AgSource Laboratories
A Subsidiary of Cooperative Resources International

106 North Cecil Street
P.O. Box 7
Bonduel, Wisconsin 54107
715-758-2178 • FAX 715-758-2620
www.agsource.com

July 15, 2013

Mr. Andrew Craig and Ms. Danielle Block
Wisconsin Department of Natural Resources
Bureau of Watershed Management – Runoff Management Section
Statewide Nutrient Management Specialist and Agricultural Runoff Management Specialist
101 S. Webster Street
Madison, WI 53707

Dear Mr. Craig and Ms. Block:

Enclosed you will find a hard copy of the irrigation information for Ebert Enterprises, LLC. Please note that some of the information like soil and manure sample data may have been included in the NMP for Ebert's Re-Application and was not duplicated in this submittal.

If you have any questions, do not hesitate to contact me via phone or email at (920)-304-6293 or nguilette@agsource.com.

Sincerely,

Nicholas A. Guilette

Nick Guilette
NMP Specialist

Enclosure

cc: Randy Ebert – Ebert Enterprises, LLC

Irrigation Management Plan

Ebert Enterprises, LLC

N6939 County Road D
Algoma, WI 54201
c/o Randy Ebert
(920) 255-1893

2013 Crop Year

Plan Written By:

Nick Guilette, CCA 34684
(920) 304-6293 (cell)
AgSource Laboratories
P. O. Box 7
Bonduel, WI 54107
(715) 758-2178 (office)

Exhibits

Additional Information about Manure or Process Wastewater Irrigation at Ebert Enterprises, LLC

Fields

In 2013-14, the only fields that are planned to receive low solids content, low nutrient value liquid manure from the 3rd stage of the lagoon system at Ebert Enterprises, LLC irrigation applications are HE and CK. Due to interest in additional information, the UW Biological Department is planning on conducting on farm research during the 2013-14 growing season. Applications of irrigated liquid manure are planned to be made under the direction of staff from the UW. If any new fields; including NS, BG, DB, MC/RN, and RK/DS; are to be added to the list of proposed liquid manure irrigation fields, information will be submitted to both the Green Bay and Madison DNR offices. These new fields would not receive low solids content, low nutrient value liquid manure applications from irrigation equipment until the review and approval process is complete. This would include written approval from the DNR.

The fields identified above are addressed in SNAP-Plus reports/calculations and have irrigation spreading restriction maps included in the 5 year NMP.

Restriction Maps and Setbacks

Restriction maps reflect all NR 243.14 general land application requirements and SWQMA setback/practices. Restriction maps also reflect NR 214.14 prohibition on floodplain location and setback requirements for wells (250 feet), occupied residences (500 feet – can be reduced or waived with written landowner permission, may be increased based on the type of irrigation system and potential for aesthetic and public health impacts). Spreading restriction maps identifying irrigation setbacks were included in Tab 5 of the 5 year NMP for review by the DNR. Manure irrigation applications are not planned to occur within grassed waterways. Maps and an application protocol have been included in Exhibit 1.

The system is a mobile center pivot system connected to permanent transfer system with a flexible hose. Wisconsin Administrative Code NR 243 refers to NR 214.14 in situations where spray irrigation of manure/wastewater may occur by a WPDES permitted facility. NR 214.14 establishes that the ground surface under a spray irrigation system shall have at least a 5 foot separation to groundwater and bedrock. Due to the nature of the application practices being proposed at Ebert Enterprises, LLC we request a waiver from this requirement and request the department require that "Manure or process wastewater may not be applied on areas of a field with a depth to groundwater or bedrock of less than 24 inches" as outlined NR 243.14(2) (b) (7) and the current WPDES permit for Ebert Enterprises, LLC. Exhibit 1A includes some additional NRCS soil descriptions. It should be noted that the soil types Cathro muck and Carbondale muck, which occur in fields CK and HE, respectively, are outside of the pivot irrigation system's footprint.

In addition NR 214.21 states the department may require a WPDES permitted facility to design and install permanent groundwater monitoring devices on fields where spray irrigation will occur. Ebert Enterprises, LLC is also requesting a waiver from this requirement due to the nature of the application

practices that are being proposed. Ebert Enterprises, LLC is proposing to use spray irrigation systems to apply low nutrient value manure onto growing crops throughout the growing season at low application rates. Typical application rates will be limited to around 9,000 gallons per acre or 1/3 of an inch. These planned applications will be based on the agronomic needs of the growing crop and not on hydrologic loading rates as allowed and outlined in NR 214. In addition, Ebert Enterprises, LLC plans to allow rest periods between applications to fields.

Irrigated Manure or Process Wastewater Characteristics

Low solids content, low nutrient value liquid manure from the 3rd stage of the lagoon system will be applied through the irrigation equipment. Ebert Enterprises, LLC (the Farm) has a closed loop mechanical separation system. A McLanahan sand separation system is used to remove coarse and fine sand. A Mutiple DairyTech separation system is used to remove manure fiber solids before the manure then proceeds to a 3 stage lagoon system. When manure is planned to be applied through the irrigation system, a Riverscreen Inc. screen is planned to be used to "suck" liquid from the top of the 3rd stage lagoon. Agitation is not planned when applying low solids content, low nutrient value liquid manure through the irrigation equipment.

Manure from the 3rd stage of the lagoon has been tested by a certified lab. Sample results have been included in an excel sheet in Tab 6 of the 5 year NMP. It should be noted that the samples collected from the 3rd stage were collected after agitation of the pit. Agitation will not be occurring when using the irrigation equipment to apply low solids content, low nutrient value liquid manure. A running average of lab sample results has been calculated and will be used to plan manure irrigation application rates. This running average will be updated as new samples are collected. To date ammonia-N content has not been analyzed for nor is it planned to be analyzed for unless required.

A manure digester is not present at Ebert Enterprises, LLC. The separation system used at the farm is described above.

Equipment Design, Operation, Timing, and Methods

The irrigation equipment is a mobile center pivot system connected to a permanent transfer system with a flexible hose. The permanent transfer system is underground which connects to risers above ground to connect flexible hoses to the application equipment. Check valves are installed on the pump to prevent contamination of clean water sources. The irrigation system will not be connected to a well. Clean water applications will come from a reservoir/pond. The permanent transfer system that is in place was designed by Conestoga-Rovers & Associates and approved by the DNR.

The center pivot system is manufactured by T-L Irrigation Company. Pictures of the equipment, nozzles, and Riverscreen have been included with this narrative. Nozzles are from Nelson Irrigation Corporation. A table outlining parameters for different nozzles has been included with this narrative. Additional information about the center pivot system and the nozzles is included in Exhibits 2 and 3. The nozzles have blue R 3000 Rotator caps with green D4 - 8 degree rotator plates. Currently, nozzle numbers range from 14 at the center to 31 at the end of the pivot. Nozzles numbers are from 3TN nozzle system. Nozzle parts may change as calibration and other observations of the equipment occur. The system is planned to be adjusted (nozzle parts, possibly pressure, or other parameters) to maximize

droplet size and minimize drift potential. Nozzles vary across the length of the pivot to be able to accomplish the planned application rate. The irrigation equipment is planned to be operated at 0-20 psi when applying low solids content, low nutrient value liquid manure.

Kevin Beckard, also from AgSource Laboratories, requested additional information from Nelson Irrigation Corporation about droplet size expected from selected Nelson nozzles. Included below is the email correspondence that occurred. Included in Exhibit 3A is the two studies referenced in the correspondence.

Hello Kevin,
Our Application Engineering department has done research on this to help out. The issue is that the ASABE Standard is not clear. Here is a comment on that from our Application Engineer, Evan Thompson.
"
That ASABE standard is directed to pest/fertilizer application spray nozzles to prevent/reduce drift of chemicals – it is not meant for sprinklers for irrigation. It is unknown whether the methodology in that standard would produce acceptable results on an irrigation sprinkler. Besides the physical differences between a spray nozzle and sprinkler, when you look at the operating flow/pressure of sprayer nozzles compared to our 3TN nozzles, it is kind of an apples-oranges situation. (There is only a little overlap of the largest sprayer nozzles with the smallest 3TN nozzles.)
Numerous studies have been done over the years using various methods to classify droplet size from sprinklers – it is a quite a different animal than spray nozzles, and as such the results vary and there has not been a standard method developed.
At any rate, you can point them to the attached study which used two methods for estimating droplet size from some older model Rotators and Spinners. With either method, the d50 droplet size of these sprinklers was 900-2400 microns. The largest size from the ASABE spray nozzle standard (Extra/Ultra Coarse) is 650 microns. So it's fairly evident that sprinkler droplet sizes exceed the largest sprayer nozzle, which is expected."

I have attached the Doboer study that he references, and the ASABE standard that I believe you may already have.
Apparently, there is not a lot of information on this topic. Hopefully there will be more available in the future.
I hope this helps answer your questions.
Thank you,
Steve McCoon

From: Kevin Beckard [kbeckard@agsource.com]
Sent: Friday, June 21, 2013 12:24 PM
To: Steve McCoon
Subject: RE: Droplet size information

Hi Steve,
Have you have any luck coming up with some anticipated droplets sizes based on the information I sent you.. The WI-DNR is looking for this information by the beginning of July. If you can't come up with any numbers let me know ASAP and we need to figure out something else....

Thank You,
Kevin

From: Kevin Beckard
Sent: Wednesday, June 05, 2013 10:59 AM
To: 'steve.mccoon@nelsonirrigation.com'
Subject: Droplet size information

Steve,
Attached is the specs for the center pivots we are using to apply low solids contents manure onto crop fields. The WI DNR is requesting if we know the approximate droplet size the nozzles on the center pivot produce. They are recommending droplet sizes to be 250 microns or greater. Just wondering if the equipment we are using meet this criteria.

Thank You,
Kevin

Kevin Beckard
NMP/GPS Specialist
AgSource Laboratories
920-309-1948

A speedup kit has been put on the irrigation equipment to ensure the ability to apply at the planned rate of 7,500 gallons/acre, applications are not planned to be over 10,000 gallons/acre. Speed will be monitored to ensure accurate application rates. A T-L Point controller is on the pivot system. This controller can be run on manual or upgraded to a T-L Precision point controller. Currently, drop nozzles that are approximately 6-7 feet above ground surface are on the irrigation system. These drop nozzles will be used on taller crops. On low growing crops or when low solids content, low nutrient value liquid manure is applied early in the crop life cycle, the Farm is planning to experiment with a low drift drop sprinkler package (picture included) on a couple of the end sections. With this package nozzles will be located within 0-5 feet of the ground surface. When the low drift drop sprinkler package is removed, nozzles will be located within 5-10 feet of the ground surface. It should be noted that the end gun is not planned to be used when applying low solids content, low nutrient value liquid manure.

Irrigation applications of low solids content, low nutrient value liquid manure will be made during the growing season of a double crop system. Typically, applications will be made after a crop has been planted, possibly before emergence, through the first 2/3 of the crop life cycle. Split applications of

low solids content, low nutrient value liquid manure are planned to spread out nutrients over a longer period of time. After an application of low solids content, low nutrient value liquid manure, an application of clean water at a low rate is planned to occur to wash off plants and to help nutrients to infiltrate into the ground. Applications made during daylight hours may increase the ability to reduce pathogens by being exposed to UV rays. Therefore, applications will not occur during darkness or at night.

When clean water is applied through the irrigation equipment, the end gun is planned to be used and pressures will likely be 30-40psi. Application rates will be made to meet the nutrient needs of crops grown on the field during the rotation and comply with all applicable rules. Follow up applications of low solids content, low nutrient value liquid manure, if planned, will likely be greater than 14 days after the 1st application of low solids content, low nutrient value liquid manure.

The 1,180 foot pivot is planned to make a full circle on a 160 acre parcel in approximately 8-10 hours. Application timing will be based on wind direction and wind speed. A rain gauge will be used to verify calibrations. (A picture of rain gauge and wind meter are included in Exhibit 3B. .During 2013-14, it is anticipated that calibrations will be made with each application. In future years, calibrations will occur once per year per center pivot system. If needed, additional calibrations can be made to adjust application rates.

Drift and Runoff Prevention + Pathogen Reduction Practices

Weather forecasts will be reviewed prior to all irrigated low solids content, low nutrient value liquid manure applications. Copies of the forecast will be printed/saved and kept with the NM plan to verify weather forecasts. Irrigation equipment will not be operated with low solids content, low nutrient value liquid manure when wind speeds are sustained at greater than 15 miles per hour. Wind speeds will be monitored using hand held wind monitors and also by checking the weather monitoring station located at the Algoma High School. A wind meter (Kestrel 2,000) will be used to determine wind speed. The hand held wind monitor will be used when observing field conditions while actually applying with the irrigation system.

A record keeping form has been provided in Exhibit 4. With on farm research planned for t 2013-14, a maximum wind speed may become apparent as to when to shut down irrigation equipment. With research data if a changed wind speed is needed, the Farm will adjust accordingly. Wind speed and direction, sunlight exposure on field (e.g., full, partial, none), and air temperature will be monitored and recorded before and during application. During the 2013-14 growing season; weather, field, field boundary, and irrigation lines/equipment conditions will be monitored hourly. Monitoring for 2013 and 2014 will be completed by both UW Researchers and Ebert staff. 2013 and 2014 will be used to determine if monitoring can be done on a less intensive schedule. The primary purpose of monitoring is to confirm if manure irrigation applications described within this plan cause or do not cause offsite movement beyond field boundaries. Fields utilizing liquid manure irrigation will also be monitored for runoff during and after application. During monitoring, the field edges will be checked to make sure no liquid manure is leaving the application site, Though highly unlikely due to low application rates, if runoff is observed proper measures will be taken to mitigate offsite movement and spill procedures

outlined in the Ebert Enterprises, LLC NMP will be initiated. A record keeping form to be used to track all monitoring activities of the irrigation pivots has been included as part of this proposal.

. The Farm is aware of its proximity to Lake Michigan and the lakes ability to influence wind direction, especially in early to mid-afternoon. Field and equipment monitoring procedures identified in the paragraph above will be followed as described to account for wind shift and to prevent drift from leaving the application site. If needed, the pivot would be shut down to account for changing conditions.

Field soil moisture conditions will used to evaluate application decisions. Other practices used to maximize droplet size and minimize drift/runoff risk were discussed in the Equipment Design, Operation, Timing, and Methods section of this narrative.

Irrigation applications of low solids content, low nutrient value liquid manure will be made during the growing season of a double crop system. Typically, applications will be made after a crop has been planted, possibly before emergence, through the first 2/3 of the crop life cycle. Split applications of low solids content, low nutrient value liquid manure are planned to spread out nutrients over a longer period of time. After an application of low solids content, low nutrient value liquid manure, an application of clean water at a low rate is planned to occur to wash off plants and to help nutrients to infiltrate into the ground. Applications made during daylight hours may increase the ability to reduce pathogens by being exposed to UV rays. Therefore, applications will not occur during darkness or at night.

Response Actions for Drift/Runoff Outside Field Boundary

Emergency action response materials have been included in Tab 10 of the 5 year NMP. In addition, if any measurable drift, runoff (beyond field boundaries), leaks, or spills are detected the irrigation equipment will be stopped and any deficiencies in the system corrected. Measurable drift will be defined as feeling droplets hit ones skin or visually seeing droplets on a pickup truck windshield, which was used to carry the observer along the outside perimeter of acceptable application areas within the field being applied to. The DNR spill line will be contacted and a report of the incident will be completed and included in the WPDES annual report. If follow up action is needed as part of the incident, it will occur as directed by DNR or Farm staff depending on the severity of the incident. A record keeping form to be used to track all monitoring activities of the irrigation pivots has been included as part of this proposal.

Included in Exhibit 5 is a map with alphabetical letters to identify some of the nearby neighbors. These alphabetical letters correspond to information and some comments made by the neighbors during visits with the Farm about the irrigation system.

DNR Manure Irrigation Research and Setback Requirements

The Farm understands that the DNR is currently funding manure irrigation research to determine pathogen content and drift distance(s) using various irrigation equipment designs, and operating/field conditions. The Farm also understands if such research demonstrates setbacks and/or practices are necessary to protect public health and/or the environment, the department may require NMP revision to reflect such setbacks and /or practices.

T24N R25E
Section 6
Kewaunee Co.

Ebert Enterprises, LLC
Irrigation Restriction Map

DEPARTMENT OF SOIL SCIENCE University of Wisconsin-Madison

NRCS

Well - No manure applications within 250 feet.

Soils w/high potential for Nitrate Leaching- Fall N restrictions, verify fields are not saturated before applying manure

No Manure Applications

Winter Restrictions (if slope > 9%)

SWQMA
(No Winter Application, Other Non-Winter Restrictions)
As described in NR 243

Perennial Streams

Intermittent Streams

PLSS Sections

N

0 750 1,500 Feet

Sources:
USDA-NRCS SSURGO
2005 NAIP imagery
WI-DNR 24k Hydro
WI DOT Roads

This map has been developed utilizing the nutrient application restrictions from the September 2005 Wisconsin NRCS 590 Nutrient Management Practice Standard. This map is an initial inventory of nutrient spreading risks which must be field verified to identify other risk areas such as concentrated flow channels, wetlands, and conduits to groundwater. See the "Considerations" section of the 590 practice standard for additional planning suggestions.
http://efotg.nrcs.usda.gov/references/public/WI/590.pdf

Oct 08, 2008

Yellow circles indicate a 500 feet setback from houses.

K

CK

Brietlow Rd

HE

D

Red Areas - Do not apply manure within 25' of wetlands, 100' of ponds, or 200' of gravel pit.

These "lakes/ponds" are not lakes.

Oak Rd

Tenth Rd

EXHIBIT 1

Irrigation Application Protocol

The following are the manure application protocols that will be followed by Ebert Enterprises, LLC when applying manure or process wastewater using mobile irrigation equipment. As manure application trials are completed, additional information will likely be added to this protocol in the future.

Land Application Procedures

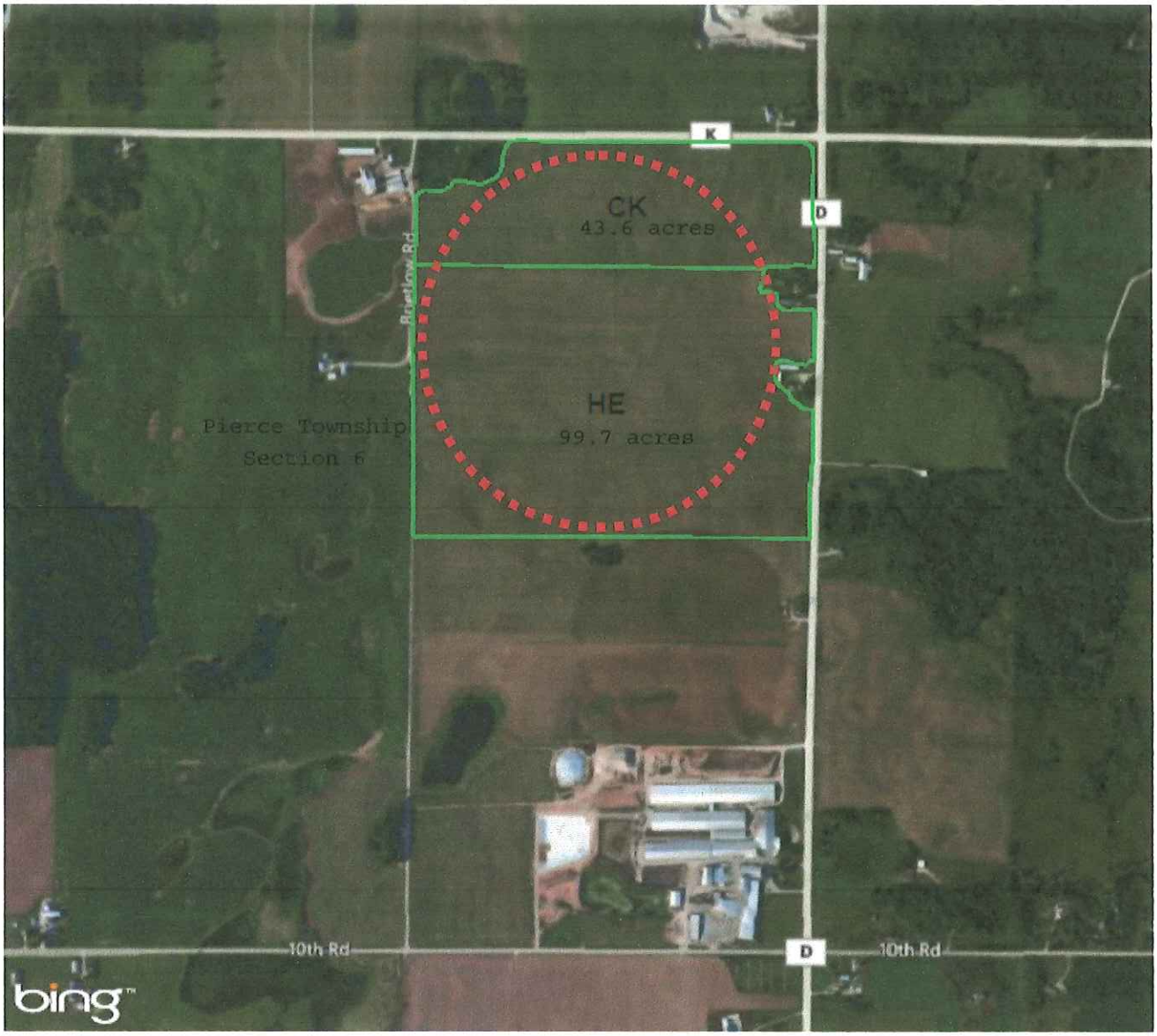
- Irrigated manure and process wastewater will be surface applied typically onto growing crops. Application rates will be low (typically around 1/3 of an inch per acre) to reduce the chances of a runoff event.
- No applications are planned to be done onto frozen or snow covered soils.
- Weather conditions will be monitored so that applications are not made when precipitation capable of producing runoff is forecast within 24 hours of the planned time of application.
- Fields will be checked before applications are made to ensure applications are not being made to saturated soils.
- Application equipment will be properly calibrated to ensure recommended application rates are followed.
- Wind speed will be taken into account before applications are made so that excess wind does not cause movement of small droplets to move off of the application site.
- Proper nozzles will be used that allow for lower pressure and larger droplet size to reduce the potential for drift.
- Manure applications will be directed onto the growing crops and not up into the air.
- Minimal agitation of the manure storage facilities will take place to help reduce odors.
- Manure and process wastewater will be conveyed to the mobile irrigation unit via overland hoses. These overland hoses will be monitored for leaks and ruptures while applications are taking place.
- Application rates will be defined in the NMP and may be adjusted depending on finding of pre-side dress nitrate tests and well as plant tissue tests. Any variations in land application rates will be reflected in the annual report submitted by Ebert Enterprises, LLC.
- In fields where tile outlets are known to be located they will be checked periodically during spray irrigation activities to ensure manure or process wastewater is not leaving the application site vie these subsurface drains.
- Continued manure sampling will be used and application rates will be adjusted depending on the nutrient values of manure testing activities.

