, 9.10	
52	**Both Irrigated Agriculture and Livestock**	SYCD, WSDA, WSU, Private Industry, Producers	Apply 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	Private, Legislature	Ongoing, 2019 Session	Dependent on technologies	Consistent with NS-9.10	
53	**Both Irrigated Agriculture and Livestock**	WSU, Producers	Integrate use of animal waste and synthetic fertilizer.	Research chemical integration of animal waste and synthetic fertilizers with objective of balancing nutrient application amounts in order to maximize crop production and full nitrogen uptake.	Feasible	Effective	Potential cost-savings	Private, Legislature	Ongoing, 2019 Session	Not difficult, but requires knowledge of soil chemistry	Consistent with NS-9.10	
54	**Both Irrigated Agriculture and Livestock**	WSDA, SYCD	Monitor changes occurring in agricultural operations. Evaluate whether those changes positively affect improvement in groundwater quality.	Prepare report to Legislature and Department of Ecology.	Feasible	Effective	Expensive	Legislature	2019 Session	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	Consistent with NS-9.10	
55	**Both Irrigated Agriculture and Livestock**	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	Expensive	Legislature	2019 Session	How to share data is unresolved, public distribution may limit participation by producers & landowners	Consistent with NS-9.10	
56	**Lead Agency / Administration / Adaptive Management**	Lead Agency	Establish a Lead Agency responsible 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	Ask County	Legislature	2019 Session	Not difficult	Consistent with NS-9.10	

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57	**Lead Agency / Administration / Adaptive Management**	Lead Agency, DOE, DOH, YHD	Establish time-based performance objectives against which well-monitoring data can be compared.	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	Ask County, DOE	Legislature	2019 Session	Difficult; need to define timeframe for water quality improvement	Consistent with NS-9.10	
58	**Lead Agency / Administration / Adaptive Management**	Lead Agency	Assess groundwater contamination potential, and mitigation strategies in localized areas	Make use of the available information on soils, geology, and groundwater in order to identify those areas that are the most vulnerable to immediate impact of contamination or can tolerate more nitrogen application. Overlay GIS density maps reflecting different sources of nitrogen in order to geographically indicate the total density from all sources. Identify areas with highly permeable and susceptible soils where fertilization and pesticide application should be most carefully managed. Identify areas that are closer to surface water, areas where recharge is faster or more frequent, or areas where shallow soils overlie soluble bedrock. Identify and assess strategies near these sensitive areas to reduce contributions of nitrate sources.	Feasible	Effective in telling producers where most sensitive properties exist	Ask County	Legislature	2019 Session	Not difficult, capacity already exists	Consistent with NS-9.10	
59	**Lead Agency / Administration / Adaptive Management**	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 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.*	Feasible	Effective	Ask County	Legislature	Continuous, 2025-2030	Not difficult, depends on funding	Consistent with NS-9.10	
60	**Lead Agency / Administration / Adaptive Management**	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	Ask County	Legislature	2019 Session	Not difficult	Consistent with NS-9.10, UT-1.1-1.7, 3.1, 3.5, 6.5	
61	**Lead Agency / Administration / Adaptive Management**	Lead Agency	Encourage municipalities within the GWMA to extend municipal sewer systems within urban growth areas and retire ROSS and LOSS.		Feasible	Effective	Ask local governments for estimates	Federal or state grant, reimbursed by water use fees	Decades	Hasn't been accomplished to date	Consistent with UT-1.3, 1.6, 11.5, 11.6, 11.7	**Steve George:** states to "Encourage extension of municipal sewer systems." Why not promote the extension or creation of potable water systems. That takes care of the immediate problem and has been the item of choice for many areas. Most areas work on the sewage treatment after they put in a water system. I did not see anything in these recs about promoting the water systems...
62	**Lead Agency / Administration / Adaptive Management**	Lead Agency	Encourage connection of residences within urban growth zones to sewer systems extended by municipalities.		Feasible	Effective	Ask local governments for estimates	Federal or state grant, reimbursed by water use fees	Decades	Hasn't been accomplished to date	Consistent with UT-1.3, 1.6, 11.5, 11.6, 11.7	**Steve George:** same as #61
63	**Lead Agency / Administration / Adaptive Management**	Lead Agency, Yakima Health District	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.		Only feasible alternative is connection to *municipal waste* treatment facility.	Not Effective	N/A	N/A	N/A	N/A	Consistent with NS-8.2. Inconsistent with UT-2.5, 12.7, *13.8*	
64	**Lead Agency / Administration / Adaptive Management**	Lead Agency	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.		Only feasible alternative is connection to municipal waste treatment facility.	Not Effective	N/A	N/A	N/A	N/A	Consistent with NS-8.2. Inconsistent with UT-2.5, 12.7, 13.8	
65	**Lead Agency / Administration / Adaptive Management**	Lead Agency, Municipalities, Yakima Health District	Require new developments to address potential impacts on groundwater quality	Through permitting review of site plan criteria.	Feasible	Effective	Approx. $10-50,000; Costly for developer & purchaser	Developer/ purchaser	Decades	Requires BOCC approval	Consistent with NS-8.2	
66	**Lead Agency / Administration / Adaptive Management**	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.	Feasible	Not Effective, based on prior efforts	Ask the County	Legislature	2019 Session	Easy	Consistent with NS-8.2	
67	**Livestock / CAFO**	Legislature	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	None	Legislature for implementation	2019 Session	Requires legislative approval	Consistent with NS-9.10. Inconsistent with NS-7.64. (Mutually inconsistent provisions.)	**Steve George:** This is a biased, closed-minded approach that I do not support. It would be hard to administer, fund and enforce. Better to see what voluntary approaches get done.
68	**Livestock / CAFO**	Washington Conservation Commission, 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	Ask WSDA	Ask WSDA	2018	Easy	Consistent with NS-9.10	
69	**Livestock / CAFO**	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	Ask WSDA/WSU	Legislature	2019 Session	Difficult without knowledge of sub-area soil chemistry and moisture information	Consistent with NS-9.10	
70	**Livestock / CAFO**	WSDA, SYCD	Continue to provide underlying soils information to individual livestock operations	So that individual property owners can evaluate contamination potential.	Feasible, info available from NRCS	Effective	Cheap	None	N/A	Easy	Consistent with NS-9.10	
71	**Livestock / CAFO**	WSDA	Complete NRCS Technical Note 23 inspections on all waste storage ponds (lagoons) within the GWMA boundaries.		Feasible	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Unknown	

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72	**Livestock / CAFO**	WSDA	Develop strategies for marketing the economic, fertilizer value, and soil enhancing properties of appropriate application of manure and other livestock wastes.		Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Ask WSDA	Consistent with NS-9.10	
73	**Livestock / CAFO**	SYCD	Charge dairies for preparation of Dairy Nutrient Management Plans		Feasible	Ineffective	Ask SYCD	Producer	2019	Dependent on producer willingness to pay the fee	Unknown	
74	**Livestock / CAFO**	SYCD, WCC	Establish a local forum for disseminating information and facilitating technical exchange regarding BMPs for 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	Ask SYCD	Legislature	2019 Session	Easy	Consistent with NS-9.10	
75	**Livestock / CAFO**	Washington Conservation Commission, WSU Extension	Provide additional funding for Yakima Valley education and outreach activities.	BMP implementation, irrigation water management, soil nutrient management and manure management and application.	Feasible	Effective	Ask WCC, WSU	Legislature	2019 Session	Ask WCC, WSU	Consistent with NS-9.10	
76	**Livestock / CAFO**	WSDA	Develop a system to evaluate which farmers need assistance in understanding appropriate farming practices.	Clearly establish expectations, list problematic management practices, encourage voluntary compliance, develop peer encouragement system. Provide information on enforcement potential.	Feasible	Improbable	Ask compliant farmers	Producers	2019	Dependent on producers	Consistent with NS-9.10	**Steve George:** I don't support this strategy. Not sure how this would be carried out or by who. I think everyone needs a little assistance or expertise at times, so a good, well-funded CD would take care of this.
77	**Livestock / CAFO**	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	Substantial	Congress	2020	Easy	Consistent with NS-9.10	
78	**Livestock / CAFO**	Producers	Make capital improvements	Install liners in liquid waste storage lagoons. Install impervious surfaces beneath silage storage.	Feasible	Effective	Substantial	Cost-share/ producers & WSDA (Legislature)	2019	Feasible	Consistent with NS-9.10	**Steve George:** OK, what kind of liners?? Are clay ok?? I would not support that everyone be mandated to install synthetic liners.
79	**Nitrogen Loading**	WSDA, DOE, Lead Agency	Assess Nitrogen 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 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. Ask the Environmental Protection Agency to use its Community Multi-scale Air Quality Modeling System (CMAQ model) -- or other tools -- to 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. Design and implement pilot studies focusing on innovative farm techniques which reduce nitrogen loading to crops and monitor results for future expansion of findings.	Feasible	Dependent upon completion of NAA & GWAC resolution of course of action	Dependent upon completion of NAA & GWAC resolution of course of action	Legislature	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	**Steve George:** I would feel more comfortable having WSU performing these tasks rather than WSDA, DOE or EPA.
80	**Regulations and Enforcement**	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	Dependent upon personnel requirements & level of enforcement	Legislature	2019 Session	Not difficult	Consistent with NS-9.10	
81	**Regulations and Enforcement**	State Department of Health	Revise WAC 246-203-130 (keeping of animals)	So that it includes specific and enforceable requirements designed to protect human health.	Feasible	Effective	Minimal	Legislature	2019 Session	Not difficult	Consistent with NS-9.10	**Steve George:** WAC 246-203-130 was not intended for production ag or ag zoned areas. It was meant to control livestock issues in urban areas. It should not be expanded to include areas that are zoned for ag production.
82	**Regulations and Enforcement**	WSDA, Producers, Fertilizer Companies, Irrigation Districts	Integrate management of synthetic/organic fertilizers and application of water	Possible model of Nutrient Management Plans.	Needs more Definition	Needs more Definition	Worthy of study	Unknown	Five years	Unknown	Consistent with NS-9.10	
83	**Remediation**	EPA, DOE, Producers,	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).	Feasible (water rights questions)	Effective (also would supplement water supply)	Substantial	Legislature	2019 Session	Unknown	Consistent with NS-9.10	**Lucy Edmondson:** One important point is that, while we may suggested strategy 83, this is not a strategy that EPA would implement. Especially since the funding would come from the state legislature, we recommend this strategy move to a state or local agency -- WSDA, the county, or the Conservation District...
84	**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, cost for WSDA to monitor DNMP, costs of soil sampling	Analogous to SEPA No Action alternative.								**Steve George:** This should not be a recommendation. It is not cost effective.

Water Quality Goals and Objectives

On February 6, 2013, the GWAC adopted the following goals and objectives in its work plan:

GWMA Goal

The primary long-term goal of the GWMA is to reduce concentrations of nitrate in groundwater to below Washington State drinking water standards.

Proposed Objectives

Objectives have been divided into six categories: Data and Monitoring, Problem Identification, Measures to Reduce Groundwater Contamination, Education, Drinking Water Systems, and General objectives.

Input from the GWAC and citizen input will be used to refine and prioritize objectives. In general, refinement of objectives in each category will begin with an updated assessment of the current status of work.

Yakima County's Comprehensive Plan – Horizon 2040 – lists the following groundwater quality goals in Chapter 2, "Natural Settings":

Visioning Goals - Environment

1. Water:
   - A. Improve and maintain water quality and quantity.
   - B. Promote increased levels of water management for the purposes of conservation, storage, delivery, and flood control.
   - C. Provide effective management for diverse and conflicting water uses: agricultural, municipal, and industrial; recreational and fishery base flows; wildlife habitat; wetlands; and rural residential.
   - D. Manage the Yakima River Basin as a unique resource.
   - E. Restore the water quality of the Yakima River.
   - F. Identify future needs and promote increased water supplies through coordinated management and conservation efforts.
   - G. Improve and maintain ground and surface water quality.
2. Land:
   - A. Coordinate land uses to reduce uncertainty and unpredictable development which sacrifices conservation and sound land management.
   - B. Preserve and protect critical areas.
   - C. Inventory public open space lands and define those to preserve for future generations.
3. Air:
   - A. Address air quality challenges while recognizing the different existing and future growth patterns and regulations for urbanizing and rural areas.
   - B. Identify the impact on air quality caused by industrial and community growth patterns, such as the quantity, size, location, and nature of the growth.
   - C. Determine what threshold of air quality we wish to achieve and maintain for health and aesthetics.
   - D. Establish county-wide quality standards based on best management practices.
4. *Education and Awareness:*
   - A. Promote environmental education opportunities.
   - B. Foster awareness necessary to address environmental challenges.
   - C. Develop an educational awareness program which informs people of the value of their resources and the steps for their protection.
5. Other Programs:
   - A. Create resources or incentives that will promote actions which enhance the natural environment.
   - B. Increase the community's participation in recycling and other innovative solid waste disposal programs.
   - C. Create a comprehensive image that links together environmental, resources and quality of life elements.
   - D. Preserve wetlands, open lands, and other habitat areas.
   - E. Establish and *enforce standards for light, glare, and noise to minimize* incompatibilities within and between land use areas and to enhance quality of life.
   - F. Consider energy supply alternatives and energy conservation opportunities.

EDUCATION
PURPOSE STATEMENT NS 2

The failure to recognize environmental limits results in depleted resources, and as a result, diminishes our present quality of life. If the County is to achieve sustainable development, residents need to look beyond the short-term benefits of their actions. This goal and related policies encourage education as a means to inform County residents and visitors that preserving environmental quality will help maintain the County's quality of life for the long term.

Goal NS 2:	Inform residents and visitors on how living and doing business in Yakima County can be satisfying and profitable without degrading environmental values.
Policies:	
NS 2.1	Make information available for the general public which outlines the various land use permitting processes. This should focus on reasons for the regulation and the basic permitting steps.
NS 2.2	Provide information and education on planning issues to schools and the community at large.
NS 2.3	Develop an educational brochure that illustrates the functions and values of Yakima County's wetlands and the natural history of the Yakima County stream corridors.
NS 2.4	Work with school districts to increase understanding of planning issues; make locally oriented planning curriculum available.

AIR QUALITY
PURPOSE STATEMENT NS 3

Federal and state standards have been set for inhalable particulate matter (PM10) and carbon monoxide, both of which are of some concern, particularly in the Yakima urbanized area. Reductions in pollution must be realized from existing as well as future sources in order to accommodate growth without causing violation of any of the standards.

Goal NS 3:	Make steady improvement in the air quality of the Yakima Valley by reducing dust, odor, auto emissions, smoke, and other contaminants.
Policies:	
NS 3.1	Support the Yakima Regional Clean Air Agency in researching the nature, magnitude, and potential solutions to problems caused by airborne particulates, taking appropriate actions, and monitoring results.
NS 3.2	Require control of emissions to the air during land development and construction projects.
NS 3.3	Participate in the review and planning efforts of the Yakima Regional Clean Air Agency to reduce smoke, odor, dust, and other air contaminants.
NS 3.4	~~To the extent physically and financially possible, control dust on County roads.~~

Policies:	
NS 7.64	Allow lawfully established agricultural activities occurring on agricultural lands to continue as they historically have. New agricultural activities on land not currently used for agriculture, conversion of agricultural lands to other uses, and other development on agricultural land that does not meet the definition of agricultural activities (including any agricultural development not specifically exempted by the provisions of RCW 90.58.030(3)(e)(iv)) should meet shoreline requirements.
NS 7.65	Encourage animal feedlot operations to locate away from shorelines.

CRITICAL AREAS: GENERAL

PURPOSE STATEMENT 8

Critical Areas are an important part of the natural setting in Yakima County. Their protection is required by the Growth Management Act and important to the quality of life of the residents of this county. Critical Areas include groundwater, fish and wildlife priority species and habitat (which includes surface waters), wetlands, frequently flooded areas, and geologic hazards. The protection of critical areas must include certain general approaches, which are provided for in the goals and policies below.

Goal NS 8:	Establish critical areas protection measures to protect environmentally sensitive areas, and protect people and property from hazards.
Policies:	
NS 8.1	Use the best available science to develop regulations to protect the functions and values of critical areas.
NS 8.2	Ensure proposed subdivisions, other development, and associated infrastructure are designed at a density, level of site coverage, and occupancy to preserve the structure, values and functions of the natural environment or to safeguard the public from hazards to health and safety.
NS 8.3	Use a preference-based system of mitigation sequencing for the County's stream, lake, pond, wetland, floodplain and fish and wildlife priority species and habitat critical areas that reduces impacts using approaches ranging from avoidance to replacement.
NS 8.4	In order to encourage Critical Area protection and restoration, the density and lot size limits stipulated in other policies may be adjusted or exceeded to accomplish clustering and bonus provisions adopted under the (Critical Areas Ordinance) CAO. The use of incentive based programs is encouraged.

PURPOSE STATEMENT 9

Groundwater is the primary source of drinking water for many people. Once groundwater is contaminated it is difficult, costly, and may be impossible to clean up. The following goal and policies address these concerns by encouraging the identification of aquifers and taking steps to reduce potential contamination.

GOAL NS 9:	Maintain and manage the quality of the groundwater resources in Yakima County as near as possible to their natural conditions and in compliance with state water quality standards.
Policies:	

NS 9.1	Identify and map important aquifers, critical aquifer recharge areas, and surface waters.
NS 9.2	Develop performance standards and regulate uses for activities which adversely impact water quantity and quality in aquifers, wetlands, watersheds and surface waters.
NS 9.3	Evaluate the potential impact of development proposals on groundwater quality, and require alternative site designs to reduce contaminant loading where site conditions indicate that the proposed action will measurably degrade groundwater quality.
NS 9.4	Continue data collection and evaluation efforts to better understand the County's groundwater system and its vulnerability to contamination.
NS 9.5	Encourage the retention of natural open spaces in development proposals overlying areas highly susceptible for contaminating groundwater resources.
NS 9.6	Conduct and support educational efforts which inform County citizens of measures they can take to reduce contaminant loading of groundwater systems.
NS 9.7	Encourage development and expansion of community public water systems to lessen the reliance on individual wells.
NS 9.8	Ensure that abandoned wells are closed properly.
NS 9.9	Ensure sufficient water quantity exists to support residential development and land use activities.
NS 9.10	Support efforts to develop long-term solutions to prevent contamination of domestic wells.

Goal NS 12:	**Restore, maintain or enhance the quality of the Yakima River Basin's surface water.**
Policies:	
NS 12.1	Maintain local control over water quality planning by: 1) providing guidance to state and federal agencies regarding water quality issues, priorities and needs; and 2) demonstrating progress in accomplishing the goals and objectives of locally developed water quality plans, thereby pre-empting externally-imposed solutions to water quality problems as much as possible.
NS 12.2	Make use of local and regional data sources to assess water quality progress.
NS 12.3	Participate in water quality improvement planning and implementation efforts by local, regional, state, federal, and tribal agencies, as well as coalitions such as local watershed planning efforts.

GENERAL UTILITY

PURPOSE STATEMENT UT 1

The County must plan for the utility and land use needs in a consistent manner, to ensure that growth occurs in areas which can be served by necessary utilities. This requires coordination with service providers for the location and timing of utility installation. This goal and its policies define how the coordination should take place.

GOAL UT 1:	**Ensure that necessary and adequate utilities are provided to all development in Yakima County in a cost effective manner consistent with *Horizon 2040.***
POLICIES:	
UT 1.1	Adopt and implement separate utility level of service standards for urban and rural areas.
UT 1.2	Ensure consistency of utility elements and utility plans by coordinating plans among adjacent jurisdictions.
UT 1.3	Develop interlocal agreements to coordinate procedures and standards in urban growth areas.
UT 1.4	Develop a coordinated process for siting regional utility facilities in a timely manner.
UT 1.5	Consult with service providers as part of the process of identifying land useful for future planned development and for the sharing of utility corridors.
UT 1.6	Coordinate the installation of utility facilities among utility service providers and with other infrastructure providers.
UT 1.7	Provide the private utilities with up-to-date County planning materials such as land use categories, population forecasts, etc. so that their utility delivery plans are accurate.

PURPOSE STATEMENT UT 2

Utility corridors, especially above-ground utilities, can have an impact on the natural environment. Camouflaging or screening utility structures and opening up utility corridors for trail or other recreational use can lessen the utilities' visual and physical impact on the natural environment. This goal and its policies describe steps that can be taken to lessen the impact of utilities.

GOAL UT 2:	**Reasonably protect the physical and natural environment while providing utilities.**
POLICIES:	
UT 2.1	Whenever possible, utility corridors should be made available for recreational use when such use does not negatively impact adjacent land uses and does not pose a public health or safety hazard, or result in property damage on adjacent lands.

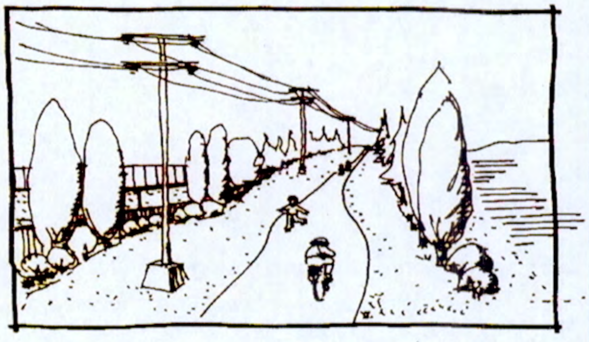


Figure 9.13-1 Recreational Use in a Utility Corridor. (UT 2.1)

UT 2.2	Encourage private utility structures (e.g., electric substations) to have design and screening that is compatible in bulk and scale with surrounding land uses.

UT 2.3	Assist and facilitate the siting of linear transmission facilities and utility-related infrastructure in a manner consistent with *Horizon 2040* through land use planning and development review policies and procedures.
UT 2.4	Encourage energy resource development in locations within Yakima County that take advantage of the County's energy resources, existing infrastructure, and also are sited to minimize environmental impacts.
UT 2.5	Consider low impact development and other appropriate "green" building standards and guidelines to comprehensively address design elements such as transportation and storm water management utility infrastructure, in order to reduce costs and retain natural hydrology and processes, using appropriate techniques such as limiting impervious surfaces, clustering, and preserving open spaces and forests.

PURPOSE STATEMENT UT 3

Utility services are costly to the community. To the extent that location and timing of utility service installation can be coordinated, the community will save on the cost of utility provision. This goal and its policies suggest coordination methods that may be cost effective over the long term.

GOAL UT 3:	**Ensure cost effective provision of utility services.**
POLICIES:	
UT 3.1	Utility services should be provided in accordance with approved utility comprehensive plans that are consistent with future population projections and the preferred land use categories defined by *Horizon 2040*.
UT 3.2	Solicit community input prior to county approval of private utility facilities which may significantly impact the surrounding community.
UT 3.3	Support electricity, natural gas, and water efficiency programs that include quantitative objectives for reducing energy and water consumption, specific programs to achieve objectives (including regular audits of facilities), a time schedule for implementation, identification of responsible departments, energy accounting, and identified sources of funding.
UT 3.4	Require timely and effective notification of interested utilities of road construction projects, and of maintenance and upgrades of existing roads to facilitate coordination of public and private utility trenching activities.
UT 3.5	Require that utility permits be considered simultaneously with the proposals requesting service and, when possible, approval of utility permits when the project to be served is approved.
UT 3.6	Preserve right-of-way needed for irrigation system maintenance.

WATER SUPPLY AND SEWAGE DISPOSAL

PURPOSE STATEMENT UT 4

Horizon 2040 *should define where water and sewer systems are appropriate.*

GOAL UT 4:	**Ensure that water supply and sewage disposal facilities throughout the County support the desired land use, and are consistent with other goals, policies and objectives of *Horizon 2040.***
POLICIES:	
UT 4.1	Follow the guidance in YCC, Title 19, Tables 19.25-1 Water and 19.25.2 Sewer to ensure that the level of water and sewer service is appropriate and consistent with the land use goals and policies for each area of the County
UT 4.2	Specific physical location and site suitability should determine which of the "required" water and sewer utilities listed in YCC, Title 19, Tables 19.25-1 Water and 19.25-2 Sewer is the most appropriate.
UT 4.3	Utilities for master planned resorts and new communities should be consistent with the guidance in YCC, Title 19, Tables 19.25-1 Water and 19.25-2 Sewer for the zoning designations in which they are located.
UT 4.4	Existing water companies, water districts, and sewer districts should be used if they have capacity to serve.

PURPOSE STATEMENT UT 5

These policies develop guidelines to promote a checks and balances system while encouraging efficient water use and water resource planning.

GOAL UT 5:	**Ensure that future development does not exceed the available amount of raw water.**
POLICIES:	
UT 5.1	Encourage water resource planning to promote more efficient management of both ground and surface water resources.
UT 5.2	Develop specific guidelines for determining the adequacy of water supplies proposed to serve new parcels and new structures and uses on existing parcels.
UT 5.3	In conjunction with the irrigation districts, evaluate the implications of the use of irrigation water for residential landscaping.
UT 5.4	File on unappropriated water rights within urban growth and transitional areas.
UT 5.5	Develop a water resource system that addresses the need for domestic water for development in unincorporated Yakima County that meets the water availability requirements of state law.

PURPOSE STATEMENT UT 6

Rural area residents depend on groundwater as their source of drinking water. Groundwater contamination is a major concern in the County. The purpose of this section is to minimize the risk to groundwater for new development, and to identify and mitigate existing threats to the quality of groundwater.

GOAL UT 6:	Protect the quality of groundwater used for domestic water supplies.
POLICIES:	
UT 6.1	Develop existing regulations regarding well construction standards
UT 6.2	Implement a long-term groundwater quantity and quality monitoring program for basins that provide domestic water supplies.
UT 6.3	Minimize impacts of development and agricultural practices on groundwater supplies.
UT 6.5	Maintain and enforce a wellhead protection program.

PURPOSE STATEMENT UT 7

The city of Yakima takes most of its drinking water from the Naches River, just below the town of Naches. To protect this important source of drinking water, Yakima County should ensure that land use in the Naches and Tieton watersheds does not impact water quality in the tributaries that drain into the Naches River.

GOAL UT 7:	Protect the quality of surface water used for potable water supply.
POLICIES:	
UT 7.1	Support cooperation with other governmental agencies in conducting source identification studies in the Lower Naches River watershed (all lands draining into the Naches River below the confluence with the Tieton River) to determine the cause of elevated pH levels and water temperature.
UT 7.2	Encourage the use of best management practices in the Lower Naches River watershed, especially those targeted to reducing pH and temperature levels.
UT 7.3	Support cooperative efforts to develop and implement a comprehensive water quality monitoring program for the Upper Naches River (above the confluence of the Naches and Tieton rivers).
UT 7.4	Support water quality monitoring efforts in the Upper Naches River and Tieton rivers, and make information available for these purposes.
UT 7.5	Participate with other agencies to develop and implement water quality information and educational programs for recreational users of the Upper Naches and Tieton River watersheds.
UT 7.6	Participate in cooperative forest watershed management programs designed to protect water quality.
UT 7.7	Participate in cooperative programs to educate recreational users and residents in the Naches and Tieton River watersheds about proper sanitary practices.

PURPOSE STATEMENT UT 8

A key component of water quality management is to ensure the health, safety and welfare of Yakima County residents. To this end, existing problems must be mitigated, and new water and sewer systems must be installed in a manner which minimizes the risk to public health and safety. This goal and its policies encourages water quality management to meet this objective.

GOAL UT 8:	Ensure the safety of public and private potable water systems.
POLICIES:	
UT 8.1	Implement a satellite management program for new or failing water systems.
UT 8.2	Ensure that water service for new development complies with all applicable laws and regulations, including operating under an approved water system plan.
UT 8.3	Review water plans to ensure that they are compatible with land use planning.
UT 8.4	Require water systems to satisfy current regulations when expanding service to additional customers, with the new customers paying for their fair share of the cost of meeting current standards or reducing the level of service available to existing customers (e.g., provide funds for future replacement of undersized lines, looping systems to increase fire flow pressure, loss in pressure on maximum demand day).
UT 8.5	Support the efforts of privately-owned public water systems to bring systems up to public standards, at which point the County will consider owning and operating them, if requested.

PURPOSE STATEMENT UT 9

Water conservation should play a major role in a community's water resource management. Two ways to meet this goal are educational training on voluntary water use reduction and requiring the installation of water conserving devices in new construction. This goal and its policies describe these methods and encourage them as part of a water conservation program.

GOAL UT 9:	Promote water conservation.
POLICIES:	
UT 9.1	Encourage water purveyors to create and implement water conservation education programs.
UT 9.2	Promote water conserving fixtures in new buildings.
UT 9.3	Promote the use of water conserving landscaping.

PURPOSE STATEMENT UT 10

In order to reduce wastewater and the costs associated with treating it, water conservation should play a major role in a community's water resource management.

GOAL UT 10:	Minimize the amount of wastewater that requires treatment.
POLICY:	
UT 10.1	Follow policies UT 9.1-9.3, which are designed to conserve domestic water.

PURPOSE STATEMENT UT 11

To protect the health, safety and welfare of its citizens, Yakima County should ensure the quantity and quality of its water resources. This goal and its policies addresses this issue by requiring specific development standards for water and sewer services throughout the County.

GOAL UT 11:	**Protect surface and ground water quality and quantity.**
POLICIES:	
UT 11.1	Development proposed for individual wells and septic systems should be allowed only at densities which meet self-sufficiency standards.
UT 11.2	The intensity to which a specific parcel can be used should be determined, to a large degree, by regulations pertaining to environmental, health, and safety concerns.
UT 11.3	In urban areas where sewer is not currently available but may be available in the future, developers shall be required to sign sewer hookup covenants and install dry lines from the septic systems to the future sewer easement.
UT 11.4	Encourage the appropriate use of community/public water and sewerage systems in Rural Transitional and Rural Settlement areas and other areas where small lots are allowed.
UT 11.5	Require urban density development within the urban growth area to be served by public sewer service.
UT 11.6	Municipal Public sewer service should not be extended outside the urban growth area unless:
	Public sewer service will remedy an existing ground water contamination or other health problem by replacing septic systems and community on-site sewage systems; or
	A formal binding agreement to service an approved planned development was made prior to the establishment of an Urban Growth Area; or
	It is mandated by the State Department of Health, Ecology, or other regulatory agency with jurisdiction over local ground water quality.
UT 11.7	Interim on-site approved septic systems may be permitted within the urban growth area if public sewer service is not available, only if:
	Ground water protection policies are enforced; and
	The design incorporates stub-outs to facilitate future hook-up; and
	The applicant agreed not to object to future Local Improvement Districts (LID) or hook-up actions; and
	Land use densities and soil conditions allow for safe operation of the septic system.
UT 11.8	Sewage system expansion must be consistent with Yakima County's *Horizon 2040* and other land use planning documents, as well as the sewage treatment plant capacity.
UT 11.9	Review current local planning and interlocal service agreements and restructure governmental and financing mechanisms as needed to ensure timely, scheduled access to regional sewer services.

URBAN WATER

PURPOSE STATEMENT UT 12

To protect the health, safety and welfare of its citizens, Yakima County should ensure the quantity and quality of its water resources. This goal and its policies addresses this issue by requiring specific development standards for water and sewer services in unincorporated urban areas.

GOAL UT 12:	Ensure protection of public health, safety and welfare by safeguarding surface and groundwater resources.
POLICIES:	
UT 12.1	Require all new urban development to connect to public drinking water supplies, or provide proof of water availability, both legal and physical, prior to the County's land use or building permit approval.
UT 12.4	Encourage use of community (public) water supply wells where area wide public water supply systems are not available.
UT 12.5	Establish well location and construction standards that will facilitate future interconnection with other public water supply systems.
UT 12.7	Encourage development or consolidation of public water supplies through:
	County application for water rights from the state for cluster development;
	Developing financing mechanisms for public water supplies;
	Establishing latecomer agreements to compensate and encourage use of existing public water supplies.

RURAL WATER

PURPOSE STATEMENT UT 13

To protect the health, safety and welfare of its citizens, Yakima County should ensure the quantity and quality of its water resources. This goal and its policies addresses this issue by requiring specific development standards for water and sewer services in rural areas.

GOAL UT 13:	Ensure groundwater resources are safeguarded to protect public health and welfare.
POLICIES:	
UT 13.1	Limit number of wells penetrating the aquifer to protect groundwater quality and supply.
UT 13.2	Encourage use of community (public) water supply.

UT 13.8	Encourage development and consolidation of community water supplies through:
	County application for water rights for cluster development;
	Establishing financing methods for public water supply;
	Developing latecomers' fees to compensate/encourage use of existing public water supplies.

SOLID WASTE

PURPOSE STATEMENT UT 15

This goal and its policies encourage continued improvements in methods of reducing landfill waste and recognizes that planning for future land needs is an important cost-control method.

GOAL UT 15:	**Manage the solid waste system in a manner that cost effectively preserves the environment and protects the public health.**
POLICIES:	
UT 15.1	Identify and adopt measures to improve the energy efficiency of recycling and trash collection, and implement feasible and effective measures.
UT 15.2	Review and revise the County Solid and Moderate Risk Waste Management Plan at least every five years; continue to assess the need for solid waste transfer facilities, recycling centers, and materials recovery facilities, identifying potential locations and suggesting revisions to the zoning code as needed.
UT 15.3	Provide an environmentally safe bio-solids management program to provide for present and future bio-solids utilization needs.

Wastewater:

GOAL YKUT-U 2:	**Protect public health and environmental quality through appropriate and efficient design, installation and maintenance of sanitary sewer facilities.**
POLICIES:	
YKUT-U 2.1	Work with adjoining jurisdictions, and local purveyors to manage, regulate and maintain the regional sewer systems.

Yakima County's Comprehensive Plan – *Horizon 2040* was under consideration of enactment during the period that the GWAC Working Groups were meeting. It became final on (date). The GWAC working groups, including GWAC's Regulatory Framework Working Groups operated with the knowledge of the Yakima County Comprehensive Plan – *Plan 2015*. However, the GWAC working groups made a number of recommendations consistent with the 2040 Plan. The GWAC Data Collection working groups made recommendations pertaining to policies NS 9.1, and 9.4. The GWAC Education and Public Outreach working group made recommendations pertaining to policy NS 9.6. The GWAC Residential, Industrial, Commercial and Municipal working group made recommendations pertaining to policies NS 9.7 and 9.8. The GWAC working groups made no recommendations pertaining to policies NS 9.2, 9.3, 9.5 or 9.9 of the 2040 Plan. NS 9.10 reflects a policy supported in principle by all the working groups. These working group recommendations were endorsed by the full GWAC and are incorporated in the alternative strategies recommended by the full GWAC.

LYVGWMA Expenditures through December, 2017

Task Description	Subtask Description	VENDOR	2013	2014	2015	2016	2017	Grand Total
Administration	Accounting	Ishizaka, Teresa	$ 4,205.87	$ 3,504.50	$ 2,509.80	$ 1,875.68	$ 2,043.09	$ 14,138.94
		Miller, Mary	$ 623.29					$ 623.29
	Accounting Total		$ 4,829.16	$ 3,504.50	$ 2,509.80	$ 1,875.68	$ 2,043.09	$ 14,762.23
	Data Collection	02 DODGE RAM	$ 42.00					$ 42.00
		Havens, Troy	$ 4,618.35	$ 278.40				$ 4,896.75
		Huard, Robin	$ 158.26					$ 158.26
		John, Jill	$ 134.83					$ 134.83
		Matson, Heidi	$ 747.45					$ 747.45
		Oliver-Murdock, Lee Ann		$ 271.97				$ 271.97
		Smith, Greta	$ 29.21					$ 29.21
		Wurtz, Mary		$ 93.73				$ 93.73
	Data Collection Total		$ 5,730.10	$ 644.10				$ 6,374.20
	Document Preparation	1st QTR 2016 Plotter Charges				$ 259.00		$ 259.00
		Brady, Roberta					$ 1,427.23	$ 1,427.23
		Montelongo, Elizabeth					$ 268.60	$ 268.60
		Naasz, Erica			$ 42.08			$ 42.08
		Office Max			$ 476.26			$ 476.26
		Printing	$ 1,955.67		$ 43.50	$ 18.99	$ 786.92	$ 2,805.08
		Rocha, Rosalinda					$ 263.54	$ 263.54
		Rosenkranz, Phillip					$ 77.72	$ 77.72
		Saunders, Christopher					$ 1,717.34	$ 1,717.34
	Document Preparation Total		$ 1,955.67		$ 561.84	$ 277.99	$ 4,541.35	$ 7,336.85
	General Admin	02 DODGE RAM		$ 90.00	$ 96.00			$ 186.00
		03 FORD F350		$ 126.75				$ 126.75
		10 FORD ESCAPE 4X4	$ 76.56	$ 307.98	$ 106.14			$ 490.68
		2016 Petty Cash				$ 38.89		$ 38.89
		Brady, Jerry					$ 18.01	$ 18.01
		Brady, Roberta			$ 2,604.50	$ 18,731.96	$ 12,290.65	$ 33,627.11
		Compucom		$ 870.57				$ 870.57
		Daily Sun News	$ 35.00	$ 205.00	$ 37.50			$ 277.50
		Davenport, James H		$ 27,759.36	$ 51,427.87	$ 45,612.36	$ 48,300.00	$ 173,099.59
		Ehlis, Carolyn	$ 2,978.96	$ 1,426.82				$ 4,405.78
		Espinoza, Karri		$ 110.30	$ 244.92			$ 355.22
		Freund, Lisa		$ 10.95				$ 10.95
		Havens, Troy	$ 2,354.77	$ 8,687.85	$ 1,263.57			$ 12,306.19
		Ishizaka, Teresa		$ 238.25				$ 238.25
		Meyers, Sarah		$ 18.22				$ 18.22
		Naasz, Erica			$ 5,366.05			$ 5,366.05
		Office Depot Inc.				$ 5.17		$ 5.17
		Office Max	$ 229.65					$ 229.65
		Oliver-Murdock, Lee Ann		$ 6,022.13	$ 19,663.70	$ 1,205.41		$ 26,891.24
		Ozanich, Marlene				$ 781.46	$ 486.03	$ 1,267.49

LYVGWMA Expenditures through December, 2017

Task Description	Subtask Description	VENDOR	2013	2014	2015	2016	2017	Grand Total
		Printing		$ 19.48			$ 29.48	$ 48.96
		Rae, Kelly	$ 746.40	$ 4,730.35	$ 680.90			$ 6,157.65
		Saunders, Christopher			$ 972.55	$ 187.06	$ 50.22	$ 1,209.83
		Smith, Greta			$ 1,357.71			$ 1,357.71
		U S Bank	$ 42.98	$ 54.28	$ 143.81			$ 241.07
		Wurtz, Mary	$ -	$ 249.95	$ 398.19			$ 648.14
		Yakima Herald			$ 71.09			$ 71.09
	General Admin Total		$ 6,464.32	$ 50,928.24	$ 84,434.50	$ 66,562.31	$ 61,174.39	$ 269,563.76
	GWAC Meetings	97 FORD CRWN VICT				$ 32.49		$ 32.49
		AY CARAMBA					$ 28.14	$ 28.14
		Brady, Jerry					$ 905.91	$ 905.91
		Brady, Roberta			$ 6.25	$ 6,268.42	$ 13,138.37	$ 19,413.04
		Cherry Hill Golf Course		$ 145.42				$ 145.42
		Cochrane, Brian	$ 526.68					$ 526.68
		Costco				$ 161.86	$ 1,318.46	$ 1,480.32
		Daily Sun News	$ 518.00	$ 67.50	$ 191.25	$ 296.25	$ 836.25	$ 1,909.25
		DOMINO'S				$ 133.55	$ 107.30	$ 240.85
		Durkee, Matthew	$ 782.24					$ 782.24
		Espinoza, Karri			$ 333.51	$ 71.10		$ 404.61
		FRED MEYER				$ 30.77	$ 69.14	$ 99.91
		Freund, Lisa			$ 31.05			$ 31.05
		GWAC Meeting				$ 31.27		$ 31.27
		Havens, Troy	$ 1,218.15					$ 1,218.15
		Haws, David	$ 506.91					$ 506.91
		Huard, Robin		$ 96.58	$ 35.99	$ 92.27	$ 263.90	$ 488.74
		Keenhan, Peter	$ 2,811.40					$ 2,811.40
		Legg, Jeffrey	$ 70.07					$ 70.07
		LOS HERNANDEZ				$ 106.69	$ 138.25	$ 244.94
		Northwest Community	$ 640.00					$ 640.00
		Office Depot Inc.				$ 12.79		$ 12.79
		Office Max			$ 42.88	$ 6.27		$ 49.15
		OLIVE GARDEN					$ 131.08	$ 131.08
		Oliver-Murdock, Lee Ann		$ 115.98	$ 172.72			$ 288.70
		Ozanich, Marlene				$ 1,110.08	$ 211.38	$ 1,321.46
		Parpart, Nicole	$ 3,108.33		$ 223.02			$ 3,331.35
		Printing				$ 765.23	$ 232.14	$ 997.37
		Rae, Kelly	$ 2,626.15		$ 77.08			$ 2,703.23
		Rocha, Rosalinda					$ 207.80	$ 207.80
		ROSAUERS					$ 22.95	$ 22.95
		Rosenkranz, Phillip					$ 90.67	$ 90.67
		SAFEWAY					$ 51.80	$ 51.80
		Saunders, Christopher			$ 482.27	$ 956.73	$ 800.44	$ 2,239.44

LYVGWMA Expenditures through December, 2017

Task Description	Subtask Description	VENDOR	2013	2014	2015	2016	2017	Grand Total
		School District #201	$ 117.00		$ 15.00	$ 168.00	$ 539.00	$ 839.00
		Sedighi, Ali	$ 3,297.87					$ 3,297.87
		Smith, Greta			$ 726.04			$ 726.04
		Strasser, Christine					$ 1,661.38	$ 1,661.38
		Sub Shop of Yakima	$ 2,069.01	$ 678.39	$ 127.24	$ 416.39		$ 3,291.03
		Supplies Dec			$ 16.23			$ 16.23
		U S Bank	$ 3,428.01		$ 2.95			$ 3,430.96
		United Parcel Service	$ 83.97					$ 83.97
		WALMART					$ 9.58	$ 9.58
		WASH FRUIT PLACE					$ 18.00	$ 18.00
		Wurtz, Mary	$ 167.49	$ 1,602.25	$ 58.04			$ 1,827.78
		Yakima Herald	$ 1,373.00	$ 548.37	$ 381.80	$ 742.72	$ 1,717.76	$ 4,763.65
	GWAC Meetings Total		$ 23,344.28	$ 3,254.49	$ 2,923.32	$ 11,402.88	$ 22,499.70	$ 63,424.67
	Travel	03 FORD F350 4X4	$ 255.75					$ 255.75
		07 FORD TAURUS			$ 314.88	$ 71.00		$ 385.88
		08 FORD ESCAPE 4X2				$ 155.44		$ 155.44
		10 FORD ESCAPE 4X4	$ 596.82					$ 596.82
		4 DODGE RAM PICKUP	$ 2.25					$ 2.25
		5 DODGE RAM PICKUP	$ 63.00					$ 63.00
		8 DODGE RAM PICKUP	$ 54.00					$ 54.00
		97 FORD CRWN VICT	$ 52.80					$ 52.80
		Brady, Jerry					$ 72.53	$ 72.53
		Brady, Roberta			$ 31.29	$ 1,199.85	$ 1,008.36	$ 2,239.50
		Espinoza, Karri			$ 61.41			$ 61.41
		Freund, Lisa	$ 110.75					$ 110.75
		Naasz, Erica			$ 174.79			$ 174.79
		Ozanich, Marlene				$ 198.02	$ 81.71	$ 279.73
		Parpart, Nicole			$ 51.14			$ 51.14
		Rae, Kelly			$ 38.55			$ 38.55
		Saunders, Christopher			$ 156.41	$ 165.23	$ 72.30	$ 393.94
		Sedighi, Ali	$ 1,068.93					$ 1,068.93
		Smith, Greta			$ 405.74			$ 405.74
		Strasser, Christine					$ 245.32	$ 245.32
	Travel Total		$ 2,204.30		$ 1,234.21	$ 1,789.54	$ 1,480.22	$ 6,708.27
Administration Total			$ 44,527.83	$ 58,331.33	$ 91,663.67	$ 81,908.40	$ 91,738.75	$ 368,169.98
Best Management Practices	Database QA/QC Plan	HDR Engineering Inc.	$ 42,819.20	$ 6,740.57				$ 49,559.77
	Database QA/QC Plan Total		$ 42,819.20	$ 6,740.57				$ 49,559.77
	Effectiveness Evaluation	HDR Engineering Inc.	$ 7,341.64	$ 19,598.40				$ 26,940.04
	Effectiveness Evaluation Total		$ 7,341.64	$ 19,598.40				$ 26,940.04
Best Management Practices Total			$ 50,160.84	$ 26,338.97				$ 76,499.81

LYVGWMA Expenditures through December, 2017

Task Description	Subtask Description	VENDOR	2013	2014	2015	2016	2017	Grand Total
Deep Soil Sampling	Data Collection	Roza Irrigation District		$ 1,497.04				$ 1,497.04
		South Yakima Conservation		$ 47,169.13	$ 140,487.80	$ 46,705.55		$ 234,362.48
		Sunnyside Valley		$ 2,821.99				$ 2,821.99
	Data Collection Total			$ 51,488.16	$ 140,487.80	$ 46,705.55		$ 238,681.51
	Plan Development	HDR Engineering Inc.		$ 49,883.68				$ 49,883.68
	Plan Development Total			$ 49,883.68				$ 49,883.68
	Program Support	Printing		$ 126.60				$ 126.60
	Program Support Total			$ 126.60				$ 126.60
Deep Soil Sampling Total				$ 101,498.44	$ 140,487.80	$ 46,705.55		$ 288,691.79
Education and Outreach	Data Dissemination	ALBA Enterprises		$ 40.00				$ 40.00
		Daily Sun News					$ 746.08	$ 746.08
		HDR Engineering Inc.		$ 9,435.84				$ 9,435.84
		Yakima Herald					$ 609.90	$ 609.90
	Data Dissemination Total			$ 9,475.84			$ 1,355.98	$ 10,831.82
	Document Preparation	ALBA Enterprises	$ 690.00	$ 120.00			$ 200.00	$ 1,010.00
		AMAZON				$ 85.11		$ 85.11
		CLEARBAGS				$ 78.17		$ 78.17
		Espinoza, Karri	$ 1,553.52	$ 110.30				$ 1,663.82
		Huard, Robin	$ 11.73					$ 11.73
		John, Jill	$ 31.81					$ 31.81
		Office Max				$ 25.48		$ 25.48
		Printing	$ 1,013.45	$ 1,242.44		$ 1,088.12	$ 2,491.74	$ 5,835.75
		Rae, Kelly	$ 19.20					$ 19.20
		Seibert, Sandra	$ 14.18					$ 14.18
		Wurtz, Mary	$ 749.43	$ 474.05				$ 1,223.48
	Document Preparation Total		$ 4,083.32	$ 1,946.79		$ 1,276.88	$ 2,691.74	$ 9,998.73
	Health Provider Education	Printing				$ 162.30	$ 56.26	$ 218.56
		Yakima Health District	$ 1,000.00					$ 1,000.00
	Health Provider Education Total		$ 1,000.00			$ 162.30	$ 56.26	$ 1,218.56
	Program Support	03 FORD F350				$ 267.96		$ 267.96
		10 FORD ESCAPE 4X4				$ 80.60		$ 80.60
		Espinoza, Karri	$ 310.59	$ 1,255.81	$ 333.67	$ 277.52		$ 2,177.59
		Freund, Lisa				$ 44.37		$ 44.37
		Lamar Companies				$ 1,000.00	$ 3,000.00	$ 4,000.00
		Lower Yakima Valley Ground				$ 288.89		$ 288.89
		Office Depot Inc.				$ 37.77		$ 37.77
		Office Max	$ 90.90					$ 90.90
		Oliver-Murdock, Lee Ann		$ 145.04	$ 3,013.21			$ 3,158.25
		Pauls Properties, LLC					$ 2,393.45	$ 2,393.45
		Saunders, Christopher				$ 1,699.16	$ 262.17	$ 1,961.33
		Wurtz, Mary		$ 265.58				$ 265.58

LYVGWMA Expenditures through December, 2017

Task Description	Subtask Description	VENDOR	2013	2014	2015	2016	2017	Grand Total
		Yakima Herald					$ 112.64	$ 112.64
	Program Support Total		$ 401.49	$ 1,666.43	$ 3,346.88	$ 3,696.27	$ 5,768.26	$ 14,879.33
	Public Survey	Brady, Roberta				$ 8.64		$ 8.64
		Ehlis, Carolyn	$ 855.01					$ 855.01
		Heritage University	$ 5,300.00					$ 5,300.00
		Nitrate Program - Postage		$ 139.38				$ 139.38
		Office Max				$ 23.78		$ 23.78
		POP UP BANNER				$ 325.34		$ 325.34
		SURVEYMONKEY				$ 288.13	$ 315.00	$ 603.13
	Public Survey Total		$ 6,155.01	$ 139.38		$ 645.89	$ 315.00	$ 7,255.28
	Travel	03 FORD F350					$ 56.98	$ 56.98
		Freund, Lisa	$ 25.99					$ 25.99
		Saunders, Christopher				$ 413.20	$ 37.67	$ 450.87
		Wurtz, Mary		$ 30.80				$ 30.80
	Travel Total		$ 25.99	$ 30.80		$ 413.20	$ 94.65	$ 564.64
Education and Outreach Total			$ 11,665.81	$ 13,259.24	$ 3,346.88	$ 6,194.54	$ 10,281.89	$ 44,748.36
Facilitation	GWAC Meetings	EnviroIssues Inc.	$ 67,256.26	$ 41,805.15				$ 109,061.41
		U S Bank		$ 117.91				$ 117.91
	GWAC Meetings Total		$ 67,256.26	$ 41,923.06				$ 109,179.32
Facilitation Total			$ 67,256.26	$ 41,923.06				$ 109,179.32
Monitoring and Assessment	Data Analysis	Oliver-Murdock, Lee Ann			$ 3,123.46			$ 3,123.46
	Data Analysis Total				$ 3,123.46			$ 3,123.46
	Data Collection	Sedighi, Ali	$ 68,113.79					$ 68,113.79
		U S Bank			$ 43.26			$ 43.26
		US Dept of the Interior					$ 337,000.00	$ 337,000.00
	Data Collection Total		$ 68,113.79		$ 43.26		$ 337,000.00	$ 405,157.05
	Plan Development	HDR Engineering Inc.	$ 43,080.07	$ 20,001.02				$ 63,081.09
		Pacific Groundwater Group Inc.				$ 37,485.00		$ 37,485.00
	Plan Development Total		$ 43,080.07	$ 20,001.02		$ 37,485.00		$ 100,566.09
	Program Support	10 FORD ESCAPE 4X4	$ 44.08					$ 44.08
		HDR Engineering Inc.	$ 33,626.01	$ 20,450.81				$ 54,076.82
		U S Bank	$ 1,406.60					$ 1,406.60
	Program Support Total		$ 35,076.69	$ 20,450.81				$ 55,527.50
	Report Writing	HDR Engineering Inc.	$ 10,422.87					$ 10,422.87
	Report Writing Total		$ 10,422.87					$ 10,422.87
	Source Mapping	HDR Engineering Inc.		$ 10,047.42				$ 10,047.42
	Source Mapping Total			$ 10,047.42				$ 10,047.42
	Well Assessment	Adelante Media Group		$ 900.00				$ 900.00
		ALBA Enterprises		$ 120.00	$ 280.00			$ 400.00
		Bustos Media			$ 925.00			$ 925.00

LYVGWMA Expenditures through December, 2017

Task Description	Subtask Description	VENDOR	2013	2014	2015	2016	2017	Grand Total
		Espinoza, Karri		$ 1,597.57	$ 982.74	$ 1,819.00	$ 429.36	$ 4,828.67
		GWMA			$ 404.86			$ 404.86
		HACH COMPANY				$ 134.97		$ 134.97
		Huard, Robin			$ 68.99			$ 68.99
		LeBlanc, Patty			$ 66.57	$ 180.56		$ 247.13
		Matson, Heidi			$ 108.99			$ 108.99
		Office Depot Inc.				$ 27.04		$ 27.04
		Office Max				$ 85.51		$ 85.51
		Oliver-Murdock, Lee Ann			$ 2,332.85	$ 5,609.93		$ 7,942.78
		Printing		$ 340.83	$ 2,058.62	$ 791.22		$ 3,190.67
		Radio Yakima			$ 500.00			$ 500.00
		REFUND				$ (78.00)		$ (78.00)
		Rosenkranz, Phillip			$ 34.39			$ 34.39
		Saunders, Christopher			$ 361.77	$ 430.05		$ 791.82
		Strasser, Christine				$ 189.30	$ 310.52	$ 499.82
		Townsquare Media		$ 1,884.00	$ 2,748.60	$ (1,185.00)		$ 3,447.60
		Wurtz, Mary			$ 682.10			$ 682.10
		Yakima Health District	$ 3,215.30	$ 41,184.70	$ 30,500.00	$ 42,000.00		$ 116,900.00
	Well Assessment Total		$ 3,215.30	$ 46,027.10	$ 42,055.48	$ 50,004.58	$ 739.88	$ 142,042.34
Monitoring and Assessment Total			$ 159,908.72	$ 96,526.35	$ 45,222.20	$ 87,489.58	$ 337,739.88	$ 726,886.73
Nutrient Loading/Nitrogen	Plan Development	Wash St Dept of Agriculture			$ 13,020.35	$ 31,979.65		$ 45,000.00
	Plan Development Total				$ 13,020.35	$ 31,979.65		$ 45,000.00
Nutrient Loading/Nitrogen Total					$ 13,020.35	$ 31,979.65		$ 45,000.00
Regulatory Review	Data Collection	HDR Engineering Inc.	$ 8,783.89	$ 2,091.65				$ 10,875.54
	Data Collection Total		$ 8,783.89	$ 2,091.65				$ 10,875.54
Regulatory Review Total			$ 8,783.89	$ 2,091.65				$ 10,875.54
Grand Total			$ 342,303.35	$ 339,969.04	$ 293,740.90	$ 254,277.72	$ 439,760.52	$ 1,670,051.53

Site 1
Preliminary Drill Site and Field Located Site

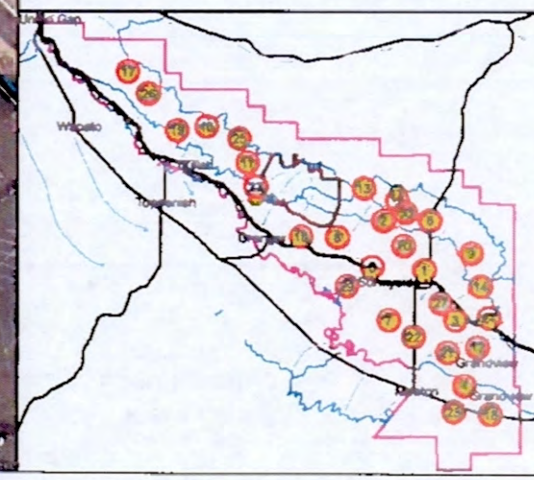
PGG

Field Located MW Site Stake

Preliminary Drill Site

Canals & Lateral Lines

Parcel Data from Country. Does not necessarily reflect precise parcel boundary.
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.

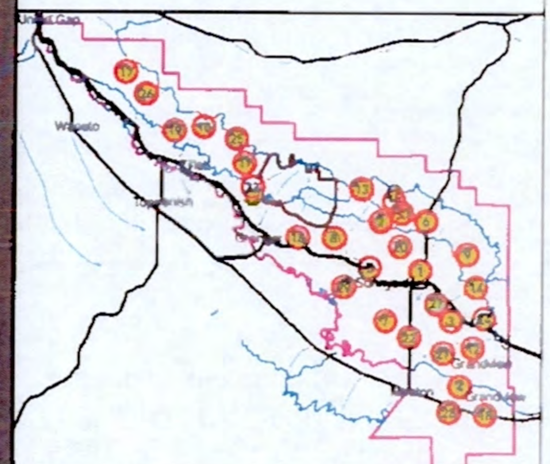


Site 2
Preliminary Drill Site
and Field Located Site

PgG

- Field Located MW Site Stake
- Preliminary Drill Site
- Canals & Lateral Lines

Parcel Data from Country. Does not necessarly reflect precise parcel boundary.
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.



Site 3
Preliminary Drill Site
and Field Located Site

PGG

Field Located MW Site Stake

Joint Drains (JD_Lines)

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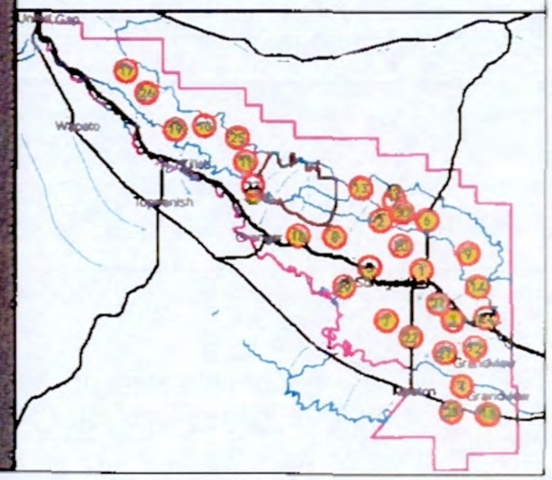
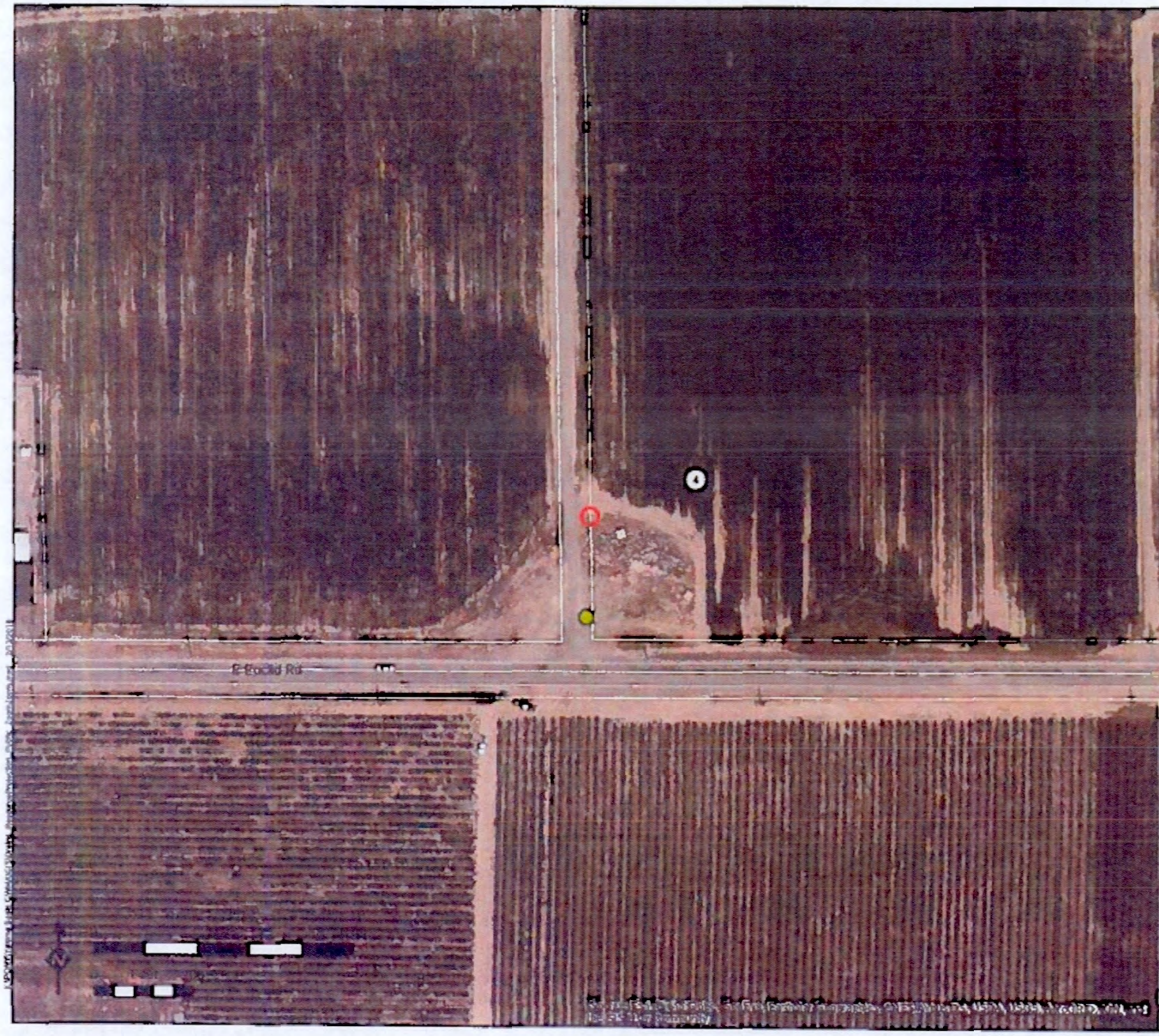
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.



Site 4
Preliminary Drill Site
and Field Located Site

PGG

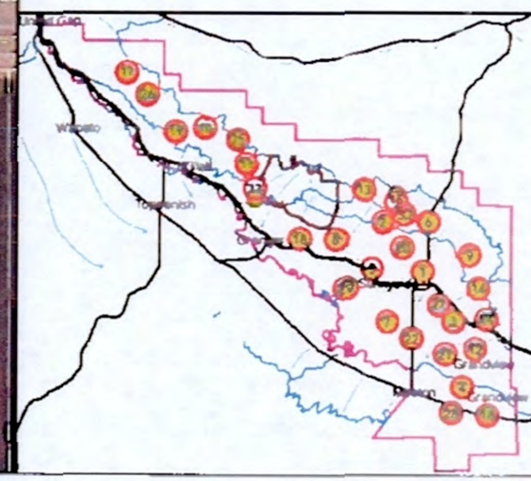


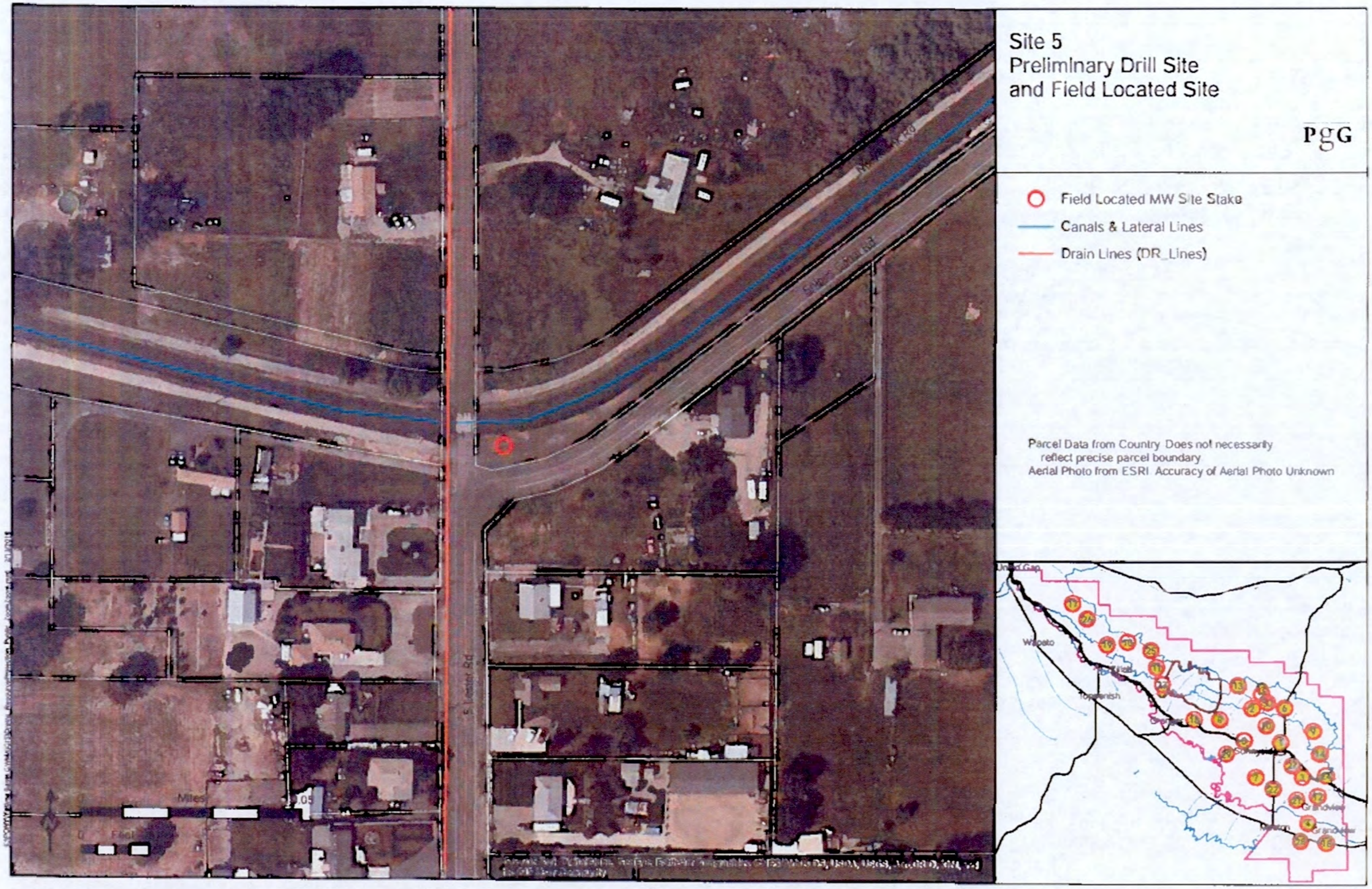
Field Located MW Site Stake

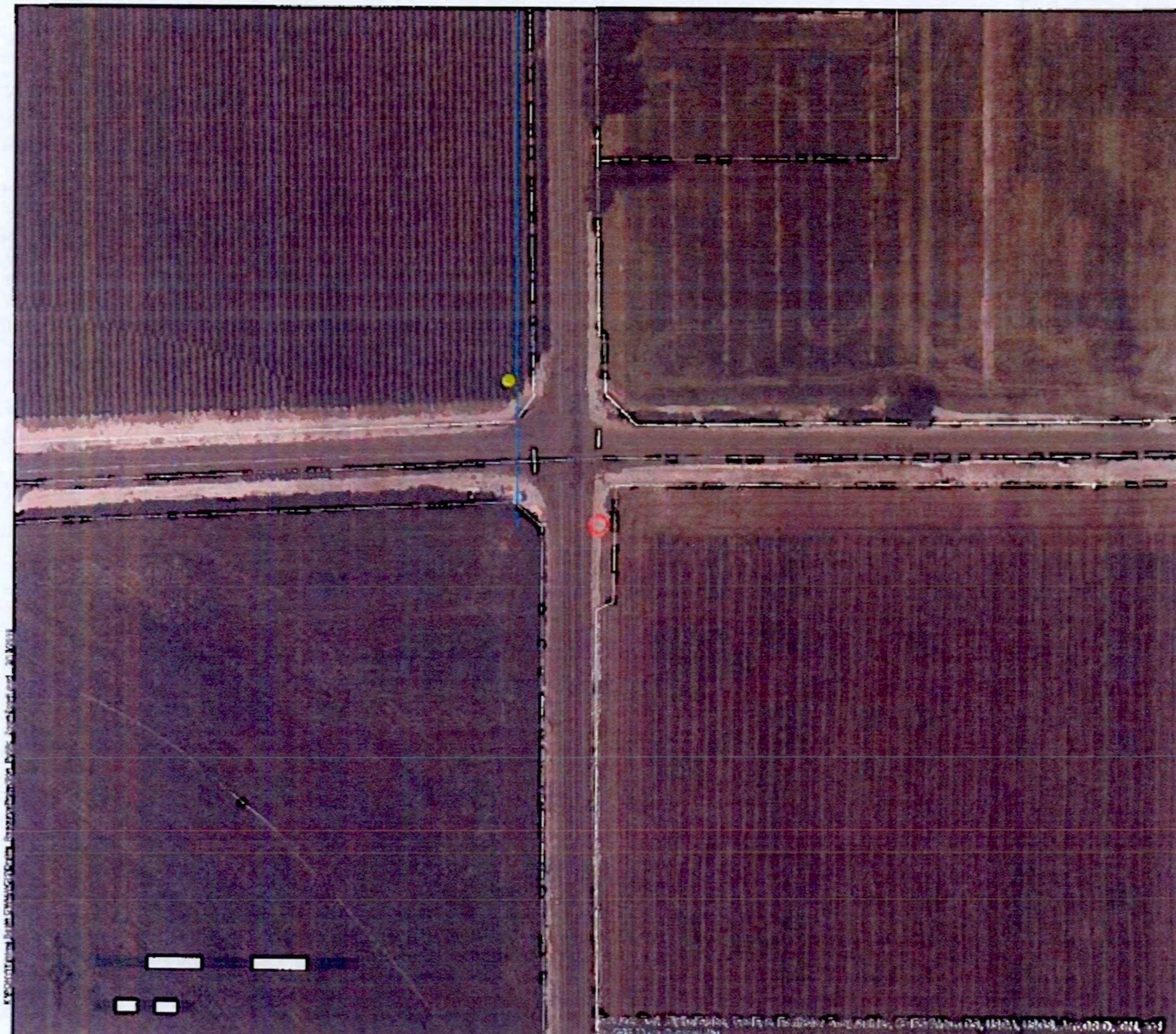
General Well Location

Preliminary Drill Site

Parcel Data from Country. Does not necessarily
reflect precise parcel boundary
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.




