Horizon Organic Dairy NPDES Permit Application August 2012

Nine Minimum Measures

1) Ensure adequate storage of manure, litter, and process wastewater, including procedures to ensure proper operation and maintenance of the storage facilities.
   a) Liquid and Solid Waste Storage
      i) The production areas are designed, constructed, operated, and maintained to contain all manure, litter, process wastewater, and the runoff and direct precipitation from the 25-year, 24-hour storm events.
      ii) Adequate storage exists to contain:
         (1) The normal precipitation less evaporation during the storage period;
         (2) The normal runoff during the storage period;
         (3) The direct precipitation from a 25-year, 24-hour storm event;
         (4) The runoff from the 25-year, 24-hour storm event from the production area;
         (5) The residual solids after liquid has been removed;
         (6) The necessary freeboard to maintain structural integrity;
         (7) The necessary Minimum treat volume for treatment lagoons.
      iii) Runoff at Production Areas
         (1) East Dairy
            (a) Storage Volume Required 621,252 ft3
            (b) Storage Volume Available 3,547,974 ft3
         (2) West Dairy (including Feed Storage Areas 2 & 3)
            (a) Storage Volume Required 746,822 ft3
            (b) Storage Volume Available 4,254,690 ft3
      iv) Process wastewater
         (1) East Dairy
            (a) Storage Volume Required 2,555,000 ft3
            (b) Storage Volume Available 3,547,974 ft3
      v) Solid Waste in Lagoon (Sludge)
         (1) Storage Volume Required 163,816 ft3
         (2) Storage Volume Available 4,254,690 ft3
   b) Solid Waste Management and Handling
      i) All solid manure, including vacuumed manure is composted at either the north or south compost area, and then land applied as described in the NMP.
   c) Feed Storage Areas
      i) Feed storage runoff is contained and either evaporates or is directed to the East Dairy Lagoon, and is land applied.
   d) Exported Waste
      i) All waste is land applied on site. There are no exports.
   e) Operation and Maintenance of Storage Facilities
      i) East Dairy Lagoon and Settling Basins

(1) Operation consists of pumping the lagoon water out over the growing season through pivots mixed 1:1 with clean water onto the fields listed in the NMP as receiving manure water.

(2) Maintenance of the lagoon consists of

(a) A drag line or extended excavator is used to remove solids from the bottom of the lagoon, which are spread on compost piles.

(b) Sludge is pumped from the lagoon bottom into a truck, then is injected twelve inches deep on fields within 1.5 miles of the dairy, using a tractor with an injector and a drag hose. This is done in the late fall until most of the sludge is removed.

(3) Maintenance of the Settling Basins

(a) Settling basins sludge is pumped in the spring and fall into a truck, then is injected twelve inches deep on fields within 1.5 miles of the dairy, using a tractor with an injector and a drag hose.

(b) Two to three more times during the year, sludge is removed from the settling basins with a scoop, transported in a truck, then spread on the compost rows.

(c) Solids from the solid separator are taken to the compost rows.

ii) West Dairy Lagoons

(1) When there are no milking cows at the West Dairy, the lagoons only collect runoff. They are pumped during the irrigation season onto nearby fields.

(2) When there are dairy cows on the West Dairy, the lagoons are maintained in the same way as described above for the East Dairy Lagoons.

iii) North and South Compost Areas

(1) Manure from the East and West Dairy facilities, the Dry Cow Lots, and the North and South Heifer Lots (when used), is spread in rows in the compost area to dry. East Dairy Lagoon solids and Settling Basin solids are spread over the top of composting rows. A compost turner is used to turn the compost as needed, depending on the temperature. After about ten weeks, the compost is completed. It can be stored at the compost area (summer) or spread directly on fields (fall, winter, spring), using a manure spreader.

iv) Exported Waste

(1) There is no compost available for export. All is land applied on dairy land.

2) Ensure proper management of mortalities

Mortalities will be temporarily stored at the concrete storage area south of the West Dairy, and then will be removed by Darling International every one to two days. No runoff will be possible from the storage area.

3) Ensure that clean water is diverted, as appropriate, from the production areas.

a) Maps are located in Appendix H of the Nutrient Management Plan.

b) East Dairy: On-site inspection verified that piping of run-on through the dairy pastures to eliminate the major source of run-on has been done. Pipe size is adequate. The inlet to the pipe on the east side does need to be checked monthly for debris. If present, the debris needs to be removed, so there is no impediment to water entry. Run-on from an area east of the southeast area of dairy pastures flows through a low area of Pastures 504, 505, 506, and 507. On the west side of 507, this water will flow through a buffer of 175 feet of grass and trees, to

which no additional nutrients will be applied. The water then flows under the road to the west and dead ends in the desert.

c) West Dairy: An irrigation water drain ditch (Main Drain) constructed and maintained by the A and B Irrigation District conveys drain water and storm runoff water from a large upstream area (approximately 50 square miles) through the west dairy. This ditch is currently sized inadequately to carry flow from a 25 year-24 hour storm. The ditch will be redesigned and rebuilt so that no production area runoff can flow into the ditch. This construction will be completed by December 31, 2013. When adequate flow is present, this channel will convey runoff through the dairy and under a flume in the Milner –Gooding irrigation canal. Berms and or conservation practices applied on this facility will prevent nutrients from entering the Main Drain.

d) Based on survey information and hydrologic analyses, the capacity of the culvert passing irrigation water under the county road and into an open channel at the northeast side of the west dairy is not adequate to convey expected runoff from the 25 year 24 hour design storm. A new design is being developed for this channel.

Site visits and analyses indicate that adequate run-on and runoff control can be achieved on sites d through i listed below under current conditions or with relatively minor additional berming.

e) Dry Cow Lots; No runoff will leave the dry cow area because there is adequate berming to contain all runoff.

f) Feed Storage Area 1, 2, 3, 4, and 5 (All required construction will be completed by December 31, 2013)

   i) <u>Feed Storage 1 (FS1):</u> This site shown in **Figures B2 and B3** is composed of a number of bunker silo trenches excavated into the hillside on the east side of the farm road and several above-ground silage piles on the west side of the road. Amount of run-on water is minimal in both areas since the upslope end is very close to the top of the ridge. Drainage area is 16.1 acres. Runoff from the east portion of the site is collected by an existing berm across the bottom end, as shown in **Figure B3**. This berm will be enlarged and additional berming installed to direct runoff into an existing lagoon at the base of the slope. Runoff water will be temporarily stored until evaporation in an area upslope of the south berm of the new bypass channel.

   ii) <u>Feed Storage area 2 (FS2):</u> This site, also shown in **Figures B2 and B4**, is located along the western border of the west dairy footprint. Large bales of hay and straw are stored in this area. Drainage area is 18.8 acres. Slope is to the south, and any runoff flows into Lagoon #1. Lagoon storage is adequate. Existing berming should be upgraded to more reliably carry runoff from field 145 to Lagoon #1.

   iii) <u>Feed Storage 3 (FS3):</u> This site, located at the north end of the West Dairy, is shown in **Figures B2 and B5**. Drainage area is 6 acres. It slopes to the east and has a blacktop surface covering. Runoff is directed by berms along the north and south sides toward the east end, just beyond the hard surface area. Runoff flows into this low area and into a vertical standpipe from which it is pumped into a liquid transport and emptied into Lagoon 4. For larger storm events, runoff temporarily backs up onto the blacktop apron until it is removed by pumping.

iv) Feed Storage 4 (FS4): is shown in **Figure B6**. It contains metal grain storage bins, a feed mill and liquid feed supplement tanks. It is located adjacent to, and on the south side of the railroad tracks. Because the grain and liquid supplements are in sealed storage, potential for any contamination of surface water on the site is low. Run-on is minimal and runoff will flow from the site to the southwest and into a closed basin area of the adjacent desert.

v) Feed Storage 5 (FS5): This area, shown in **Figure B6**, is where the baby calf rations are mixed. The milk replacer powder is stored in sealed containers in the building on site. Water and detergent from mix container and feed bottle cleanup goes into an underground storage tank and is then pumped out into the dry corner through one hand line. The daily hydraulic loading due to this small amount of water is applied over a sufficiently large area that no runoff occurs. Should runoff from precipitation ever occur, it will be contained in a natural basin about ¼ mile down-gradient.

g) North Compost Area (Required construction will be completed by December 31, 2013)

- Site area, square feet (acres): 752,970 (17.3)
- 100- year, 24 hour precipitation, inches: 2.4 inches
- Runoff volume, cubic feet: 150,594

This area, shown in **Figure B7**, slopes to the northwest with an average slope of about 3-4%. It is located so that the top of the site is at the peak of the ridge, nearly eliminating run-on. A small berm (ridge height of 1 ft) will eliminate all possible run-on. The slope flattens at the base, giving a nearly-level area at least 100 feet wide on the west half and at least 50 feet wide on the east half. Site area is 752,970 square feet. Using 100-year, 24 hour precipitation of 2.4 inches and a runoff coefficient of one (all precipitation runs off the compost area), the required storage is 150,594 cubic feet. Runoff from the east portion is contained by a natural ridge over 3 feet high. The west portion will require a berm with a design height of at least 2.5 feet.

h) South Compost Area (Required construction will be completed by December 31, 2013)

- Site area, square feet (acres): 2,118,148 (48.6)
- 100- year, 24 hour precipitation, inches: 2.4
- Runoff volume, cubic feet: 423,630

This area, shown in **Figure B8**, slopes to the south, with an average slope of about 2-3%. An upslope band of desert land varying in width from about 200-400 feet contributes run-on to the site. A berm (design height of 1.5 ft in diversion areas with ridge height such that maximum ridge elevation slopes toward the diversion outlet in a nearly uniform slope across one local impoundment area) will eliminate all possible run-on. The slope flattens at the base, giving a nearly-level area at least 100 feet wide. Land area beyond the base to the south is very low slope. Site area is 2,118,148 square feet. Using 100-year, 24 hour precipitation of 2.4 inches and a runoff coefficient of one (all precipitation runs off the compost area), the required storage is 423,630 cubic feet. A berm with a design height ranging from 3.0' (west portion) to 2.5' (middle portion) to 2.0' (east portion) across the base of the slope will be required to contain the runoff.

i) North heifer lots (Required construction will be completed by December 31, 2013)

The North Heifer Lots will be bermed, both at the north and south ends, to prevent run-on and runoff.

j) South Heifer Lots

k) The South Heifer Lots have a runoff collection pond west of the lots, where runoff evaporates.

4) Prevent the direct contact of animals confined or stabled at the facility with Waters of the United States. No direct contact exists between animals and Waters of the U.S.

5) Ensure that chemicals and other contaminants handled on-site are not disposed of in any manure, litter, process wastewater, or storm water storage or treatment system unless specifically designed to treat such chemicals or contaminants.

a) Chemicals and Other Contaminants Handled On-Site

i) Waste oil is generated at Shop 1 and the East Dairy Parlor (hydraulic system)

(1) Waste oil is collected in drums at Shop 1 and is picked up for recycling by Gordon Paving

ii) Antifreeze Waste is Generated at Shop 1

(1) Waste antifreeze is collected in the same waste oil drums at Shop 1 and is picked up for recycling by Gordon Paving

ii) Propane Tank (1,000 gallon) Locations-All are Protected by 2'x6'x2' Concrete Block Surround

(1) 1 at Office
(2) 4 are Behind West Dairy
(3) 4 are behind East Dairy
(4) 1 at Shop 1
(5) 1 at West Dairy Old Shop
(6) 1 at Wash Pad at West Dairy
(7) 1 at Shop by RR (FS 4)
(8) 1 at Dry Cow Facility

iii) Fuel Tank Locations

(1) West of Shop 1

(a) 3-1,000 gal tanks, 1-12,000 gallon silo

(i) Two tanks and silo contain on-road diesel

(ii) One tank contains gasoline

(b) Surrounded by concrete base and low wall for containment

(2) 1,000 gallon fuel tank at East Dairy with no containment

(3) 1,000 gallon fuel tank at south Compost Yard with no containment

iv) Equipment Wash down is done mostly at the Wash Pad west of the West Dairy, and occasionally at Shop 1.

v) Wash Pad Runoff flows to the West Dairy Lagoons.

vi) Shop 1 wash down runoff drains to a bermed pasture containment area southeast of Shop 1.

vii) Shop 1 runoff would primarily contain manure nutrients and soil.