Manure and Process Wastewater Application Prohibitions/Restrictions

- Manure or process wastewater may not pond on the application site.
- Manure or process wastewater may not run off the application site nor discharge to waters of the state through subsurface drains.
- Manure or process wastewater may not cause fecal contamination of water in a well.
- Manure or process wastewater may not be applied to saturated soils.
- Manure or process wastewater may not be applied on areas of a field with a depth to groundwater or bedrock of less than 24 inches.

- Manure or process wastewater applied by an irrigation unit may not be applied within 250 feet of potable water supply wells. NR 214.14 (1) (a).
- Manure or process wastewater may not be applied within 100 feet of direct conduits to groundwater. Ex. tile inlets.
- Manure or process wastewater cannot be surface applied within 200 feet of direct conduits to groundwater (ex. Tile inlets) without being incorporated within 48 hours.
- Manure or process wastewater may not be surface applied when precipitation capable of producing runoff is forecast within 24 hours of the time of planned applications.
- The nearest edge of wastewater spray shall be separated by at least 500 feet from the nearest inhabited dwelling. This distance may be reduced with the written consent of any affected owners or occupants. NR 214.14 (1) (b).

Irrigation



Date: 6/10/2013
Farm: Irrigation
Grower: Ebert Enterprises, LLC 797
Area: 143.51 ac

N

One in = 1055 feet

0 354 708 1062 1415 1769

Irrigation (143.51 ac)

Approximate location of mobile center pivot.

Kewaunee County
Pierce Township
T24N - R25E
Section 6

EXHIBIT 1A

LOCATION BOYER MI+IL IN OH WI

Established Series
Rev. RWJ-EPW-MLK
08/2012

BOYER SERIES

The Boyer series consists of very deep, well drained soils formed in sandy and loamy drift underlain by sand or gravelly sand outwash at depths of 51 to 102 cm (20 to 40 inches). The soils are on outwash plains, valley trains, kames, beach ridges, river terraces, lake terraces, deltas, and moraines. Slope ranges from 0 to 50 percent. Mean annual precipitation is about 864 mm (34 inches), and mean annual temperature is about 9.4 degrees C (49 degrees F).

TAXONOMIC CLASS: Coarse-loamy, mixed, semiactive, mesic Typic Hapludalfs

TYPICAL PEDON: Boyer loamy sand, on a 4 percent slope in a cultivated field. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 18 cm (7 inches); dark grayish brown (10YR 4/2) loamy sand, light brownish gray (10YR 6/2) dry; weak fine granular structure; very friable; many fine roots; slightly acid; abrupt smooth boundary. [15 to 30 cm (6 to 12 inches) thick]

E1--18 to 30 cm (7 to 12 inches); brown (10YR 5/3) loamy sand; weak medium granular structure; very friable; common fine roots; about 2 percent gravel; moderately acid; clear wavy boundary.

E2--30 to 46 cm (12 to 18 inches); yellowish brown (10YR 5/4) loamy sand; weak fine subangular blocky structure; very friable; few fine roots; about 3 percent gravel; moderately acid; clear wavy boundary. [Combined thickness of the E horizon is 0 to 56 cm (22 inches).]

2Bt1--46 to 76 cm (18 to 30 inches); brown (7.5YR 4/4) gravelly sandy loam; weak coarse subangular blocky structure; firm; few fine roots; few thin clay films on faces of peds; about 15 percent gravel; slightly acid; gradual wavy boundary.

2Bt2--76 to 86 cm (30 to 34 inches); brown (7.5YR 4/4) gravelly sandy clay loam; weak coarse subangular blocky structure; firm; common thin and medium clay films on faces of peds; about 15 percent gravel; neutral; abrupt irregular boundary. [Combined thickness of the 2Bt horizon is 18 to 66 cm (7 to 26 inches).]

3C--86 to 152 cm (34 to 60 inches); grayish brown (10YR 5/2) stratified gravel and coarse sand; single grain; loose; strong effervescence; moderately alkaline.

TYPE LOCATION: Clinton County, Michigan; about 1 1/2 miles north and 3/4 miles west of

Bath; 1090 feet south and 450 feet west of northeast corner sec. 6, T. 5 N., R. 1 W.

RANGE IN CHARACTERISTICS:
Thickness of the solum: 51 to 102 cm (20 to 40 inches)
Depth to the sand and gravel: 51 to 102 cm (20 to 40 inches)
Depth to carbonates: 51 to 102 cm (20 to 40 inches)

Ap or A horizon:
Thickness: A horizon, where present is less than 8 cm (3 inches) in thickness
Hue: 7.5YR or 10YR, or is neutral
Value: 2.5 to 5, 6 dry
Chroma: 0 to 3
Texture: loamy fine sand, loamy sand, sandy loam, fine sandy loam, loam, gravelly loamy sand, or gravelly sandy loam
Rock fragment content: 1 to 30 percent gravel
Reaction: moderately acid to moderately alkaline

E horizon:
Hue: 7.5YR or 10YR
Value: 4 to 6
Chroma: commonly 2 or 3, but ranges to 6
Texture: loamy fine sand, loamy sand, sandy loam, fine sandy loam, gravelly loamy sand, or gravelly sandy loam
Rock fragment content: 1 to 30 percent gravel
Reaction: moderately acid to moderately alkaline

2Bt horizon:
Hue: 10YR to 5YR
Value: 3 to 6
Chroma: 3 to 6
Texture: sandy loam, coarse sandy loam, fine sandy loam, loam, sandy clay loam, coarse sandy clay loam, or the gravelly analogues of these textures; the lower part commonly extends 15 to 30 cm (6 to 12 inches) downward into the 3C horizon in tongues 5 to 15 cm (2 to 6 inches) wide; in some pedons, the lower part consists of layers 5 to 10 cm (2 to 4 inches) thick separated by E horizons of loamy sand
Sand content: 50 percent or more fine sand or coarser
Rock fragment content: 1 to 30 percent gravel
Reaction: moderately acid to moderately alkaline

Some pedons have BC horizons of loamy sand. Some pedons have Bk horizons below the argillic horizon, usually in the form of secondary carbonates on the undersides of rock fragments.

3C horizon:
Hue: 7.5YR or 10YR
Value: 4 to 7
Chroma: 2 to 6

Texture: sand, coarse sand, gravelly sand, very gravelly sand, gravelly coarse sand, very gravelly coarse sand, or stratified sand and gravel
Rock fragment content: 2 to 55 percent gravel

Loamy substratum phases are currently recognized.

COMPETING SERIES: These are the Lapeer and Wyocena series. Lapeer soils do not have sand texture in the fine-earth fraction in the lower part of the series control section. Wyocena soils do not have carbonates within a depth of 102 cm (40 inches).

GEOGRAPHIC SETTING: Boyer soils are on outwash plains, valley trains, kames, beach ridges, river terraces, lake terraces, deltas, and moraines of Wisconsinan age. The slope gradients are dominantly 0 to 12 percent, but range from 0 to 50 percent. Boyer soils formed in sandy and loamy drift underlain by sand or gravelly sand outwash at depths of 51 to 102 cm (20 to 40 inches). Quartz is the dominant mineral in the 3C horizon, which contains, in addition, varying amounts of material from igneous and metamorphic rocks, limestone, and dolomite. Mean annual precipitation ranges from 711 to 1016 mm (28 to 40 inches). Mean annual temperature ranges from 8.3 to 10.0 degrees C (47 to 50 degrees F).

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Gilford, Hillsdale, Lapeer, Miami, Oshtemo, Perrin, Spinks, and Wasepi soils. Boyer soils are the well drained member of drainage sequence that includes the moderately well drained Perrin, poorly drained Gilford, and somewhat poorly drained Wasepi soils. Spinks and Oshtemo soils are closely associated on the outwash plains and valley trains. Miami, Lapeer, and Hillsdale soils on adjoining moraines.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Well drained. Depth to the seasonal high water table is greater than 163 cm (6 feet). Potential surface runoff is negligible to medium depending upon slope. Saturated hydraulic conductivity is high in the solum and very high in the substratum. Permeability is moderately rapid in the solum and very rapid in the substratum.

USE AND VEGETATION: Soils are cultivated in most areas. Principal crops are corn, small grain, soybeans, field beans, and alfalfa hay. A few areas remain in permanent pasture or forest. The dominant forest trees are oaks, hickories, and maples.

DISTRIBUTION AND EXTENT: MLRAs 94A, 95A, 95B, 96, 97, 98, 99, 110, and 111B in southern Michigan, northern Indiana, northern Ohio, southern Wisconsin, and northern Illinois. The type location is in MLRA 98. The series is of large extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: AMHERST, MASSACHUSETTS

SERIES ESTABLISHED: Berrien County, Michigan, 1938.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon: from the surface to a depth of 46 cm (18 inches) (Ap, E1, and E2 horizons).
Argillic horizon: from a depth of 46 to 86 cm (18 to 34 inches) (2Bt1 and 2Bt2 horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION CARBONDALE MI+MN NY VT WI
Established Series
Rev. RWJ-WEF
11/2000

CARBONDALE SERIES

The Carbondale series consists of very deep, very poorly drained soils formed in organic deposits more than 51 inches thick on ground moraines, outwash plains and lake plains. These soils have moderately slow to moderately rapid permeability. Slopes range from 0 to 2 percent. Mean annual precipitation is about 30 inches, and mean annual temperature is about 43 degrees F.

TAXONOMIC CLASS: Euic, frigid Hemic Haplosaprists

TYPICAL PEDON: Carbondale muck - on a slope less than 1 percent in a forested area. (Colors are for moist soil unless otherwise stated.)

Oa1--0 to 5 inches; very dark gray (10YR 3/1) broken face muck, very dark brown (10YR 2/2) rubbed; about 35 percent fiber, less than 10 percent rubbed; weak medium granular structure; primarily herbaceous fibers; slightly acid (pH 6.3 in water); clear smooth boundary.

Oa2--5 to 28 inches; very dark brown (10YR 2/2) broken face and rubbed muck; about 25 percent fiber, less than 5 percent rubbed; weak medium granular structure; primarily herbaceous fibers, few woody fibers; slightly acid (pH 6.4 in water); abrupt smooth boundary.

Oa3--28 to 39 inches; black (10YR 2/1) broken face and rubbed muck; about 10 percent fiber, less than 5 percent rubbed; massive; primarily herbaceous fibers and a few woody fragments; slightly acid (pH 6.4 in water); abrupt smooth boundary.

0e--39 to 60 inches; dark brown (7.5YR 3/2) broken face mucky peat, very dark brown (l0YR 2/2) rubbed; about 70 percent fiber, about 35 percent rubbed; massive; primarily herbaceous fibers; few woody fibers; slightly acid (pH 6.4 in water).

TYPE LOCATION: Emmet County, Michigan; about 6 miles north of Pleasant View; 2,660 feet east and 400 feet north of the southwest corner of sec. 16, T. 37 N., R. 5 W.

RANGE IN CHARACTERISTICS: The organic layers are more than 51 inches thick. Organic material has hue of 10YR to 5YR, or is neutral; value of 2 or 3; and chroma of 0 to 2. Wood fragments, from 1 to several inches in diameter, are throughout some pedons.

Some pedons have a thin 1 to 3 inch layer of peat on the surface. The surface tier contains either muck (sapric material) or mucky peat (hemic material) or both. It generally has granular structure, but in some pedons, the primary structure is weak or moderate coarse blocky or

prismatic. It commonly is derived from herbaceous plants, but in some pedons a moderate amount of the material is woody. Below depths of 12 inches woody materials typically comprise minor amounts of the recognizable fiber. More than one-half the volume of the middle tier is muck (sapric material). Where this layer contains muck, mucky peat, and peat, muck is the largest component. The subsurface tier has mainly pH of 6.5 to 7.5 in calcium chloride and 5.1 to 7.0 in water, and the full range is from 5.5 to less than 7.8 in calcium chloride. Below depths of 12 inches the soil is commonly massive, but some of it breaks into thick to thin plates which appear to be related to the mode of deposition. The bottom tier commonly is dominated by mucky peat (hemic material), and in some pedons the entire layer is mucky peat. More than 10 inches of the subsurface and bottom tiers are mucky peat.

COMPETING SERIES: There are no competing series. Closely related series are the Cathro, Greenwood, Markey, Rifle, and Tawas series. Cathro, Markey, and Tawas soils have mineral soil material at depths of less than 51 inches. Greenwood soils are dysic. In addition, the middle tier is dominated by mucky peat. Rifle soils have mucky peat dominant in the middle tier and have less than 10 inches of muck or peat in the middle and lower tiers.

GEOGRAPHIC SETTING: Carbondale soils are in depressions on ground moraines, outwash plains, and lake plains. Small areas of these soils are common between drumlins or eskers. The mean annual precipitation is ranges from about 27 to 44 inches, and the mean annual temperature ranges from 40 to 45 degrees F.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Cathro, Markey, and Tawas soils which are near the edges of the Carbondale soils. The Angelica, Ensley, and Roscommon are mineral soils commonly on the margins of the Carbondale soils.

DRAINAGE AND PERMEABILITY: Very poorly drained. Depth to the seasonal high water table ranges from 1 foot above to 1 foot below the surface at times during the period from November to May.. Surface runoff is ponded. Permeability is moderately slow to moderately rapid.

USE AND VEGETATION: Most of these soils are in forest of northern whitecedar, balsam fir, black spruce, and white birch. Small areas are cleared and used for pasture.

DISTRIBUTION AND EXTENT: Michigan, New York, Vermont, and Wisconsin. The series is of large extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: St. Paul, Minnesota

SERIES ESTABLISHED: Chippewa County, Michigan, 1927.

REMARKS: Diagnostic horizons and features recognized in this pedon are: organic material greater than 51 inches thick; hemic material greater than 25 cm thick in the subsurface of bottom tiers - Hemic subgroup.

ADDITIONAL DATA: Soil Interpretation Record No.: MI0089

National Cooperative Soil Survey
U.S.A.

LOCATION CATHRO MI+ME MN ND NY VT WI
Established Series
Rev. WEM-WEF-LMC-AGG
06/2006

CATHRO SERIES

The Cathro series consists of very deep, very poorly drained organic soils moderately deep to loamy materials. They formed in organic material 16 to 51 inches thick overlying loamy glacial deposits on ground moraines, end moraines, outwash plains, lake plains, stream terraces, and flood plains. Permeability is moderately slow to moderately rapid in the organic material and moderately slow or moderate in the loamy material. Slopes range from 0 to 2 percent. Mean annual precipitation is about 32 inches. Mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Loamy, mixed, euic, frigid Terric Haplosaprists

TYPICAL PEDON: Cathro muck - on a slope of 1 percent in a forested area (Colors are for moist conditions unless otherwise stated.)

0a1--0 to 6 inches; black (5YR 2/1) rubbed and pressed muck (sapric material); about 40 percent fiber, about 15 percent rubbed; weak fine granular structure; nonsticky; primarily herbaceous fibers; neutral (pH 6.8 in water); clear wavy boundary.

0a2--6 to 11 inches; black (5YR 2/1) broken face and rubbed muck (sapric material), dark reddish brown (5YR 2/2) pressed; about 35 percent fiber, about 10 percent rubbed; weak medium granular structure; nonsticky; primarily herbaceous fibers; neutral (pH 6.8 in water); clear smooth boundary.

0a3--11 to 23 inches; black (5YR 2/1) on broken face and rubbed muck (sapric material); about 40 percent fibers, less than 10 percent rubbed; massive; nonsticky; primarily herbaceous fibers; neutral (pH 6.8 in water); abrupt smooth boundary. (Combined thickness of Oa horizons is 15 to 51 inches.)

Cg--23 to 60 inches; grayish brown (2.5Y 5/2) sandy loam; massive; slightly sticky; common coarse prominent reddish brown (5YR 5/3) and common coarse distinct brown (10YR 5/3) Fe concentrations; strongly effervescent; moderately alkaline.

TYPE LOCATION: Delta County, Michigan; about 4 miles south of Ensign; 1,620 feet north and 200 feet east of the southwest corner of sec. 23, T. 40 N., R. 21 W.

RANGE IN CHARACTERISTICS: The depth to the loamy C horizon ranges from 16 to 51 inches. Woody fragments over 2cm in size comprise less than 15 percent of the organic material. The organic portion of the control section has hue of 10YR, 7.5YR, or 5YR; value of 2 or 3; and chroma of 0 to 3 or are neutral. In some pedons the value or chroma or both increases 1 or 2 units

when exposed to the air. The organic portion of the control section ranges from pH 4.5 to less than pH 7.8 in calcium chloride and does not have free carbonates.

The surface tier exclusive of loose surface litter or mosses, is comprised of mucky peat (hemic material) or muck (sapric material) material with an unrubbed fiber content that ranges from about 20 percent to 50 percent; rubbed is less than 20 percent. Up to 4 inches of peat is on the surface in some pedons. The surface tier is weak or moderate fine granular structure. Typically the structure grade becomes stronger as the amount of recognizable woody material increases.

The subsurface tier is muck (sapric material). The unrubbed fiber content ranges from 50 to less than 10 percent and is less than 16 percent after rubbing. Some pedons have thin layers of mucky peat (hemic material) in the control section. Ash content of the organic layer just above the loamy substratum is as much as 40 percent in some pedons.

A thin A horizon is present in some pedons. It has hue of 10YR, 2.5Y, 5Y or is neutral, value of 2 or 3 and chroma of 0 to 2. It is sandy loam, fine sandy loam, sandy clay loam, loam, silt loam or their mucky analogs. It ranges from moderately acid to slightly alkaline.

The C horizon has hue of 5YR, 7.5YR, 10YR, 2.5Y, 5GY, 5GB, or 5Y; value of 4 to 6; and chroma of 1 to 3. It is sandy loam, fine sandy loam, very fine sandy loam, sandy clay loam, loam, silt loam, clay loam or silty clay loam. Stratified substratums phases containing thin strata of fine sand or sand, less than 3 inches thick are recognized. It ranges from moderately acid to moderately alkaline. Coarse fragments range from 0 to 25 percent by volume. Some pedons do not contain free carbonates.

COMPETING SERIES: These are the Berner, Bullwinkle, Dingle, Nidaros, and Wonsqueak series. Berner soils have a sandy layer above the loamy sediment. Bullwinkle soils have greater than 15 percent woody fragments in the organic material. Dingle soils occur in areas with 14 to 16 inches of annual precipitation and in elevations from 5900 to 6000 feet. Nidaros soils have sandy underlying materials. Wonsqueak soils are substantially drier in the moisture control section during the 120 days following the summer solstice.