Site 5
Preliminary Drill Site
and Field Located Site
PGG
Field Located MW Site Stake
Canals & Lateral Lines
Drain Lines (DR_Lines)
Parcel Data from Country Does not necessarily
reflect precise parcel boundary
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown
S Lester Rd
Miles
Feet
Wapato
Toppenish
Grandview



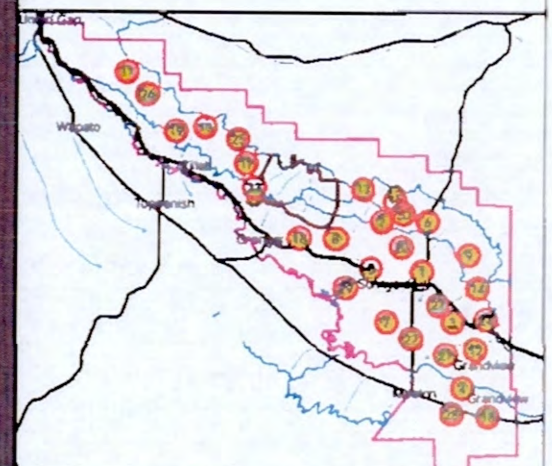
Site 6
Preliminary Drill Site
and Field Located Site

PgG

Field Located MW Site Stake

Preliminary Drill Site

Parcel Data from Country. Does not necessarily
reflect precise parcel boundary
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.



Site 7
Preliminary Drill Site
and Field Located Site

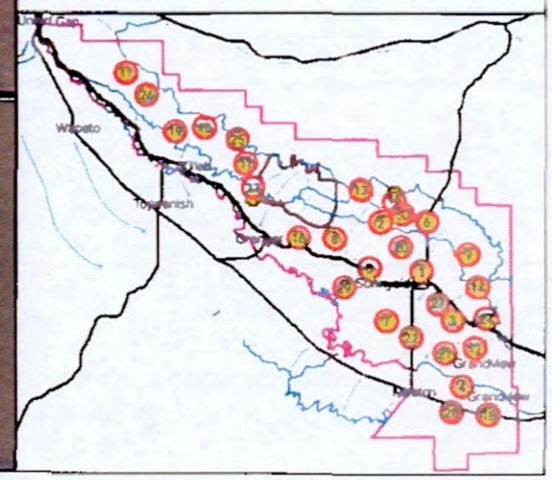
PGG

Field Located MW Site Stake

Preliminary Drill Site

Canals & Lateral Lines

Parcel Data from Country. Does not necessarily
reflect precise parcel boundary.
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.

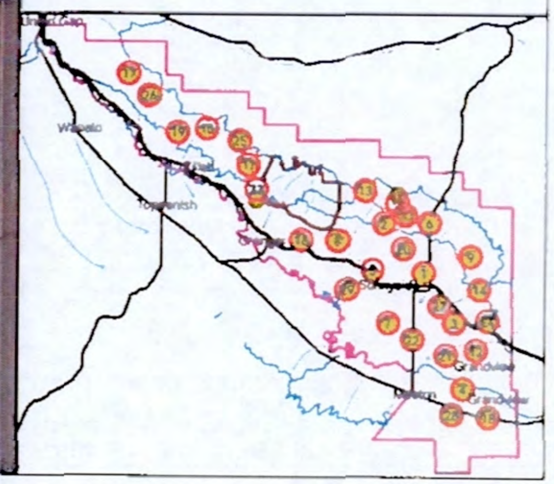


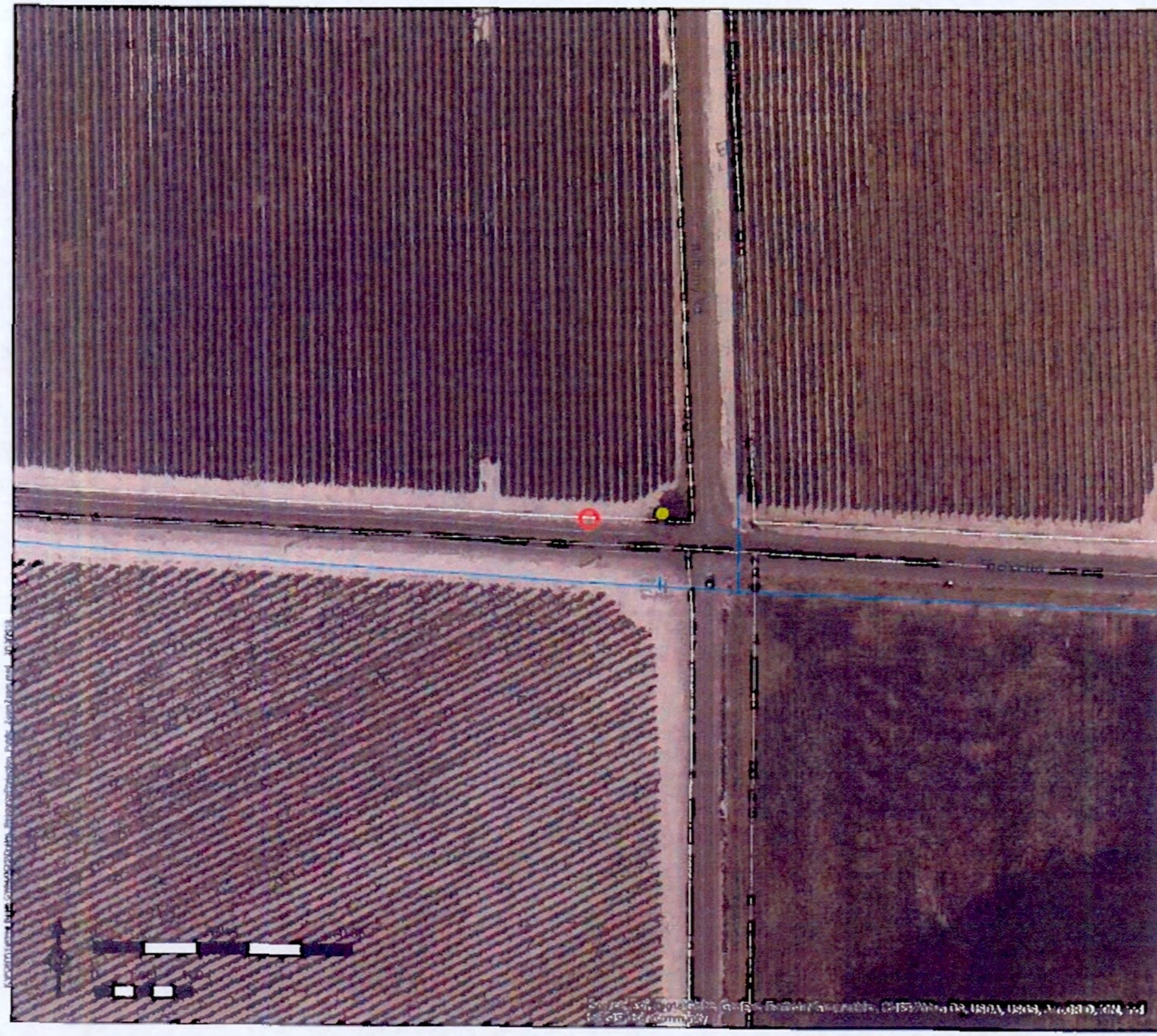
Site 8
Preliminary Drill Site
and Field Located Site

PGG

Field Located MW Site Stake
Preliminary Drill Site
Canals & Lateral Lines

Parcel Data from Country. Does not necessarily
reflect precise parcel boundary.
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.



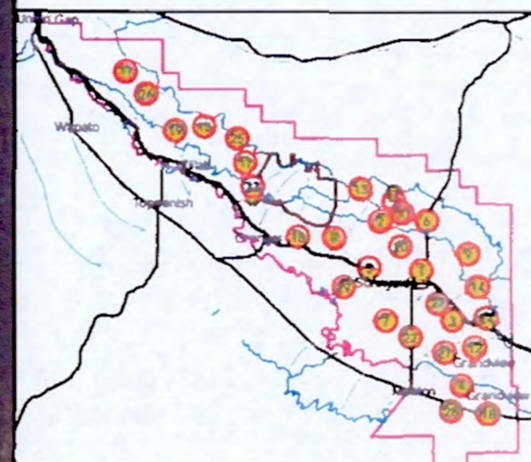


Site 9
Preliminary Drill Site and Field Located Site

PgG

- Field Located MW Site Stake
- Preliminary Drill Site

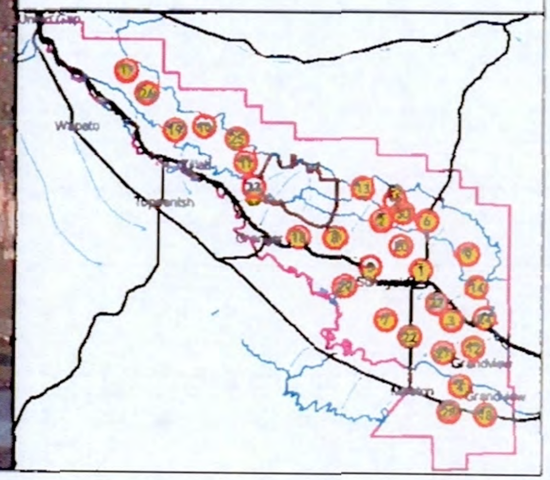
Parcel Data from Country Does not necessarily reflect precise parcel boundary
Aerial Photo from ESRI Accuracy of Aerial Photo Unknown



Site 10
Preliminary Drill Site and Field Located Site

Field Located MW Site Stake

Parcel Data from Country. Does not necessarily reflect precise parcel boundary.
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.

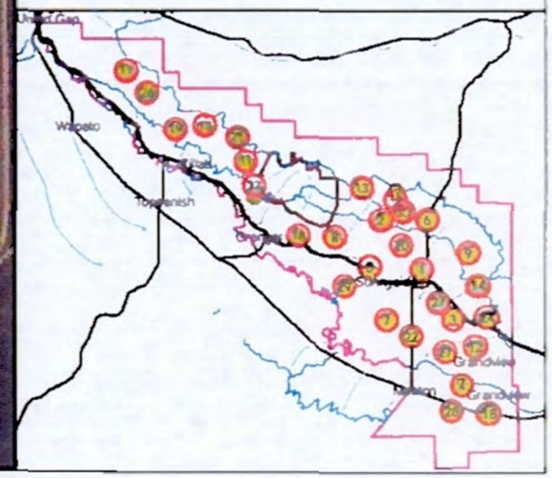


Site 11
Preliminary Drill Site
and Field Located Site

PgG

Field Located MW Site Stake
Preliminary Drill Site

Parcel Data from Country. Does not necessarily reflect precise parcel boundary.
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.



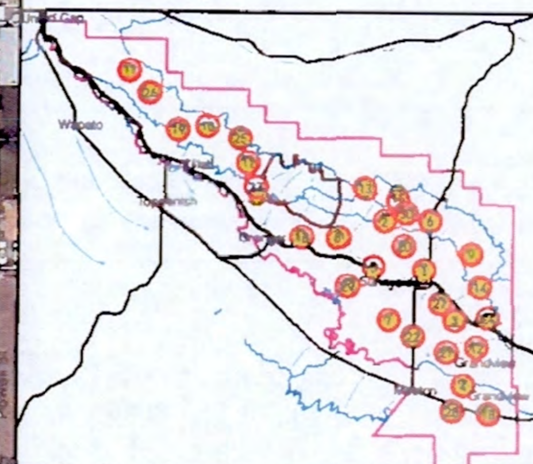
Site 12
Preliminary Drill Site
and Field Located Site

PgG

Field Located MW Site Stake

Preliminary Drill Site

Parcel Data from Country Does not necessarily
reflect precise parcel boundary
Aerial Photo from ESRI Accuracy of Aerial Photo Unknown

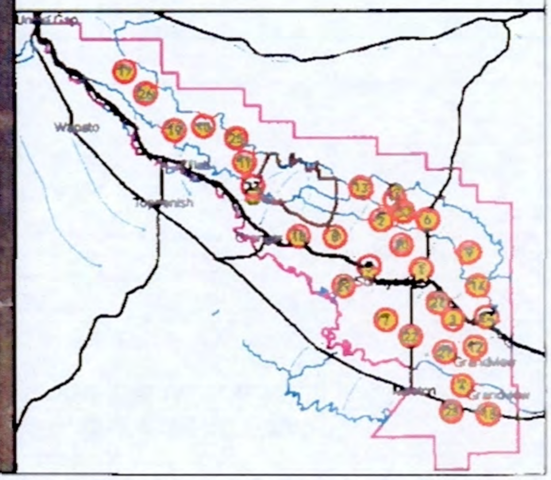


Site 13
Preliminary Drill Site
and Field Located Site

PgG

Field Located MW Site Stake
Preliminary Drill Site

Parcel Data from Country. Does not necessarily reflect precise parcel boundary
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.



Site 14
Preliminary Drill Site
and Field Located Site

PgG

Field Located MW Site Stake

Preliminary Drill Site

Parcel Data from Country. Does not necessarily reflect precise parcel boundary.
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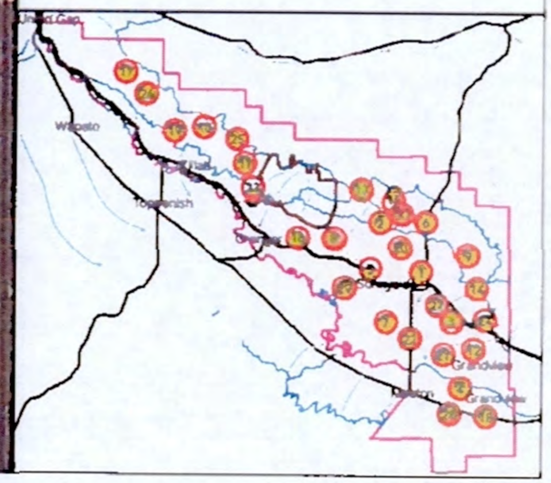

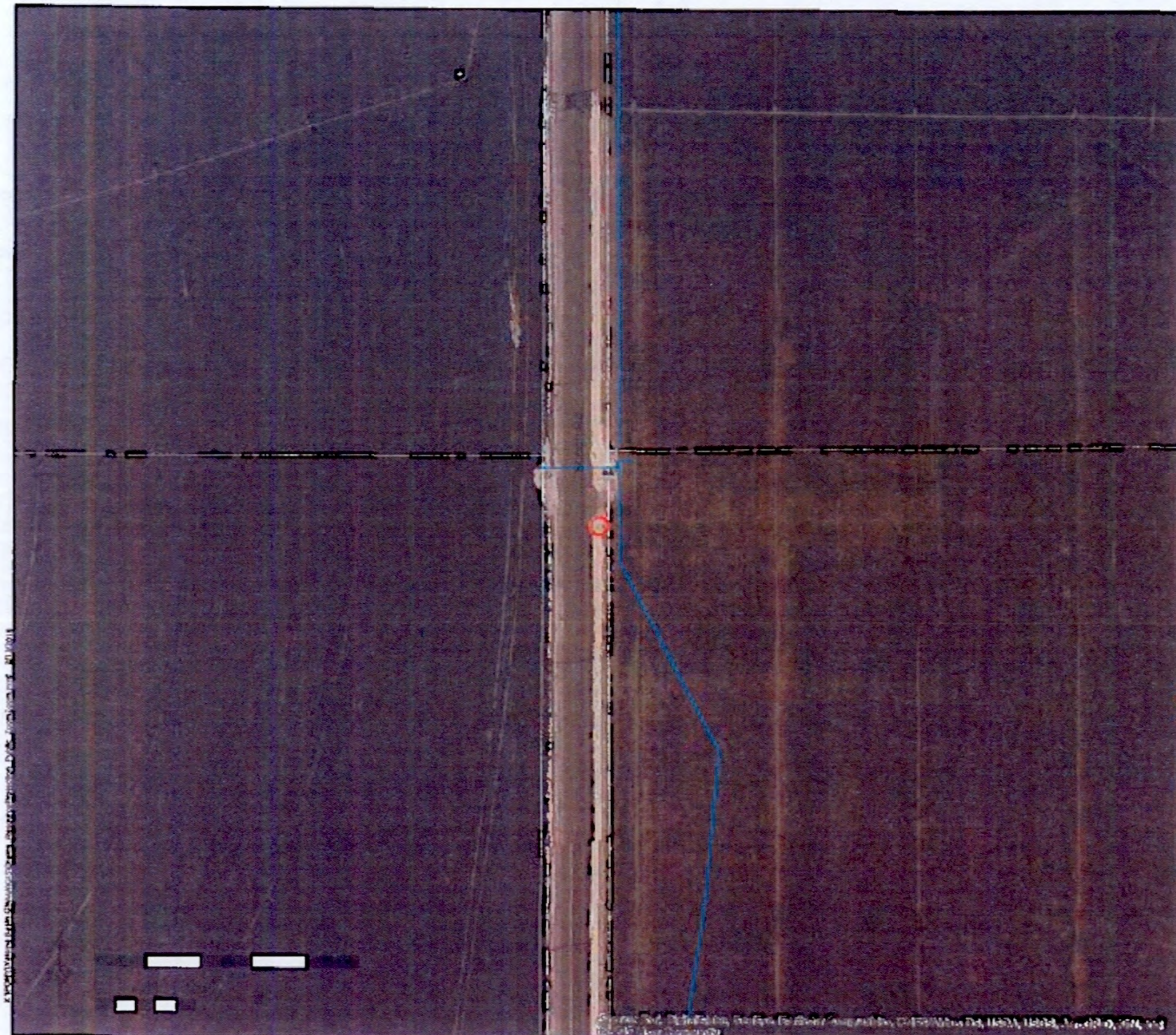

Site 15
Preliminary Drill Site and Field Located Site

PgG

○ Field Located MW Site Stake

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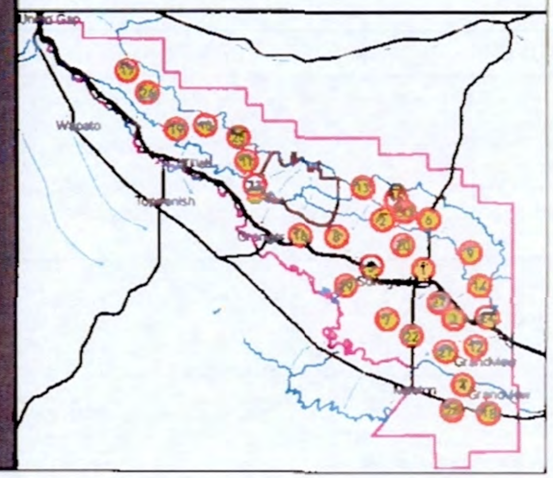

Site 16
Preliminary Drill Site and Field Located Site

PgG

- Field Located MW Site Stake
- Preliminary Drill Site
- Canals & Lateral Lines

Parcel Data from Country. Does not necessarily reflect precise parcel boundary.
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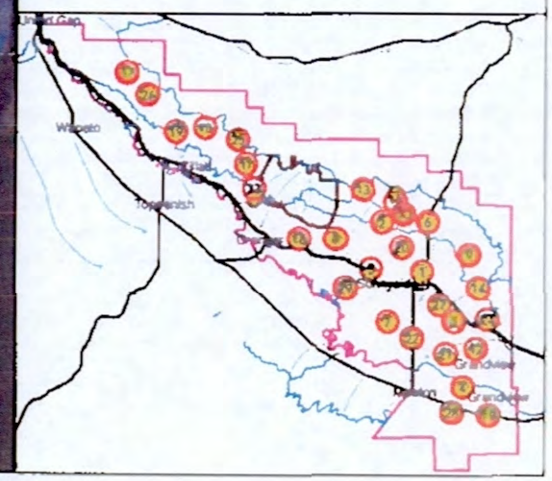

Site 17
Preliminary Drill Site
and Field Located Site

PgG

Field Located MW Site Stake

Preliminary Drill Site

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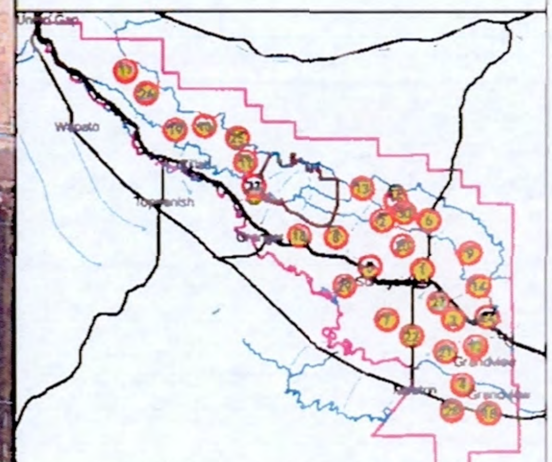

Site 18
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and Field Located Site

Field Located MW Site Stake

Preliminary Drill Site

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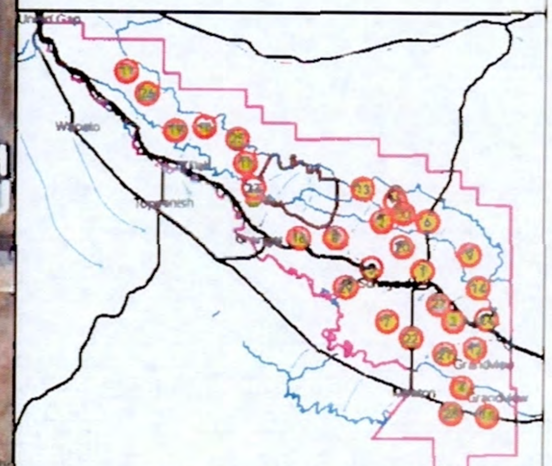

Site 19
Preliminary Drill Site
and Field Located Site

PgG

Field Located MW Site Stake

Preliminary Drill Site

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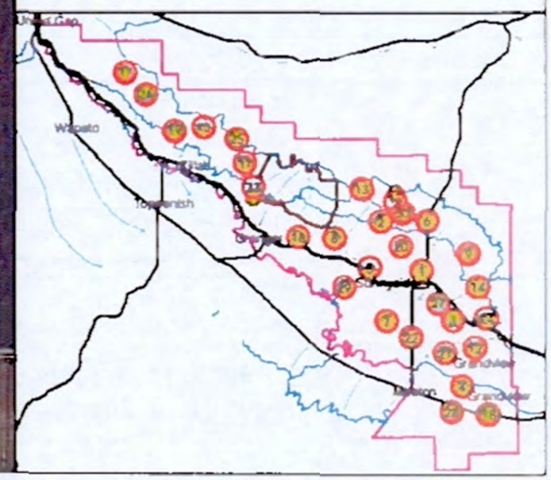

Site 20
Preliminary Drill Site
and Field Located Site

PgG

Field Located MW Site Stake
General Well Location
Preliminary Drill Site
Canals & Lateral Lines

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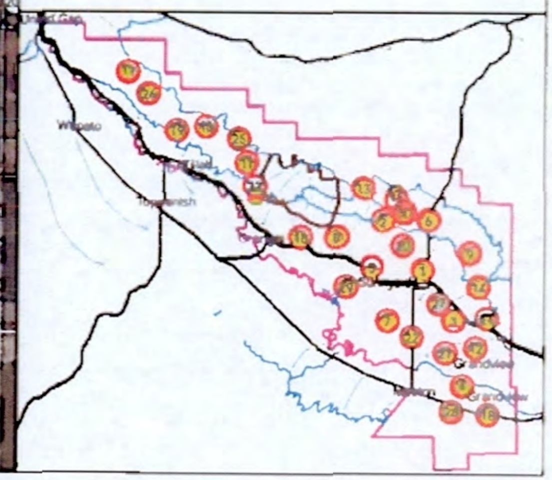
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.



Site 21
Preliminary Drill Site and Field Located Site

PgG

- Field Located MW Site Stake
- Preliminary Drill Site
- Canals & Lateral Lines
- Drain Lines (DR_Lines)

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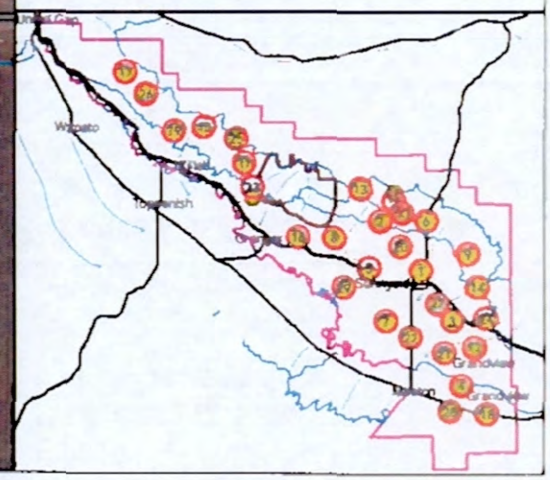

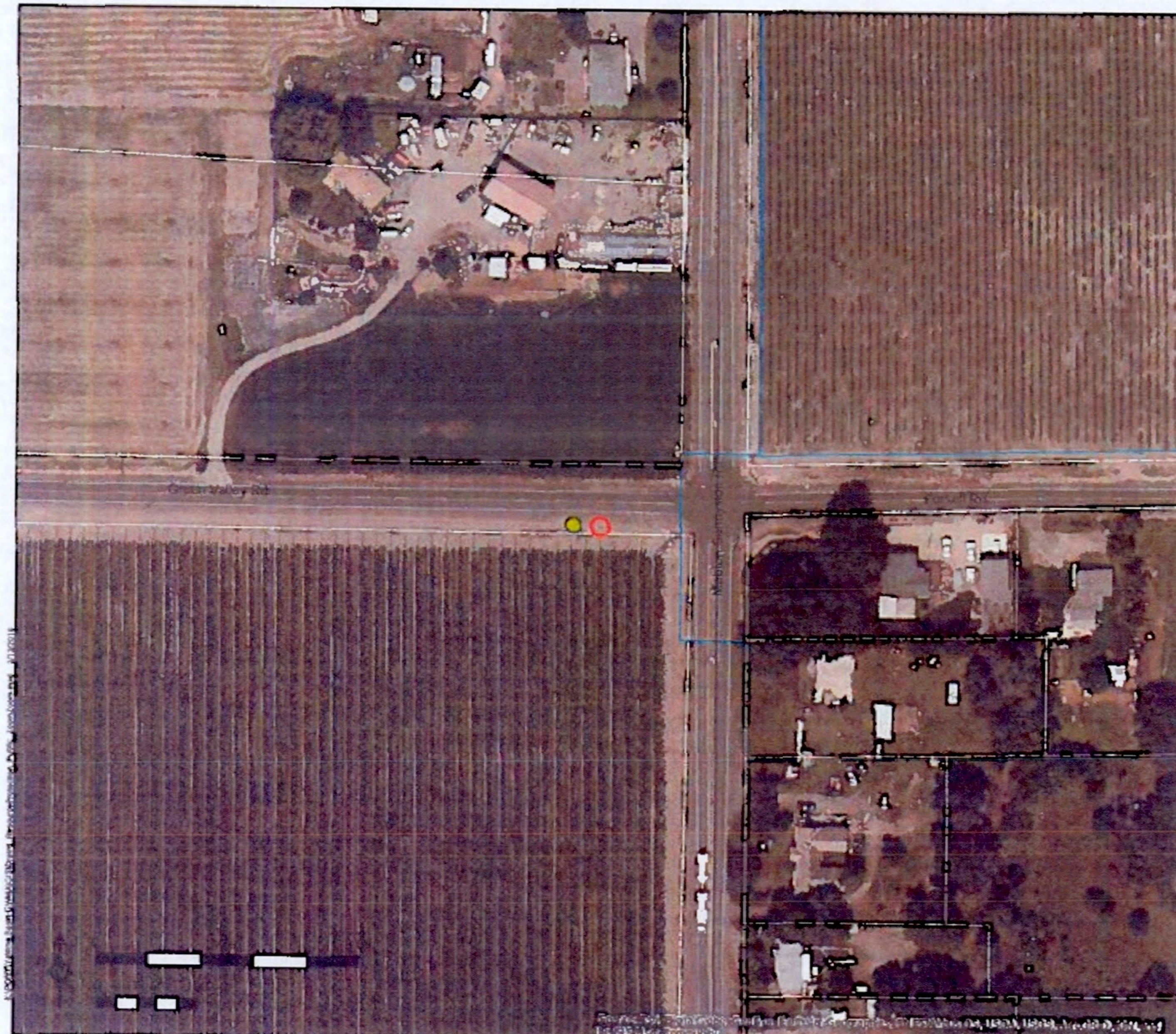

Site 22
Preliminary Drill Site and Field Located Site

PgG

- Field Located MW Site Stake
- Preliminary Drill Site
- Canals & Lateral Lines

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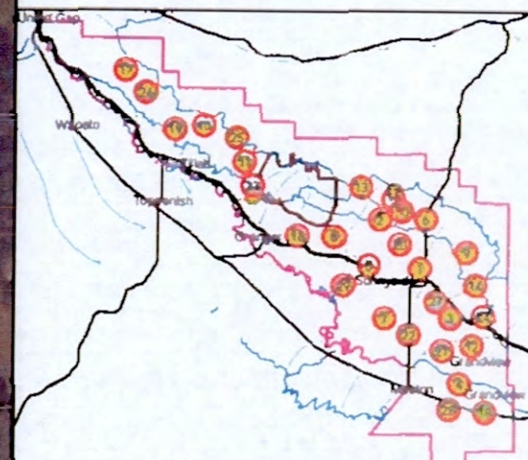
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.



Site 23
Preliminary Drill Site
and Field Located Site

PGG

Field Located MW Site Stake

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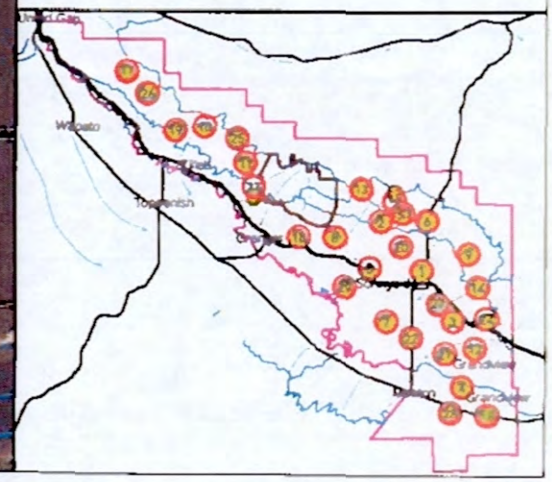
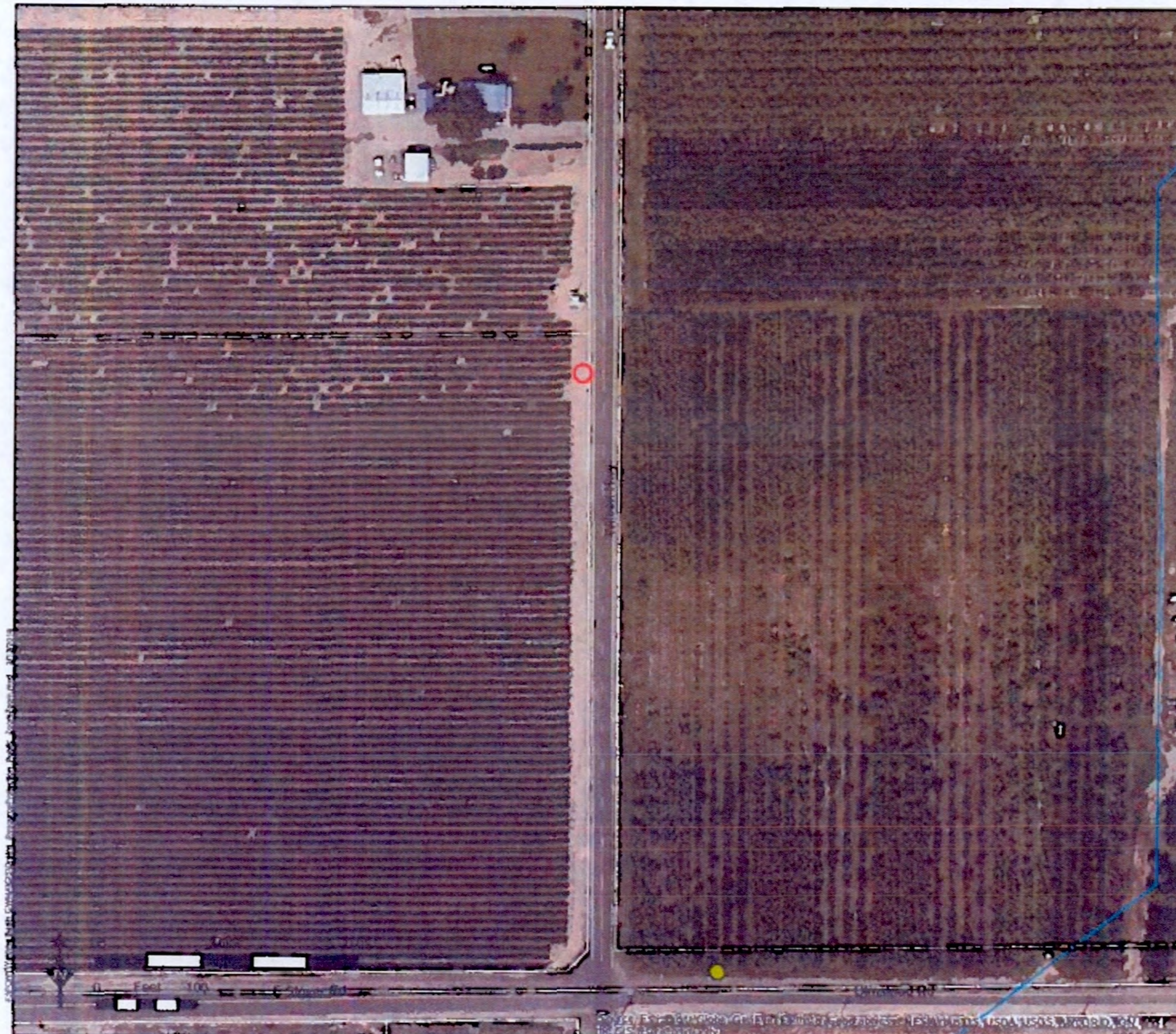




Site 24
Preliminary Drill Site
and Field Located Site

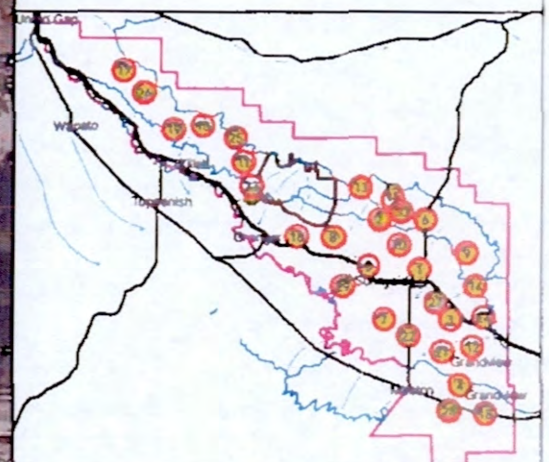
PgG

Field Located MW Site Stake

Preliminary Drill Site

Canals & Lateral Lines

Parcel Data from Country. Does not necessarly
reflect precise parcel boundary.
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.



Site 25
Preliminary Drill Site
and Field Located Site

PgG

Field Located MW Site Stake
General Well Location
Preliminary Drill Site

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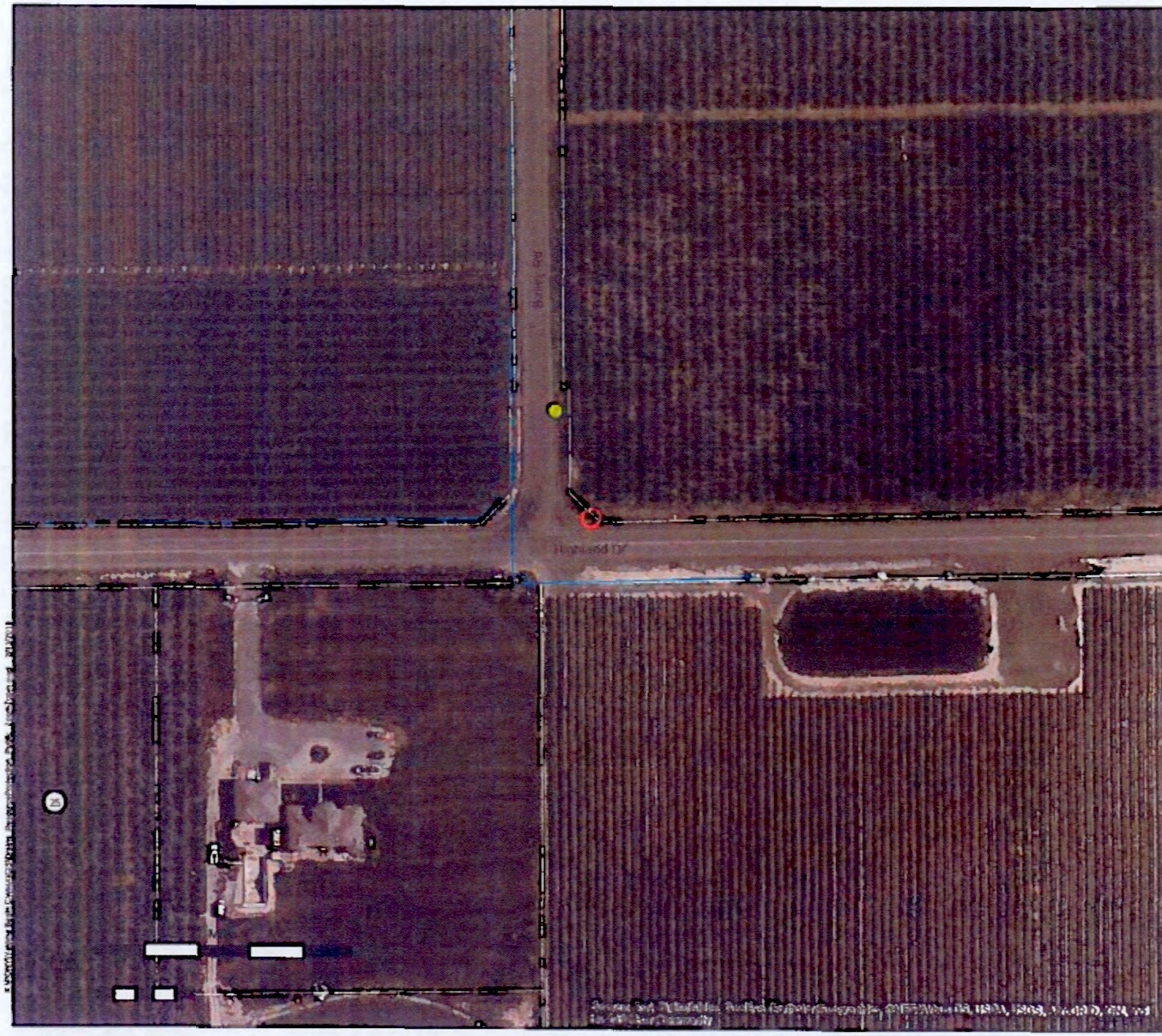

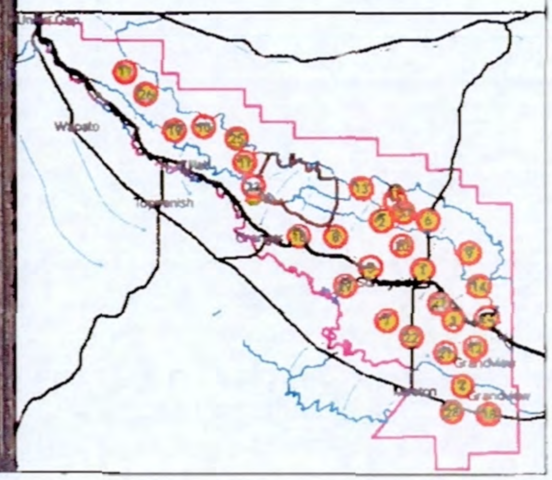

Site 26
Preliminary Drill Site and Field Located Site

PgG

Field Located MW Site Stake

Preliminary Drill Site

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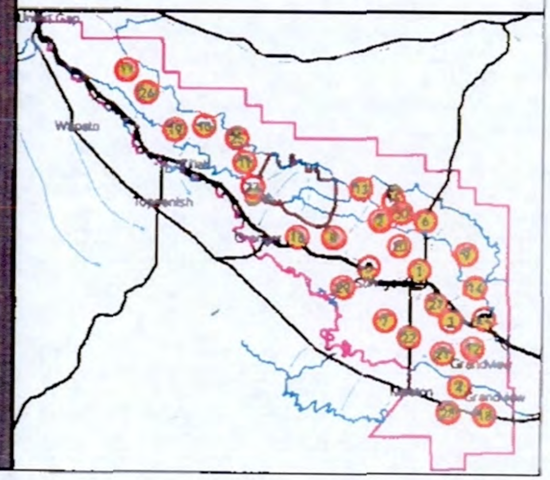

Site 27
Preliminary Drill Site
and Field Located Site

PgG

- Field Located MW Site Stake
- Preliminary Drill Site
- Canals & Lateral Lines

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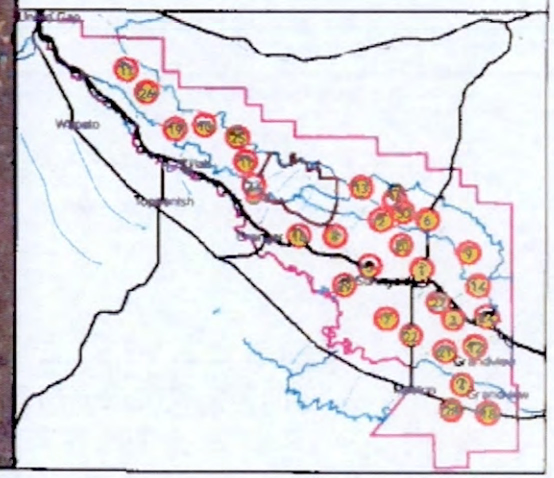
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.



Site 28
Preliminary Drill Site
and Field Located Site

PgG

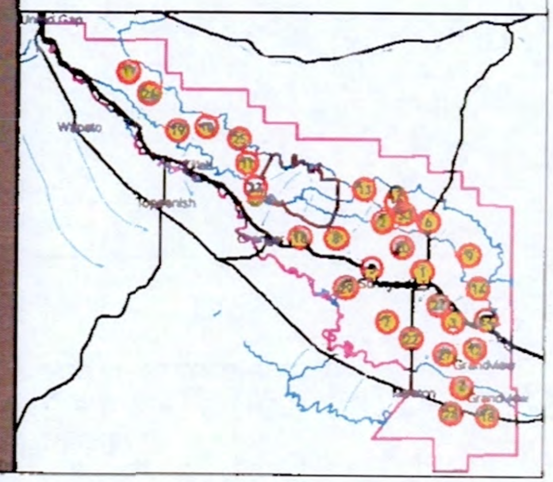
Field Located MW Site Stake

General Well Location

Preliminary Drill Site

Canals & Lateral Lines

Parcel Data from Country. Does not necessarily reflect precise parcel boundary.
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown



Site 29
Preliminary Drill Site
and Field Located Site

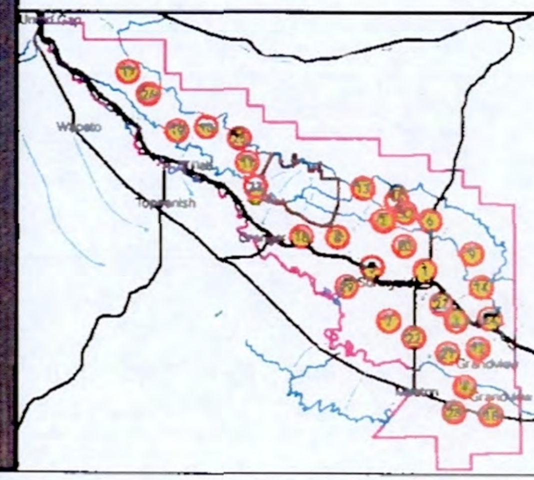
PGG

Field Located MW Site Stake

Preliminary Drill Site

Canals & Lateral Lines

Parcel Data from Country. Does not necessarily reflect precise parcel boundary.
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown.

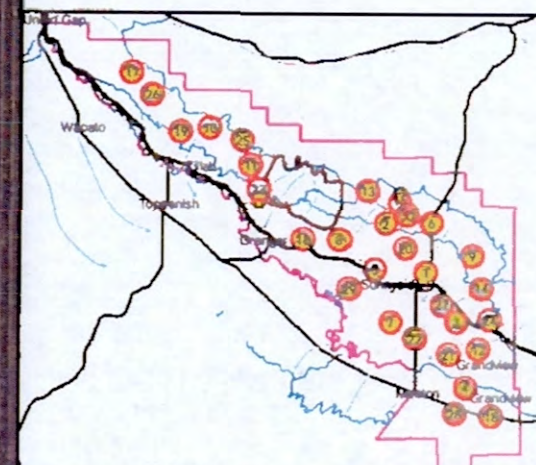


Site 30
Preliminary Drill Site and Field Located Site

PgG

- Field Located MW Site Stake
- Preliminary Drill Site
- Canals & Lateral Lines

Parcel Data from Country. Does not necessarily reflect precise parcel boundary.
Aerial Photo from ESRI. Accuracy of Aerial Photo Unknown



Attachment C

- Index for 3.1.2018 Program Release to GWAC
- LYVGWMA Program JHD, 02-26-18

INDEX FOR PROGRAM RELEASE TO THE GWAC

MARCH 1, 2018

Table of Contents

Contents

Characterization of the Area

The following discussion describes the area as it currently exists. The information relates in some instances to Yakima County generally and in others to the LYVGWMA in particular. Caution should be exercised to notice the particular area under discussion as various information is presented. Investigations and analysis pursued during the process of the LYVGWMA are presented in a later section of this Program.

Boundary of the Groundwater Management Area

The Lower Yakima Valley Groundwater Management Area (or LYV GWMA) is located within the Lower Yakima Valley, south of Union Gap, northeast of the Yakima River and west of the Yakima-Benton County line. It lies in the southeastern portion of the Lower Yakima Valley. Its total area is 175,161 acres. The western boundary abuts the Toppenish Basin. The southern boundary is bordered by the Horse Heaven Hills. The northeastern boundary generally follows the northern flank of the Cold Creek Syncline.

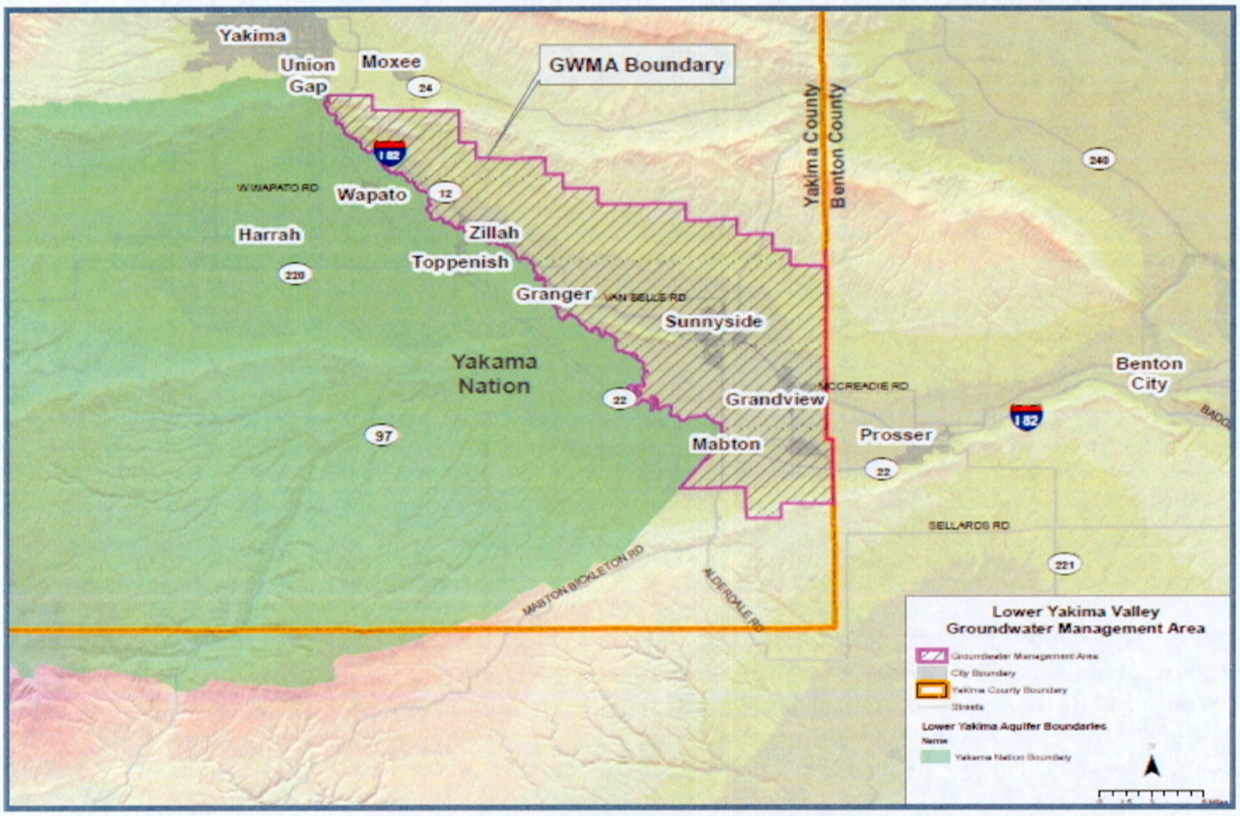


FIGURE 1 - GWMA BOUNDARY

The Groundwater Management Area addressed in this program is essentially the same as the Western and Eastern Study Areas as identified within the 2010 *Preliminary Assessment.* [1] It includes the non-reservation lands along the northeastern side of the Yakima River south of Union Gap and the southeast Yakima Valley downstream of the confluence of the Satus and Yakima Rivers. Approximately 60 percent of the valley population resides in this area. The Groundwater Management Area includes the incorporated communities of Zillah, Sunnyside, Granger, Grandview, and Mabton and the rural settlements of Buena and Outlook.

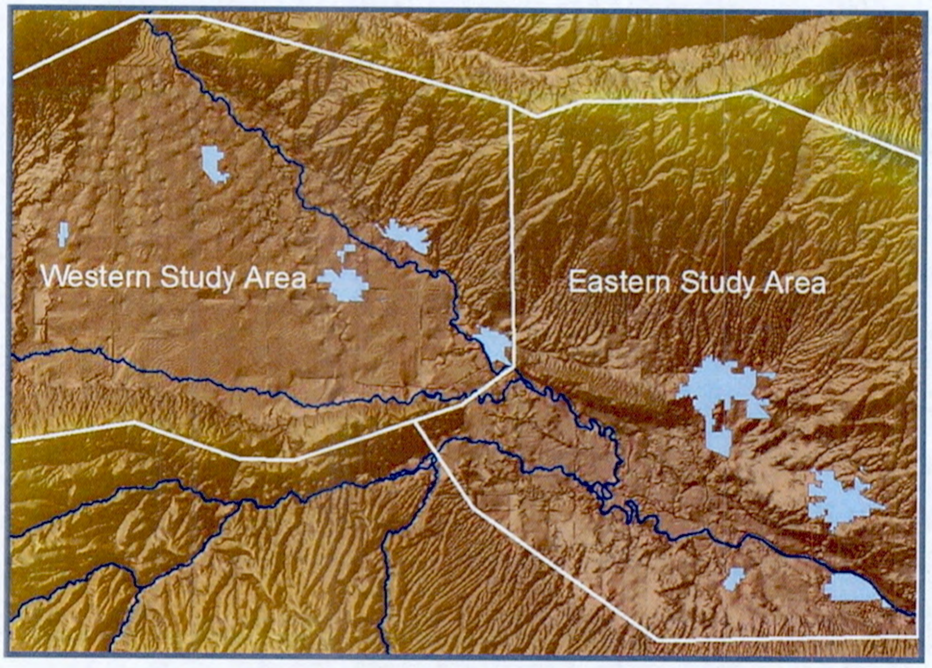


FIGURE 2 - AREAS OF PRELIMINARY ASSESSMENT

The *Preliminary Assessment* had subdivided the study area in order to reflect geographic, geological, and geopolitical constraints and corresponded to divisions reflected in the historical water quality data set.[2]

[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. (See Appendix A. for Administrative Background.)

[2] These two subareas roughly mirror the areas designated as upper and lower study areas in the 2002 Valley Institute for Research and Education groundwater study, and correspond to the Toppenish and Benton basins referenced in other studies. Both areas cover approximately 368,600 acres within Yakima County.

The Yakama Nation[3], while maintaining a presence on the GWAC advisory board, chose to address nitrate levels independently, under the oversight of the Environmental Protection Agency.

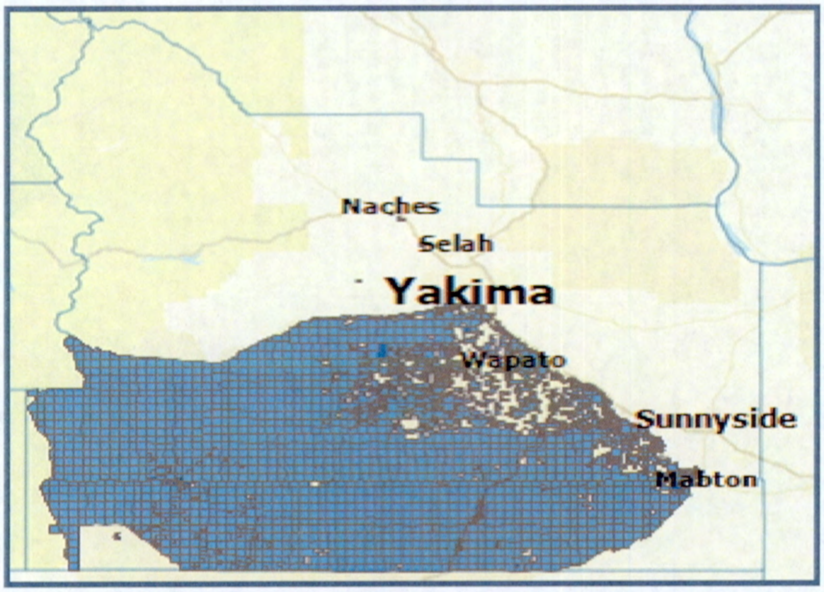


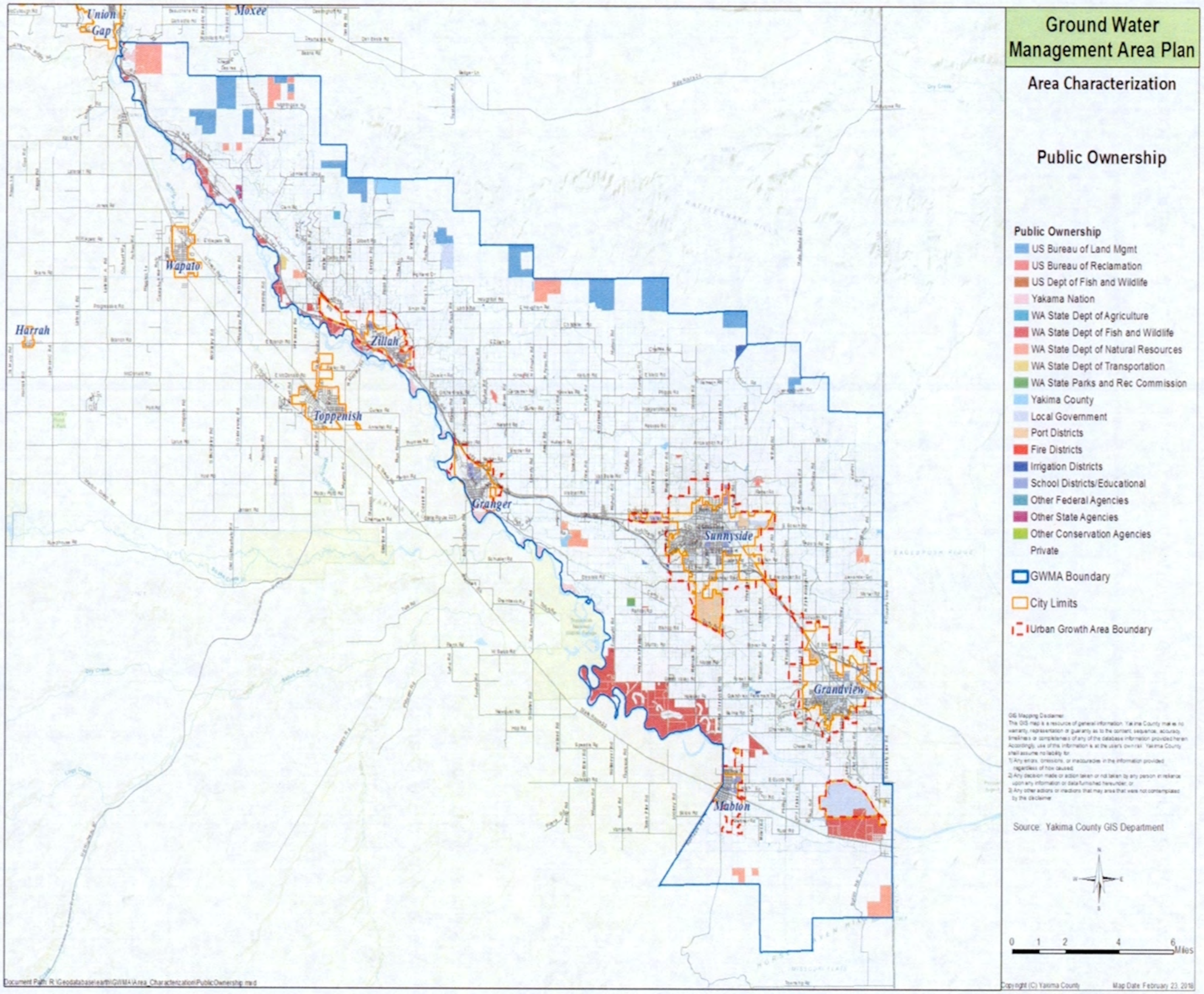
FIGURE 3 - YAKAMA INDIAN RESERVATION

Jurisdictional Boundaries: Federal, State, Local, Tribal

All the land within the GWMA is within the jurisdiction of Yakima County, with the exception of land within the municipalities of Zillah, Granger, Sunnyside, Grandview, and Mabton. While properties owned by the United States exist within the GWMA, they do not present relevant issue areas that relate to the nitrate problem addressed by this Program.

[3] Confederated Tribes and Bands of the Yakama Nation (Yakama Nation). The Yakama Indian Reservation, lies along the southwest side of the Yakima River and extends beyond Yakima County boundaries into the northern edge of Klickitat County and Southeastern corner of Lewis County. It covers an area of approximately 1.3 million acres. The Yakama Nation has nearly 9,000 enrolled members from 14 bands and tribes.

Figure 4 - Jurisdictional Boundaries and Public Ownership



General Land Description

The Yakima River Basin

The Yakima River Basin is located in south-central Washington and includes three Washington State Water Resource Inventory Areas (WRIA—numbers 37, 38, and 39), part of the Yakama Nation lands, and three eco-regions (Cascades, Eastern Cascades, and Columbia Basin), and touches parts of four counties: Klickitat, Kittitas, Yakima, and Benton (USGS 2006). 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 one 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. All are clearly defined by the geologic structure in the Yakima River Basin. The LYVGWMA includes only parts of the Toppenish and Benton Sedimentary Basins.

The Toppenish Sedimentary Basin is fully contained within Yakima County. It is bordered on the north by the Ahtanum Ridge, on the south by the Toppenish Ridge, and bisected by the Wapato Syncline. The eastern boundary of this basin abuts the Benton Sedimentary Basin. Only the southeastern corner of the Toppenish Sedimentary Basin, northeast of the Yakima River, is included in the LYVGWMA boundaries.

The Benton Sedimentary Basin is bordered on the south by the Horse Heaven Hills structure. 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. The basin is dissected with numerous faults and folds surrounding the Rattlesnake Hills structure in its eastern part. The western part is dissected by the Wapato Syncline and several unnamed folds that lie within the broad flat plain that encompasses the Yakima River floodplain. Only the western portion of the Benton Sedimentary Basin, approximately a third, is in the LYVGWMA boundaries.

Geology

The Columbia Plateau has been informally divided into three physiographic subprovinces (Meyers and Price, 1979; USGS. 2009a). The western margin of the Columbia Plateau contains the Yakima Fold Belt subprovince.

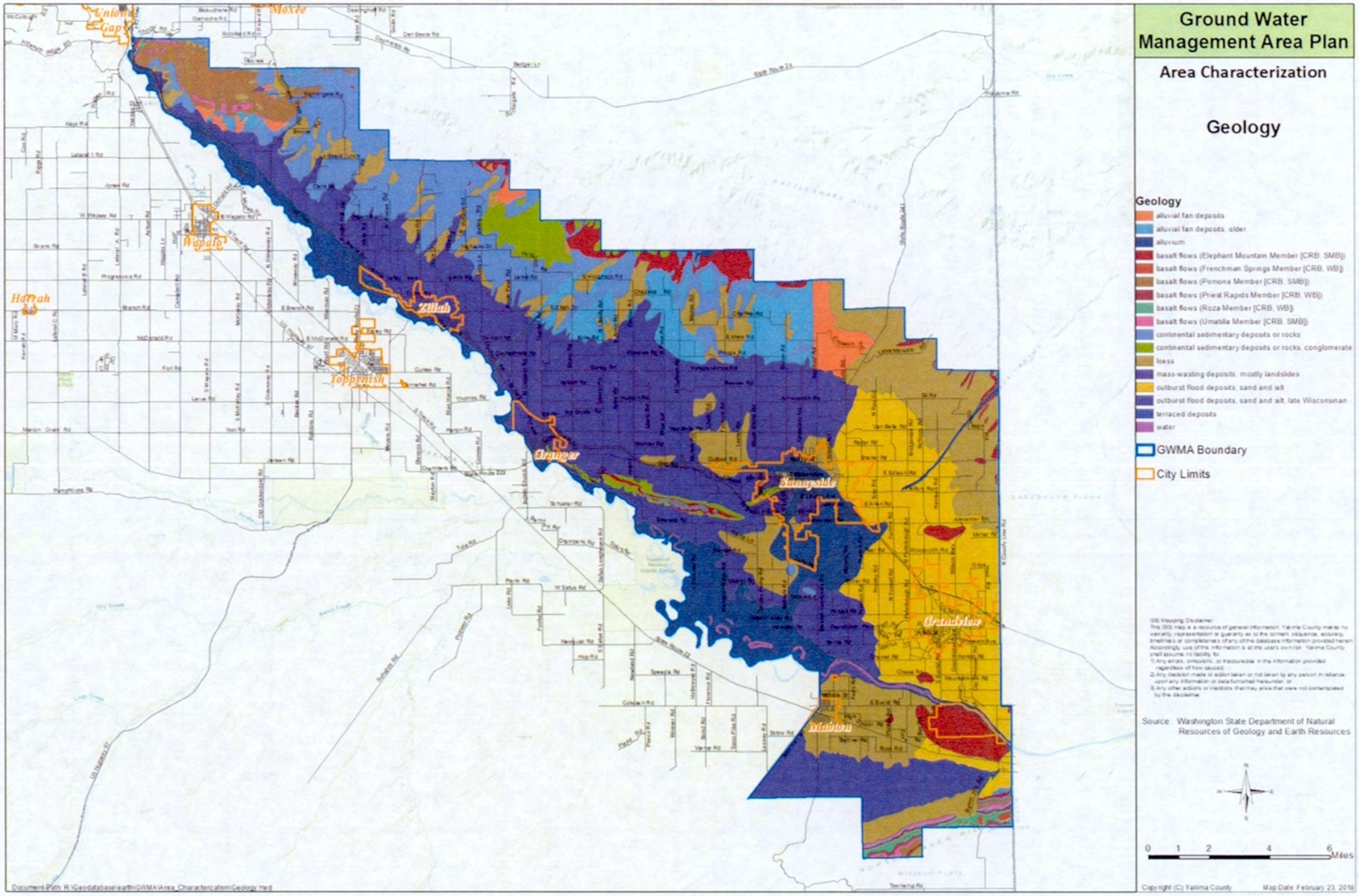
The Yakima Fold Belt

The LYVGWMA 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 Cenezoic 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 folding that created the anticlines and synclines within the Yakima region are the consequence of tectonic compression (McCaffrey et al 2016), initially of the sedimentary rocks now underlying the Columbia River Basalt Group, from south of the Fold Belt region (the anticline's slopes are steeper on the north side) which probably began during the latter part of the Cenezoic 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 so 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 the same anticline. (Alt/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 the parts of the plain that 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).

FIGURE 5 – GEOLOGY



Basalt

The Yakima Basalt formation is several thousand feet thick, interbedded with a few minor sedimentary strata. It overlays the basal rock unit, or bedrock, of the Yakima region. It is a portion of the Columbia Basin Basalt Group. The CRBG covers an area of more than 59,000 square miles (Tolan et al. 1989) and spanning parts of Washington, Oregon, and Idaho. It is subdivided into three primary units, or formations, designated the Saddle Mountains Basalt, the Wanapum Basalt, and the Grande Ronde Basalt (GSI 2009a, 2011d). The Saddle Mountains Basalt is often exposed at the surface. Its thicknesses range from 180 to 800 feet and averages 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 Yakima Basalt formation includes these three primary units and their subunits within the Yakima Basin.

The uppermost basalt, 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 Horse Heaven Hills. It is made up of the Umatilla Member flows, the Wilbur Creek Member flows, the Asotin Member flows (13 million years ago), the Weissenfels Ridge Member flows, the Esquatzel Member flows, the Elephant Mountain Member flows (10.5 million years ago), the Bujford Member flows, the Ice Harbor Member flows (8.5 million years ago) and the Lower Monumental Member flows (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. (EPA 2013).

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; USGS 2009a). The basaltic lava flows were extruded from fissures located in the eastern part of the Columbia Plateau (USGS 1962), most likely in the vicinity of Hells Canyon, Oregon. The extrusions of basaltic lava 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 volcanic flow is called the Columbia Basin Basalt Group, of which the Yakima Basalt is a portion. The Yakima Basalt is that thick sequence of basaltic lava flows 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 ft. The total basalt thickness in the central part of the plateau is estimated to be greater than 10,000 ft (USGS 1990) and the maximum thickness in the Yakima River basin is more than 8,000 ft. (USGS 1962).

Extrusions and flows of volcanic material now within the Yakima Basalt 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). Natural gas was extracted from beneath the LYVGWMA between 1929 and 1941. (Alt/Hindman 2007).

The Ellensburg Formation

The Yakima Basalt is overlain in many places by the Ellensburg Formation.

At the west side of the basaltic lava plain, approximately where the present Cascade Mountains now stand, there was a region of more intense volcanic activity 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 volcanic debris creates by this volcanic activity in those ancestral Cascade Mountains was the source of the sedimentary materials which were subsequently deposited upon the lava plain, either transported by eastward flowing streams, in lakes, or aeolian processes moving ash and pumice, that together constitute the Ellensburg Formation. (USGS 1962) The majority of the volcanic materials created by the volcanic activity was deposited upon the lava plain after these flows ceased and the Cascades continued to rise. (USGS 1962; USGS 1999a).

The Ellensburg Formation in consists of 85 to 95 percent semiconsolidated clay, silt, and sand and only 5 to 15 percent gravel and conglomerate. It often appears as sedimentary interbeds found between the various Yakima Basalt 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 shaly parting also are found. Some sand and gravel strata are crossbedded. The thickness of the individual beds ranges 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 1000 ft of course-grained volcanclastic 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).

<u>Lower Yakima Valley Fill</u>

A variety of fine and coarse-grained sediments including and overlying the Ellensburg Formation and the underlying major basalt flows also exists within the Toppenish Basin. (EPA 2013). These sediments pinch out along the flanks of the ridges. They include 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 1999a) (EPA 2013) (USGS 2009a) (USGS 1990) (USGS 1962).

About 16,000 years ago these glacial outburst floods created "Lake Lewis," in what is today the lower Yakima Valley and the LYVGWMA, when the restricted flow of waters from periodic cataclysmic floods from 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. Water also backed up further downstream on the Columbia River between Washington and Oregon, delaying the drainage of Lake Lewis. The water remained for iterative undefined periods before the flood waters drained through Wallula Gap, permitted surfacious loess and basalt materials collected in the floods' transit southeast from the Spokane area to settle out to the lake's bottom, thus forming at least some of the fine grained gravelly and sandy materials extant today on the valley bottom of the Yakima River within the LYVGWMA. 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. (Bjornstad, 2006) (Alt, 2001) (Carson/Pogue, 1996).

Hydrogeology

The geologic framework and some of its hydrogeologic units of the Columbia Plateau regional aquifer system was described by Drost and others. (USGS 1990) The aquifer system consists of a large thickness of basalt made of numerous flows with minor interbedded sediments. (USGS 1990) The principal water bearing zones in the basalt sequence are those upper parts of certain flows rendered relatively permeable by weathering, jointing, and vesicularity. (USGS 1962)

The lithology, or general physical character, of the materials, within the hydrogeologic units of the LYVGWMA was described by USGS in its 2009 report. (USGS 2009a). The five units described have various consolidated or unconsolidated structure. The unconsolidated units include alluvial, alluvial fan, terrace, glacial, loess, lacustrine, and flood (Touchet Beds) deposits that range from coarse-grained gravels to fine-grained clays, with some cemented gravel (Thorp gravel and similar unnamed gravels). Most of the unconsolidated units consist of coarse-grained deposits. The consolidated units are principally deposits of the Ellensburg Formation, but also include some undifferentiated continental sedimentary deposits. These units include continental sandstone, shale, siltstone, mudstone, claystone, clay, and lenses or layers of uncemented and weakly to strongly cemented gravel and sand (conglomerate). These clastic deposits are one of the most stratigraphically complex parts of the aquifer system. (USGS 2009a).