6) Conservation Practices to Prevent Runoff

Please see Appendix B of the NMP for the site specific conservation practices that are or will be implemented to control runoff of pollutants to Waters of the United States. Appendix B lists which of the following practices will be applied on each field to control runoff of pollutants: Setbacks and buffers will be used around sensitive areas.

a) Sludge will not be applied to rock outcrops. Liquid manure is land applied through sprinklers to land with small areas of rock outcrops. Irrigation water management is carefully used to ensure there is no deep leaching to groundwater. Lagoon water will be mixed 1:4 with fresh water and applied only during the last one-third of each irrigation. These irrigations will only be done going into a low precipitation period. Compost will not be applied to rock outcrops, except in cases where it cannot be avoided, such as on fields with very frequent outcrops that still need nutrients for the crops. On these fields, irrigation water management will be carefully monitored to prevent deep leaching.
b) On sensitive fields, as listed in the NMP, compost applications will be incorporated into the soil within 72 hours after application to minimize potential for runoff and volatilization
c) Nutrients will be applied and managed in a manner that maintains or improves the physical, chemical, and biological condition of the soil.
d) Soil compaction and rutting (which often lead to runoff) will be prevented as much as possible by applying nutrients when the soil is not overly wet.
e) Crop uptake rates were used in the development of the NMP compost application rates, to help manage soil phosphorus levels. When the soil test P is between 40 and 80 ppm, compost will be applied at 75% of the crop phosphorus uptake rate. At soil test levels above 80 ppm, the application rate will be reduced to 50% of crop uptake.
f) Horizon Organic Dairy utilizes grid soil sampling to allow for varying nutrient application rates in different areas of each field.
g) Irrigation water management will be utilized on each field to help prevent runoff. See the IWM plan in Appendix I of the NMP.
h) Field application of compost or wastewater will be delayed, if possible, when precipitation capable of producing runoff is forecast within 24 hours of the time of the planned application.
i) HOD actively manages the soil/crop system to encourage the build-up of soil carbon.
j) Fall cover crops (alfalfa, pasture, red clover, barley) are utilized in the crop rotation to immobilize excess residual N and retain for future use.
k) Crop residue management is utilized to help prevent runoff.
l) Conservation crop rotation is used to help prevent runoff.
m) A 35' vegetated buffer or a 100' setback will be used around all well heads, downgradient waters of the U.S., or other conduits to waters of the U.S. There are no known sinkholes or down gradient tile line intakes on this property. If waste is land applied to a field, AND the Risk Assessment is high or greater, THEN additional BMPS are required. These are listed in Appendix B.

n) Please see Appendix B of the NMP for site specific conservation practices.

7) Protocols for Manure and Soil Testing

a) Compost, Sludge, and Lagoon Water Sampling and Testing

i) Compost, sludge, and lagoon water samples will be collected and prepared according to UI "Manure and Wastewater Sampling" (CIS 1139), Appendix E.

(1) Compost Testing; A minimum of eight subsamples will be taken from random locations across the mature compost rows at a depth of 18". These will be mixed well; a one-quart composite sample will be taken from this and placed in a zip lock bag to be taken to the lab for analysis.

(2) Sludge sampling; A twenty foot rod with a cup mounted on the end will be used to pull sludge samples at least six feet from the edge of the lagoon at a depth of 1 foot from the bottom. Eight samples will be taken around the lagoon and combined to take one subsample. This sample will be placed in a glass jar and taken to the lab for analysis.

(3) Wastewater Sampling; A fourteen foot rod with a cup mounted on the end will be used to pull lagoon water samples at least six feet from the edge of the lagoon at a depth of 1 foot. Eight samples will be taken around the lagoon and combined to take one subsample. This sample will be placed in a glass jar and taken to the lab for analysis.

ii) Manure, litter, and lagoon water samples will be analyzed by Stukenholtz Laboratory, Twin Falls, Idaho. This lab is NAPT certified and will use the testing protocols listed in Appendix F.

b) Soil Sampling and Analysis

i) Soil sampling on irrigated fields is done using a GIS-based five-acre grid sampling system.

(1) One composite sample is taken from eight sub-samples pulled within a six foot radius of the grid point for each five acre area. Samples will be taken at 0-12" and 12-24". Once every five years, ISDA requires 18-24" samples on fields designated as ground water resource concerns, so these will also be taken. For the nutrient budget on each field, the grid samples can be averaged over each field, or can be developed for each grid area.

(2) Soil samples will be analyzed by Agsource Harris Laboratories. This lab is NAPT certified and will use the testing protocols listed in Appendix G.

8) Protocols for Land Application of Manure (Compost), Lagoon Sludge, and Waste Water

a) Annual Nutrient Budget

i) Soil and manure analysis data will be used to develop an annual nutrient budget beginning with the first crop year after issuance of the Permit.

ii) The *Manure Application Rate Requirement by Year* begins on page 19 of the NMP.

iii) The waste application rates will be reduced as described on page 19 of the NMP on fields on which the phosphorus level in the first foot is over 40 ppm.

b) Compost

i) Compost will be spread using a manure spreading truck, either evenly over each field based on the whole field average phosphorus level, or spread according to the grid sampling data, with higher application in areas with the lowest soil test phosphorus.

ii) On fields with a high risk rating or adjacent to irrigation drains, compost will only be applied when it can be incorporated within 72 hours. On pastures and alfalfa,

incorporation is done using an Aerway Aerator on the field. On other cropland, incorporation is done by running a disk through them.

(1) Fields with a high risk rating are listed in Appendix B of the NMP.

(2) Fields adjacent to the Main Drain or to an irrigation drain flowing into the Main Drain are listed in Appendix B of the NMP.

iii) Setbacks and buffers will be used as described in the NMP around irrigation drain ditches and wells. These areas will receive no land applied nutrients.

iv) Application of nutrients on rock outcrops will be avoided whenever feasible.

v) On fields that are not a high risk or adjacent to irrigation drains, compost will be applied in the winter when the weather is dry and there is little risk of runoff.

(1) Land will either have a winter crop (alfalfa, pasture grass, barley, red clover), or will have a very rough surface (after corn) to prevent runoff.

(2) Compost on these fields will be incorporated using a disk or aerator (on pasture and alfalfa) early in the spring.

vi) Waste and fertilizer application equipment will be calibrated to ensure recommended rates are applied.

c) Lagoon Sludge

i) Lagoon sludge is pumped from the bottom of the Lagoon and from the Settling Basins into a truck, and then is land applied by injecting twelve inches deep through an injector behind a tractor with a drop hose.

ii) Lagoon sludge is also taken to the compost piles and applied to the top of the piles.

iii) The NMP describes the conditions under which sludge is land applied or is applied to compost piles.

d) Lagoon Water

i) Lagoon water is applied evenly over the crop growing season through pivots to fields 500 to 507, 432, and 433.

ii) Lagoon water is mixed with clean water in a 1:1 ratio.

iii) Lagoon water is applied so that there is no runoff from these fields.

e) Emergency Application—See Appendix A.

f) Yearly Nutrient Budgets will be developed for each field based on soil and manure test results.

g) Additional organic by-products may be added as needed and as detailed in the Annual Nutrient Budget.

9) Record Keeping

All records required and listed on pages 31-33 of the NPDES Permit will be recorded and kept on-site. An Annual Report will be submitted containing the information listed on page 36 in the NPDES Permit. This will be submitted to EPA, with a copy to ISDA.

Appendices

Appendix A. Emergency liquid manure application

Appendix B: Hydrologic Analysis

Appendix C. Scheduled Construction

Appendix D. Implementation of Conservation Measures

Appendix E. University of Idaho Manure and Wastewater Sampling CIS 1139

Appendix F. Manure Testing Protocols at Stukenholtz Laboratories

Appendix G. Soil Testing Protocols at Agsource Harris Labs

Appendix A

Emergency liquid manure application:

From the USDA-NRCS 590 Standard (2007):

"Nutrients shall not be applied to frozen, snow-covered or saturated soil if the potential risk for runoff exists." This precludes spreading on:
• frozen and/or snow-covered soils, and
• when the top 2 inches of soil are saturated from rainfall or snow melt.
if the potential risk for runoff exists. The potential for runoff can be minimized by using winter cover crops and turning the soil so that a very rough surface is present in the winter.

Exceptions for the above criteria can be made for surface-applied manure nutrients when specified conditions are met and adequate conservation measures are installed to prevent the offsite delivery of nutrients. The adequate treatment level and specified conditions for winter applications of manure nutrients must be defined by NRCS in concurrence with the water quality control authority in the State. At a minimum, the following site and management factors must be considered:
• slope,
• organic residue and living covers,
• amount and form of nutrients to be applied, and
• adequate setback distances to protect local water quality. "

West Dairy:

With re-routing of upslope runoff around the dairy and into a new bypass channel, the lagoon storage at the west dairy is more than adequate to contain any runoff from the dairy footprint. Therefore, need for emergency liquid manure application is not anticipated. If required, the application area would be the center portion of field 140, which is a closed basin.

East Dairy:

If emergency liquid manure application is required at the East Dairy, liquid can be applied to fields 500-507 and 432 and 433 through an existing liquid piping distribution system. These fields are all irrigated grass pasture which provide permanent cover and minimize runoff potential. Fields selected for possible winter land application will have minimal slope. Given these requirements, the best fields are 504, 505, and 506. These are all permanent pasture with minimal slope and located to give the longest distance from the Main Drain.

Figure A1 will serve as an operating curve for lagoon management. The curves shown are for total lagoon capacity, total – design storm runoff volume, and the daily wastewater generation. The need for emergency application will be indicated at times when the storage remaining in the lagoon is less than the anticipated wastewater generation plus design storm precipitation and runoff from the dairy footprint (shown by the "days to full" curve in Figure A1).

Irrigation water management on the designated fields will anticipate the need for possible winter wastewater application by keeping soil moisture as low as possible without reducing pasture growth or overall health in the late-fall pre-dormancy and dormancy periods. Managing in this way will maximize the potential for storage of winter precipitation and wastewater application. Irrigation management on these fields will be aided by portable soil water content meters and/or soil moisture sensors and data loggers to determine soil water content and remaining

water-holding capacity in the crop root zone. For additional discussion see "SCHEDULING WINTER LAND APPLICATION OF LAGOON EFFLUENT BASED ON ET, PRECIPITATION AND SOIL MOISTURE" by Howard Neibling (Presented at the 2010 University of Idaho Nutrient Management Conference, Shoshone)

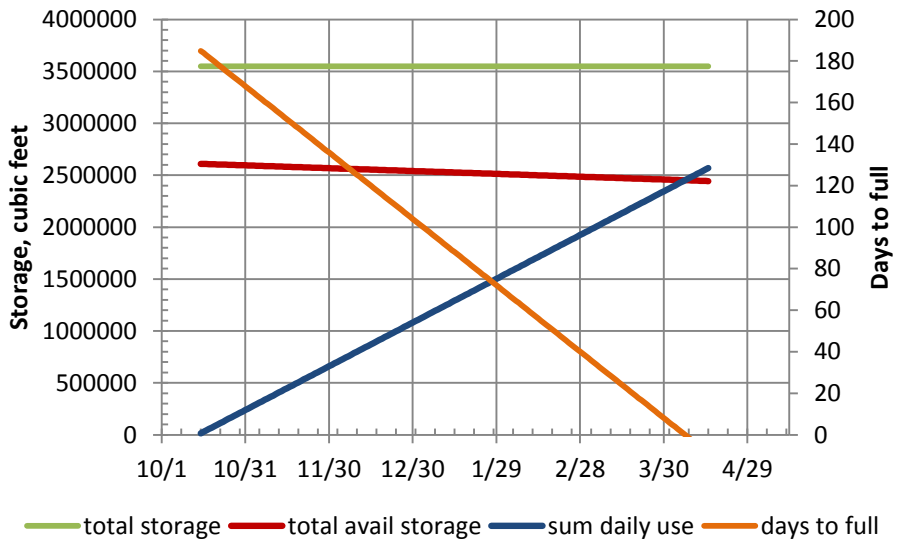

Figure A1. East dairy lagoon storage and cumulative lagoon loading due to daily water inflow. **Curves assume 105000 gallons per day water use.** Days before available lagoon storage –room for design storm runoff is exceeded are shown in the orange curve.