GEOGRAPHIC SETTING: Cathro soils commonly are in relatively small depressions mainly within ground moraines, end moraines, lake plains and outwash plains. A few areas are on narrow flood plains. Individual bodies range in size from about 10 to 100 acres. Slopes are 0 to 2 percent. The ground water carrying minerals from the surrounding upland, influences the composition of the organic deposit. Mean annual precipitation ranges from about 19 to 43 inches. Mean annual air temperature ranges from 36 to 45 degrees F. Frost-free days range from 70 to 145. Elevation above sea levl ranges from 600 to 2,000 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Carbondale and Rifle soils that occupy similar landscape positions and the Angelica and Ensley soils. Angelica and Ensley soils are poorly drained mineral soils commonly located adjacent to the edges of Cathro soils. The Carbondale soils have hemic soil materials within 51 inches. Rifle soils formed in hemic materials 51 inches or greater.

DRAINAGE AND PERMEABILITY: Very poorly drained. Depth to the seasonal high saturation ranges from 1 foot above the surface to 0.5 foot below the surface at some time from October to June in most years. Ponded phases have a seasonal high saturation from 4 foot above the surface to 0.5 foot below the surface throughout the year. Surface runoff is neglible to low. Permeability is moderately rapid to moderately slow in the organic portion and moderately slow or moderate in the mineral substratum. Stratified substratum phases have saturated hydraulic conductivity ranging up to moderately rapid or rapid in the individual sand strata.

USE AND VEGETATION: Most of these soils are in woodland, however some are in sedge and cattails. Vegetation includes white cedar, alder, and balsam fir. A few areas are cleared and are used for pasture.

DISTRIBUTION AND EXTENT: Northern Lower Peninsula and Upper Peninsula of Michigan, northern Minnesota, northern Wisconsin and upper New England.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: St. Paul, Minnesota.

SERIES ESTABLISHED: Delta County, Michigan, 1969.

REMARKS: Diagnostic horizons and features recognized in this pedon are: sapric material from the surface to 23 inches (Oa1, Oa2, and Oa3 horizons); terric feature at 23 inches (Cg horizon); aquic moisture regime (low chroma in the soil moisture control section.)

National Cooperative Soil Survey
U.S.A.

LOCATION HORTONVILLE WI

Established Series
Rev. HFG-AAC
12/2010

HORTONVILLE SERIES

The Hortonville series consists of very deep, well drained soils formed primarily in calcareous loamy till on drumlins and ground moraines. Slope ranges from 1 to 35 percent. Mean annual precipitation is about 762 mm (30 inches). Mean annual temperature is about 8.9 degrees C (48 degrees F).

TAXONOMIC CLASS: Fine-loamy, mixed, active, mesic Haplic Glossudalfs

TYPICAL PEDON: Hortonville fine sandy loam - on a west-facing 2 percent slope in an alfalfa-red clover field at an elevation of about 268 meters (880 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 23 cm (0 to 9 inches); dark grayish brown (10YR 4/2) fine sandy loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; friable; common fine roots; about 6 percent gravel; slightly acid; abrupt smooth boundary. [15 to 23 cm (6 to 9 inches) thick]

B/E--23 to 31 cm (9 to 12 inches); about 75 percent brown (7.5YR 4/4) sandy clay loam (Bt); strong fine and medium subangular blocky structure; firm; common faint dark brown (7.5YR 3/4) clay films on faces of peds; penetrated by tongues of brown (10YR 5/3) fine sandy loam (E), light gray (10YR 7/2) dry; weak medium platy structure; friable; common fine roots; few worm holes and casts in upper 3 to 5 cm (1 to 2 inches); about 1 percent gravel; slightly acid; clear wavy boundary. [Glossic horizon - 5 to 48 cm (2 to 19 inches) thick]

Bt1--31 to 41 cm (12 to 16 inches); reddish brown (5YR 4/4) clay loam; weak coarse prismatic structure parting to strong fine angular blocky; firm; common fine roots; many faint reddish brown (5YR 4/3) clay films on faces of peds; few light gray (10YR 7/2) dry, coatings on vertical faces of prisms; about 1 percent gravel; neutral; clear wavy boundary.

Bt2--41 to 56 cm (16 to 22 inches); reddish brown (5YR 4/4) clay loam; weak coarse prismatic structure parting to strong fine angular blocky; firm; common fine roots; many faint reddish brown (5YR 4/3) clay films on faces of peds; about 5 percent gravel; slightly alkaline; clear wavy boundary.

Bt3--56 to 71 cm (22 to 28 inches); reddish brown (5YR 4/4) loam; moderate medium subangular blocky structure; firm; common fine roots; few faint reddish brown (5YR 4/3) clay films mainly on vertical faces of peds; about 12 percent gravel and 2 percent cobbles; slightly alkaline; clear wavy boundary. [Combined thickness of the Bt horizons ranges from 20 to 76 cm

(8 to 30 inches).]

C--71 to 152 cm (28 to 60 inches); reddish brown (5YR 4/4) fine sandy loam; massive; firm; few fine roots; about 10 percent gravel and 2 percent cobbles; slightly effervescent; moderately alkaline.

TYPE LOCATION: Waupaca County, Wisconsin; about 1.5 miles south and 2 miles west of Weyauwega; 2580 feet south and 1080 feet west of the northeast corner of sec. 18, T. 21 N., R. 13 E.; USGS Weyauwega, Wisconsin topographic quadrangle;I lat. 44 degrees 17 minutes 37 seconds N., and long. 88 degrees 57 minutes 56 seconds W., NAD 27

RANGE IN CHARACTERISTICS:
Depth to the base of the argillic horizon: 51 to 102 cm (20 to 40 inches)
Depth to carbonates: 51 to 102 cm (20 to 40 inches)
Thickness of the loess mantle: less than 30 cm (12 inches)
Clay content in the particle-size control sectin: averages from 27 to 35 percent but ranges from 20 to 40 percent in the in individual subhorizons of the argillic.
Volume of gravel: 1 to 15 percent throughout
Volume of cobbles: 0 to 5 percent throughout
Reaction: moderately acid or slightly acid in the surface layer and upper subsoil but ranges to slightly alkaline, where the soil is limed, and ranges from moderately acid to slightly alkaline in the lower part of the subsoil and is slightly alkaline or moderately alkaline in the substratum.
Calcium carbonate equivalent: 5 to 40 percent in the substratum

Ap horizon:
Hue: 7.5YR or 10YR
Value: 3 or 4, dry value exceeds 5.5
Chroma: 2 or 3
Texture: silt loam, loam, or fine sandy loam

A horizon [3 to 13 cm (1 to 5 inches) thick]:
Hue: 7.5YR or 10YR
Value: 2 or 3
Chroma: 1 or 2
Texture: silt loam, loam, or fine sandy loam.

E horizon (where present):
Hue: 7.5YR or 10YR
Value: 4 to 6
Chroma: 2 or 3, colors of 4/3 and 5/3 have dry value of 7 or more
Texture: fine sandy loam, loam, or silt loam.

E/B or B/E or 2E/B or 2B/E glossic horizon:
E part:
Hue: 7.5YR or 10YR
Value: 4 to 6

Chroma: 2 or 3, colors of 4/3 and 5/3 have dry value of 7 or more
Texture: fine sandy loam or loam
Bt part:
Hue: 5YR or 7.5YR
Value: 3 to 6
Chroma: 4 to 6
Texture: silty clay loam with more than 15 percent sand or clay loam but is sandy clay loam in some pedons

Bt or 2Bt horizon:
Hue: 2.5YR, 5YR or 7.5YR
Value: 3 to 6
Chroma: 4 to 6
Texture: clay loam or silty clay loam with more than 15 percent sand but grades to loam or fine sandy loam in the lower part in most pedons

C horizon:
Hue: 5YR or 7.5YR
Value: 4 or 5
Chroma: 4 to 6
Texture: fine sandy loam or loam
Calcium carbonate equivalent: 15 to 40 percent

COMPETING SERIES: These are the Guelph, and Waymor series. Guelph soils have hues yellower than 5YR throughout the argillic horizon. Waymor soils average 18 to 27 percent clay in the particle size control section.

GEOGRAPHIC SETTING: Hortonville soils are on drumlins and ground moraines. Slope ranges from 1 to 35 percent. Hortonville soils formed mostly in calcareous loamy till of late Wisconsinan Age. Mean annual precipitation ranges from 710 to 840 mm (28 to 33 inches). Mean annual air temperature ranges from 8.3 to 10.0 degrees C (46 to 50 degrees F). The frost free period ranges from about 135 to 155 days. Elevation ranges from 213 to 305 meters (700 feet to 1000 feet).

GEOGRAPHICALLY ASSOCIATED SOILS: These are mainly the Symco and Kewaunee soils. The somewhat poorly drained Symco soils form a drainage sequence with the Hortonville soils. Kewaunee soils are nearby on landscape positions similar to those of Hortonville soils where there is more clay in the soil.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Well drained. The potential for surface runoff ranges from medium to very high. saturated hydraulic conductivity is moderately high (1.41 to 4.23 micrometers per second). Permeability is moderately slow.

USE AND VEGETATION: Most areas are used for cropland. Common crops are corn, small grain, and hay. A few areas are used for pastureland or woodland. Native vegetation is mixed hardwood forest. Common trees are American basswood, sugar maple, northern red oak, and

yellow birch.

DISTRIBUTION AND EXTENT: East-central Wisconsin. Hortonville soils are of large extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Indianapolis, Indiana

SERIES ESTABLISHED: Outagamie County, Wisconsin, 1975.

REMARKS: The Hortonville soils were formerly included with the Kewaunee series.

A new series is needed for 1,755 acres correlated as Hortonville, limestone substratum in Outagamie County (limestone at 40 to 60 inches).

In Winnebago County, there are 28,568 acres correlated as a Taxadjunt to the Hortonville series because they do not have a glossic horizon. It appears they classify as fine-loamy, mixed, active, mesic Typic Hapludalfs. They do not fit any existing series. A new series is needed.

10/04 The difference in concept between Hortonville and Waymor is unclear. It appears that, at the time of mapping, the concept was that Hortonville had more clay than Waymor in the lower subsoil and in the substratum. However, numerous field descriptions and limited lab data do not show a significant mutually exclusive difference. This revision differentiates the two soils based on the weighted average clay content in the particle-size control section (18-27% for Waymor and 27-35% for Hortonville). The limited lab data available supports this. However, field descriptions do not entirely support this separation. For example, the typical pedon for Waymor in Kewaunee County has textures of silty clay loam and clay loam in the argillic horizon. If the textures are correct, this pedon would average more than 27 percent clay in the argillic. Additional study of these two soils is needed to determine if they can be separated and on what criteria.

Diagnostic horizons and features recognized in this pedon are: ochric epipedon - 0 to 23 cm (0 to 9 inches) (Ap); glossic horizon - 23 to 31 cm (9 to 12 inches) (B/E); argillic horizon - 23 to 71 cm (9 to 28 inches) (B/E, Bt1, Bt2, Bt3); haplic feature - glossic horizon less than 51 cm (20 inches) thick.

ADDITIONAL DATA: Refer to soil survey sample number S78WI-135-003 for NSSL data on the typical pedon.

National Cooperative Soil Survey
U.S.A.

LOCATION ZURICH IL+OH WI
Established Series
Rev. GOW-JEP-DEC
07/2007

ZURICH SERIES

The Zurich series consists of very deep, moderately well drained soils which formed in loess or silty material and in the underlying calcareous, loamy outwash. These soils occur on outwash plains. Slope ranges from 0 to 35 percent. Mean annual precipitation is about 840 mm (33 inches), and mean annual air temperature is about 9 degrees C (49 degrees F).

TAXONOMIC CLASS: Fine-silty, mixed, superactive, mesic Oxyaquic Hapludalfs

TYPICAL PEDON: Zurich silt loam - on a west-facing slope with a 2 percent gradient in a wooded area at an elevation of 195 meters (640 feet). (Colors are for moist condition unless otherwise stated.)

A--0 to 13 cm (0 to 5 inches); very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; few very fine and fine roots; neutral; clear smooth boundary. [5 to 15 cm (2 to 6 inches) thick]

E--13 to 23 cm (5 to 9 inches); 60 percent dark grayish brown (10YR 4/2) and 40 percent brown (10YR 4/3) silt loam, light brownish gray (10YR 6/2) dry; weak medium platy structure parting to weak fine subangular blocky; friable; few very fine and fine roots; common distinct very dark grayish brown (10YR 3/2) organic coatings on faces of peds; slightly acid; clear smooth boundary. [0 to 20 cm (0 to 8 inches) thick]

BE--23 to 41 cm (9 to 16 inches); dark yellowish brown (10YR 4/4) silt loam; weak fine subangular blocky structure; friable; few very fine and fine roots; few distinct light brownish gray (10YR 6/2) dry silt coatings on faces of peds; few distinct brown (10YR 4/3) clay films on faces of peds; moderately acid; clear smooth boundary. [0 to 20 cm (0 to 8 inches) thick]

Bt1--41 to 58 cm (16 to 23 inches); brown (7.5YR 4/4) silty clay loam; moderate fine and medium subangular blocky structure; friable; few very fine roots; few distinct light brownish gray (10YR 6/2) dry silt coatings on faces of peds; many distinct brown (7.5YR 4/3) clay films on faces of peds; slightly acid; clear smooth boundary.

Bt2--58 to 71 cm (23 to 28 inches); brown (7.5YR 4/4) silt loam; weak medium prismatic structure parting to moderate medium subangular blocky; friable; few very fine roots; common distinct brown (7.5YR 4/3) clay films on faces of peds; neutral; clear smooth boundary. [Combined thickness of the Bt horizon is 25 to 64 cm (10 to 25 inches).]

2Bt3--71 to 79 cm (28 to 31 inches); brown (7.5YR 4/3) loam; moderate medium subangular blocky structure; friable; few very fine roots; common distinct brown (7.5YR 4/2) clay films on faces of peds; common medium distinct grayish brown (10YR 5/2) and common medium prominent light brownish gray (10YR 6/2) iron depletions in the matrix; very slightly effervescent; slightly alkaline; clear smooth boundary. [8 to 30 cm (3 to 12 inches) thick]

2BC--79 to 97 cm (31 to 38 inches); yellowish brown (10YR 5/4) loam; moderate medium subangular blocky structure; friable; few very fine roots; common fine black (10YR 2/1) very weakly cemented iron and manganese oxide concretions throughout; common medium distinct yellowish brown (10YR 5/6) and brown (7.5YR 4/4) masses of iron accumulation in the matrix; many medium and coarse distinct light brownish gray (10YR 6/2) iron depletions in the matrix; slightly effervescent; moderately alkaline; gradual smooth boundary. [0 to 20 cm (0 to 8 inches) thick]

2C--97 to 163 cm (38 to 64 inches); 70 percent yellowish brown (10YR 5/4 and 5/6) and 30 percent light brownish gray (10YR 6/2) stratified silt loam and very fine sandy loam; massive; friable; common fine black (10YR 2/1) very weakly cemented iron and manganese oxide concretions throughout; few fine and medium white (10YR 8/1) carbonate concretions throughout; strongly effervescent; moderately alkaline.

TYPE LOCATION: Lake County, Illinois, about 3.2 kilometers (2 miles) southeast of Half Day; 689 meters (2,260 feet) east and 91 meters (300 feet) north of southwest corner of sec. 23, T. 43 N., R. 11 E.; USGS Wheeling topographic quadrangle; lat. 42 degrees 10 minutes 59 seconds N. and long. 87 degrees 55 minutes 03 seconds W., NAD 27; UTM Zone 16, 424215E, 4670516N, NAD 83.

RANGE IN CHARACTERISTICS: The depth to the base of soil development ranges from 61 to 114 cm (24 to 45 inches). The depth of horizons containing more than 15 percent sand ranges from 51 to 102 cm (20 to 40 inches). Depth to carbonates is typically 64 to 89 cm (25 to 35 inches) but ranges from 51 to 102 cm (20 to 40 inches).

The upper part of the series control section (Ap, A, or E horizon) is silt loam. The Ap or A horizon has hue of 10YR, value of 3 or 4, and chroma of 1 to 3. Value of 5 is allowed in eroded pedons.

The E horizon, when present, has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. Reaction ranges from moderately acid to neutral.

The second part of the series control section (Bt horizon) has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It is silty clay loam or silt loam. Average clay content ranges from 25 to 35 percent. Reaction ranges from strongly acid to slightly alkaline.

The third part of the series control section (2Bt or 2BC horizon) has hue of 7.5YR, 10YR, or 2.5Y; value of 4 to 6; and chroma of 2 to 6. It is silt loam, loam, sandy loam, or fine sandy loam. Reaction ranges from neutral to moderately alkaline.

The lower part of the series control section (2C horizon) has hue of 10YR or 2.5Y, value of 4 to 6, and chroma 2 to 8. It is loam, sandy loam, silt loam, silt, loamy sand, sand, or the fine or very fine analogs where appropriate. The sand fraction in individual strata or subhorizons is poorly sorted and well graded. Gravel content is less than 15 percent. Reaction is slightly alkaline or moderately alkaline.

COMPETING SERIES: These are the Baraboo, Birkbeck, Cadiz, Campton, Elco, Eleroy, Homen, Inton, Iona, Libre, Mayville, Minnith, Morningsun, Redbud, Rocheport, Rockfield, Somonauk, Uniontown, and Winfield series. Libre, Minnith, Rockfield, Somonauk and Morningsun soils do not have carbonates within a depth of 40 inches. Birkbeck, Campton, Homen, Inton, Iona, Redbud, Uniontown, and Winfield soils are greater than 40 inches to horizons containing more than 15 percent sand. Elco and Cadiz soils contain more than 25 percent clay in the lower part of the series control section. Eleroy, Rocheport, and Baraboo soils have a lithic or paralitihic contact within the series control section. Mayville soils are not stratified and have well graded and poorly sorted sand fraction in the lower part of the series control section.

GEOGRAPHIC SETTING: Zurich soils typically are on convex slopes which are gently rolling to very steep in outwash plains of Wisconsin Age. Slopes commonly are between 1 and 18 percent, but range from 0 to 35 percent. The soils formed in 51 to 102 cm (20 to 40 inches) of loess or silty material and calcareous stratified outwash. Climate has cold winters and hot summers. Mean annual air temperatures range from 7 to 11 degrees C (45 to 52 degrees F.), annual precipitation ranges from 740 to 1140 mm (29 to 45 inches), frost free days range from 140 to 180, and elevation ranges from 183 to 305 meters (600 to 1,000 feet).

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Aptaksic, Grays, and Saylesville soils. Aptakistic soils are the somewhat poorly drained member of the same drainage sequence and are on the more level areas in the landscape. Grays soils are mollic intergrades and are on similar landscape positions nearby. The Saylesville soils which contain more clay are on lakebed positions nearby.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Moderately well drained. An intermittent apparent seasonal high water table is from 61 to 107 cm (2 to 3.5 feet) below the surface from December to April in most years. The potential for surface runoff is medium to high. Saturated hydraulic conductivity is moderately high to high (4.23-14.11 micrometer/second). Permeability is moderate (0.60-2.00 inches/hour).

USE AND VEGETATION: Most areas are cropped or urbanized. Crops commonly grown are corn, soybeans, and small grain. Natural hardwood forest was oak, hickory and maple.

DISTRIBUTION AND EXTENT: Eastern Illinois, southeastern Wisconsin, and possibly northern Indiana. Known extent is small in MLRAs 95A, 95B, and 110.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Indianapolis, Indiana

SERIES ESTABLISHED: Lake County, Illinois, 1970.

REMARKS: With this revision the typical pedon site was resampled and redescribed.