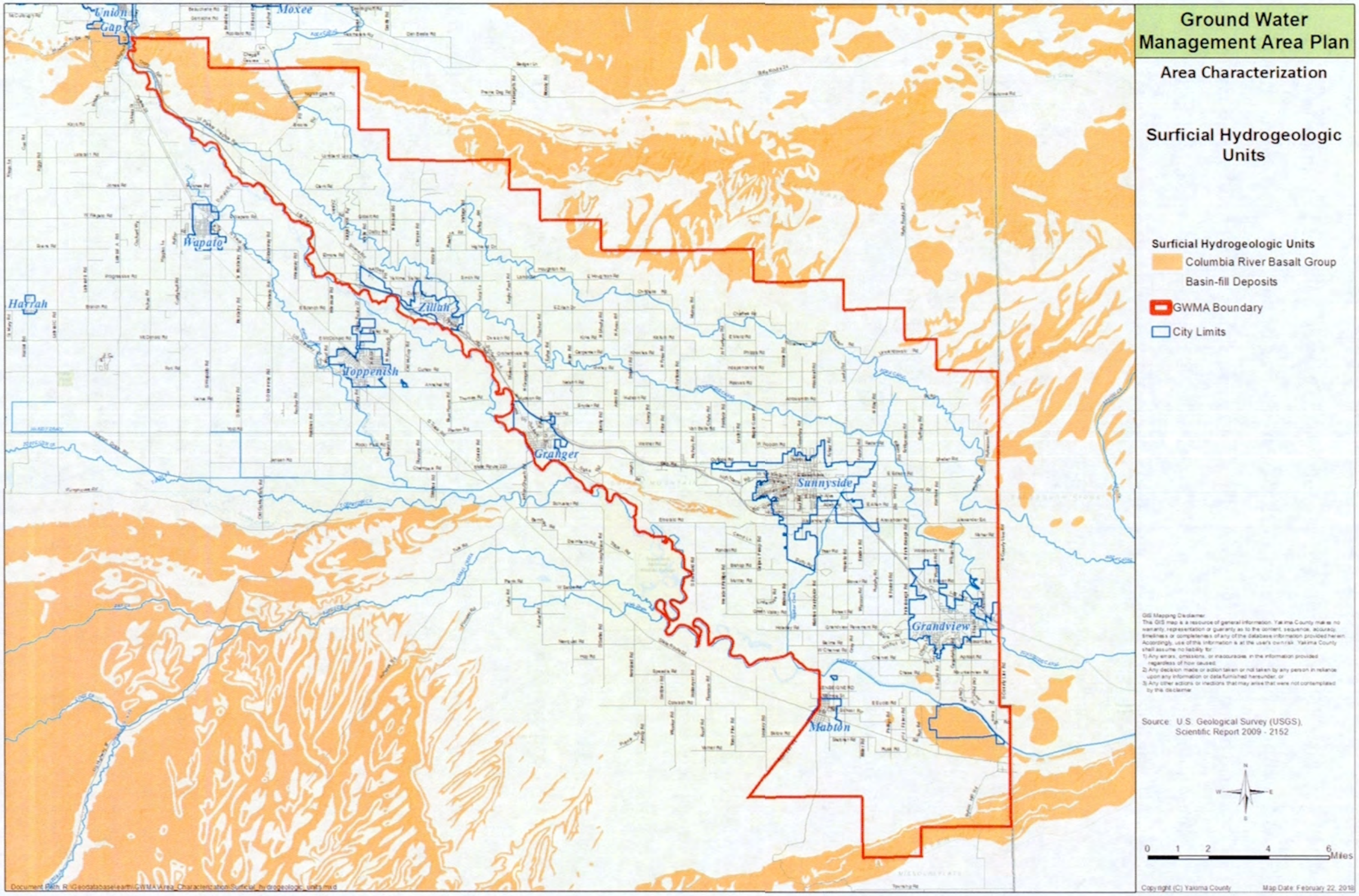
Table 1 - Hydrogeologic Units (after USGS 2009a)

LYVGWMA Hydrogeologic Units						
Structural Basin Name	Mapped Area	Unit	Lithology	Thickness		
				Range	Average	Median
Toppenish Basin	440	1 (fine grained consolidated)	Touchet Beds, terrace, loess, and some alluvial deposits	0 to 80	10	10
		2 (coarse grained unconsolidated)	Coarse-grained sand and gravel deposits	0 to 270	90	80
		3 (consolidated)	Consolidated deposits of the upper Ellensburg Formation and undefined continental sedimentary deposits	0 to 970	350	320
		4 (fine grained deposits)	Top of Rattlesnake Ridge unit of the Ellensburg Formation or "Blue Clay unit"	0 to 520	170	140
		5 (coarse grained deposits)	Base of Rattlesnake Ridge unit of the Ellensburg Formation	0 to 140	20	20

Bedrock units underlie the hydrogeologic units. (USGS 2009a) As bedrock units likely hold little or no groundwater to be taken up by wells for domestic water supply, they are not discussed here.

Figure 6, derived from the USGS' 2009 report shows the surficial hydrogeologic units within the LYVGWMA.

FIGURE 6 SURFICIAL HYDROGEOLOCIC UNITS



Aquifers

In 2009, the United States Geological Survey published its study of the geology, hydrology and hydrogeology of aquifers in the Yakima River Basin. The study found that there are two main aquifer types in the LYVGWMA. The first is a surficial unconfined to semi-confined alluvial aquifer. This aquifer is composed of highly layered alluvial material with predominantly silt, sand and cobbles and, according to USGS, has a total thickness of up to 500 feet.

The second aquifer is an extensive basalt aquifer of great thickness underlying the surficial aquifer described above. The basalt aquifer is believed by the USGS to be semi-isolated from the surficial aquifer and stream systems. Natural groundwater flow within the shallower, surficial aquifer generally follows topography, but may be locally influenced by irrigation practices, ponds, lagoons, drains, ditches, and canals. Groundwater in this shallower aquifer generally flows to the south, down the valley, and is used locally for residential water supply and eventually feeds the Yakima River.

An aquifer is rock material that is sufficiently saturated to be capable of transmitting and yielding appreciable amounts of water. Ground water occurs in the interstices in rock materials, in the spaces not occupied by solid material. The ability of soil or rock to transmit water is determined by the abundance, character, and degree of interconnection of those spaces.

Natural rock materials differ greatly in porosity. Porosity is a measure of the ability of the rock to contain water. It is the ratio of the volume of its interstices to its total volume. The porosity of some consolidated rocks, such as tightly cemented sandstone or massive lava flows, is only a few percent or even a fraction of a percent. The porosity of some clays may exceed 50 percent. In unconsolidated rocks, the well-sorted materials, such as clay or clean even-textured sand or gravel, have very high porosity. Poorly sorted materials, in which the smaller particles fill the openings between the larger grains, have low porosity.

Both "confined" and "unconfined" aquifers are known to exist within the LYVGWMA. A "confined aquifer" is one in which water has become confined between relatively impermeable materials due to the weight of the water in an unconfined part of the aquifer. Water in confined aquifers will rise higher in a well than the bottom of the overlying confining bed. Such wells are called "artesian." The level to which water will theoretically rise in an artesian well is called the piezometric surface.

An "unconfined aquifer" (or "water table aquifer") is one where the upper surface of the water in the rock mass is free to find a relatively even level. This level is called the "water table." The water table is the upper surface of an unconfined aquifer. The level at which water stands in a well penetrating an unconfined zone of saturation represents the water table at that place.

Aquifer dynamics are generally described in terms of amounts of water entering and exiting the aquifer. "Recharge" is the natural replenishment of an aquifer's water volume by downward seepage from the surface (rainfall, snowmelt, infiltration from lakes, wetlands and streams, or irrigation), or groundwater moving from other underground sources. Water exiting the aquifer (water seeping from the ground (spring) or departing the aquifer into surface water (wetland, stream, lake, estuary, ocean) or the atmosphere) is "discharge". The water table fluctuates chiefly in response to variations in recharge to, and discharge from, the ground-water body. Natural recharge may occur because of precipitation. Artificial recharge may occur through irrigation. Surface water streams or irrigation canals that cross permeable zones may recharge the aquifers beneath. Surface water streams or rivers that flow at an elevation below the water table discharge water from the aquifer.

Both the piezometric surface of a confined aquifer and the water table of an unconfined aquifer are usually sloping, irregular, fluctuating surfaces. They are higher in areas of ground-water recharge and lower in areas of discharge and affected by differences in permeability within the aquifer. The slope of either surface is called the "hydraulic gradient." The slope adjusts automatically to the velocity of the moving water and the permeability of the rock. It is highest in areas of recharge, where water is added to the aquifer, and slopes downward to areas of discharge, where water leaves, or is removed from, the aquifer.

The water table has irregularities that are generally comparable with the configuration of the land surface, although more subdued. Additional irregularities are caused by local differences in the permeability of the rock materials and by local differences in ground-water discharge and recharge. Rocks of low permeability require a steeper gradient than more permeable rocks to transmit water at a given rate.

An aquifer is "perched" if it is held above an unsaturated zone by a relatively impermeable rock stratum.

Figure 7, derived from USGS' 2009 study (USGS 2009a), shows the location of known springs within the Toppenish Basin. Figure 8, derived from the same study, shows the mean annual recharge of the surficial aquifers within the LYVGWMA.

FIGURE 7 – SPRINGS WITHIN THE TOPPENISH BASIN

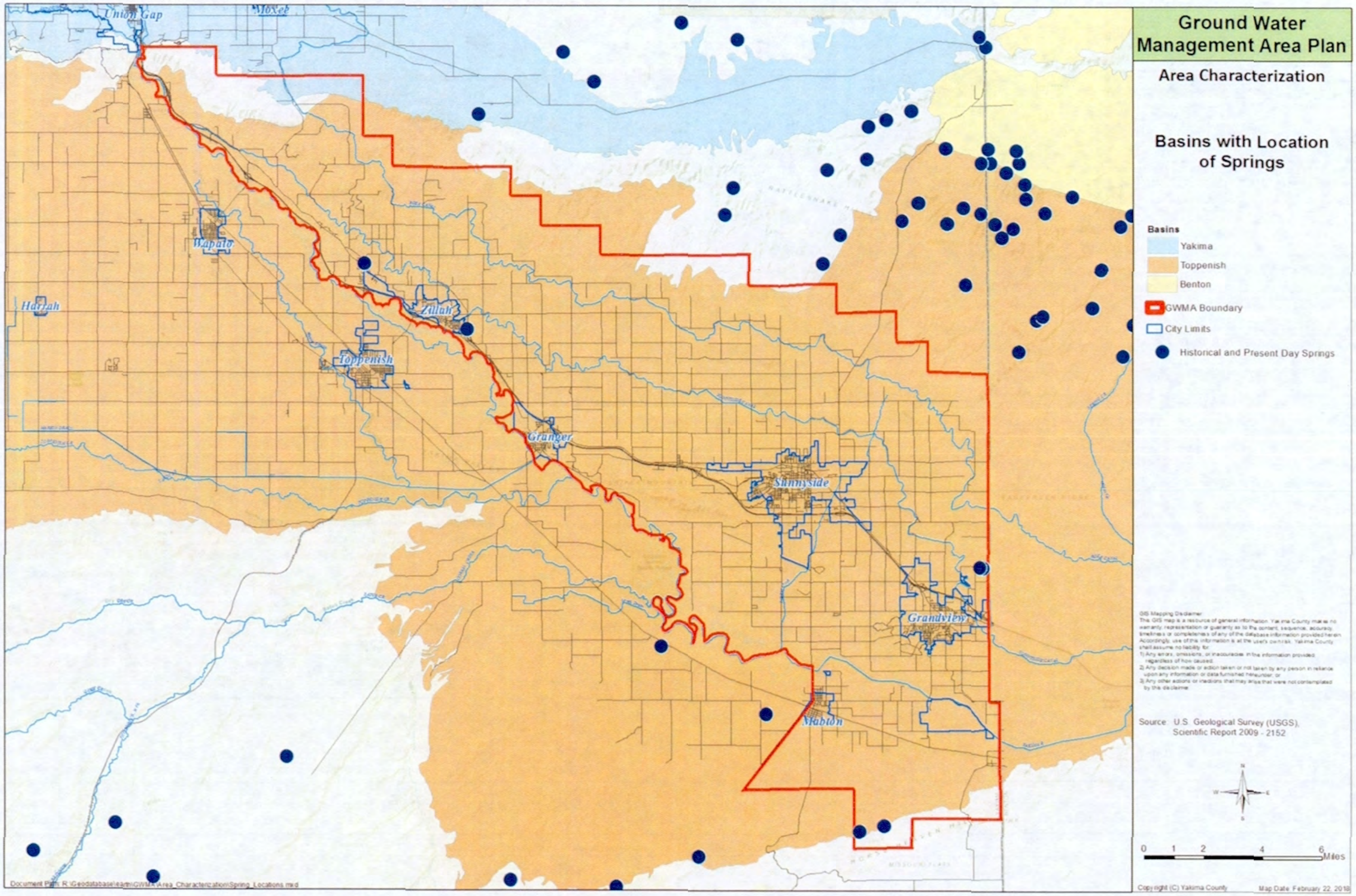
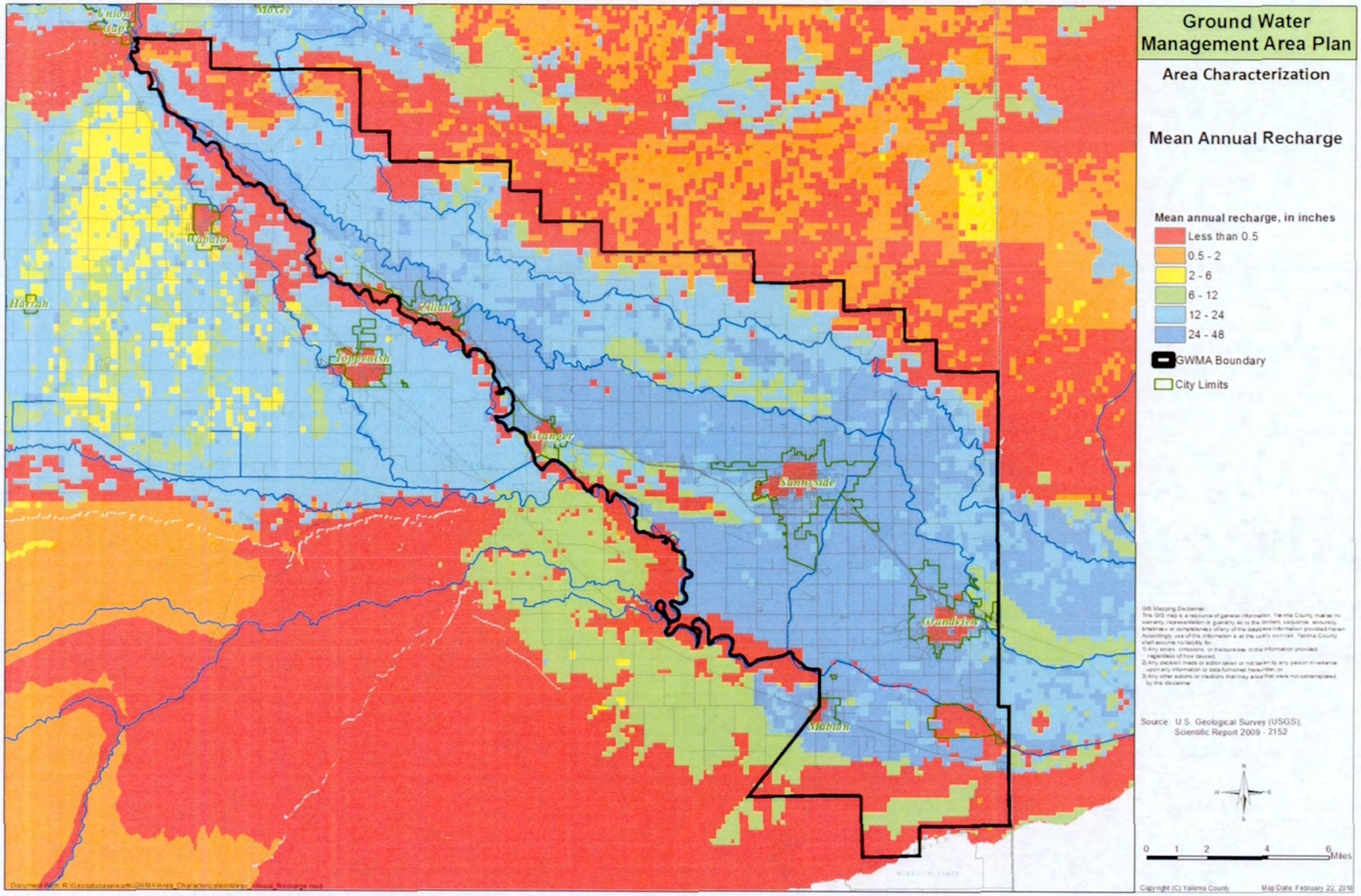


FIGURE 8 – MEAN ANNUAL RECHARGE WITHIN THE LVYGWMA



Amount and Direction of Groundwater Flow

The volume and velocity of groundwater flow is measured in hydraulic conductivity, the measure of a material's ability to transmit water laterally. It is expressed in units of cubic feet per square feet per day—simplified to feet per day (ft/d). Values of hydraulic conductivity can be estimated from specific-capacity data reported on drillers' logs, or determined from aquifer tests or groundwater flow modeling.

The movement of water into, within, or out of an aquifer is typically called "groundwater flow." Within the aquifer ground water flows through the ground from where it is recharged to where it is discharged. Groundwater flow is generally measured in "groundwater travel time." Groundwater travel time is usually measured in feet per day. The pace of flow is influenced by the "hydraulic conductivity" of the geologic matrix that composes the aquifer. The higher the hydraulic conductivity, the faster the flow. The direction of groundwater flow is determined by "gradients." The "gradient" is the difference in elevation between two locations of the water table or the differences in pressure between locations in a confined aquifer. The direction of groundwater flow is from the higher elevation or pressure to the lower elevation or pressure. The higher the gradient, the variance between the two, the faster the flow.

Table 2 - Porosity, Specific Yield, Hydraulic Conductivity

Representative values of porosity, specific yield and *hydraulic conductivity for selected geologic materials*			
Material	Porosity % by volume	Specific Yield	Hydraulic Conductivity m^3/sec
Clay	40-70	1-10	0-000094
Sand	25-50	10-30	0.005-0.14
Gravel	25-40	15-30	0.05-0.71
Sand and Gravel	20-35	15-25	0.009-0.24
Sandstone	5-30	5-15	0.000005-0.002
Shale	1-30	.5-5	0-0.000005

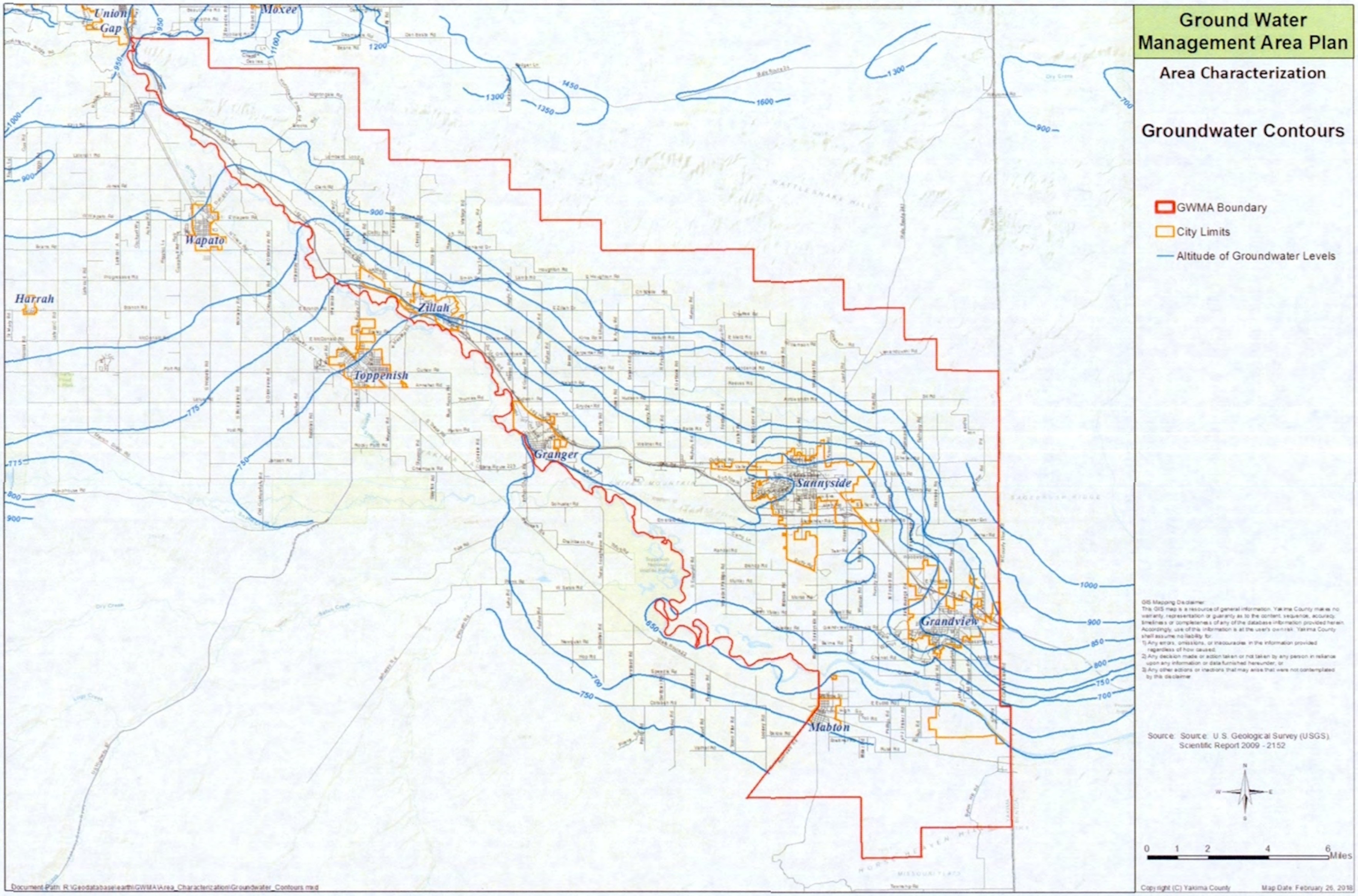
Unconfined (water-table) aquifers flow generally in accordance with the topography towards rivers, streams, lakes, and springs. The direction of groundwater flow in unconfined aquifers is normally perpendicular to groundwater contours premised upon measured or hypothetical water table levels. Groundwater in confined aquifers flows from the direction of the highest pressure to the lowest pressure. Ground water moves primarily in response to gravity, taking into account the resistance imposed by physical obstruction or pressure gradient. The USGS uses the normal approach with respect to surficial groundwater flow and has drawn its best judgment of the direction of that groundwater flow within the LYVGWMA. See Figure 16.

Other factors may be relevant in determining groundwater flow direction within the area. The EPA, for example, suggests a "pattern" involving deeper basaltic layers that may convey waters across local flow divides to more regionally significant discharge locations such as the Columbia River. "This pattern produces a major flow direction from northwest to southeast as water moves down the valley parallel to the course of the Yakima River." (EPA 2013) The EPA acknowledges that flow at shallower depth in the uppermost sediments tends to be "toward the Yakima River" and that direction may bemodified by geologic structures and irrigation practices, drains, ditches, canals and other hydrologic features. (EPA 2013).

Because the piezometric surface or water table of confined and unconfined aquifers, respectively, are variable, it is difficult to determine with certainty the depth of either from the ground surface. The USGS has, however, established groundwater level contours that can be used to compare against ground surface contours. Figure 9, derived from USGS' 2009 report (USGS 2009a), shows groundwater level contours. Figure 10 shows ground surface contours (topography) (in meters). Figure 11, derived from determining the distance between the two contours, shows depth to groundwater.

The ground surface material above the aquifer is called the "vadose zone." The vadose zone is the vertical depth between ground surface and an aquifer. It consists of unsaturated earthen materials. Depth to water is the distance between the ground surface and the water table or piezometric surface through the vadose zone. The deeper the water table and less permeable the vadose zone, the longer the travel time from the surface to the aquifer. Earthen materials within the vadose zone have different degrees of "permeability." Permeability is a measurement of the rate of infiltration in inches of water per hour. Infiltration rate is a measure of how fast water and pollutants can move downwards through the earthen materials of the vadose zone. The more permeable ground is, the faster water moves down through it. Coarse sands and gravels are more permeable and allow water to pass through much more quickly than fine silts, clays or glacial till which are less permeable.

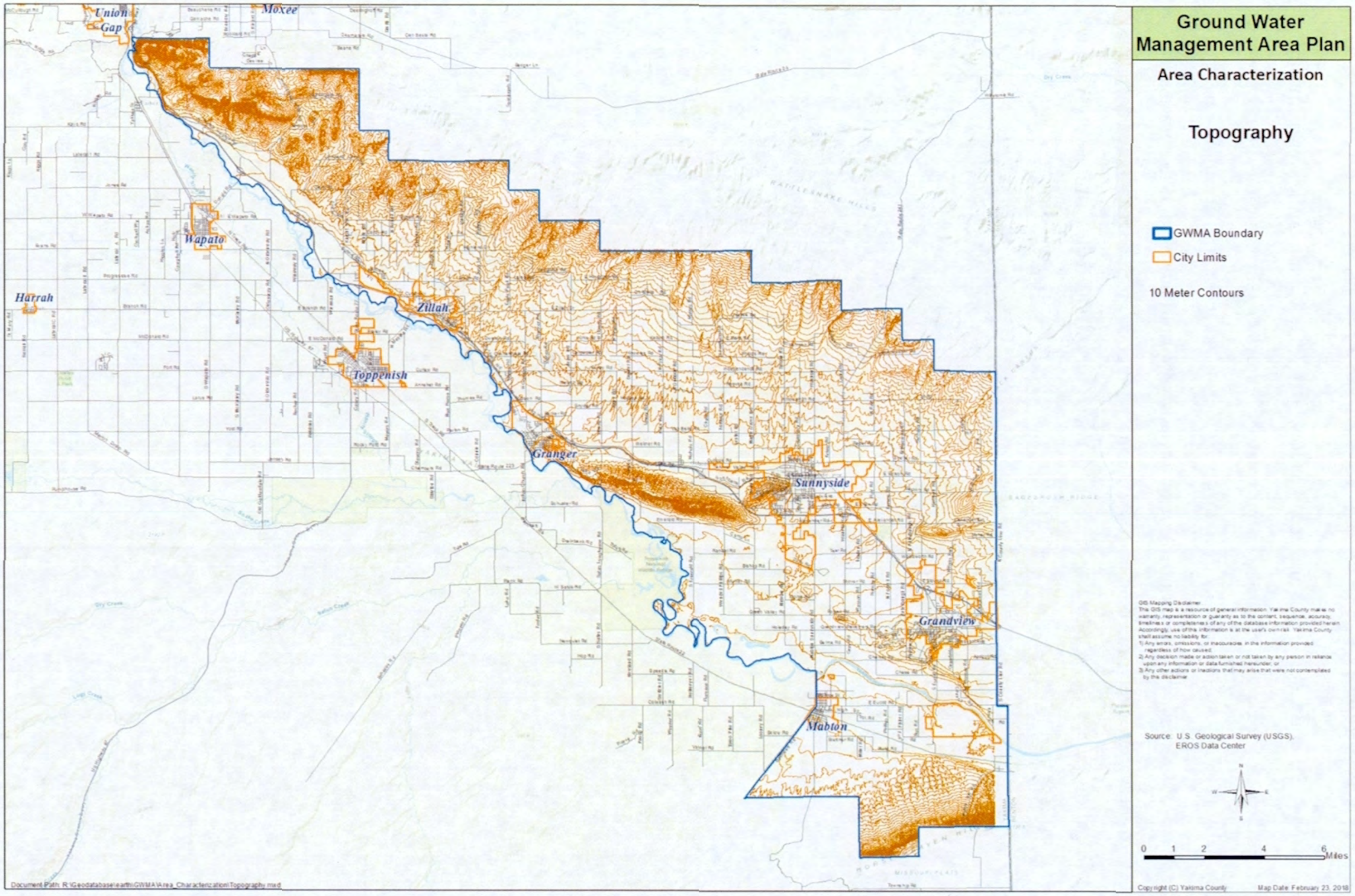
Figure 9 – Groundwater Level Contours Established by USGS within the LYVGWMA



Topography

The topographical surface of the groundwater management area is undulating hillside running down (from an elevation of approximately 400 meters (1312 feet) above sea level) to the valley floor and river floodplain (at an elevation of approximately 230 meters (755 feet) above sea level). The topographical map on the next page illustrates essentially parallel elevation contours (denominated in meters)—evidence of a gradual descent from north-northeast along the Rattlesnake Ridge to south-southwest along the Yakima River.

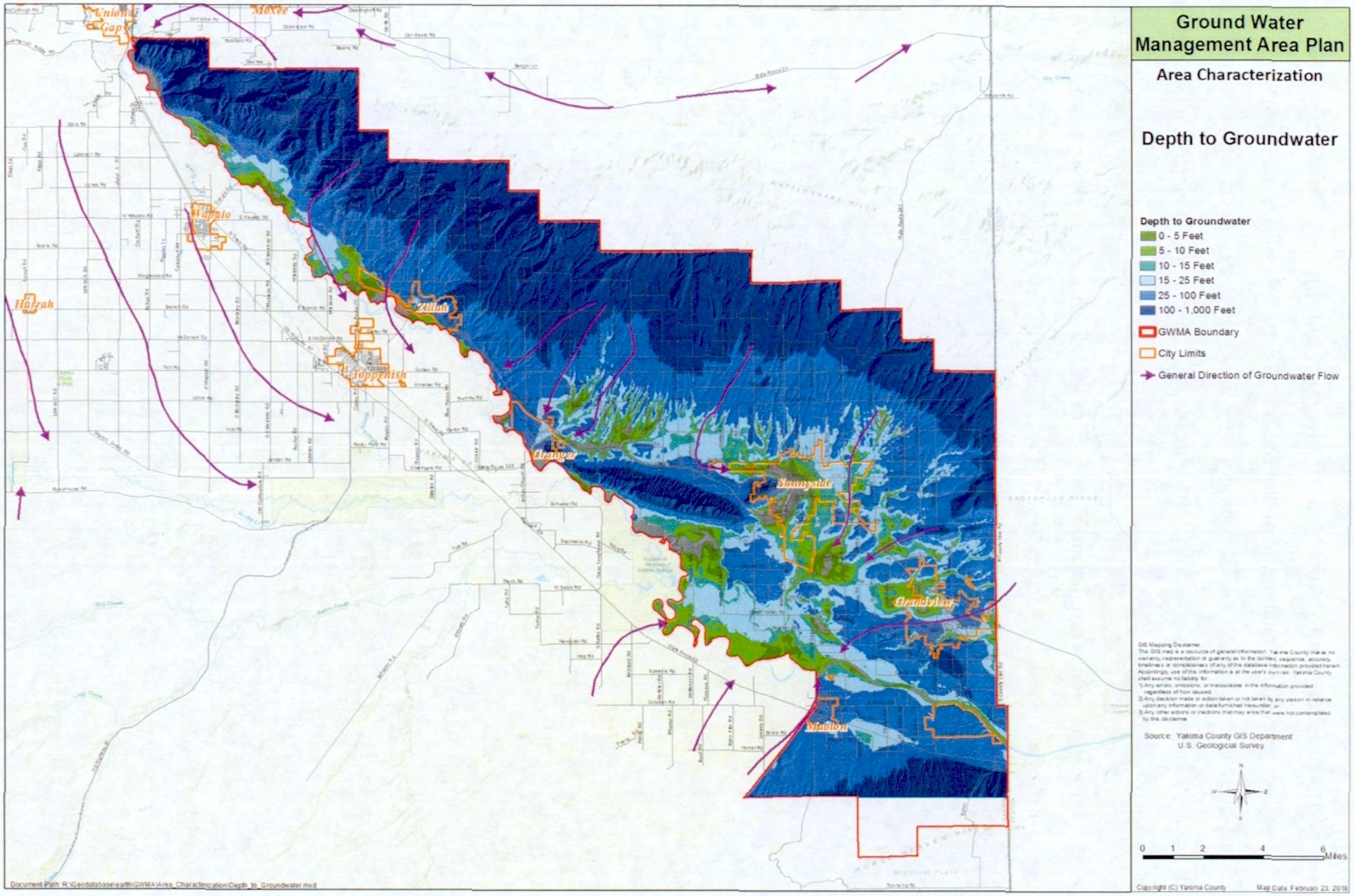
FIGURE 10 – GROUND SURFACE CONTOURS (TOPOGRAPHY) WITHIN THE LYVGMA



Depth to Groundwater

Groundwater levels are very shallow (0-15 feet) in the valley bottom and in several areas northeast of Granger, north and southeast of Sunnyside, surrounding Grandview and southeast of Mabton. They are marginally deeper (15-25 feet) in adjacent lands running east-southeastward from north of Granger past areas north of Sunnyside to Grandview and in the areas surrounding Mabton. Groundwater levels are deeper (25-100 feet) roughly in the areas between the SVID and RID irrigation canals. They become much deeper (100- 1000 feet) in areas above the RID irrigation canal.

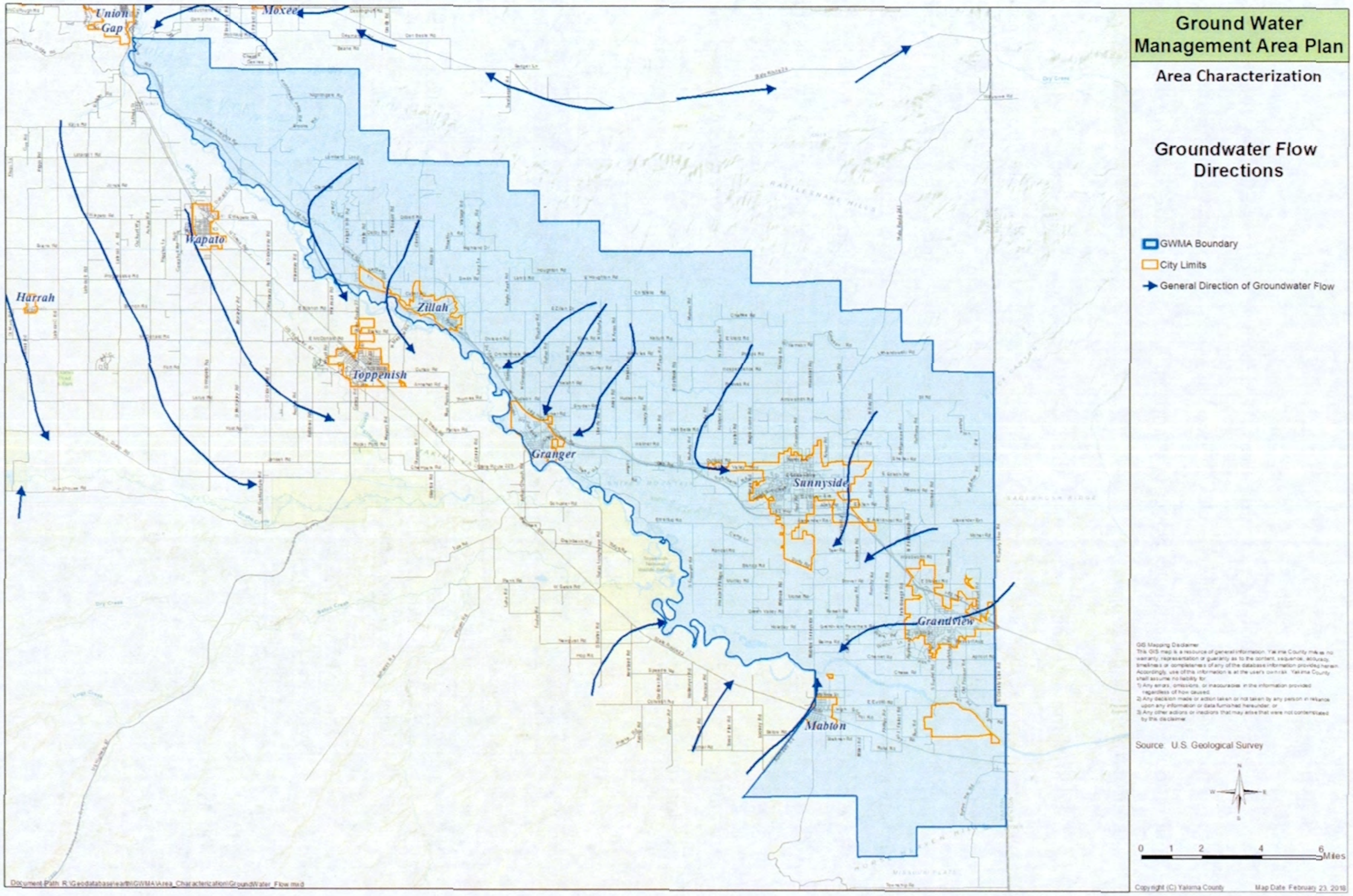
FIGURE 11 – CALCULATED DEPTH TO GROUNDWATER WITHIN THE LYVGMA



Water movement can also be influenced by "chemical retardation" or "adsorption." Chemical retardation is a measurement of how clays and organic matter react with some chemicals to slow their passage or change them chemically. " Adsorption" is a measurement of the tendency of ions dissolved in water to stick to particles of silt or clay. Particle size and the amount of organic matter affect adsorption. A sand with no organic matter may not adsorb at all, while an organic silt or clay may adsorb well.

Based on the configuration of groundwater surface contours (see Figure 9), USGS determined the direction of groundwater flow. Figure 12, derived from USGS 2009 report (USGS 2009a) shows direction of groundwater flow within the LYVGWMA.

FIGURE 12 – DIRECTION OF GROUNDWATER FLOW WITHIN THE LYVGWMA



Soil Types

There are 89 soil types within the GWMA. They differ based on constituency of materials (coarse to very fine sands, loams, clay), values of porosity, specific yield, hydraulic conductivity and infiltration rate. Hydraulic conductivity and infiltration rate are calculated presuming complete saturation of the soil material.

Predominant soil types within the GWMA are Scoon silt loam and Burk silt loam (ground surface roughly above 300 meters (1000 ft.) above sea level), Warden fine sandy loam interlineated generally northeast to southwest with Harwood-Burke-Wiehl very stony silt loams and Esquatzel silt loam (ground surface roughly between 300 meters (1000 ft) and 250 meters (800 ft) above sea level), and Esquatzel silt loam, Quincy loamy fine sand, Wanser loamy find sand, Warden fine sandy loam and Warden silt loam (roughly within the valley bottom between 250 meters (800 ft.) and 200 meters (650 ft.) above sea level). The infiltration rate of each of these primary soil types are presented in Table 3 below. The rates set forth in the table presume full soil saturation. Because soils in the vadose (unsaturated) zone within the LYVGWMA are only intermittently wetted, by irrigation or precipitation, the rates set forth must be variously reduced for those soils.

Table 3 – Primary Soil Types Infiltration Rates

Infiltration Rates of Primary Soil Types	
Soil type	Gallons/ ft2/day
Esquatzel silt loam, 0 to 2 percent slopes	0.45
Burke silt loam, 2 to 5 percent slopes	0.45
Harwood-Burke-Wiehl very stony silt loams, 15 to 30 percent slopes	0.45
Quincy loamy fine sand, 0 to 10 percent slopes	0.60
Scoon silt loam, 15 to 30 percent slopes	0.45
Wanser loamy fine sand	0.60
Warden fine sandy loam, 5 to 8 percent slopes	0.60
Warden silt loam, 0 to 2 percent slopes	0.45

FIGURE 16 - SOIL TYPES

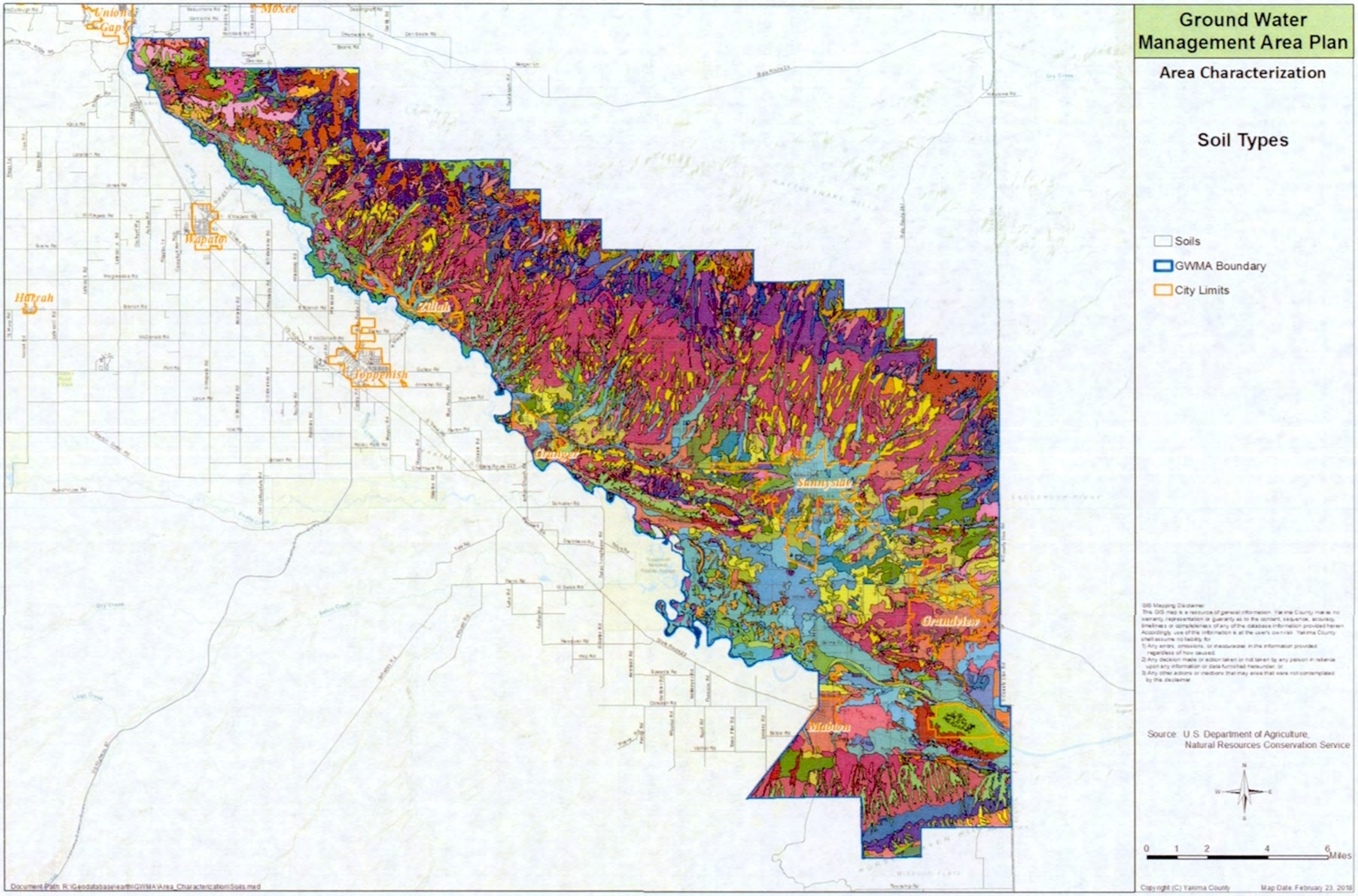


Table 4 – List of All Soil Types within the LYVGWMA

Soils

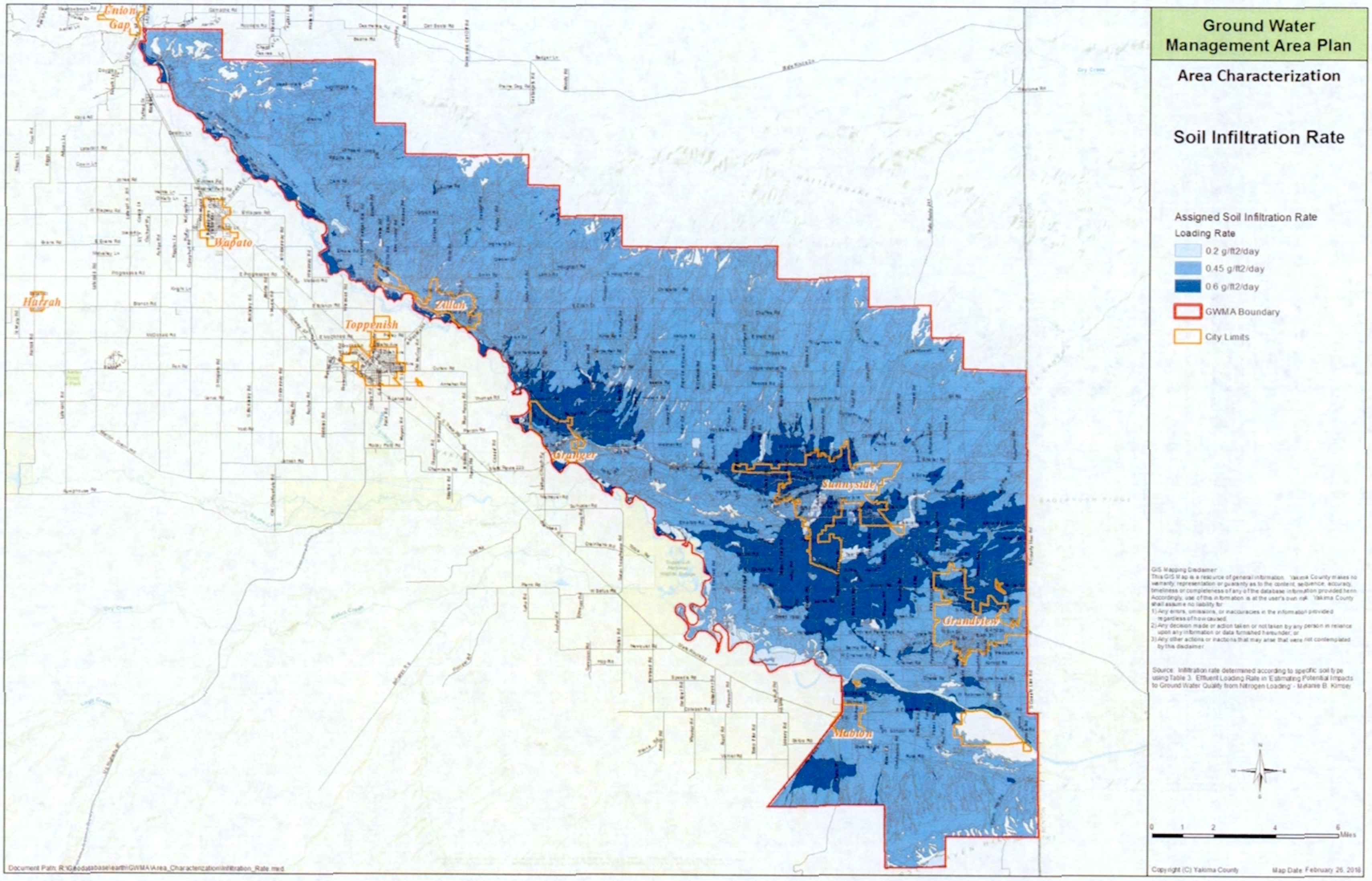
- Bakeoven very cobbly silt loam, 0 to 30 percent slopes
- Burke silt loam, 2 to 5 percent slopes
- Burke silt loam, 5 to 8 percent slopes
- Burke silt loam, 8 to 15 percent slopes
- Cleman very fine sandy loam, 0 to 2 percent slopes
- Cleman very fine sandy loam, 2 to 5 percent slopes
- Dam
- Esquatzel silt loam, 0 to 2 percent slopes
- Esquatzel silt loam, 2 to 5 percent slopes
- Fiander silt loam
- Finley cobbly fine sandy loam, 0 to 5 percent slopes
- Finley silt loam, 0 to 2 percent slopes
- Finley silt loam, 2 to 5 percent slopes
- Finley silt loam, 5 to 8 percent slopes
- Finley silt loam, 8 to 15 percent slopes
- Gorst loam, 2 to 15 percent slopes
- Harwood-Burke-Wiehl silt loams, 15 to 30 percent slopes
- Harwood-Burke-Wiehl silt loams, 2 to 5 percent slopes
- Harwood-Burke-Wiehl silt loams, 30 to 60 percent slopes
- Harwood-Burke-Wiehl silt loams, 5 to 8 percent slopes
- Harwood-Burke-Wiehl silt loams, 8 to 15 percent slopes
- Harwood-Burke-Wiehl very stony silt loams, 15 to 30 percent slopes
- Hezel loamy fine sand, 0 to 2 percent slopes
- Hezel loamy fine sand, 2 to 15 percent slopes
- Kiona stony silt loam, 15 to 45 percent slopes
- Kittitas silt loam
- Lickskillet very stony silt loam, 5 to 45 percent slopes
- Logy silt loam, 0 to 2 percent slopes
- McDaniel-Rock Creek complex, 5 to 30 percent slopes
- Mikkalo silt loam, 0 to 5 percent slopes
- Mikkalo silt loam, 15 to 30 percent slopes
- Mikkalo silt loam, 5 to 15 percent slopes
- Moxee cobbly silt loam, 0 to 30 percent slopes
- Moxee silt loam, 15 to 30 percent slopes
- Moxee silt loam, 2 to 15 percent slopes
- Outlook fine sandy loam
- Outlook silt loam
- Pits
- Prosser silt loam, 0 to 15 percent slopes
- Quincy loamy fine sand, 0 to 10 percent slopes
- Ritzville silt loam, 15 to 30 percent slopes
- Ritzville silt loam, 2 to 5 percent slopes
- Ritzville silt loam, 30 to 60 percent slopes
- Ritzville silt loam, 5 to 8 percent slopes
- Ritzville silt loam, 8 to 15 percent slopes
- Ritzville silt loam, basalt substratum, 15 to 30 percent slopes
- Ritzville silt loam, basalt substratum, 5 to 15 percent slopes
- Scoon silt loam, 15 to 30 percent slopes
- Scoon silt loam, 2 to 5 percent slopes
- Scoon silt loam, 5 to 8 percent slopes
- Scoon silt loam, 8 to 15 percent slopes
- Scooteney cobbly silt loam, 0 to 5 percent slopes
- Scooteney silt loam, 0 to 2 percent slopes
- Scooteney silt loam, 2 to 5 percent slopes
- Scooteney silt loam, 5 to 15 percent slopes
- Shano silt loam, 15 to 30 percent slopes
- Shano silt loam, 2 to 5 percent slopes
- Shano silt loam, 5 to 8 percent slopes
- Shano silt loam, 8 to 15 percent slopes
- Sinloc fine sandy loam, 0 to 2 percent slopes
- Sinloc silt loam, 0 to 2 percent slopes
- Sinloc silt loam, 2 to 5 percent slopes
- Sinloc silt loam, 5 to 8 percent slopes
- Starbuck silt loam, 2 to 15 percent slopes
- Starbuck-Rock outcrop complex, 0 to 45 percent slopes
- Starbuck-Rock outcrop complex, 45 to 60 percent slopes
- Umapine silt loam, drained, 0 to 2 percent slopes
- Umapine silt loam, drained, 2 to 5 percent slopes
- Wanser loamy fine sand
- Warden fine sandy loam, 0 to 2 percent slopes
- Warden fine sandy loam, 2 to 5 percent slopes
- Warden fine sandy loam, 5 to 8 percent slopes
- Warden fine sandy loam, 8 to 15 percent slopes
- Warden silt loam, 0 to 2 percent slopes
- Warden silt loam, 15 to 30 percent slopes
- Warden silt loam, 2 to 5 percent slopes
- Warden silt loam, 5 to 8 percent slopes
- Warden silt loam, 8 to 15 percent slopes
- Water
- Weirman fine sandy loam
- Weirman gravelly fine sandy loam
- Weirman sandy loam, channeled
- Willis fine sandy loam, 2 to 5 percent slopes
- Willis silt loam, 2 to 5 percent slopes
- Willis silt loam, 8 to 15 percent slopes
- Yakima silt loam
- Zillah sandy loam
- Zillah silt loam
- Zillah silt loam, channeled

All of the 89 soil types within the LYVGWMA illustrated in Figure 13 were sorted into infiltration rate categories. These are presented in Table 5 and illustrated in Figure 14.

Table 5 Soil Infiltration Rate Scale

Simplified Soil Infiltration Rate Categories	
Soil Textural Classification Description	gallons/ft2/day
Coarse sands (includes the ASTM C-33 sand)	1.2
Medium Sands	1
Fine sands, Loamy coarse sands, Loamy medium sands	0.8
Very fine sands, Loamy fine sand, Loamy very fine sands, Sandy loams, Loams	0.6
Silt loams that are porous and have well developed structure	0.45
Other silt loams, Sandy clay loams, Clay loams, Silty clay loams	0.2

FIGURE 14 – SIMPLIFIED SOIL INFILTRATION RATES OF SOILS IN THE LYVGGWMA



Climate

The Western Regional Climate Center maintains climate data at three stations within the Lower Yakima Valley at Wapato, Sunnyside, and Prosser. Temperatures have historically ranged from 90 to 24 degrees Fahrenheit over the course of a year.

Table 6 - Climate

WAPATO, WASHINGTON (458959)

Period of Record Monthly Climate Summary, Western Regional Climate Center, wrcc@dri.edu

Period of Record : 10/01/1915 to 09/05/2013

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	39	47	58	66	75	81	89	88	80	67	50	40	64.8
Average Min. Temperature (F)	23	27	33	39	47	54	59	57	49	38	30	25	40.1
Average Total Precipitation (in.)	1	0.7	0.6	0.5	0.5	0.6	0.2	0.3	0.3	0.5	1	1.2	7.35
Average Total SnowFall (in.)	5.8	2.2	0.7	0	0	0	0	0	0	0	1.9	5.4	15.9
Average Snow Depth (in.)	2	1	0	0	0	0	0	0	0	0	0	1	0

SUNNYSIDE, WASHINGTON (458207)

Period of Record Monthly Climate Summary, Western Regional Climate Center, wrcc@dri.edu

Period of Record : 09/14/1894 to 01/05/2014

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	39	47	58	67	75	82	90	89	80	67	51	40	65.3
Average Min. Temperature (F)	23	27	32	38	45	51	54.7	53	46	37	30	25	38.4
Average Total Precipitation (in.)	0.9	0.6	0.5	0.5	0.5	0.5	0.18	0.3	0.4	0.6	0.9	0.9	6.8
Average Total SnowFall (in.)	4.5	1.8	0.2	0	0	0	0	0	0	0	1.8	4	12.4
Average Snow Depth (in.)						No	Data						

PROSSER, WASHINGTON (456768)

Period of Record Monthly Climate Summary, Western Regional Climate Center, wrcc@dri.edu

Period of Record : 07/01/1925 to 01/04/2015

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	38	46	56	65	73	80	89	87	78	65	49	40	63.9
Average Min. Temperature (F)	24	28	33	38	45	50	55	53	47	39	31	26	38.9
Average Total Precipitation (in.)	1.1	0.7	0.6	0.6	0.6	0.7	0.2	0.3	0.4	0.7	1	1.2	7.95
Average Total SnowFall (in.)	2.6	1.2	0.1	0	0	0	0	0	0	0	0.9	2.3	7.2
Average Snow Depth (in.)	1	0	0	0	0	0	0	0	0	0	0	0	0

Land Use

Agriculture is the primary economic and land use activity in the area. Approximately 70-80% of the area is used for agriculture. Agricultural production on the 464,000 irrigated acres within the Yakima Basin is annually worth $1.3 billion. Most cropland in the area is irrigated. Major commodities grown in the valley include apples, pears, cherries, peaches, vegetables, hay, mint and hops. In 2002, Yakima County ranked first statewide for apple, milk, hop, and grape production and first nationally for apple and hop production. Dairy operations were greatly expanded starting in the late 1980's. Also, animal feeding operations operate at various sizes from very small home lots to large commercial feedlots. The dairies and animal feeding operations are concentrated in the lower parts of the valley in and around the cities of Sunnyside, Grandview, Mabton and Granger, although some occur in more disperse parts of the valley on the Yakama Indian Reservation.

Viewed from the perspective of American history, problems of nitrate contamination have been identified progressively from eastern to western regions of the United States, corresponding with the historical origination of more intensive agricultural practices in those regions. Nitrate contamination was identified as a public concern first in New England, then in the Ohio Valley, progressing to the Middle West and ultimately in the American West, particularly in Montana, Idaho, California, and now Eastern Washington. In each case, the length of more intensive agricultural practice history has reached about 100 years before the degree of contamination has become sufficiently great to cause public or governmental response.

Catholic Missionaries arrived in the Yakima River basin in 1848. They established a mission in 1852 on Atanum (now Ahtanum) Creek, using irrigation on a small scale. Miners and cattlemen immigrated to the basin in the 1850s and 1860s. In 1859, Ben Snipes first drove cattle through the Yakima Valley. Five years later, he returned, established the Snipes and Allen Company, grazing 40,000-50,000 head of cattle in the lower Yakima Valley. By the 1880s, it is estimated that there were 200,000 cattle, 350,000 sheep, and 125,000 horses grazing in the Yakima Valley. With increasing settlement in the mid-1860s, irrigation of the valley bottoms began. Outlying areas were used extensively for raising stock. Private companies began to deliver water through canal systems built between 1880 and 1904 for the irrigation of large areas. Irrigated agriculture began to be practiced more widely at this time. The Northern Pacific Railway was constructed through the Yakima Valley, reaching Yakima in December 1884 and Seattle in 1896, facilitating the development of irrigated agriculture through transport of agricultural goods to markets. Statehood in 1889 assisted Lower Yakima Valley agricultural growth, Yakima contending for state capital. By 1902, about 120,000 acres were under irrigation, mostly by surface-water.

By 1901, farming had largely replaced livestock ranching in the easily irrigated acres of the valley. A state survey of that year reported the following crops grown in the Yakima Valley: apples, pears, prunes, plums, cherries, apricots, peaches and grapes; alfalfa, corn, wheat, barley, oats, rye, flax, broom corn, other grasses including brome, orchard, tall meadow fescue, timothy, red top, and clover; melons, potatoes, garden vegetables, hops and sugar beets.

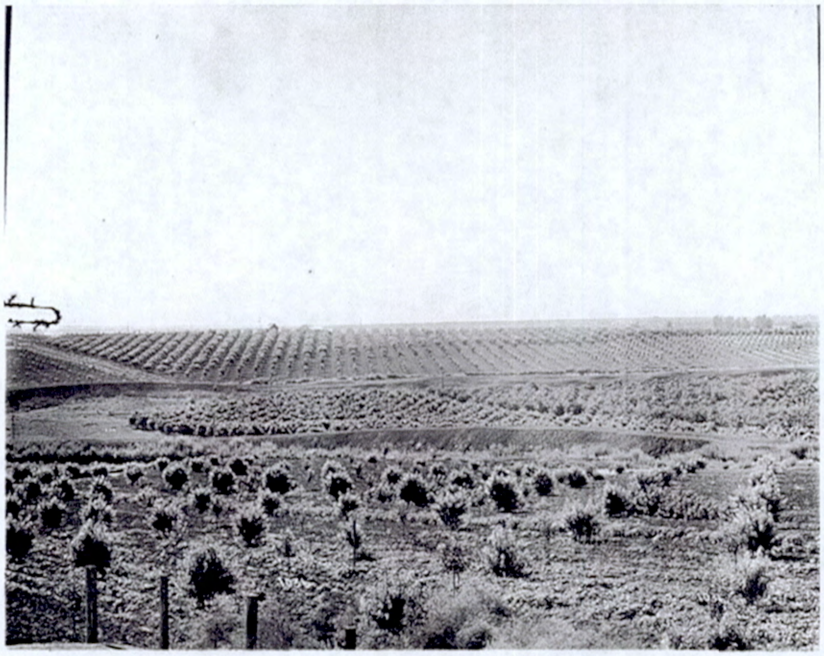
Crops

The Yakima Valley Museum maintains a collection of photographs which indicate significant production of hops in the early period, primarily in the Moxee and North Yakima area.[4]

Above Union Gap, early crops included hops. In the Lower Valley, early agriculture primarily involved the production of hay.

[4] Historical photographs courtesy of the Yakima Valley Museum. For further study, see http://www.yakimamemory.org/

Newly planted orchards were planted in the Sunnyside area by 1908:



Between 1905 and 1912 the lower Yakima Valley towns of Sunnyside, Mabton, Toppenish, Wapato, Grandview, Granger and Zillah were all incorporated.

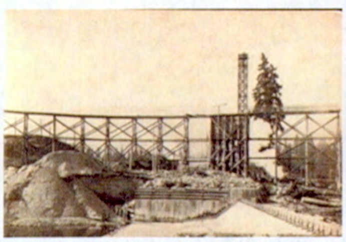
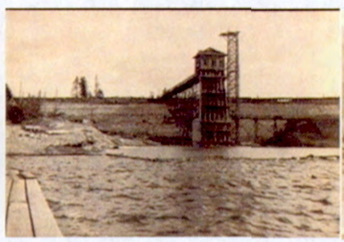
Another survey assembled in 1917 showed the following crops and agricultural products produced in the Yakima Valley: strawberries, cherries, prunes, appled, peaches, pears, apricots, grapes cantaloupes and watermelons; onions, turnips, green corn, carrots, rutabagas, cabbage, asparagus, tomatoes, green peppers, squash, pumpkins, beans, potatoes, hops and sugar beets; alfalfa hay, wheat, oats and barley.

Field crops, such as potatoes, onions, and corn primarily watered by flood irrigation, either through total inundation or rill irrigation, were successful crops by the early 1920s:

Tree fruits had become successful export products by the 1930s.



The Federal Reclamation Act of 1902 and Washington State's Yakima Federal Reclamation Act of 1905 authorized construction of water delivery facilities to irrigate about 500,000 acres of Lower Yakima Valley agriculture. Six dams and five reservoirs were constructed as part of the Yakima Project.


These Federal reservoirs provide storage to meet water requirements of the major irrigation districts during the period of the year, called "storage control," when the natural streamflow from unregulated streams can no longer meet demands.

Farm sizes were relatively small during the first half of the twentieth century. According to the Agricultural History of Yakima County, a report prepared by Margaret Drenna, there were 6,351 farms in Yakima County, making up 600,106 acres of farmland, in 1925.

> "Farmers often produced their own livestock feed on farm, and maintained soil fertility through crop rotations and the retention of manure and crop residues on-farm. Weeds, insects, and plant diseases were controlled largely through mechanical practices, crop rotation, and the use of natural predators. During this time the conversion from horse-powered farming to the widespread use of tractors was taking place. . . . This spread of mechanization made it possible for farmers to use agricultural practices like intensive inversion-based tillage that remove all cover from the soil and use large amounts of fuel." (WSDA 2013)

The National Map Company's 1930 map entitled *Latest Official Survey of Washington* now located within the Presby Museum in Goldendale Washington, shows the route of two railroads then running through the GWMA area, with which to ship agricultural goods to market. The density of the railroad's depots indicates the abundance of agricultural commodity available to be sent to market. The Union Pacific route stopped in Grandview, Forsell, Waneta, Midvale, Morris, Emerald, Bain, Noride, Granger, Blaine Acres, Dalton, Boone, Pam, Zillah, Buena, Flint, Sawyer, Dunbro and Parker en route to Union Gap and Yakima. The Northern Pacific route stopped at Grandview, Lichty, Sunnyside, Outlook Nass, Sinto, Granger, Boone, Gilliland, Cenauer, Zillah, Keck, Cutler, Buena, Sawyer, Donald, Mellis and Parker en route to Union Gap and Yakima.

The number of farms and the area being farmed throughout Yakima County both stabilized during the 1940s. In the 1950s, the total number of farms began to decrease while the total amount of land being farmed increased, due primarily to the growth of land used as pasture. Between the 1960s and early 2000s, the total amount of land being farmed in Yakima County remained relatively static. It is reasonable to presume that the same trends occurred more specifically within the lower Yakima Valley area.

Information regarding the total number of acres farmed in each crop category throughout Yakima County was collected by the U.S. Department of Commerce, Bureau of the Census and published in the *United States Census of Agriculture:* It was assembled by Margaret Drennan in a report entitled "Agricultural History of Yakima County." (WSDA 2013) The census information does not segregate data into geographic subdivisions of Yakima County. Nevertheless, the information does reflect trends in agricultural practices within the LVTGWMA, as this area constitutes a major portion of the County's agricultural economy.

Table 7- Agricultural Census Data—General Crop Types

Summary of Yakima County Acres Farmed--- As Reported in USDOC Agricultural Censuses (numbers rounded)				
	Number of acres farmed (x1000)			
	1935	1959	1982	2007
Apples, cherries, peaches, pears, plums, prunes and grapes	52.0	83.0	89.0	95.0
Corn, wheat, oats, barley, rye and triticale	55.0	94.0	101.0	83.0
Hay, forage, haylage and silage (including small agrains cut for hay, wild hay, sorghum cut for silage or greenchop)	71.0	49.0	32.0	52.0
Potatoes, sugar beets, mint, hops, dill and dried herbs	18.0	48.0	36.0	44.0
Vegetables (including snap and string beans, cabbages, sweet corn, tomatoes and watermelons)	6.0	23.0	20.0	10.0
Field seeds and grass seeds	0.0	10.0	0.5	1.0
Legumes (excluding cover crops)	0.1	0.3	3.3	0.5
Berries	0.0	0.1	0.0	0.1

Some County-wide information on specific field crops is also available from the USDOC Agricultural Censuses.

Table 8 – Agricultural Census Data—Field Crops

Yakima County Acres Farmed--Several Specific Crops (numbers rounded)				
	Number of acres farmed (x1000)			
	1935	*1959*	*1982*	*2007*
Sweet Corn	1.00	9.00	5.00	2.00
Asparagus	2.00	10.00	10.00	2.50
Hops	4.00	19.00	19.00	19.00
Mint	0.00	10.00	25.00	10.00
Sugar Beets	1.00	19.00	8.00	2.00
Alfalfa	65.00	40.00	30.00	41.00
Alfalfa seed	0.30	10.00	3.00	1.00
Wheat	20.00	31.00	60.00	21.00
Corn for grain and silage	8.00	43.00	21.00	42.00
Barley	7.00	17.00	17.00	0.50

According to the information contained in several years' Agricultural Census, the number of cattle raised in Yakima County (excluding dairy cows) increased from 45,403 animals in 1925 to 212,762 animals in 2007. The number of dairy cows in Yakima County was stable at about 20,000 animals between 1925 and 1950. The number decreased during the 1950s and 1960s, reaching a low of 7,868 animals in 1969. The total number of dairy cows (excluding calves) reached 89,575 by 2007.

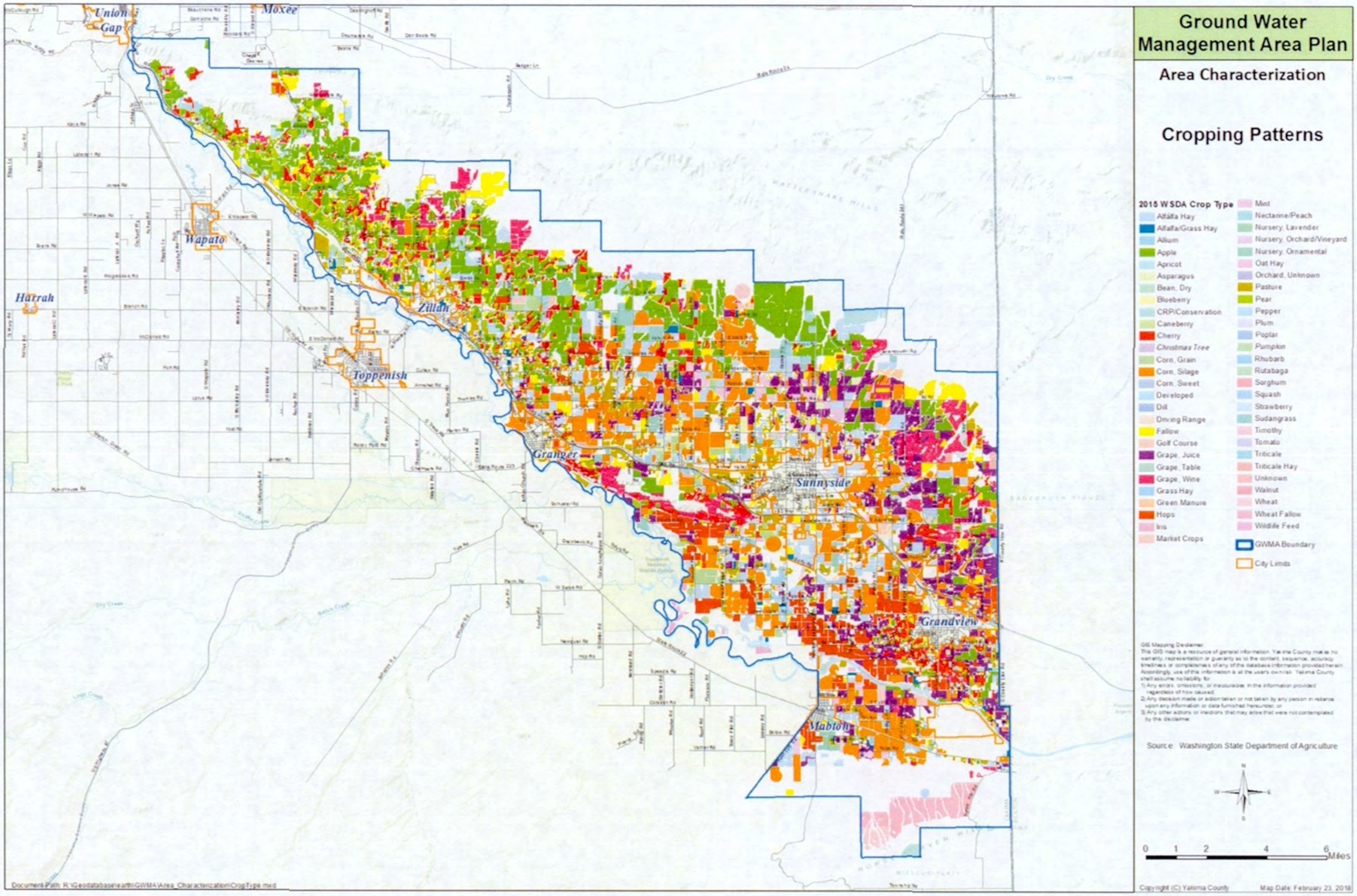
Table 9 – Agricultural Census--Livestock

Yakima County Livestock--As Reported by USDA Census				
	Number of Livestock (x1000)			
	1935	1959	1982	2007
Cattle and calves	51	135	152	213
Dairy Cows	20	18	19	90
Chickens	220	240	520	300
Sheep	100	75	25	10

Trends in U.S. farming began shifting after World War II from mixed crop and livestock operations to specialized monocultures. Livestock became commonly raised separately on feedlots. Crop rotation decreased. Livestock manure, commercial fertilizer and pesticides became more greatly available. Yields of corn, wheat and rice increased during the latter half of the Twentieth Century, due to large-scale mechanization of tilling, planting and harvesting, improved plant varieties, development of irrigation infrastructure, availability of low cost fertilizers and pesticides, and favorable commodity prices. Economies of scale led farm sizes to increase. By 2007, there were 3,540 farms, making up 1,649,281 acres, in Yakima County. (WSDA 2013).