In: Proc. of the 2010 Nutrient Management Conference, Shoshone, ID

SCHEDULING WINTER LAND APPLICATION OF LAGOON EFFLUENT BASED ON ET, PRECIPITATION AND SOIL MOISTURE

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ABSTRACT

Proper management of liquid livestock manure must consider all aspects of production, storage, treatment and land application as one system to maximize agronomic benefits and minimize the potential for odor production and environmental degradation. Judicious winter land application of lagoon effluent is an important component in the overall management plan because it can reduce odor production during the land application process and reduce the volume of odor-producing lagoon water in storage in the spring as the temperature warms and biological activity increases. From an environmental perspective, liquid waste may be applied on pasture ground or cropland all year as long as no deep percolation or runoff occurs. Because of low temperatures, winter application assures that N and P initially in organic, difficult-to-transport forms remain in those forms until temperatures rise in the spring and plant uptake increases.

INTRODUCTION

Regardless of the care involved in planning and facility management, sometimes circumstances beyond the dairyman's control require winter land application of lagoon effluent to avoid overtopping the lagoon embankment. Overtopping carries a significant risk of embankment failure and the resulting uncontrolled release of large quantities of effluent. Therefore, a scientifically sound method of determining when and how much effluent can be applied is needed. Such a method must assure that no runoff occurs and that the soil profile of the receiving field will not be hydraulically overloaded. Elimination of runoff assures that nutrients will be contained on the application site, and not hydraulically overloading the root zone minimizes possible movement of crop nutrients below the root zone.

Three factors determine when and how much lagoon effluent can be applied to a receiving field. These are ET, precipitation and available soil moisture storage in the crop root zone. A deep- rooted crop on a deep, high water holding capacity soil will allow more flexibility in land application than will a shallow or light-textured soil. The pattern of winter precipitation compared to the pattern of ET determines which months may be appropriate for land application. This information, in addition to the active root zone depth for the crop planted, and water holding capacity – soil moisture relationships, can be used to determine the depth of water that could be applied without deep percolation for any measured soil moisture content.

METHODS

This paper uses existing data collected by Dr. James Wright, USDA-ARS, and standard hydrologic analyses to develop strategies for land application of lagoon effluent. Measured cumulative ET from bare soil and grass, 30-year average daily precipitation and monthly average precipitation for the 5 years of study at Kimberly, Idaho are shown in Figure 1. These data show an excess of about 0.75 inches in grass ET relative to average precipitation over the October – March period. ET is greater than precipitation for October and March while precipitation exceeds ET for the winter months. Similar data for a “low snow year” are shown in Figure 2 and for a “high snow year in Figure 3. For a low

snow year, ET is greater than precipitation for the entire winter. In this case, even with a full soil profile on October 1, some lagoon water could be applied without deep percolation. In a high snow winter, however, cumulative precipitation exceeded ET from both alfalfa stubble and grass for the winter period. In this case, land application except to an initially dry, deep high water holding capacity soil should not occur before mid-winter. Comparison of the precipitation data points for the years studies and for the 30-year average (solid line) indicate that precipitation for the study period was representative of that from the entire record.

Curves in Figures 4, 5, 6 and 7 can be used with appropriate soil moisture information to decide how much effluent can be added after January 1 for either bare soil or grass conditions. As shown in Figure 4, precipitation exceeds ET for January and February. However, Figure 4 would indicate that if about 0.75 inches of available root zone storage was available on January 1, no water would move below the root zone during the remainder of the winter. That is, the maximum difference between cumulative precipitation and grass ET is about 0.75 inches at any point from January 1 to the end of March. Any root zone storage in excess of 0.75 inches could be used to store lagoon water without risk of deep percolation under average conditions for the remainder of the winter. Figure 4 also indicates that for bare soil conditions, precipitation exceeds ET by only about 0.4 inches, and this occurs in January. Thus, for bare soil conditions land application could occur if more than 0.4 inches of available soil moisture storage was available.

As time passes, less of the winter precipitation is yet to come so uncertainty is less. For example, in Figure 5 if more than 0.45 inches of root zone storage is available on January 15, the excess storage could be used for lagoon water. Corresponding values of 0.2 inches for February 1 and 0.1 inch for February 15 can be obtained from Figures 6 and 7, respectively.

Therefore, the information required for determination of the maximum depth of lagoon water to apply on any date is the type of cover, current crop (if applicable), future crop and rooting depth, and the water content of the root zone (or future root zone) based on soil moisture measurements at 6-inch depth increments. Soil moisture content may be determined by sampling and oven drying, use of USDA-NRCS publication “Estimating Soil Moisture by Feel and Appearance” (USDA-NRCS, 1998), or by any of a number of matric potential or soil moisture by volume sensors. University of Idaho personnel can provide information to convert any of these measurements into remaining available soil moisture in the root zone.

Soil Moisture Sensors: Granular matrix (Watermark) soil moisture sensors are the preferred sensing device since they have been used successfully in irrigation scheduling research for a number of years, are relatively inexpensive, and will give valid readings beneath a frozen soil surface. These devices measure soil matric potential, and indirectly, soil water content. As long as soil matric potential levels indicate drier soil conditions than field capacity, almost no saturated flow below the root zone can occur. These or other equivalent devices should be installed at three randomly selected locations, representative of topographic conditions, in each field where winter land application is desired. Three should be placed at the 12" depth and three at the 24" depth. Because of evaporation, the moisture gradient will be upward except during a few large precipitation events (saturated flow). Therefore, any unsaturated flow will be upward.

Monitoring: An independent third party should monitor soil moisture levels as indicated above and check these sensors periodically to be sure they are working properly. Soil moisture levels will be monitored monthly and before and after lagoon water application. The purpose of monitoring is to determine at those times when land application is desired, both the soil moisture storage available in the soil profile, and the degree of soil saturation. At other times, sensors can indicate conditions where deep leaching may occur but cannot indicate if leaching did occur and the amount of leaching. The best estimate of leaching is spring soil testing to determine nitrate and phosphorus concentrations with depth, and analysis of trends over time. Yearly soil testing will be used to evaluate the potential movement of nutrients below the root zone.

RESULTS AND DISCUSSION

The procedure for determination of maximum depth of lagoon water to apply on any date would then be:

1. Sample or read instruments and determine remaining available soil moisture in the root zone depth,
2. From the appropriate figure (Fig. 4-7) for the date and soil cover type, determine the minimum soil moisture storage required to contain the remainder of expected winter precipitation,
3. Determine any excess storage available for land application,
4. Determine pivot speed required for land application of the desired depth and apply subject to the following constraints:
   - Do not apply on frozen ground or snow if application depth is greater than 0.15 inches
   - Do not apply more than 0.5 inches total during the winter to minimize potential infiltration problems due to accumulation of small organic particles on the soil surface,
   - The total depth of lagoon effluent applied during the year should be limited by agronomic uptake rates as specified by an approved nutrient management plan.
   - If odor problems during land application have been a historic problem at this site, use drop hoses to release water about one foot above the soil surface. Drag hoses may reduce odor a bit more but will apply water less uniformly and with an increased risk of runoff on the outer spans of the pivot.

REFERENCES

USDA-NRCS. 1998. Estimating Soil Moisture by Feel and Appearance. Program Aid # 1619. U.S. Dept. of Agric. Natural Resources Conservation Service. 12pp.

Wright, J.L. 1993. Nongrowing Season ET from Irrigated Fields. In: “Management of Irrigation and Drainage Systems”. Symposium Proceedings. Park City, UT July 21-23. Pp 1005-1014.

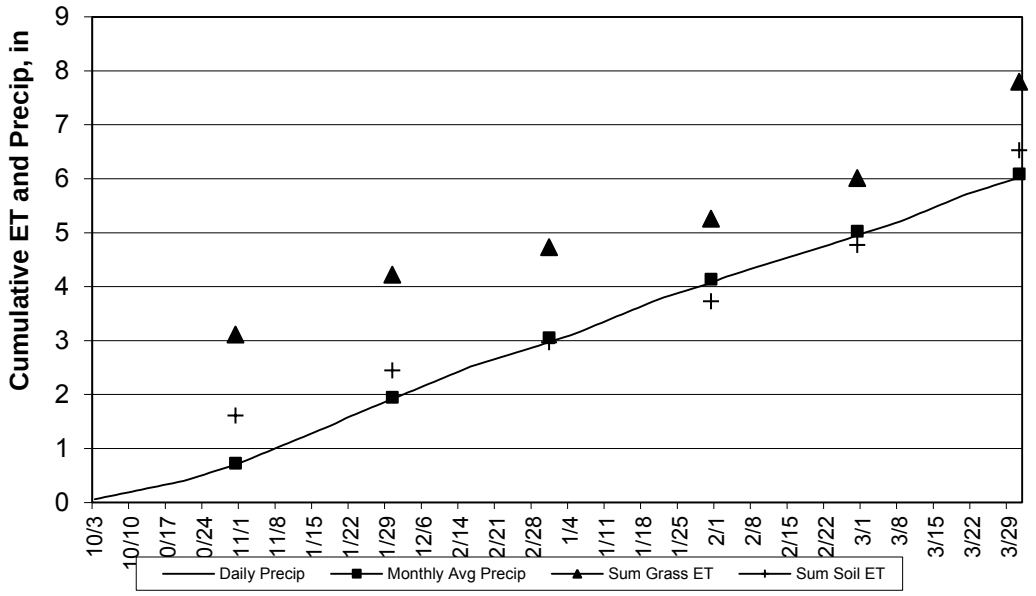

Figure 1. Cumulative October – March ET and precipitation. ET data from lysimeter studies at Kimberly, ID (Wright, 1993).

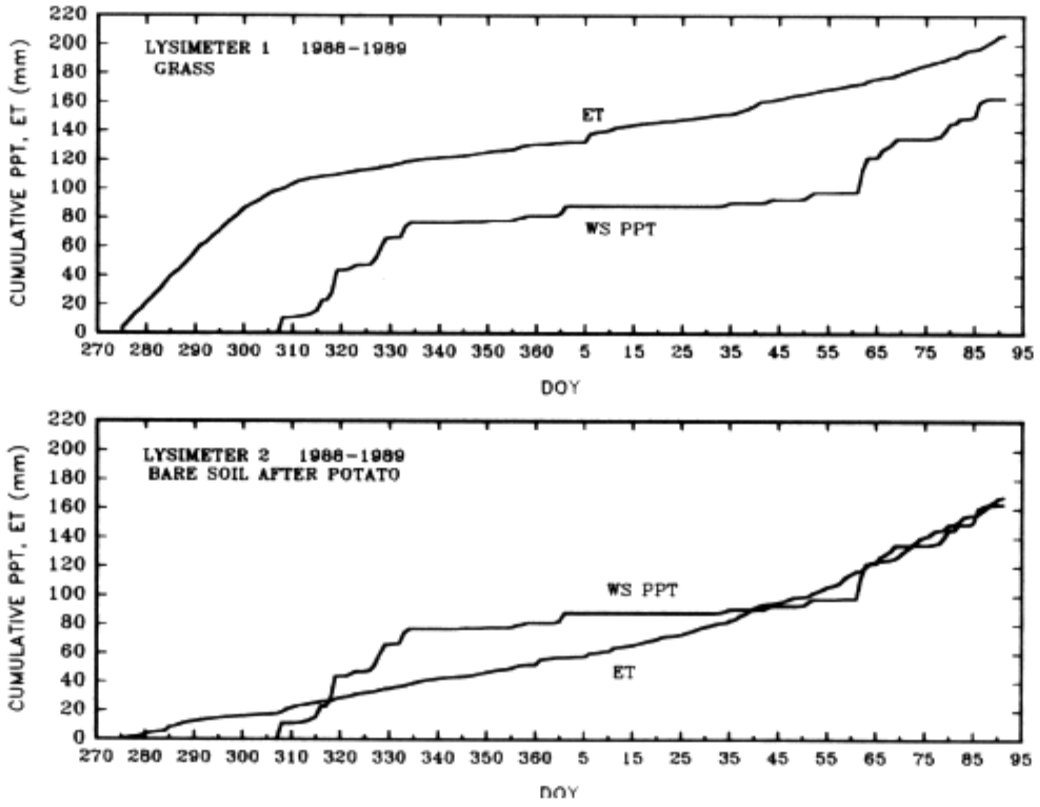

Figure 2. Non-growing season cumulative precipitation and ET for a low snow season (From Wright, 1993)