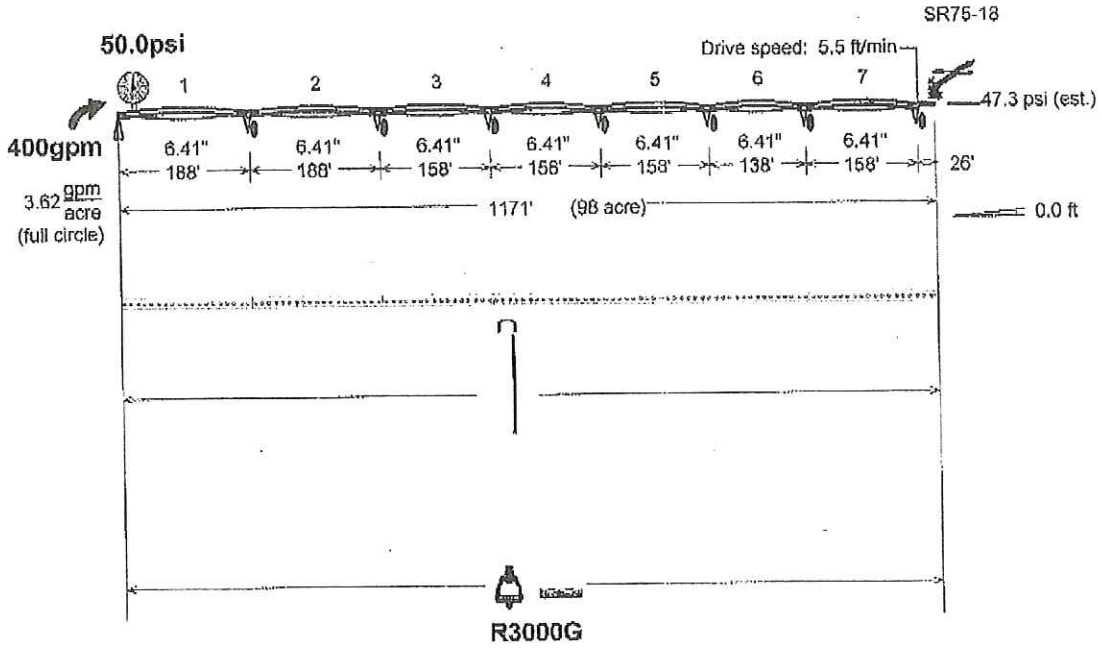
Diagnostic horizons and features recognized in this pedon are: ochric epipedon - the zone from the surface to a depth of 23 cm (9 inches) (A and E horizons); argillic horizon - the zone from 41 to 79 cm (16 to 31 inches) (Bt1, Bt2, and 2Bt3 horizons); lithologic discontinuity - the contact between the Bt2 and 2Bt3 horizons at 71 cm (28 inches); udic moisture regime.

National Cooperative Soil Survey
U.S.A.

EXHIBIT 2

T-L Irrigation

31013	TATRO IRRIG. & POTATO	RANDY EBERT
30 May 2012	CUSTER, WI 54423	R3000G - TB BODY
	30003	STEEL 9'



DISCLAIMER

The products manufactured by Nelson Irrigation Corporation which are specified as a part of this system design are covered by the manufacturer's printed "Warranty and Disclaimer", which applies to the individual components of its own manufacture. The manufacturer cannot be responsible for the performance of the system and makes no warranties, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE and does hereby disclaim any liability for damages due to failure of the system to perform as anticipated.

Nelson Irrigation Corporation WinCHART 2.10

T-L Irrigation
CENTER PIVOT SPRINKLER CHART
LOG NUMBER: 31013
DATE: 30 May 2012

CUSTOMER: TATRO IRRIG. & POTATO
CUSTER, WI 54423
30003

IDENTIFYING MARKS: RANDY EBERT
R3000G - TB BODY
STEEL 9'

NUMBER OF TOWERS:	7	NOZZLE FILES:	R3000G
PIVOT PRESSURE:	50.0 psi	FRICTION C-FACTOR:	135
TOTAL SYSTEM FLOW:	400.0 gpm	FULL CIRCLE GPM / ACRE:	3.6
TOTAL PIPE LENGTH:	1171.6 FT	COVERAGE WITHOUT GUN:	1174.8 FT
END GUN TYPE:	SR75-18	ADJ. END GUN RADIUS:	65.6 ft

SYSTEM MANUFACTURER: T-L

			FT	PIPE ID
1	765+	SPAN 1,	188.2,	6.41 in
1	765+	SPAN 2,	187.5,	6.41 in
3	865	SPANS 3- 5,	158.0,	6.41 in
1	965	SPAN 6,	138.3,	6.41 in
1	865	SPAN 7,	158.0,	6.41 in
1	25	OVERHANG,	25.6,	4.79 in

DISCLAIMER

The products manufactured by Nelson Irrigation Corporation which are specified as a part of this system design are covered by the manufacturer's printed "Warranty and Disclaimer", which applies to the individual components of its own manufacture. The manufacturer cannot be responsible for the performance of the system and makes no warranties, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE and does hereby disclaim any liability for damages due to failure of the system to perform as anticipated.

WinCHART 2.10

----OUTLET---- No	Loc	Sep	-REG- Model	PSI SprIn	---GPM--- Req	Del	----SPRINKLER----- Model	Plate	SpNo.	---NOZZLE---
-x-							PLUG			
3	35.1	35.1		52.3	0.6	2.4	T3000R	Green	1	#14 Lime
4							PLUG			
5	45.0									
6	54.8	19.7		52.2	0.8	2.4	T3000R	Green	2	#14 Lime
7							PLUG			
8	64.6									
9	74.5	19.7		52.2	0.9	2.4	T3000R	Green	3	#14 Lime
10							PLUG			
11	84.3									
12	94.2	19.7		52.1	1.1	2.4	T3000R	Green	4	#14 Lime
13							PLUG			
14	104.0									
15	113.8	19.7		52.0	1.1	2.4	T3000R	Green	5	#14 Lime
16							PLUG			
17	123.7									
18	133.5	19.7		51.9	1.3	2.4	T3000R	Green	6	#14 Lime
19							PLUG			
	143.4									
	153.2	19.7		51.8	1.5	2.4	T3000R	Green	7	#14 Lime
							PLUG			
	163.0									
	172.9	19.7		51.8	1.7	2.4	T3000R	Green	8	#14 Lime
	182.7						PLUG			
	188.2	TOWER NO. 1			INLINE PRESSURE: 49.3 psi					
20	193.1	20.2		51.7	1.9	2.4	T3000R	Green	9	#14 Lime
21							PLUG			
22	202.9									
23	212.8	19.7		51.6	2.1	2.4	T3000R	Green	10	#14 Lime
24							PLUG			
25	222.6									
26	232.4	19.7		51.6	2.3	2.4	T3000R	Green	11	#14 Lime
27							PLUG			
28	242.3									
29	252.1	19.7		51.5	2.5	2.4	T3000R	Green	12	#14 Lime
30							PLUG			
31	262.0									
32	271.8	19.7		51.4	2.8	2.8	T3000R	Green	13	#15 Lime w/lav
33							PLUG			
34	281.6									
35	291.5	19.7		51.3	2.9	2.8	T3000R	Green	14	#15 Lime w/lav
36							PLUG			
37	301.3									
38	311.2	19.7		51.2	3.2	3.1	T3000R	Green	15	#16 Lavender
39							PLUG			
40	321.0									
41	330.9	19.7		51.0	3.4	3.5	T3000R	Green	16	#17 Lvndr w/gra
42							PLUG			
43	340.7									
44	350.5	19.7		51.0	3.4	3.5	T3000R	Green	17	#17 Lvndr w/gra
45							PLUG			
46	360.4									
47	370.2	19.7		50.9	3.7	3.5	T3000R	Green	18	#17 Lvndr w/gra
48							PLUG			
	375.7	TOWER NO. 2			INLINE PRESSURE: 48.7 psi					
49	380.6						PLUG			
50	390.4	20.2		50.8	4.1	3.9	T3000R	Green	19	#18 Gray
51							PLUG			
	400.3									
	410.1	19.7		50.6	4.2	4.4	T3000R	Green	20	#19 Gray w/trqu
							PLUG			
	420.0									
	429.8	19.7		50.5	4.2	4.4	T3000R	Green	21	#19 Gray w/trqu
							PLUG			
	439.6									
	449.5	19.7		50.5	4.4	4.4	T3000R	Green	22	#19 Gray w/trqu
							PLUG			
	459.3									
	469.1	19.7		50.3	4.7	4.9	T3000R	Green	23	#20 Turquoise
							PLUG			
	479.0									
	488.8	19.7		50.2	4.8	4.9	T3000R	Green	24	#20 Turquoise
	498.7						PLUG			

----OUTLET---- No	Loc	Sep	-REG- Model	PSI SprIn	---GPM--- Req	Del	----SPRINKLER----- Model	Plate	SpNo.	---NOZZLE---
52	508.5	19.7		50.2	4.9	4.9	T3000R	Green	25	#20 Turquoise
53	518.3						PLUG			
54	528.2	19.7		50.0	5.4	5.3	T3000R	Green	26	#21 Trqu w/yllw
	533.7	TOWER NO. 3			INLINE PRESSURE: 48.2 psi					
55	538.6						PLUG			
56	548.4	20.2		49.8	5.7	5.9	T3000R	Green	27	#22 Yellow
57	558.3						PLUG			
58	568.1	19.7		49.9	5.5	5.3	T3000R	Green	28	#21 Trqu w/yllw
59	578.0						PLUG			
60	587.8	19.7		49.7	6.1	5.8	T3000R	Green	29	#22 Yellow
61	597.6						PLUG			
62	607.5	19.7		49.5	6.3	6.3	T3000R	Green	30	#23 Yllw w/red
63	617.3						PLUG			
64	627.2	19.7		49.4	6.2	6.3	T3000R	Green	31	#23 Yllw w/red
65	637.0						PLUG			
66	646.8	19.7		49.4	6.3	6.3	T3000R	Green	32	#23 Yllw w/red
67	656.7						PLUG			
68	666.5	19.7		49.1	6.7	7.0	T3000R	Green	33	#24 Red
69	676.3						PLUG			
70	686.2	19.7		49.1	6.8	7.0	T3000R	Green	34	#24 Red
	691.7	TOWER NO. 4			INLINE PRESSURE: 47.9 psi					
71	696.6						PLUG			
72	706.4	20.2		49.0	7.0	7.0	T3000R	Green	35	#24 Red
73	716.3						PLUG			
74	726.1	19.7		48.8	7.3	7.5	T3000R	Green	36	#25 Red w/white
75	736.0						PLUG			
76	745.8	19.7		48.8	7.3	7.5	T3000R	Green	37	#25 Red w/white
77	755.6						PLUG			
78	765.5	19.7		48.7	7.4	7.5	T3000R	Green	38	#25 Red w/white
79	775.3						PLUG			
80	785.2	19.7		48.7	7.8	7.5	T3000R	Green	39	#25 Red w/white
81	795.0						PLUG			
82	804.8	19.7		48.4	8.3	8.1	T3000R	Green	40	#26 White
83	814.7						PLUG			
84	824.5	19.7		48.1	8.4	8.7	T3000R	Green	41	#27 White w/blu
85	834.3						PLUG			
86	844.2	19.7		48.4	8.3	8.1	T3000R	Green	42	#26 White
	849.7	TOWER NO. 5			INLINE PRESSURE: 47.6 psi					
87	854.6						PLUG			
88	864.4	20.2		48.1	9.0	8.7	T3000R	Green	43	#27 White w/blu
89	874.3						PLUG			
90	884.1	19.7		47.7	9.1	9.4	T3000R	Green	44	#28 Blue
91	894.0						PLUG			
92	903.8	19.7		48.1	8.8	8.7	T3000R	Green	45	#27 White w/blu
93	913.6						PLUG			
94	923.5	19.7		47.7	9.3	9.4	T3000R	Green	46	#28 Blue
95	933.3						PLUG			
96	943.2	19.7		47.7	9.3	9.4	T3000R	Green	47	#28 Blue
97	953.0						PLUG			

----OUTLET---- No	Loc	-REG- Sep	Model	PSI Sprln	---GPM--- Req	Del	-----SPRINKLER----- Model	Plate	SpNo.	---NOZZLE---
98	962.8	19.7		47.7	9.6	9.4	T3000R	Green	48	#28 Blue
99	972.7						PLUG			
100	982.5	19.7		47.3	10.1	10.0	T3000R	Green	49	#29 Blue w/brn
	988.0	TOWER NO. 6			INLINE PRESSURE: 47.5 psi					
101	992.9						PLUG			
102	1002.8	20.3		47.3	10.2	10.0	T3000R	Green	50	#29 Blue w/brn
103	1012.6						PLUG			
104	1022.4	19.7		46.9	10.4	10.7	T3000R	Green	51	#30 Drk Brown
105	1032.3						PLUG			
106	1042.1	19.7		47.3	10.1	10.0	T3000R	Green	52	#29 Blue w/brn
107	1052.0						PLUG			
108	1061.8	19.7		46.9	10.7	10.7	T3000R	Green	53	#30 Drk Brown
109	1071.6						PLUG			
110	1081.5	19.7		46.9	10.8	10.7	T3000R	Green	54	#30 Drk Brown
111	1091.3						PLUG			
112	1101.2	19.7		46.6	11.1	11.3	T3000R	Green	55	#31 Brwn w/orng
113	1111.0						PLUG			
114	1120.8	19.7		46.6	11.1	11.3	T3000R	Green	56	#31 Brwn w/orng
115	1130.7						PLUG			
116	1140.5	19.7		46.6	11.3	11.3	T3000R	Green	57	#31 Brwn w/orng
	1146.0	TOWER NO. 7			INLINE PRESSURE: 47.5 psi					
117	1150.9						PLUG			
118	1160.8	20.2		48.2	8.1	8.1	T3000R	Green	58	#26 White
119	1168.1	7.4		48.9	6.2	6.3	T3000R	Green	59	#23 Yllw w/red
END GUN: (NOZZLE SELECTED BASED ON RECOMMENDED ARC: 170°)										
	1171.6			47.3	39.3	37.5	SR75-18			.45"

SYSTEM INLINE END PRESSURE: 47.4 psi, INCLUDING 0 ft INCREASE IN ELEVATION

TOTAL gpm DELIVERED: 400.2

-x-INDICATES 2 OR MORE SUCCESSIVE OUTLETS SHOULD BE PLUGGED.

59 MOUNTING ASSEMBLIES:	First outlet=	4, Last outlet= 119	
STEEL 3/4" PIPE		0000-000	(Length= 6.00 ft)
3/4" Steel Tube Gooseneck		1000-006	
3/4" Steel Tube Drop Pipe	<Vari>	1007-072	(Length= 6.00 ft)
Standard Tee		1000-001	(as needed)
Standard Regulator		1000-002	(as needed)

NOZZLE SELECTION VERIFICATION

SPAN #	1	2	3	4	5	6	7	OH+EG
ACRE	2.6	7.6	10.4	14.0	17.6	18.3	24.3	15.7
GPM REQ.	9.0	28.1	36.7	49.5	61.7	65.2	85.9	53.7
GPM DEL.	19.1	28.9	37.1	50.0	61.9	65.1	86.1	51.9
% DEV.	112%	3%	1%	1%	0%	-0%	0%	-3%

A high deviation in span 1 is unavoidable due to nozzle size limitations.

DATA FILE IDENTIFICATION

File	Sprinkler	Plate	SprNo	ID	Regulator	Flow	PSI	In x Out	ID
R3000G	Rotator	Green	1- 59	AA3F	NONE				

CUSTOMER: TATRO IRRIG. _POTATO
CUSTER, WI 54423
30003

IDENTIFYING MARKS: RANDY EBERT
R3000G - TB BODY
STEEL 9'

PIVOT PRESSURE: 50.0 psi
TOTAL SYSTEM FLOW: 400.0 gpm
TOTAL PIPE LENGTH: 1171.6 FT

Notes

Constant length drops in 'in'.

Length Summary

Total Length = 345 ft

MOUNTING ASSEMBLIES:

a= STEEL 3/4" PIPE
3/4" Steel Tube Gooseneck
3/4" Steel Tube Drop Pipe Vari Len
Standard Tee
Standard Regulator

	Model	Sprinkler Plate		Regulator Flow Duty PSI Outlet
A=	R3000G	Rotator	Green	NONE

TOWER NO. 0, ID= 6.41
1
2
3
4 70a 1A #14
5
6 70 2 #14
7
8 70 3 #14
9
10 70 4 #14
11
12 70 5 #14
13
14 70 6 #14
15
16 70 7 #14
17
18 70 8 #14
19

TOWER NO. 1, ID= 6.41
1 70 9 #14
2
3 70 10 #14
4
5 70 11 #14
6
7 70 12 #14
8
9 70 13 #15
10
11 70 14 #15
12
13 70 15 #16
14
15 70 16 #17
16
17 70 17 #17
18
19 70 18 #17

TOWER NO. 2, ID= 6.41
1
2 70 19 #18
3
4 70 20 #19
5
6 70 21 #19
7
8 70 22 #19
9
10 70 23 #20
11
12 70 24 #20
13
14 70 25 #20
15
16 70 26 #21

TOWER NO. 3, ID= 6.41
1
2 70 27 #22
3
4 70 28 #21
5
6 70 29 #22
7
8 70 30 #23
9
10 70 31 #23
11
12 70 32 #23
13
14 70 33 #24
15
16 70 34 #24

TOWER NO. 4, ID= 6.41
1
2 70 35 #24
3
4 70 36 #25
5
6 70 37 #25
7
8 70 38 #25
9
10 70 39 #25
11
12 70 40 #26
13
14 70 41 #27
15
16 70 42 #26

TOWER NO. 5, ID= 6.41
1
2 70 43 #27
3
4 70 44 #28
5
6 70 45 #27
7
8 70 46 #28
9
10 70 47 #28
11
12 70 48 #28
13
14 70 49 #29

TOWER NO. 6, ID= 6.41
1
2 70 50 #29
3
4 70 51 #30
5
6 70 52 #29
7
8 70 53 #30
9
10 70 54 #30
11
12 70 55 #31
13
14 70 56 #31
15
16 70 57 #31

TOWER NO. 7, ID= 4.79 OVERHANG
1
2 70 58 #26
3 70 59 #23
END GUN TYPE:SR75-16 .45"

PERCENTAGE TIMER REPORT

CUSTOMER: TATRO IRRIG. & POTATO
CUSTER, WI 54423
30003

IDENTIFYING MARKS: RANDY EBERT
R3000G - TB BODY
STEEL 9'

SYSTEM MANUFACTURER: T-L
TOTAL PIPE LENGTH: 1171.6 FT
TOTAL SYSTEM FLOW: 400.2 gpm

END GUN RADIUS: 65.6 ft
IRRIGATED AREA: 110.4 acre

Detailed Drive Train Information Not Specified.

Last Tower Ground Speed at 100% Timer Setting: 5.50 ft/min

WATER APPLICATION DEPTH PER REVOLUTION

Water Application (in)	Timer Setting (%)	Last Tower Ground Speed (ft/min)	Time Per Revolution (hrs)
0.17	100.0	5.50	21.82
0.19	90.0	4.95	24.24
0.22	80.0	4.40	27.27
0.25	70.0	3.85	31.17
0.27	65.0	3.58	33.57
0.29	60.0	3.30	36.37
0.32	55.0	3.02	39.67
0.35	50.0	2.75	43.64
0.39	45.0	2.48	48.49
0.44	40.0	2.20	54.55
0.50	35.0	1.93	62.34
0.58	30.0	1.65	72.73
0.70	25.0	1.38	87.28
0.87	20.0	1.10	109.10
1.17	15.0	0.82	145.47
1.46	12.0	0.66	181.83
1.94	9.0	0.50	242.44
2.91	6.0	0.33	363.66
5.83	3.0	0.17	727.33

The relationships between water application, timer setting and pivot speed provided above are theoretical. Actual application rates may vary due to the following: tire slippage, tire inflation and tread wear; variations in terrain and soils; wind drift; evaporation; and drive train efficiency. For this reason the above data are intended only as a guide and should be used with due caution.

-PART NUMBER AND SHIPPING SUMMARY-

PART NO.	SHIP QTY	SYSTEM QTY	DESCRIPTION
10208-045	1	1	.45" TR75 End Gun Nozzle
10229-118	1	1	SR75-18° End Gun
10419-001	59	59	N/T3000 BODY
8844	59	59	D4 ROTOR PLATE -8 deg. (Green)
9461-014	12	12	#14 3TN-14 NOZZLE Lime
9461-015	2	2	#15 3TN-15 NOZZLE Lime w/lav
9461-016	1	1	#16 3TN-16 NOZZLE Lavender
9461-017	3	3	#17 3TN-17 NOZZLE Lvndr w/gra
9461-018	1	1	#18 3TN-18 NOZZLE Gray
9461-019	3	3	#19 3TN-19 NOZZLE Gray w/trqu
9461-020	3	3	#20 3TN-20 NOZZLE Turquoise
9461-021	2	2	#21 3TN-21 NOZZLE Trqu w/yllw
9461-022	2	2	#22 3TN-22 NOZZLE Yellow
9461-023	4	4	#23 3TN-23 NOZZLE Yllw w/red
9461-024	3	3	#24 3TN-24 NOZZLE Red
9461-025	4	4	#25 3TN-25 NOZZLE Red w/white
9461-026	3	3	#26 3TN-26 NOZZLE White
9461-027	3	3	#27 3TN-27 NOZZLE White w/blu
9461-028	4	4	#28 3TN-28 NOZZLE Blue
9461-029	3	3	#29 3TN-29 NOZZLE Blue w/brn
9461-030	3	3	#30 3TN-30 NOZZLE Drk Brown
9461-031	3	3	#31 3TN-31 NOZZLE Brwn w/orng
9539	59	59	R3000 BLUE CAP/MOTOR

Pivot Control Options

T-L Irrigation Systems

Manual Speed and Direction Control
Control speed and direction with two simple hydraulic valves.