The Washington State Department of Agriculture maintains an annual inventory of crops grown on particular properties. The inventory is maintained in a Geographic Information System (GIS) format. Figure 15 illustrates the variety and location of crops grown within the LYVGWMA in 2015.

FIGURE 15 – LOCATION OF CROPS GROWN WITHIN THE LVYGWMA (2015)



A narrower inventory, limited only to the acreage within the LYVGWMA was conducted by the Washington State Department of Agriculture. See Figure 15. In 2015, the crops constituting 1% or more of the acreage within the GWMA were:

Table 10 - WSDA 2015 Crop Inventory within LVYGWMA

Top 20 Crop Types	Acres	% of Total Acres
Apple	17,351	18%
Corn Silage	16,826	17%
Grape, Juice	10,269	11%
Alfalfa Hay	7,977	8%
Pasture	6,702	7%
Cherry	6,361	7%
Hops	5,922	6%
Grape, Wine	5,129	5%
Fallow	4,791	5%
Pear	3,335	3%
Wheat Fallow	1,761	2%
Sudangrass	1,623	2%
Mint	1,414	1%
Wheat	1,283	1%
Corn, Grain	1,148	1%
Grass Hay	1,133	1%
Developed	1,019	1%
Asparagus	853	1%
Nectarine/Peach	843	1%
Alfalfa/Grass Hay	648	1%
Total Acreage	96,459	

The acreage totals in Table 10 do not account for multiple cropping of any particular acreage in a single year. According to WSDA, 10,780 acres of triticale were farmed ("double-cropped"), primarily on the same ground as corn silage, after the corn silage had been harvested. Double cropping was taken into account however in the WSDA's Nitrogen availability assessment (WSDA 2017b).

Fertilizers

According to the USDOC Agricultural Census, as reported in the Agricultural History of Yakima County, (WSDA 2013). 136,553 farmed acres were fertilized in Yakima County in 1954.

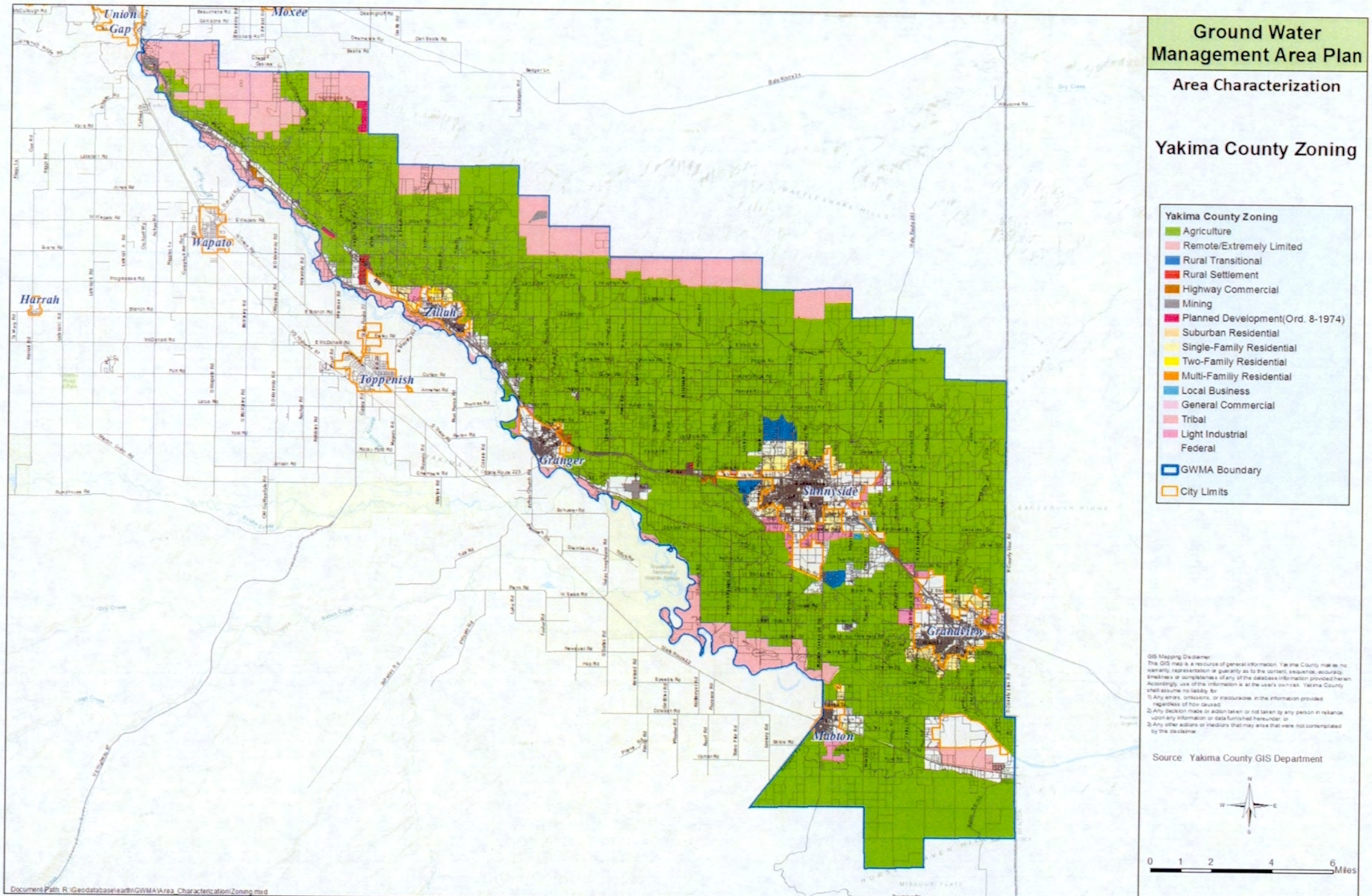
203,062 farmed acres were fertilized in 1964. The number of fertilized acres remained at about that rate through 2007. In 2002, 28,152 acres were fertilized by manure. In 2007, 27,742 acres were fertilized by manure, or approximately 14 % of total fertilized acres within the county.

The USDOC Agricultural Census also collected information, between 1954 and 1974, about the number of acres within Yakima County that were fertilized with chemical fertilizer. The maximum number of acres fertilized with chemical fertilizer occurred in 1970, when approximately 110,000 acres received chemical fertilizer. (WSDA 2013)

The use of synthetic fertilizers began to increase between 1900 and 1944. After WWI, the use of chemical pesticides increased as well.

Land use within the LYVGWMA is subject to the Yakima County Code. Most of the land within the GWMA is within the Agricultural Zone. Figure 16 illustrates Yakima County zoning districts within the LYVGWMA.

FIGURE 16 - YAKIMA COUNTY ZONING WITHIN LYVGWMA



Water Use

The lower Yakima Valley, south of Union Gap, is semi-arid with a mean annual precipitation of 6.8 inches. Precipitation and snowpack in the Cascade Mountains provide the source water and natural storage capacity for the Yakima River and the primary irrigation supply. Diversions from the River are equivalent to about 60% of its mean annual flow.[5] Five major reservoirs in the Cascade Mountains, with the total capacity of 1,065,400 acre-feet (ac-ft), provide 40% of the April to October water users' entitlements (2,490,755 ac-ft).[6]

Surface and groundwater use within the GWMA is conducted pursuant to individual water rights recognized by the Washington State Department of Ecology.

Irrigation water can also be drawn from wells. Under the Washington State Groundwater code (RCW 90.44.050), prospective groundwater users must obtain authorization of a water right for irrigation (other than that exempted by the statute). Post-1945 well-drilling technologies, legal rulings, and the onset of a multi-year dry period in 1977 stimulated the drilling of numerous irrigation wells. Population growth in the basin as also resulted in an increase drilling of shallow domestic wells as well as deeper public - supply wells. There are now more than 20,000 wells in the basin, more than 70 percent of which are shallow, 10–250 ft deep, domestic wells. The Department of Ecology's online water-rights database indicates that there are 2,874 active groundwater rights associated with wells in the Yakima basin. They collectively withdraw about 529,231 acre-ft during dry years. The irrigation rights are for the irrigation of about 129,570 acres. There are about 16,600 groundwater claims in the basin, for some 270,000 acre-ft of groundwater. (USGS 2011). The more limited numbers of groundwater irrigation rights and acreage watered by groundwater specifically within the LYVGWMA has not been determined.

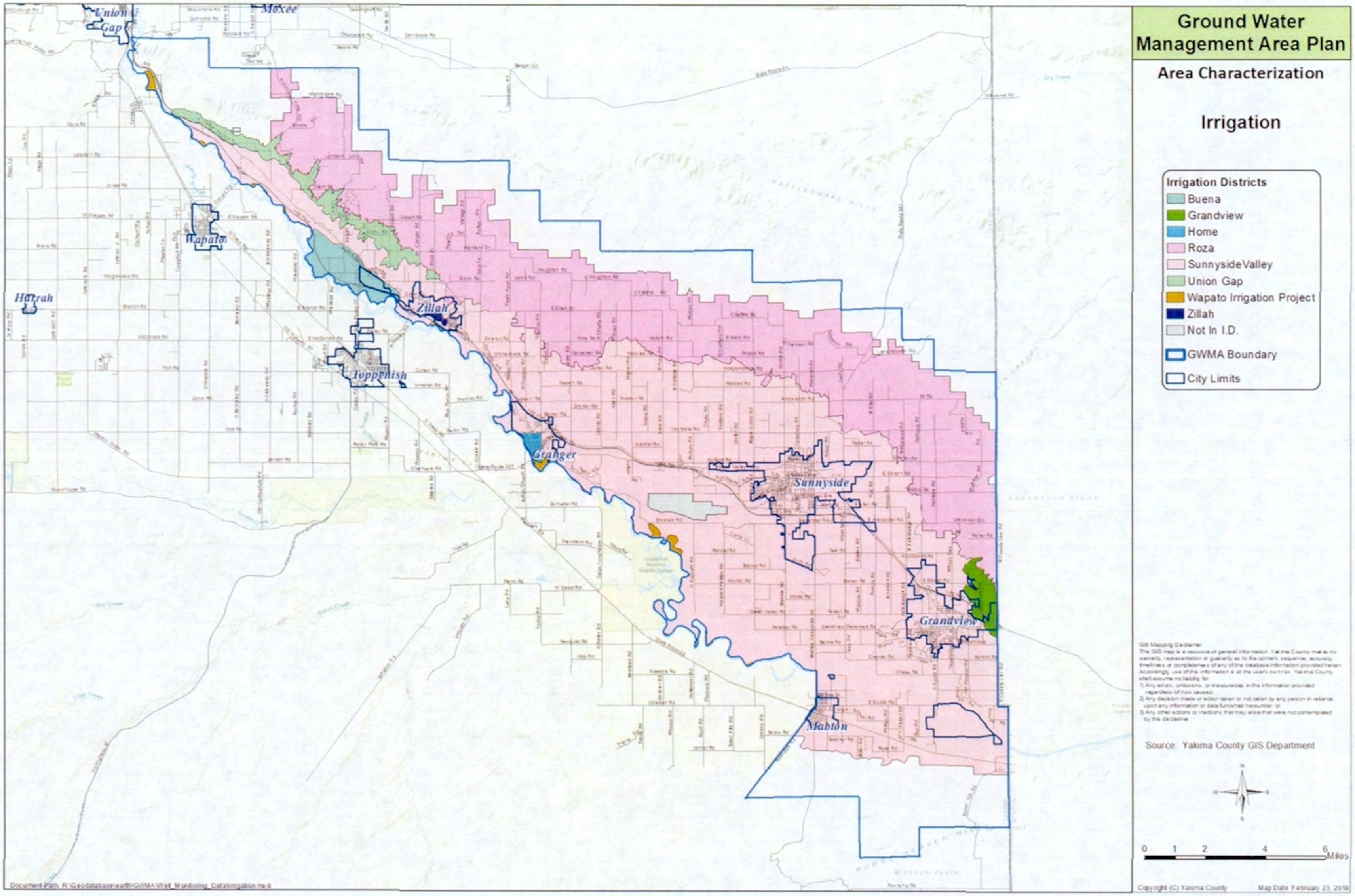
The three largest irrigation providers in the lower valley are the Wapato Irrigation Project, Sunnyside Valley Irrigation District, and the Roza Irrigation District. Wapato Irrigation Project serves irrigators within the Yakama Indian Reservation and is managed by the U.S. Bureau of Indian

[5] The mean annual run-off of the Yakima River varies greatly; for example, 1.3 million ac-ft in 1977, the lowest water-year on record, and 4.4 million ac-ft in the abundant water year of 1999. The mean annual irrigation diversion from 1961 to 1990 was 2.2 million ac-ft. Mean annual streamflow from 1961 to 1985 was 2.6 million ac-ft at Kiona.

[6] Bumping Dam (1910, Kachess Dam (1912), Clear Creek Dam (1914), Keechelus Dam (1917), Tieton Dam (Rimrock Lake) (1925), Cle Elum Dam (1933). About 78 percent of storage capacity is in the upper arm of the Yakima River and 22 percent is in the Naches River arm.

Affairs on behalf of the U.S. Bureau of Reclamation. In 2012, the Sunnyside Valley Irrigation District (SVID) served 94,614 acres on the valley floor and lower slopes. The Roza Irrigation District (RID) served 72,491 acres, some of which are not within the LYVGWMA, at higher elevations. Those within the LYVGWMA are on the north slopes of the valley. (WSDA 2013) Diverse crops are grown in both of the latter districts but, generally, forage crops dominate the SVID and tree fruits dominate the RID. SVID diverts its water near Parker into a 60-mile canal. RID diverts its water from the Yakima River upstream of the City of Selah into a 94.8-mile canal. Both canals end, returning tail water to the Yakima River, near Benton City. From the canals, water is delivered through 709 miles of laterals to over 5,300 individual deliveries. Diversions usually begin in March to prime the canal system and cease in mid-October. On-farm deliveries typically begin in early April. (Joint Board 2009) Figure 17 shows the service areas of the SVID and RID within the LVYGWMA.

FIGURE 17 – Sunnyside Valley and Roza Irrigation Districts within the LVYGWMA



Irrigation Methods

Irrigation in the Yakima River Basin is accomplished using one of three methods: rill, sprinkler, or drip. Rill (or gravity) irrigation is the oldest and simplest form in use. In its simplest form, an open channel (head ditch) delivers water to the high point of a field. Water is siphoned out of the head ditch and into small furrows cut into the field between each crop row. Water exits the furrows at the low point of the field, and is collected in a second open channel (tail ditch). The tailwater in the tail ditch is routed to a drain that feeds into the regional drainage network. On many rill-irrigated fields, the open head ditch has been replaced with PVC pipe. Instead of siphon tubes, manually operated spigots or sliding gates direct irrigation water into the furrows.

A variety of sprinkler systems are used throughout the Yakima River Basin, and each system varies in its efficiency of delivering water. Portable solid set, wheel lines, and big guns are examples of simple systems to operate, but typically do not provide a uniform coverage of water to a field. They also require manual labor to move from place to place in a field. Fixed solid set, center pivots, and liners are more expensive to install and more complex to operate, but they provide a more even coverage and give the farmer greater control over the irrigation process. These systems can be fully automated, enabling the farmer to irrigate a large area with less labor. The most sophisticated systems use feedback from soil-moisture probes to cycle the irrigation system off and on. (USGS 2004).

Drip irrigation employs plastic lines with small openings to deliver water directly to the base of the plant. The drip lines may be installed above or below the soil. A properly operating drip-irrigation system enables a farmer to make maximum use of his allotment of water—very little water is lost to evaporation, no tailwater is generated, and virtually no water is lost to the ground-water system. Drip systems also enable the farmer to deliver nutrients and some pesticides through the lines, significantly reducing the amount of chemicals used on the field and reducing the potential for the chemical to leave the field. (USGS 2004).

Sprinkler irrigation systems increased in the Roza and Sunnyside Irrigation Districts between 2005 and 2012, the years in which records are available. Rill (gravity) irrigation systems have decreased. Sprinkler irrigation in those districts is somewhat lower than it is statewide. Low-flow drip irrigation had increased to 26.16% of the acreage in the Roza District by 2010. (WSDA 2013).

Demographics

Population

Yakima County Quick Facts

- Eighth largest county in state by population: 244,654
- 2nd largest county in State by land mass: 4,311 square miles
- 14 Cities and Towns
- GWMA population: 56,210
- GWMA population living in a rural area: 19,952
- Source: figure derived using ARCGIS, a geographic information system, in combination with the 2010 Decennial Census. (See original text)

Where People Live

There are 14 cities in Yakima County. Five of those cities are in the LYV GWMA —Sunnyside, Grandview, Granger, Zillah and Mabton. Over half of the GWMA's residents live in those cities—10,158 of its 16,260 households:

- City of Sunnyside-4,556 households
- City of Grandview-3,136 Households
- City of Granger-813 Households
- City of Zillah-1,105 Households
- City of Mabton-2,548 Households

The remaining 6,511 households reside in an unincorporated area. Most of those remaining households– approximately 6,185 (19,952 individuals) – reside in a rural area not served by public water or sewer. These residents typically rely on a private or shared well for their drinking water. A nearly equal number rely on an on-site sewage system (OSS, or septic system) to dispose of their waste.

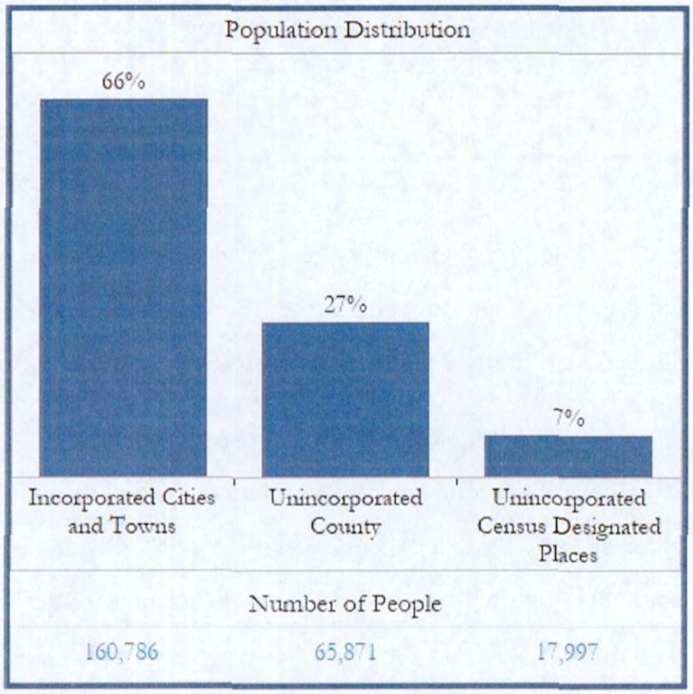


FIGURE 21 – POPULATION DISTRIBUTION

In the GWMA, economics and livelihood play a critical role in the decision to live in a rural area instead of an urban one. Affordable housing is a draw to rural areas, and so is the proximity to agricultural-related employment. Farmers, for example, usually live on or near the acreage they farm.

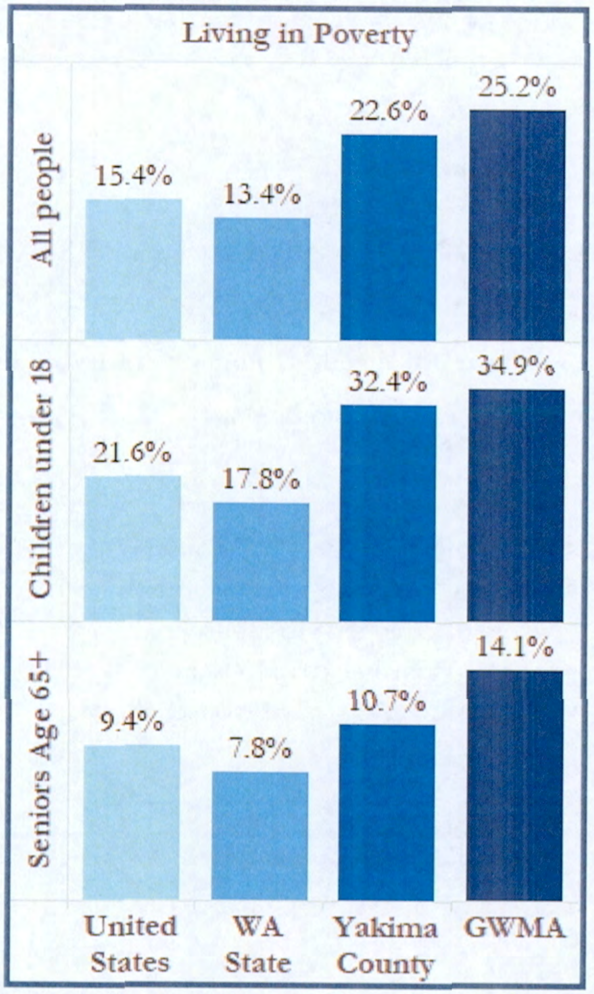


FIGURE 22 - POVERTY

However, other factors are at play in addition to affordable housing and agricultural. In recent decades in Yakima County, large-tract farmsteads have been parceled off and sold in smaller pieces over time. The smaller parcels were not large enough to make a living at farming, but they did offer part-time farming opportunities for people already employed in seeking a country lifestyle. This is perhaps the chief characteristic of "rural" living in Yakima County and the GWMA [Horizon 2040 5.9.4 Rural Lands-Existing Conditions]. The desire for a "country" environment in part accounts for the growing number of rural GWMA households— ranging in property size from .5 to 10 acres— whose distance from urban areas preclude them from receiving municipal water or sewer services.

Income and Poverty

The U.S. Census (5-Year American Community Survey for the years 2009-2013), has Yakima County's median household income at $43,506, well below the $59,478 median for Washington State. The County's per capita income was $19,433, compared to $30,742 for the State.

According to the U.S. Census (5-Year American Community Survey for the years 2009-2013), 22.6 percent of the population of Yakima County was living below the poverty level, an increase of 2.4 percent since 1990. In comparison, only 13.4 percent of all persons in Washington State live below the poverty level [Yakima County's Comprehensive Plan, Horizon 2040-GMA Update June 2017]

The population of the GWMA is generally poorer than the rest of Yakima County, with over a quarter of the GWMA's population living in poverty. There is also a higher percentage of children in the GWMA living in poverty which is in line with the larger percentages of children living there.

Education

The educational disparity between the State, Yakima County, and the GWMA is even greater than the income disparity. In Washington State, for example, 10 percent of the population did not graduate from high school or receive a high school diploma. In Yakima County that rate is almost 3 times higher at 29 percent. Yet in the GWMA it is almost 4 times higher than the state at 39.6 percent. In some GWMA pockets the span is even greater: in the city of Mabton, which lies in the southeast section of the GWMA, 28.1 percent of the population over the age of 25 has less than a ninth-grade education.

Households and Families

The average household size in the GWMA ranges from 3.36 to 3.98 people per household, larger than the County (3.02 people) and State (2.54 people). Average family size in the GWMA ranges from 3.72 to 4.38 people—again, larger than the average County family size (3.53) or the State (3.11). In the GWMA, 80.2 percent of all households are comprised of families compared to 73.0 percent for the County and 64.5 percent for the State.

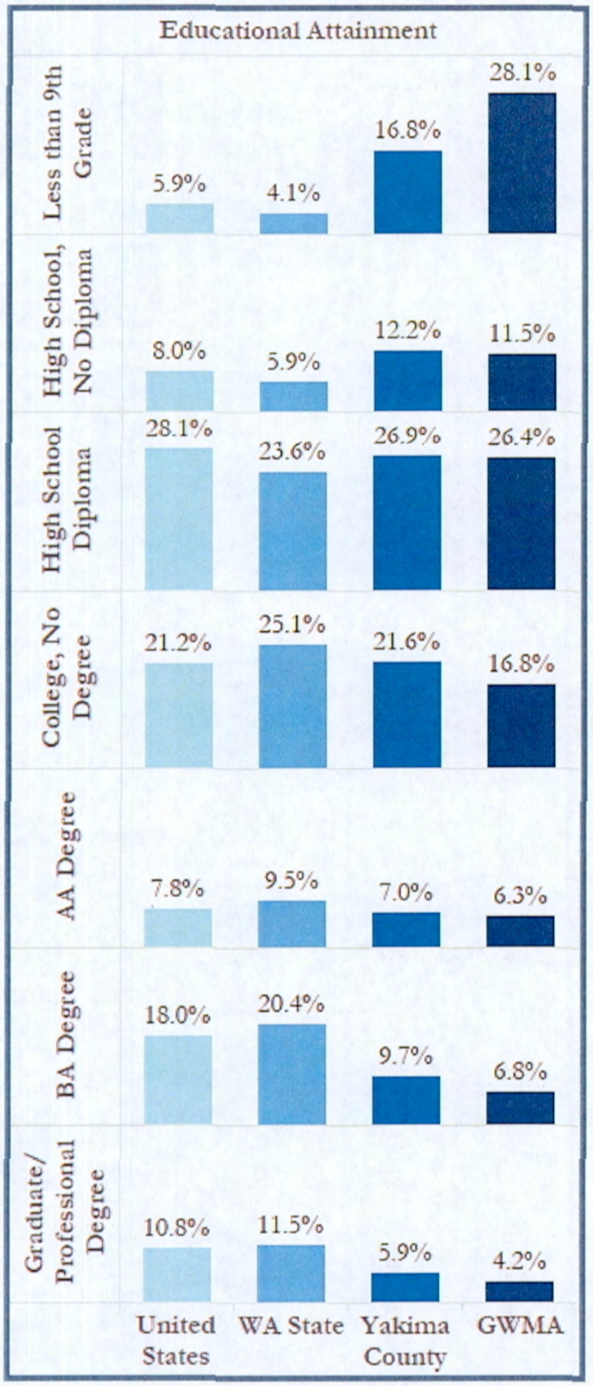


FIGURE 23 – EDUCATIONAL ATTAINMENT

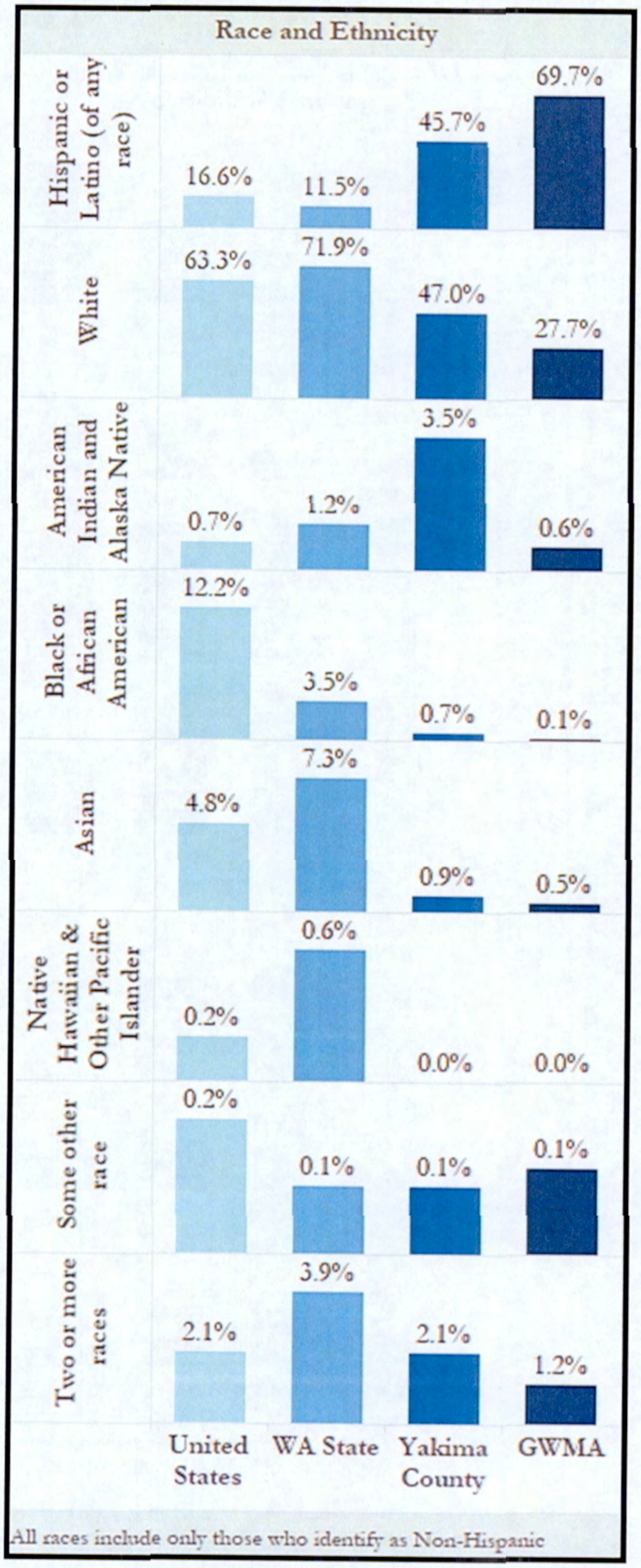


FIGURE 24 – RACE AND ETHNICITY

Race and Ethnicity

The GWMA has a higher concentration of individuals whose ethnicity is Hispanic/Latino compared to Yakima County, Washington State, or the Nation, and a lower concentration of American Indian/Alaska natives and Blacks/African-Americans.

Within Yakima County there is a wide gap between communities for both race and ethnicity. For example, the range for individuals who are Hispanic/Latino ranges from 0.4 percent in the city of Naches to 96.1 percent in the City of Mabton. Additionally, the range of individuals who are American Indian/Alaskan Native ranges from 0.0 percent in the city of Selah to 21.7 percent of the town of Harrah, which is located outside of the GWMA on the Yakama Indian Reservation.

The racial groups of Asian, Black or African-American, and native Hawaiian or other Pacific Islander represent a very small part of the population in the GWMA as well as Yakima County when compared to the State and the Nation.

Language

60 percent of people in the GWMA do not speak English at home.

In Yakima County, 39.6 percent of the population over age 5 speaks a language other than English at home (predominantly Spanish). 18.6 percent speak English less than "very well" indicating that the other 21.0 percent a bilingual. In the GWMA, 60.6 percent of the population over five speaks a language other than English at home – 24 percent speak English less than "very well" indicating that the other 36.4 percent are bilingual.

Environmental Effects

Nitrate

Nitrate is an acute contaminant. It is colorless and odorless. It is found in most fertilizers, manure, liquid waste from septic tanks, and food processing waste. Rain or irrigation water can carry nitrate down through the soil into groundwater. Drinking water wells may contain nitrate if they draw from this groundwater (Ecology 2010).

The Nitrogen Cycle

The Nitrogen Cycle was adequately described in the EPA's 2012 Report, "Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley":

Nitrogen is present in many chemical forms in the environment. Nitrogen gas (N2) composes about 78 percent of the atmosphere. Nitrite (NO2-), nitrate (NO3-) and organic nitrogen, ammonium (NH4) are also present.

Nitrogen is critical to plant growth. It aids in the formation and function of cellular tissue, proteins, and reproductive structures. Nitrogen can be supplied to plants through the application of synthetic fertilizers or animal waste products or by the organic decomposition of other plants. Atmospheric nitrogen must be processed, or fixed, to be used by plants. The majority of fixation occurs by bacteria. Small quantities of nitrate may wash out of the atmosphere from aerosol salt particles from the ocean or dusts from arid regions, or from fossil fuel combustion. (EPA 2013)

Important processes in the nitrogen cycle include nitrogen fixation, mineralization, nitrification, and denitrification. The mobility of nitrogen is highly dependent on its form and the matrix through which it moves. Organic nitrogen is nearly immobile. Mineralization occurs when organic nitrogen in the soil is converted by bacteria into ammonium (NH4). Nitrification occurs as ammonium is biologically oxided to become nitrite. Nitrate is then biologically oxidized to become nitrate as it moves through the vadose zone.

Nitrate is the most mobile form of nitrogen in both the vadose and saturated zones. Nitrate moves quickly in the saturated zone, together with migrating groundwater. Its mobility is enhanced by the action of negatively charged soil particles, which repel the negatively charged nitrate ion. (USGS 2000b). In the absence of denitrification, nitrate moves with the groundwater until the groundwater is discharged to surface water, or extracted from a well. Denitrification is the conversion of nitrate back into nitrogen gas (N2) by bacteria. It occurs in poorly drained, anoxic conditions or organic soils where oxygen is depleted in the root zone. (EPA 2013).

Nitrate Leaching

"Leaching" is the process of the removal of soluble material from a substance through the percolation of water. Nitrate can "leach" from the agricultural soils to the elevation of the groundwater aquifer. "The increase in groundwater nitrate concentration measured in domestic wells, irrigation wells, and public supply wells lags significantly behind the actual time of nitrate discharge from the land surface. The lag is due, first, to travel time between the land surface, which ranges from less than one year in areas with shallow water table to several years or even decades where the water table is deep. High water recharge rates shorten travel time to a deep water table, but in irrigated areas with high irrigation efficiency and low recharge rates, the transfer to a deep water table may take many decades." (Harter 2012)

Attenuation, Soils and Climate

Attenuation of nitrogen in Lower Yakima Valley soils, or the gradual loss in intensity of the amount of nitrates in flux through the soil profile, depends upon the specific type and condition of the local soils, micro-environment and, where the overlying property is farmed, the particular horticultural variety being farmed. Attenuation is more likely in the near-surface root zone of agricultural activities than in the deeper soils or deeper geologic strata.

Health Effects to People and Animals

Exposure to excessive nitrate concentrations can reduce the ability of red blood cells to carry oxygen. (Harter 2012) In most adults and children these red blood cells rapidly return to normal. However, in infants it can take much longer. Infants who drink water with high levels of nitrate (or eat foods made with nitrate contaminated water) may develop a serious health condition due to the lack of oxygen. This condition is called methemoglobinemia or "blue baby syndrome."

> "Infants younger than 6 months may develop acquired methemoglobinemia from contaminated well water that has excess nitrates. Bacteria in a baby's digestive system mixes with the nitrates and leads to methemoglobinemia. Fully developed digestive systems keep children older than 6 months and adults from developing this nitrate poisoning." (McDowell/Biggers 2017)

While the problem is relatively well understood, there are no accurate statistics on its occurrence. Acute cases do occur, but there have been no deaths reported by medical professionals within the GWMA since it was established.

Bottled water is recommended for use in babies' foods and drinks. Although boiling water kills bacteria, it will not remove chemicals such as nitrate. In fact, boiling may actually increase the nitrate level. "Some studies have shown a positive association between long term exposure to nitrate exposure in drinking water and risk of cancer and certain reproductive outcomes." (EPA 2013, Ward 2005) Other studies have shown no association. (Ward 2005, Avery 1999). As nitrates rise in water supplies, the potential for increasing the health risk rises.

An infant with moderate to serious "blue baby syndrome" may have a brownish-blue skin tone due to lack of oxygen. This condition may be hard to detect in infants with dark skin. Infant discolorization is not required to be reported by physicians as health effects data. An infant with mild to moderate "blue baby syndrome" may have symptoms similar to a cold or other infection (fussy, tired, diarrhea or vomiting). While there is a simple blood test to see if an infant has "blue baby syndrome," doctors may not think to do this test for babies with mild to moderate symptoms.

The best way to prevent "blue baby syndrome," is to avoid giving babies water that may be contaminated with nitrate or foods that are high in nitrate. Infants less than one-year-old should not be given drinking water with nitrate levels more than 10 ppm. High-nitrate vegetables such as beets, broccoli, carrots, cauliflower, green beans, spinach, and turnips should not be offered until after six months of age. If a baby has a brownish-blue skin tone, he or she should be taken to a hospital immediately. A medication called "methylene blue" will quickly return the baby's blood to normal.

Red blood cells in older children and adults quickly return to normal. However, some health conditions make people susceptible to health problems from nitrate. They include individuals who don't have enough stomach acids and individuals with an inherited lack of the enzyme that converts affected red blood cells back to normal (methemoglobin reductase).

The *Preliminary Assessment* concluded that over 2,000 people in the area are exposed to nitrate over the maximum contaminant level (MCL) through their drinking water. (EPA 2010) But it also found that not all water supplies in the area have been affected, particularly including public water system supply. Public water systems are regularly monitored for suspected contaminants. They must meet national and state drinking water standards, and public systems that use contaminated water are required by law to treat the water, thus maintaining a safe supply of drinking water to their customers. Until treatment has been installed, or if the treatment isn't working, public water systems must notify their users if nitrate levels exceed the standard.

The *Preliminary Assessment* found that many families of the Lower Yakima Valley are served by private wells and do not have access to public water systems. Regular testing of drinking water is not required for private water wells. The *Preliminary Assessment* concluded that "There is sufficient data to suggest that many of these well water supplies are at risk, even if they do not currently exceed a drinking water standard." (Ecology 2010). The Valley Institute for Research and Education collected data from the wells of low income households in 2001 and 2002. In some areas, up to 40 percent of the wells sampled were above 5 mg/L nitrate, a level below the 10 mg/L Drinking Water Standard., but nevertheless recognized in the *Preliminary Assessment* as a concern. The LYVGWMA has caused testing of private groundwater wells to occur since it was organized. The data collected from that testing is set forth below under the section entitled "Investigation and Analysis"

Owners of private wells who are unsure about their water quality may have their water tested for coliform bacteria and nitrate. The Yakima Health District (YHD) can advise where to get water tested and has specific recommendations for testing. Many certified labs in Washington charge $20 to $40 per test. If nitrate test results are over 8 mg/L, annual testing is recommended. If results are less than 8 mg/L, testing every three years is recommended.

The *Preliminary Assessment* expressed the concern that those who rely on private well water may not know the quality of the drinking water within their homes. They may not use tested wells, and if so, they may not know how to interpret the test results. Many residents are renters and are not the property or well owners. The well owner of record may not be the current property owner. Current property owners may not live on the property. Property owners may fear or question the implications of owning a contaminated well (in terms of liability, responsibility, property values, and access to safe and affordable housing) (Ecology 2010).

Nitrates in groundwater may impact both domestic animals and wildlife. This can be either directly by ingestion, or indirectly through impacts to habitats, where groundwater discharging to surface water contributes to nutrient loading of streams, lakes, and wetlands.

The *Preliminary Assessment* found that nitrate-nitrogen concentrations are greatest in shallow groundwater. Shallow wells, poorly sealed or constructed wells, and wells that draw from shallow aquifers are at greatest risk of nitrate contamination. Manure and septic-tank waste may also contain disease-causing bacteria and viruses. Nitrate levels in well water can vary throughout the year. A significant decrease in nitrate-nitrogen concentrations was found in groundwater samples collected from depths below 300 feet. The highest percentage of samples exceeding State Drinking Water Standards (10 mg/l nitrate-nitrogen) was obtained from shallow wells (less than 300 feet deep), a well depth typical of most private domestic drinking water wells. (EPA 2013)

Yakima River Surface Water Quality

The USGS' Hydrogeologic Framework the Yakima River Basin Aquifer System (USGS 2009a) posited an hydrologic connection between the surface water within the Yakima River and the groundwater beneath lands adjacent to the river. However, no direct correlation has been established between nitrogen in groundwater and nitrogen in the Yakima River.

Section 303(d) of the CWA, 33 U.S.C., § 1313(d), requires states to identify waters where current pollution control technologies alone cannot meet the water quality standards set for that waterbody. Every two years, states are required to submit a list of impaired waters plus any that may soon become impaired to EPA for approval. The impaired waters are prioritized based on the severity of the pollution and the designated use of the waterbody (e.g., fish propagation or human recreation). States must establish the "total maximum daily load(s)" of the pollutant(s) in the waterbody for impaired waters on their list.

A "total maximum daily load" or "TMDL" is the amount of a specific pollutant that a waterbody can receive and still meet water quality standards. A TMDL is made up of the sum of all the point source loads ("wasteload allocation") and load associated with nonpoint sources and background sources ("load allocation"). TMDLs must include a margin of safety (explicit or implicit) and consider seasonal variations. Potential wasteload allocations include background, groundwater inflow, diffuse runoff, irrigated agriculture return flow, agricultural stormwater, atmospheric deposition, nonpoint sources, stormwater point sources, and non-stormwater point sources.

Numerous water quality assessments of the Yakima River are contained within Washington State's 303(d) list. Primary Yakima River surface water quality problems of concern are temperature, dissolved oxygen (DO) and acidity (pH). Nitrogen is an aquatic nutrient in surface water, which contributes to algae growth, but not included in the Yakima River's surface water quality problems.

Ecology has proposed three TMDL projects within the Lower Yakima River area. Two have been approved by the EPA. They are: Lower Yakima River Suspended Sediment and DDT TMDL—project approved for DDT and TSS parameters. (Ecology 1997) Granger Drain Bacteria TMDL—project approved for fecal coliform bacteria parameter. (Ecology 2002) The third is in development.

Sources of Nitrate and the Regulatory Environment

Groundwater quality in Washington is regulated by the federal Safe Drinking Water Act and Clean Water Act, the state Water Pollution Control Act and Water Resources Act and the State Department of Health's authorizing statute.

While we have attempted to make this document as readable as possible, this section contains in-depth discussion of scientific and regulatory topics. As a result, clarity of language may suffer.

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. "States are responsible for reviewing, establishing, and revising water quality standards." "States may develop water quality standards more stringent than required" by federal regulations 40 CFR § 131.4 (a). DOE has adopted Chapter 173-200 WAC, *Water quality standards for groundwaters of the State of Washington.* Washington's drinking water quality standard for nitrate is 10 milligrams per liter (mg/L), or 10 parts per million (ppm). State law requires public water systems to sample for many contaminants, including nitrate, on a regular basis. Public water systems with nitrate levels over 10 ppm must notify the people who receive water from them.

DOE's groundwater regulations, WAC 173-200, implement Washington's Water Pollution Control Act, Ch. 90.48 RCW, and Water Resources Act of 1971, Ch. 90.54 RCW. The goal of the regulations is to maintain the highest quality of the state's groundwaters and protect existing and future beneficial uses of the groundwater through the reduction or elimination of the discharge of contaminants to the state's groundwaters. The regulations set groundwater quality standards that, together with the state's technology-based treatment requirements, seek to protect the environment, human health and existing and future beneficial uses of groundwaters. The regulations apply to all groundwaters of the state that occur in a saturated zone or stratum beneath the surface of land or below a surface water body. They do not apply to:

(a) contaminant concentrations found in saturated soils where those contaminants are chemicals or nutrients that have been applied at agronomic rates for agricultural purposes if those contaminants will not cause pollution of any groundwaters below the root zone;

(b) contaminant concentrations found in saturated soils where those contaminants are constituents that have been applied at approved rates and under approved methods of land treatment if those contaminants will not cause pollution of any groundwaters below the root zone; or

(c) clean up actions approved by the Department under the Model Toxics Control Act, ch. 70.105D RCW, or approved by the United States Environmental Protection Agency under the Comprehensive Environmental Response Compensation and Liability Act, 42 U.S.C. 9601 et seq., WAC 173-200-010.

WAC 173-200-040 (2) establishes "groundwater concentrations" that groundwaters of the state may not exceed. Nitrate concentrations in groundwater may not exceed 10 mg/L. WAC 173-200-040 (2) (Table 1).

> No person shall engage in any activity that violates or causes the violation of [ch. 173-200 WAC]." WAC 173-200-100 (2).

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 DOE 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 DOE 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.

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 "wilfull," 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.

Clean Water Act

The Clean Water Act, 33 U.S.C. §1251 et seq., establishes the basic structure for regulating discharges of pollutants into the waters of the United States. Under the Clean Water Act, states develop water quality standards to protect waters of the U.S. EPA approves those standards. The standards are comprised of: criteria, designated uses and antidegredation. Those standards are used to establish effluent limits in NPDES permit. If standards are not being attained in a water body, then the states must add the water body to their §303(d) impaired water body list and develop total maximum daily loads, "TMDLs," for the water body. These TMDL's should set forth an implementation plan for ultimately achieving water quality standards in the impaired water body. 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) NPDES permitting authority has been delegated to the DOE. (33 U.S.C. 1342 (b)).

The DOE is the primary agency in Washington State responsible for the protection of both ground and surface water quality. DOE's Water Quality Program operates primarily pursuant to the Water Pollution Control Act, Chapter 90.48 RCW. The Act 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)

DOE may implement measures to protect both ground and surface waters from pollutants, and has established regulations for the protection of ground and surface water quality, permitting of discharging activities, and financing of water quality protection activities. This regulation lists numerical limits for specific contaminants ("water quality criteria") that apply to all groundwaters in the state. These criteria are used when evaluating the performance of permitted discharge activities (such as sprayfields and holding ponds), implemented best management practices, or when conducting clean-up activities at historical or current waste sites.

DOE's water quality standards incorporate an "antidegradation policy," an otherwise existing part of state water quality law (WAC 173-200-030). This policy forbids degradation which would harm existing or future beneficial uses of groundwater (drinking water, irrigation and support of wildlife habitat). The standards provide numeric values which must not be exceeded to protect the beneficial use of drinking water. Washington's water quality standards are enforceable through DOE's actions. Washington's Water Pollution Control Act authorizes DOE 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).

DOE's water quality standards 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.

DOE's permits describe penalty provisions which may be put into effect if discharge limitations (or other conditions specified in the permit) are not met. DOE has the enforcement discretion to impose those penalties.

"General permits" 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 have been issued to industries and municipalities for treated discharges into surface waters such as Sulphur Creek Wasteway or the Yakima River.

General permits establish standards for management. The standards apply to all underground waters in the saturated zone (generally at or below the water table), but do not apply in the root zone of saturated soils where agricultural pesticides and nutrients have been applied at agronomic rates for agricultural purposes and pollution does not occur below the root zone. (WAC 173.200.010(3)(a)).

General permits are issued for fixed terms not exceeding five years from the effective date. Point source facility operators must apply to the DOE 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 the DOE, or the expired general permit has been terminated by the DOE. 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 DOE which indicates that cumulative effects on the environment from dischargers covered under the general permit are unacceptable. (WAC 173-226-230 (1)(d)) DOE 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 the DOE to require a discharger authorized by a general permit to apply for and obtain an individual permit. (WAC 173-226-240 (2), (3))

DOE 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 DOE 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))

Currently, the permit framework is reactive, a permit is not required unless there is or was a documented discharge to surface waters. The permitting process now requires a facility to submit a complete Nutrient Management Plan with the permit application. The Nutrient Management Plan is approved by DOE and becomes the facility's effluent limitation. After a facility is permitted, it must submit an updated Nutrient Management Plan if it wants to make changes to its operation.

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 program—a program that relates to discharges to surface water only.

State Department of Health

DOH 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.

DOH 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).

DOH is 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)

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 chemical fertilizers applied to the soil in amounts greater that can be used as fertilizers or soil conditioners may be the disposal of solid waste.

Irrigated Agriculture

There are 360,906 acres of crops in Yakima County. 96,459 (27 percent) of those acres are located within the GWMA (WSDA 2017b). In 2015, irrigated agriculture within the GWMA occupied 55 percent of the total land area within the GWMA boundaries (175,161 acres). (WSDA 2017b).

Most crops grown in the GWMA have the potential for positive nitrogen loading under some management practices. WSDA 2015 crop data shows that there is a large and diverse number of crops grown in the GWMA. The top 15 crops by acreage represent 96 percent of the irrigated agricultural land within the GWMA. Each crop has a unique cultivation practice.

Anecdotal information provided by members of the GWMA's Irrigated Agriculture Working Group indicates that growers do not want to over-irrigate and have disincentives to over-applying commercial fertilizers.

The native organic matter content of lower Yakima soils is around one percent but when these soils have a history of organic inputs such as manure, there can be an increase in organic matter levels of two to three percent. In general, organic matter in soils can mineralize to provide between 20 and 65 lbs N per one percent organic matter for crop utilization.

Nitrogen from organic matter becomes available for crop uptake as well as losses including leaching below the crop root zone with water.

The South Yakima Conservation District completed a Deep Soil Sampling project for the Irrigated Agriculture Work Group. The sampling data from the project, including 163 samples taken in spring and fall have been assembled by Yakima County Public Services.

a. Crops Supporting Livestock Operations

A significant portion of irrigated agricultural acreage within the GWMA (31,790 acres or 32 percent) is dedicated to crops and land uses (corn, triticale, pasture, and alfalfa) that support dairy or other livestock operations. The majority of manure and compost applications observed by representatives of the WSDA during interviews with farmers and crop consultants were taking place on crops intended for animal feed.

Triticale is "double-cropped" (two crops in one growing year). Triticale is planted in the fall (September-October) and harvested in the spring (April-May). Silage corn is seeded immediately afterward and harvested in late summer or fall (August-September).

Alfalfa is also planted. Alfalfa is a complex perennial crop. It removes large quantities of nutrients from the soil (Pacific Northwest Extension Publication PNW0611). It can meet most of its nitrogen needs from the atmosphere through nitrogen fixation, but is dependent both on the presence of rhizobia bacteria in the soil and on whether or not supplemental nitrogen is added. Alfalfa is considered a "lazy" plant and will use nitrogen from other sources such as manure or commercial fertilizer if given the chance. The practice of nitrogen supplementation on alfalfa does occur within the GWMA. However, agricultural practices used for perennial crops like alfalfa and pasture remove the majority of the plant residue from the field during harvest (hay/silage) or through grazing.

Based on a DOE survey during 1998-2003, 29 percent of the irrigated acres in the Granger drainage and 12 percent in the Sulphur drainage were owned by dairies (Laurie Crowe, South Yakima Conservation District, personal communication, February 2004) and there were 20, 24, 2, and 0 dairies in Granger, Sulphur, Spring and Snipes drainages, respectively. (RSJB 2009).

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. 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.

b. Tree Fruit and Vegetable Crops

The other main crops in the region are tree fruit, grapes (both juice and wine), hops, wheat, mint, and asparagus. The orchard and vineyard crops, e.g., apples, grapes, cherries, pears, peaches/nectarines are permanent crops.

Fertilizers

Fertilizers available within the GWMA include commercial fertilizer, manure, or compost. There is no current measured data regarding the distribution of the amounts of these three nitrogen sources within the GWMA. WSDA interviews with farmers and crop consultants indicate that the most commonly used product is commercial fertilizer. The only exceptions were silage corn and triticale, where more acres were fertilized with manure than with commercial fertilizer. The only crops where growers or crop consultants reported use of all three fertilizer products were hops and triticale.

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.

Chemigation procedures are described by regulations of the Department of Agriculture. Ch. 16-202 WAC. 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.

Fertilizer application timing can affect nitrogen availability for plant uptake and resultant leaching of excess nitrogen. For instance, synthetic fertilizers are formulated to release a specific amount of nutrients at a specific rate over a select period of time. Nitrogen from compost or manure would be released over a much longer period of time at a much lower rate. Crop fertilizers (manure, compost, and synthetic fertilizer) also react differently at the point of application. Compost or manure also contain components with soil health improvement properties.

Generally, crop fertilizer application choices are affected by several parameters including fertilizer type, crop nitrogen needs, application recommendations, expected crop pricing, and anticipated yields. They also may be influenced by recommendations from crop consultants and fertilizer guides, historical practices, and practices of other growers in the community. This variability, in combination with effects of fertilizer types used, irrigation type and practices, and nutrient application timing, soil type and organic matter content, soil nutrient content, manure nutrient content, handling, and storage before application, organic carbon cycling and mineralization, and fertilizer fixing in alfalfa will all affect whether or not any fertilizer application represents a nitrogen loading risk. (Alfalfa will resort to fixing nitrogen (i.e., create its own nitrogen by pulling it out of the air) only if there is insufficient nitrogen already in the soil. If there is sufficient nitrogen in the soil, it will utilize the soil nitrogen first.)

Generally speaking, fertilizers of any type should be applied only at an "agronomic rate," that is, the rate of application of nutrients to supply crop or plant nutrient needs to achieve realistic yields, while at the same time minimizing the movements of nutrients to surface and ground waters. Cf. WAC 16-611-010.

Further information should be developed about the use of each of the three fertilization materials, as well as information about application timing and specific application site characterization prior to application.

a. Crops Supporting Livestock Operations

Annual crops such as silage corn, triticale (for silage) and wheat use both commercial nitrogen and manure throughout the GWMA. Generally, the nitrogen application for this corn/triticale cropping system is split - one in the fall and one in the spring. Corn (silage and grain) use fairly even amounts of commercial nitrogen and manure on most of the acreage.

b. Tree Fruit and Vegetable Crops

High nutrient applications or application of multiple nutrient sources may be used on permanent tree fruit and vegetable crops to improve soil health and maximize fruit production. Producers of crops intended for human consumption may be reluctant to make manure and compost application because of concerns about pathogen transfer, reducing fertilization options.

c. Organic Fertilizers: Cover Crops, Manure and Compost

Cover crops can fix nitrogen within the soil, if plowed into the soil onsite. The variety of cover crop and number of years of integration of cover-crops into the soil can affect overall nitrogen concentrations in the soil.

Manure from dairy and livestock operations within the GWMA is a widely-used source of organic fertilizer for irrigated crops within the GWMA. While total volume of manure production can be calculated, as a function of total animals, no public records are currently maintained from which to analyze whether, in gross (minus exportation of such materials), the application of such volume on available irrigated acreage within the GWMA equates to an agronomic rate in-gross. Some pre-application site-specific soil characterization is practiced, so as to accomplish specific site application at an agronomic rate.

Manure contains two primary forms of nitrogen: ammonium and organic nitrogen. Organic nitrogen is nearly immobile. It becomes mobile, and available to crops as fertilizer, through mineralization, the process by which soil microbes decompose organic nitrogen into ammonium. The rate of mineralization varies with soil temperature, soil moisture, and the amount of oxygen in the soil. After mineralization, microorganisms within the soil convert ammonium into nitrate. This process, called nitrification, occurs most rapidly when the soil is warm, moist, and well-aerated.

Although livestock wastes contain low concentrations of nitrogen relative to inorganic fertilizer, it is difficult to estimate nitrogen loading to soil, air and water from manure application without sufficient analysis of nitrogen content in these waste streams. These are subject to some nitrogen loss to air and soil under natural conditions.

The Dairy Nutrient Management Act requires that manure transfer records, including imports or exports, be maintained by dairies that transfer ownership of manure to others. These records should include date of manure transfer; amount of nutrients transferred, the name of the persons 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.

d. Synthetic Fertilizers

There is no public record of the total amount of synthetic fertilizers sold or used within the GWMA. Anecdotal evidence suggests that the form of synthetic fertilizers has shifted, generally, from dry, granulated fertilizers to liquid fertilizers capable of simultaneous application with irrigation water ("fertigation").

Crop consultants or agronomists, either academic or mercantile (G.S. Long, Co., D & M Chemical, Bleyhl's, Wilbur-Ellis, Simplot, Crop Production Services, Husch and Husch) are used by the majority of commercial farms operating within the GWMA. There are only a few companies that do this type of work. These consultants are not usually farmers. They create prescriptions for pesticide and fertilizer applications across multiple crops on many different farms. Mercantile crop consultants have economic incentives to recommend larger applications of fertilizers. Agronomists without such incentives could review and evaluate such recommendations for farmers.

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.

Water Applications

Irrigation practices can affect both amounts and rates of nitrogen leaching and the potential for increased nitrogen concentrations in irrigation return flows (which relocate nitrogen applied through fertilizer).

The irrigation water nitrogen input is unique to each commodity. The average N concentration of high flow (late spring) and low flow (late summer) conditions of the Yakima River at Kiona during the 2012 irrigation season was 0.809 mg N/L. (USGS 2013)

Irrigated agriculture is mapped statewide by WSDA, including the area within the GWMA. There is no current measured data regarding the distribution of the three general irrigation methods (sprinkler, drip, macro/rill) within the GWMA. Interviews with farmers and crop consultants indicate that sprinkler irrigation was used on 61 percent of the total irrigated acreage in the GWMA, drip irrigation (including drip, micro sprinkler, drip/sprinkler, and combinations) was used on 23 percent of the acreage. Macro, or rill, irrigation was used on 15 percent of the acreage.

Silage corn and triticale cultivation is almost all irrigated with sprinkler or center pivot irrigation systems. Triticale cultivation rarely occurs on rill irrigated fields.

Any improperly decommissioned wells beneath livestock operations, including crop fields onto which waste is applied, could provide a direct conduit for contaminants to reach the groundwater.

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.

Livestock Operations/CAFOs and Groundwater Quality Regulation

a. Dairy Operations

The WSDA's Nitrogen Availability Assessment (WSDA 2017b) reported that USDA's 2012 estimate of dairy operations was 99,532 milk cows on 97 farms (USDA NASS 2014) in Yakima County. The majority, or near total of these, are thought to be located within the GWMA. According to WSDA, dairy farms are increasing in size while the number of farms is decreasing.

Manure and other animal wastes supply nutrients to crops because they contain nitrogen and other elements essential to plant growth, and that the recycling of animal nutrients to increase soil fertility and crop yield is a historic practice. Manures are recommended over commercial fertilizers where there is a desire to build the soil profile by increasing and diversifying soil organisms, increasing moisture holding capacity, and reducing the need for inputs. Manure is a "dairy nutrient" under Washington State's Dairy Nutrient Management Act. Ch. 90.64 RCW "'Dairy nutrient' means any organic waste produced by dairy cows or a dairy farm operation." RCW 90.64.010 (11)

Livestock operations have the potential to release nitrate, chloride, sulfate, and bacteria to surface or groundwater. (Harter, et al., 2002; Harter et al., 2012. Whether groundwater contamination occurs depends on contaminant characteristics, management practices, meteorological conditions, soil types, geological conditions, and groundwater characteristics. (Viers et al., 2012) Contaminant sources can be animal holding areas, manure storage impoundments (either lagoons or settling ponds/basins), and manure applications to cropland. (Harter et al 2002).

The national statistical average of manure production of milk cows (in 2000) was 15.24 tons per animal unit of manure excreted per year. The national statistical average of nitrogen per ton of manure excreted is 10.69 pounds of nitrogen per ton. (Kellog, et al., 2000). The formulas used by the EPA to calculate animal manure production, nitrogen production and losses due to volatilization or denitrification (EPA, 2012c, attributable to WSDA) in the Yakima Valley are as follows:

> Annual manure production is calculated using the following formula: [((# of milking cows)*1.4*108) + ((# of dry cows)*1.4*51) + ((# of heifers)*0.97*56) + ((# of calves *0.33*83)]*365/2000 (WSDA 2010)
>
> Nitrogen production is calculated using the following formula: [((# of milking cows)*1.4*.71) + ((# of dry cows)*1.4*.3) + ((# of heifers)*0.97*.27) + ((# of calves *0.33*.42)]*365/2000 (WSDA 2010)

Losses due to volatilization or denitrification during storage are estimated at 35 percent. This does not include application losses.

The effects of livestock operations on groundwater quality are addressed through the Clean Water Act's regulations and Washington's Dairy Nutrient Management Act. DOE has authority under Washington's Water Pollution Control Act to enforce the Clean Water Act. Voluntary financial and technical assistance programs are available from the National Resource Conservation Service to eligible landowners and agricultural producers to help them manage natural resources in a sustainable manner.

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)). and to "help maintain a healthy agricultural business climate." 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 (DNMP) on site within six months after licensing. DNMP'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 dairy 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 DNMP. "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 (SYCD) often writes the NMPs for dairy farms and later certifies them.

The primary goal of an NMP is to protect water quality from dairy 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 waste water to other persons when the receiving facility is in direct control of application acreage, rate or time, and transfer rate and time.

Dairy 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.

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 GWMA's Livestock/CAFO Working Group found consensus that DNMPs are important tools for managing nitrate concentrations in groundwater within the GWMA but was unable to reach consensus whether alternative or additional regulatory approaches should be implemented.

b. Concentrated Animal Feeding Operations

The Clean Water Act's regulations (40 CFR, Part 122) define dairies with 750 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 DOE administers the CAFO permit, decides when a facility is required to apply for a permit, approves the nutrient management plan that is required under the permit and is responsible for enforcing the permit.

In Washington, the NPDES permit program, including the CAFO permit, is the responsibility of the DOE. On February 3, 2017, the DOE announced its reissuance of a new CAFO NPDES and a new State Waste Discharge (SWD) General Permit. These permits became effective on March 3, 2017, and expire March 2, 2022. They were reissued as two separate permits, the CAFO SWD General Permit (state permit) and the CAFO NPDES and SWD General Permit (combined permit). 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 state permit conditionally authorizes discharges to groundwater only. The combined permit conditionally authorizes discharges to surface and groundwater, including agricultural stormwater. Coverage under a general permit will be available to facilities that meet the definition of a CAFO and that have a discharge or that voluntarily apply for permit coverage.

The CAFO permit requires large-scale livestock operations in Washington to implement specific practices to better protect groundwater, rivers, lakes and marine waters from manure pollution. Discharges conditionally authorized by the CAFO permit must not cause or contribute to a violation of water quality standards.

The DOE has the authority to decide when a facility is required to apply for a permit, approves the nutrient management plan that is required under the permit and is responsible for enforcing the permit. DOE issued a CAFO General permit in 2006 that covered five of the 69 dairies in Yakima County. None of the 11 small or medium sized dairies in the county were considered CAFOs and were not covered by the prior CAFO permit.

The permittee is 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 except when:

1. Precipitation events cause an overflow of manure, litter, feed, process wastewater, or other organic by-product management and storage facilities which are designed, constructed, operated, and maintained to contain all manure, litter, feed, process

wastewater, and other organic by-products including the contaminated runoff and direct precipitation from a 25-year, 24-hour rainfall event for the location of the facility and still have lagoon design freeboard;

And,

2. The production area is operated in accordance with the applicable inspection, maintenance, recordkeeping, and reporting requirements of this permit.

Also, a permittee is prohibited by the permit from discharging manure, litter, feed, process wastewater, or other organic by-products from their land application fields, unless the discharge is generated only by precipitation, not caused by human activities during the precipitation, and the permittee is otherwise in compliance with the permit. The permit establishes production area runoff controls, including the requirement that the permittee must keep manure, litter, and process wastewater from being tracked out onto public roadways. If manure, litter, process wastewater, or other sources of pollutants are tracked out onto public roadways, the permittee must clean-up the material tracked onto the roadway.

The permit establishes conditions related to solid manure, litter, and feed storage, composting facilities, above and below-ground infrastructure, diversion of clean water, prevention of direct contact between animals and water, handling of chemicals, management of dead animals, sampling and analysis of manure, litter, process wastewater, and other organic by-products, and soil sampling.

The permittee must land-apply manure, litter, process wastewater, or other organic by-products in accordance with their yearly field nutrient budgets and at the appropriate rates and times. If the permittee generates more manure, litter, process wastewater, or other organic by-products than the land application fields available to the permittee can appropriately utilize according to their yearly field nutrient budgets, the permittee must find other avenues of appropriately utilizing the excess manure, litter, process wastewater, or other organic by-products e.g., export, composting. The permittee's staff must have sufficient training to be able to land apply in accordance with the yearly field nutrient budgets and at appropriate rates and times to comply with permit conditions.

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

The GWMA's Livestock/CAFO Working Group found consensus that the DOE's reissued CAFO permits are an affirmative action in addressing groundwater nitrate concentrations within the GWMA, but did not find consensus whether the conditions contained in the reissued CAFO permits are overly, satisfactorily, or insufficiently restrictive.

The elements of a 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: high quality, productive soils, clean and abundant water, healthy plant and animal communities, clean air, an adequate energy supply, and 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. 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 under its Dairy Nutrient Management Program.

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).

c. Waste Storage Facilities (Lagoons)

Liquid manure stored in lagoons can be a source of nitrate and other contaminants. Contents of lagoons often consist of liquid manure (including urine), rainfall and snowmelt, any other liquid corral runoff, and process water from feeding pens and milking areas. Design, construction and management of lagoons are all very important for the protection of groundwater. In studying dairy, beef, and swine lagoons, researchers found substantial variation in the composition of solids, liquids and dissolved constituents and leakage rates causing a wide variation in the potential to impact groundwater quality. (Ham 2002, Harter et al., 2012a,) The distinction between a lagoon, a settling basin, a settling pond, or a pond can be hard to clarify. Different professionals use different terms for different manure storage impoundments, and different impoundments may be used for different purposes at different times of year. Producers may mix manure and water in additional ponds before land application.

Different industry experts classify impoundments based on different criteria and experience. In addition, there are a wide variety of different construction techniques and operational techniques for settling ponds and basins. Some are earthen impoundments that are drained and cleaned as needed. Some ponds are concrete lined, engineered basins, which would make using permeabilities for a clay lined impoundment inappropriate.

Lagoon nitrogen concentration depends on farm practices and unit operations on site. Operational differences are often related to whether a dairy uses a flush or scrape system to clean barns, the type of solids separation systems utilized and whether irrigation water is mixed with liquid manure for land application, and potential seasonal effects.

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 $1x10^{-6}$ 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.

d. Animal Holding Areas or Corrals

Animal holding areas or corrals at animal feeding operations are typically unvegetated areas that include pens, freestalls, corrals, and resting and feeding areas. Some areas have extensive concrete and other areas are dominated primarily with a flooring or surface of unlined and compacted soil that can be susceptible to leaching or runoff to contaminant areas. If properly constructed and maintained, concrete floor surfaces can contain wastes and minimize leaching. Corral surfaces become compacted with use and become dense enough to slow down the downward movement of water and pollutants. Manure accumulating on the surface mixes with the soil layer and forms a low-permeability interface layer that further reduces the permeability of corral and pen surfaces. (Harter et al., 2012a) Nitrogen loading from corrals and pens at dairy and feedlot facilities is governed by engineered sloping, soil type, dairy or feedlot age, unsaturated zone thickness, stocking rate, rainfall, and evapotranspiration rates. In some situations, increased short-term leaching in corrals may occur due to cracking during seasonal weather events.

e. Pens and Composting Areas

There are 2,632 acres within the GWMA identified by WSDA as pens or composting areas. (1,597 acres Dairy CAFO, 499 acres Nondairy CAFO, 536 acres compost). The nitrogen loading rates of pens vary depending upon number and size of stock contained within them and the management of those pens. Nitrogen leaching potential in pens and compost areas is mitigated by low annual precipitation and management of the amount of manures in those pens. Beef cattle feedlots and dairies have different number of animals per-lot. The majority of pens that have been identified as non-dairy CAFOs are most likely dedicated to raising or housing dairy support animals (calves and heifers). However, individual pens may hold calves during one time period and after those animals are moved out, heifers and adult cows may be moved into that same corral or pen.

Management practices are required on the site of dairy 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

"Composting," which as a term may refer to a category of activities rather than a specific practice or technology, may occur in windrows, composting in bags, spreading material out over a concrete pad or large surface area to dry, turning frequency, potential moisture additions to material that has dried out. Composting reduces the weight of the basic material. Composted waste can be desired by organic growers as a source of additive to soil structure, soil density, nutrient and weed defoliant.

WSDA, although it does not regulate dairy waste composting, reports that a number of dairies compost their manure on site. 30% to 40% of that composted material is exported out of Yakima Valley. Limiting factors are the costs of processing and loading. Generally, liquids are applied close to dairies, solids can be transported mid-range and compost may be moved further, due to weight reduction.

f. Buildings Housing Animals

Animals may spend time in freestall barns, milking parlors or loafing sheds. These facilities are built with concrete floors and are cleaned multiple times a day. Potential leaching from these types of buildings, even anticipating cracks in concrete floors that could provide a pathway to leaching, is much smaller than potential from pens and lagoons.

g. Administration and Enforcement

The 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 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 DNMA does not authorize the WSDA to compel nutrient management consistent with dairy nutrient management plans, Washington's Water Pollution Control Act authorizes the DOE 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)

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. 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.

Washington's Water Pollution Control Act authorizes the DOE 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)

DOE 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 DOE 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. (WSDA 2011)

Under the MOU, DOE is responsible to EPA for Clean Water Act compliance for AFOs and CAFOs. DOE 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, DOE recognizes WSDA as lead. Where DOE is involved in investigations and compliance actions against non-permitted dairies, DOE will discuss the compliance actions with WSDA to ensure that timely compliance actions are sufficient to protect human health and the environment. DOE is responsible for the approval of best management practices used to show compliance with water quality standards. DOE must provide available monitoring data and trend analysis for livestock related pollutants to WSDA upon request. DOE's TMDL process must involve WSDA as a stakeholder if livestock issues are anticipated.