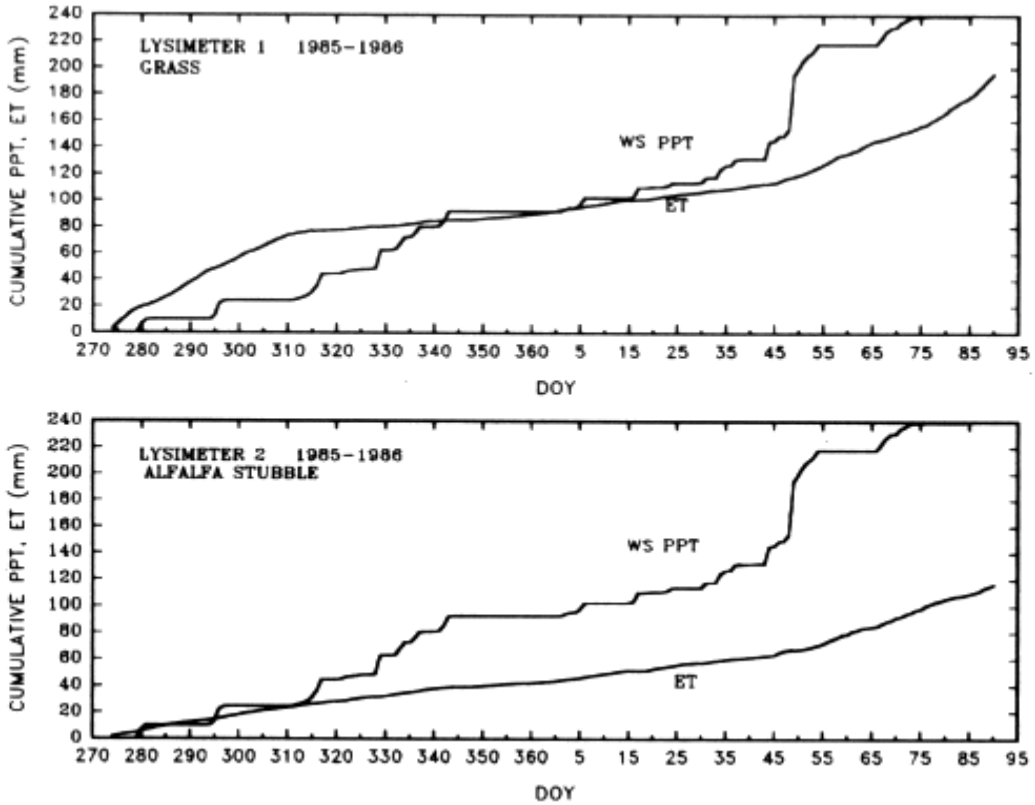

Figure 3. Non-growing season cumulative precipitation and ET for a high snow season (From Wright, 1993)

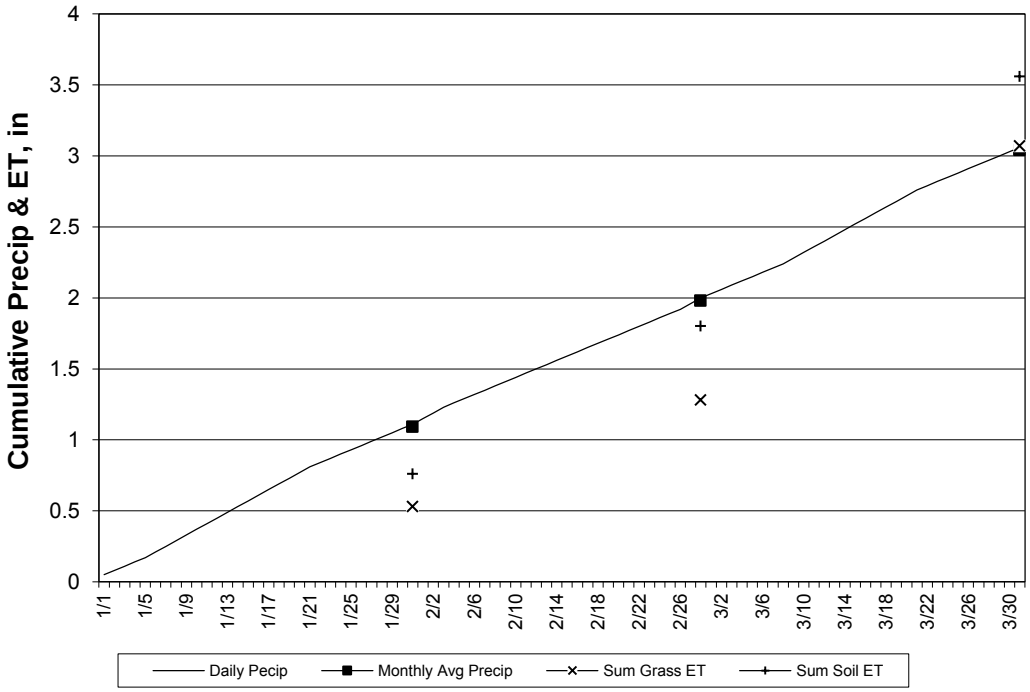

Figure 4. Cumulative January 1– March ET and precipitation. ET data from lysimeter measurements at Kimberly, ID (Wright, 1993).

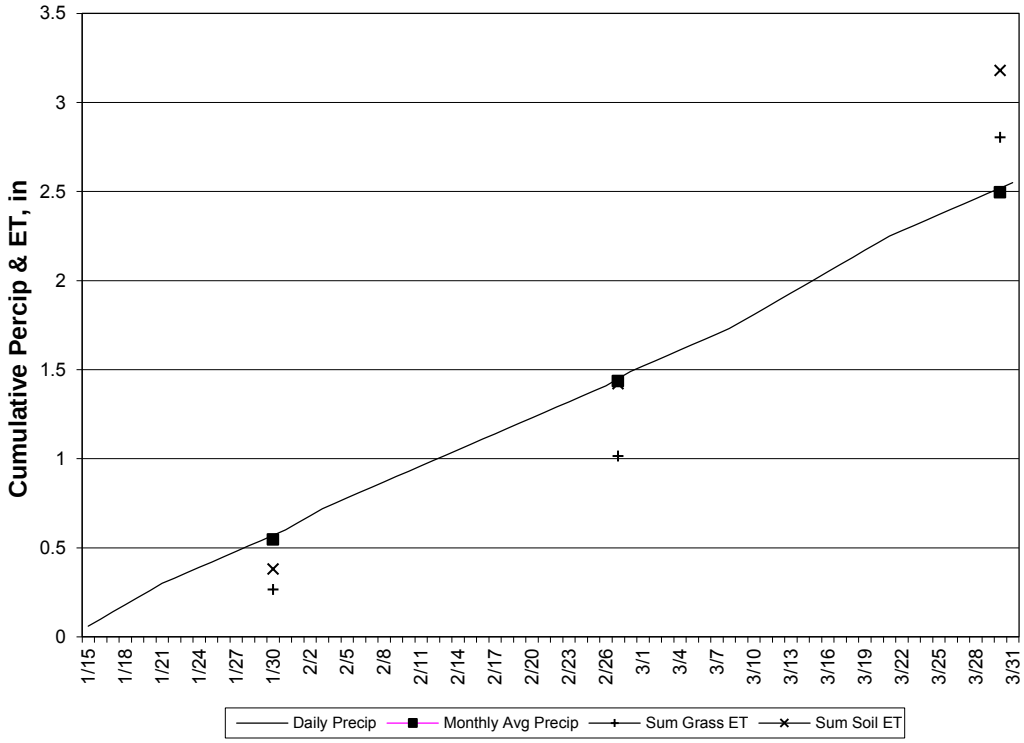

Figure 5. Cumulative January 15– March ET and precipitation. ET data from lysimeter measurements at Kimberly, ID (Wright, 1993).

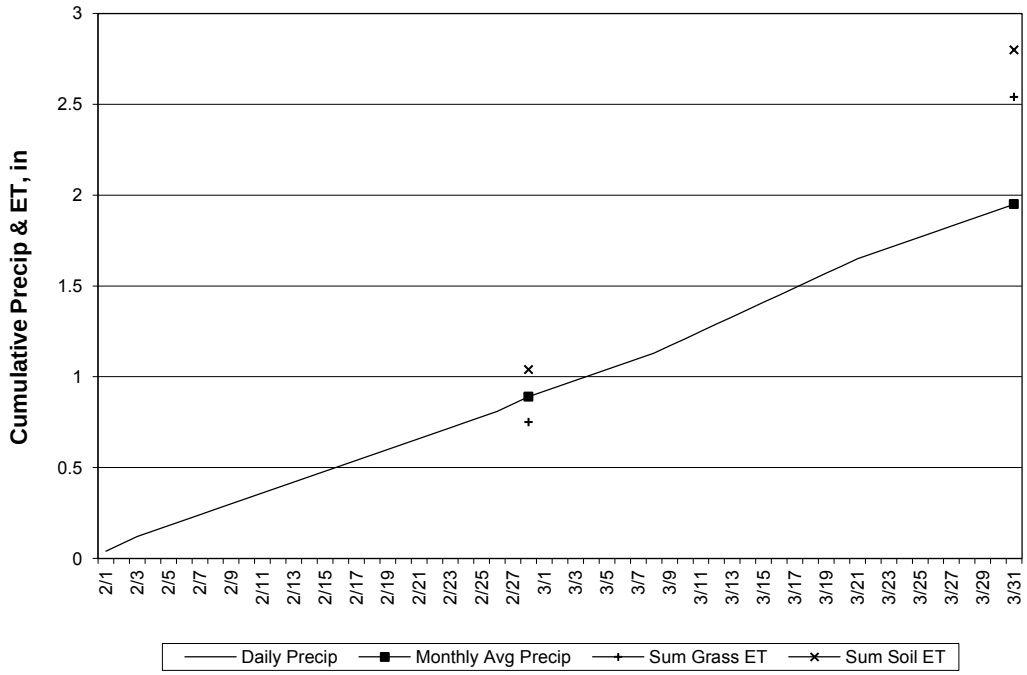

Figure 6. February 1 – March cumulative ET and precipitation. ET data from lysimeter measurements at Kimberly, ID (Wright, 1993).

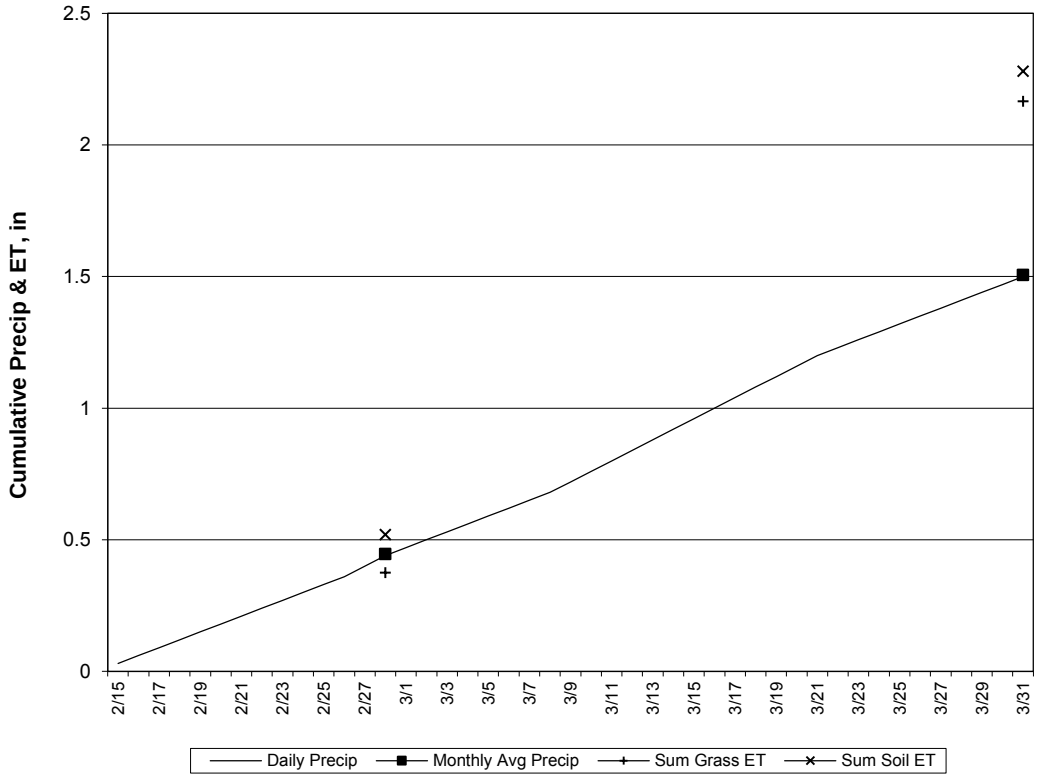

Figure 7. Cumulative February 15 – March 30 ET and precipitation. ET data from lysimeter measurements at Kimberly, ID (Wright, 1993).