T-L Point Control
Control speed and direction from the pivot or remote location. Safe 24VDC Control.

T-L Precision Point Control III
Control speed, direction, end gun, and auto/stop locations with GPS or encoder position sensors. Closed loop speed control for maximum uniformity. Safe 24VDC Control.

Variable Rate Irrigation (VRI) application available.

T-L Pivot Manager II
Create programs for full control of all irrigation functions. Monitor water pressure and flow. Closed loop speed control for maximum uniformity. Safe 24VDC Control.

Variable Rate Irrigation (VRI) application available.

T-L | Proven Technology that Works!

ISO 9001 CERTIFIED QUALITY

SINCE 1955 OVER 55 YEARS IRRIGATION EXCELLENCE

Pivot Controls Comparison

Features	Manual Control	Point Control	Precision Point Control III	Pivot Manager II
Continuous Movement of ALL Towers	•	•	•	•
No High Voltage AC on System	•	•	•	•
Auto Restart Operation (Electric Power)	•	•	•	•
Start on Water Pressure (Electric Power)	•	•	•	•
AC Power Not Required (Engine Power)	•	•	•	•
Auto Reverse/Stop	•	•	•	•
No Copper Wire on System	•			
Low Voltage 24VDC Control		•	•	•
Speed Feedback from End Tower		•	•	•
Precision Speed Control			•	•
Auto Reverse Delay Timer			•	•
GPS Position in Field (Degrees)			•	•
Encoder Position in Field (Degrees)			•	•
End Gun Control by Degrees (GPS/Encoder)			•	•
Auto Reverse/Stop by Degrees (GPS/Encoder)			•	•
Programmable Speeds			•	•
Set Application Depth			•	•
Create Programs/Steps				•
Safety History				•
Auxiliary Control Relays				•
Offset Control Panel Location		•	•	•
Remote Monitor (AgSense)	•	•	•	•
Remote On-Off Control (AgSense)	•	•	•	•
Remote Precision Link (AgSense)			•	
Variable Rate Irrigation (VRI)			•	•

Don't have a QR Code Reader? Just open the mobile browser on your smartphone and visit scan.mobi.

T-L Irrigation Company
151 East Hwy 6 & AB Road · P.O. Box 1047
Hastings, Nebraska 68902-1047 USA
Phone: 1-800-330-4264 · Fax: 1-800-330-4268
Phone: (402) 462-4128 · Fax: (402) 462-4617
sales@tlirr.com · www.tlirr.com

Quick Tow

Fastest in the business.

4 Wheel Towable Pivot Point

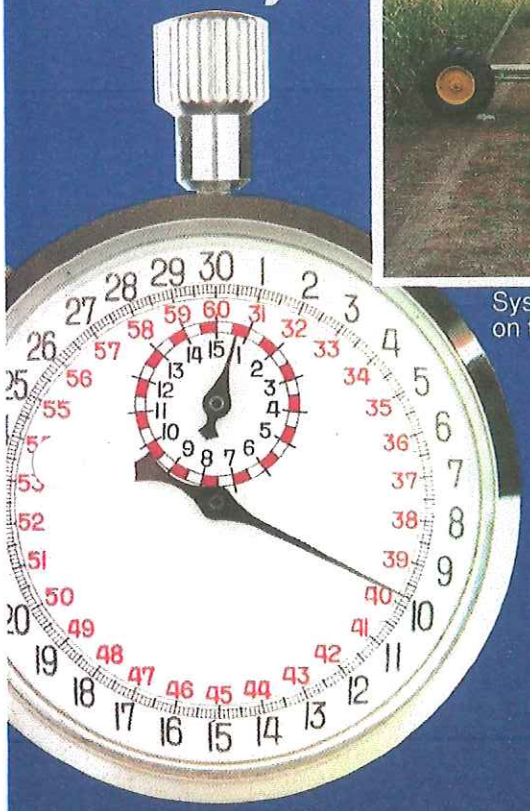
CERTIFIED ISO 9001 QUALITY

IRRIGATION EXCELLENCE SINCE 1955 50 YEARS

The ONLY towable pivot you

Dependable and safe hydraulic p

T-L makes it an EASY job.



System stopped on tow-road.

Tower raised by T-L scissor jack.

Gear boxes free-wheeled.

You can water full circles or any segment of a circle and quickly tow to the next pivot point. End guns can be turned on to capture corners and maximize your irrigated acres.

Irrigate from 10 to 140 acres per circle. . . fit your farm precisely.

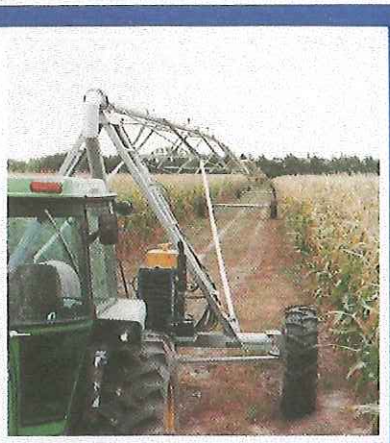
can move in minutes. . . not hours.

ower makes the difference again.

Rotate wheels 90°.

Wheels turned, lower the tower.

Ready for towing—Less than one minute per tower.



Towing the system.

Versatility describes the T-L Quick Tow best. Ideal where crop rotation is important. . . OR when covering a lot of acres with supplemental irrigation. . . OR when double cropping and timely germination of the second crop is critical. Also there are many field situations where a large stationery pivot isn't practical and the flexibility of T-L's Quick Tow will provide additional benefits at a lower cost per irrigated acre.

T-L's Quick Tow can provide the exact amount of moisture needed for maximum yields. And, speaking of maximum yields, T-L's Quick Tow is at home in everything from fieldcorn to carrots.

And that's the versatilitly of T-L Quick Tow.

Quick Tow

2 Wheel Pivot Point

T-L gives you the choice of two-wheel mobile pivot points or the four-wheel cart style shown here.

T-L's mobile pivot design mounts the power source, hydraulic pump and fuel tank on the pivot point, making the system tow-ready with a minimum of preparation. T-L's exclusive scissor jacks make tower wheel rotation an easy task . . . so while others are struggling to get their portable system ready to move, you'll be moved and irrigating. Supply water to your T-L system with underground or surface mainline pipe.

Even though the Quick Tow is portable, it retains all of the important T-L efficiencies, including the industry's most uniform water application, a direct result of continuous movement, hydrostatic drive. You can depend on T-L's planetary gear system to deliver years of trouble-free irrigating with a minimum of maintenance . . . and every T-L owner knows the importance of T-L design simplicity, eliminating troublesome microswitches and high voltage electricity on the system. When you've studied it all, the choice is simple . . . it's T-L.

T-L IRRIGATION COMPANY
P.O. Box 1047
Hastings, Nebraska 68902-1047 U.S.A.
Ph. 1-800-330-4264 • FAX 1-800-330-4268
Ph. (402) 462-4128 • FAX (402) 462-4617
www.tlirr.com

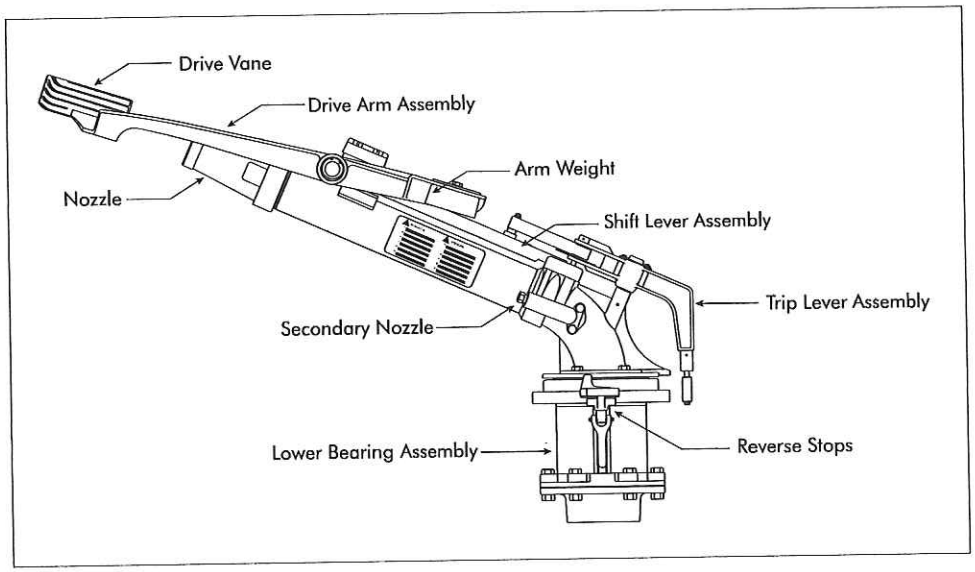
BAC 319110/3/05 Printed in U.S.A.

EXHIBIT 3

innovation in irrigation™ NELSON

SR100 BIG GUN®

SR100 BIG GUN® OPERATION AND MAINTENANCE INSTRUCTIONS



SET UP FOR OPERATION:

1. Install nozzle. If using ring nozzle set, install desired ring size in ring nozzle cap. The ring nozzle cap can be sufficiently tightened by hand.

   If using the **100 DN** ring nozzle, **correct orientation** is important. For reliable sprinkler operation, be sure to orient the ring with the correct side out and the "up" at the top of the nozzle. Incorrect orientation can result in failure of sprinkler to drive.

2. Adjust location of reverse stops to give desired arc of coverage. Stops must be mounted so that arrows point toward each other and the trip lever is located between arrows. If the stops are set incorrectly on the wrong end of the arc, the sprinkler will fail to reverse.

3. The SR100 is factory set for normal rotation speed. If a faster or slower speed is desired, move arm weight backward for faster operation or forward for slower operation.

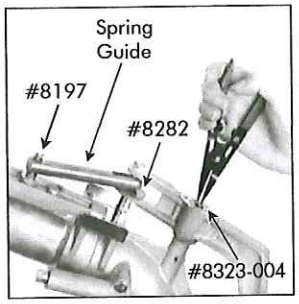
NOTE ON LUBRICATION: The Big Gun® sprinkler is lifetime lubricated and does not require periodic lubrication. The ball bearings in the H.D. lower bearing operate in a water resistant lubricant that is packed in the housing cavities and retained by seals. If repair of the lower bearing is done, it is recommended to use Nelson #6143 lubricant or a good grade of water resistant lubricant such as Lubriplate 130-AA.

BE CAREFUL: Read operating instructions before operating sprinkler or making any adjustments. Never make adjustments or perform service while sprinkler is in operation. Stand clear of operating sprinkler. Stand clear of high velocity water stream. Never direct water stream onto roadway or electrical transmission lines.

SR100 MAINTENANCE

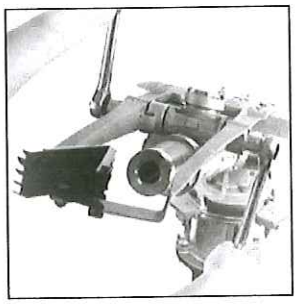
SEE SR100 PARTS LISTS FOR COMPLETE PARTS LIST AND DESCRIPTION

DISASSEMBLY



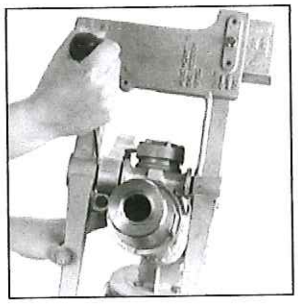
STEP 1 (Trip Lever)

Remove #6714 Cotter Pin from #8197 Pin. Remove two #8311 Screws and #8263 Cap. Using small retaining ring pliers, remove #8323-004 Retaining Ring. Pull entire trip lever assembly and spring guide from gun. At this time inspect wear on #8282 Follower. Replace if worn.



STEP 2 (Drive Arm)

Using internal retaining ring pliers, remove #6565 Retaining Ring from both arm hubs. Remove two #10067-001 Arm Caps. Using two 11/16" sockets, loosen and remove one #6603 Nut from left side of arm. Holding the opposite #6603 Nut, pull shaft free from hub.

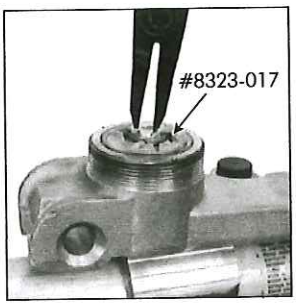


STEP 3

Using a thin-bladed screwdriver, push #8327-001 Spacer back into arm hub. Holding onto counterweight, remove drive arm and counterweight. Be careful not to damage seals.

STEP 4 (Counterweight)

Inspect seal spacer and counter-weight spacer for wear. If spacers show excessive wear, replace both spacers and #6600 Seals. To remove seals, drive thin-bladed screwdriver under lip of seal and pry seal out. To replace seals, use block of wood over seal making sure lip is to the outside, and secure by lightly tapping on wooden block until seal lip is flush with hub. Apply a light coating of #9673 Silicone Grease to #6600 Seal Lips.



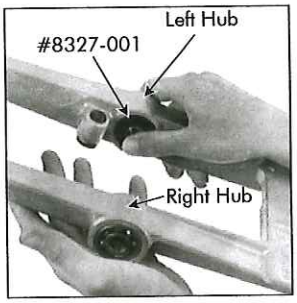
STEP 5 (Shift Lever)

Remove #10070-001 Cap Assembly. Using external retaining ring pliers, remove #8323-017 Retaining Ring. Pull Shift lever from mount. A gear puller will help in removing the lever. Inspect all parts for wear and replace as required.

REASSEMBLY

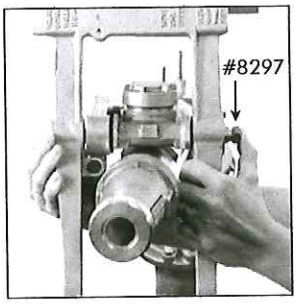
STEP 6

At the upper portion of the gun, inspect the mount shaft for wear. Press the #8325 Shift Lever assembly onto the mount. With external retaining ring pliers, snap the #8323-017 Retaining Ring on. Screw on #10070-001 Cap Assembly.



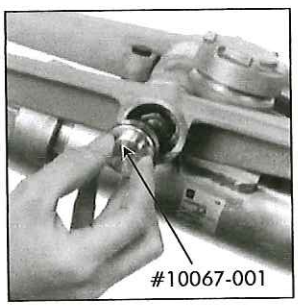
STEP 7 (Drive Arm)

Lubricate #6600 Seal lips with #9673 Silicone Grease. Install #8327-001 Spacer flush with #6600 Seal in left arm hub. Insert two #6607-001 conical Spacers into seals on inside of counterweight and right drive arm hub. Start #8297 Shaft into right arm hub.



STEP 8

Holding counterweight in place on the left side of shift lever, roll drive arm into position shown by pushing on the left arm bearing. Work #8327-001 Spacer into seal on counterweight. Be sure spacer is correctly positioned in counterweight to prevent cutting of the seal lip. Push shaft through the bearings and spacers and assemble #6603 Nut. Torque to 25 ft. lbs. using two 11/16" sockets. (Metric Torque = 34 NM or 3.5 MKG.)



STEP 9

Fill two #10067-001 Arm Cap Assemblies with #6143 Grease and snap into place. Install two #6565 Retaining Rings. Arm must have free movement at this point. If arm feels sticky, assure that lip seals at counterweight and right arm hub are not rubbing on each other.

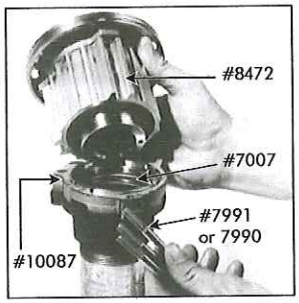
STEP 10 (Trip Lever)

Mount trip lever assembly along with spring guide onto their respective pins. Install #8323-004 Retaining Ring. Install #8263 Cap using two #8311 Screws. Install #8409 Washer and #6714 Cotter Pin onto spring guide.

LOWER BEARING MAINTENANCE

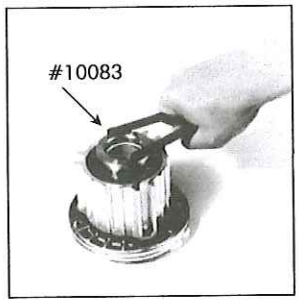
SEE BACK PAGE FOR PARTS LIST

DISASSEMBLY (LOWER UNIT)



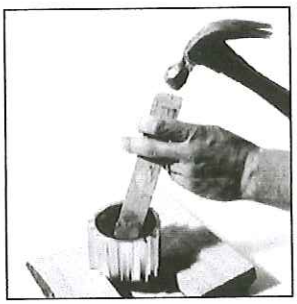
STEP 11

Remove three #7990 or #7991 bolts from flange. Separate #8472 housing from #10087 Spacer Assembly. Remove #7007 O-Ring from #10087 Spacer Assembly.



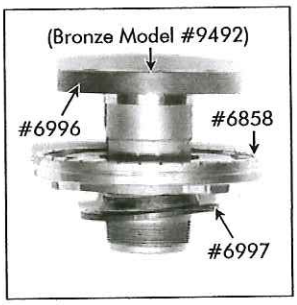
STEP 12

The #10083 Retainer Assembly is removed by using spanner wrench. To hold the #7031 Shaft Assembly from rotating insert two 5/16-18 bolts (#6635) into shaft top. Clamp bolt heads into a vise securely. Remove retainer and #8472 Housing from bearing shaft.



STEP 13

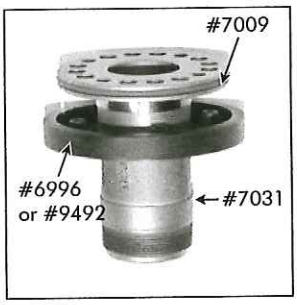
Remove the #6998 Seal. To remove the two #6559 Bearings use a hammer and three blocks of wood. Lightly tap uniformly around inner race of bearing until removed. Bearings are removed from opposite sides of the #8472 Housing.



STEP 14

Remove #6585 Cover from shaft. Remove #6997 Seal from cover. Remove #6996 Brake Ring and #7009 Dust Seal from shaft.

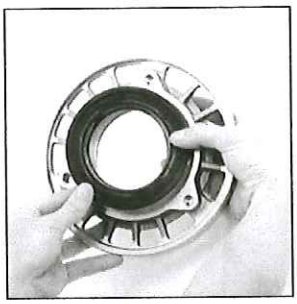
Inspect all parts for wear and replace as required.



REASSEMBLY (LOWER UNIT)

STEP 15

Assemble #7009 Dust Seal onto #7031 Shaft Assembly. Slide #6996 Brake Ring onto shaft. Locate the four studs of the brake ring in the center holes between the smaller threaded holes.



STEP 16

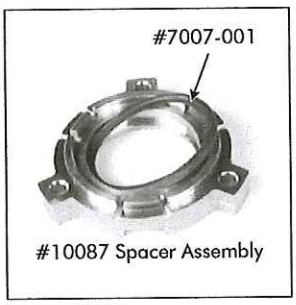
Place #6997 Lip Seal into #6858 cover as shown with Nelson name toward ball bearing. Pack #6559 Bearing with #6143 lubricant or equivalent. (See "Notes on Lubrication" on the front cover.) Press bearing into #6858 Cover. Slide cover assembly onto bearing shaft. CAUTION: Do not get grease on brake surfaces. To clean plastic brake, use soap and water (solvents may damage plastic). Clean #6858 cover with acetone.

STEP 17

Assemble #6566 Gasket. Press on #8472 Housing. Fully pack housing with #6143 Lubricant. Assemble #6559 Bearing into housing.

STEP 18

Install #6999 O-Ring in #7003 Retainer and assemble retainer on shaft. Using method described in disassembly (Lower Unit) instructions Step 12, secure bearing shaft from rotating. Torque Retainer to 95-110 ft. lbs. Apply a light coating of #9673 Silicone Grease to O.D. of Retainer. Assemble #6998 Lip Seal. Orient with lip side out. Metric Torque = 129-149 NM or 13-15 MKG.



STEP 19

Install 7007-001 O-Ring into Spacer and mount onto assembly.