The DOE/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 DOE 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. DOE 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 DOE 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 DOE's PARIS database.

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.

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 lawsuits sounding in nuisance. 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) 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

Residential, Commercial, Industrial and Municipal Groundwater Quality Regulation

Residential and non-residential Onsite Sewage Systems (OSS) are present throughout the Lower Yakima Valley Ground Water Management Area (LYV GWMA) outside of those areas served by municipal sewage collection and treatment systems. Outside of the municipal sewage systems, OSS provide some level of sewage treatment and disposal for both residential and non-residential activities. Residential OSS are especially common in and near the urban growth boundaries of many of the valley's municipalities. Non-residential OSS are scattered throughout the project area serving a variety of public and private entities. OSS comprise one of the several potential sources contributing nitrate-N to the underlying shallow alluvial groundwater system.

Non-agricultural sources of potential contamination of groundwater within the GWMA boundaries include the following:

a. Residential Onsite Sewage Systems (ROSS)

Residential Onsite Sewage Systems (OSS) are present throughout the Lower Yakima Valley Ground Water Management Area (LYV GWMA) outside of those areas served by municipal sewage collection and treatment systems. Residential OSS are especially common in and near the urban growth boundaries of many of the valley's municipalities. Non-residential OSS are also scattered throughout the project area serving a variety and public and private entities. OSS comprise one of the several potential sources contributing nitrate-N to the underlying shallow alluvial groundwater system.

"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. Information about the septic system should be disclosed to any future buyer of the property.

There are 6,044 residential households within the GWMA that discharge wastewater to an onsite sewage system. Nitrogen in residential wastewater is mainly generated from human body wastes and food materials from kitchen sinks and dishwashers. The amount of nitrogen present in the wastewater is typically expressed as a concentration in milligrams per liter (mg/L) and/or as a mass loading in grams/person/day.

The highest density of OSS is within and near urban growth areas associated with municipalities. Specifically:

- The highest density of OSS are found on the east and north side of Sunnyside where OSS density ranges from 80 to 100 OSS per section.
- West of Sunnyside near Outlook where OSS density approaches 80 OSS per section.
- In the Zillah to Buena area where density approaches 80 OSS per section.
- Slightly lower OSS density is found south of Grandview, Sunnyside, and Mabton where the OSS range from 50 to 70 per section.

Density of 1-10 ROSS per section are considered to be low density, 11-40 ROSS per section is considered medium density, and over 40 ROSS per section are considered to be high density by the EPA.

The frequency of septic tank pumping in each ROSS in the GWMA is unknown. In a survey conducted by Yakima County, without statistical sampling methodology, 82 percent of 458 surveys collected indicated that they had had their "septic tank pumped recently."

Wastewater discharged to a ROSS is subject to several biological processes including nitrification and denitrification. These processes can take place depending on the environmental conditions and occur most effectively when the soil is unsaturated because the wastewater is forced to percolate over the soil particle surfaces where treatment can take place and air is able to diffuse through the soil. Whether these processes occur and their effectiveness in treatment depends on the physical characteristics of the soil and the environmental conditions of the soil through which the wastewater percolates. Wastewater parameters, such as levels of nitrogen, are removed to varying degrees. Under good conditions (and proper operation and management), organic or ammonia nitrogen is readily and rapidly nitrified biochemically in aerobic soil and some biochemical denitrification can occur in the soil, but without plant uptake, 60 to 90 percent of the nitrate enters the groundwater. Under anaerobic soil conditions, nitrification will not occur, but the positively charged ammonium ion is retained in the soil by adsorption onto the soil particles. The ammonium may be held until aerobic soil conditions return allowing nitrification to occur. (EPA 2002) Within the GWMA, moderate denitrification occurs about three months a year and poor denitrification occurs about three months (soil saturated and no warmth). These factors determine that the total denitrification average in the GWMA is in the range of 10 to 13 percent.

Conventional ROSS technology relies on primary treatment (settling) for solids and organic reduction prior to dispersion to the ground. Innovative ROSS technologies combine the primary treatment with biological treatment to achieve a higher level of treatment. The biological processes promote the removal of nitrogen from wastewater through the multi-step bacterial conversion of ammonia and organic nitrogen to nitrates (nitrification) and the reduction of nitrates to gaseous nitrogen (denitrification). The optimum nitrogen removal of properly operating conventional ROSS technology is up to 20 percent. The projected nitrogen removal of properly operating innovative ROSS technology could be up to 50 percent.

The predominant soil types underlying the ROSS drain fields located within the GWMA are characterized as silt loams that are porous and have a well-developed structure. The estimated depth to groundwater is equal to or greater than 10 feet at approximately 90 percent of the ROSS locations. It is reasonable to assume that the environmental conditions underlying the drain fields are conducive to some level of denitrification.

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).

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. 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 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.

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.

TABLE X (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 V (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% 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.

b. Large Onsite Sewer Systems (LOSS)

A LOSS is a septic system serving multiple residences or nonresidential establishments serving twenty or more people per day or having a design volume over 3,500 gallons. Washington State Department of Health records show that there are two LOSS located within the GWMA. One is located outside of Zillah with a design capacity of 5,000 gallons. The second LOSS site is located outside of Granger with a design capacity of 4,850 gallons. Annual reports for LOSS are submitted to the DOH.

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 DOE and DOH.

c. Commercial Onsite Sewer Systems (COSS)

A COSS is a septic system used for employees working at agricultural or other businesses that operate year-round and are not classified as a LOSS by the DOH. The most likely locations of these facilities within the GWMA are wineries, schools, agriculture packing lines, small businesses (stores, fire stations), agricultural business offices and maintenance buildings, churches, and confined animal feeding operations (CAFOs).

d. Biosolids

Biosolids are a nutrient rich soil amendment derived from public waste treatment plant septage. Septage is a class of biosolids that comes from septic tanks, treatment works and similar systems receiving domestic wastes. WAC 173-308-050. Biosolids are produced by treating sewage sludge to meet certain quality standards that allow it to be applied to the land for beneficial use.

The DOE's biosolid program is administered independently of other agencies, but 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. The DOE'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. Application rates require advance approval based on pre-plant soil tests, evaluation of crop type and yield estimates, soil types, use of irrigation. Intermittent post-harvest tests are also conducted. Permittees receive coverage under a statewide general permit. Permit coverage is mandated for those who produce and/or land apply biosolids. The DOE'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. Application rates require advance approval. Intermittent post-harvest tests are also conducted. The single site approved for land application of biosolids within the GWMA is Natural Selection Farms, 6800 Emerald Road, Sunnyside. Yakima County also receives some biosolids and County landfills.

e. Residential Lawn Fertilizers

Residential lawns exist primarily within towns or urban growth areas within the GWMA. Anecdotal evidence indicates that not all residents fertilize their lawn regularly, and some do not fertilize their lawns at all. Rough estimates are necessary to evaluate how much nitrogen is applied within the GWMA to residential lawns. Nitrate accumulation in the groundwater is not just a matter of nitrogen application rates but also water application rates. While not everyone fertilizes regularly, overwatering occurs at municipal properties, including residences, schools and businesses, particularly if they water daily. Both can have an effect on the loading of even a small amount of nitrogen. Higher population density areas can have a higher percentage of lawn area and the associated potential for more fertilization and overwatering that could be a factor in N loading.

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.

f. "Hobby Farms"

The term "hobby farm" is intended to mean a land, which may or may not contain a residence, other than lawns, upon which minimialist agriculture is maintained without the intention of profit. It may contribute nitrogen within the GWMA area. These land uses are on parcels of land less than 10 acres that are not included in the WSDA's crop inventory. Nitrogen contributions on these parcels may come from individual gardens, pastures, pets, and other animals. Co-location of septic drain fields and hobby farming operations, particularly animal farming operations, may cause drain field failure and reduction of denitrification potential.

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

Underground Injection Wells

Most UIC's in Yakima County are road based and county-owned, put in place to receive surface water runoff from county roads.

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 !47.2400. The program regulates the injection of fluids underground for storage, enhanced recovery, and disposal to prevent the contamination of underground sources of drinking water. 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 presenceof 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).

Transport

1. Abandoned or Improperly Decommissioned Wells

2. Surface streams and wasteways

Water Quantity and Quality Goals and Objectives

Investigation and Analysis

Investigation

The GWMA project is a multi-agency, citizen-based, coordinated effort to reduce groundwater nitrate concentrations in the Lower Yakima Valley to below Washington State drinking water standards. To achieve this goal, activities contributing to elevated groundwater nitrate concentrations must be identified based on scientific data and evaluation, and strategies for implementing best management practices must be developed.

The GWAC Work Plan identified the following tasks to be undertaken:

- *Characterize the nature and extent of nitrate concentrations in Lower Yakima Valley groundwater.*
- Collect and incorporate existing nitrate and nitrogen data into a shared data management system or data sharing site to improve understanding of the sources and extent of contamination.
- Identify and rank the sources of elevated nitrate in groundwater, with site-specific characteristics developed for "hot spots" as appropriate.
- Identify and describe activities contributing to groundwater contamination based on scientific data and evaluation. Scientific and other data will be shared among the partners to facilitate development of effective programs and strategies.
- Establish a monitoring program to identify sources of nitrate contamination and their relative importance.
- Establish and conduct a long-term groundwater quality monitoring program and evaluate progress.

Regulatory Framework

The GWAC first identified applicable local, state, and federal regulatory requirements that control and manage nitrates in groundwater. These were integrated into the discussion of sources above in this document.

Best management practices

The LYVGWMA initially contracted with HDR to produce a complete list of all the potential best management practices that may be applicable to agricultural, industrial, urban and domestic activity within the LYVGWMA. Two working groups within the Groundwater Advisory Committee, Irrigated Agriculture and Livestock/CAFO, reviewed the HDR produced list and selected those best management practices they felt particularly relevant to their respective operations. Those best management practices are set forth in Appendices D and E of this Program.

Groundwater Monitoring Plan

The GWAC developed an Interim Final Groundwater Monitoring Plan (PGG 2014) in order to establish a network of wells and field procedures with which to evaluate current and future nitrate concentrations in the Area's groundwater. The objectives of this Plan were to establish procedures for the collection and analysis of representative groundwater samples for nitrate and nitrate related analytes. Data collected pursuant to the Plan were intended to be used to: evaluate BMP effectiveness, evaluate groundwater trends, identify nitrate hotspots, and calculate basin-wide average nitrate concentrations. Analytic results from the same data would be used by the GWAC to make administrative decisions and policy recommendations. The Plan, prepared in accordance with hydrogeologic practices generally accepted at this time in the relevant area, addressed sampling procedures, sampling schedule (developed following identification of the sampling network), establishment of sampling network, quality assurance/quality control, reporting frequency and schedule.

The sampling program described in the Plan involved collecting groundwater samples from a network of wells for analyses of nitrate, nitrite, ammonia, and the sum of organic nitrogen + ammonia + ammonium (Total Kjeldahl Nitrogen). The network includes wells that already have pumps (private, public, and irrigation supply wells) and monitoring wells that require use of sampling pumps. Groundwater samples were analyzed by labs accredited by the Washington State

Department of Ecology (Ecology). A Groundwater Monitoring Quality Assurance/Quality Control Plan (PGG 2013) was prepared in anticipation of the Groundwater Monitoring Plan.

Drinking Water Quality Testing Program

Yakima County contracted with the USGS to test and evaluate the quality of drinking water supplies within the LYVGWMA. USGS identified ___ water wells common to USGS' water testing data base and Yakima County's water testing data base all of which had existing drilling records from which to determine water levels, well construction details and some prior testing history. USGS then tested these wells six times each during calendar year 2017.

Results

Deep soil sampling program

Nitrogen loading assessment

Yakima County contracted with the Washington State Department of Agriculture to study the amount of nitrogen "loaded" to groundwater within the LYVGWMA. WSDA produced a draft report in 2017, incorporating analysis provided by Yakima County regarding nitrogen contributions from residential, commercial, industrial and municipal sources. (WSDA 2017b) That report estimated and analyzed the amount of nitrogen available for potential loading, but did not take into account soil processes between the point of availability and the groundwater surface.

Geographic Information System Study

Yakima County maintains a geographic information system (GIS) data bank of numerous categories of information delivered to or through the county's various governmental processes. Data requests were made to the Washington State Departments of Agriculture, Ecology, Health, and Natural Resources, U.S. Departments of Agriculture (NRCS), Geological Survey (USGS), Census Bureau, Environmental Protection Agency and National Atmospheric Deposition Program for additional relevant information maintained or organized by geographic coordinates capable of inclusion in Yakima County's GIS system. Information from WSDA's nitrogen availability study (WSDA 2017) was fully integrated into the GIS system. All that data was mined for information relevant to the LYVGWMA and structured into layers of information that could be "overlaid" to evaluate structural or causal relationship between various data, events or outcomes.

Description of Alternative Actions To Address the Problem

RCW 90.44.410 (4) requires that this Program include:

> (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. . . . . 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. . . . .

RCW 90.44.410 (4) suggests that the Program may include, "if necessary, alternative data collection and analysis programs" with which to "enable better characterization of the groundwater and potential quality and quantity problems."

> "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."

In Yakima County, including the area within the LYVGMA, these subjects, to wit: 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, are being addressed through the Yakima River Basin Integrated Water Management Plan (WBIWRP 2012).

The Groundwater Management Committee first made a list of some 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 RCW 90.100.100 (4). When that evaluation was complete, ___ recommendations were unanimously chosen by the GWAC as their final recommendations.

Discussion of Pros and Cons of Alternative Actions

In addition to the statutory criteria required by RCW 90.100.100 with which to evaluate alternatives, the GWAC applied the concept of "environmental justice." Environmental justice is the concept that all people regardless of race, color, national origin, or income should enjoy fair treatment and meaningful involvement in the development, implementation, and enforcement of environmental laws, regulations, and policies and the consequent environmental quality thereby created. Minority populations may disproportionally undertake or may be subjected to environmentally hazardous activities because they have few economic alternatives or are not fully aware of the risks involved. A combination of this lack of awareness and relative lack of political and economic power tends to make placement of environmentally harmful activities easier in poor minority communities.

Governmental actions should therefore avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations, and ensure the full and fair participation by all potentially affected communities.[i]

The *Preliminary Assessment* (Ecology 2010) found that the demographics of the Lower Yakima Valley require that final implementation of any or all the recommendations takes into account, cultural, economic, and geographic factors." English is not the primary language (written or spoken) in many households in the Lower Yakima Valley. Existing outreach materials in Spanish and other languages are limited and focused for specific audiences and purposes (coliform boil water notices, nitrate advisories for high risk populations). New materials developed under any of the recommendations made below should be developed to address the specific needs of the lower valley residents and should be written and delivered in means which are most likely to reach all components of the residents of the LYVGWMA.

Recommended Actions

Implementation Work Plans

Parties responsible for implementation of the recommended action
Schedule for implementation of the recommended action
Monitoring system for evaluation effectiveness of recommended action

Process for Periodic Review and Revision of Groundwater Management Program

Table of Figures

Appendices

Appendix A—Administrative Background

In May 1985, the Washington Legislature adopted a law authorizing the identification of ground water management areas and the identification of groundwater management procedures.[7] Shortly thereafter, the Department of Ecology adopted "guidelines, criteria, and procedures for the designation of groundwater management areas, subareas or zones."[8] They set forth "a process for the development of groundwater management programs for such areas, subareas, or zones, in order 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

[7] Ch. 453, Laws of 1985 (RCW 90.44.400-.440.)

[8] December 1985, pursuant to RCW 90.44.430,

published a report entitled *Lower Yakima Valley Groundwater Quality, Preliminary Assessment and Recommendations Document.*[9] 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."[10]

and that:

> "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% of domestic well users are exposed to nitrate levels in their drinking water that exceed the health-based standard of 10 mg/L."[11]

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
- 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

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[9] *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.*")

[10] *Preliminary Assessment* p. ES 2.

[11] *Preliminary Assessment*, p. ES 2.

- 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[12] for the development of a groundwater management program, prepare a work plan, budget for development of a GWMA Program. The contents of a GWMA Program are identified in RCW 90.44.410.[13] Yakima County has therefore conducted studies, collected and analyzed data, drawn

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[12] 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.

[13] See Appendix A.

conclusions, and drafted reports related to hydrogeology, water quality, water use, land use, and population projections for GWAC review.

The GWMA Program, adopted by the Groundwater Management Committee, is implemented by the Department of Ecology.[14]

[1414] Pursuant to RCW 90.44.420, See Appendix A.

Appendix B—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.

Appendix C—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:

- Commercial, municipal, and industrial discharges
- Underground or surface storage of harmful materials in containers susceptible to leakage
- Accidental spills
- Waste disposal, including liquid, solid, and hazardous waste
- Storm water disposal
- Mining activities
- Application and storage of roadway deicing chemicals

- Agricultural activities
- Artificial recharge of the aquifer by injection wells, seepage ponds, land spreading, or irrigation
- Aquifer over-utilization causing seawater intrusion, other contamination, water table declines or depletion of surface waters
- Improperly constructed or abandoned wells
- 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 D—BMPs 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 chemigation
	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 waste water 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 waste 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 E—BMPs 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 (362) 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
VegetativeTreatment 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

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[i] See, Executive Order 12898, 59 FR 7629, http://www.archives.gov/federal-register/executive-orders/pdf/12898.pdf

Attachment D

- MR_ Deep Soil Sampling (DSS) in the Lower Yakima Valley GWMA
- MR_Draft Deep Soil Sampling Analytical Analysis
- Analysis of DSS Attachment 1 - 2014 03 28 Deep Soil Sampling Plan
- Analysis of DSS Attachment 2 - DSS PowerPoint
- DSS Presentation to LYV GWMA Data WG
- Soil Types and GWMA DSS

Deep Soil Sampling (DSS) in the Lower Yakima Valley GWMA

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), and ammonium (NH_4 as N) and organic matter were analyzed 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.
- Focus on analytical data in this evaluation.
- 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.
- Cannot extrapolate this data to represent the entire Lower Yakima Valley.
- This is a snapshot in time.
- Quality Assurance – assure all data used is credible
    - PGG performance evaluation
    - Laboratory QA

Fall vs. Spring

Slide #1

Mean soil nitrate concentrations for all fall samples compared to all spring samples.

- 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.

Slide #2

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.

Slide #3

Maximum soil nitrate concentration for each depth compared for each sampling event.

- 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.

Slide #4

The maximum soil nitrate concentration for each depth is > 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).

Depth

Slides #5 and #6

The number of soil nitrate which are in four different concentration brackets; < 15 ppm, 15 – 30 ppm, 30 – 45 ppm, and > 45 ppm. This graph compares all depths. The first set of bars in slide #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.

Slide #7

This slide 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 slide 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%

Distribution by sampling event and depth

Slides #8, 9, 10, 11 and 12

These slides show the concentration distribution for each depth for each sample. The first four graphs are divided by sampling event. The last slide has all samples collectively. These graphs allow a comparison of where the highest and lowest nitrate concentrations are found for each sample.

2:17 pm

Slide #13

MR: Haven't looked @ ammonium & organic matter.

This graph is the same as #12 except the data are ordered by cumulative nitrate concentrations.

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

> 30 ppm
> 45 ppm
> 200 ppm cumulative

2:00

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%

MR: % below 30 ppm

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%

JDav: What does this tell us,
MR: Lot of sites where things going right. Stats somewhere 23% elevated N. Prob not across board, but still have to manage sites. Irrigation application, how to improve
SG: 23% of ag land in GWMA.
MR: No 23% of sample sites
SG: Ppl already know methods but don't have $.
SP: Rec from GWMA: $ for funding
SG: GWMA challenge is getting new tech to fit pieces.

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

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

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

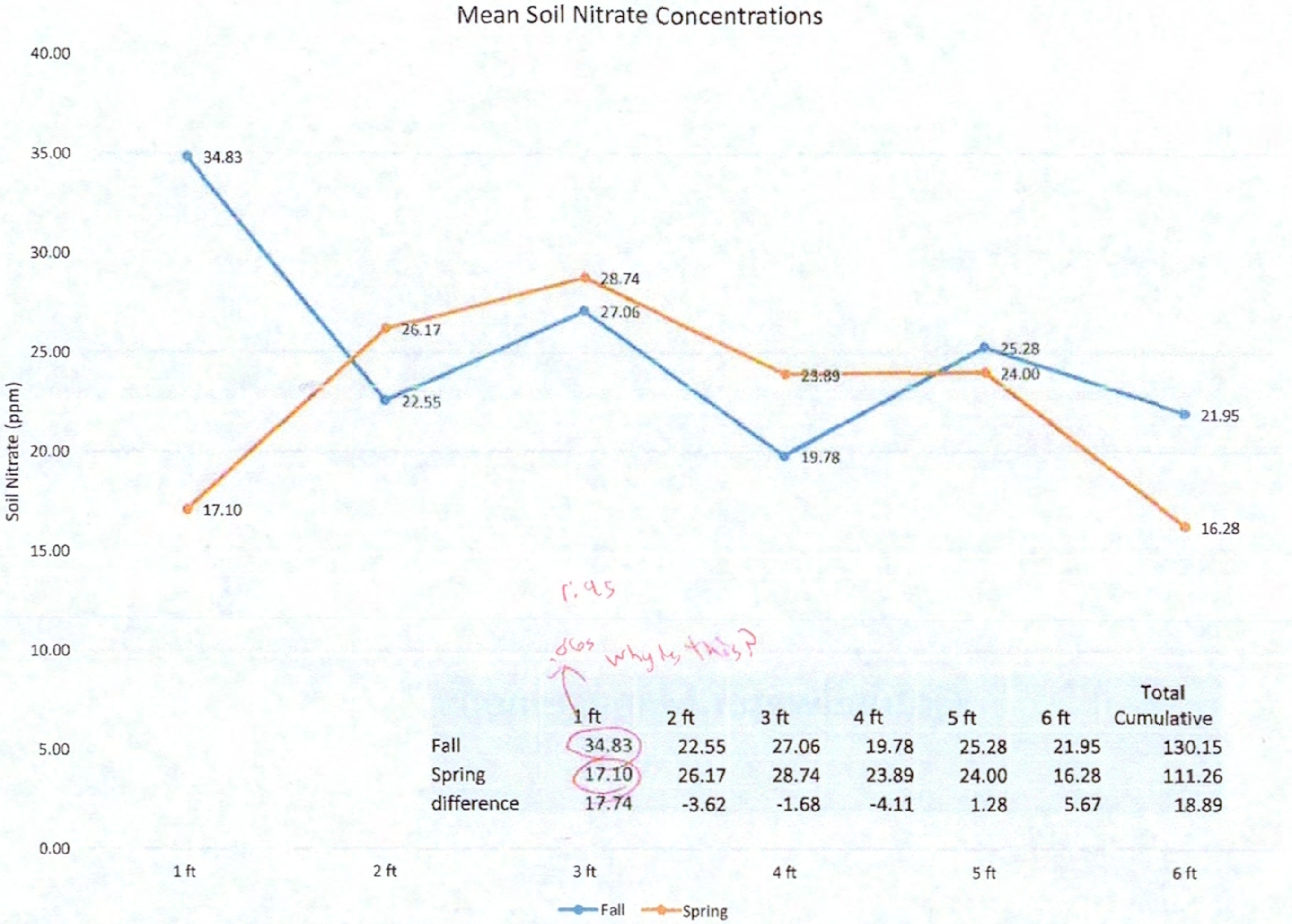
ID	Time	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	Total Cumulative
4143	SPRING 2016	32.25	72.5	43.5	16.5	7.5	2.25	174.5
4144	SPRING 2016	8.25	5	4.25				17.5
4145	SPRING 2016	3.25	1	0.75	0.75			5.75
4146	SPRING 2016	8.75						8.75
4147	SPRING 2016	13.5	12.75	24	49.25	80.75		
4148	SPRING 2016	10.25	9.75					20
4149	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

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

DRAFT

Deep Soil Sampling Analytical Data Analysis

Lower Yakima Valley
Groundwater Management Area

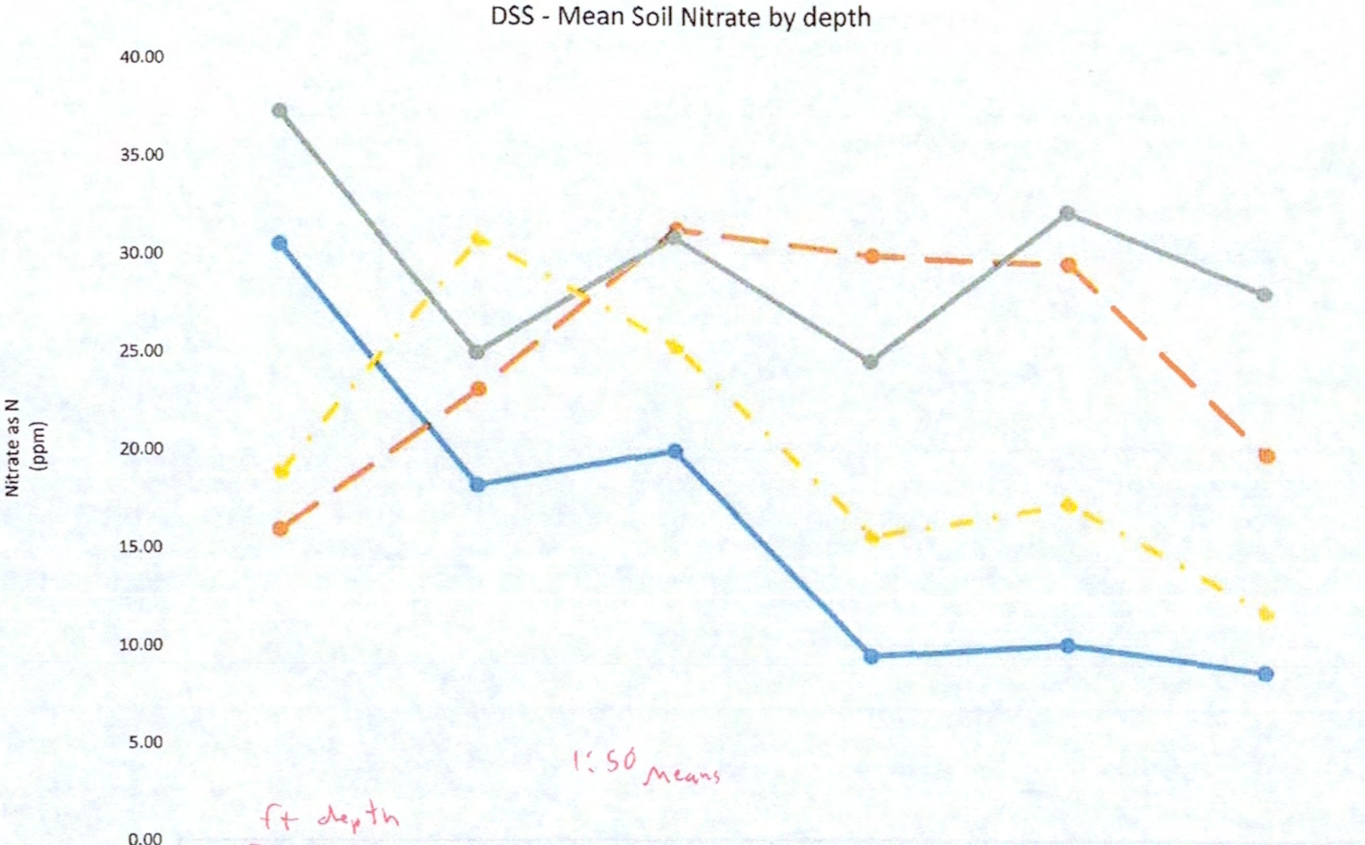


r: .95

.065 why is this?

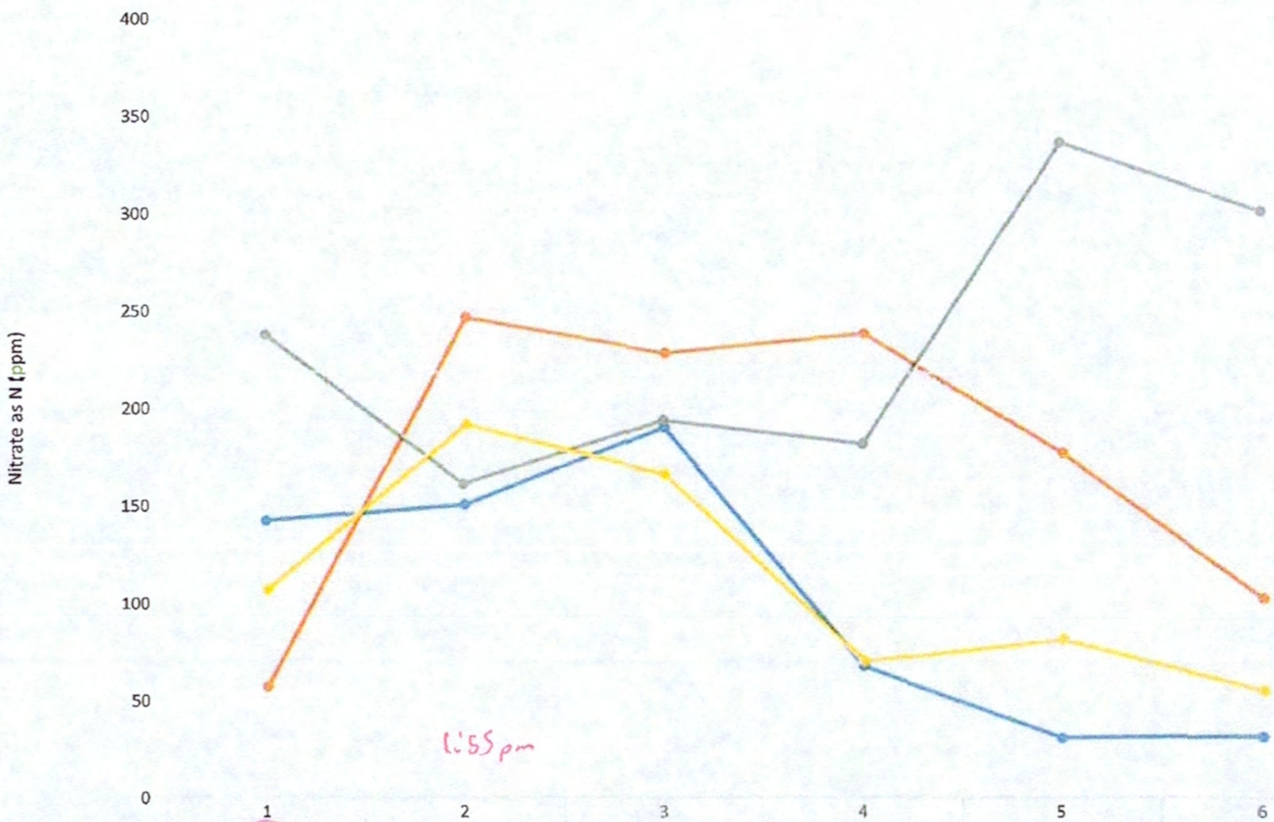
	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	Total Cumulative
Fall	34.83	22.55	27.06	19.78	25.28	21.95	130.15
Spring	17.10	26.17	28.74	23.89	24.00	16.28	111.26
difference	17.74	-3.62	-1.68	-4.11	1.28	5.67	18.89

2



	1	2	3	4	5	6
FALL 2014	30.45 2x	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 2x	24.96	30.88	24.49	32.11	28.03
SPRING 2016	18.84	30.77	25.27	15.54	17.21	11.73

DSS - Maximum Soil N by Depth



	1	2	3	4	5	6
FALL 2014	142 3x	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 2x	161	194	181.5	336 highest	301
SPRING 2016	106.75	191.5	166	69.75	80.75	54.75

All over 30

JD: Same w/ minimum

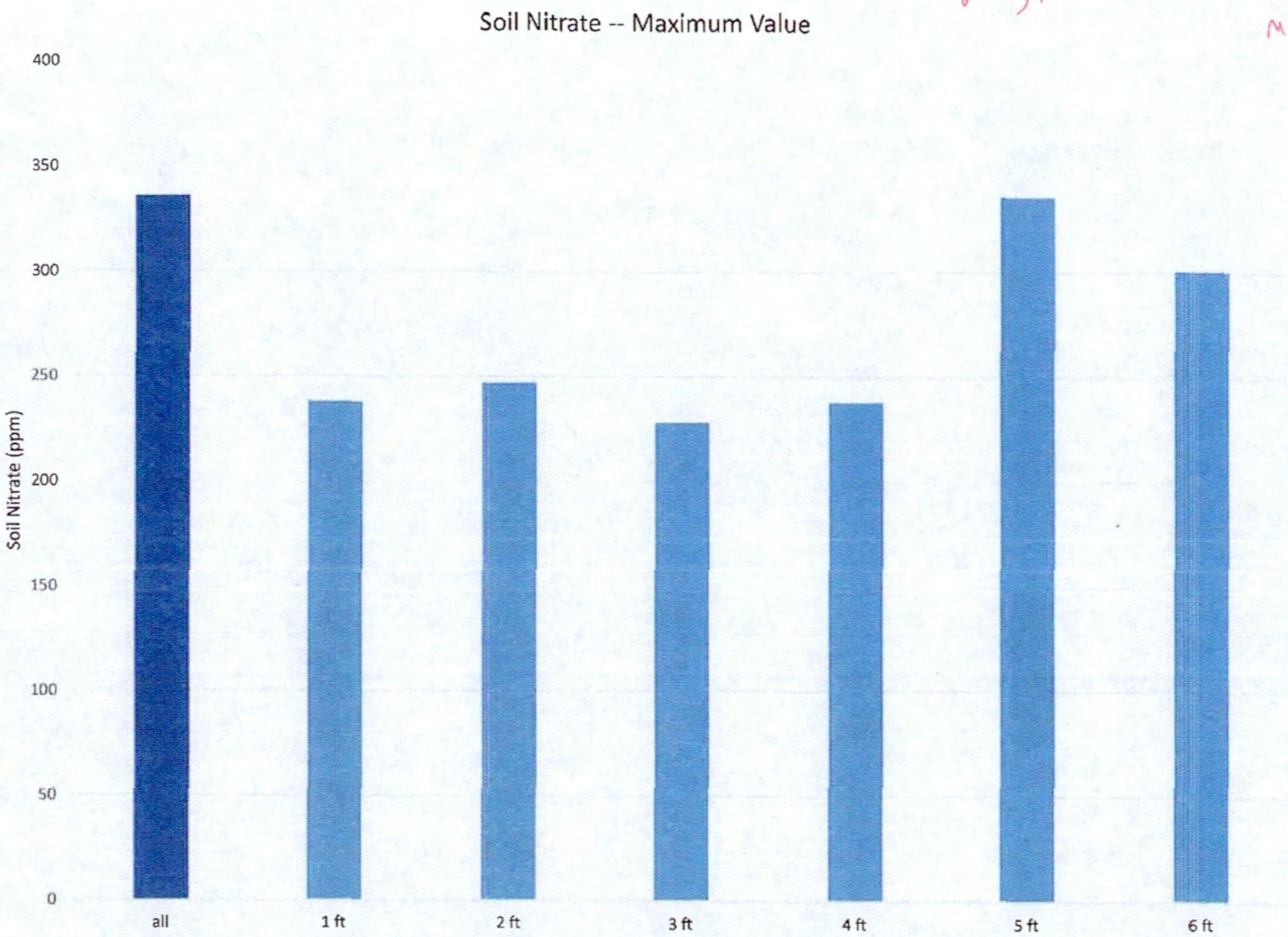
MR: No. Right @ detection limit. Did in other p S other sheet.

2:08

MR: Pretty high in all depths. These highest of all ~~These all ...~~ samples

SG: Includes both Fall & spring? Yes. What time of spring? Skews data too.

MR: Helps to



5

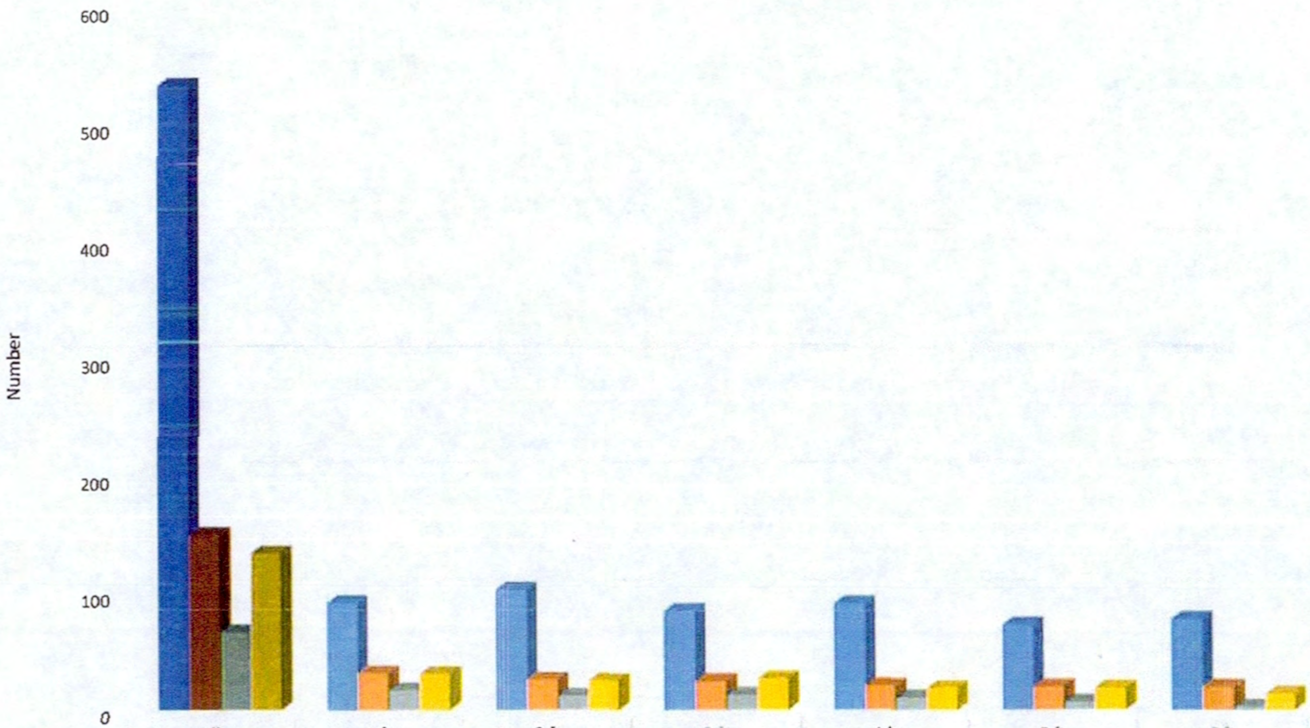
2:10

MA: Awful lot of low samples, but also some over 45

JDev: If all tests done in areas known safe, get that result
Location of wells makes prob

VR: Not wells, SSJ

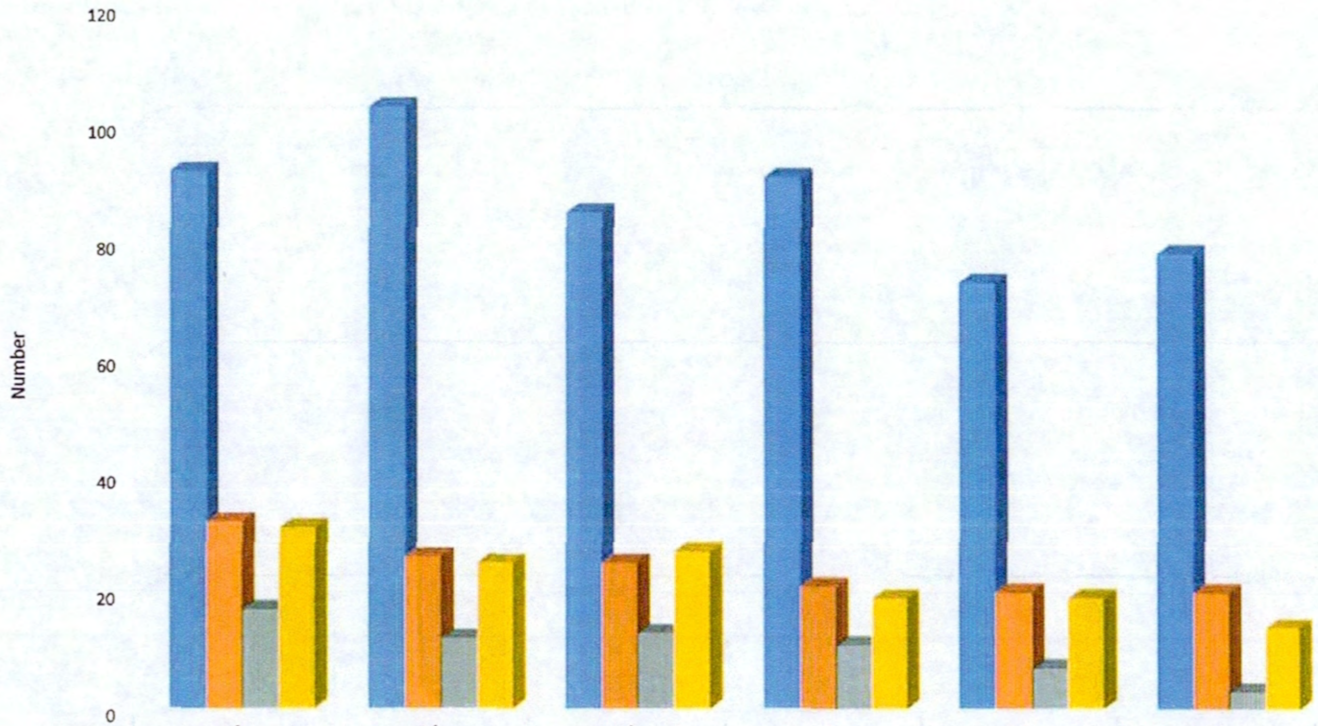
Number of Soil Nitrate Samples in Concentration Range



	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

<15 ppm 15 - 30 ppm 30 - 45 ppm > 45 ppm

Number of Soil Nitrate Samples in Concentration Range



	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

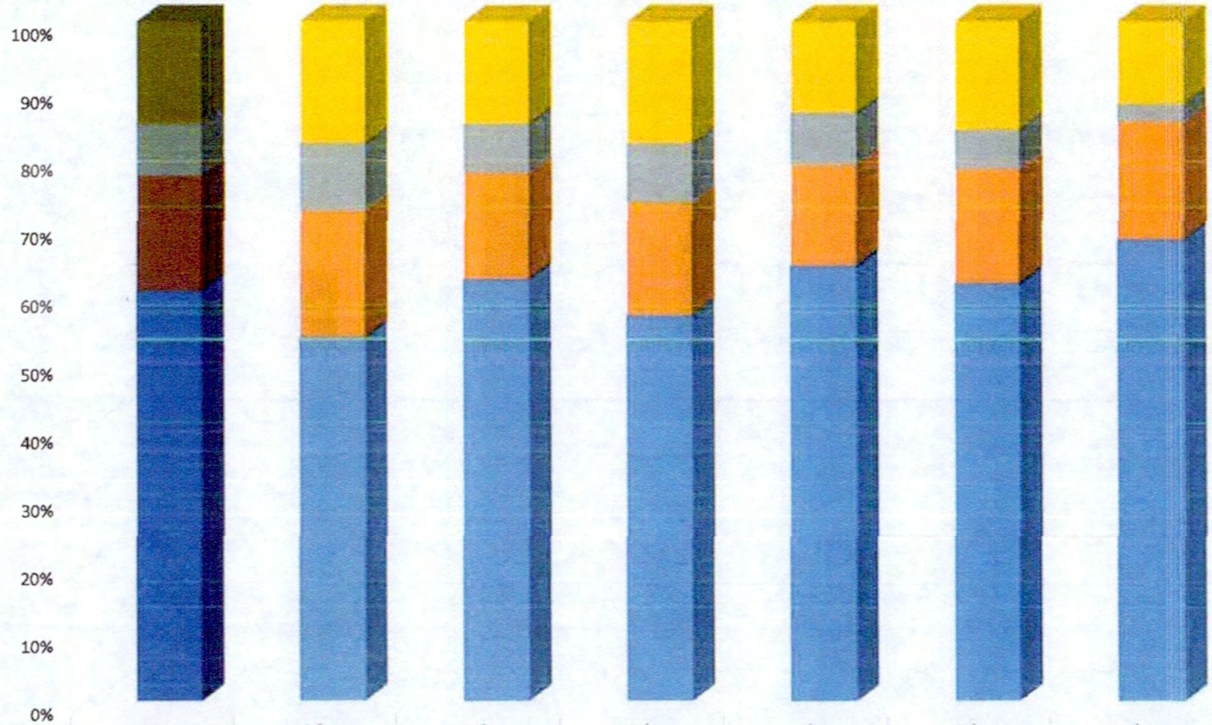
AC: Wouldn't want to know 6ft deeper N wind up in drinking water.
What is root zone.

VR: Reports have captured bottom of roots. In soil sample.

* MR: Get to tie to this data.

*) M: That could be done

Percent of Soil Nitrate Values in Concentration Ranges



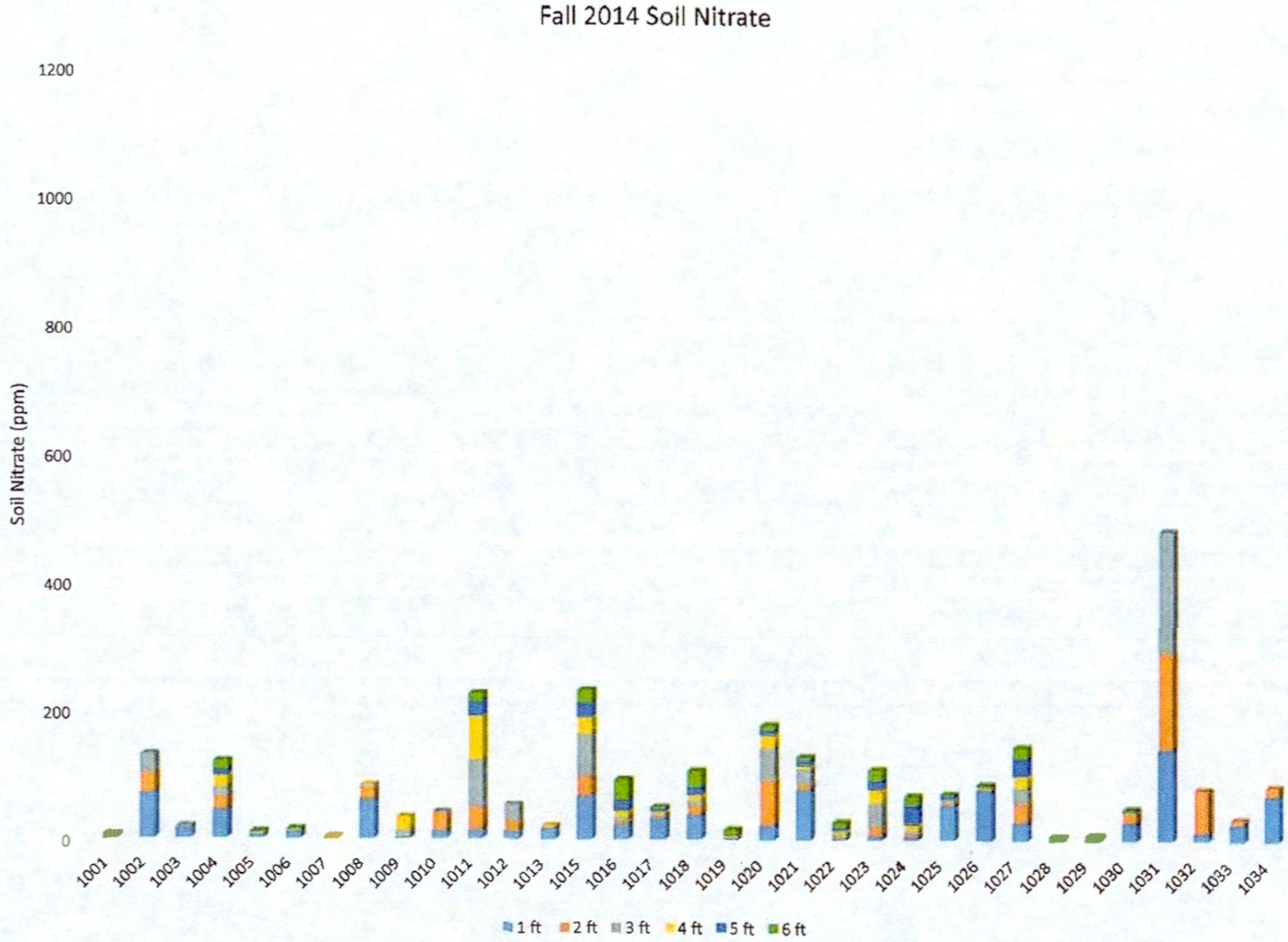
	all	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft
> 45 ppm	15% 23%	18% 2>	15%	17%	13%	15%	12%
30 - 45 ppm	8%	10% 6A	7%	8%	7%	6%	3%
15 - 30 ppm	17%	18%	15%	16%	14%	16%	17%
<15 ppm	60%	53%	61%	55%	62%	59%	65%

<15 ppm 15 - 30 ppm 30 - 45 ppm > 45 ppm

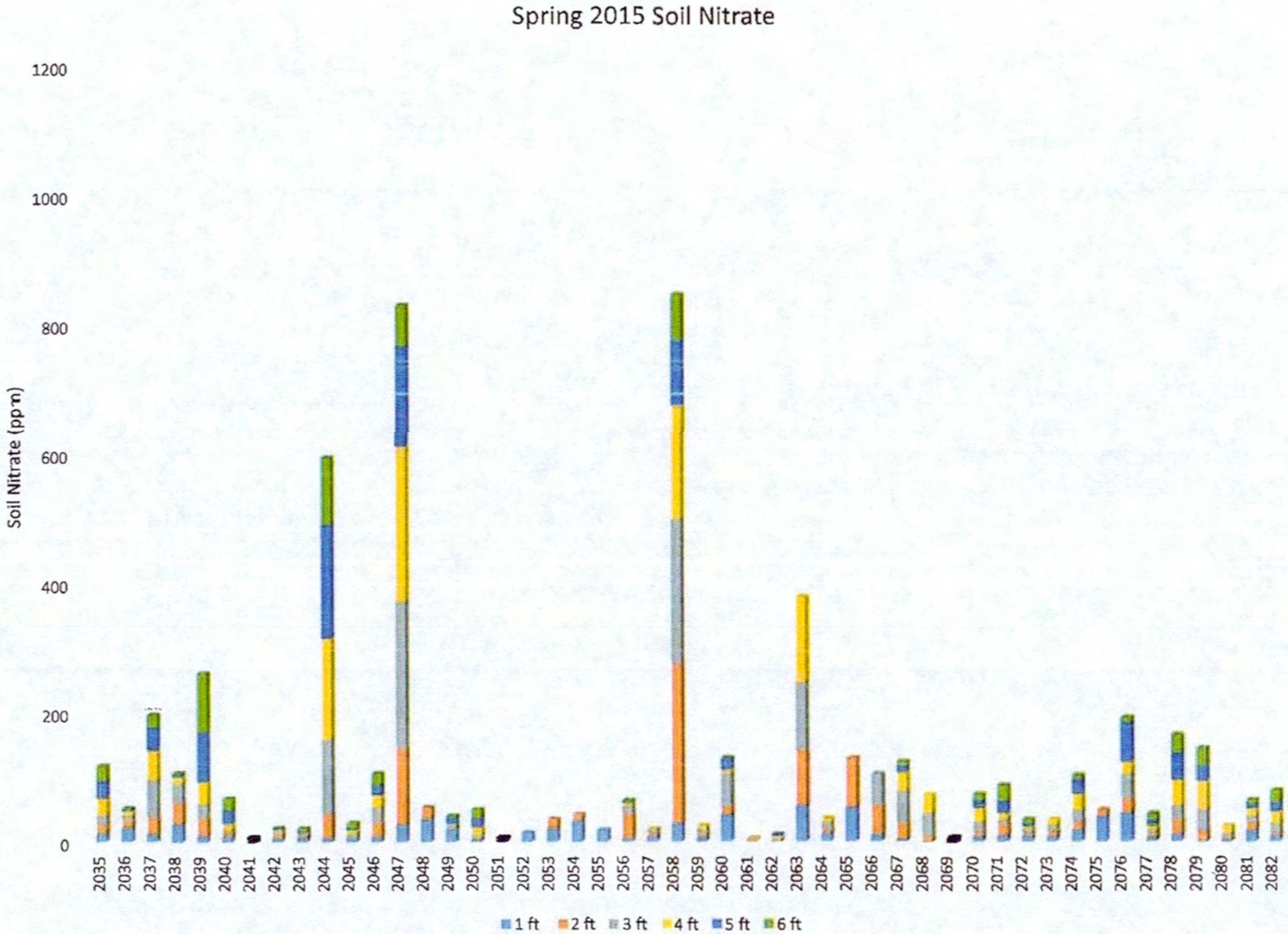
8

MR: Don't find as useful as other chart.

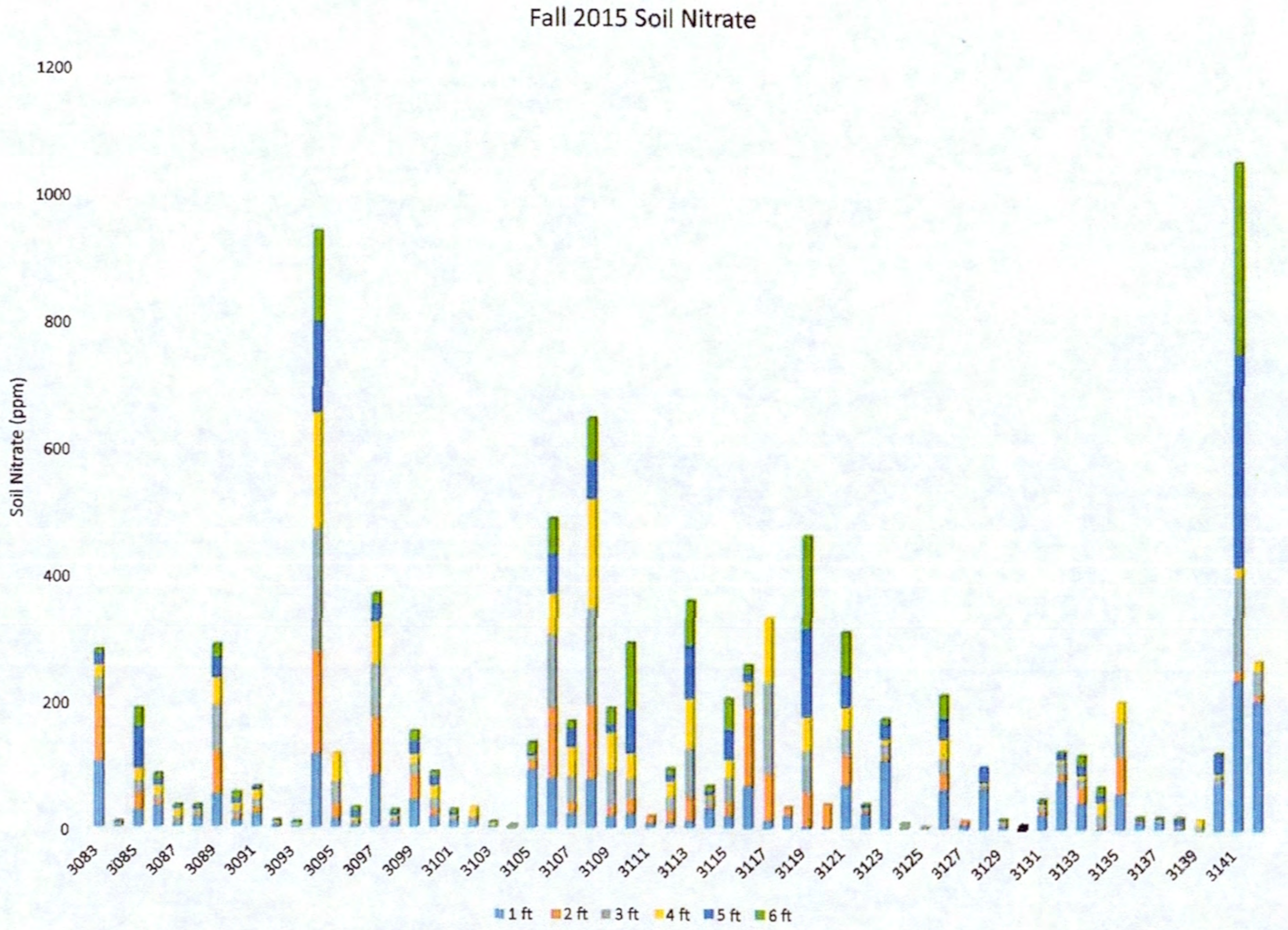
2:15 pm



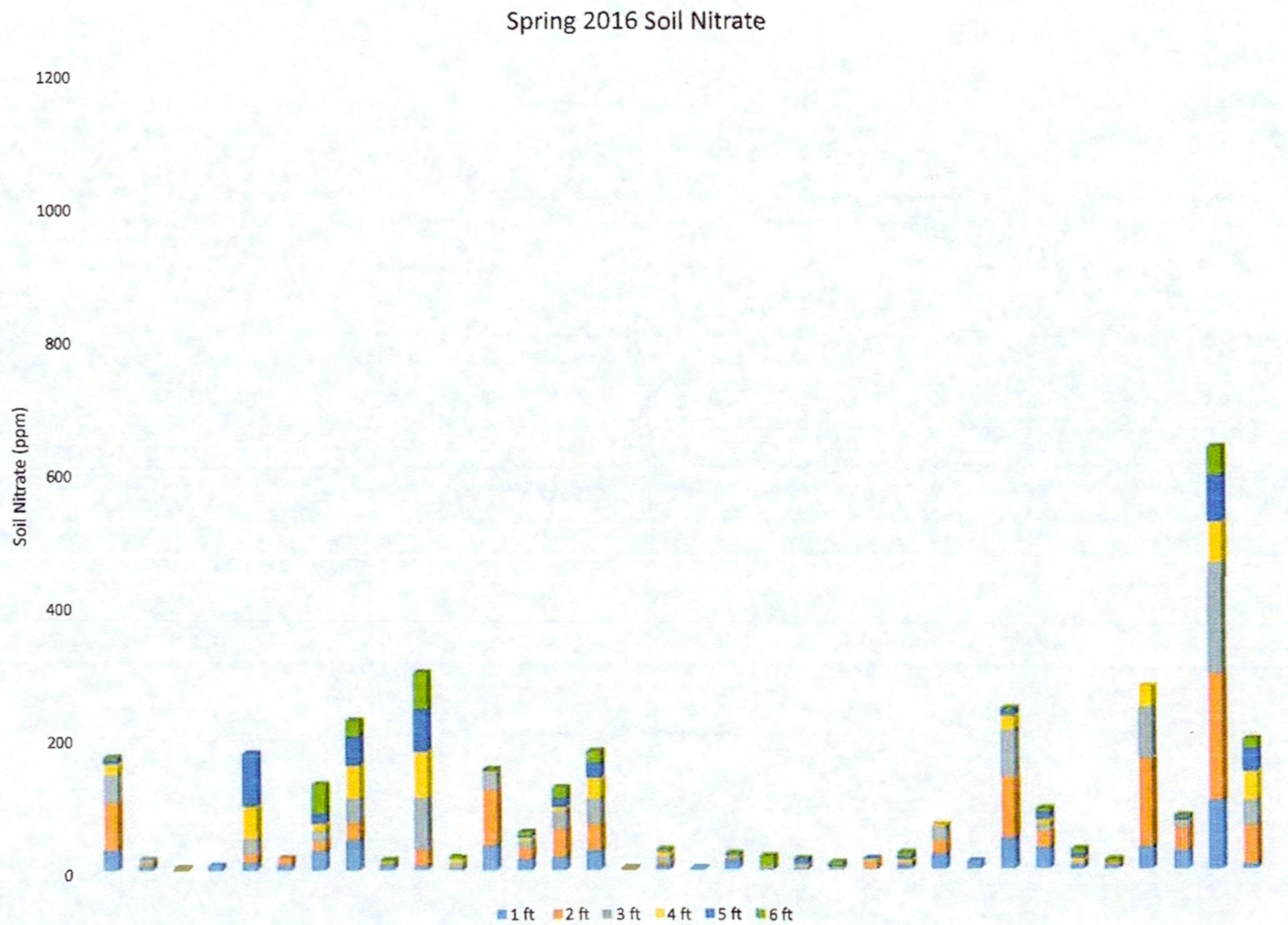
9



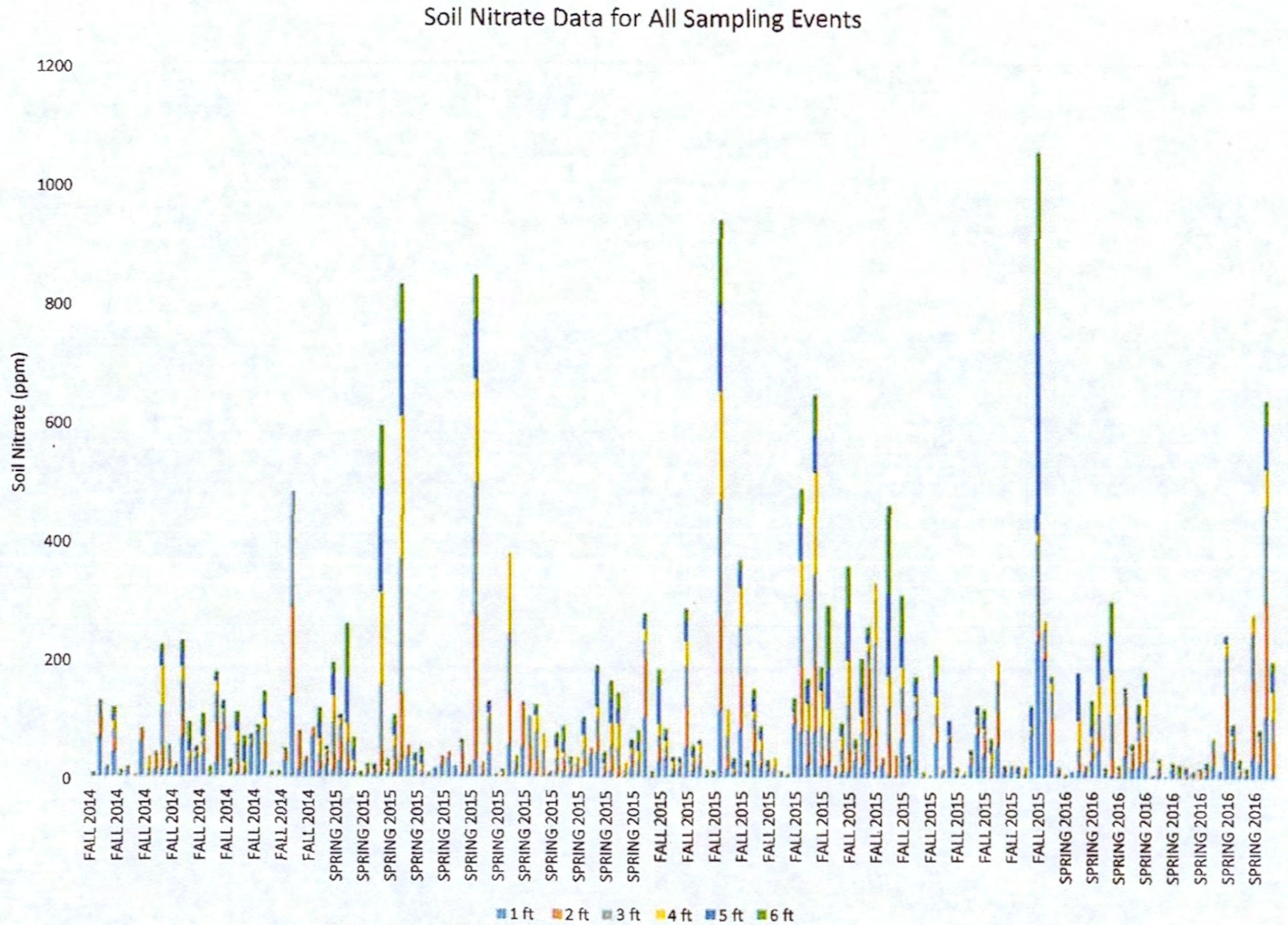
Spring 2015 Soil Nitrate
Soil Nitrate (ppm)
1200
1000
800
600
400
200
0
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
1 ft
2 ft
3 ft
4 ft
5 ft
6 ft



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

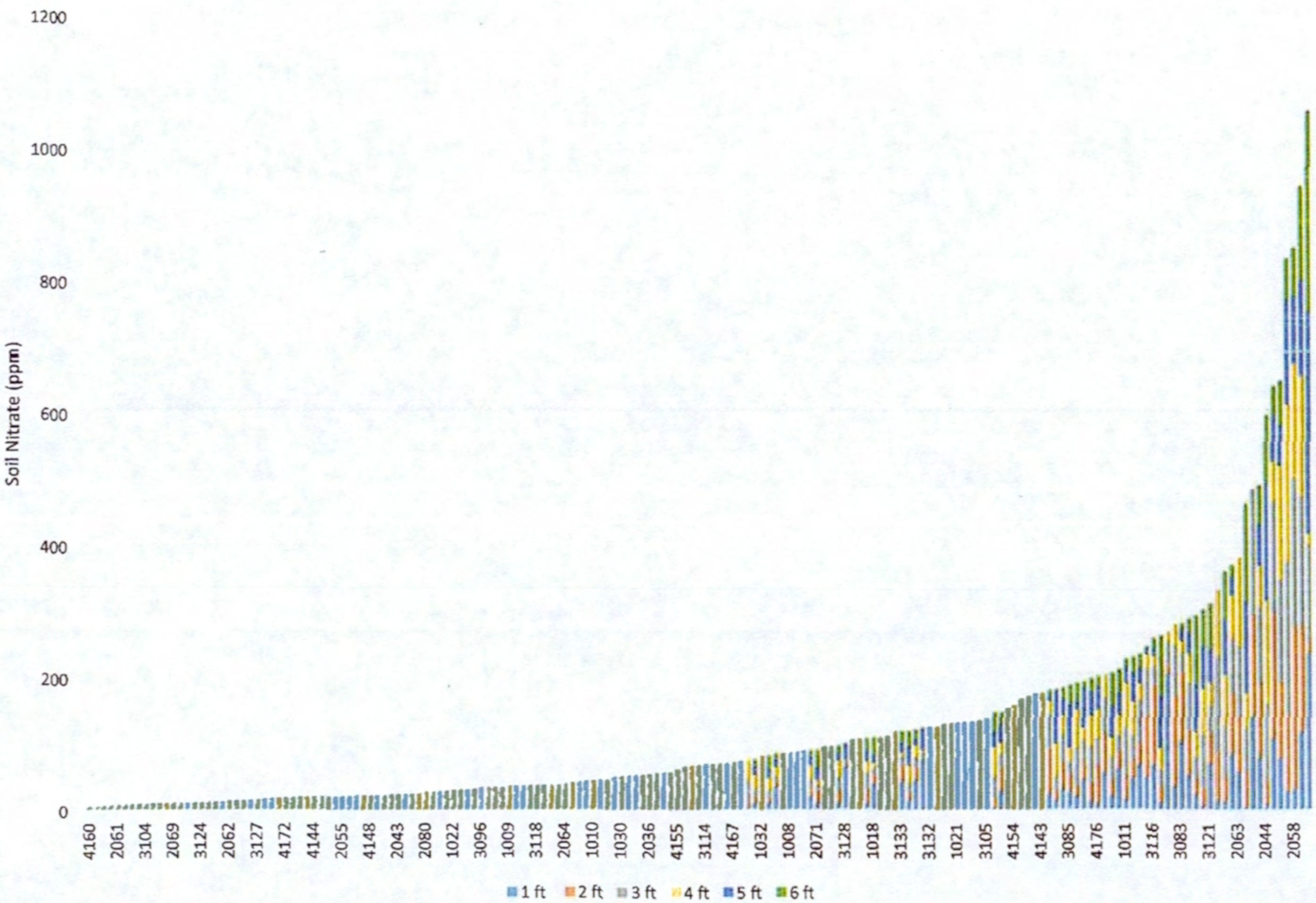


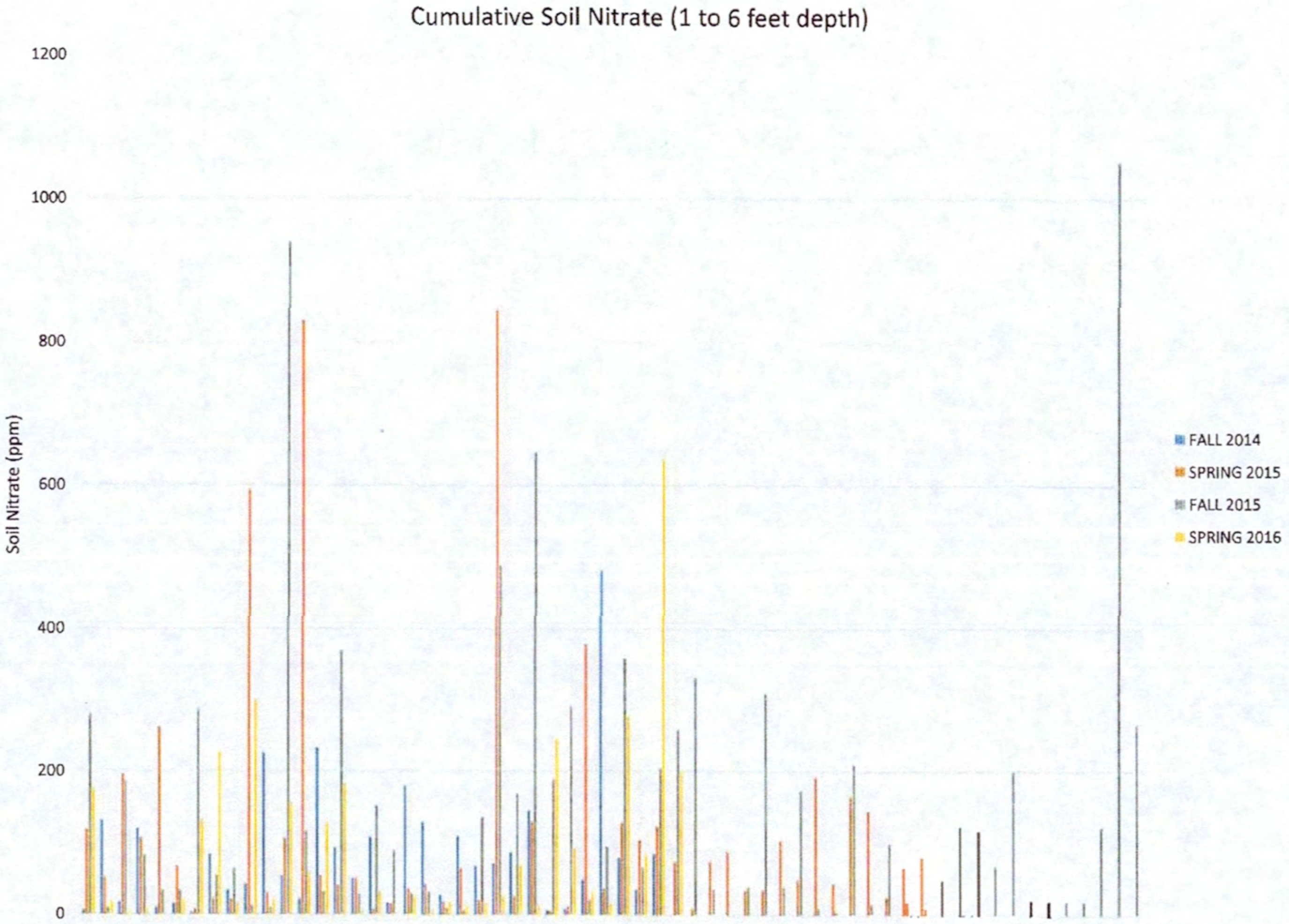
Spring 2016 Soil Nitrate
1200
1000
800
600
400
200
0
Soil Nitrate (ppm)
1 ft
2 ft
3 ft
4 ft
5 ft
6 ft