Run-on entering north side of West Dairy from upstream watershed:The watershed area above the West Dairy is shown in **Figure B1**. This topographic map was created to define the watershed boundary upstream of the entrance of the A and B Irrigation District Main Drain ditch as it entered the north side of the dairy. The boundary was checked with field investigation along most of the watershed boundary. Watershed area was determined to be approximately 50 square miles.

The majority of the watershed area is composed of sagebrush/forb/grass rangeland. Topography is highly variable and contributes to many areas of small-scale runoff storage. The soils vary from significant rock at or near the surface to productive irrigated fields. Watershed slope is greatest on the north end downslope of several buttes and flattens toward the outlet.

In the past, watershed runoff from large winter storm events flowed down the A and B Irrigation District main drain and crossed the E 500 S road between feed storage area 1(FS1) on the dairy and the residence to the east. The nearly flat portion of field 140 just east of the dairy was covered with water. The existing A and B wastewater ditch flowing through the dairy was unable to handle the large volume of runoff water since it was designed to carry only expected drain water. Culvert capacity entering the dairy is about 46 cfs. Downslope culverts vary in capacity but the maximum flow that can pass through the drain is about 50 cfs.

For the purpose of this analysis, the most severe condition for runoff would be in the winter with rain falling on frozen ground. Under this condition, which has occurred in several recent years, almost no water can infiltrate, producing a high ratio of runoff to precipitation. Factors that would tend to reduce runoff volume and peak rate under these conditions are presence of local areas of depression storage due to variable topography and elevated roadbeds with no culverts.

Peak runoff rate was determined using the USDA-NRCS TR55 computer-based hydrologic model. Relevant inputs are watershed area, slopes and roughness of the overland flow, shallow channel and channel flow regions, antecedent soil moisture condition(I, II or III), soil intake index(A, B, C, D) and runoff curve number, based on cover, soil and antecedent moisture. The soils in this area are primarily class C (moderately high runoff potential). For rain on snow or frozen soil conditions, class D (high runoff potential) and antecedent moisture condition III (very wet soil before the event) was used. The 25-year 24-hour storm for this area was 2.0 inches, based on USGS maps. For these conditions, a peak runoff rate of 6100 cfs was calculated. This far exceeds the capacity of the A and B ditch and generally supports the observed flooding events. Therefore, a run-on control structure is proposed to route water above the ditch capacity across E 500 S road. Two berms, shown in **Figure B2**, will be constructed to guide this water through field 140 to a new channel with the entrance south of the current drain ditch. This new channel will allow all run-on water to bypass the dairy lots and lagoons.

Feed Storage 1 (FS1): This site shown in **Figures B2 and B3** is composed of a number of bunker silo trenches excavated into the hillside on the east side of the farm road and several above-ground silage piles on the west side of the road. Amount of run-on water is minimal in both areas since the upslope end is very close to the top of the ridge. Drainage area is 16.1 acres. Runoff from the east portion of the site is

collected by an existing berm across the bottom end, as shown in **Figure B3**. This berm should be enlarged and additional berming installed to direct runoff into an existing lagoon at the base of the slope. Runoff water will be temporarily stored until evaporation in an area upslope of the south berm of the new bypass channel.

Feed Storage area 2 (FS2): This site, also shown in **Figures B2and B4**, is located along the western border of the west dairy footprint. Large bales of hay and straw are stored in this area. Drainage area is 18.8 acres. Slope is to the south, and any runoff flows into Lagoon #1. Lagoon storage is adequate. Existing berming should be upgraded to more reliably carry runoff from field 145 to Lagoon #1.

Feed Storage 3 (FS3): This site, located at the north end of the West Dairy, is shown in **Figures B2 and B5**. Drainage area is 6 acres. It slopes to the east and has a has a blacktop surface covering. Runoff is directed by berms along the north and south sides toward the east end, just beyond the hardsurface area. Runoff flows into this low area and into a vertical standpipe from which it is pumped into a liquid transport and emptied into Lagoon 4. For larger storm events, runoff temporarily backs up onto the blacktop apron until it is removed by pumping.

Feed Storage 4 (FS4): is shown in **Figure B6**. It contains metal grain storage bins, a feed mill and liquid feed supplement tanks. It is located adjacent to, and on the south side of the railroad tracks. Because the grain and liquid supplements are in sealed storage, potential for any contamination of surface water on the site is low. Run-on is minimal and runoff will flow from the site to the southwest and into a closed basin area of the adjacent desert.

Feed Storage 5 (FS5): This area, shown in **Figure B6**, is where the baby calf rations are mixed. The milk replacer powder is stored in sealed containers in the building on site. Water and detergent from mix container and feed bottle cleanup goes into an underground storage tank and is then pumped out into the dry corner through one hand line. The daily hydraulic loading due to this small amount of water is applied over a sufficiently large area that no runoff occurs. Should runoff from precipitation ever occur, it will be contained in a natural basin about ¼ mile down-gradient.

North Compost Area

- Site area, square feet (acres): 752,970 (17.3)
- 100- year, 24 hour precipitation, inches: 2.4 inches
- Runoff volume, cubic feet: 150,594

This area, shown in **Figure B7**, slopes to the northwest with an average slope of about 3-4%. It is located so that the top of the site is at the peak of the ridge, nearly eliminating run-on. A small berm (ridge height of 1 ft) will eliminate all possible run-on. The slope flattens at the base, giving a nearly-level area at least 100 feet wide on the west half and at least 50 feet wide on the east half. Site area is 752,970 square feet. Using 100-year, 24 hour precipitation of 2.4 inches and a runoff coefficient of one (all precipitation runs off the compost area), the required storage is 150,594 cubic feet. Runoff from the east portion is contained by a natural ridge over 3 feet high. The west portion will require a berm with a design height of at least 2.5 feet.

<u>South Compost Area</u>

- Site area, square feet (acres): 2,118,148 (48.6)
- 100- year, 24 hour precipitation, inches: 2.4
- Runoff volume, cubic feet: 423,630

This area, shown in **Figure B8**, slopes to the south, with an average slope of about 2-3%. An upslope band of desert land varying in width from about 200-400 feet contributes run-on to the site. A berm (design height of 1.5 ft in diversion areas with ridge height such that maximum ridge elevation slopes toward the diversion outlet in a nearly uniform slope across one local impoundment area) will eliminate all possible run-on. The slope flattens at the base, giving a nearly-level area at least 100 feet wide. Land area beyond the base to the south is very low slope. Site area is 2,118,148 square feet. Using 100-year, 24 hour precipitation of 2.4 inches and a runoff coefficient of one (all precipitation runs off the compost area), the required storage is 423,630 cubic feet. A berm with a design height ranging from 3.0’ (west portion) to 2.5’ (middle portion) to 2.0’ (east portion) across the base of the slope will be required to contain the runoff.

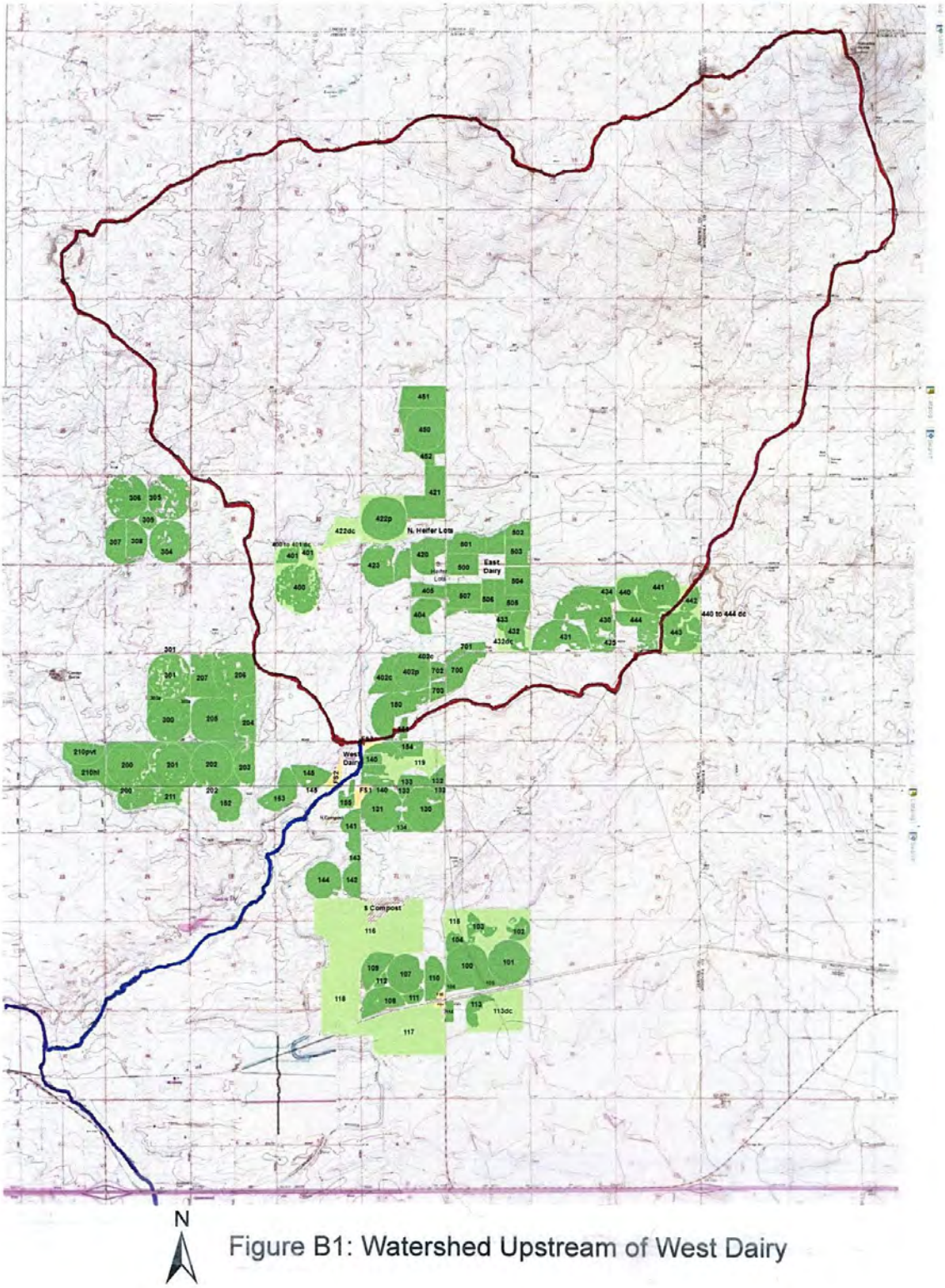

Figure B1.

Watershed upstream of the West Dairy. Boundary is shown in red. The A&B Main Drain passing through the West Dairy is shown in blue. The North Side Canal is shown in the lower left in purple.