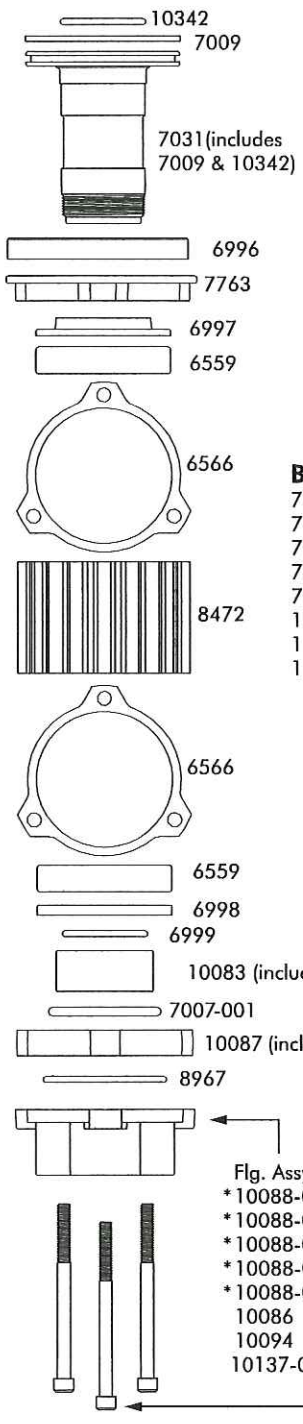
STEP 20

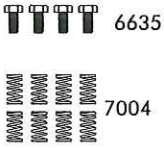
Assemble #8967 O-Ring into the Flange Adapter. Mount Flange Adapter using required Bolts. Torque Bolts to 130-150 inch pounds.

Innovation in Irrigation™ NELSON

LOWER BEARING ASSEMBLY PARTS LIST

1/10





BEARING ASSEMBLY NOS.

7863	2" FNPT
7864	2.5" FNPT
7865	2" FBSP
7862	NELSON FLANGE
7008-018	EURO FLANGE
10265-201	ANSI/DIN FLANGE
10380-007	1.5" FNPT
10380-010	1.5" FBSP

Flg. Assy.	Connection	(3) Screws
*10088-006	1.5" FNPT	7990
*10088-007	1.5" FBSP	7990
*10088-001	2" FNPT	7990
*10088-003	2" FBSP	7990
*10088-002	2.5" FNPT	7991
10086	Nelson Flg.	7006
10094	Euro Flg.	7006
10137-001	ANSI/DIN Flg.	7006

*Includes 8967

BEARING ASSEMBLY HD 100

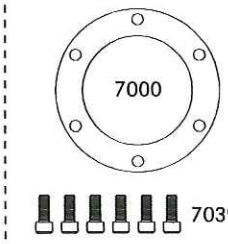
part number	description	qty.
6559	Bearing, Ball, 50 x 80 x 16mm	2
6566	Gasket, Housing - HD100	2
6635	Screw, .3125 -18 x .688" Hex Hd Cap	4
6996	Ring, Brake - HD100	1
6997	Seal, Upper - HD100	1
6998	Seal, Center - HD100	1
6999	O-Ring, -224	1
7004	Spring, Brake - HD100	8
7006	Screw, .312-18 x 3.50" Hex Skt Hd Cap	3
7007-001	O-Ring, -331 Special, w/ grease & graphite	1
7009	Seal, Dust - HD100	1
7031	Shaft Assembly - HD100	1
7763	Cover, Full Circle - HD100	1
7990	Screw, .312-18 x 4.25" Hex Hd Cap	3
7991	Screw, .312-18 x 4" Hex Skt Hd Cap	3
8472	Housing - HD100	1
8967	O-Ring -231, Special	1
10083	Retainer Assembly - HD100	1
10086	Flange Assembly, Nelson	1
10087	Spacer Assembly - HD100	1
10088-001	Flange Assembly, 2" FNPT	1
10088-002	Flange Assembly, 2.5" FNPT	1
10088-003	Flange Assembly, 2" FBSP	1
10088-006	Flange Assembly, 1.5" FNPT	1
10088-007	Flange Assembly, 1.5" FBSP	1
10094	Flange Assembly, Euro	1
10137-001	Flange Assembly, ANSI/DIN	1
10342	O-Ring, -225	1

MOUNTING HARDWARE

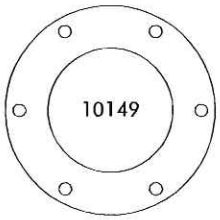
part number	description	qty.
7000	Gasket, Flange	1
7039	Screw, .312-18 x .75" Hex Skt Hd Cap	6
10149	Gasket, Euro Flange	1

FLANGE GASKET AND FASTENERS FOR MOUNTING GUN

NELSON FLG. CONN.



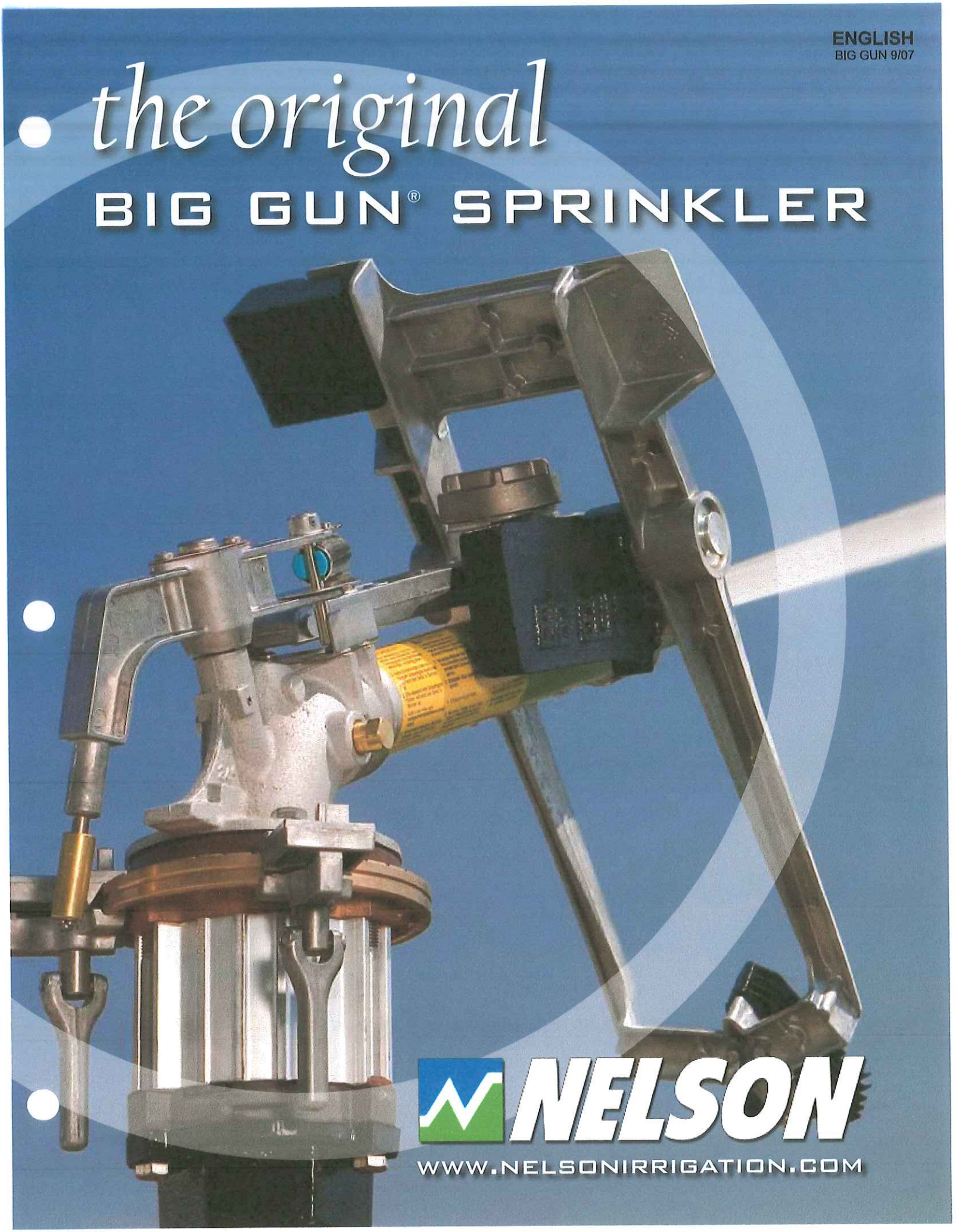
EURO FLG. CONN.



Nelson Irrigation Corporation 848 Airport Rd. Walla Walla, WA 99362-2271 USA Tel: 509.525.7660 Fax: 509.525.7907 info@nelsonirrigation.com Web site: www.nelsonirrigation.com

ENGLISH
BIG GUN 9/07

the original
BIG GUN® SPRINKLER



NELSON
WWW.NELSONIRRIGATION.COM

NELSON BIG GUN® SPRINKLERS

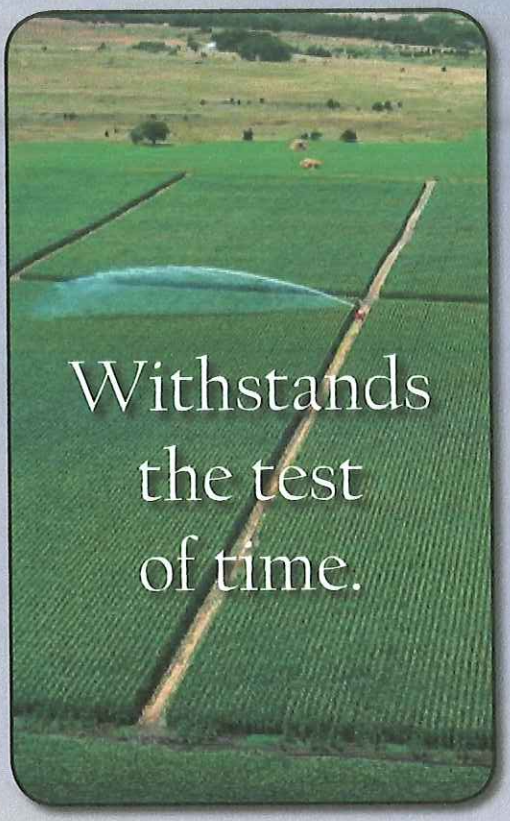
The Leader in Quality, Performance & Support

In the field of large-volume sprinklers, Nelson Big Guns® are recognized the world over as the leader in quality, performance and technical support. They are engineered and precision manufactured for heavy-duty reliability and long wear life. Every Nelson Big Gun® is subjected to the toughest inspection testing and quality control standards in the industry — including individual water testing of every gun at the factory.

Durable and reliable with engineered simplicity.

The preferred choice for tough applications.

NELSON WWW.NELSONIRRIGATION.COM



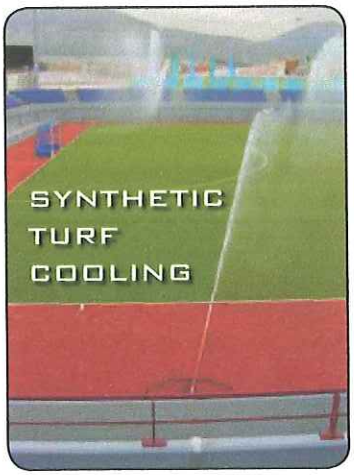
The only gun for hour after hour, year after year operation.

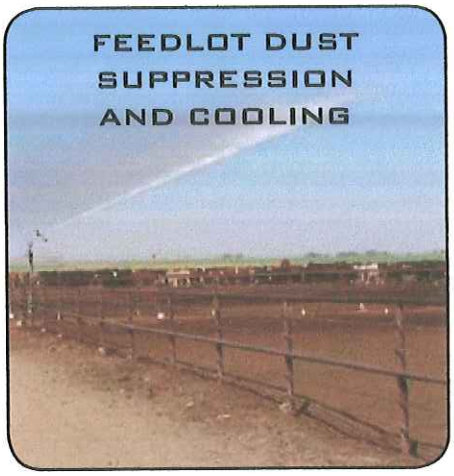
SET IT AND FORGET IT. A simple, positive, reliable adjustment allows for setting the arc to within 1 degree, without overriding the stops. The setting will not change over time, a concept proven with years in the field.

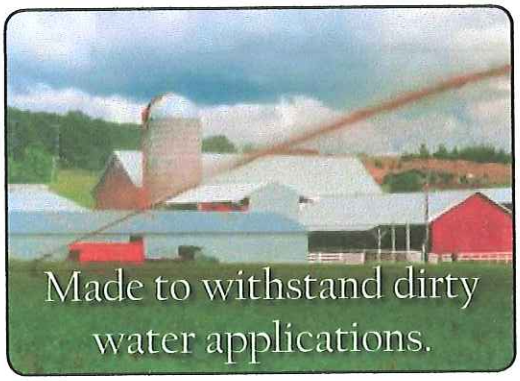
WORKS RIGHT OUT OF THE BOX. Nelson pioneered the concept of a slow, steady and uniform forward and reverse drive action. The drive vane automatically compensates through the full range of nozzle sizes and pressures.

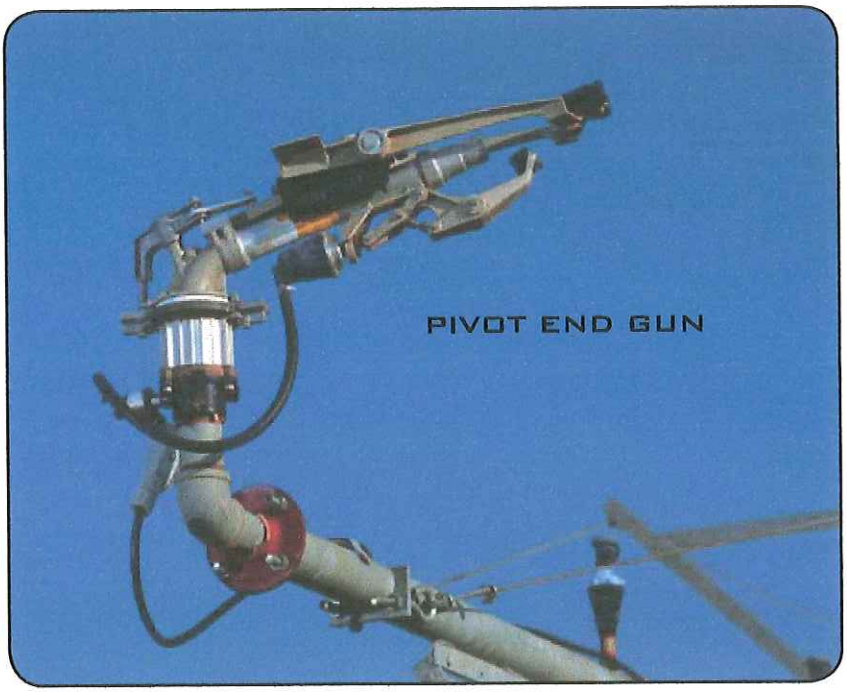
APPLICATIONS

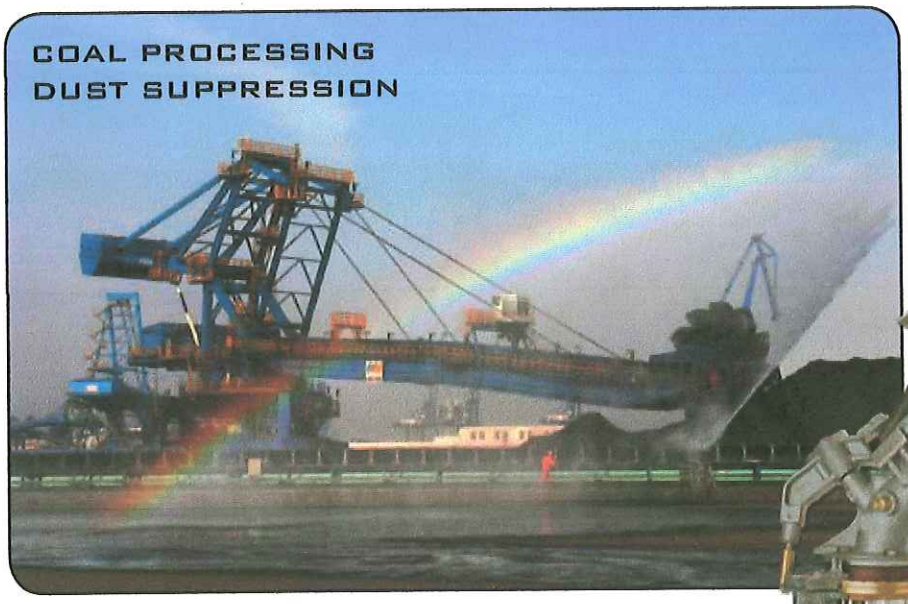
- Pivot End Gun Irrigation
- Traveler Irrigation
- Solid Set Irrigation
  - Corn, Sugar Cane, Pineapple, Pastures, etc.
- Environmental Applications
  - Feedlot Dust Suppression & Cooling
  - Wastewater Applications
  - Mining Dust Suppression
- Sports Field Applications
  - Turf Irrigation
  - Synthetic Turf Cooling & Conditioning

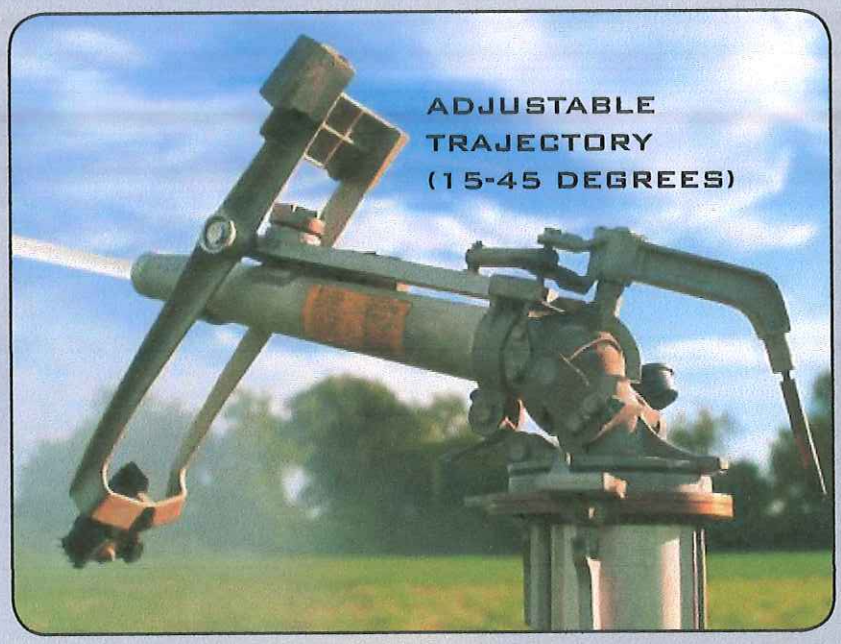








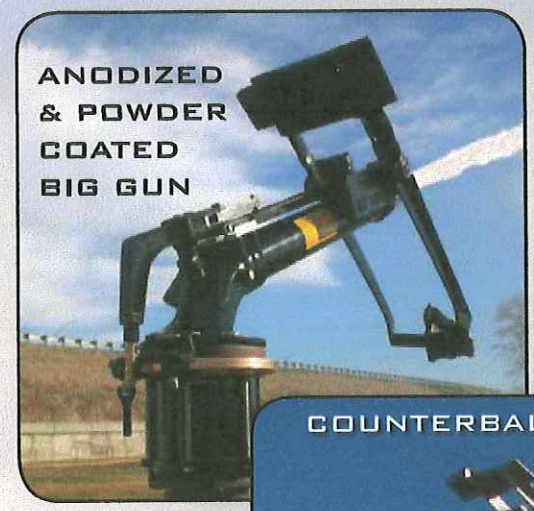




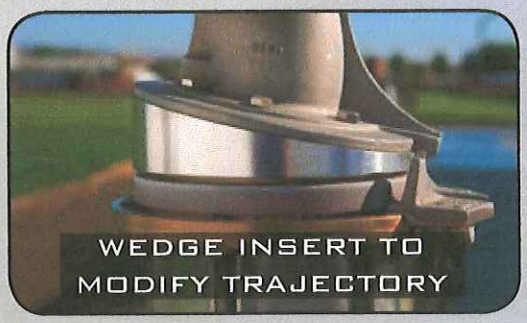
OPTIONS

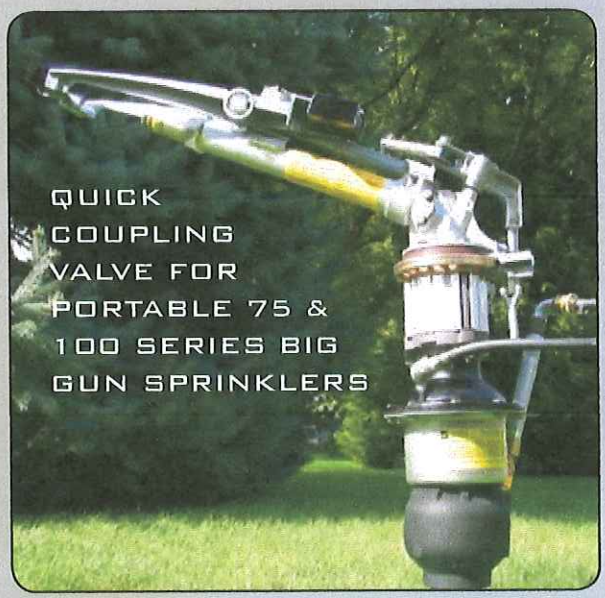
- Adjustable Trajectory
- 800 Series Valve/Big Gun® Combination
- Nozzle Valve
- Quick Coupling Valve
- Special Coatings
- Add-on Kits: Secondary Nozzle, Wedge and Counterbalance

(See *Big Gun® Add-on Kits* literature for details.)