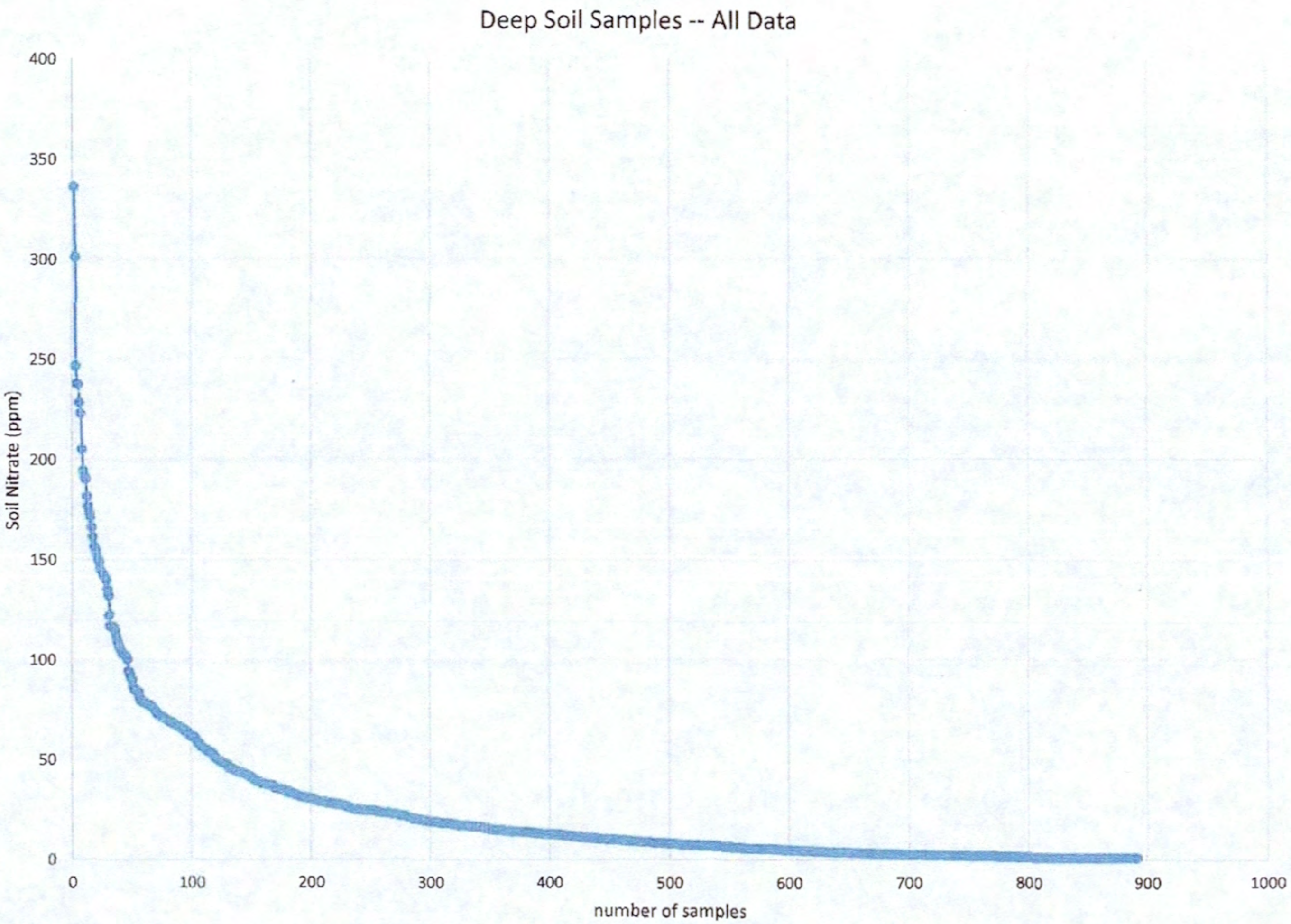
Soil Nitrate Data for All Sampling Events
Soil Nitrate (ppm)
1200
1000
800
600
400
200
0
FALL 2014
FALL 2015
SPRING 2015
SPRING 2016
1 ft
2 ft
3 ft
4 ft
5 ft
6 ft

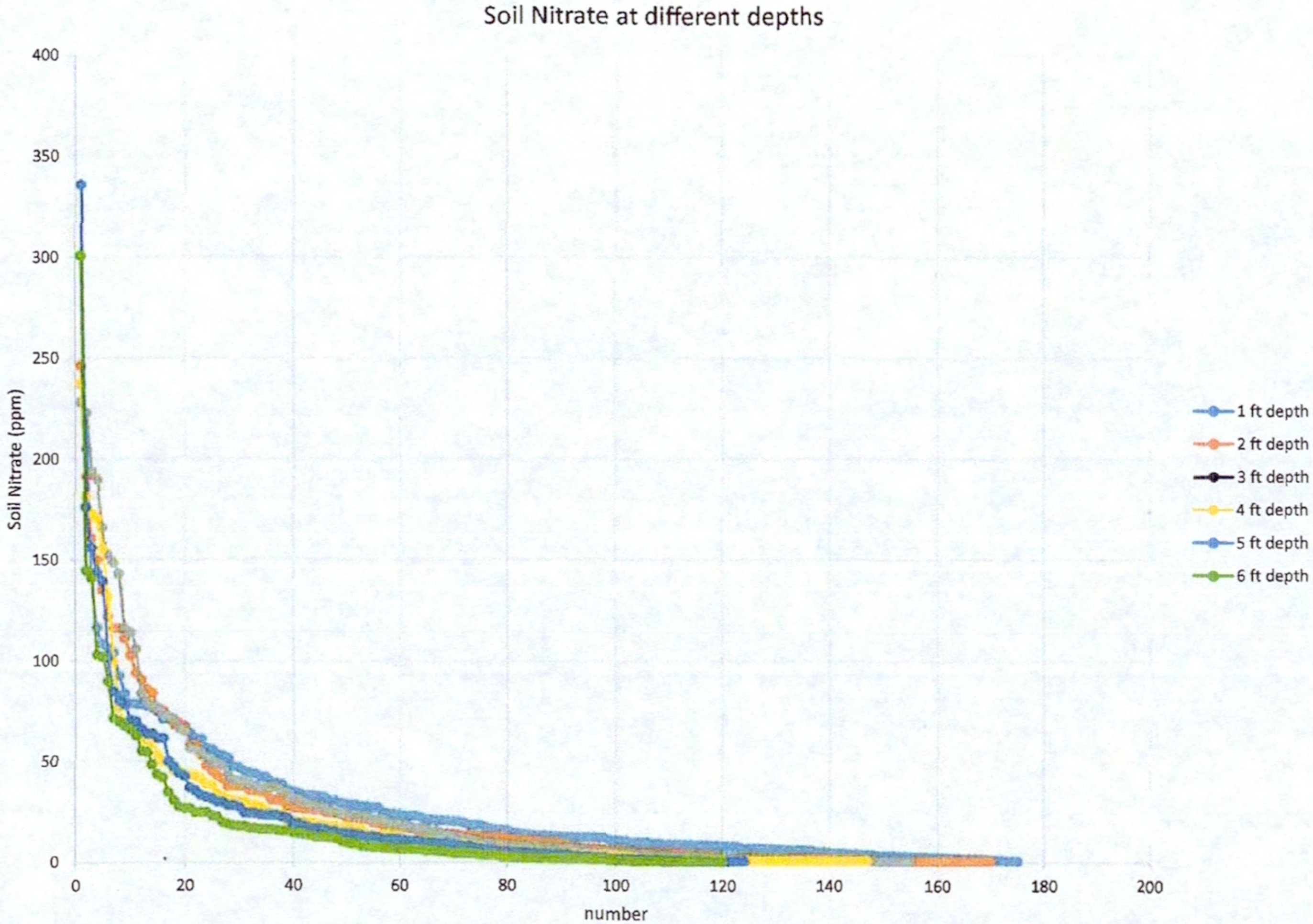
Cumulative Soil Nitrate for all Deep Soil Sampling Sites





Cumulative Soil Nitrate (1 to 6 feet depth)
Soil Nitrate (ppm)
0
200
400
600
800
1000
1200
FALL 2014
SPRING 2015
FALL 2015
SPRING 2016


Deep Soil Samples -- All Data
Soil Nitrate (ppm)
0
50
100
150
200
250
300
350
400
0
100
200
300
400
500
600
700
800
900
1000
number of samples



Soil Nitrate at different depths
Soil Nitrate (ppm)
number
0
50
100
150
200
250
300
350
400
0
20
40
60
80
100
120
140
160
180
200
1 ft depth
2 ft depth
3 ft depth
4 ft depth
5 ft depth
6 ft depth

DEEP SOIL SAMPLING PLAN
LOWER YAKIMA VALLEY
GROUNDWATER MANAGEMENT AREA

March 28, 2014

DEEP SOIL SAMPLING PLAN
LOWER YAKIMA VALLEY
GROUNDWATER MANAGEMENT AREA

Prepared for:

Lower Yakima Valley GWMA
Yakima County, Administrator

Prepared by:

Irrigated Agriculture Working Group

March 28, 2014
2014 03 28 Deep Soil Sampling Plan -VERSION 6 clean.docx

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ATTACHMENTS

1.0 INTRODUCTION

The GWMA project is a multi-agency, citizen-based, coordinated effort to reduce groundwater nitrate concentrations in the Lower Yakima Valley (LYV) to below Washington State drinking water standard. This project will identify activities contributing to nitrate groundwater contamination based on scientific data and evaluation.

Nitrate is added to soil by natural processes and human activities. Human activities include growing crops, and managing animal waste, human waste, and waste waters. Nitrate within the plant root zone may be utilized by the plants and if managed properly, leaching to groundwater can be minimized.

Nitrate in soil results primarily from land use at that location over time. Measuring deep soil nitrate may therefore help identify activities that contribute to nitrate groundwater contamination. Looking at nitrate concentrations in soil samples can provide relatively quick feedback on the effectiveness of changes to management practices designed to reduce groundwater contamination.

Initial deep soil sampling should be conducted for the purposes of:

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.

This deep soil sampling may not be sufficient to address future technical questions that may arise during the course of data collection and assessment conducted by current and future consultants tasked by the LYV GWMA Executive Committee (GWAC). Deep soil sampling will be conducted initially for two years to collect baseline information. Deep soil sampling may be repeated in future years to allow analysis of the effects of changing management practices. The timing and budget of future sampling will be coordinated with the pace of change in nitrogen application and irrigation water management practices, as determined by the GWAC.

This deep soil sampling plan will be implemented by South Yakima Conservation District (SYCD) and is summarized below.

1. Grower participation will be solicited by general mailings and outreach by SYCD and other participants of the GWAC.

2. Beginning in 2014, SYCD will distribute a unique identification number (UIN) to be retained by the grower only. The UIN will be translated into a bar code that will be used by the grower to identify their survey, the field and soil samples.

    a. The Deep Soil Sampling Program Questionnaire will include information **specific to an individual field** such as pertinent management information including cropping systems, nitrogen sources and amounts, historical yields, irrigation practices and application methods (Attachment A).

3. Soil sampling and analysis will begin in Fall 2014:
    a. After crop harvest but prior to nitrogen applications where possible.
    b. Soil samples will be collected at 1-foot increments from 0 to a depth not exceeding 6 feet, or to the depth of refusal as basalt, gravel or caliche that define the limits of a shallower potential root zone.
    c. The 0-1 foot sample will be analyzed for nitrate, ammonium and organic matter content.
    d. Deeper soil samples will be analyzed for nitrate only.
    e. Soil descriptions will be recorded in the field, and the NRCS Soil Series will be identified and documented.
4. Sampling and analysis will be performed by qualified firms contracted to SYCD. Funding to SYCD will be from the LYV GWMA budget.
5. SYCD will use results from soil sampling to identify risk of nitrate leaching posed by the various soil/cropping/irrigation systems.
6. Data will be available on the GWAC Web site and available at SYCD. Data will be identified using and Unique Identification Number (UIN) and kept confidential using bar codes supplied to the grower. Only the participating grower will be able to identify his/her sample(s).
7. The GWAC will retain technical data for analysis.

2.0 DEEP SOIL SAMPLING PROGRAM

2.1 PROJECT ADMINISTRATION

The program will be administered by SYCD under the direction of the GWAC and this plan. Attachment B contains contact information for key project personnel.

SYCD will perform the following tasks:

- Recruit growers for the sampling program with assistance from the GWAC and the Irrigated Agriculture Working Group (IAWG). Effort will be made to get as diversified participation as possible considering crop type and areal distribution.
- Distribute UIN and labels with bar codes for soil samples and grower surveys.
- Contract firms to collect and analyze soil samples.

- Maintain records of sampling and analysis results.
- Record sampling data, analytical results, and quality assurance/quality control (QA/QC) results in a computer database (database design provided by GWMA).
- Provide the county with data to be published on the county web site.
- Report to the GWAC.

2.2 SELECTION OF SAMPLING SITES

The goal in field selection will be to involve as many growers and field conditions as possible for the established budget.

2.2.1 Outreach to Growers

Grower participation will be solicited by general mailings and outreach by SYCD and others participating in the GWAC. Growers will be encouraged to propose fields for sampling by contacting SYCD. In preparation for sampling, outreach should begin during spring/summer 2014.

2.2.2 Sites Identified by Other GWAC Work Groups

Sites other than irrigated agricultural fields may be sampled using the methods of this plan. Such sites may be proposed by the RCIM (residential-commercial-industrial-municipal) or Livestock-CAFO work groups. For application to sites other than agricultural fields, the method should be reviewed and modified if necessary to conform to site conditions. For instance:

- The number of boreholes and the radius within which boreholes are drilled may need to be reduced if a site with a small footprint is investigated.
- The depth of sampling should be coordinated around land cover, and water and waste management specific to the site.
- Analytes should be reviewed.

If the RCIM and Livestock-CAFO work groups propose sites for sampling, they will produce addenda to this plan indicating the sampling sites and necessary modifications to methods. Sites should be proposed prior to SYCD contracting for the work.

2.3 SAMPLING REQUIREMENTS

2.3.1 Expected Variability

The LYV GWAC understands that it would be cost prohibitive to characterize each field to a level of detail necessary to identify all the variability within a field or to accurately quantify field-level leaching estimates. Sampling sites will therefore be selected to measure effects of management practices for the predominant field conditions. The GWAC will evaluate the deep soil sampling program to determine whether the sample requirements and evaluation criteria should be modified during future sampling events.

Generic Variability: Generic conditions exist which create variability in all fields. Examples include field border effects, cultivation patterns, and position relative to an irrigation system. Figures 1 through 12 provide sampling schemes to be used for common field conditions that will be encountered by the program[1]. These figures provide minimum setback distances to avoid field border and cultivation effects. They also suggest sampling locations and transect directions relative to irrigation systems so that known differences in irrigation uniformity can be avoided or incorporated appropriately.

Field Specific Variability: Factors that cause field specific variability include soil type, topography, and management practices. Selecting a sample site with relatively uniform conditions will be the responsibility of the grower. While resources are available to aid the grower, most growers have intimate knowledge of their fields and are best suited to select the locations of average field conditions.

2.3.2 Definitions

Based on the discussion above and for use in this document, the following definitions have been developed.

Sampling Setbacks: Those areas of the field that are automatically determined to be not representative of the average field condition and therefore inappropriate for sampling (Figures 1 – 12). Examples include field borders, first span of a center pivot, and known lap areas.

Sampling Zone: The field area available for sampling after the setbacks described in Figures 1 - 12 are taken into account.

Sampling Site: A sixty-foot diameter circle within the Sampling Zone where samples will be collected from at least four boreholes. The same sampling site will be used year-to-year if possible.

Borehole: A borehole where discrete soil samples are collected to contribute to the composite samples. Boreholes may be advanced by any method capable of collecting discrete samples of sufficient volume over 1-ft intervals – mechanized sampling devices are recommended.

Discrete Sample: A soil sample from a borehole, prior to compositing.

Composited One-foot Sample: The soil sample that will be analyzed to represent concentrations in a given one-foot depth increment within a sampling site. This soil will come from a composite mixture of discrete samples from the same depth from all boreholes.

2.3.3 Sampling Method Requirements

Samplers and laboratories will be contracted by SYCD to perform the field and laboratory work. SYCD will establish terms of the contract including minimum qualifications, and hardware and software to be employed. Samplers shall use GPS-based field location equipment coupled to soil survey maps for working with the grower on site selection and field orientation. The contracts will reference this plan as the basis for sampling and analysis requirements.

[1] Figures 3 and 4 apply to dryland sites which are not currently proposed for sampling. These figures are included for possible future reference.

Samples will be collected within a 60 foot diameter sampling site identified by the grower in conjunction with the sampler. The latitude and longitude at the center of the sampling site will be measured with a global positioning system device (GPS) provided by the sampler. The sampler will provide the coordinates to the grower for future reference. Latitude and longitude coordinates will be based on the datum WGS84 and measured/recorded to a precision of four decimal places (1x10-4 decimal degrees). Example: 46.3874, -120.1408. This level of precision results in the coordinate being rounded to +/- 12 ft East-West and +/- 18 ft North-South. The accuracy of the coordinates will depend on the type of GPS device & the alignment of satellites or the scale of the basemap. Care should be taken to make sure the GPS device is working properly and recording the locations as accurately as possible.

A minimum of four boreholes are required within each sampling site. A mechanized sampling tool (eg: Giddings, AMS, GeoProbe) is recommended that can collect soil from discrete one-foot increments to a depth of 6 feet below ground. The minimum nominal diameter of the standard cores shall be 2-inches; however, below a depth where a sampler is unable to advance a 2-inch core, as small as a 1-inch diameter core may be used. The pattern and location of the boreholes within the sample site will be conducted per the guidelines found in Figures 1 - 12. Portions of the sampling tools that contact soil must be cleaned between sample runs to minimize cross contamination of samples.

The soil from each borehole will be collected at one foot increments and placed temporarily in clean plastic buckets (one for each depth interval) in preparation for composite mixing. Buckets shall be cleaned at least between each sampling site. Each discrete soil sample will be described by the sampler in terms of consistency, moisture content, color, grain size, and other observations such as odor. The sampler will record soil descriptions on Boring Logs (Attachment C). In addition, the sampler will fill out one Soil Sample Field Form (Attachment D) for each site to document the soil sample compositing and lab-submittal process. The Boring Logs, Soil Sample Field Form, and Grower Survey Questionnaire will be returned to the SYCD by the sampler.

Boreholes will be advanced to a maximum depth of 6 feet or until refusal, whichever is shallower. If boreholes terminate at different depths, composite samples will be created by compositing available discrete samples (which may number less than four). During boring and soil collection, care should be taken to avoid mixing the soil from discrete one-foot depth increments with soils from shallower or deeper depths.

After all boreholes have been dug and the soil from each individual depth increment has been placed in the plastic buckets, the soil will be mixed thoroughly in the buckets to form a composite one-foot sample. After compositing, a portion of soil in each quadrant of the bucket will be transferred to a lab-prepared sample container. Tools used to mix and transfer samples must be clean to minimize cross contamination of samples.

Boreholes will be backfilled by the sampler using tamped native soil to prevent creation of a vertical conduit.

2.3.4 Safety and Liability

Because of the proposed sample depths, samplers should use mechanized sampling equipment, which is inherently dangerous. In addition to physical hazards of the equipment itself, there is the potential to intersect power and other utility lines that may lie above or beneath a sampling site.

The sampler must call the utility notification center (information at http://www.callbeforeyoudig.org) and leave sufficient time for their response prior to field work. The grower must identify and record the location of utilities on private land during orientation with SYCD and flag/stake any underground utilities in the field that are within 200 ft of the agreed sample site.

Responsibility for personnel safety will reside with the sampling company.

The GWMA project will repair damage to property of the cooperating grower caused by field sampling except for that caused by the negligence of the sampler. Property damage caused by negligence on the part of the sampler will be repaired by the sampler.

2.3.5 Sampling Schedule

Each sampling site will be sampled for baseline purposes once, unless additional soil sampling is requested based on review of data by GWMA workgroups.

When possible, samples will be collected after crop harvest but prior to any nitrogen amendments. Recent crop, nutrient, and irrigation actions will be recorded by SYCD.

2.3.6 Handling and Custody

A Soil Sample Field Form (Attachment D) will be filled-out by the grower/sampler for each field to be sampled. The UIN will be distributed by the SYCD. The UIN will be used to identify each composited soil sample. Grower identification information will not be included on the Deep Soil Sampling Questionnaire, Soil Sample Field Form, Boring Logs, or sample container labels.

Soil samples will be delivered by contracted samplers to contracted commercial laboratories. For delivery to the lab, samples shall be placed in a cooler with reusable ice substitutes or with ice. If ice is used, sample containers must be placed inside a waterproof bag to prevent contact with melting ice. At no time shall the sampler store samples for more than 48 hours. Samplers may dry samples using methods acceptable to the laboratories and consistent with analytical methods. If the laboratory cannot analyze the sample within 48 hours of sample collection the laboratory must preserve the samples by methods acceptable for the analytical method and standard practice.

The sampler and lab must complete a Chain of Custody form for each batch of samples delivered. The COC must contain the Date, Time, Sampler Name, Bar Code for the UIN, and Sample Depth for each sample submitted. The sampler relinquishing the samples and the laboratory receiving the samples must sign the COC. The "owner" and "client" information on the COC shall be the SYCD, not the grower.

2.4 ANALYTICAL METHODS

The following analytes are required for this program.

- nitrate-nitrogen
- ammonium-nitrogen
- organic matter

The sample from the upper one-foot will be analyzed for all three analytes. Samples below the first foot will be analyzed solely for nitrate-nitrogen. The following subsections specify the laboratory analysis methods.

SYCD will contract with one laboratory to perform the work. Only laboratories that participate in the North American Laboratory Proficiency Testing Program (NAPT) and NAPT's Proficiency Assessment Program (PAP) for the methods listed in this plan will be eligible.

The laboratory shall be instructed to report nitrate concentrations in parts per million (ppm) or milligrams per kilogram (mg/kg) and as pounds per acre (lbs/acre) for each one-foot layer. All reporting values shall be on a dry weight basis. Laboratories shall report assumptions used in conversion from ppm (mg/Kg) to lbs/acre.

The analytical lab report (including QA/QC results) will be submitted to SYCD within three weeks from the date of the analysis. The lab report must indicate the date and time of the analysis for each sample.

2.4.1 Nitrate-Nitrogen

Either of the two analytical methods below are acceptable for measuring nitrate-nitrogen.

Method: Cadmium Reduction

Reporting limit: 1 mg/Kg or lower

Method Reference: Cadmium Reduction Method, S-3.10, Western States Laboratory Proficiency Testing Program: Soil and Plant Analytical Methods, 3rd Edition, 2005, From: Plant, Soil, and Water Reference Methods for the Western Region. 1994, R.G: Gavlak, D.A. Horneck, and R.O. Miller, WREP 125.

Method: Automated Cadmium Reduction (with extraction step added for application to soil samples)

Reporting Limit: 1 mg/Kg or lower

Method Reference: 4500-NO3. F, 1987. Annual Book of ASTM Standards, Vol. 11.01. American Soc. Testing & Materials, Philadelphia, Pa.

2.4.2 Ammonium-Nitrogen

Method: KCL Extraction / Exchangeable ammonium

Reporting Limit: 1 mg/Kg or lower

Method Reference: KCL Extraction / Exchangeable ammonium Method; S-3.50; Western States Laboratory Proficiency Testing Program: Soil and Plant Analytical Methods, 3rd Edition, 2005, From: Plant, Soil, and Water Reference Methods for the Western Region. 1994, R.G: Gavlak, D.A. Horneck, and R.O. Miller, WREP 125.

2.4.3 Organic Matter

Method: Walkley-Black Titration

Reporting Limit: 0.1 percent

Method Reference: Walkley-Black ; S-9.10; Western States Laboratory Proficiency Testing Program: Soil and Plant Analytical Methods, 3rd Edition, 2005, From: Plant, Soil, and Water Reference Methods for the Western Region. 1994, R.G: Gavlak, D.A. Horneck, and R.O. Miller, WREP 125.

2.5 QUALITY CONTROL AND DATA QUALITY OBJECTIVES

Adherence to this plan will maintain quality control for the project. Quality assurance samples shall be analyzed and the results reported to SYCD. The SYCD contract with samplers and laboratories will allow for the GWMA project to discuss results with the samplers and laboratories to determine the cause of problems and arrange for changes in procedure to achieve the data quality objectives.

Laboratories shall perform laboratory blank measurements, calibration measurements, method detection limit determinations, duplicate analyses and performance evaluation samples according to standard laboratory and method-specific procedures. In addition, SYCD will submit performance evaluation samples to the labs. Quality assurance data must be reported with each analytical report submitted to SYCD.

2.5.1 Quality Control Requirements

2.5.1.1 Instrument and Equipment Testing, Inspection, Calibration, and Maintenance

The participating laboratories will follow their standard operating procedures for maintenance and calibration of instruments or systems used for this project. The frequency of calibration will also be consistent with their standard operating procedures.

2.5.1.2 Inspection/Acceptance of Supplies and Consumables

Soil sampling tools shall be supplied by the participating samplers and they will assure the tools are clean and in proper operating condition. Laboratories will inspect and accept supplies per their standard operating procedures. Samplers will obtain sampling containers from the participating laboratories. Samplers shall only accept new (not used) sample containers that are clean.

2.5.1.3 Data to Support Repeat Sampling

To promote consistency and avoid confusion where sites are sampled repeatedly, SYCD and the grower shall refer to the prior Soil Sample Field Form and the latitude and longitude of the sampling site retained by the grower so that the same sites can be revisited. In repeat sampling, growers shall the reuse previous UIN and any remaining bar-code labels (grower/sampler can hand-write the UIN on forms and samples as necessary). Growers shall fill out a new Deep Soil Sampling Questionnaire to reflect field conditions since the last sample round. For data analysis, SYCD shall use the combination of common UIN but different sample dates to match sites that are resampled.

2.5.1.4 Specialized training

Labs and sampling firms are responsible for providing personnel who are qualified to perform the work.

2.5.2 Quality Control Samples and Data Quality Objectives

Requirements to assess accuracy, representativeness, comparability and completeness are summarized below. Data Quality Objectives (DQOs) have been established to help the GWMA project meet its overall objectives. Project DQOs may be revised by GWAC approval in the future.

2.5.2.1 Accuracy

Accuracy is a measure of confidence that describes how close a measurement is to its "true" value. In this program, accuracy will be measured by analysis of performance evaluation (PE) samples provided by a third party and by evaluation of internal lab control samples where such samples are standard to the lab practice.

PE samples (soil with known nitrate concentration) will be obtained by SYCD and submitted blind to prospective laboratories prior to contracting with SYCD. These samples will be obtained from a source used by the North American Laboratory Proficiency Testing program. Two concentrations of PE samples will be used and will represent medium (10-15 mg/kg) and high (>50 mg/kg) soil nitrate values. In addition, SYCD will provide the contracted laboratory blind samples from the medium and high PE samples at least twice during the project time period each year. The RPD between the known value and the reported value from each laboratory will be calculated. A RPD of 20% will be acceptable for this project. If the RPD for individual laboratories regularly falls outside this range, the GMWA project will take corrective action which may include denying the laboratory further participation in the GWMA program.

2.5.2.2 Representativeness

Representativeness is the degree to which data from the project accurately represent a particular characteristic of the environmental matrix which is being tested. Representativeness of samples is ensured by adherence to the field sampling protocols and standard laboratory protocols. The design of the sampling scheme and number of samples should provide a representativeness of the soil matrix being sampled.

2.5.2.3 Comparability

Comparability is the degree to which data can be compared directly to similar studies. Using standardized sampling, analytical methods and units of reporting with comparable sensitivity helps ensure comparability. The GWMA project is using sampling and analysis methods that are currently being employed by the agricultural industry for nutrient management decisions. The Columbia Basin Deep Soil Sampling Program was conducted using similar procedures.

2.5.2.4 Completeness

Completeness is the percentage of valid results obtained compared to the total number of samples taken for a parameter. A complete or valid result will include full completion of the Deep Soil Sampling Questionnaire, Soil Sample Field Form, Boring Logs, and a laboratory analysis report, all linked through the UIN. Percent completeness may be calculated using the following formula. A DQO of 80% is established for this parameter.

$$\% \, Completeness = \frac{\#\, of\, valid\, results}{\#\, of\, samples\, taken} X\ 100$$

2.6 INFORMATION MANAGEMENT

2.6.1 Soil Sampling

Documentation of field and laboratory work for each soil sampling site will consist of submittal of the following documents to SYCD:

- Completed Deep Soil Sampling Questionnaire
- Completed Soil Sample Field Form
- Completed Boring Logs
- A completed Chain of Custody Form
- A copy of the analytical results, including QA/QC results

Forms shall be submitted to the SYCD who will retain the minimum records necessary for technical analysis of the data, documentation to facilitate repeat sampling, and possible audit of financial data.

2.6.2 Computerization of Technical Information

SYCD will enter sample and analytical data into a computer database. The GWMA project will provide the SYCD the database entry form. Computerized data will include technical data necessary for interpretation of the results by the GWMA project. Such data will include sample ID; sampling date; nitrate, ammonium, and OM concentrations; and depth; field information including nitrogen sources and amounts, historical yields, and irrigation practices. The sampling and analytical data will be linked to the soil type, nitrate leaching potential (per NRCS), irrigation type, crop, and other data provided by the grower and recorded by SYCD. SYCD will provide the GWMA the computer database within 90 days of the close of the sampling season (eg: by mid August assuming a mid-May end of sampling season).

SYCD will provide the county with data and copies of the documents listed in section 2.6.1 above identified only by the UIN.

The county will publish data on the LYV GWMA website. Growers will access data from the website or from SYCD.

3.0 TARGETED SAMPLING

Analysis of initial Deep Soil Sampling data collected in 2014 will likely reveal uneven coverage of geographic areas, soil types, crop types, irrigation types, and nitrogen sources. Uneven coverage is expected and may be acceptable; however, extreme bias or uneven coverage could jeopardize fulfillment of GWMA project goals. The GWMA project will analyze distribution of the 2014 data across the field conditions, and identify possible unacceptable bias or gaps in coverage. If unacceptable bias or gaps are present, the GWMA project will reach-out to growers in uncovered areas and request participation in the deep soil sampling program. Outreach should occur in winter of 2014-15, and sampling to fill data gaps will occur in early 2015.

Targeted sampling may also include sampling of the following sites not accessible through the 2014 program. Note these locations may involve locations that are not irrigated agricultural fields, and would be identified through work of appropriate GWMA subcommittees (eg: livestock-CAFO or residential-commercial-industrial-municipal).

- control sites without intentional nitrogen application
- industrial and commercial sites managing nitrogen fertilizers or wastes
- point sources of possible nitrogen contamination
- private fields in close proximity to wells

FIGURES

Figure 1. Sampling scheme for center pivot irrigation system.

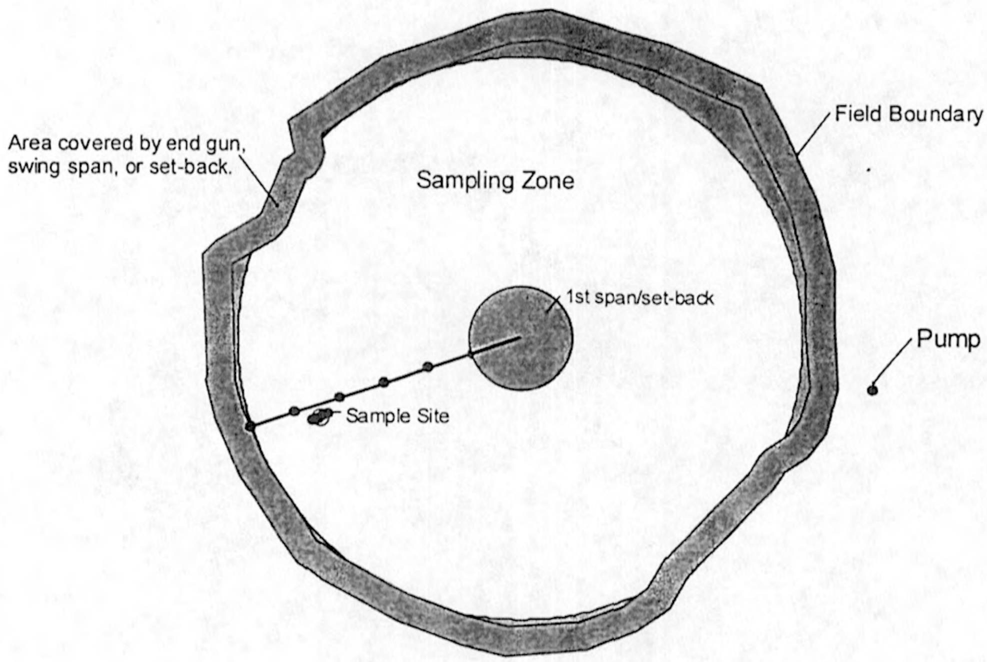


Figure 2. Sample site detail for center pivot irrigation.

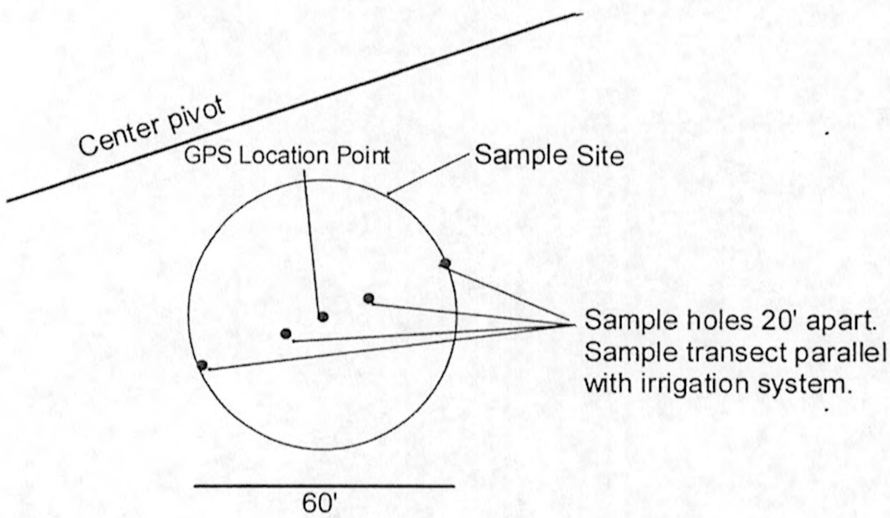


Figure 3. Sampling scheme for dryland fields.

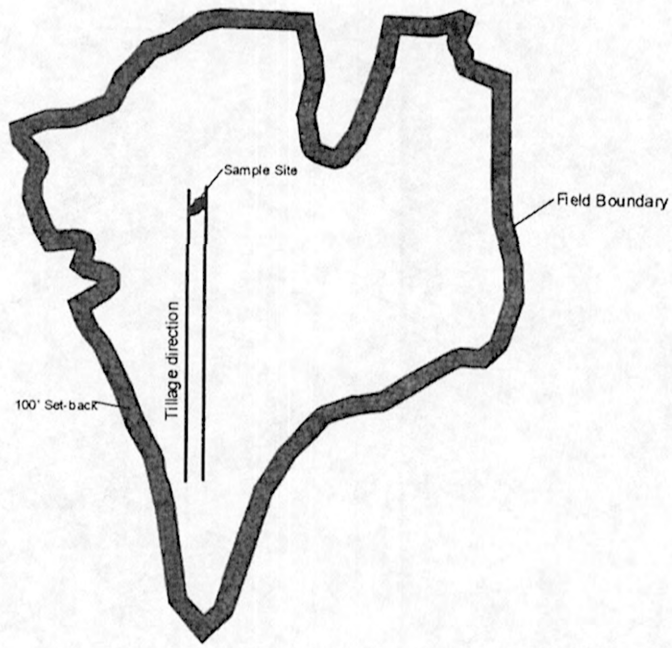


Figure 4. Sample site detail for dryland fields.

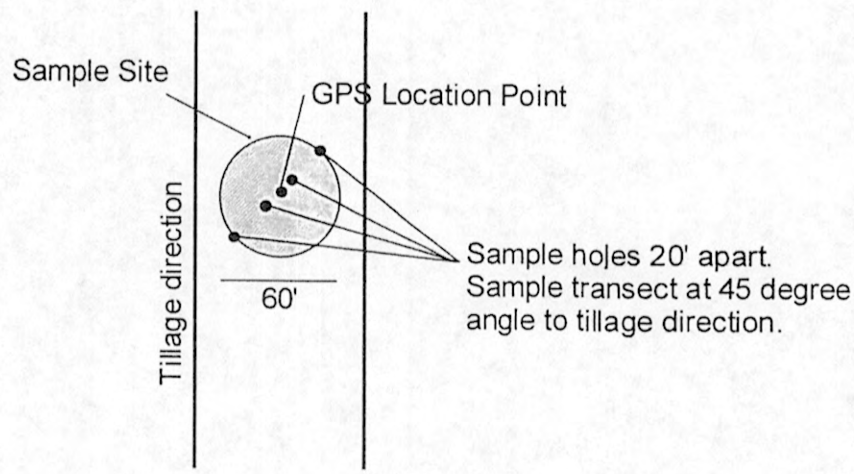


Figure 5. Sampling scheme for handline, wheelline, or solid set (row crop) irrigation systems.

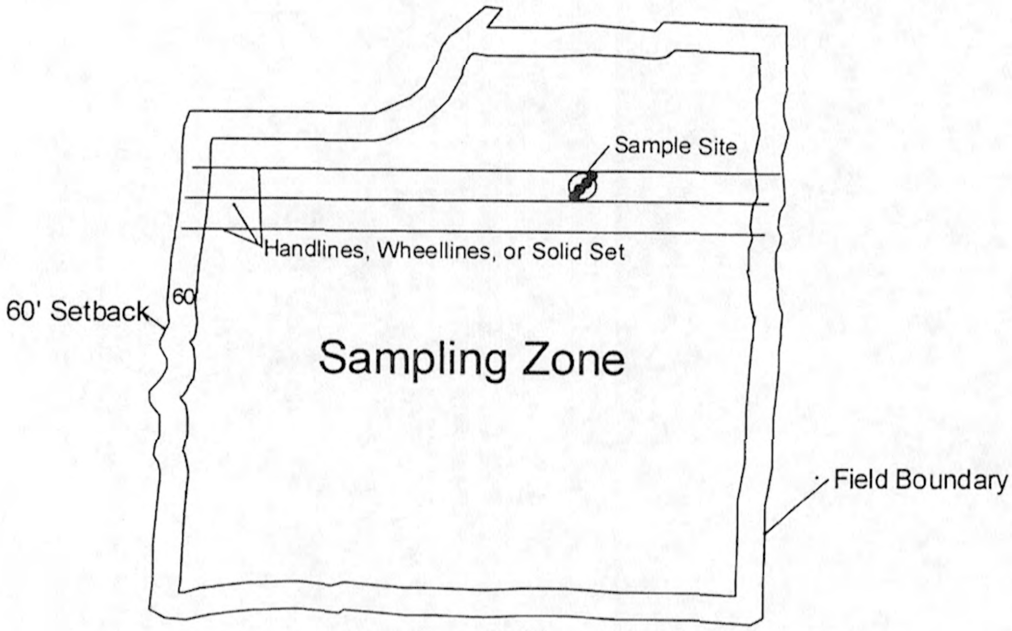


Figure 6. Sample site setail for handline, wheelline, or solid set (row crop) irrigation systems.

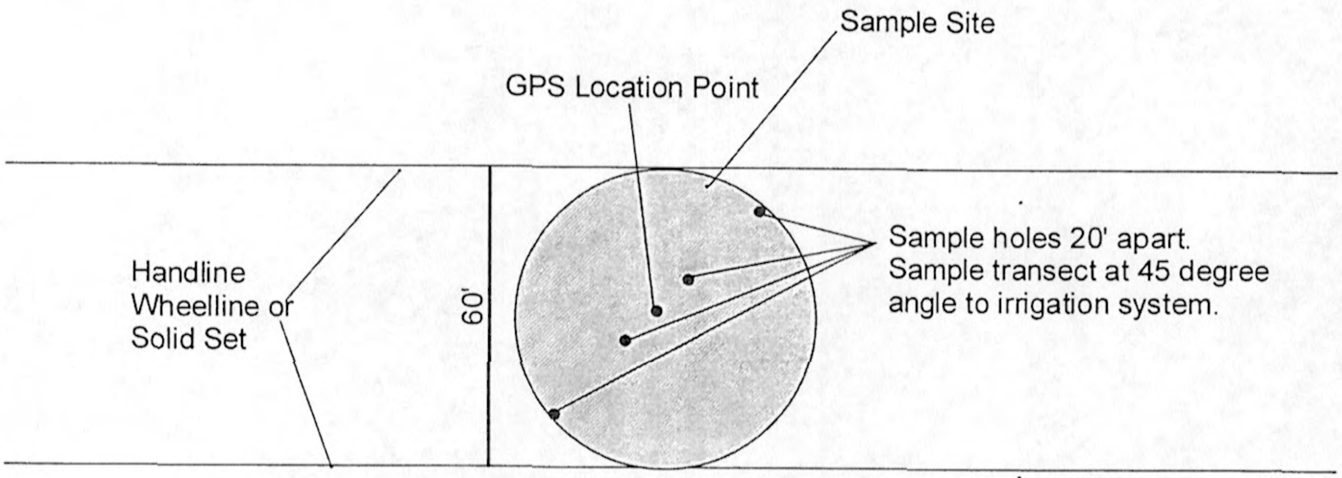


Figure 7. Sampling scheme for rill irrigation systems.

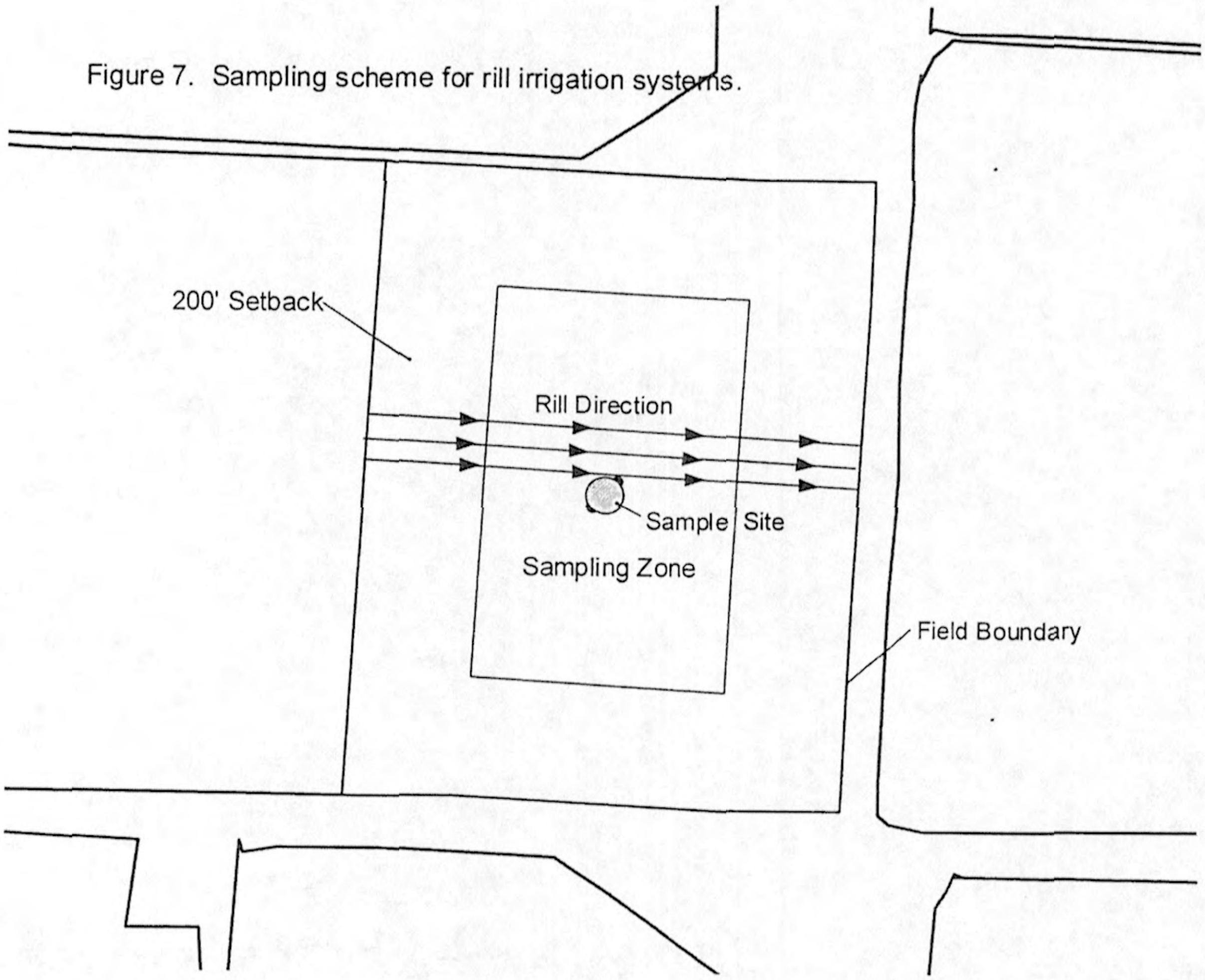


Figure 8. Sample site detail for rill irrigation systems.

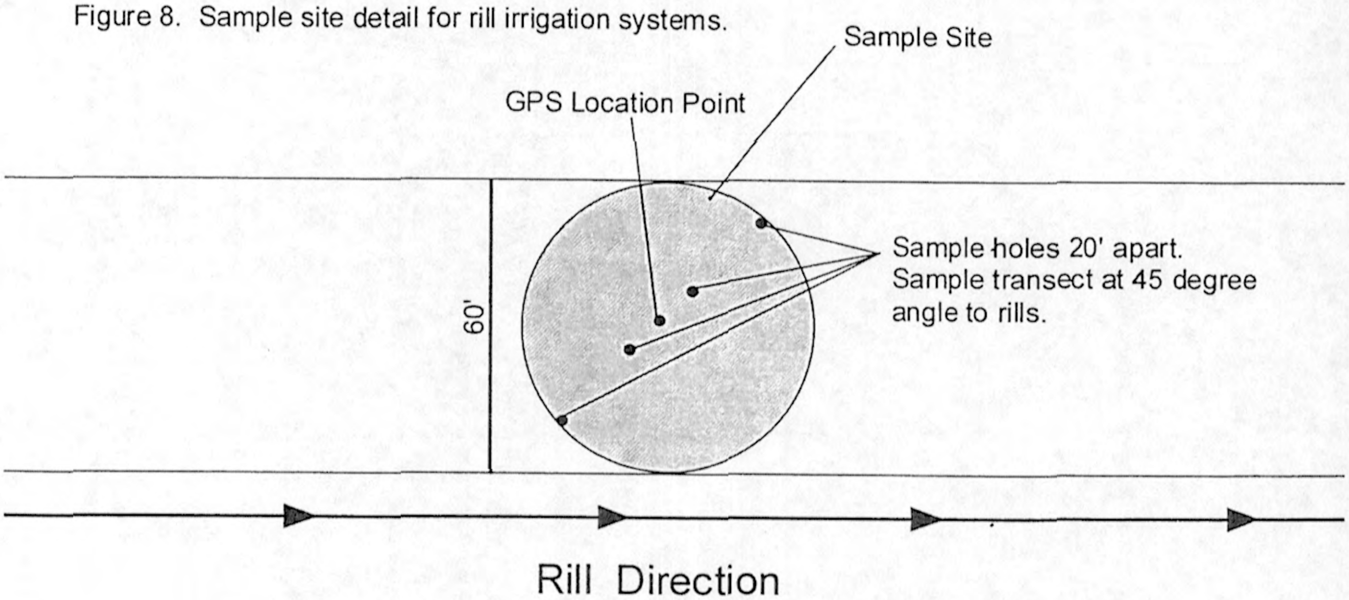


Figure 9. Sampling scheme for solid set or micro-spray (orchards & vineyards) irrigation systems.

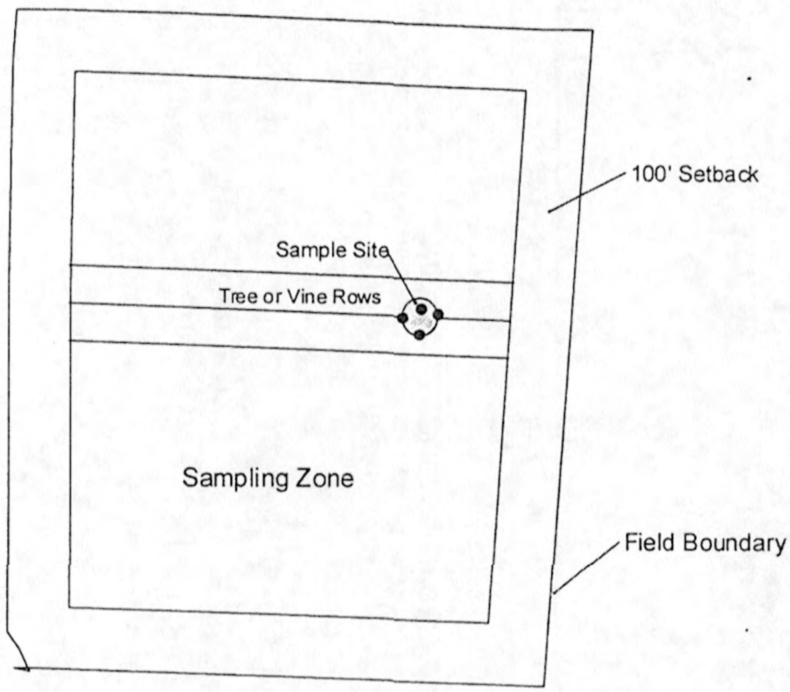


Figure 10. Sample site detail for orchard and vineyards wtih solid-set or drip irrigation systems.

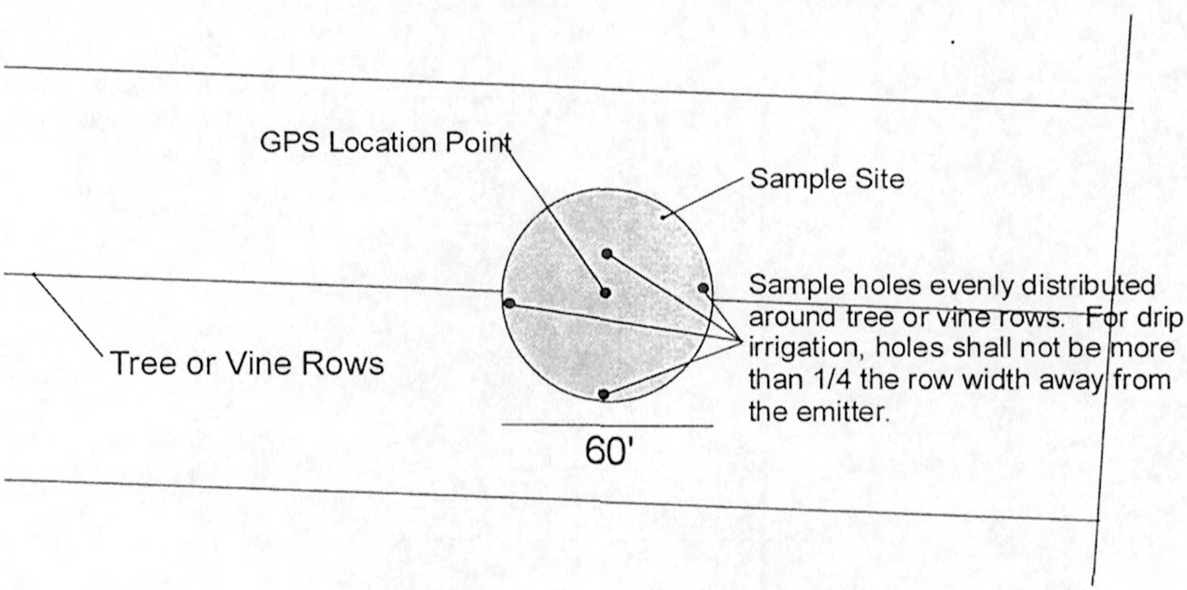


Figure 11. Sampling scheme for linear move irrigation systems.

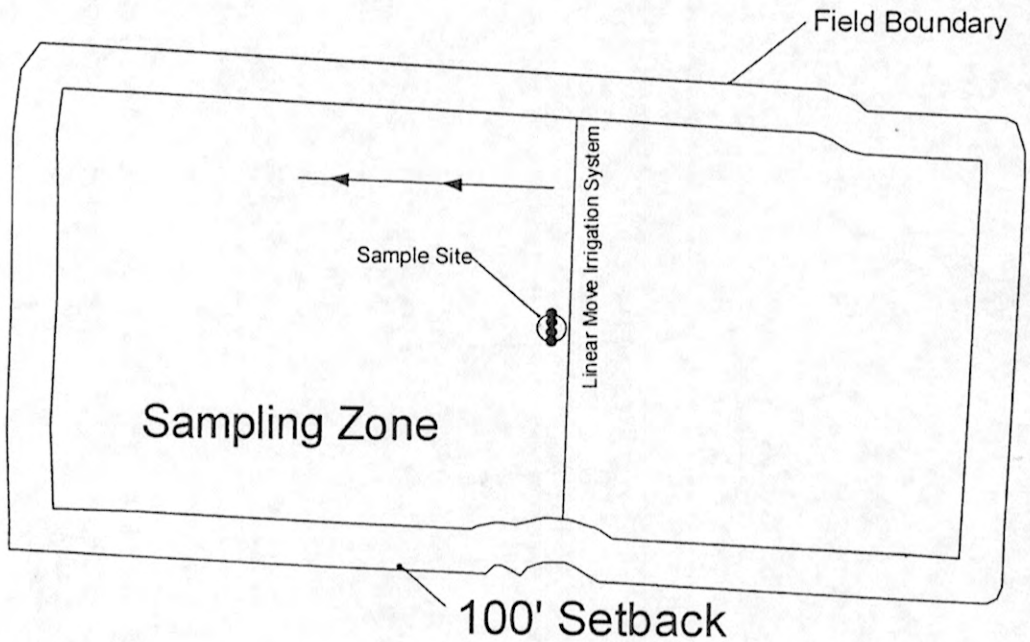
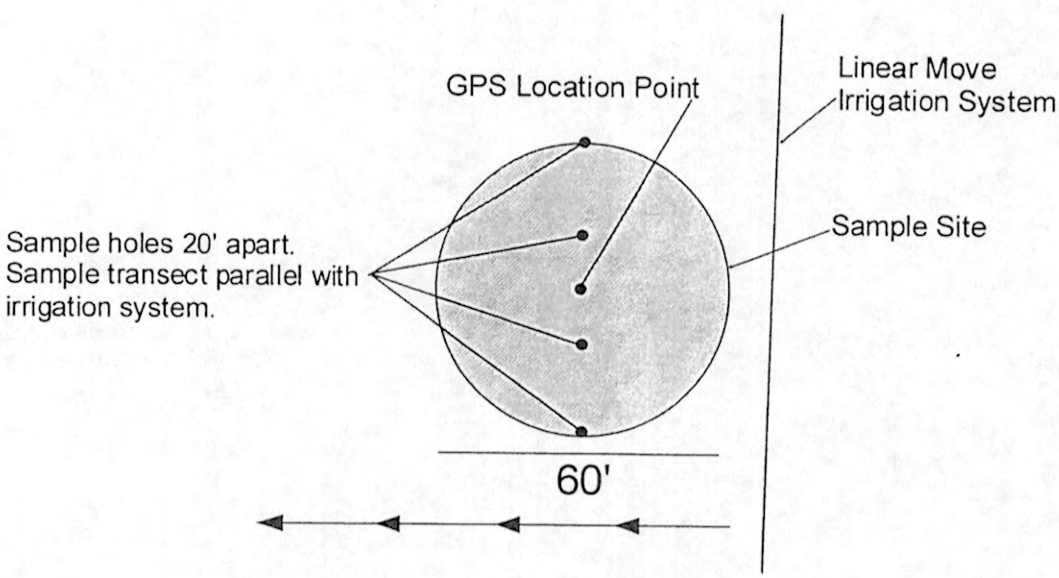


Figure 12. Sample site detail for linear move irrigation systems.



ATTACHMENT A
DEEP SOIL SAMPLING PROGRAM QUESTIONNAIRE

Deep Soil Sampling Program
Questionnaire

General:

As you may know, the aquifer in the Lower Yakima Valley has been shown to have groundwater nitrate concerns. Nitrogen that has migrated below the root zone is useless to crops and can be damaging to water quality. The Lower Yakima Valley Groundwater Advisory Committee (GWAC) designed this grower survey to help everyone better understand current production methods and provide guidance to improve farming practices to assist in improved farming practices. The correlation of the questionnaire with the Deep Soil Sampling Program is an attempt to understand the relationships between the amount and form of nitrogen applied, the application method and timing, the irrigation method, the amount of nitrogen required for plant growth based on cropping patterns, and the quantity of nitrogen that has migrated below the root zone. Participation will be anonymously structured as explained below.

The LOWER YAKIMA VALLEY Groundwater Advisory Committee (GWAC) is encouraging broad producer participation in the Deep Soil Sampling Program – at no cost to the grower. Nitrogen is an expensive input and once it migrates below the root zone it becomes an expensive loss. The results of your soil samples can help guide your input decisions and potentially reduce your nutrient expenses. A grower survey has been designed to better understand current production methods and assist in improved farming practices, where they may be needed to reduce nitrates in groundwater. For those producers who, for whatever reason chose not to participate in the Deep Soil Sampling Program, the GWAC would still encourage participation through completion of the landowner survey to help us understand current production practices. This questionnaire is intended for either growers who participate in the soil sampling project and those growers who choose not to participate.

We are thanking you in advance for agreeing to participate in the Lower Yakima Valley Groundwater Management Area Deep Soil Sampling Program and for completing the questionnaire. As mentioned above, samples will be taken on your property and analyzed at no cost to you, if you participate in the soil sampling program. We are also interested in knowing your agricultural practices such as crops grown, plant nutrients applied, irrigation practices, and soil type. While information gathered in the study will be summarized, your specific data will be confidential. Site specific information asked for on the questionnaire will not be public information. It will be summarized and used in a collective manner to help describe farming operations in the resulting report.

We have developed a procedure to protect your identity and the location of the soil sample locations. This protects your identity in your participation on the questionnaire as well. You are welcome to share that information with the South Yakima Conservation District or anyone else, but are under no obligation to do so.

Please keep the number associated with the attached bar code sheet. The bar code is the same number. It should be filed in a safe location so that you can refer to it to review your results of the soil sampling. With this number, you will be the only person that can identify your soil samples. It is not necessary to include all of the fields on your farm. You can select as many fields to include in the study as you feel comfortable with and may be able to add others later. If you decide not to include all fields in the study, be sure and convey that information to the person collecting the samples when they arrive.

Place one bar code sticker on the questionnaire and return it in the envelope addressed to the South Yakima Conservation District and mail it. Do not include your return address. When the samples are collected, give the bar codes to the sampler who will attach them to the sample containers.

When all of the samples have been collected, analyzed, and tabulated they will be posted on a website or published in a format suitable for public access. The results from your farm will be identified by the number only you will know.

Participation in the Deep Soil Sampling Program can benefit you economically, as the analytical results will help determine whether or not expensive nitrogen is being applied in excess of what your crop can utilize.

Thanks for your participation.

Note to SYCD: Among other specifications for the samplers, the successful sampler must have an application on a portable device that will pull up the soil information from the NRCS site.

Deep Soil Sampling Program
Questionnaire

WORKSHEET FOR IRRIGATED CROPLAND
Bar Code (Place Bar Code Here) **Date: __________**

Field History
Years Owned/Farmed____________ Soil Type (if know): ________________
Currently Soil Testing ___Yes ___No If yes, how often?__________________________
Number of Acres: ______
Tillage Practices For Crop Cycle

Current Crop (2014)_____________________Crop condition: _____Poor ____Fair ____Good
Tons/Bushels/Bins/Acre__________ actual or planned (circle one)

Cropping History (Include Double Crossing)

Crop Rotation:

2011 Crop 1__________Tons/Bushels/Bins/Acre _____; Crop 2__________Tons/Bushels/Bins/Acre_____

2012 Crop 1__________Tons/Bushels/Bins/Acre _____; Crop 2__________Tons/Bushels/Bins/Acre_____

2013 Crop 1__________Tons/Bushels/Bins/Acre _____; Crop 2__________Tons/Bushels/Bins/Acre_____

2014 Crop 1__________Tons/Bushels/Bins/Acre _____; Crop 2__________Tons/Bushels/Bins/Acre_____

Current method of scheduling irrigation:
_____ ET; _____ soil moisture sensors; _____ Routine _____ hr. sets; Weather Stations_______

Current Irrigation System: **Years of use on crop? ______________**

___Flood Irrigation

___Rill Irrigation

___ Solid Set above canopy - ___Impact Sprinklers, ___ Micro spray ___Rotators

___Solid Set below canopy - ___Impact Sprinklers, ___ Micro spray ___Rotators

___Wheel lines ___Impact Sprinklers ___Rotators

___ Hand lines ___Impact Sprinklers ___Rotators

___ Linear move ___Impact Sprinklers, ___ Micro spray ___Rotators

___ Drip ___ tube,___ tape,___ bury line___ above ground line

___ Pivot ___Impact Sprinklers, ___ Micro spray ___Rotators

Deep Soil Sampling Program
Questionnaire

___ Pod line____Impact Sprinklers ___Rotators

___ Other: ____________________

Previous Irrigation System: **Years of use on crop?** ________________

___Flood Irrigation

___Rill Irrigation

___ Solid Set above canopy - ___Impact Sprinklers, ___ Micro spray ___Rotators

___Solid Set below canopy - ___Impact Sprinklers, ___ Micro spray ___Rotators

___Wheel lines ___Impact Sprinklers ___Rotators

___ Hand lines ___Impact Sprinklers ___Rotators

___ Linear move ___Impact Sprinklers, ___ Micro spray ___Rotators

___ Drip ___ tube,___ tape,___ bury line___ above ground line

___ Pivot ___Impact Sprinklers, ___ Micro spray ___Rotators

___ Pod line____Impact Sprinklers ___Rotators

___ Other: ____________________

Nitrogen applications

Manure - Liquid

Year	Gallons/Acre applied	#N/1000 gal	How applied	Hours to incorporation	notes
2014					
2013					
2012					
2011					

Manure - Solid

Year	Tons/Acre applied	#N/ton	How applied	Hours to incorporation	notes
2014					
2013					
2012					
2011					

Commercial Fertilizer

Year	Material type?	#N/Acre applied	How applied	Hours to incorporation	notes
2014					
2013					

Deep Soil Sampling Program
Questionnaire

2012					
2011					

Biosolids

Year	Tons/Acre applied	#N/ton	How applied	Hours to incorporation	notes
2014					
2013					
2012					
2011					

Compost

Year	Tons/Acre applied	#N/ton	How applied	Hours to incorporation	notes
2014					
2013					
2012					
2011					

Other

Year	Tons applied	#/ton	How applied	Hours to incorporation	notes
2014					
2013					
2012					
2011					

Please provide additional information if appropriate such as split applications, starter, side dress, etc.____

Comments:____

ATTACHMENT B
KEY PERSONNEL

Attachment B - Key Personnel

Deep Soil Sampling

Lower Yakima Valley Groundwater Management Area

Deep Soil Sampling Program Role	Person
Deep Soil Sampling Project Manager	To be determined
SYCD Project Administrator	Laurie Crowe, SYCD, (509) 829-9025
Groundwater Advisory Committee Alternate Chair	Vern Redifer, Yakima County, (509) 574-2300
Irrigated Agriculture Committee Chair	Jim Trull, SVID, (509) 837-8611
Livestock / Confined Animal Feeding Operation Committee Chair	Charlie McKinney, Dept. Ecology, 509-457-7107
Data Committee Chair	Kirk Cook, WSDA, (360) 902-1936
Education and Public Outreach Committee Chair	Lisa Freund, Yakima County, (509) 574-2300

ATTACHMENT C
BORING LOG

Soil Boring Log

LOWER YAKIMA VALLEY
GROUNDWATER
ADVISORY
COMMITTEE

Return this form, filled out, to South Yakima Conservation District
PO Box 1766 (or 200 Chenye Rd), Zillah, WA 98953
Fax: (509) 829-9027

Bar Code (Place Bar Code Here)

Boring Number: ____________________

Boring Date: ____________________ Boring Logged by: ____________________

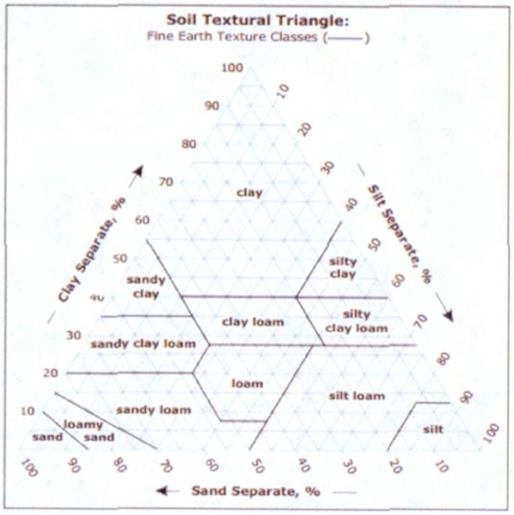
Boring and Sampling Device (example: AMS 9100 Ag Probe with 2-inch tube sampler) ____________________

____

NRCS Soil Series (soil type) ____________________

Describe each soil sample.

Depth in ft	Munsel color	Consistence	Moisture	Texture	Other
0-1					
1-2					
2-3					
3-4					
4-5					
5-6					
6-7					
7-8					



TEXTURE MODIFIERS - Conventions for using "Rock Fragment Texture Modifiers" and for using textural adjectives that convey the "% volume" ranges for **Rock Fragments - Size and Quantity**.

Fragment Content % by Volume	Rock Fragment Modifier Usage
< 15	No texture adjective is used (noun only; e.g., *loam*).
15 to < 35	Use adjective for appropriate size; e.g., gravelly.
35 to < 60	Use "**very**" with the appropriate size adjective; e.g., *very gravelly*.
60 to < 90	Use "**extremely**" with the appropriate size adjective; e.g., *extremely gravelly*.

Moisture options: D=dry
M=moist
Dp=damp
W=wet

Consistance options:
L=loose, S=soft, SH=slightly hard, HA=hard, EH=extremely hard, FR=friable, FI=firm; VFI=very firm; C=cemented.
See Field Book for Describing and Sampling Soils, NRCS, August 2011.

ATTACHMENT D
SOIL SAMPLE FIELD FORM

Soil Sample Field Form

LOWER YAKIMA VALLEY
GROUNDWATER ADVISORY COMMITTEE

Return this form, filled out, to South Yakima Conservation District
PO Box 1766 (or 200 Chenye Rd), Zillah, WA 98953
Fax: (509) 829-9027

Bar Code (Place Bar Code Here)

Sample Collection Date: ____________________ Sampled by: ____________________________

Check depths sampled in each borehole, and samples submitted to lab:

Depth in ft	Borehole 1	Borehole 2	Borehole 3	Borehole 4	Composite Submitted
0-1					
1-2					
2-3					
3-4					
4-5					
5-6					
6-7					
7-8					

Sampling Site Sketch:
Draw sampling site and borings in relation to irrigation system and other features.
Provide GPS coordinates to owner (to 0.0001 decimal degree precision).