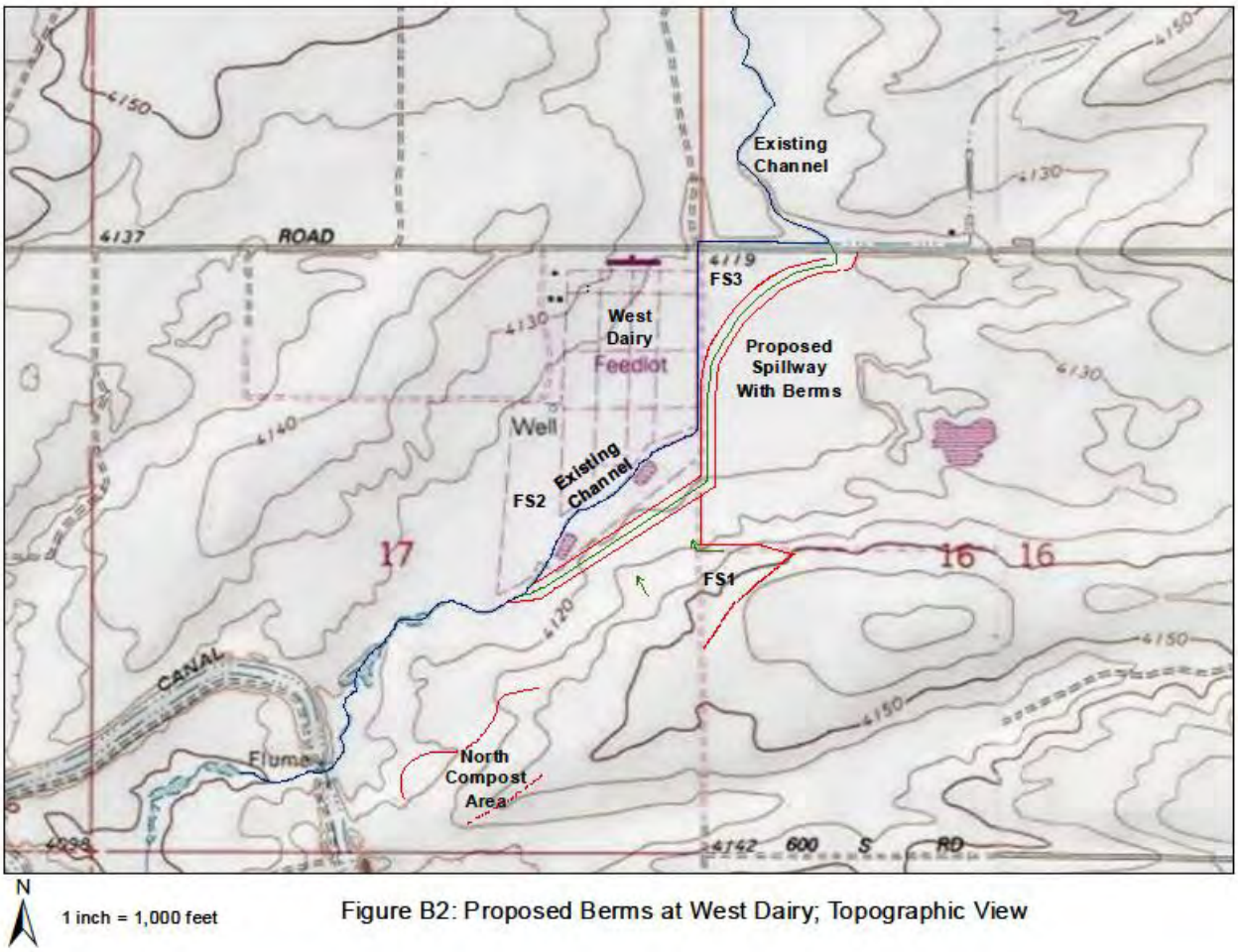

Figure B2 Overview of Feed Storage Areas 1-3 and proposed berms at West Dairy; topographic view.

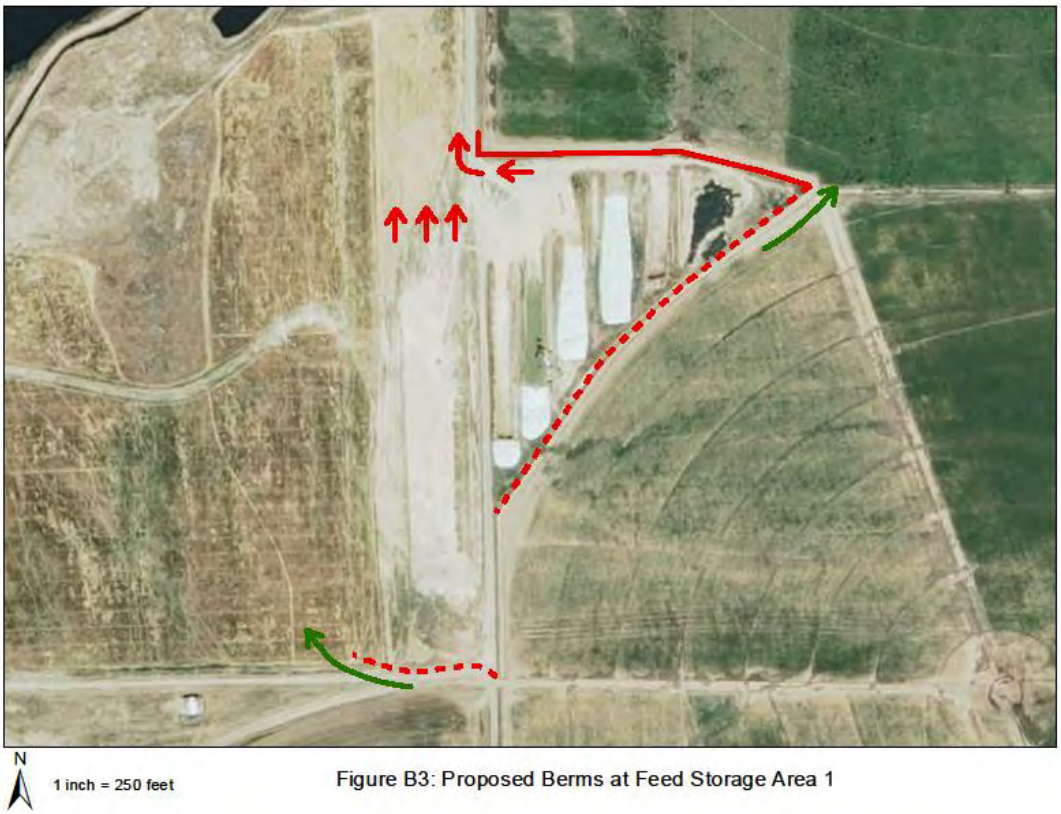

Figure B3. Proposed berms at Feed Storage Area 1.

Figure B4. Current berms requiring enlargement at Feed Storage Area 2.

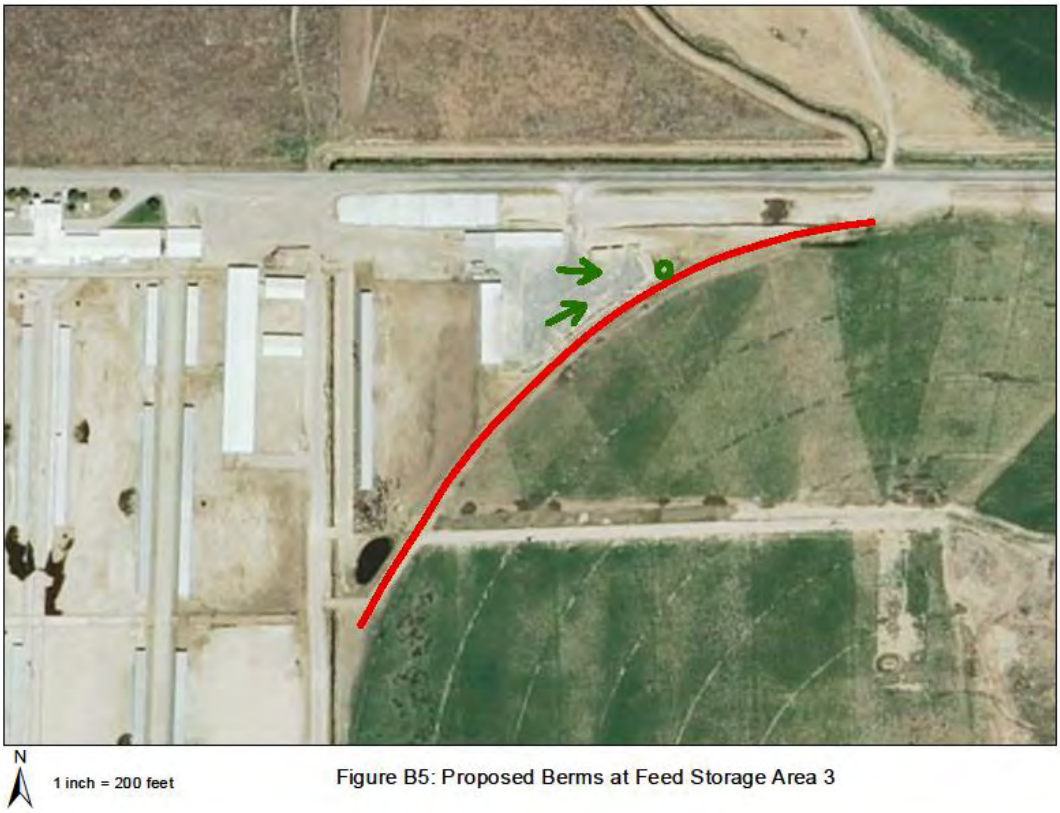

Figure B5. Proposed berm to prevent large storm runoff from entering Feed Storage Area 3.

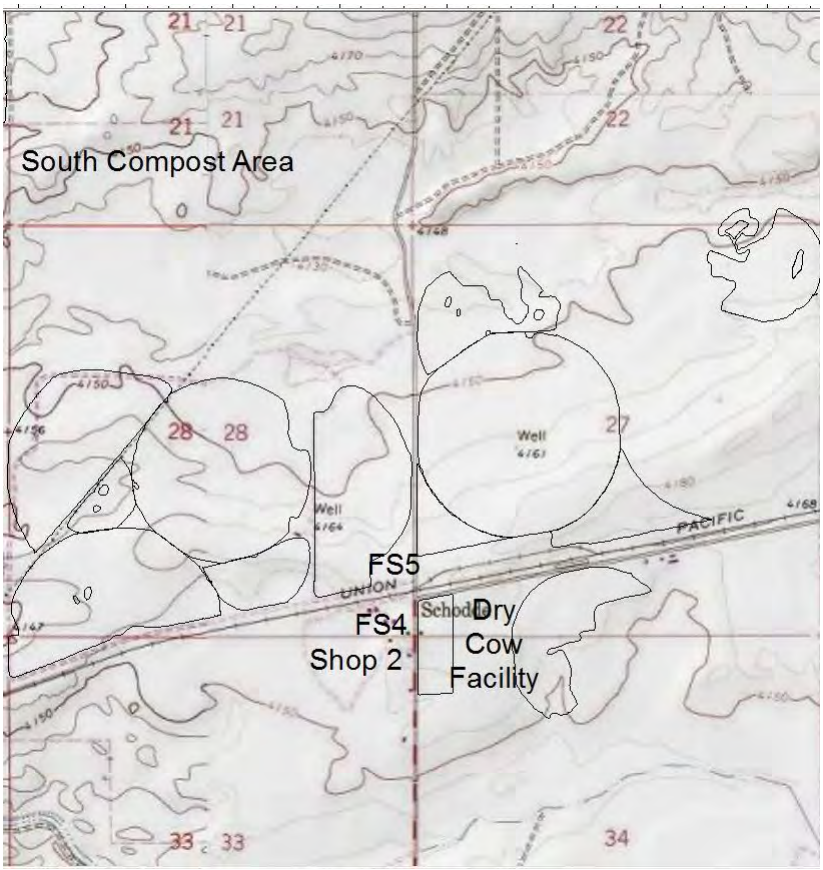

Figure B6. Feed Storage Areas 4 and 5.

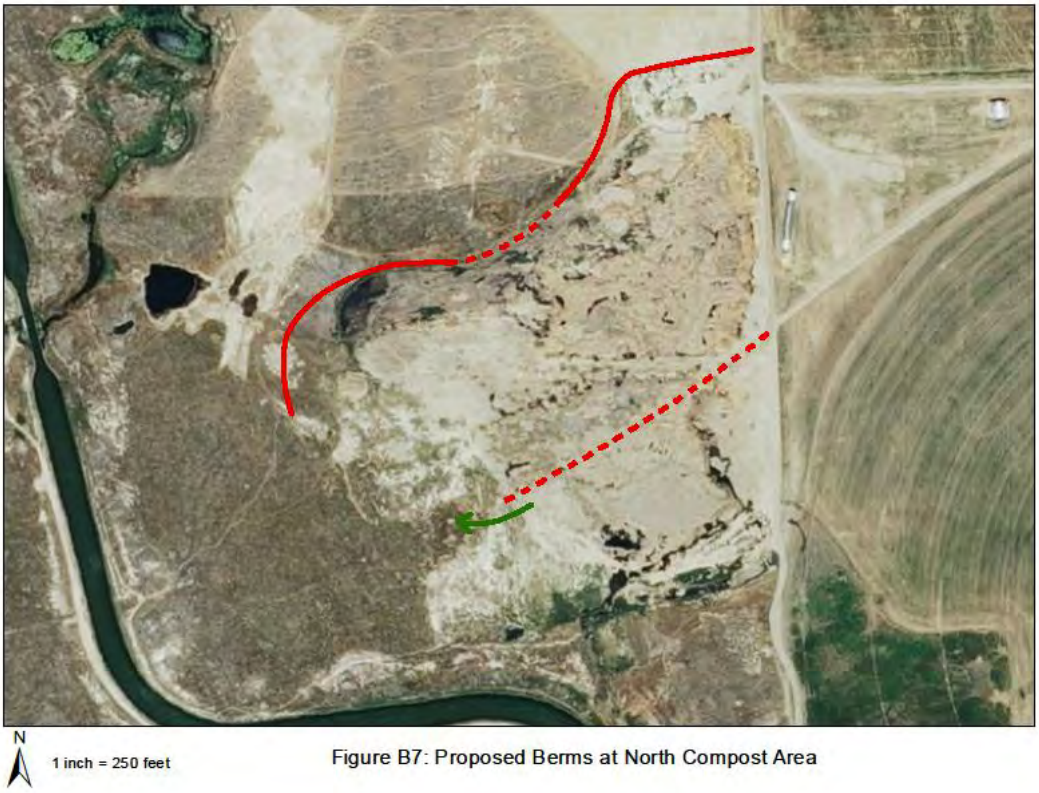

Figure B7: Proposed Berms at North Compost Area

Figure B7. Proposed berms at the north compost area. Solid line is containment berm. Dashed line is diversion berm to prevent run-on.