NOZZLE VALVE





800P END GUN CONTROL VALVE*

*No electric solenoid required for Big Gun® control when used with a booster pump

HEAVY DUTY — PRECI

THE BIG GUN® NAME has a world-wide reputation for quality, performance and support in a number of heavy-duty agricultural and industrial applications.

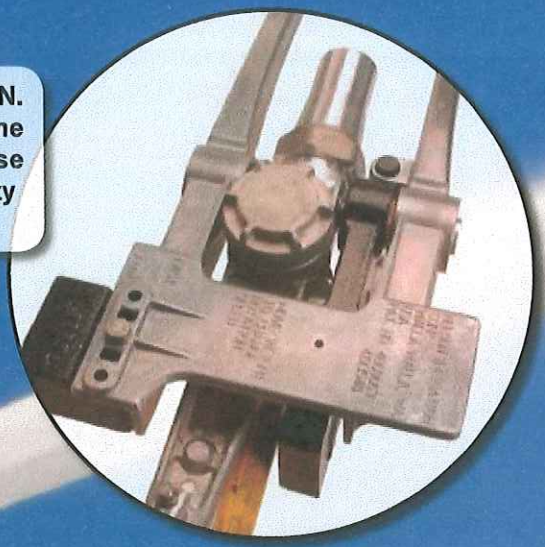
GREATEST RANGE OF OPTIONS. Full & part-circle sprinklers available in a variety of trajectory, nozzle & coating options.

TWIN BALL BEARING IN LOWER BEARING UNIT. Gun has a total of 9 ball bearings — all sealed and lifetime lubricated for long wear life and reliability.

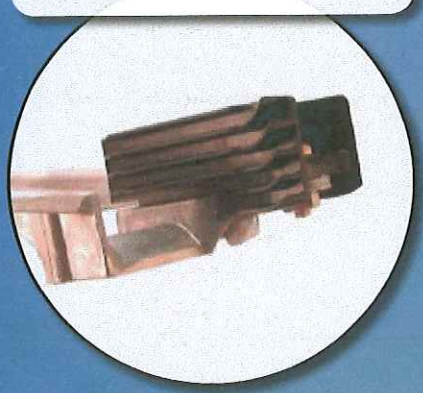
HAND ADJUSTABLE STOPS for Precise Arc Control.

SION MANUFACTURED

EXCELLENT DRIVE ACTION. The SR Series has the same slow forward and reverse speeds, increasing stability and improving uniformity.

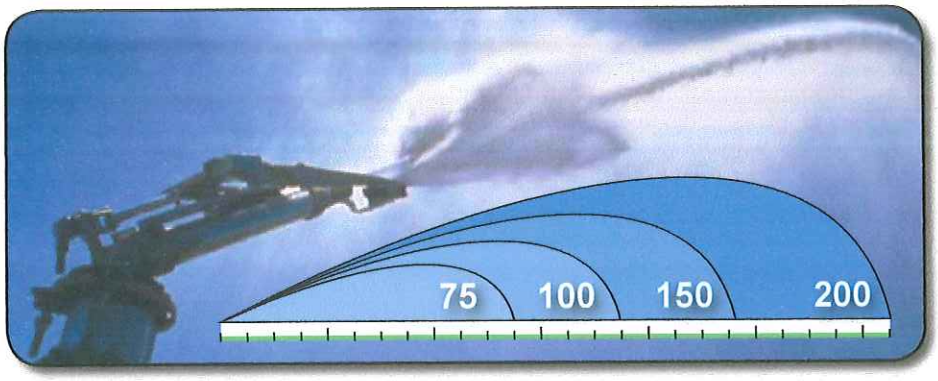


PATENTED PRESSURE AND FLOW COMPENSATING DRIVE SPOON eliminates need for adjustments throughout the full range of nozzle sizes and pressures.



CONSISTENT BRAKE LOAD. The brake provides a consistent resistance to rotation over the life of the gun.

BIG GUN® OPTIONS AVAILABLE



TO ORDER BIG GUNS® SPECIFY THE FOLLOWING:

Model No., Trajectory, Connection Size & Type, Nozzle Size & Type, Optional Coatings (Anodized or Anodized and Powder Coated) NOTE: Extended lead time may be necessary for large quantities of anodized or anodized and powder coated products.

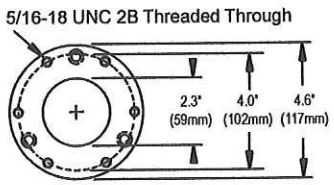
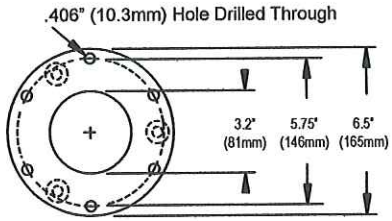
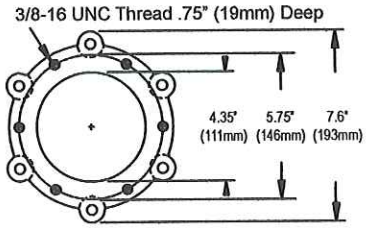
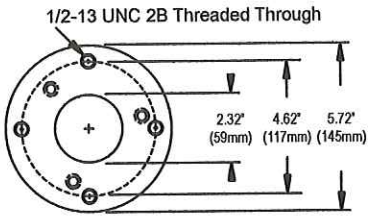
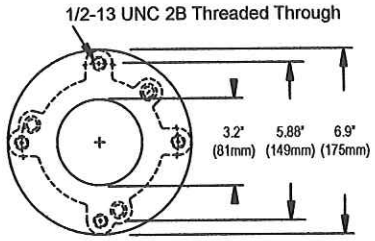
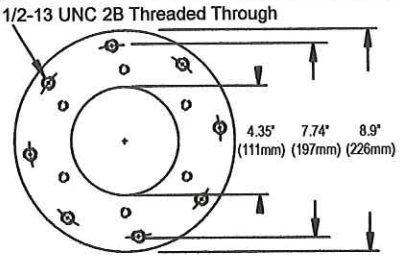
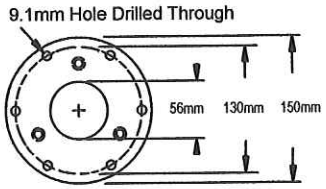
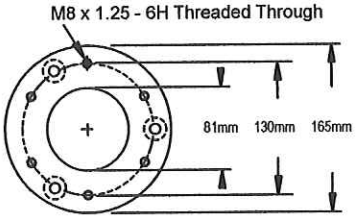
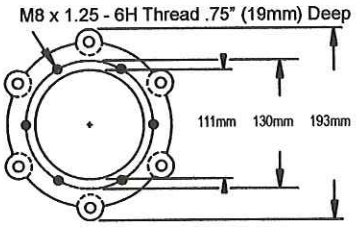
Specification Example:
SR100 (24°), 2" FNPT, 100T-0.8"

	75 SERIES	100 SERIES	150 SERIES	200 SERIES
PERFORMANCE	30-160 GPM (6.8-36.3 M³/H) 25-80 PSI (1.75-6 Kg/cm²)	50-300 GPM (10-70 M³/H) 40-110 PSI (3.5-8 Kg/cm²)	100-630 GPM (23-150 M³/H) 50-120 PSI (3.5-9 Kg/cm²)	250-1200 GPM (55-275 M³/H) 60-130 PSI (4-9 Kg/cm²)
MODEL & TRAJECTORY	Full Circle F75: 21°, 24° Part Circle SR75: 18°, 21°, 24°, 43°	Full Circle F100: 18°, 21°, 24°, 43° Part Circle SR100: 18°, 21°, 24°, 43° Part Circle SRA100: 15-45° Adjustable	Full Circle F150: 21°, 24° Part Circle SR150: 21°, 24°, 27°, 43° Part Circle SRA150: 15-45° Adjustable	Full Circle F200: 21°, 24°, 27° Part Circle SR200: 21°, 24°, 27°
NOZZLE OPTIONS — TAPER (0.4-0.8" (10.2-20.3 mm))	Not Available	100T (Specify Size)	150T (Specify Size)	200T (Specify Size)
NOZZLE OPTIONS — TAPER RING (0.4-0.8" (10.2-20.3 mm))	TR75 (Specify Size)	100TR (Specify Size); NA for SRNV	150TR (Specify Size)	Not Available
NOZZLE OPTIONS — RING (0.4-0.8" (10.2-20.3 mm))	Not Available	100R (Includes Set of Rings); NA for SRNV	150R (Includes Set of Rings)	200R (Includes Set of Rings)
SPECIAL OPTIONS	Not Available	Anodized & Powder Coated, Vaneless Range Tube*	Anodized & Powder Coated, Stainless Steel (SRA150 N/A), Vaneless Range Tube	Anodized & Powder Coated
ADD-ON KITS	HD Lower Bearing, 12° Wedge Kit, Counterbalance Kit, Stream Straightener Vane	Low-Pressure Drive Vane Kit, Counterbalance Kit, Secondary Nozzle Kit, 12° Wedge Kit, Stream Straightener Vane	Counterbalance Kit, Secondary Nozzle Kit, Stream Straightener Vane	Secondary Nozzle Kit (standard), 12° Wedge Kit (SR200 only)
MOUNTING DETAILS	Fits QC** & 2" 800 Series Valve	Fits QC** & 2" 800 Series Valve (QC NA for SRNV100)	Substantial thrust on riser, use 3" valve minimum	Substantial thrust on riser, use 4" valve minimum
CONNECTION OPTIONS	1 1/2" or 2" FNPT or FBSP ANSI/DIN Nelson or Euro Flange	2" FNPT or FBSP, 2 1/2" FNPT ANSI/DIN, Nelson or Euro Flange; 2" FNPT or FBSP for SRNV	Nelson, Euro or ANSI/DIN Flange Also, Nelson Flange to Female Adapters	Nelson, Euro or ANSI/DIN Flange Also, Nelson Flange to Female Adapters

*Vaneless Range Tube option is for wastewater applications containing hair, straw, etc.

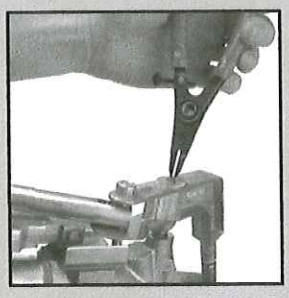
** The "Quick Coupling Valve" inlet is available in both 2" and 3" FNPT and FBSP for connection to the piping system. The "Quick Coupling Key" outlet is available in 2" FNPT, 2" FBSP, and Nelson Flange Connection for connection to the Big Gun.

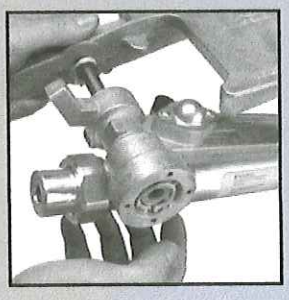
BIG GUN® FLANGE DETAILS

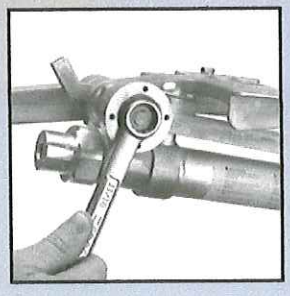
	75 & 100 SERIES	150 SERIES	200 SERIES
NELSON FLANGE	 Use 5/16-18 Bolts *Connects to 2" Nelson Flange Bolt Pattern*	 Use 3/8-16 Bolts & Nuts or M10 Bolts & Nuts *Connects to 3" Nelson Flange Bolt Pattern*	 Use 3/8-16 Bolts & Nuts *Connects to 4" Nelson Flange Bolt Pattern* *(F200 has same bolt pattern as SR150.)*
ANSI/DIN COMPATIBLE FLANGE	 Use 1/2-13 Bolts *Connects to 2" ANSI or 50mm DIN Flanges*	 Use 1/2-13 Bolts *Connects to 3" ANSI or 80mm DIN Flanges*	 Use 1/2-13 Bolts *Connects to 4" ANSI or 100mm DIN Flanges*
EURO FLANGE	 Use M8 Bolts & Nuts *Connects to European Traveler Flange*	 Use M8 x 1.25 Bolts *Connects to European Traveler Flange*	 Use M8 x 1.25 Bolts *Connects to European Traveler Flange*

Contact the factory or go to **www.nelsonirrigation.com** for Parts Lists, Operation & Maintenance Guides, Repair Kits, Dimensional Drawings, Add-on Kit literature & Thrust Force information.

Nelson Big Guns are easy to repair with readily available parts.







BIG GUN® PERFORMANCE (U.S. UNITS)

Flow and diameter (feet) information at various pressures with different nozzle sizes. (See information at bottom of page 11.)

75 TAPER RING NOZZLE — 24° TRAJECTORY

PSI	0.4"		0.45"		0.5"		0.55"		0.6"		0.65"		0.7"		0.75"		0.8"	
	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT
25*	—	—	—	—	—	—	42	146	50	155	59	161	69	167	80	174	91	182
30*	—	—	—	—	37	158	45	158	55	165	64	172	75	182	87	187	99	192
35	—	—	32	154	40	164	49	172	59	178	69	191	81	196	93	202	106	208
40	27	149	35	160	43	171	52	180	63	190	74	198	87	204	98	213	112	221
45	29	155	37	167	46	180	56	189	67	198	79	206	91	214	104	223	118	230
50	30	161	39	174	48	186	59	195	70	203	83	212	95	220	109	230	123	237
55	32	165	41	179	50	193	62	203	74	213	87	221	100	230	115	239	130	247
60	33	169	42	184	53	198	64	208	77	220	91	228	104	237	120	245	136	254
65	35	172	44	189	55	205	67	216	80	227	95	237	109	247	125	254	142	263
70	36	175	45	194	57	210	69	221	83	232	98	243	113	254	129	260	147	270
75	37	179	47	201	59	217	72	228	86	239	101	250	117	261	134	268	153	277
80	39	182	49	207	61	222	74	234	89	244	105	256	121	266	138	274	158	283

*Operating at pressures above 30 PSI provides better performance.

100 TAPER BORE NOZZLE — 24° TRAJECTORY

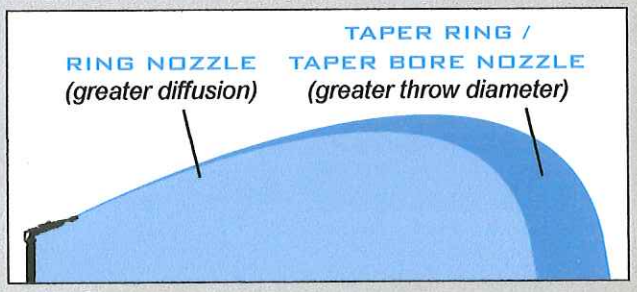
PSI	0.5"		0.55"		0.6"		0.65"		0.7"		0.75"		0.8"		0.85"		0.9"		1.0"	
	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT
40	47	191	57	202	66	213	78	222	91	230	103	240	118	250	134	256	152	262	—	—
50	50	205	64	215	74	225	87	235	100	245	115	256	130	265	150	273	165	280	204	300
60	55	215	69	227	81	240	96	250	110	260	126	270	143	280	164	288	182	295	224	316
70	60	225	75	238	88	250	103	263	120	275	136	283	155	295	177	302	197	310	243	338
80	64	235	79	248	94	260	110	273	128	285	146	295	165	305	189	314	210	325	258	354
90	68	245	83	258	100	270	117	283	135	295	155	306	175	315	201	326	223	335	274	362
100	72	255	87	268	106	280	123	293	143	305	163	316	185	325	212	336	235	345	289	372
110	76	265	92	278	111	290	129	303	150	315	171	324	195	335	222	344	247	355	304	380

150 TAPER BORE NOZZLE — 24° TRAJECTORY

PSI	0.7"		0.8"		0.9"		1.0"		1.1"		1.2"		1.3"		1.4"	
	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT
50	100	250	130	270	165	290	205	310	255	330	300	345	350	360	408	373
60	110	265	143	285	182	305	225	325	275	345	330	365	385	380	446	396
70	120	280	155	300	197	320	245	340	295	360	355	380	415	395	483	412
80	128	290	165	310	210	335	260	355	315	375	380	395	445	410	516	427
90	135	300	175	320	223	345	275	365	335	390	405	410	475	425	547	442
100	143	310	185	330	235	355	290	375	355	400	425	420	500	440	577	458
110	150	320	195	340	247	365	305	385	370	410	445	430	525	450	605	471
120	157	330	204	350	258	375	320	395	385	420	465	440	545	460	632	481

200 TAPER BORE NOZZLE — 27° TRAJECTORY

PSI	1.05"		1.1"		1.2"		1.3"		1.4"		1.5"		1.6"		1.75"		1.9"	
	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT	GPM	DIAM. FT
60	250	345	285	355	330	375	385	390	445	410	515	430	585	445	695	470	825	495
70	270	360	310	380	355	395	415	410	480	430	555	450	630	465	755	495	890	515
80	290	375	330	395	380	410	445	430	515	450	590	470	675	485	805	515	950	535
90	310	390	350	410	405	425	475	445	545	465	625	485	715	505	855	535	1005	555
100	325	400	370	420	425	440	500	460	575	480	660	500	755	520	900	550	1060	575
110	340	410	390	430	445	450	525	470	605	495	695	515	790	535	945	565	1110	590
120	355	420	405	440	465	460	545	480	630	505	725	530	825	550	985	580	1160	605
130	370	425	425	445	485	465	565	485	655	515	755	540	860	560	1025	590	1210	620



See opposite page for nozzle descriptions.

BIG GUN® PERFORMANCE (METRIC)

Flow and diameter (meters) information at various pressures with different nozzle sizes. (See information at bottom of page.)

75 TAPER RING NOZZLE TR75 — 24° TRAJECTORY

	10.2 mm			11.4 mm			12.7 mm			14.0 mm			15.2 mm			16.5 mm			17.8 mm			19.1 mm			20.3 mm		
Kg/cm²	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M
1.75*	—	—	—	—	—	—	—	—	—	2.64	9.5	44	3.17	11.4	48	3.72	13.4	49	4.30	15.5	51	4.91	17.7	54	5.59	20.1	56
2.00*	—	—	—	—	—	—	2.33	8.4	48	2.82	10.2	48	3.39	12.2	51	3.98	14.3	52	4.59	16.5	56	5.25	18.9	58	5.97	21.5	59
2.50	—	—	—	2.11	7.6	47	2.61	9.4	50	3.16	11.4	53	3.79	13.6	55	4.45	16.0	58	5.14	18.5	60	5.87	21.1	62	6.68	24.0	64
3.00	1.83	6.6	47	2.32	8.3	50	2.86	10.3	53	3.46	12.4	57	4.15	14.9	59	4.88	17.6	61	5.63	20.3	63	6.43	23.1	66	7.32	26.3	69
3.50	1.98	7.1	49	2.50	9.0	52	3.09	11.1	57	3.74	13.4	60	4.48	16.1	62	5.27	19.0	64	6.08	21.9	67	6.95	25.0	70	7.90	28.4	73
4.00	2.11	7.6	50	2.67	9.6	54	3.30	11.9	59	3.99	14.4	62	4.79	17.2	65	5.63	20.3	67	6.50	23.4	71	7.43	26.7	73	8.45	30.4	76
4.50	2.24	8.1	52	2.84	10.2	57	3.50	12.6	62	4.24	15.2	66	5.08	18.3	68	5.97	21.5	71	6.89	24.8	75	7.88	28.4	78	8.96	32.3	80
5.00	2.36	8.5	53	2.99	10.8	60	3.69	13.3	64	4.46	16.1	68	5.35	19.3	70	6.30	22.7	74	7.26	26.1	78	8.30	29.9	80	9.45	34.0	84
5.50	2.48	8.9	55	3.13	11.3	62	3.87	13.9	66	4.68	16.9	70	5.61	20.2	73	6.60	23.8	77	7.62	27.4	81	8.71	31.3	83	9.90	35.7	86
6.00	2.59	9.3	56	3.27	11.8	63	4.04	14.6	68	4.89	17.6	72	5.86	21.1	74	6.90	24.8	79	7.96	28.6	84	9.09	32.7	85	10.3	37.2	87

*Operating at pressures above 2 Kg/cm² provides better performance.