North

Summary of Proposed Allocation Process

1. **Define groups of crops**
2. **Define groups of irrigation types**
3. **Average NRCS leaching potential for each field**
4. **Place each field into a category based on:**
    a. average NRCS leaching potential
    b. crop type
    c. irrigation type
5. **Calculate total acreage within each category. Rank categories according to acreage.**
6. **Allocate samples to each category plus allocate to special high-risk conditions and locations proposed by CAFO or RCIM committees.**

How Number of Categories and Samples Per Category could affect Budget

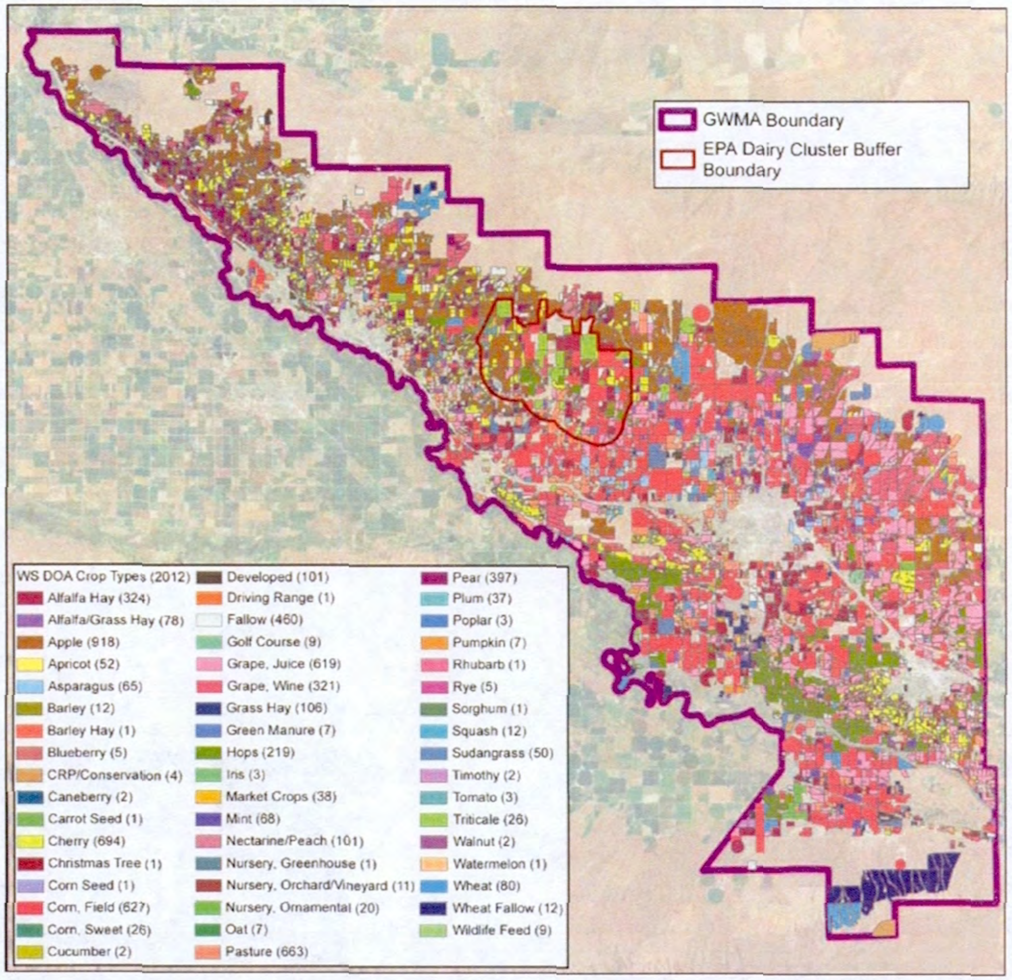
CALCULATION OF NUMBERS OF FIELDS SAMPLED DEPENDING ON DESIGN OF ALLOCATION PROCESS

	hypothetical sample allocation				
	A	B	C	D	E
number of NRCS N Leach Potential values	4	4	3	3	3
number of crop types	6	6	5	4	4
number of irrigation types	4	4	3	3	3
number of categories:	96	96	45	36	36
number of fields sampled for first quintile	0	0	0	0	3
number of fields sampled for second quintile	0	0	0	0	3
number of fields sampled for third quintile	3	2	2	3	3
number of fields sampled for fourth quintile	5	4	4	4	3
number of fields sampled for fifth quintile	8	6	6	6	3
total number of fields sampled	307	230	108	94	100

GWMA Crops

Crop Type	Number of Fields	Acres	% of total	Cumulative %
Corn, Field	627	18565.7	19%	19%
Apple	918	16738.5	17%	36%
Grape, Juice	619	10624.8	11%	47%
Alfalfa Hay	324	6405.2	7%	54%
Cherry	694	6402.9	7%	61%
Pasture	663	5468.8	6%	66%
Grape, Wine	321	4987.9	5%	71%
Hops	219	4846.8	5%	76%
Pear	397	3859.1	4%	80%
Fallow	460	3221.9	3%	84%
Wheat	80	2219.0	2%	86%
Wheat Fallow	12	1852.2	2%	88%
Sudangrass	50	1278.6	1%	89%
Mint	68	1234.5	1%	91%
Triticale	26	1214.0	1%	92%
Grass Hay	106	1167.3	1%	93%
Asparagus	65	994.4	1%	94%
Nectarine/Peach	101	952.5	1%	95%
Alfalfa/Grass Hay	78	933.7	1%	96%
CRP/Conservation	4	626.1	1%	97%
Developed	101	625.3	1%	97%
Nursery, Ornamental	20	346.8	0%	98%
Apricot	52	305.3	0%	98%
Barley	12	240.4	0%	98%
Market Crops	38	214.9	0%	98%
Corn, Sweet	26	202.8	0%	99%
Squash	12	169.7	0%	99%
Plum	37	157.6	0%	99%
Golf Course	9	148.3	0%	99%
Wildlife Feed	9	144.0	0%	99%
Pumpkin	7	127.5	0%	99%
Rye	5	100.7	0%	99%

WSDA Crop data by field



Rooting Depths

WA682.50 Table WA682.50 –
methods.

Adapted Crops	Effective Root Zone (80% feeder roots)
Alfalfa Hay	5+
Alfalfa-Grass Hay	4
Alfalfa Seed	5+
Apples	5
Apricot	5
Asparagus	5+
Bean (bush)	2
Bean (dry)	2
Bean (pole)	5
Beet (sugar)	2.5
Beet (table)	1.5
Berries	5
Broccoli	2
Brussel Sprout	2
Bulb, Spring	2
Bulb, Fall	2
Cabbage	2
Cantaloupe	4
Carrot	2
Cauliflower	2
Celery	2
Chard	3
Cherry	5
Citrus	5
Clover-Grass Hay	2
Clover, Ladino	2
Clover Seed	2
Corn (Field & Silage)	3
Corn (Sweet)	2
Cranberries	1
Cucumbers	2
Flower Seed	2
Grain (Spring & Fall)	3
Grapes	3
Grass Seed	3
Hops	5
Lettuce	1.5
Mint	2
Melons	5
Nursery Stock	2
Nut Trees	5+
Oats	2.5
Onion, Dry	[illegible]
Onion, Green	2
Parsnip	3
Pasture/Turf	2.5
Peaches	5
Peas (all)	2
Pears & Plums	5
Potatoes	2
Pumpkin	4
Radish	1
Raspberries	4
Safflower	5
Sorghum	3
Soybeans	2.5
Spinach	2
Squash	3
Strawberries	1.5
Sunflowers	5
Tomatoes	4
Turnip	2.5
Watermellon	3.5

NRCS Irrigation Guide
(1985)

Table 3–4 Depths to which the roots of mature crops will extract available soil water from a deep, uniform, well drained soil under average unrestricted conditions (depths shown are for 80% of the roots)

Crop	Depth (ft)	Crop	Depth (ft)
Alfalfa	5	Peas	2 - 3
Asparagus	5	Peppers	1 - 2
Bananas	5	Potatoes, Irish	2 - 3
Beans, dry	2 - 3	Potatoes, sweet	2 - 3
Beans, green	2 - 3	Pumpkins	3 - 4
Beets, table	2 - 3	Radishes	1
Broccoli	2	Safflower	4
Berries, blue	4 - 5	Sorghum	4
Berries, cane	4 - 5	Spinach	1 - 2
Brussel sprouts	2	Squash	3 - 4
Cabbage	2	Strawberries	1 - 2
Cantaloupes	3	Sudan grass	3 - 4
Carrots	2	Sugar beets	4 - 5
Cauliflower	2	Sugarcane	4 - 5
Celery	1 - 2	Sunflower	4 - 5
Chard	1 - 2	Tobacco	3 - 4
Clover, Ladino	2 - 3	Tomato	3
Cranberries	1	Turnips	2 - 3
Corn, sweet	2 - 3	Watermelon	3 - 4
Corn, grain	3 - 4	Wheat	4
Corn seed	3 - 4		
Corn, silage	3 - 4		
Cotton	4 - 5	**Trees**	
Cucumber	1 - 2	Fruit	4 - 5
Eggplant	2	Citrus	3 - 4
Garlic	1 - 2	Nut	4 - 5
Grains & flax	3 - 4		
Grapes	5	**Shrubs & misc. trees for windbreaks**	
Grass pasture/hay	2 - 4		
Grass seed	3 - 4	< 10 ft tall	2 – 3+
Lettuce	1 - 2	10 – 25 ft tall	3 – 4+
Melons	2 - 3	> 25 ft tall	5+
Milo	2 - 4		
Mustard	2	**Other**	
Onions	1 - 2	Turf (sod & lawn)	1 - 2
Parsnips	2 - 3	Nursery stock	1 - 3
Peanuts	2 - 3	Nursery stock	pots

NRCS Irrigation Guide
(1997)

Define Crop Groups

SYCD Proposed Crop Groups

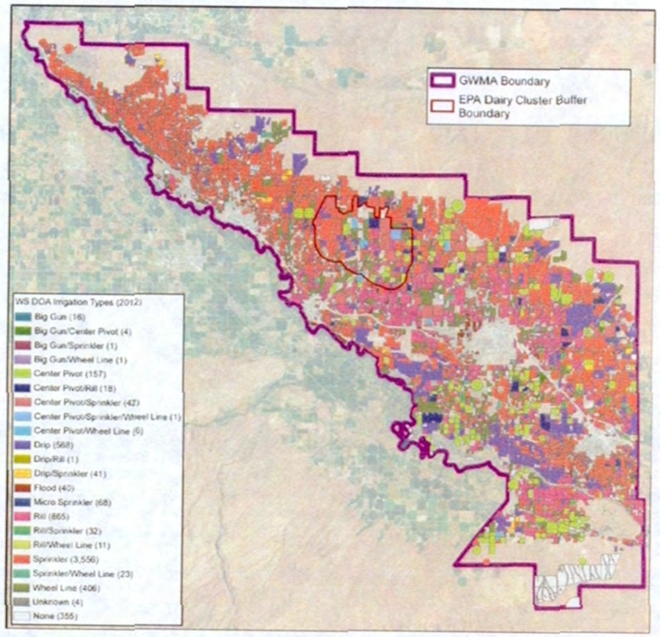
Rooting Depth (ft)	Important GWMA Crops
More than 4	Alfalfa, asparagus, tree fruits, hops
2.5 up to 4	Corn, wheat, grains/triticale, Sorghum/Sudangrass, pasture, grapes(1)
Less than 2.5	Mint

(1) NRCS data on grapes is not consistent: 1985 value is 5 ft, 1997 value is 3 ft.

Irrigation Types in GWMA

Irrigation Type	Number of Fields	Acres	% of Area	Cumulative %	Leach Rank
Sprinkler	3556	41459.1	43%	43%	3
Rill	865	13944.8	14%	57%	4
Drip	568	10492.9	11%	68%	2
Wheel Line	406	8789.5	9%	77%	3
Center Pivot	157	7035.9	7%	84%	3
None	355	5453.6	6%	90%	1
Center Pivot/Sprinkler	42	3398.7	4%	94%	3
Center Pivot/Rill	18	1291.8	1%	95%	3
Micro Sprinkler	68	1128.5	1%	96%	2
Drip/Sprinkler	41	773.8	1%	97%	2
Flood	40	614.9	1%	97%	4
Rill/Sprinkler	32	598.9	1%	98%	4
Sprinkler/Wheel Line	23	470.3	0%	99%	3
Center Pivot/Wheel Line	6	423.0	0%	99%	3
Rill/Wheel Line	11	347.3	0%	99%	4
Big Gun	16	271.1	0%	100%	3
Big Gun/Center Pivot	4	157.9	0%	100%	3
Center Pivot/Sprinkler/Wheel Line	1	153.9	0%	100%	3
Big Gun/Wheel Line	1	29.8	0%	100%	3
Unknown	4	24.8	0%	100%	1
Big Gun/Sprinkler	1	7.9	0%	100%	3
Drip/Rill	1	2.4	0%	100%	2

WSDA Irrigation Type and Leach Rank



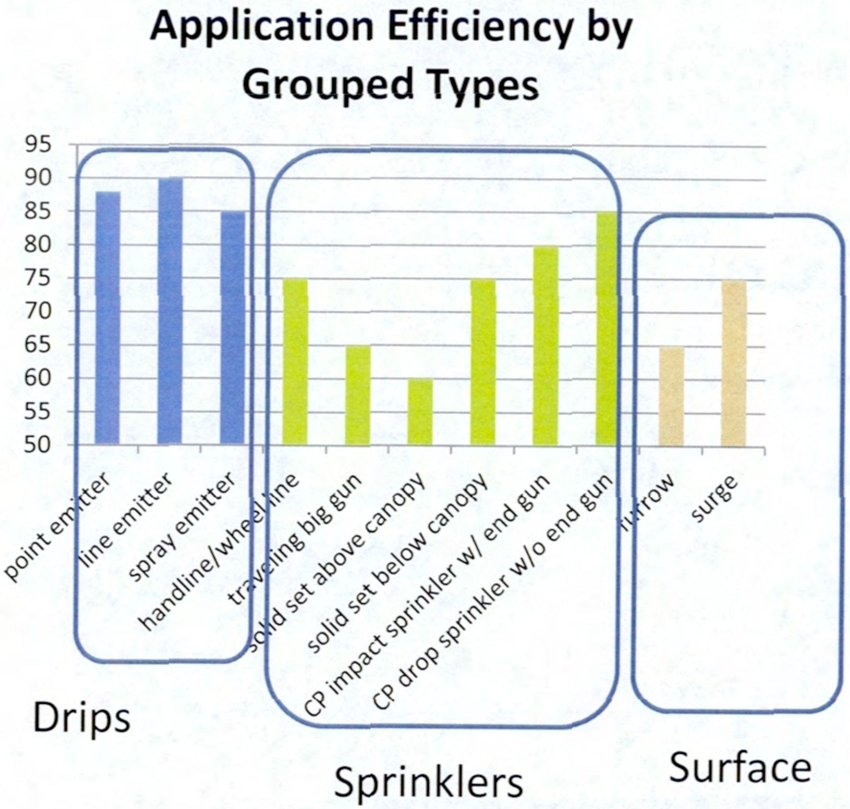
Option to Group Irrigation Types

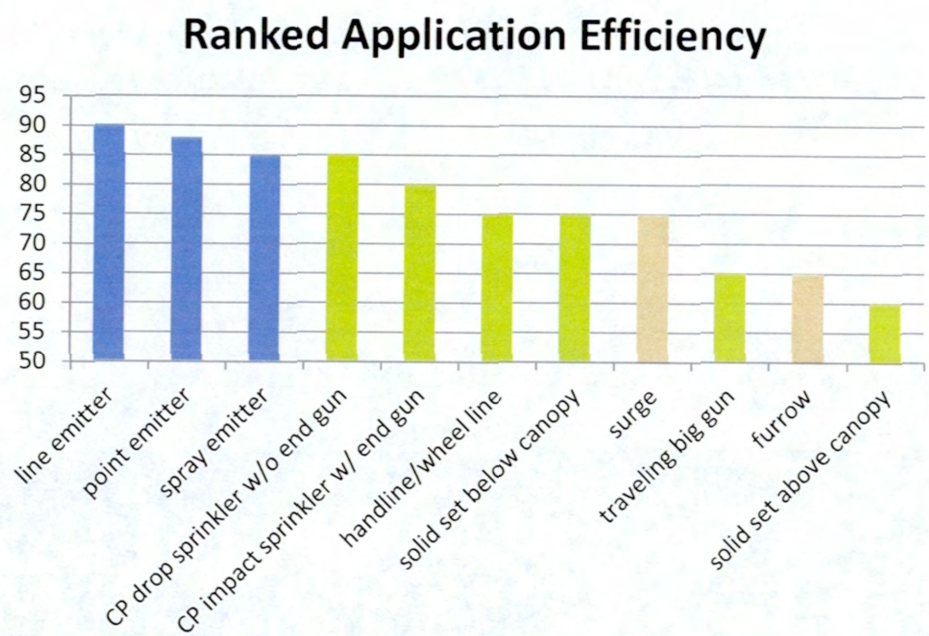
Group by WSDA Leach Rank

WSDA Leach Rank	Irrigation Types
1	none, none + anything, unknown
2	drip, micro sprinkler, drip + anything
3	sprinklers, sprinklers + anything, hand
4	flood, rill, rill + sprinkler

Option to Group Irrigation Types

Group by Efficiency (Data from NRCS Part 652 Irrigation Guide)





NRCS Leaching Potential

Factors Considered:

1. Annual precipitation minus PET (has a low weighting factor for irrigated areas)
2. Water travel time through soil (K and thickness)
3. Available water capacity to 150 cm (at field capacity)
4. Depth and duration of shallow water table
5. Land slope

Determined for soil mapping units (not fields) – therefore requires GIS to calculate average value for field.

NRCS web tool output for soil mapping unit:

1. Map
2. Value between 0 and 1 for soil map units
3. Class (high, med-high, med, low)
4. Dominant factors

GWMA could use numbers to define 3 classes (high, med, low)

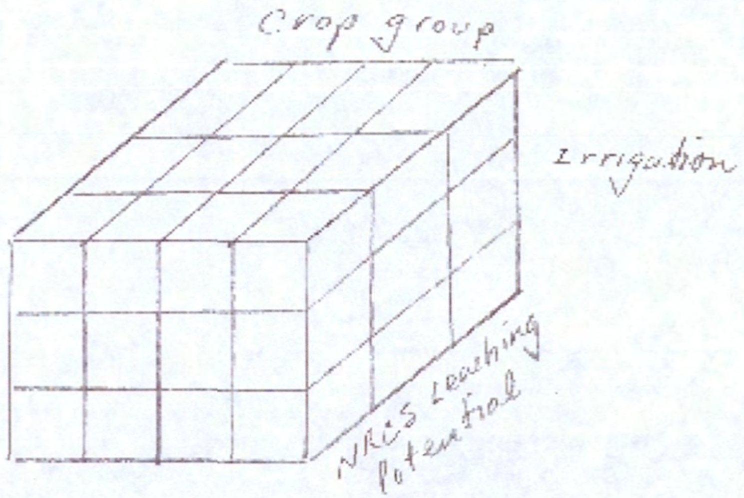
NRCS Leaching Potential Example Output

Yakima County Area, Washington

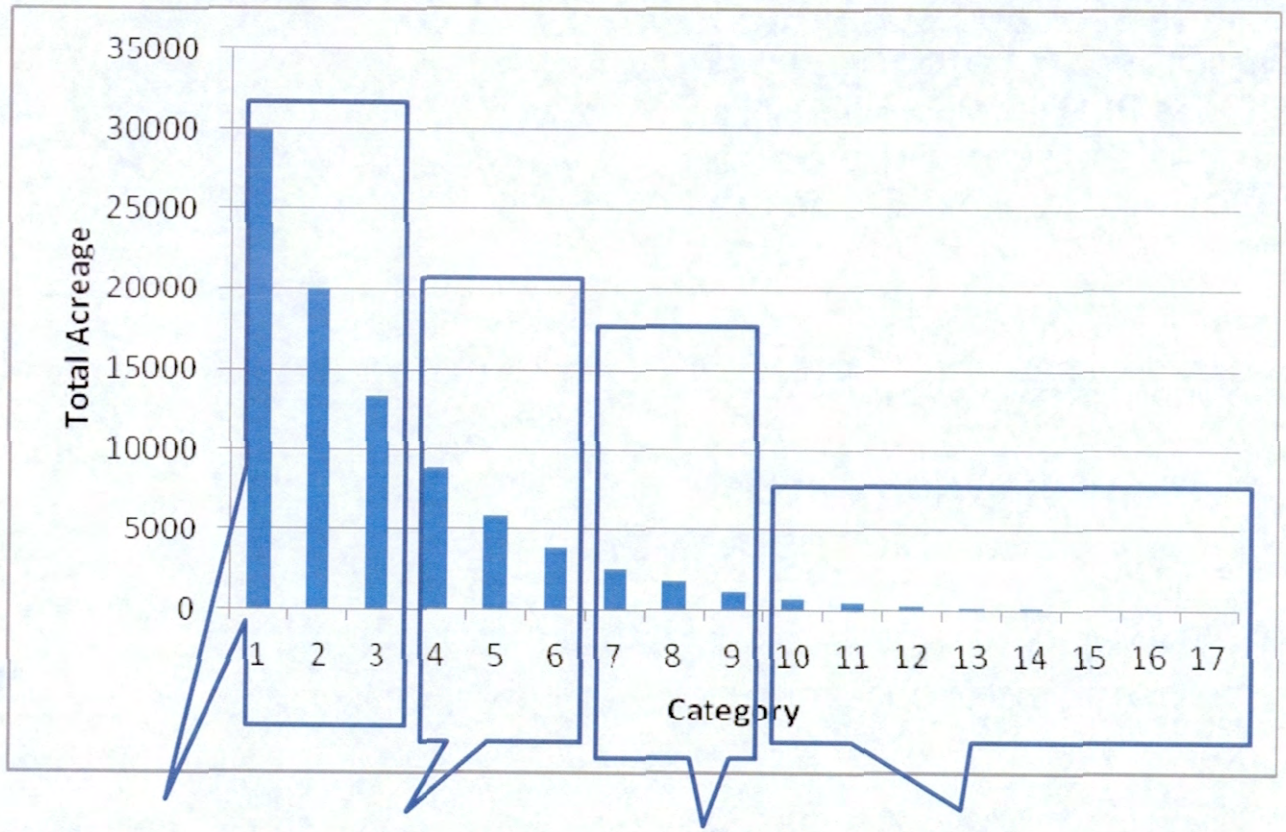
Map symbol and soil name	Pct. of map unit	Nitrate Leaching Potential, Nonirrigated (WA)		Nitrate Leaching Potential, Irrigated (WA)	
		Rating class and limiting features	Value	Rating class and limiting features	Value
173:					
Outlook	5	Not rated		Not rated	
174:					
Warden	100	Low	0.2	Moderate	0.49
		Water travel time	0.81	Water travel time	0.81
175:					
Warden	100	Low	0.2	Moderate	0.49
		Water travel time	0.81	Water travel time	0.81
176:					
Warden	100	Low	0.2	Moderate	0.49
		Water travel time	0.81	Water travel time	0.81
177:					
Warden	100	Low	0.2	Moderate	0.49
		Water travel time	0.81	Water travel time	0.81
33:					
Esquatzel	100	Low	0.2	Moderate	0.49
		Water travel time	0.81	Water travel time	0.81
34:					
Fiander, drained	85	Low	0.06	Low	0.17
		Available water capacity	0.43	Available water capacity	0.43

Categories

1. Define groups of crops
2. Define groups of irrigation methods
3. Average NRCS leaching potential for each field
4. **Place each field into a category based on:**
   a. average NRCS leaching potential
   b. crop type
   c. irrigation type
5. **Calculate total acreage within each category. Rank categories according to acreage.**
6. **Allocate samples to each category plus allocate to special high-risk conditions and locations proposed by CAFO or RCIM committees.**



Example Sample Allocations



Sample 6 fields per category

Sample 4 fields per category

Sample 3 fields per category

Sample 0 fields per category

Analysis of Lower Yakima Valley Groundwater Management Area Deep Soil Sampling

Presentation to LYV GWMA Data Work Group

March 29, 2018

Conclusions

- 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. (See Attachment 2)
    - o Data was gathered for 15 out of 27 categories.
    - o Only 7 categories had six or more samples
    - o One category had 3 samples
    - o Two categories had 2 samples
    - o 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

Conclusions

- 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.

Purposes of DSS

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.

Some Problems with Data

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.

Outliers

- Alfalfa fields #2044, #2047 and #4152
- Grape fields #3117 and #3119
- Hop field #3141
- Asparagus fields # 4175 and #4176

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.

History of Soil Testing

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.

Crop History

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.

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

Table 8. Top 15 crops and their acreage in the GWMA

Crop	Acreage
Apple	17,333
Corn (silage)	16,778
Triticale	10,780
Grape (juice)	10,257
Alfalfa	7,989
Pasture	6,731
Cherry	6,336
Hops	5,961
Grape (wine)	5,126
Pear	3,331
Mint	1,418
Wheat	1,283
Corn (grain)	1,166
Asparagus	854
Peach/Nectarine	843

Fertilization Practices

- 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

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

Soil Types

- **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)

Soil Types

Most frequent soil types listed in the DSS spread sheet were: 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)

Scoon Silt Loam 2-5% Slopes

- 1003 – Cherries, drip, commercial fertilizer
- 2048 – Triticale & Alfalfa, sprinkler, liquid M
- 2052 – Triticale, sprinkler, liquid M
- 2055 – Wheat, Corn Silage, Alfalfa, sprinkler, liquid M
- 2066 – Triticale, sprinkler, commercial in 2012
- 3104 – Grass Hay, sprinkler, liquid M
- 4146 – Survey Not Returned

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.

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.

This Analysis

For purposes of this comparison the number of categories is reduced to 27 possible combinations: (Irrigation = 3) x (Crops = 3) x (Leaching = 3).

Irrigation = sprinkler, rill & drip

Crops = < 3.5 ft, 2.5 ft – 4 ft, & > 4 ft

Leaching = very low to mod low, mod high to high, & high to very high

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

Problems with Cropping by Depth

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:

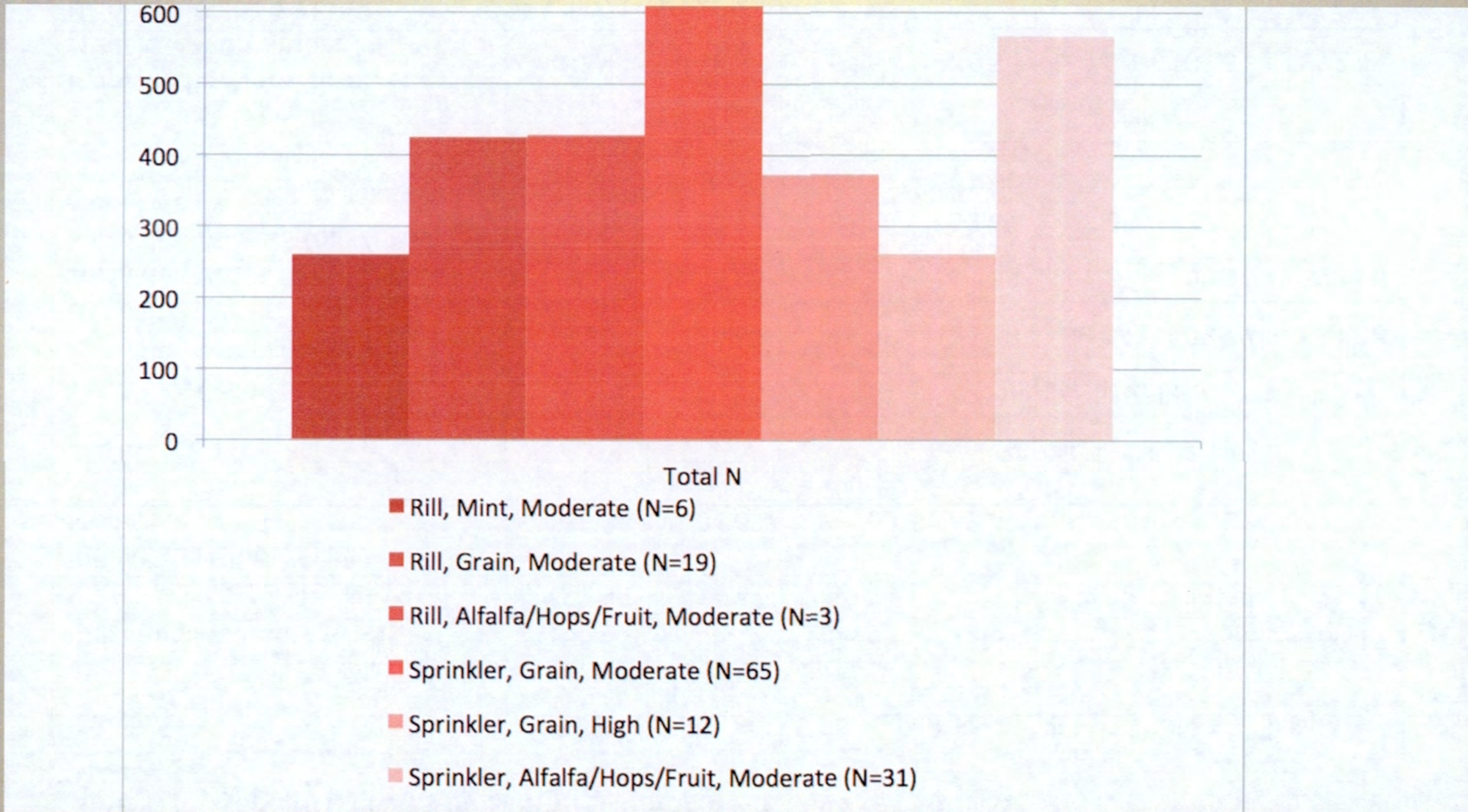
- Very low to moderately low – 6% of fields
- Moderately high to high – 84% of fields
- High to very high – 10% of fields
- We do not know the actual percentages of leaching categories in the GWMA target area, but Laurie Crowe states that most of the land is in the moderate to high leaching category

Table 4. Average NO_3 Levels by Sampling Category for LYV GWMA DSS

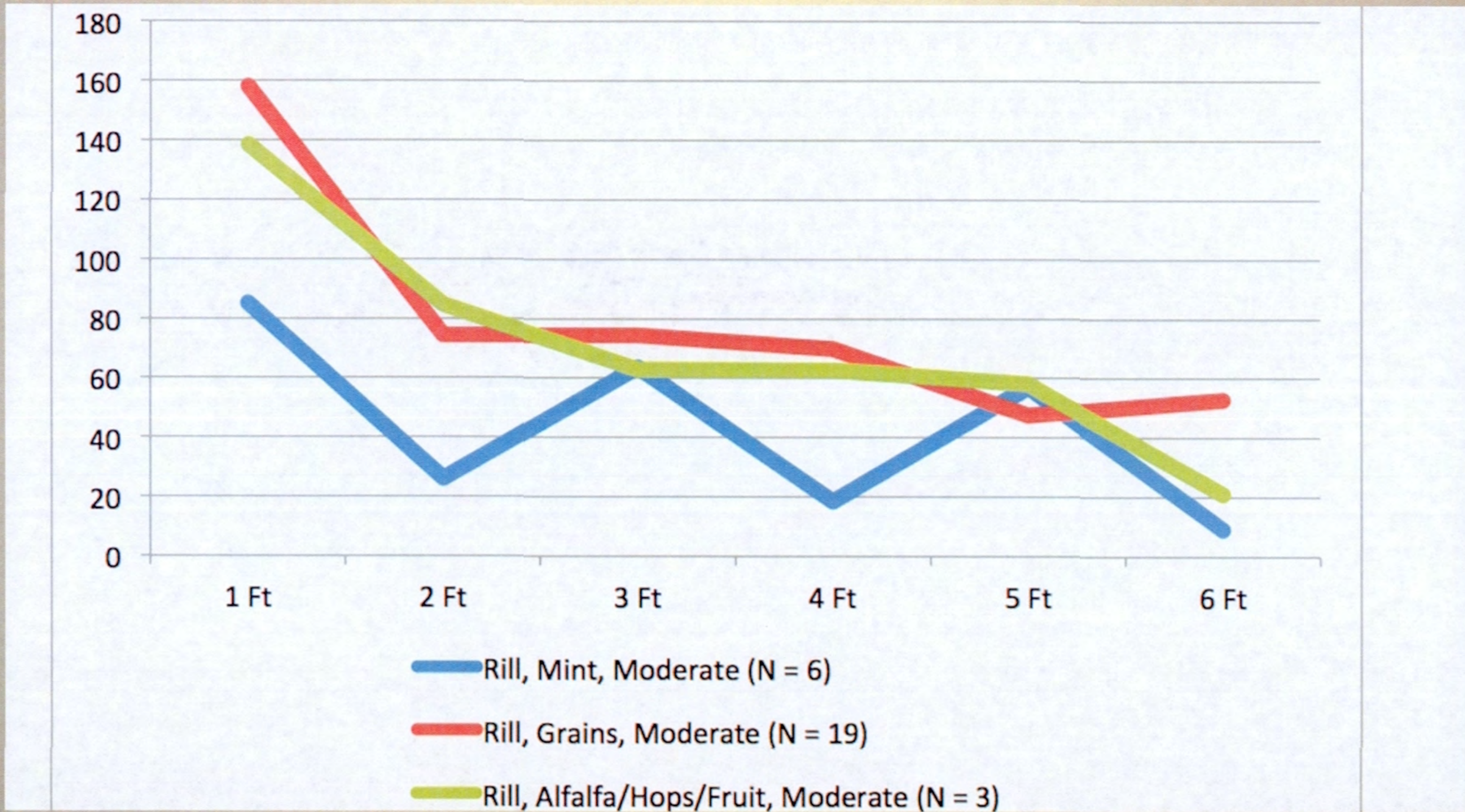
Category	1 FT	2Ft	3 Ft	4 Ft	5 Ft	6 Ft	Total N
Rill, Mint, Moderate (N=6)	85.33	26.17	63.67	18.67	57.17	9.17	260.17
Rill, Grain, Moderate (N=19)	157.95	74.42	69.74	47.37	52.88	33.69	425.16
Rill, Alfalfa/Hops/Fruit, Moderate (N = 3)	138.33	84.67	63	62.67	58	21	427.67
Sprinkler, Grain, Low (N=8)	92.88	80.83	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.

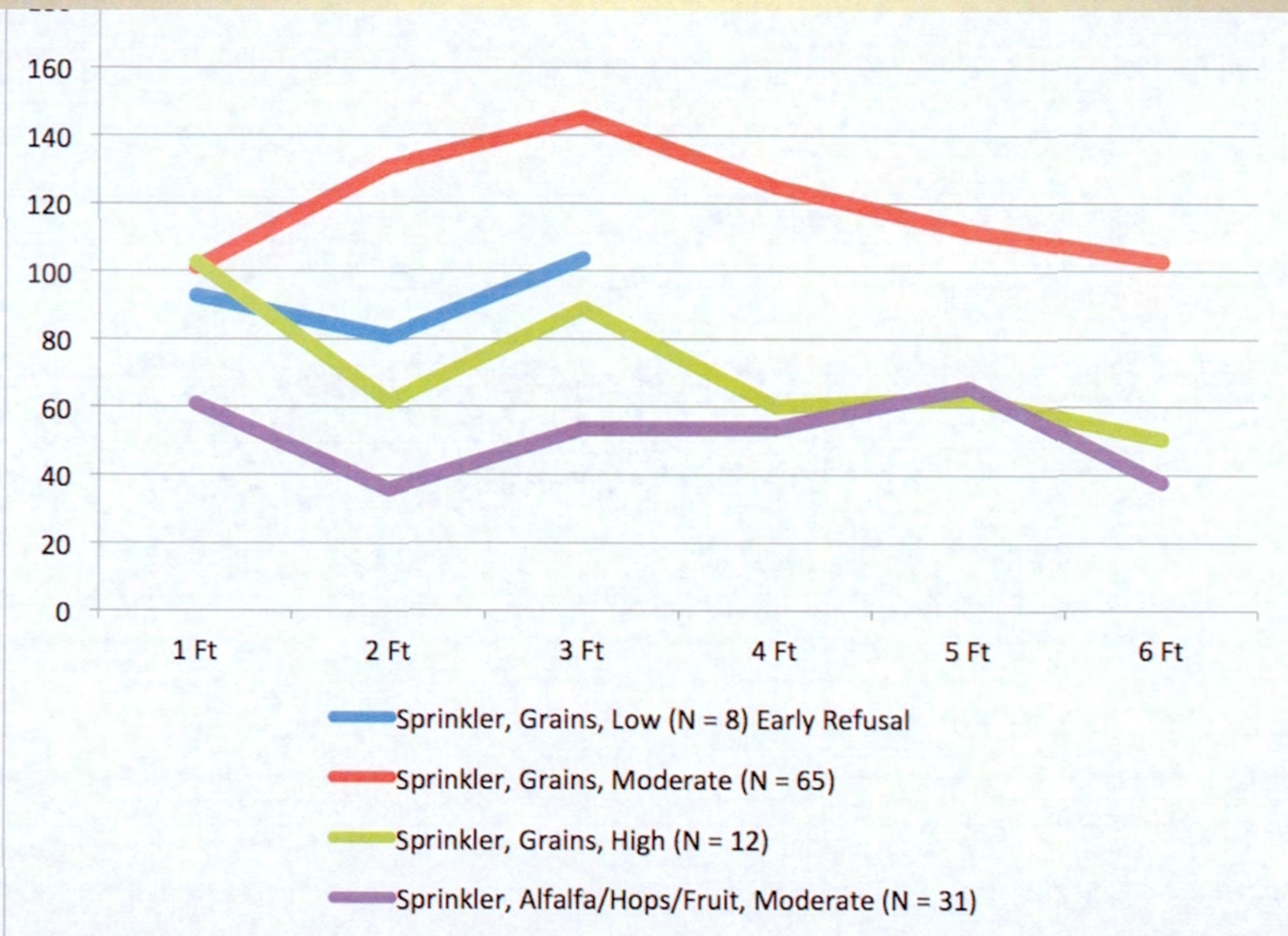
Total N for Major Sampling Categories



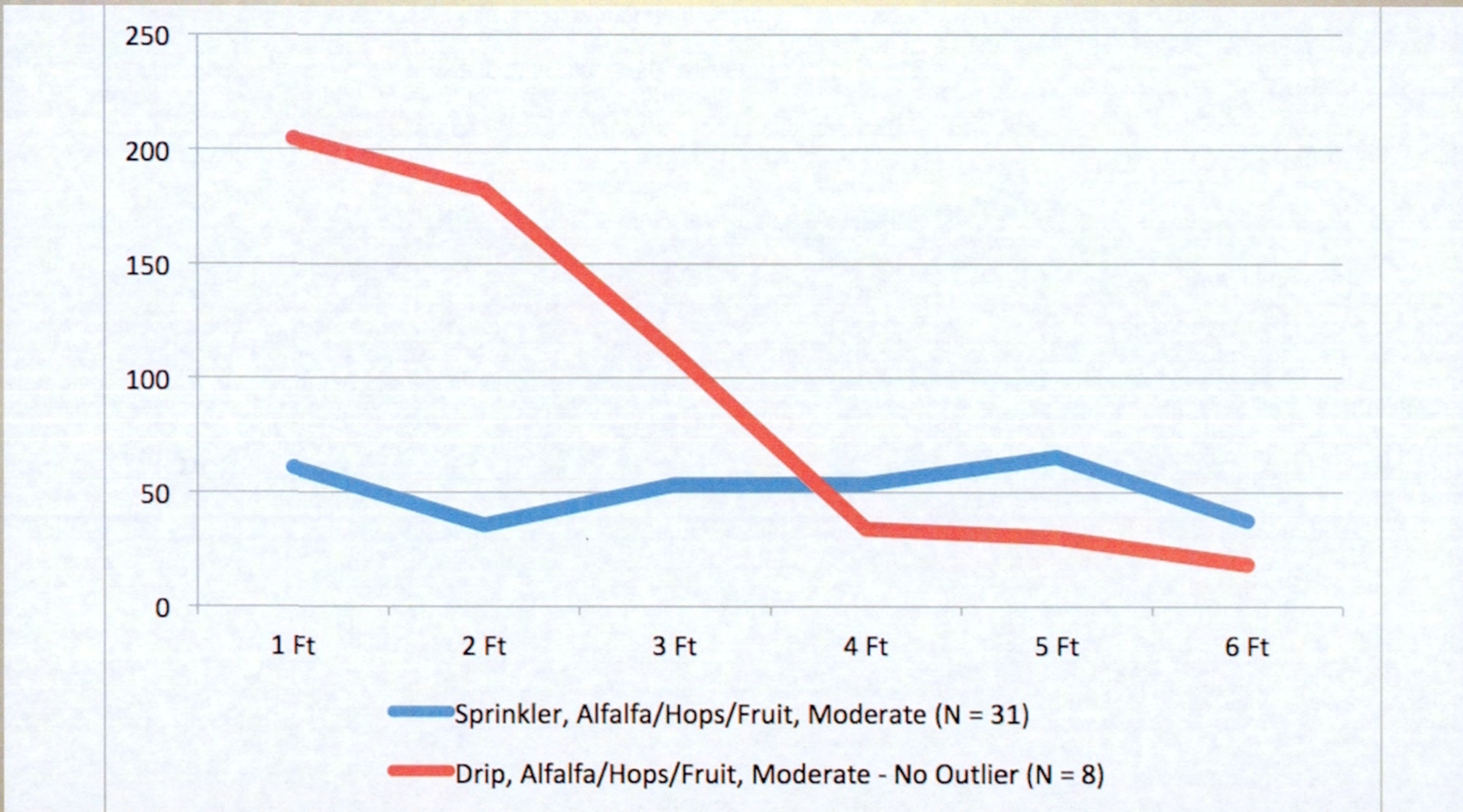
Rill Irrigation – lbs. NO3 per Acre



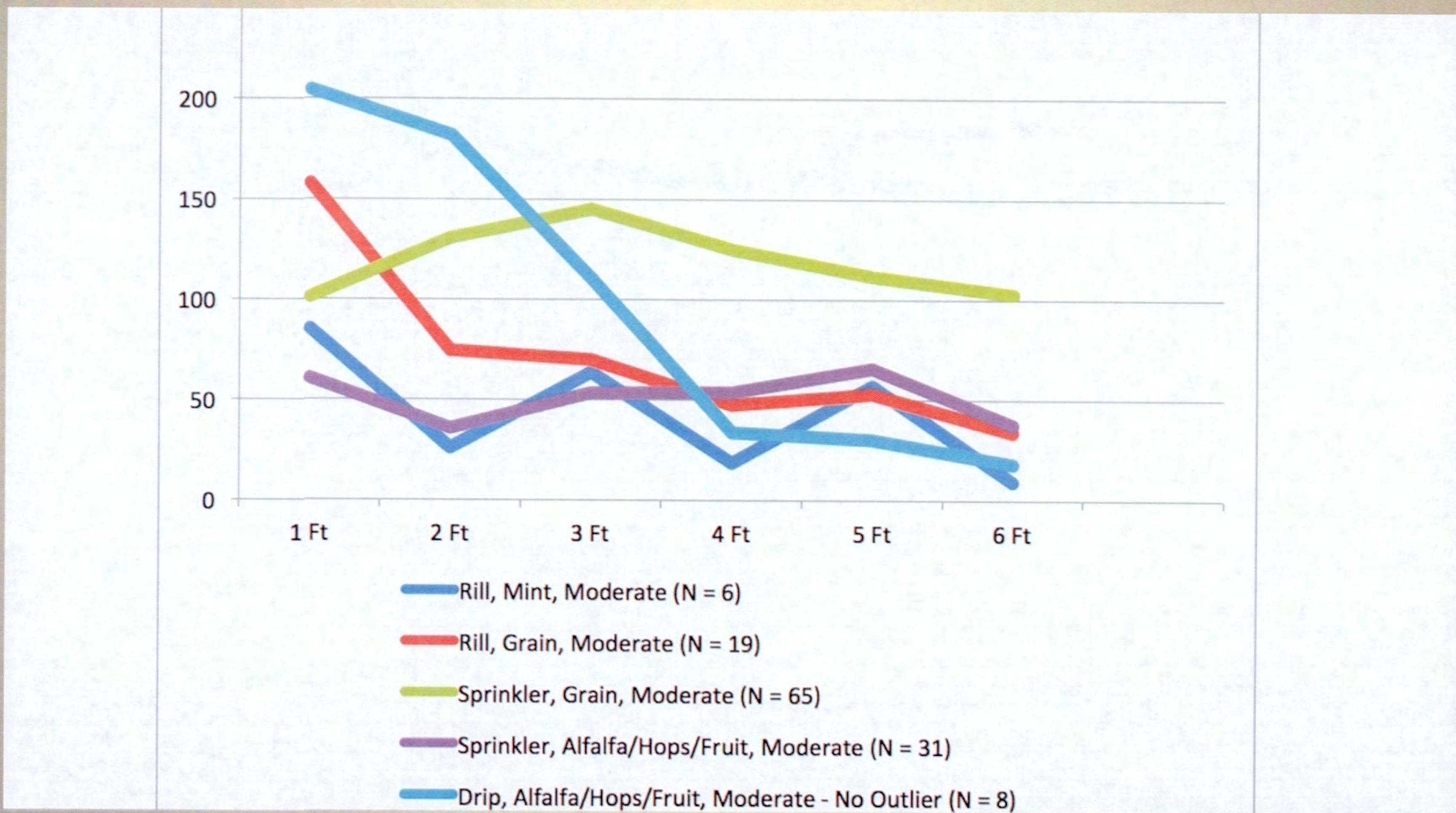
Sprinkler Irrigation – lbs. NO3 per Acre



Crops > 4 Ft – lbs. NO3 per Acre



Moderate Leaching – lbs NO3 per Acre



Descriptive Analysis of the DSS Data

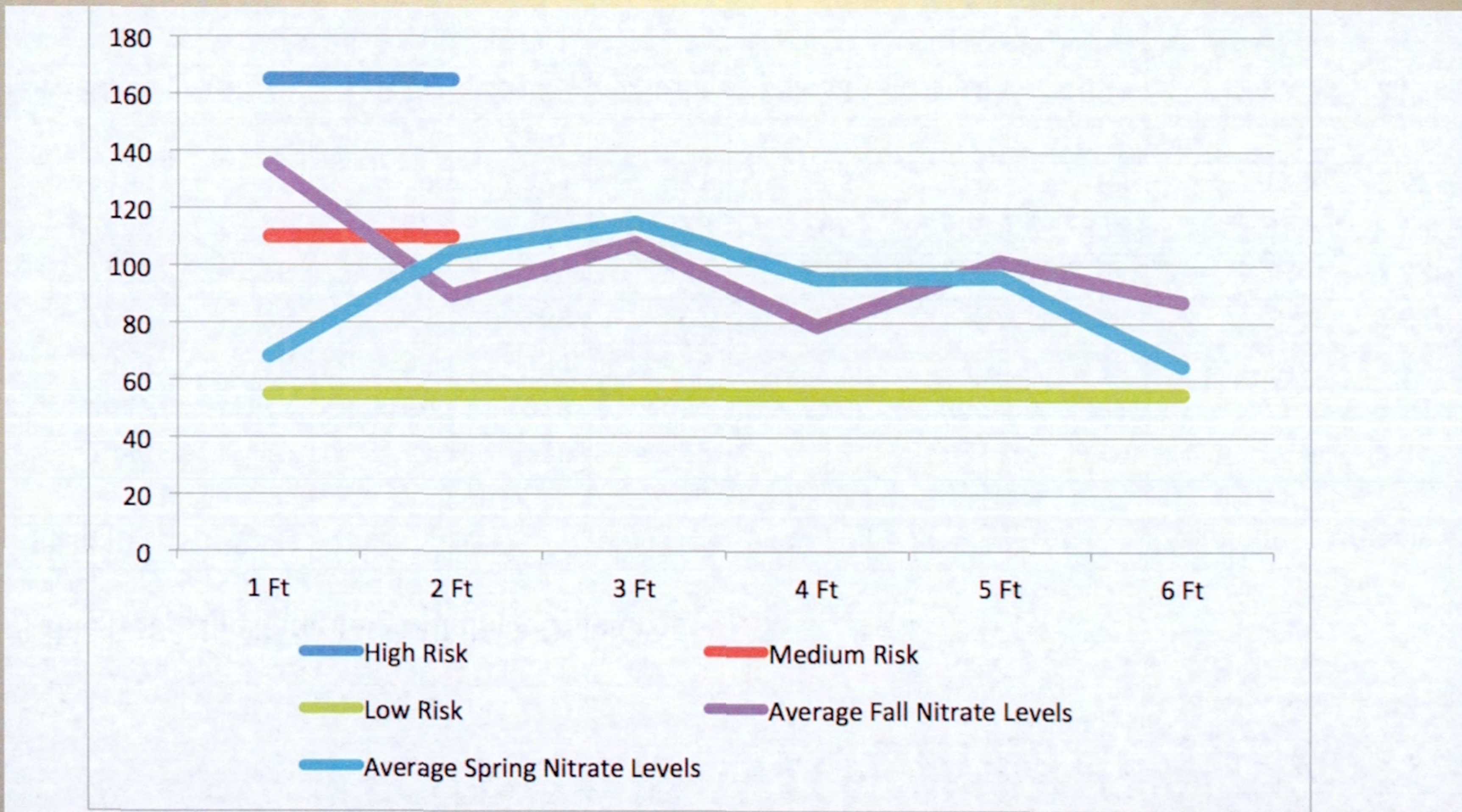
Based on the number of samples available certain groupings of data in the DSS lend themselves to limited analysis

- alfalfa,
- alfalfa + other
- triticale & corn silage
- analysis of the impact of double cropping
- fertilizer practices
- 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

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.

Goals for End of Harvest Soil

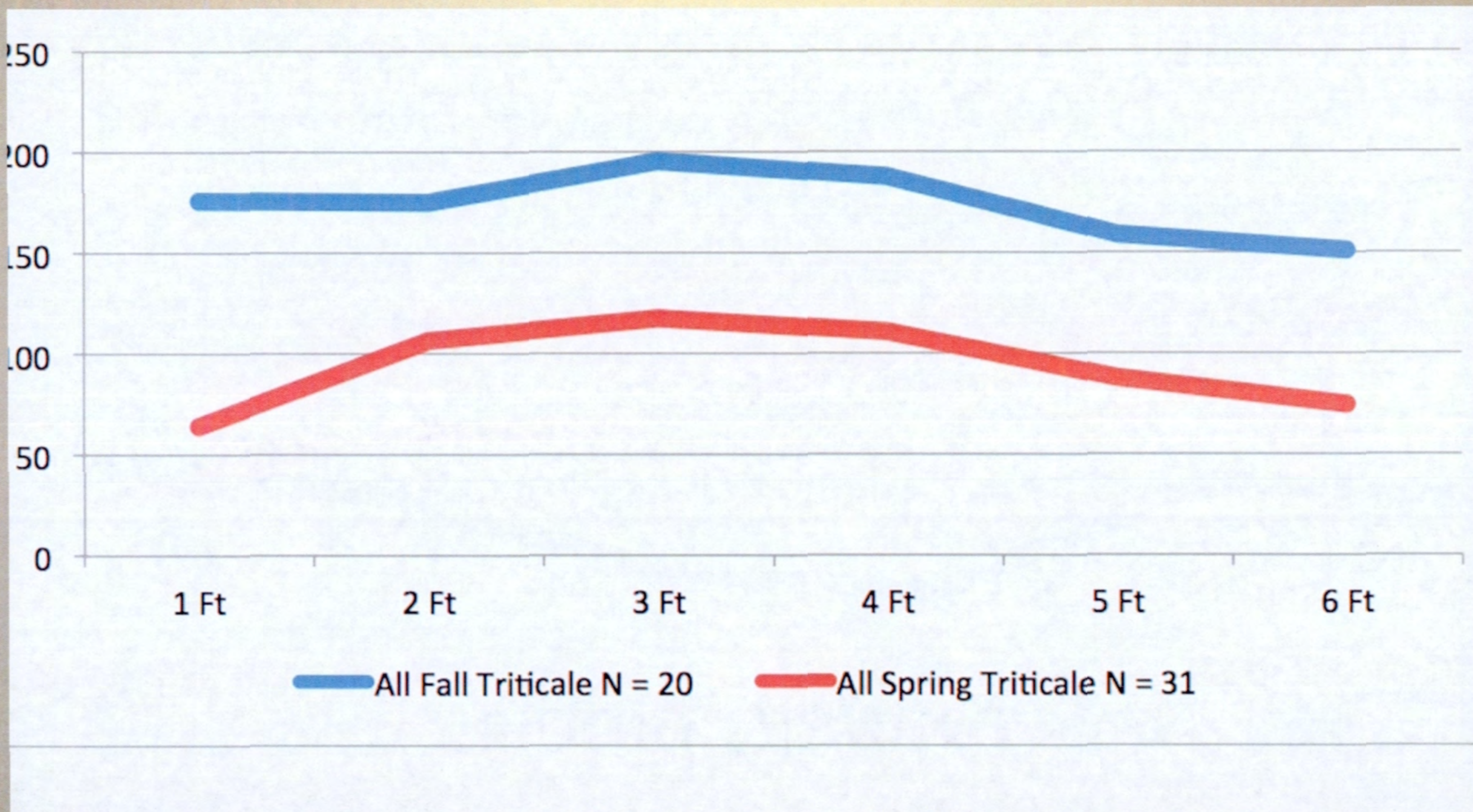


Problems with Alfalfa

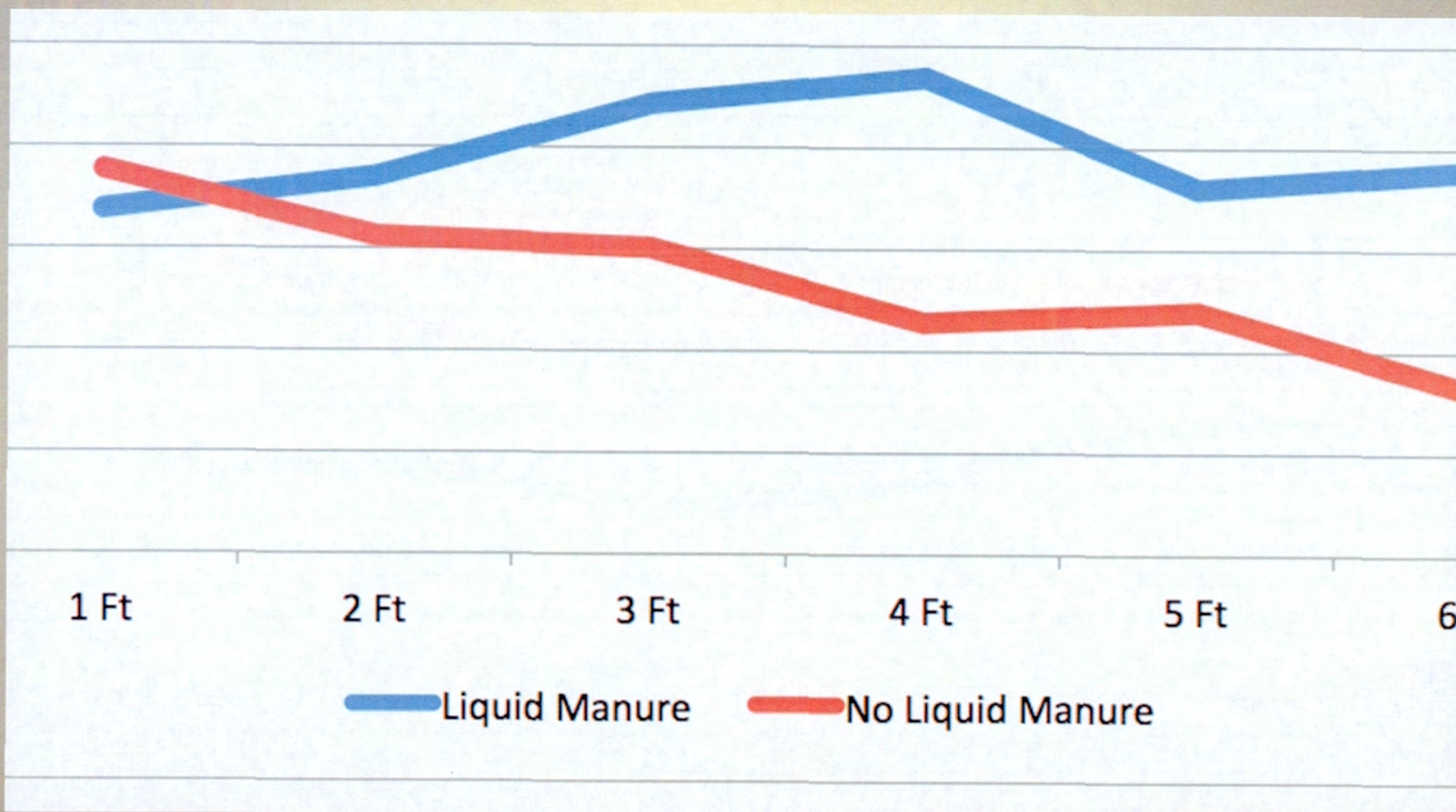
Table 5. Spring Sampling: Alfalfa = Only Crop

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

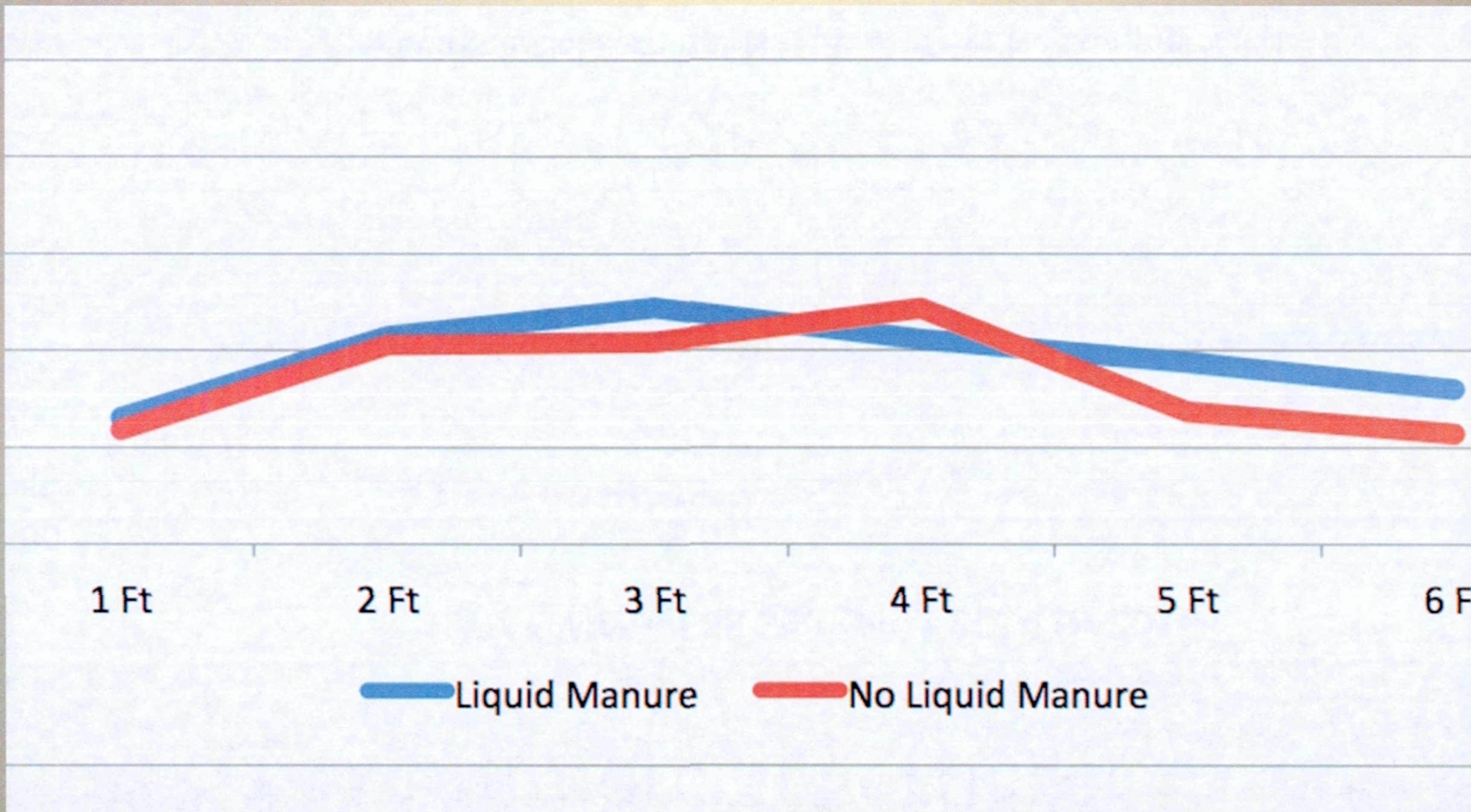
Triticale: lbs. NO3 per Acre



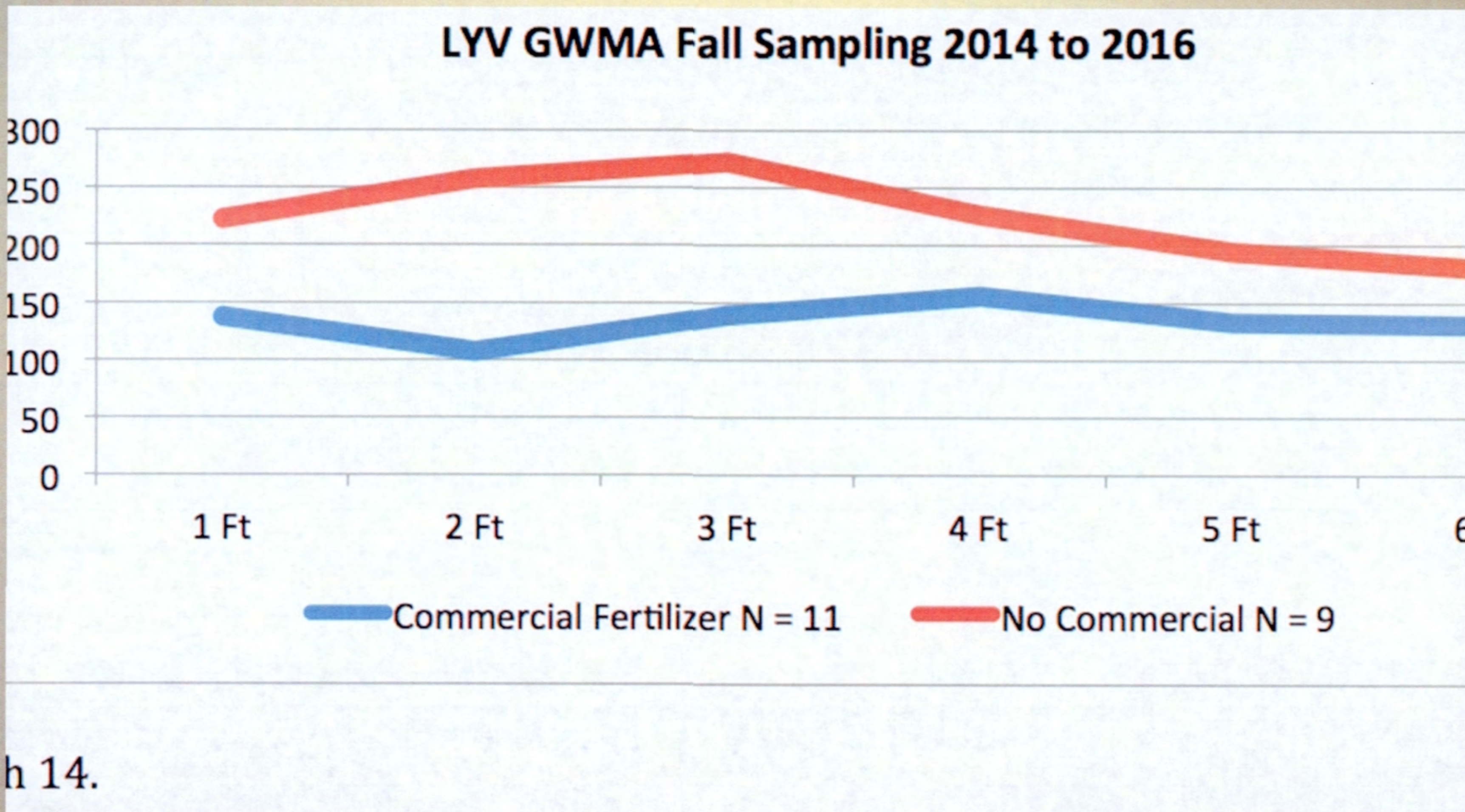
Fall Triticale: lbs. NO3 per Acre for Liquid Manure



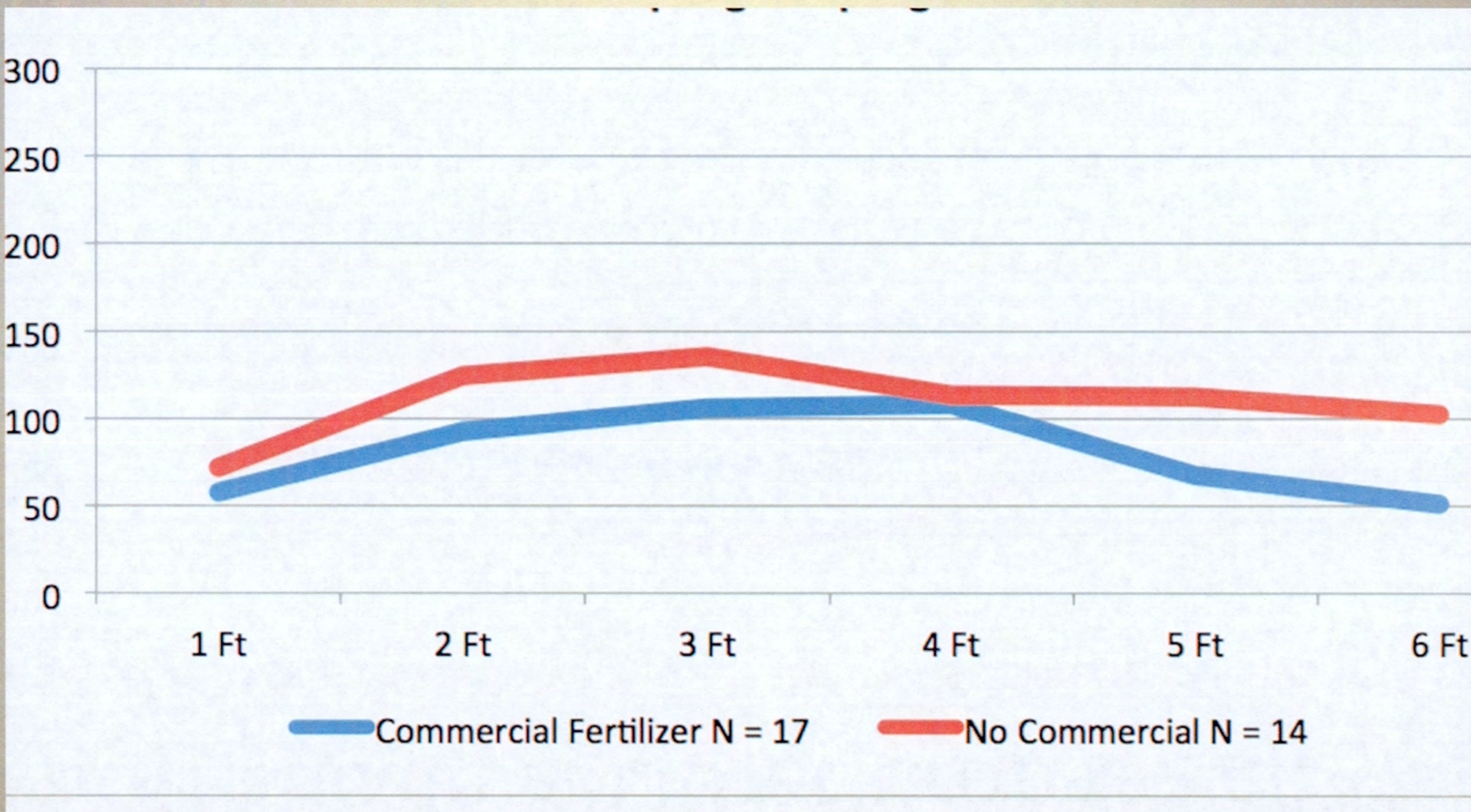
Spring Triticale: lbs. NO3 per Acre for Liquid Manure