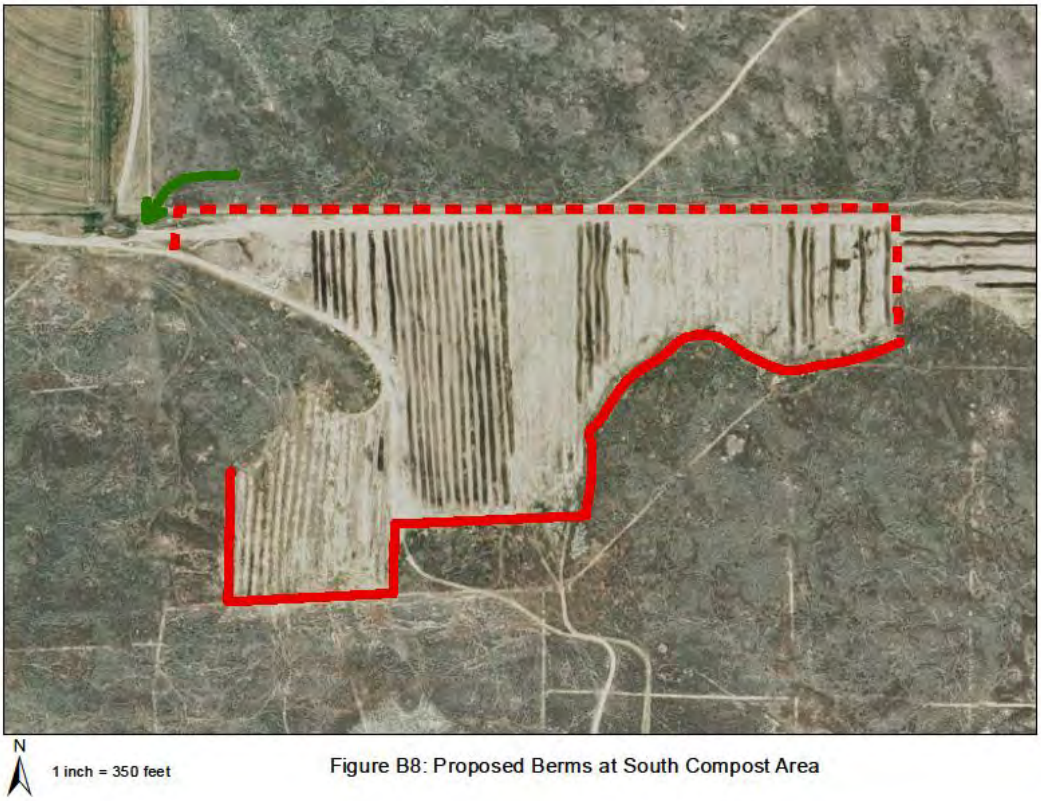

Figure B8. Proposed berms at the south compost area. Solid line is containment berm. Dashed line is diversion berm to prevent run-on.

Appendix C. Scheduled Construction

Area	***Work to be Completed***
Feed Storage Area 1	Berms will be designed and constructed or amended as discussed in the Hydrologic Analysis. This will be completed by December 31, 2013
Feed Storage 2	
Feed Storage Area 4 Runoff Storage	
Feed Storage Area 5 Runoff Storage	
North Compost Area Runoff Storage	
South Compost Area Runoff Storage	
Heifer North Facility	
Heifer South Facility	
Run-on to Heifer North Facility	
Reconstruct Main Drain Northeast, East and South of West Dairy	

Appendix D. Implementation of Conservation Measures

All conservation measures will be in place no later than December 31, 2013.

All Wells downslope of fields receiving any form of animal waste will have either a 35' vegetated buffer or a 100' setback

The following Fields are adjacent to the Main Drain or to a ditch draining to the Main Drain and will have a 35' vegetated buffer (VB) and/or berming (B). Compost will only be applied to these fields when it can be incorporated by chiseling, plowing, or conservation tillage (on pastures it will be aerated) within 72 hours.

140 Berm when new path for Main Drain is built

144 VB on northwest side

150p VB (in field) along Main Drain

150c VB at southwest corner adjacent to ditch flowing to the west

155 VB at north end adjacent to Main Drain

405 VB at north end adjacent to drainage ditch

420 VB at north and south ends

421 Berm along south side to prevent runoff from flowing into the North Heifer Lots

422p VB at southeast corner

423&424 VB on both sides of Main Drain flowing through field

430 VB along drain ditch

431 VB along drain ditch

434 VB along drain ditch

440 VB along drain ditch

441 VB along drain ditch

501 VB along drain ditch

502 VB along drain ditch

504 VB on west side of 507

505 VB on west side of 507

506 VB on west side of 507

507 VB on west side of 507

601 VB on south side

BMP's Used on Horizon Organic Dairy

Cropland after corn Chiseling and Subsoiling

Cropland after barley Conservation Cover, Cover/Green Manure Crop

All Cropland Conservation Tillage, Crop Rotation, Residue Management, Sprinkler System, Irrigation Management, Berm, Vegetative Buffer or Filter Strip

All Permanent Pasture Grazing Land Mechanical Treatment- Aerway Pasture Aerator, Prescribed Grazing, Watering Facility, Sprinkler System, Irrigation Management, Berm, Vegetative Buffer or Filter Strip, Conservation Cover

Dairy Sediment Basin

Dairy Composting Facility

Appendix E.

University of Idaho Manure and Wastewater Sampling
CIS 1139

University of Idaho
College of Agricultural and Life Sciences

CIS 1139

Manure and Wastewater Sampling

by Ron E. Sheffield and Richard J. Norell

Nutrient concentrations vary within most types of manure. A review of samples from 42 dairies in Idaho (Table 1) showed that nitrogen (N) and phosphorus (P) in wastewater lagoons vary greatly between farms. For example, on small open lot dairies (< 1,000 head), P can range from 16 to 28 pounds/per acre-inch while on large open lot dairies (> 1,000 head), the range is 12 to 20 pounds per acre-inch. Phosphorus concentrations on freestall flush dairies ranged from 23 to 31 pounds per acre-inch, while scraped freestall dairies ranged from 17 to 39 pounds per acre-inch. This is a broad range of nutrient levels with the maximum and minimum values differing by more than a factor of two.

These numbers should send a clear message: Average nutrient estimates may be suitable for the purposes of developing a manure utilization plan, but these averages are not adequate for calculating proper application rates.

Do not base your application rates on laboratory test results from previous years because nutrient concentrations can change significantly, particularly when the manure has been exposed to the environment. For example, nutrient levels in a lagoon or storage pond can be greatly diluted by more rainfall than normal or concentrated due to excessive summertime evaporation.

Manure should be tested as close to the date of application as practical. Preferably, the sample should be taken as near the application time as possible prior to the manure application, or within 30 days of application. However, if you urgently need to pump down a full lagoon or storage pond, you should not wait until you can sample and obtain the results. Instead, you should sample the day of irrigation. The results can later be used to determine the nutrients applied to the fields and identify the need for additional nutrients to complete crop production.

Producers who do not test each manure source before or just after land application are faced with a number of questions they simply may not be able to answer:

- Am I supplying plants with adequate nutrients?
- Am I building up excess nutrients that may ultimately move to surface waters or groundwater?
- Am I applying heavy metals at levels that may be toxic to plants and permanently alter soil productivity?

Because environmental damage and losses in plant yield and quality often happen before visible plant symptoms, always have your manure analyzed by a competent lab. Certified labs in Idaho can analyze manure samples and may be able to make agronomic recommendations regarding the use of the manure as a fertilizer.

Manure sampling

Proper sampling is the key to reliable manure analysis. Although lab procedures are accurate, they have little value if the sample fails to represent the manure product.

Manure samples submitted to a lab should represent the average composition of the material that will be applied to the field. Reliable samples typically consist of material col- lected from a number of locations. Precise sampling meth- ods vary according to the type of manure. The lab, county extension agent, or crop consultant should have specific instructions on sampling, including proper containers to use and maximum holding or shipping times. General sampling recommendations follow.

Preparing liquid manure for lab analysis. Liquid manure samples submitted for analysis should meet the following requirements:

- Place sample in a sealed, clean plastic container with about a 1-pint volume. Glass is not suitable because it is breakable and may contain contaminants.

Table 1. Average lagoon wastewater concentrations from various types of Idaho dairies.

Farm Type[1]	Ammonia (NH_3) lb/ac-in	Total Kjeldahl Nitrogen (TKN) lb/ac-in	Total Phosphorus (TP) lb/ac-in	Total Solids (TS) mg/l	Biochemical Oxygen Demand (BOD) mg/l
OL < 1,000 hd	40 +/- 2	119 +/- 29	22 +/- 6	29,291 +/- 12,098	21,067 +/- 20,240
OL > 1,000 hd	61 +/- 22	92 +/- 36	16 +/- 4	5,087 +/- 1,386	1,068 +/-192
FS Scrape	175 +/- 75	181 +/- 75	28 +/- 11	24,122 +/- 13,826	2,135 +/- 968
FS Flush	149 +/- 23	162 +/- 24	27 +/- 4	10,770 +/- 2,138	1,912 +/- 481

[1] Farm Type: OL = Open Lot Dairy; FS = Freestall Dairy; hd = head.

Average values +/- standard error.

- Leave at least 1 inch of air space in the plastic container to allow for expansion caused by the release of gas from the manure material.
- Refrigerate or freeze samples that cannot be shipped on the day they are collected, minimizing chemical reactions and pressure buildup from gases.

Ideally, liquid manure should be sampled after it is thoroughly mixed. Because this is sometimes impractical, samples can also be taken in accordance with the suggestions that follow.

Lagoon liquid. Premixing the surface liquid in the lagoon is not needed, provided it is the only component that is being pumped. Growers with multistage systems should draw samples from the lagoon they intend to pump for crop irrigation. Samples should be collected using a clean, plastic contain- er similar to the one shown in **Figure 1.** One pint of material should be taken from at least eight sites around the lagoon and then mixed in the larger clean, plastic container. Effluent should be collected at least 6 feet from the lagoon's edge at a depth of about a foot. Shallower samples from anaerobic lagoons may be less representative than deep samples because oxygen transfer near the surface sometimes alters the chemistry of the solution. Floating debris and scum should be avoided. One pint of mixed material should be sent to the lab. Galvanized containers should never be used for collec- tion, mixing, or storage due to the risk of contamination from metals like zinc in the container.

A University of Idaho study compared nutrient composi- tion from two sampling locations: direct from storage and during land application. Nitrogen concentration averaged 15 pounds per acre-inch higher in storage samples than from land application samples. Conversely, phosphorus and potassium concentrations were similar between storage and land application samples. Nitrogen application rates may be overestimated if based on nutrient analysis from storage samples. These recommendations are adequate for average irrigation volumes. If an entire storage structure is to be emptied by such means as furrow irrigation, more frequent sampling with many more sampling points is recommended.

Liquid slurry. Manure materials applied as a slurry (approximately 5 to 12 percent solids) from a pit, storage pond, or vacuumed from a feed alley should be mixed prior to sampling. If you agitate your pit or basin prior to sampling, a sampling device pictured in **Figure 1** can be used. If you wish to sample a storage structure without agitation, you must use a composite sampling device as shown in **Figure 2**. Manure should be collected from approximately eight areas around the pit or pond and mixed thoroughly in a clean, plastic container. An 8- to 10-foot section of 0.5- to 0.75-inch plastic pipe can also be used: extend the pipe into the pit with ball plug open, pull up the ball plug (or press your thumb over the end to form an air lock), and remove the pipe from the manure, releasing the air lock to deposit the manure in the plastic container.