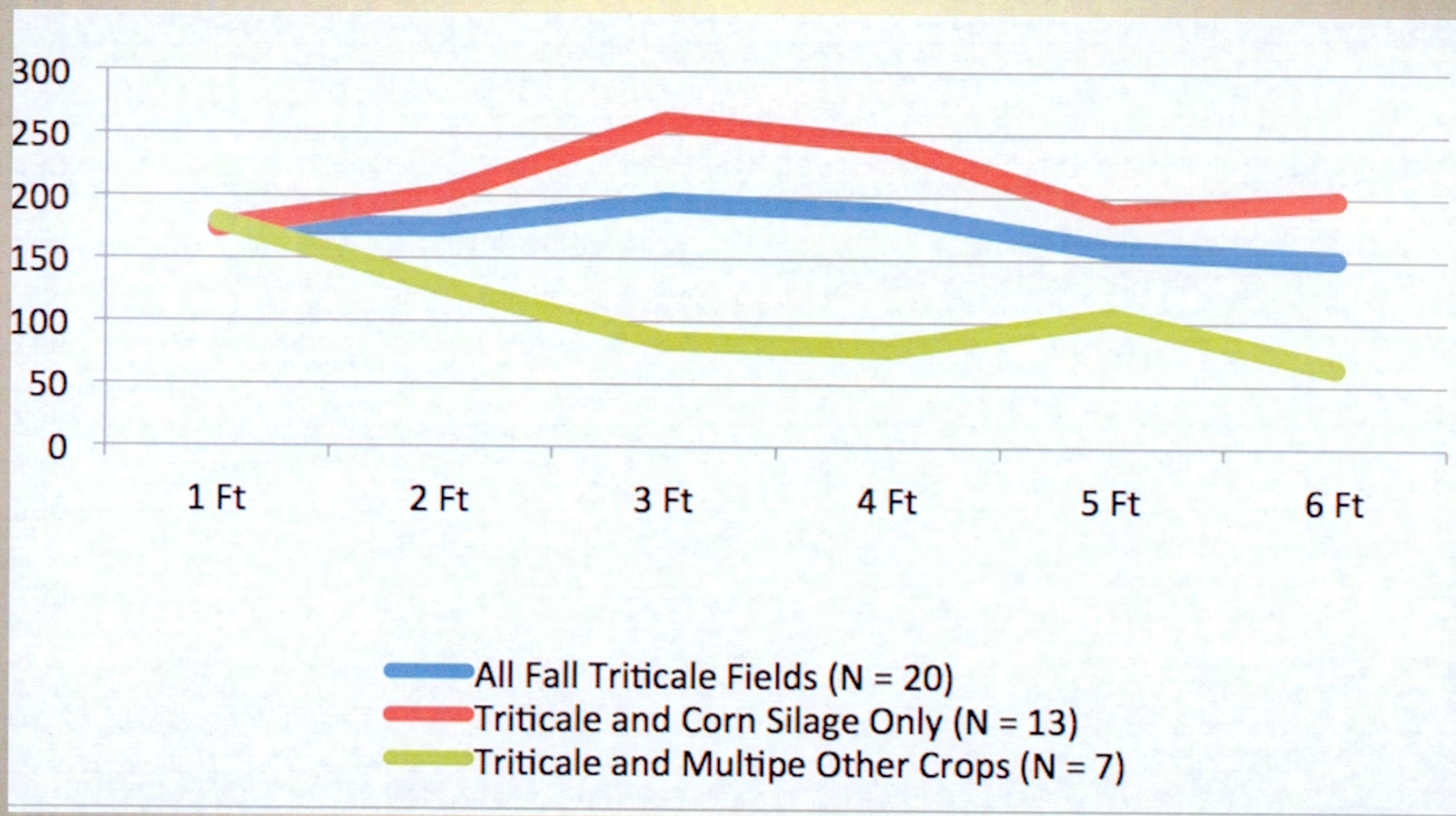
Fall Triticale: lbs. NO3 per Acre for Commercial Fertilizer



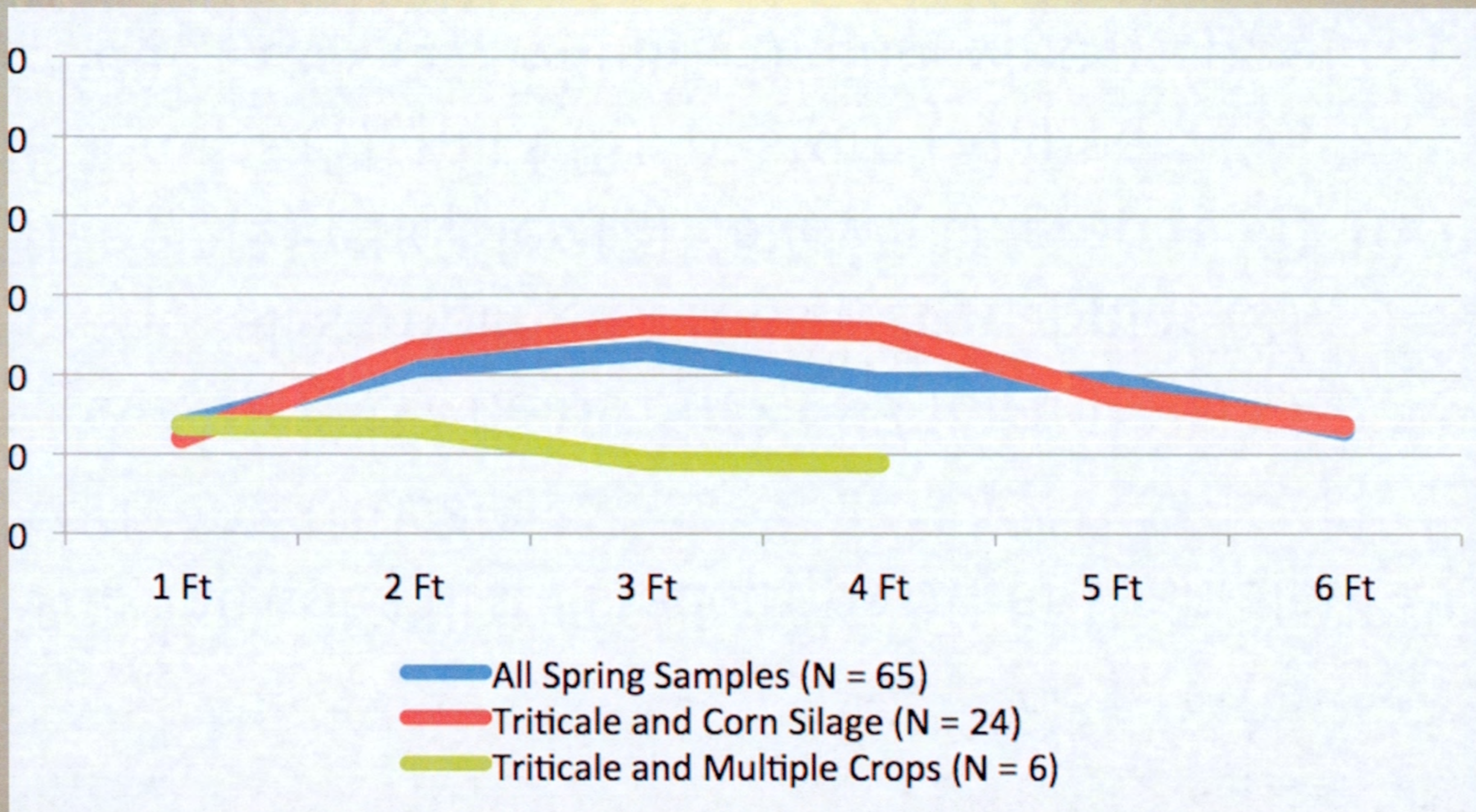
Spring Triticale: lbs. NO3 per Acre for Commercial Fertilizer



Triticale & Other Crops - Fall



Triticale & Other Crops - Spring

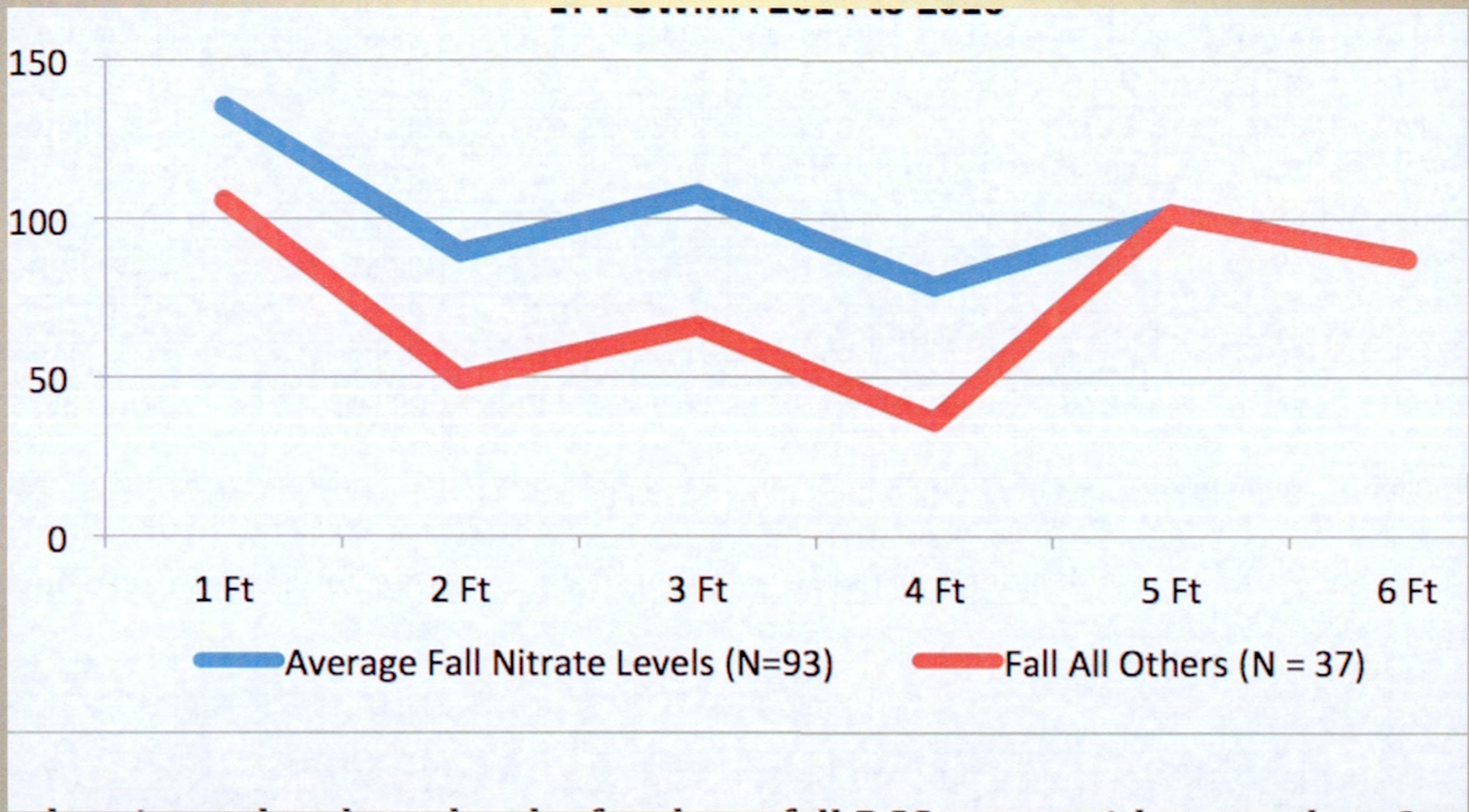


All Other Crops

This includes first listed crops other than alfalfa, corn and triticale.

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)

All Other Crops - Fall



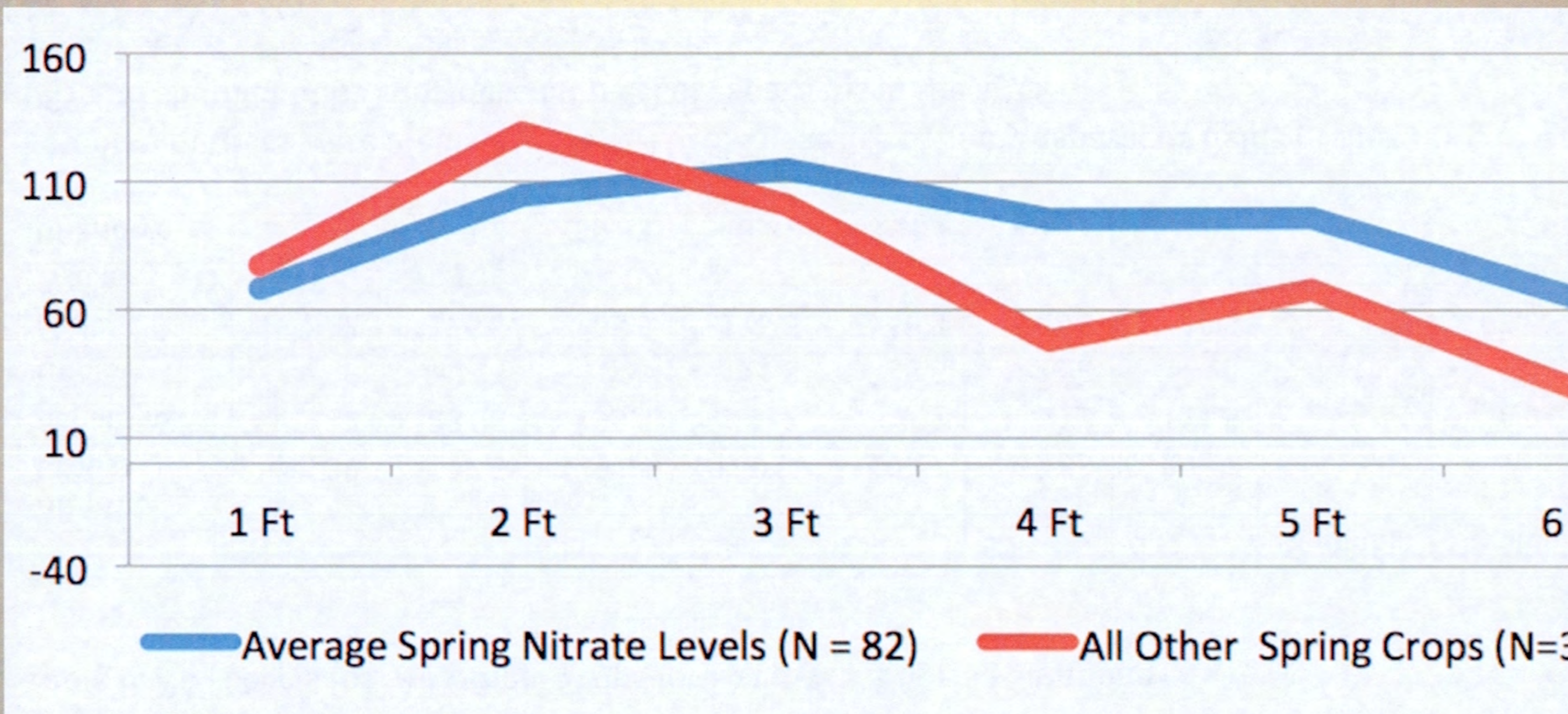
Breakdown of All Other - Fall

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:

All Other Crops - Spring



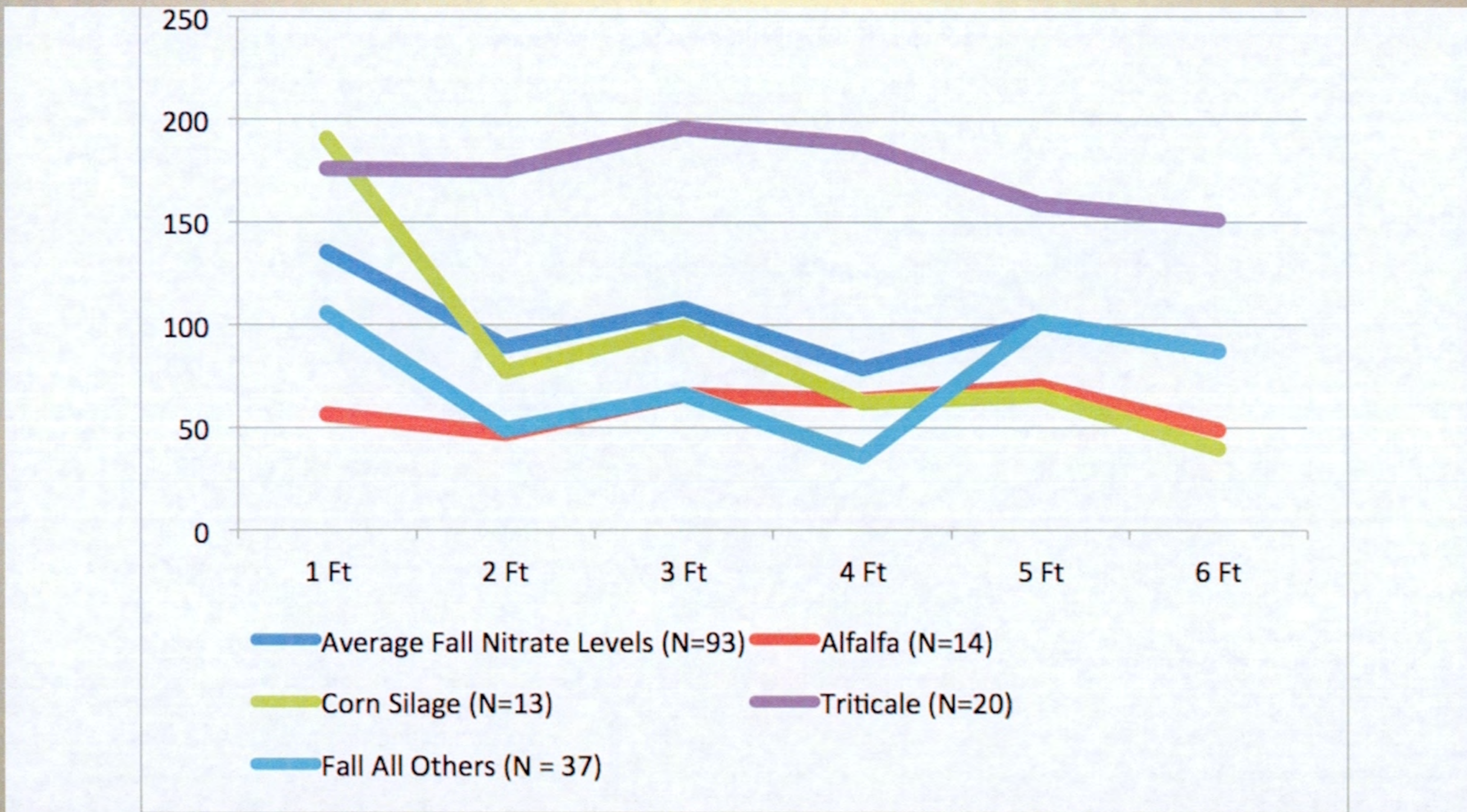
Breakdown of Other - Spring

Table 8. NO_3 Levels for "All Other" Crops for LYV GWMA Spring Sampling

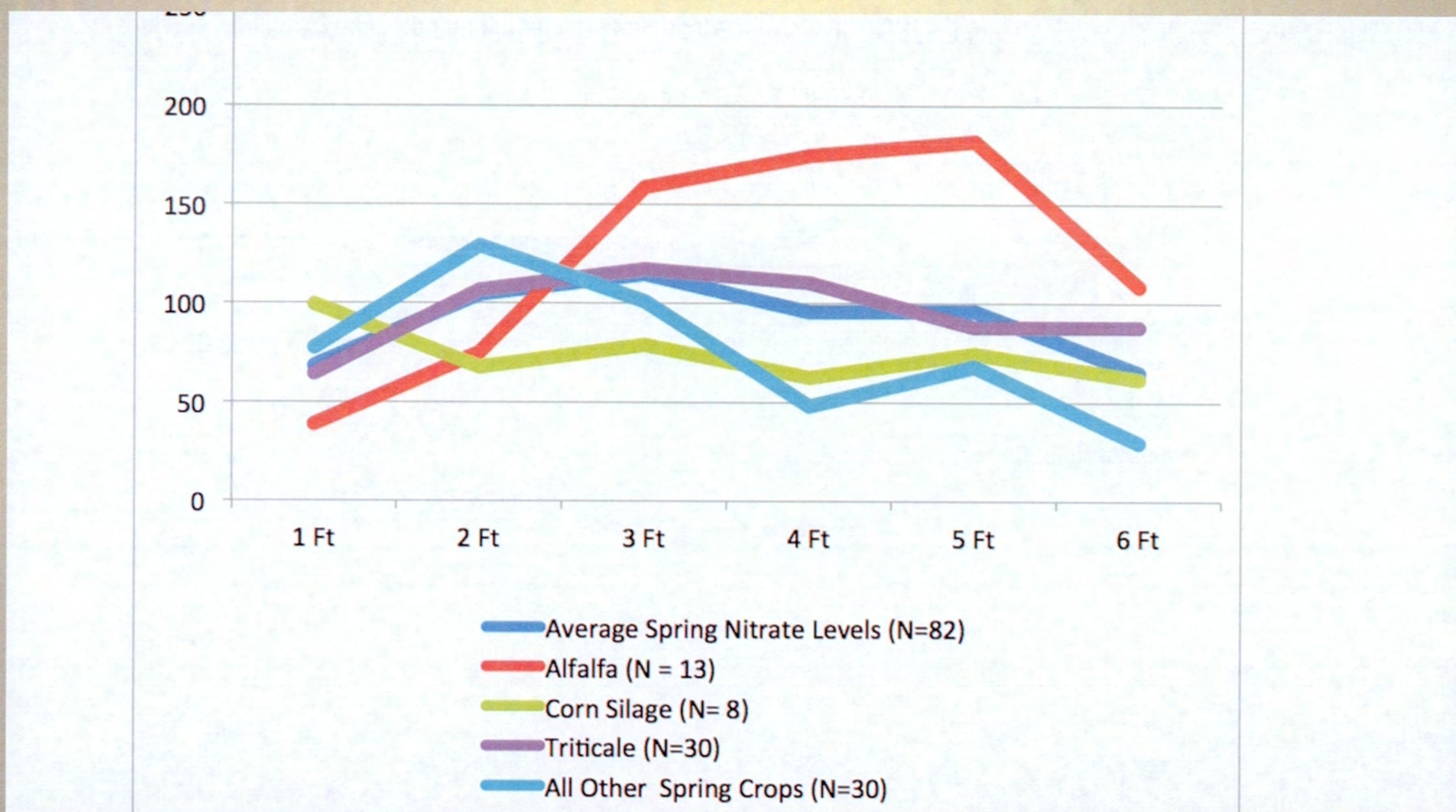
	N	1 FT	2Ft	3 Ft	4 Ft	5 Ft	6 Ft	Ammonia	Organic
All Other Crops	30	77.5	129.04	101.04	48.17	67.85	29.47	16.87	1.75
Asparagus *	2	231.5	499.5	412	207	212	111.5	14	0.91
Hops	5	124	223	111.8	28.8	30.2	20	11.4	1.43
Mint	2	176.5	68.5	175.5	48.5	158	18.5	10	162.63
Wheat	2	104	40					42	3.38
Unknown	15	31.2	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.

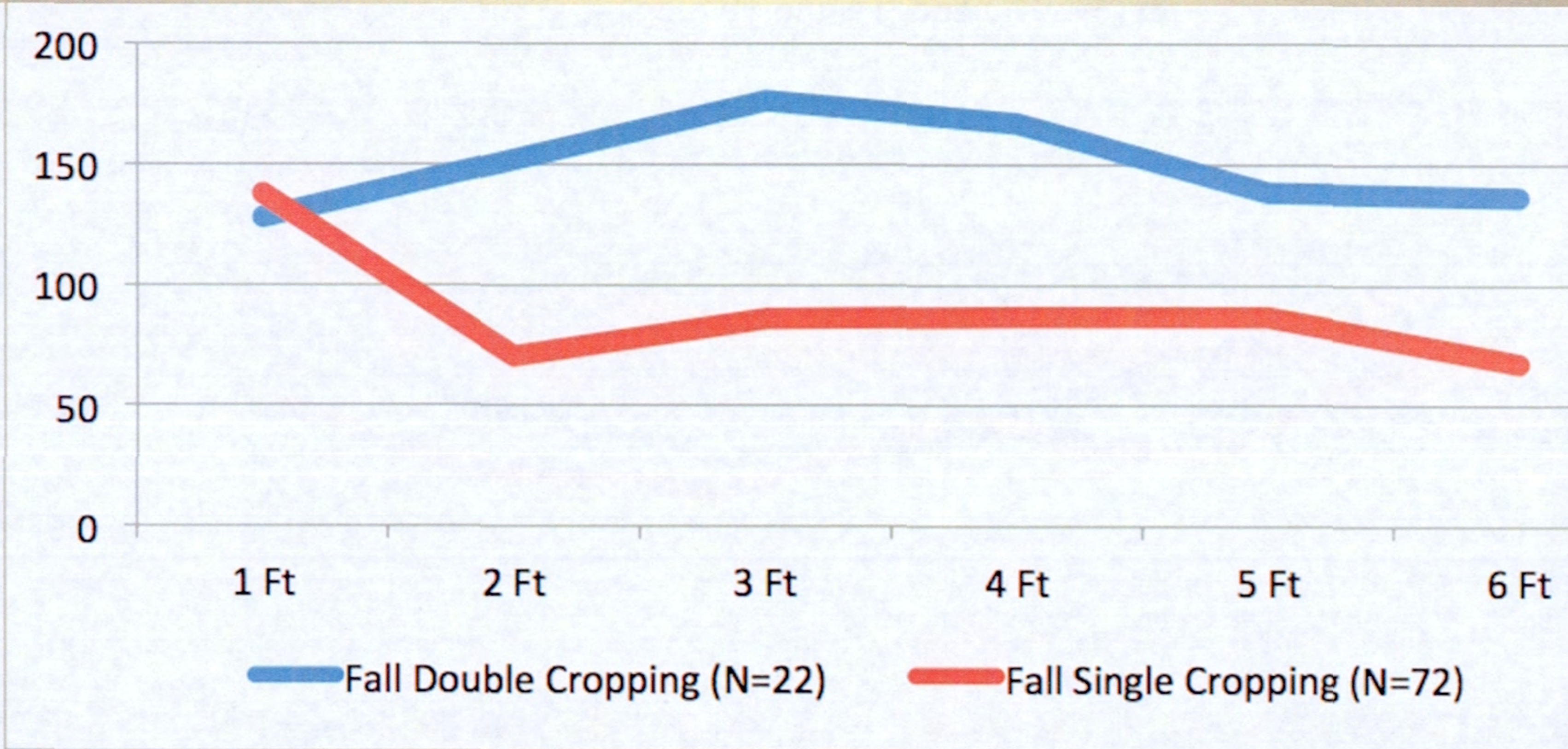
Major Crops lbs. NO3 per Acre – Fall



Major Crops lbs. NO3 per Acre -Spring

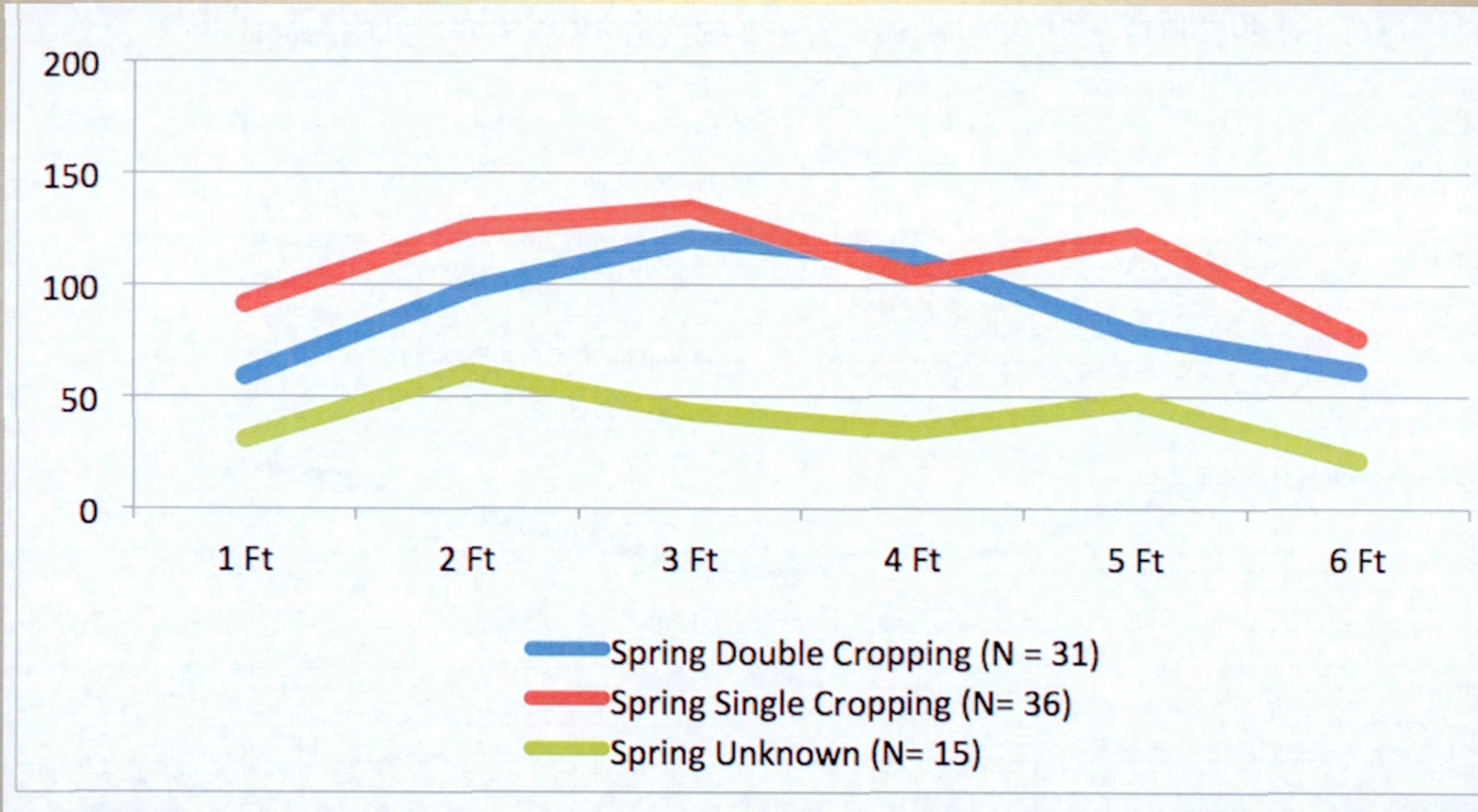


Double Cropping - Fall

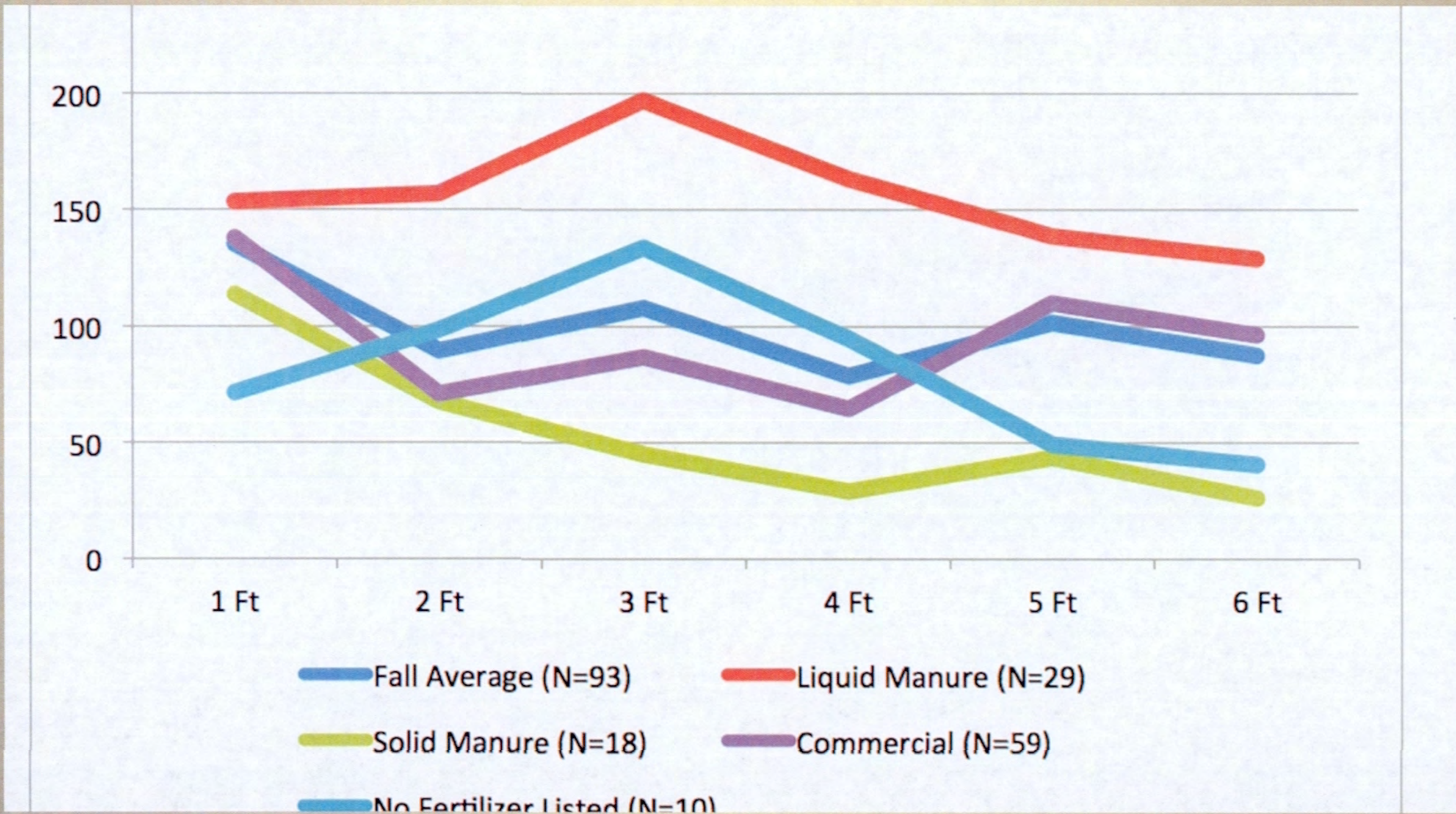


ı 24.

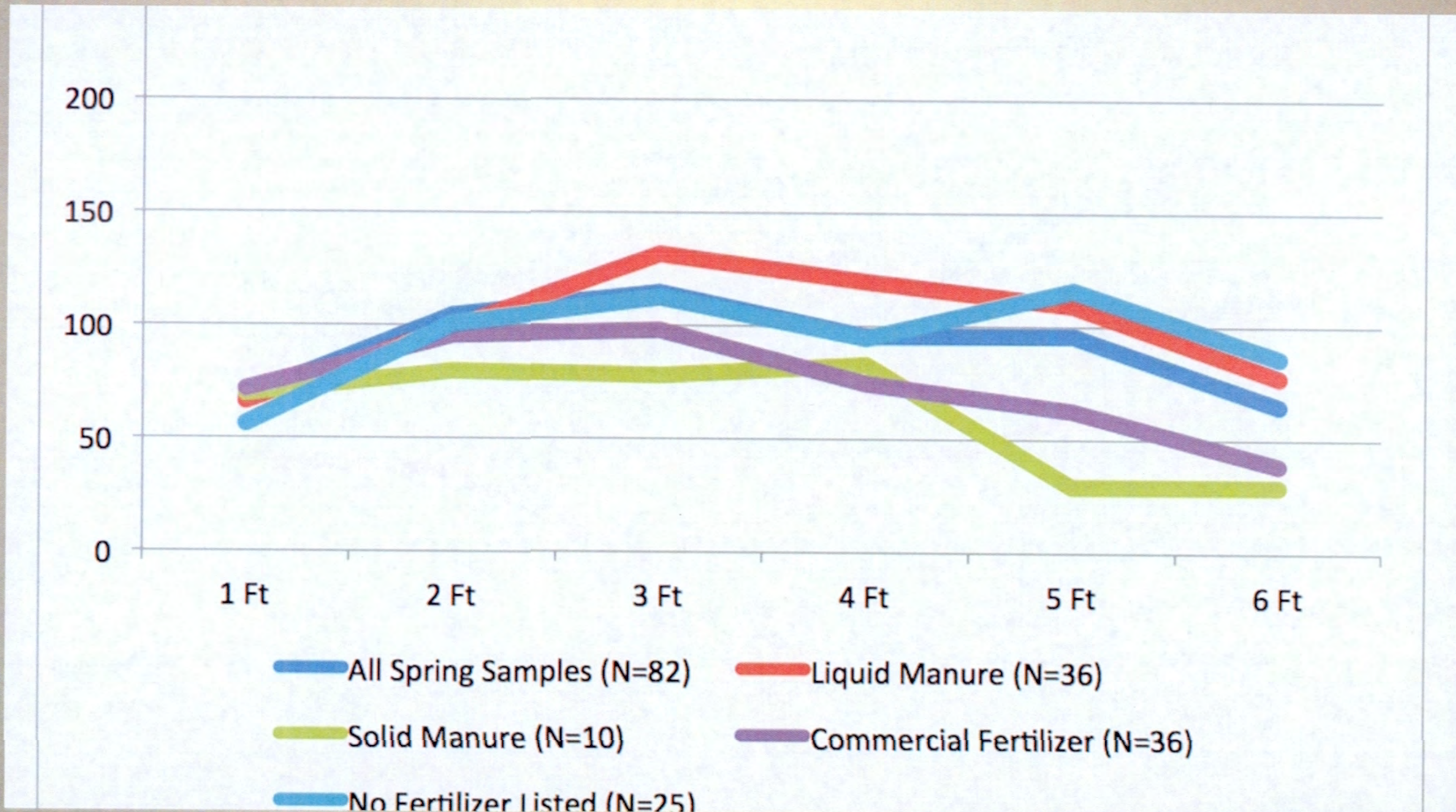
Double Cropping - Spring



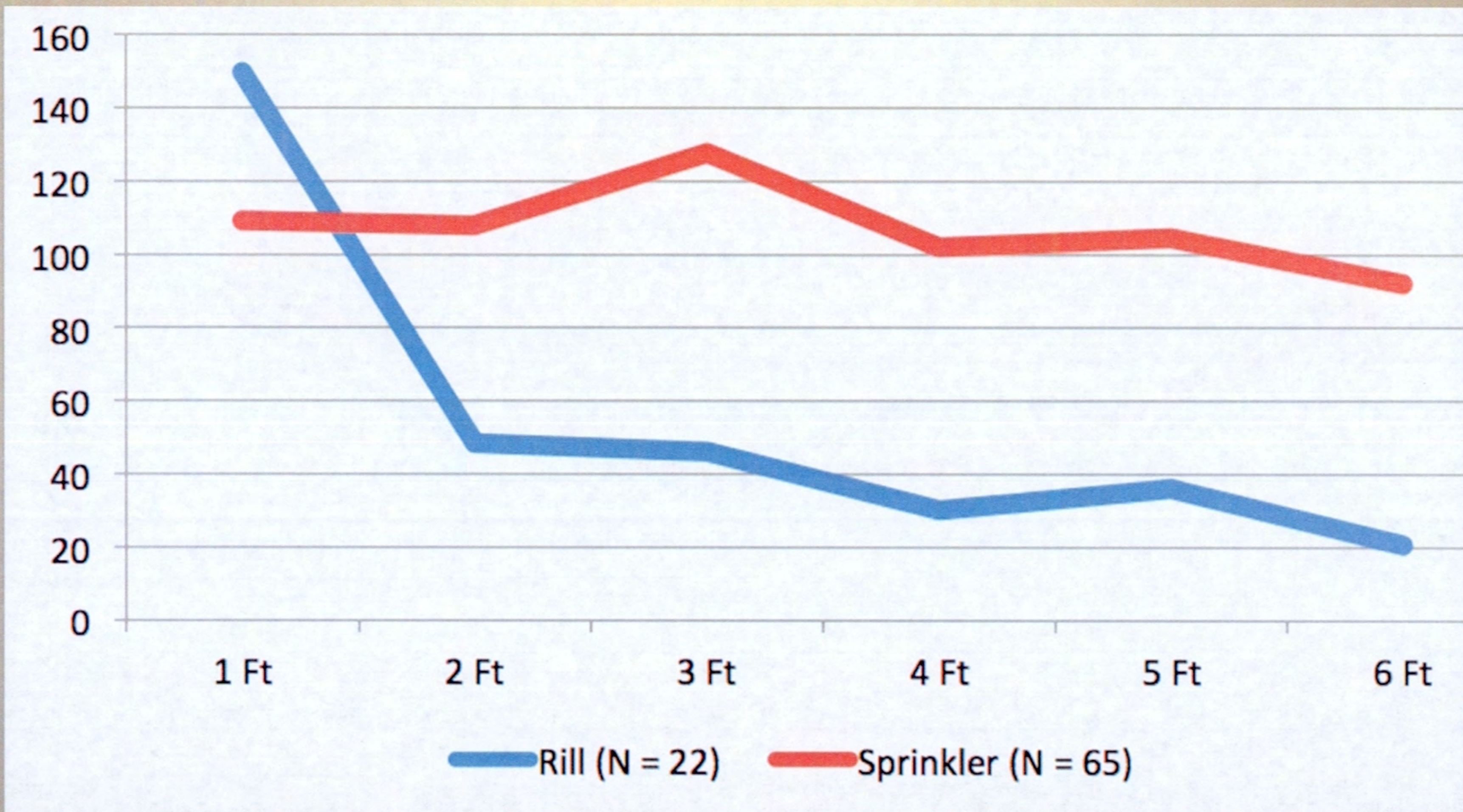
Fall: lbs. NO3 per Acre by Fertilizer



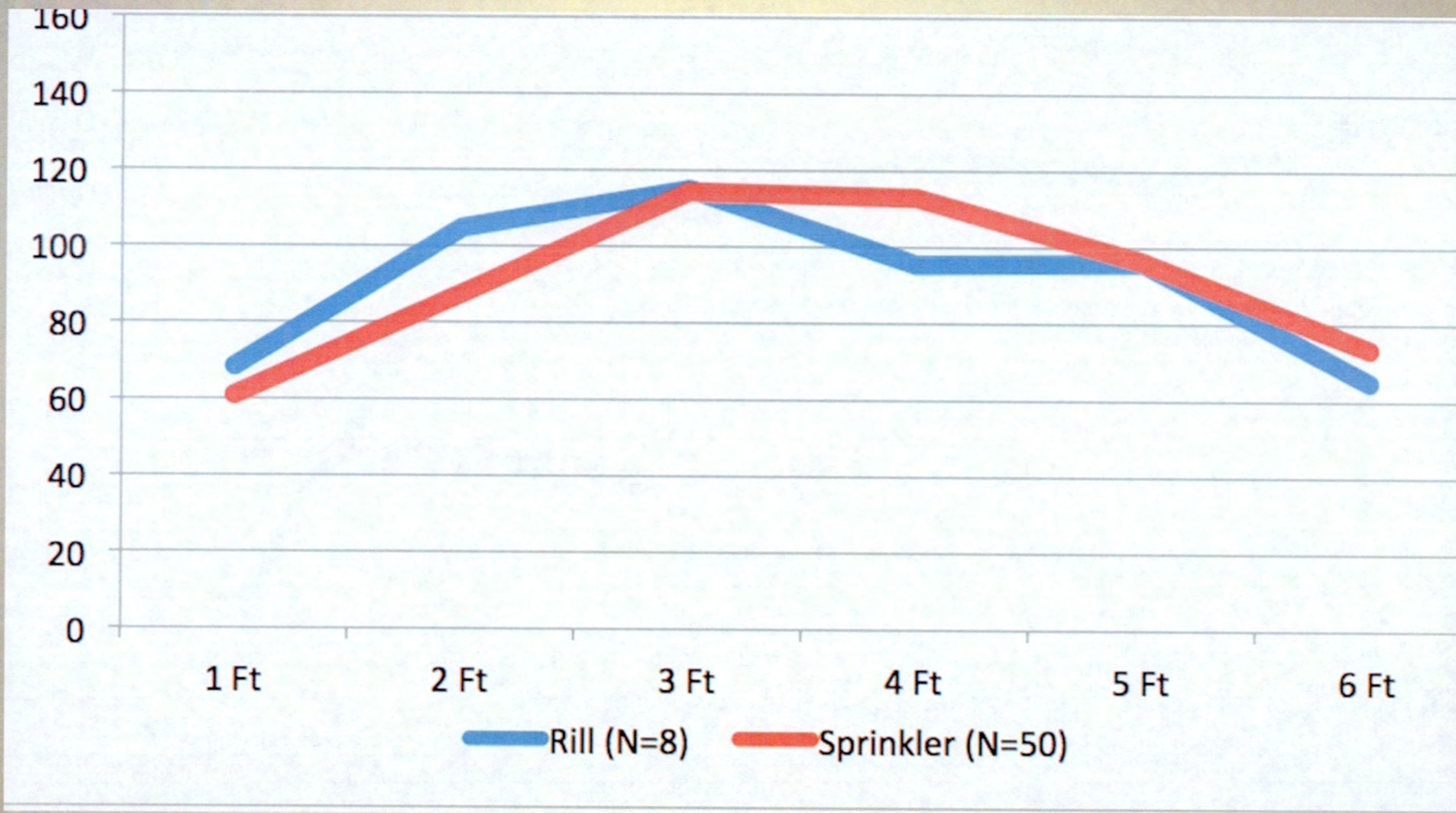
Spring: lbs. NO3/Acre by Fertilizer



Fall: lbs. NO3/Acre by Irrigation



Spring: lbs. NO3/Acre by Irrigation



Statistical Analysis at Two Feet

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)

Significant Results

- 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* $p < .05$.
- 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* $p < .05$.

Significant Results

- 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* $p < .05$.

Statistical Analysis at Four Feet

Characteristics of Risk Levels at Four Foot Sampling Depths

(Low Risk is < 55 lbs NO3/Acre, Medium Risk/High Risk is 55 lbs NO3/Acre to 165 lbs NO3/Acre, Very High Risk is > 165 lbs NO3/Acre)

Significant Results

- 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 $p < .05$.*

Significant Results

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 $p < .05$.

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* $p < .05$.

Significant Results

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.*
- 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.*

Thanks for Listening

Soil Types in the LYV GWMA DSS

10 = Burke Silt Loam 2-5% Slopes	Very Low to Moderately Low
18 = Cleman Very Fine Sandy Loam 0-2% Slopes	Moderately High to High
19 = Clemen Very Fine Sandy Loam 2 - 5% Slopes	Moderately High to High
32 = Ezquatel Silt Loam 0 - 2% Slope	Moderately High to High
37 = Finley Silt Loam 0 - 2% Slopes	High
40 = Finley Silt Loam 8 - 15% Slopes	High
57 = Hezel Loamy Fine Sand 0 - 2 % Slopes	Moderately High
58 = Hezel Loam Fine Sand 2 - 15% Slopes	Moderately High
66 = Kittitas Silt Loam	Moderately High
91 = Outlook Fine Sandy Loam	Moderately High to High
92 = Outlook Silt Loam	Moderately High to High
95 = Quincy Loamy Fine Sand 0 - 10% Slopes	High to Very High
120 = Scoon Silt Loam 2-5% Slopes	Very Low to Moderately Low
121 = Scoon Silt Loam 5-8% Slopes	Very Low to Moderately Low
122 = Scoon Silt Loam 8 - 15% Slopes	Very Low to Moderately Low
125 = Scootenay Silt Loam 2 - 5% Slopes	Moderately High to High
132 = Shano Silt Loam 2-5% Slopes	Moderately High to High
138 = Sinloc Fine Sandy Loam 0-2% Slopes	Moderately High to High
139 = Sinloc Silt Loam 0-2% Slopes	Moderately High to High
140 = Sinloc Silt Loam 2 - 5 % Slopes	Moderately High to High
141 = Sinloc Silt Loam 5-8% Slopes	Moderately High to High
142 = Starbuck Silt Loam 2 - 15% Slopes	Moderately High to High
143 = Starbuck-Rock Outcrop Complex 0 - 45% Slope	Moderately High to High
171 = Wamser Loamy Fine Sand	High to Very High
172 = Warden Fine Sandy Loam 0 - 2% Slopes	Moderately High to High
173 = Warden Fine Sandy Loam 2 - 5% Slopes	Moderately High to High
174 = Warden Fine Sandy Loam 5 - 8% Slope	Moderately High to High
176 = Warden Silt Loam 0-2% Slopes	Moderately High to High
177 = Warden Silt Loam	Moderately High to High
178 = Warden Silt loam 5-8% Slopes	Moderately High to High
179 = Warden Silt Loam 8 - 15% Slopes	Moderately High to High
180 = Warden Silt Loam 15 - 30% Slope	Moderately High to High

From https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

Attachment E

- Amendment Number 1 to Agreement C1600074
- Contract between Yakima County and PGG for the Monitoring Well Installation

DEPARTMENT OF
ECOLOGY
State of Washington

AMENDMENT NO. 1

TO

Agreement NO. C1600074

BETWEEN THE

STATE OF WASHINGTON DEPARTMENT OF ECOLOGY

AND

YAKIMA COUNTY

PROJECT TITLE: Lower Yakima Valley Ground Water Management Area (LYV-GWMA)

PURPOSE: To extend the term of this Agreement between the State of Washington, Department of Ecology, hereinafter referred to as "ECOLOGY," and Yakima County, hereinafter referred to as "County."

WHEREAS: Additional time is needed to accomplish the current phase of this project. This time is needed to finalize the Washington State Department of Agriculture (WSDA) Nitrogen Availability Assessment, complete the drinking water well testing and purpose-built monitoring well construction and testing by the United States Geological Survey (USGS), and finalize the Groundwater Advisory Committee evaluation of alternatives.

IT IS MUTUALLY AGREED the Agreement is amended as follows:

1) Subject to other provisions, the period of performance of the Agreement shall be extended from December 31, 2017 to December 31, 2018.

All other terms and conditions of the original Agreement including any Amendments remain in full force and effect, except as expressly provided by this Amendment.

This Amendment is signed by persons who represent that they have the authority to execute this Amendment and bind their respective organizations to this Amendment.

This Amendment is effective upon the signature date of Ecology.

IN WITNESS WHEREOF: the parties hereto, having read this Amendment in its entirety, including all attachments, do agree in each and every particular and have thus set their hands hereunto.

***DONE** this 2nd day of January, 2018*

State of Washington Department of Ecology	**Board of Yakima County Commissioners**
By:	**By:**
Polly Zehm, Deputy Director	Ron Anderson, Chairman
	Michael D. Leita, Commissioner
	J. Rand Elliott, Commissioner *Constituting the Board of County Commissioners for Yakima County, Washington*

SEAL OF THE BOARD OF YAKIMA COUNTY COMMISSIONERS STATE OF WASHINGTON

Attest:

Linda Kay O'Hara, Deputy Clerk of the Board

Approved as to form:

Deputy Prosecuting Attorney

BOCC1-2018
January 9, 2018

GWMA

A/E CONSULTANT AGREEMENT
FOR PROFESSIONAL SERVICES

This *Consultant Agreement for Professional Services* ("*Agreement*") is entered into as of 1/9, 2018 between Yakima County Public Services, of 128th North 2nd Street, Room 408 Courthouse, Yakima, Washington 98901-2614 ("Client"), and Pacific Groundwater Group, of 2377 Eastlake Avenue East, Seattle, WA 98102 ("Consultant"). The parties agree as follows:

I. PROJECT. Client, as administrator for the Lower Yakima Valley Groundwater Advisory Committee ("GWAC"), desires to engage the services of Consultant to perform certain consulting, design, advisory, and/or surveying services for the Consulting Services for the Lower Yakima Valley Groundwater Management Area ("GWMA") Program ("Project").

II. OBJECTIVES AND SCOPE OF SERVICES. Consultant shall perform the services described in *PGG Scope of Services, Exhibit "A"* for the Lower Yakima Valley GWAC ("Services").

III. PAYMENT. Client shall pay Consultant as compensation for the Services according to the *Schedule of Billing Rates* attached to this *Agreement* as *Exhibit "B"*, up to an amount not to exceed one hundred forty seven thousand seven hundred six dollars ($147,706.00).

IV. STANDARD PROVISIONS. The standard provisions for this *Agreement* are on the next page.

V. ADDITIONAL PROVISIONS. The following additional provisions shall apply to this *Agreement*:

Consultant shall transfer all digital and paper materials, including, without limitations, files, records, and maps, regarding the Project to Client or Client's designee within 30 days of completion or termination of this Agreement under this Additional Provision. Transfer of materials does not include proprietary records or property.

CONTRACTOR / CONSULTANT

By ______________________

Title PRINCIPAL

Date 1·3·17

BOARD OF YAKIMA COUNTY COMMISSIONERS

____
Ron Anderson, Chairman

____
Michael D. Leita, Commissioner

____
J. Rand Elliott, Commissioner
Constituting the Board of County Commissioners for Yakima County, Washington

BOARD OF YAKIMA COUNTY COMMISSIONERS STATE OF WASHINGTON

____
Attest: Linda Kay O'Hara
Deputy Clerk of the Board

Approved as to form:

____
Deputy Prosecuting Attorney

RECEIVED
JAN 10 2018
PW ACCOUNT

BOCC6-2018
January 9, 2018

1. **Payments.**

1.1 **Monthly Invoices.** Monthly invoices shall be issued for all Services performed under this *Agreement*.

1.1.1 **Lump Sum.** A lump sum contract is based on the percentage of work completed; and the contract amount may be increased for any unanticipated event, which is beyond Consultant's control and which increases the level of services required to complete the Project.

1.1.2 **Time and Materials.** A time and materials contract is based on the hourly rates set forth in Consultant's prevailing *Schedule of Billing Rates,* which may be amended from time to time, plus expenses.

1.1.3 **Retainers.** Retainers are applied toward the final invoice.

1.2 **Expenses.** Expenses include all out-of-pocket costs for technical, professional and clerical services and all costs for transportation; meals and lodging; laboratory tests and analyses; telephone; printing, copying, and binding. County shall pay all governmental fees, permits and charges.

1.3 **Payment Date.** Invoices are due and payable within thirty (30) days after the date of the invoice.

1.4 **Past Due Accounts.** Any invoice not paid within thirty (30) days after the date of the invoice shall bear interest at an annual rate of 18% on the daily outstanding balances.

1.5 **Stop Work.** Consultant may stop work on the Project and withhold delivery of all work product until County's obligations to Consultant are paid in full.

1.6 **Disputes.** Invoices shall outline the Services performed, and the charges and expenses for such Services. Disputes regarding an invoice shall be forwarded in writing to Consultant within twenty (20) days of the date of the invoice. If County does not dispute the invoice within the prescribed time period, the invoice shall be deemed to be accurate.

1.7 **Estimated Fees.** Estimated fees for Services to be performed are only estimates, and such fees may not accurately reflect the ultimate charges to County.

2. **Notice to Proceed.** This *Agreement* constitutes County's notice to proceed with the Services.

3. **Subconsultants.** Consultant may retain subconsultants to assist Consultant in performing the Services.

4. **Extra Work.** If County desires work to be performed beyond the Services described in this *Agreement* ("*Extra Work*"), County must authorize the *Extra Work* by signing a written supplement. If a written supplement is impracticable, then a written or electronic statement authorizing the *Extra Work* is required. Payment for all *Extra Work* shall be on a time and materials basis.

5. **Safety and Construction.** Consultant is not responsible for construction means, methods, techniques, sequences of procedures, or safety precautions and programs related to the work performed by contractors, subcontractors, or anyone else associated with the Project.

6. **Cost Estimates.** Consultant does not warrant construction cost estimates.

7. **Use of Documents.** County shall retain ownership to all documents and work products under this *Agreement*, and Consultant or other entities may only use such documents and work product in connection with the Project.

8. **Professional Standards.** Consultant shall perform the Services according to the standard of care ordinarily exercised under similar conditions by similarly qualified professionals who are currently practicing in the area where Consultant is located. Consultant makes no express or implied warranties.

9. **Indemnity.** The Contractor's Mutually Negotiated Waiver of Employer's Immunity under Title 51 RCW agrees, intends and promises that its duty to defend, indemnify, and hold harmless Yakima County, its officers, employees, agents, volunteers, and insurers under this Agreement shall be fully effective regardless of any provision to the contrary in Title 51 RCW, Washington's Industrial Insurance Act. Accordingly, based upon mutual negotiation between the Contractor and Yakima County, Contractor hereby expressly waives its immunity from tort liability under Title 51 RCW, but only to the extent such legal rights under this Agreement or other applicable law to be fully defended, indemnified, and held harmless by Contractor from claims or suits by Contractor's workers or employees, or any assignee of or anyone subrogated to any of their rights or their interests for injuries or losses experienced by Contractor's workers or employees caused by the acts of omissions of Contractor or by the acts or omissions of anyone directly or indirectly employed by or under contracted with Contractor or anyone for whose acts Contractor might be liable absent the provisions to Title 51 RCW.

10. **Liability Insurance.** The Consultant shall have liability insurance with coverage in the sum of $2,000,000 and shall provide proof of insurance if requested. The coverage provided to Yakima County, its officers, employees, agents, volunteers, and insurers as Additional Insureds shall be primary and not contributory to any other insurance that may be available to such Additional Insureds.

11. **Limitation of Liability.** Consultant's liability for its acts, errors or omissions is limited to the total fee for the Services performed under this *Agreement*. All actions or proceedings are barred three years after County knew or should have known of any claim or damage, or five years after substantial completion of the Services, whichever occurs first.

12. **Alternative Dispute Resolution.** In the event that any dispute shall arise as to the interpretation of this agreement, or in the event of a notice of default as to whether such default does constitute a breach of the contract, and if the parties hereto cannot mutually settle such differences, then the parties shall first pursue mediation as a means to resolve the dispute. If the afore mentioned methods are either not successful then any dispute relating to this Agreement shall be decided in the courts of Yakima County, in accordance with the laws of Washington. If both parties consent in writing, other available means of dispute resolution may be implemented.

13. **Attorney's Fees.** If any legal action or proceeding is commenced relating to this Agreement, the prevailing party is entitled to recover its reasonable attorneys' fees and costs.

14. **Termination.** This *Agreement* may be terminated upon fifteen (15) days written notice to the other party. In such event, County shall pay Consultant for all Services performed, under the scope of work and for all related expenses incurred prior to the effective date of termination.

15. **Governing Law and Venue.** This *Agreement* shall be governed by the laws of the state of Washington. Venue for any action or proceeding shall be in the Superior Court of Yakima County.

16. **Survival.** The provisions of this *Agreement* shall survive its termination and completion of Services.

17. **Complete Agreement.** This *Agreement* constitutes the complete and final understanding between the parties and may be amended by the prior written consent of both parties.

18. **Nondiscrimination.** The Consultant agrees that it shall not discriminate against any person on the grounds of race, creed, color, religion, national origin, sex, sexual orientation, age, marital status, political affiliation or belief, or the presence of any sensory, mental or physical handicap in violation of the Washington State Law Against Discrimination (RCW chapter 49.60) or the Americans with Disabilities Act (42 U.S.C. 12101 et seq.) or any other applicable state, federal or local law, rule or regulation.

Exhibit "A"

PGG SCOPE OF SERVICES

PGG SCOPE OF SERVICES

Monitoring Well Installation

Task 1 – Update Project Plans

Objective

A draft monitoring well installation plan was submitted by PGG in summer 2016 and approved for implementation by the GWAC. One purpose of this task is to submit a final version of the plan for County and GWMA project files, without making changes.

An interim final Quality Assurance / Quality Control Project Plan was submitted by PGG in 2014. We understand that this plan will be updated or replaced by others in 2017. One purpose of this task is to fund PGG's support during updating or replacement of the QA plan.

A groundwater monitoring data analysis plan has not been generated for this project. One goal of this task is to fund PGG's support in generating a data analysis plan. PGG will not be prime author of the plan.

Services

PGG will submit a final version of the well installation plan that was approved in draft form by the GWAC. The plan will be submitted as a compiled PDF document.

PGG will participate in generation of an updated or replacement QA/QC Plan to the extent of PGG's established budget. We assume that PGG will not be the prime author.

PGG will participate in generation of a groundwater monitoring data analysis plan to extent of PGG's established budget. We assume that PGG will not be the prime author.

Client Responsibilities

- Provide clear specification of roles on inter-agency cooperation on QA/QC and data analysis plans.

Assumptions

- There are no edits to the well drilling plan resulting from GWAC or Data Committee review subsequent to the draft submittal delivered by email on July 29, 2016 (GWMA Ambient Groundwater Monitoring Network Report v6.docx plus figures and tables). The "As-Built" report of Task 5 will document final locations, which may differ from those in the plan based on field proofing the planned locations by PGG and GWAC members, access issues, and utility interferences.
- PGG is not prime author of the new QA/QC plan.

- PGG is not prime author of the new data interpretation plan.

Deliverables

- Compiled well installation plan in PDF format.
- Possible contributions to new QA/QC and data interpretation plans.

Task 2 – Field-Proof Well Locations

Objective

Perform field reconnaissance of planned drilling locations and adjust locations if necessary.

Services

PGG will submit to the County a digital file of survey coordinates for 30 wells (not all of them may be drilled at this time). The County will stake the locations and then PGG, the County, and Ecology will jointly perform a field reconnaissance of the locations and place alternative stakes nearby if necessary to ease access or avoid obvious anomalies or utilities, or areas of stormwater pooling. The County will then notify GWAC members that locations are ready for their field review if desired.

The County will compile GWAC comments on well locations, and respond, involving PGG if necessary. The County will compile a final set of planned well coordinates. Note this final set of planned coordinates will not consider utility clearances.

One week prior to planned drilling start, the County will re-stake the planned well locations and request mapping of utilities in the area using the "One Call" service. PGG will be available for consultation during this process. PGG and the drillers will use the final stake locations and mapped utilities to select a drill site as close to the stake as possible.

Client Responsibilities

- See Services above.
- County will generate right-of-way permits for drill locations.
- County will generate and implement traffic control plans if necessary for drilling.

Assumptions

- Moved drill sites will not be analyzed using the process PGG used to establish the original locations.

Deliverables

- Well coordinates in digital format.

Task 3 – Support County in Procurement of Drilling Contractor

Objective

Procure drilling contractor for installation of wells.

Services

PGG will provide to the County draft and final versions of the technical portion of a specification and cost estimate for installing wells. PGG will answer questions between the advertisement and due dates and recommend amendments to the County if warranted. PGG will recommend an award if requested, and attend a pre-construction conference.

Client Responsibilities

- County will compile the bid document, advertise the work, and tabulate bids.
- County will administer the drilling contract on behalf of the GWAC.

Assumptions

- County procures drilling contractor under separate contract.
- County will provide comments on draft technical specifications, if desired.

Deliverables

- Draft and final technical portions of a specification for monitoring well construction.
- Amendments to specification, if necessary.
- Estimate of drilling contract cost.
- Award recommendation, if requested.

Task 4 – Install Wells

Objective

Install monitoring wells.

Services

PGG will act as hydrogeologist for the County during well installation, inspecting work by each drilling rig, logging soils, and modifying designs in consideration of field data. The Lower Yakima Valley GWMA Proposed Ambient Groundwater Monitoring Network plan will be used as a guide for the work, including well depths and well screen placements. PGG will maintain daily notes on contactor work, soils penetrated during drilling, and the materials and dimensions of as-built wells. PGG will mark a measuring point on the casing of each well.

Disturbed soil samples will be collected at least every five feet and be described in the field by the hydrogeologist. Soil samples may then either be discarded, or turned over to the /county for further analysis or archiving. The project budget does not include laboratory analysis of soil samples.

After well installation, County will survey as-built locations and the elevation of the measuring point.

PGG will generate a formal well log for each well and a data table summarizing key well construction data. The County will provide PGG the latest GWMA well database, PGG will upload new well data to the database, and return the expanded database to the County.

Client Responsibilities

- County will each identify one point of contact for issues relating to the field work.
- County surveyors will determine the as-built location and measuring point (top of casing) elevation of each monitoring well and report this data to PGG.
- County will maintain the GWMA well database except as indicated in Services above.

Assumptions

PGG's field time must be coordinated with the drilling approach and time frame, yet the drilling specification may leave bidders flexibility with regard to approach – with the hope that flexibility will maximize the number of wells drilled for the a fixed drill budget. The specification will require the driller to update expenditures at key intervals and submit progress billings to the County, to allow full utilization of the budget – but not exceed it. PGG has budgeted for installation of 20 wells, which is expected to exceed the number to be drilled. Thus PGG's budget should not require modification to accommodate the likely range of wells that may be afforded.

Deliverables

- Updated well database
- Soil samples, if requested
- Well data will be included in the As-Built report of Task 5. Logs will be submitted as they are completed, if requested.

Task 5 – Well Tests and Water Levels

Objectives

- Collect an initial set of static water level measurements.
- Measure local aquifer transmissivity and provide well-yield/drawdown data for sampling plan.

Services

PGG will perform short, single well pumping tests on each well. Static water level will be measured, followed by time series of pumping rate, pumping water levels, turbidity, specific conductance, ORP, and temperature. Tests will last less than one hour regardless of water quality data. Water will be discharged to the ground.

PGG is not scoped for collection of samples under this contract. However, if requested, PGG will collect a sample of water for laboratory analysis at the end of the well tests. Cost for laboratory analysis, data management, interpretation, and reporting are not included in this budget.

Client Responsibilities

None

Assumptions

Testing the many wells will take several days, and static water levels will be measured in separate wells as they are tested. Thus the static water level measurements will only approximate a "snap shot" of water table elevation across the GWMA.

Deliverables

None (data will be provided in the As-Built report).

Task 6 - As-Built Report

Objective

Document well drilling and testing.

Services

After completion of well installation and testing, PGG will submit two drafts and a final report to the County in PDF format. Drafts are assumed for review by the Data Committee and GWAC, as administered by the County. The reports will contain the following information:

- Description of drilling process.
- Geology, well construction details, unique well ID, and survey data for each well (well logs).
- Map of basin showing wells drilled in this effort, plus purpose built wells in the dairy cluster.
- Local map and photograph of each well head.
- Map of water table elevation based on measurements in the drilled wells.
- Table of well completion data including survey coordinates.
- Well test results including plots of water level drawdown and tables of water quality data.
- Calculated local aquifer hydraulic conductivity or transmissivity.

Client Responsibilities

- County will provide comments on draft reports that the County wishes PGG to respond to.
- The County may wish to coordinate water level measurements in other wells during PGG's performance of this task (e.g.: water levels in the purpose-built wells in the Dairy Cluster, landfill monitoring wells, and environmental cleanup site water table monitoring wells). Budget for such monitoring is not included herein.

Assumptions

- *Inter-well geologic interpretation is not proposed.*
- Water quality data interpretation is not proposed.

Deliverables

- Two drafts, and one final report.

Task 7 – Project Management

Objective

Monitor, control and adjust scope, schedule, and budget for a successful project.

Services

- Link with County and drilling contractor
- Attend six Data Committee meetings by phone.
- Monthly invoicing and status report
- Input to quarterly progress reports
- In cooperation with the drilling contractor, provide a summary of drilling and PGG costs after 17 wells are drilled, and assess the ability of any remaining budget to drill additional wells. Resolve scope/budget issues as scope evolves.

Client Responsibilities

- Identify a point of contact who is authorized to represent the County for this task.
- Specify communication protocols between PGG and the County, drilling contractor, Data Committee, Ecology, and other GWAC members.

Assumptions

1. The project duration is 9 months.
2. Expense backup will not be provided with invoices but will be available for review at PGG.

Deliverables

1. Monthly reports and invoices (one copy with invoice can be mailed or e-mailed PDF file)
2. Monthly project schedule and budget updates.
3. Estimate of total cost after 17 wells are drilled, and an estimate of the number of additional wells, if any, that could be drilled with any remaining budget.

Exhibit "B"

Schedule of Billing Rates

Estimated Cost for Pacific Groundwater Group
Lower Yakima Valley GWMA Monitoring Well Installation

Project Task/Subtask	Principal $185 /hr	Project $120 /hr	Technical $100 /hr	Support $60 /hr	Total Labor	Direct Expenses & Costs		Subtask Cost	Total Costs
Task 1 – Update Project Plans									$12,140
Final Well-Install Plan	4		4		$1,140			$1,140	
Consult - QA/QC Plan	10				$1,850			$1,850	
Consult - Data analysis plan	30	30			$9.150			$9,150	
Task 2 – Field-Recon Well Locations									$8,270
submit coordinates	2	4			$850			$850	
field recon	12		12		$3,420	miles	$300	$3,720	
communication/GWAC concerns	20				$3.700			$3,700	
Task 3 – Support County in Procurement of Drilling Contractor									$14,096
draft specification	24	6			$5,160			$5,160	
final specification	10	6			$2,570			$2,570	
drill cost estimate	6	4			$1,590			$1,590	
bid and award support	8		8		$2,280			$2,280	
preconstruction meeting	8		8		$2,280	miles	$216	$2,496	
Task 4 – Install Wells									$42,908
mobilization	5	5	5		$2,025			$2,025	
log 20 wells	18	118	118		$29,329	per diem + miles	$4,884	$34,213	
						field supplies	$500	$500	
draft 20 well logs	8	30			$5,080			$5,080	
update well database	2	6			$1,090			$1,090	
Task 5 – Well Tests and Water Levels									$12,331
measure water levels and test 20 wells	4.6	46	46		$10,971	miles	$360	$11,331	
						pumps and meters	$1,000	$1,000	
Task 6 - As-Built Report									$23,280
well constr descr	2	20			$2,770			$2,770	
aquifer test analysis	4	20			$3,140			$3,140	
tables and figures	2	20			$2,770			$2,770	
draft report and response to comments	30	30			$9,150			$9,150	
final report	10	30			$5,450			$5,450	
Task 7 – Project Management									$34,307
communication and 6 phone meetings	48				$8,880			$8,880	
one GWAC meeting	8				$1,480	miles	$217	$1,697	
invoicing	18			5	$3,630			$3,630	
Interim drill+PGG cost estimate (@17 wells)	8			2	$1,600			$1,600	
schedule/budget/scope issues	40				$7,400			$7,400	
manage staff	40				$7,400			$7,400	
interface with contractors	20				$3,700			$3,700	
Total Hours	401	375	201	7					
Subtotal Dollars	$74,251	$45,046	$20,138	$420			$7,477		$147,332
Supplies, equipment, and subcontractor markup		5%					$373.87		$374
Estimated PGG Cost									**$147,706**

PGG