Lagoon sludge. The best time to take a sludge sample is while measuring for volume of sludge in a lagoon. This allows samples to be collected from several points around the interior of the lagoon. How the sample is collected depends on how the sludge will be removed. Depending on the densi- ty and nutrient concentration of the lagoon effluent, the samples may differ by up to 100 percent from point to point.

To draw a sample, use the same type of sampler as described above for manure slurry (**Figure 2**) and lower the sampler until it almost reaches the bottom. Avoid using a commercial "sludge-judge," because experience has shown that these devices do not work well on thick manure sludge and settled solids.

Wearing plastic or latex gloves, collect a core or profile of lagoon effluent and sludge. Once the pipe is over a clean 5-gallon plastic bucket, slowly break the vacuum by removing your finger from the end of the pipe. If the entire lagoon is going to be agitated during sludge removal, the entire core of collected sludge and effluent should be sent to the laboratory. If the lagoon effluent is going to be drawn down and primarily only sludge pumped out, then just the collected sludge should be sent to the lab. If you are unsure how the sludge will be removed, take samples using both methods, label them separately, and have both analyzed.

Place several samples in the bucket and mix thoroughly before removing a sub-sample for analysis. Consider using a plastic, wide-mouth bottle when shipping samples to the laboratory.

Solid Manure. Solid manure samples should represent the manure's average moisture content. If the material varies

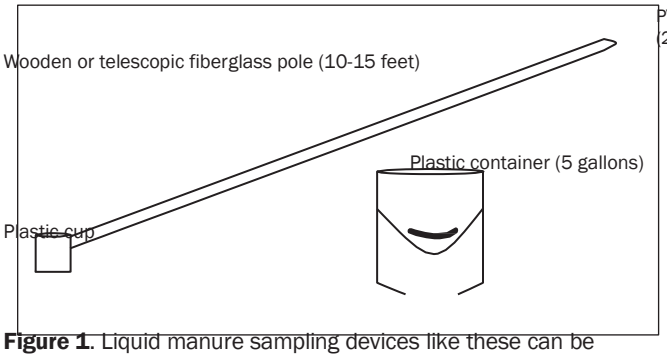

Figure 1. Liquid manure sampling devices like these can be purchased or made.

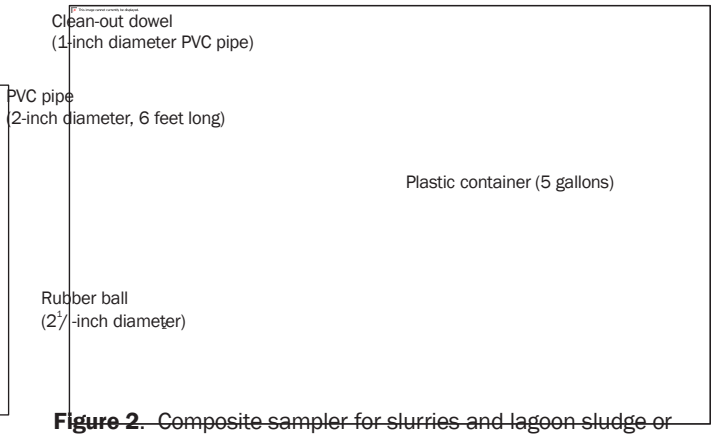

Figure 2. Composite sampler for slurries and lagoon sludge or settled solids includes a collecting PVC pipe and a clean-out dowel (smaller PVC pipe), string, and a rubber ball big enough to cover one end of the collecting pipe.

greatly in its moisture content, you should submit at least 3 samples to a laboratory and take an average of each analysis. A 1-quart sample is adequate for analysis. Samples should be taken from approximately 8 different areas in the manure pile, placed in a clean plastic container, and thoroughly mixed. Samples should be taken wearing plastic or latex gloves and using a plastic or stainless steel hand shovel or trowel. Do not use galvanized trowels or buckets because they will likely contaminate the sample, rendering falsely high concentrations of metals like zinc in the analysis. Approximately 1 quart of the mixed sample should be placed in a plastic bag, sealed, and shipped directly to the lab. Samples stored for more than 1 day should be refrigerated.

Stockpiled manure or litter. Ideally, stockpiled manure and separated solids should be stored under cover on an impervious surface. The weathered exterior of uncovered waste may not accurately represent the majority of the material. Additionally, rainfall will move water-soluble nutrients down into the pile. If an unprotected stockpile is applied over an extended period, it should be sampled before each application.

Stockpiled manure should be sampled at a depth of at least 18 inches at 6 or more locations around the pile. The collected material should be combined in a plastic container and mixed thoroughly. The 1-quart lab sample should be taken from this mixture, placed in a plastic container or bag, sealed, and shipped to the lab for analysis. If the sample cannot be shipped within one day of sampling, it should be refrigerated.

Surface-scraped manure. Surface-scraped and piled materials should be treated like stockpiled manure. Follow the same procedures for taking samples. Ideally, surface-scraped materials should be protected from the weather unless they are used immediately.

Composted manure. Ideally, composted manure should be stored under cover on an impervious surface. Although nutrients are somewhat stabilized in these materials, some nutrients can leach out during rains. When compost is left unprotected, samples should be submitted to the lab each time the material is applied. Sampling procedures are the same as those described for stockpiled manure.

Who can analyze my manure sample?

Both public and private labs analyze manure samples. Use only labs that are certified or conduct their analysis according to the North American Proficiency Testing – Manure Assessment Program (NAPT-MAP) to test manure and wastewater, or the North American Proficiency Testing – Compost Assessment Program (NAPT-CAP) to test com- post. Private labs can be found through local Cooperative Extension Service (CES) agents, state regulators, or on the NAPT-MAP Web site: *http://ghex.colostate.edu/map/*.

Deciding which lab to use depends on several factors:

- Is the lab certified or does it conduct its analysis according to NAPT-MAP or NAPT-CAP guidelines?
- What is the cost to run the sample?
- How long will it take to get your results?
- Does the lab offer all parameters needed for your operation?
- Can you get your sample to the lab in the required time?

When you have selected a lab to analyze the manure, you need to follow its specific sample requirements. Many labs offer sample containers that they ask you to use. Sample collection procedures, including holding times allowed and refrigeration and shipping requirements, must be closely followed to obtain accurate results. One standard that applies to all labs and sampling recommendations is to sample as close to the application time as possible.

Essential analyses include concentrations of essential plant nutrients, including nitrogen as ammonium (NH_4-N), and Total Kjeldahl Nitrogen (TKN), Total phosphorus (TP) and potassium (K). Additionally, you may consider sampling for nitrate (NO_3-N), dissolved phosphorus (PO_4-), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), dry matter content or total solids (TS), pH, and electrical conductivity (for liquid samples). Where applicable, check your NPDES permit (National Pollutant Discharge Elimination System) for specific sampling requirements.

What does my manure analysis report tell me?

Lab results may be presented in a number of ways. The easiest to use is a wet, "as-is" basis in pounds of available nutrient (N, P, or K) (1) per ton; (2) per 1,000 gallons of manure or wastewater; or (3) per acre-inch of manure or wastewater.

If a lab reports results on a dry basis, you must have the moisture content of the manure to convert the results back to a wet basis. A lab may also give results as a concentration (parts per million [ppm] or milligram per liter [mg/l]), which likewise requires conversion factors to get the results into a usable form based on how you apply the manure. Finally, if a lab reports P and K as elemental P and K, you must convert them to the fertilizer basis of P_2O_5 or K_2O. This can be done with the following conversions:

P X 2.29 = P_2O_5 K
X 1.20 = K_2O

Select a lab that reports an analysis on an "as-is" basis in the units of measure most useful to your operation.

Most useful information

The most useful information is predicted nutrients available for the first crop. Nutrient availability is predicted based on estimates of manure breakdown and nutrient loss according to application method. If the lab does not report plant-avail- able nutrients, contact your nutrient management planner, a certified crop advisor, or your local extension office for assistance.

Of the total nutrients predicted to be available for the first crop, 50 to 75 percent will likely become available during the first month. It is, therefore, important to apply manure near the time nutrients are required by plants. The remaining nutrients gradually become available over the next three months. Nutrients not available for the first crop are slowly

released to available forms over time. In soils that do not readily leach with heavy rainfall, nutrients may accumulate to significant quantities over time.

You should review the report to see if the analysis is within the expected ranges for your manure. It is common for manure analyses to vary between seasons, due to excess rain- fall, drought, or changes in management practices. However, you should compare your results to the results from previous manure reports to ensure that they appear reasonable. If your results are significantly different from what you expect- ed, it is advisable to resample the manure. The original sam- ple may have been mislabeled or improperly collected, and thus not be representative of the manure.

To meet a specific plant nutrient requirement, nutrients listed in the report or calculated as "available for the first crop" should be used in determining the actual application rate. For the availability prediction to be reliable, you must have properly identified the type of manure and the applica- tion method on the information sheet submitted to the lab. It is important to understand that nutrient availability can- not be determined with 100 percent accuracy. Many vari- ables, including the type of manure product and environ- mental factors (i.e., soil type, rainfall, temperature, and gen- eral soil conditions), influence the breakdown of the manure and nutrient loss. Remember, the worst sample of your manure is always better than the best book value.

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Appendix F. Manure Testing Protocols at Stukenholtz Laboratories

Steukenholtz Laboratory

Twin Falls, Idaho

METHODS FOR MANURE/ COMPOST ANALYSIS

EPA Digestion Metals: EPA Method 3050, AO AC 990.08
Dry Matter: AOAC 925.04
Nitrate-Nitrogen: 1:5 Extraction KCl , colorimetric determination, Method WCC-103 S-3.50
TCN: AOAC 990.3
Salts/ pH: AOAC 973.4

Method detection limits:

Nitrate-N:	6 ppm or mg/kg
TCN:	0.001
P:	50
K:	60
S:	15
Na:	50
Ca:	5
Mg:	4
Zn:	6
Fe:	4
Mn:	4
Cu:	4
B:	2

Appendix G. Soil Testing Protocols at Agsource Harris Labs

AgSource Harris Laboratory Test Methods

Analysis	Units	Description
Soil pH	N/A	1:1 Soil/Water Slurry
Buffer pH	N/A	Sikora Method
Soluble Salt	mmhos/cm	1:1 Soil/Water Slurry
Cations (Ca, K, Mg, Na)	ppm	Ammonium Acetate Extraction
Phosphorus	ppm	Bray I extraction
	ppm	Olson extraction
Traces (Zn, Mn, Cu, Fe)	ppm	DTPA extraction
Sulfur	ppm	Phosphate extraction
Boron	ppm	DTPA/Sorbitol
Nitrate Nitrogen	ppm	Cadmium reduction
Particle Size Analysis	%	Hydrometer measurement
Salinity Evaluation	mmhos/cm	Saturated Paste extraction
Plant Analysis		
Nitrate Nitrogen	ppm	Acetic Acid digestion
Phosphate Phosphorus	ppm	Acetic Acid digestion
Total Nitrogen	%	Kjedahl digestion
Total Nutrients	%	Nitric acid/Hydrogen Peroxide digestion
Phosphorus	"	"
Potassium	"	"
Magnesium	"	"
Calcium	"	"
Sodium	"	"
Sulfur	"	"
Zinc	"	"
Manganese	"	"
Copper	"	"
Iron	"	"
Boron	"	"
Aluminum	"	"
Greenhouse Media Testing		
Media pH	N/A	Saturated Media Extract (SME)
Electrical Conductivity	mmhos/cm	"
Phosphate	ppm/Meq	"
Potassium	"	"
Calcium	"	"
Magnesium	"	"
Sodium	"	"
Zinc	ppm	"
Manganese	ppm	"
Copper	ppm	"
Iron	ppm	"
Boron	ppm	"
Aluminum	ppm	"
Nitrate Nitrogen	ppm	"
Ammonium Nitrogen	ppm	"
Extracted Traces		

(Zn, Mn, Cu, Fe)	ppm	DTPA extraction
Organic Matter	%	Loss on Ignition
Organic Carbon	%	"
Total Nitrogen	%	Kjedahl Digestion
Soluble P2O5	%	Citric Acid Digestion
Soluble K2O	%	Ammonium Oxalate

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