100 TAPER BORE NOZZLE — 24° TRAJECTORY

	12.7 mm			14.0 mm			15.2 mm			16.5 mm			17.8 mm			19.1mm			20.3 mm			21.6 mm			22.9 mm			25.4 mm		
Kg/cm²	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M
3.0	3.00	10.8	59.5	3.73	13.4	62.6	4.33	15.6	66.1	5.09	18.3	66.8	5.84	21.0	71.4	6.71	24.1	74.5	7.64	27.5	77.5	8.74	31.5	79.5	9.67	34.8	81.4	11.9	42.8	88.1
4.0	3.40	12.2	64.3	4.25	15.3	67.8	5.00	18.0	71.8	5.86	21.1	74.8	6.82	24.6	77.8	7.73	27.8	81.0	8.66	31.2	82.8	10.1	36.2	86.4	11.2	40.4	88.6	13.8	49.5	94.8
5.0	3.79	13.6	69.0	4.72	17.0	72.7	5.59	20.1	76.4	6.56	23.6	80.2	7.62	27.5	84.4	8.66	31.2	86.7	9.91	34.9	90.4	11.3	40.5	92.5	12.5	45.2	94.7	15.5	55.6	103
6.0	4.17	15.0	73.4	5.14	18.5	77.3	6.12	22.1	80.7	7.19	25.9	85.0	8.35	30.1	88.7	9.51	34.3	91.8	10.9	38.2	94.7	12.4	44.5	97.7	13.7	49.5	101	16.8	60.5	109
7.0	4.53	16.3	77.6	5.52	19.9	81.6	6.61	23.8	85.0	7.75	27.9	89.3	9.02	32.5	93.0	10.3	37.0	96.1	11.7	41.3	99.0	13.3	48.0	102.2	14.8	53.5	105	18.2	65.5	113
8.0	4.89	17.6	81.7	5.84	21.0	85.7	7.07	25.5	89.3	8.25	29.7	93.1	9.64	34.8	97.3	11.0	39.4	99.7	12.5	44.1	103	14.2	51.2	105.8	15.9	57.2	109	19.5	70.2	116

150 TAPER BORE NOZZLE — 24° TRAJECTORY

	17.8 mm			20.3 mm			22.9 mm			25.4 mm			27.9 mm			30.5 mm			33.0 mm			35.6 mm		
Kg/cm²	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M	L/S	M³/H	DIAM. M
3.5	6.39	23.0	76.0	8.29	29.8	82.0	10.5	37.8	88.0	13.0	46.9	95.0	15.9	57.1	101	19.0	68.3	105	22.3	80.1	110	25.8	92.9	114
4.0	6.83	24.6	79.6	8.86	31.9	85.6	11.2	40.4	91.6	13.9	50.1	97.8	16.9	61.0	104	20.3	73.0	109	23.8	85.7	114	27.4	98.6	118
5.0	7.63	27.5	85.4	9.91	35.7	91.6	12.6	45.2	98.6	15.6	56.0	105	18.9	68.2	111	22.7	81.7	117	26.6	95.8	121	30.8	111	126
6.0	8.36	30.1	89.7	10.9	39.1	96.7	13.8	49.5	104	17.0	61.3	110	20.8	74.7	117	24.9	89.5	123	29.1	105	128	33.6	121	133
7.0	9.03	32.5	95.0	11.7	42.2	101	14.9	53.5	108	18.4	66.3	114	22.4	80.7	122	26.8	96.6	128	31.5	113	134	36.4	131	139
8.0	9.66	34.8	99.3	12.5	45.1	105	15.9	57.2	112	19.7	70.8	118	24.0	86.3	126	28.7	103	132	33.7	121	138	38.9	140	145
9.0	10.2	36.9	104	13.3	47.9	110	16.8	60.6	117	20.9	75.1	123	25.4	91.5	131	30.4	110	137	35.7	129	143	41.1	148	149

200 TAPER BORE NOZZLE — 27° TRAJECTORY

	26.7 mm			27.9 mm			30.5 mm			33.0 mm			35.6 mm			38.1 mm			40.6 mm			44.5 mm			48.3 mm		
Kg/cm	L/S	M³/H		L/S	M³/H		L/S	M³/H		L/S	M³/H		L/S	M³/H		L/S	M³/H		L/S	M³/H		L/S	M³/H		L/S	M³/H	
4.0	15.5	55.7	104	17.8	63.9	106	20.3	73.1	112	23.8	85.8	117	27.5	98.9	123	32.2	116	129	36.1	130	134	42.9	154	141	50.7	183	149
5.0	17.3	62.3	111	19.9	71.5	117	22.7	81.7	121	26.7	96.0	126	30.7	111	132	36.0	130	138	40.3	145	143	48.0	173	152	56.7	204	158
6.0	19.0	68.2	115	21.8	78.3	121	24.9	89.5	126	29.2	105	132	33.7	121	138	39.4	142	144	44.2	159	149	52.6	189	158	62.1	224	164
7.0	20.5	73.7	122	23.5	84.6	128	26.9	96.7	134	31.5	114	140	36.3	131	146	42.6	153	152	47.7	172	159	56.8	204	168	67.1	241	175
8.0	21.9	78.8	126	25.1	90.4	132	28.7	103	138	33.7	121	144	38.9	140	152	45.5	164	159	51.0	184	165	60.7	218	174	71.7	258	182
9.0	23.2	83.6	130	26.6	95.9	136	30.4	110	142	35.8	129	148	41.2	148	157	48.3	174	164	54.1	195	170	64.4	232	180	76.0	274	188

Diameters are based on a 24° trajectory for the 75, 100 and 150 Series and a 27° trajectory for the 200 Series. The lower trajectory angles result in better wind fighting ability, but reduced throw distances. Throw reduction depends upon nozzle flow rate. In general, the throw distance is reduced approximately 3% with each 3° drop in trajectory angle. Use of the wedge insert to modify trajectory will affect distance. Big Gun® performance data has been obtained under ideal test conditions and may be adversely affected by wind, poor hydraulic entrance conditions or other factors. Test riser height of 3 feet (0.91 meters) above measurement surface. No representation regarding droplet condition, uniformity, application rate, or suitability for a particular application is made herein.

Additional nozzle options and sizes available. Go to www.nelsonirrigation.com or contact the factory for nozzle performance.

TAPER BORE NOZZLE. Most common nozzle type. Used where the available water flow and pressure are consistent. A nozzle size must be specified when ordering a Big Gun with a Taper Bore Nozzle. *The Nozzle Valve End Gun requires a Taper Bore Nozzle.*

RING NOZZLE SET. The Ring Nozzle Set is an easy and economic way of changing nozzles to match the available water flow and pressure. These are commonly used where the available water flow and pressure are variable and or when the Big Gun is shifted between various water sources with different capacities. The abrupt orifice of the nozzle is less efficient so the radius of throw is less than that achieved with an equivalent diameter Taper Bore nozzle. The abrupt orifice of the Ring Nozzle does break the stream of water up more, which can be an advantage in low pressure applications. The Ring Nozzle comes with a set of rings. *The Ring Nozzle should not be used with the Nozzle Valve End Gun.*

TAPER RING NOZZLE. This nozzle combines the changeability of a Ring Nozzle with some of the efficiency of a Taper Bore Nozzle. When ordering the Taper Ring Nozzle, specify the size as only one Taper Ring comes with the nozzle body and cap. Additional taper ring sizes can be purchased. *The Taper Ring Nozzle should not be used with the Nozzle Valve End Gun.*

THE BEST PRODUCT SUPPORT IN THE INDUSTRY.

Nelson is proud of its reputation for quality and integrity. We work hard to make our products the best, and we stand behind them with a one-year warranty.

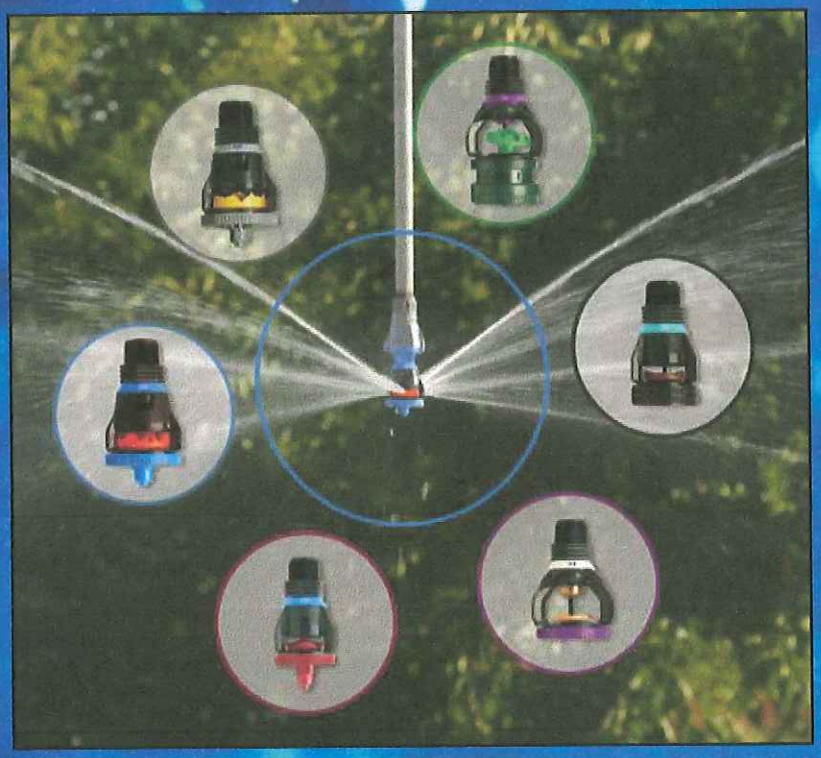
Nelson Irrigation Corporation's worldwide network of professional dealers provides customized water application solutions.

NELSON

Nelson Irrigation Corporation 848 Airport Rd., Walla Walla, WA 99362 USA
Tel: 509.525.7660 Fax: 509.525.7907 info@nelsonirrigation.com

Nelson Irrigation Corporation of Australia 35 Sudbury Street, Darra QLD 4074
Tel: +61 7 3715 8555 Fax: +61 7 3715 8666 info@nelsonirrigation.com.au

water application solutions
FOR CENTER PIVOT IRRIGATION



Nelson 3000 Series Pivot Products

R	S	N	D	A	T
R3000	S3000	N3000	D3000	A3000	T3000

NELSON

save water, save energy and do a better job of irrigating.

FROM PIVOT POINT TO END GUN

Nelson Irrigation Corporation offers a full-range of water application solutions for center pivot irrigation. From control valves, to pivot sprinklers and pressure regulators to end guns — the package is complete. Efficiency and effectiveness are at the heart of this superior center pivot irrigation package. **Save water, save energy and do a better job of irrigating with Nelson products.**

PRESSURE REGULATORS

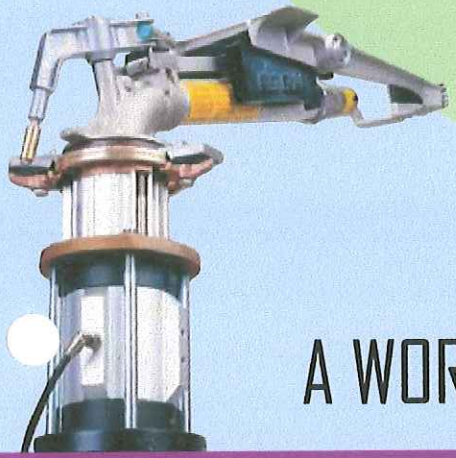
Nelson Pressure Regulators are precision manufactured and feature a patented dampening system, improved plug resistance with a patented single strut design, and extended flow range.

CONTROL VALVES

You'll fully appreciate the extra built-in quality and reliability of a Nelson control valve when it performs under the most demanding operating conditions. Specify a Nelson 800 Series Control Valve at the Pivot Point and as part of your End Gun Control Package.

3000 SERIES PIVOT SPRINKLERS

Only Nelson offers such a complete line of advanced design pivot sprinklers. A highly-intuitive modular system of components make up Nelson's 3000 Series Pivot Products.



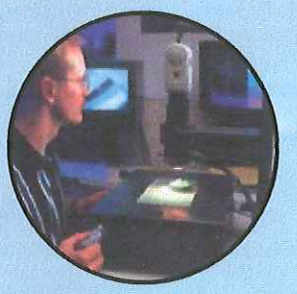
BIG GUN® SPRINKLERS

All end guns are not the same. Only the Nelson SR series Big Guns® have stood the test of time on center pivots — recognized the world over as the leader in quality and performance.

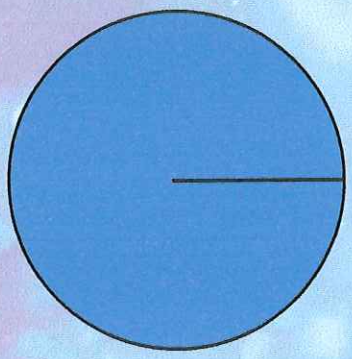
A WORLDWIDE REPUTATION FOR EXCELLENCE

IT'S SIMPLE

Choose the right sprinkler configuration for your crop type, soil type, system type, and water and energy needs.



SPECIFY NELSON ON BOARD



UNIFORMITY BEGINS WITH THE ASSURANCE OF QUALITY. Nelson Irrigation has the highest standards in engineering design, precision manufacturing, and quality assurance with state-of-the-art sprinkler package design software.

FOCUS ON SOLUTIONS. Nelson Irrigation offers a complete line of pivot sprinklers that provide the perfect combination of features to irrigate a multitude of crops — corn, cotton, potatoes, alfalfa — to name a few.

CHOOSE HIGH PERFORMANCE. Nelson's 3000 Series Pivot Products take into account the variety of soils and their differing content of sand, silt, and clay. Water droplet size and energy affect both wind-fighting ability and the integrity of the soil structure. Choose the product that best fits your soil type and maximizes efficiency.

INCREASE PRODUCTIVITY. Center pivot irrigation has proven itself to be a highly effective and efficient means of irrigation. Take advantage of the benefits of improved uniformity and high application efficiency. Solve problems like runoff, while increasing yield and grade.

MAXIMIZE IRRIGATION EFFICIENCY. The need to save water, save energy, and do a better job of irrigating is no longer an option – it's a necessity. Nelson Irrigation is focused and very dedicated to doing things that improve the state-of-the-art of agricultural irrigation by making products that maximize efficiency and uniformity at lower pressure.

PRODUCTS THAT MEET YOUR NEEDS

> an irrigation SYSTEM — it's greater than the sum of its parts

S 3000 spinner

GENTLE RAIN AT LOW PRESSURE. The free-spinning action of the S3000 Spinner provides a gentle, rain-like droplet for sensitive soils and crops.

SUPERIOR UNIFORMITY AT LOW PRESSURE. A low pressure alternative to fixed sprayheads, the S3000 provides higher uniformity with better overlap and lower application rates.

R 3000 rotator®

GREATER THROW RADIUS. As a rotating type sprinkler the R3000 Rotator® produces a wider pattern resulting in a lower application rate, reduced runoff and longer soak time.

HIGHER UNIFORMITY. The R3000 greatly improves uniformity because of the increased overlap from adjacent sprinklers.

REDUCED WIND DRIFT AND EVAPORATIVE LOSS. The R3000 more than meets the challenge of putting a rotating type sprinkler on drop tubes — down out of the wind — to minimize wind drift and evaporative loss.

NEW! PATENTED PLATE TECHNOLOGY

> 3TN

THE 3TN NOZZLE IS THE CENTER OF THE 3000 SERIES PIVOT PRODUCT LINE

A 3000 accelerator

DESIGNED FOR IN-CANOPY WATER APPLICATION. A hybrid sprinkler using both Rotator® and Spinner technology, the Accelerator increases rotation speed as the nozzle size increases. This maximizes throw distance and minimizes evaporative losses at low flow rates. At the end of the system it transforms into a Spinner to lower instantaneous application rates while treating the soil correctly.

MAXIMUM APPLICATION EFFICIENCY. Operating at 10 psi (.7 BAR) the A3000 maintains the lowest possible trajectory angle without sacrificing throw distance.

N 3000 nutator®

DESIRED DROPLETS AT LOW PRESSURE. The N3000 Nutator® is designed for operation at 10-15 psi (.7-1.0 BAR). Choose from two plate designs to best fit specific irrigation needs.

HIGH UNIFORMITY. Designed for optimal performance from the pivot point to the end of the machine, the N3000 Nutator provides uniformity through the nozzle range.

WIND-FIGHTING DROPLET. By maintaining the lowest possible trajectory angle without sacrificing throw distance, the N3000 Nutator provides unsurpassed wind-fighting ability for maximum application efficiency.

NOZZLE

- EXPANDED NOZZLE RANGE
- QUICK-CHANGE
- COLOR-CODED
- COMMON TO ALL 3000 SERIES SPRINKLERS
- HIGH WEAR-RESISTANCE
- PRECISION ACCURACY

D 3000 sprayhead

GERMINATE, IRRIGATE & CHEMIGATE. The flip-over dual spray cap allows easy conversion of the spray pattern. Choose from spray plate options to germinate, irrigate, and chemigate.

"LOW ENERGY DOWN IN THE CROP". The sleek, crop-guarded body design provides durability for dragging the D3000 Sprayhead down in tall growing crops like corn.

OPTIONAL LEPA ACCESSORIES. The hose drag adapter allows simple conversion of the D3000 to a hose drag system while the bubbler clip transforms the D3000 into a LEPA "bubbler" device.

T 3000 trashbuster

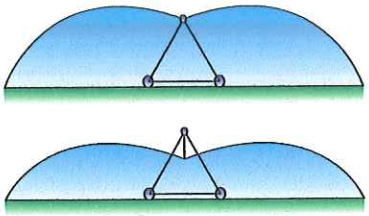
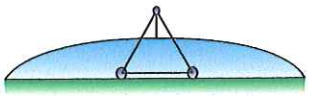
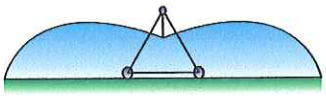
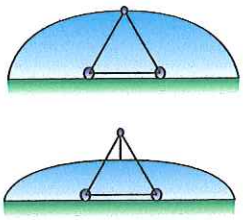
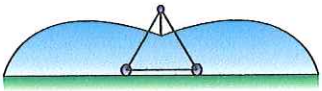
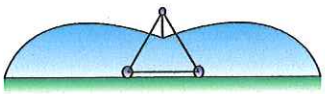
FLOW CONTROL NOZZLE. The 3000FC Nozzle not only eliminates the need for pressure regulators, but also passes debris more easily. It is not to be used on flexible hose drop assemblies.

BODY DESIGNED FOR WASTEWATER. The open architecture design of the body allows for debris to pass through more easily, alleviating build up of material on the plate and body.

By operating on drop tubes you can distribute effluent more days of the year, keep corrosive water off the pivot structure, eliminate excess wind/pathogen drift, and reduce odor. The T3000 Trash-buster can be configured into either a spray or rotator sprinkler.

> 3000 series		DESCRIPTION	NOZZLE TYPE	OPERATING RANGE	APPLICATION RATE
R3000	 rotator®	The **R3000 Rotator®** features the greatest throw distance available on drop tubes. The wide water pattern from rotating streams equates to lower average application rates, longer soak time and reduced runoff. More overlap from adjacent sprinklers improves uniformity.	3TN	15-50 PSI (1-3.4 BAR)	LOW
S3000	 spinner	The **S3000 Spinner** utilizes a free-spinning action to produce a gentle, rain-like water pattern. Designed for more sensitive crops and soils, low instantaneous application rates and reduced droplet kinetic energy help maintain proper soil structure.	3TN	10-20 PSI (.7-1.4 BAR)	LOW - MEDIUM
N3000	 nutator®	The **N3000 Nutator®** combines a spinning action with a continuously offset plate axis for a highly uniform pattern even in the wind. Larger, wind-penetrating droplets and low trajectory angles reduce wind exposure for maximum application efficiency.	3TN	10-15 PSI (.7-1 BAR)	LOW - MEDIUM
D3000	 sprayhead	The **D3000 Sprayhead** is a fixed spray designed with future needs in mind. As irrigation requirements change throughout the s eason, the D3000 features a flip-over cap to change spray patterns. The D3000 is easily convertible to LEPA or other 3000 Series sprinklers.	3TN	6-40 PSI (.41-2.8 BAR)	HIGH
A3000	 accelerator	The **A3000 Accelerator** maximizes performance of in-canopy water application. Designed as a hybrid of Rotator and Spinner technology, the Accelerator increases rotation speed through the nozzle range.	3TN	10-15 PSI (.7-1 BAR)	MEDIUM
T3000	 trashbuster	Developed for the land application of wastewater, the **T3000 Trashbuster** features an open-architecture body design to pass debris more easily. Available with the 3000 FC, a plug-resistant, flow compensating sprinkler package can simplify maintenance.	3TN or 3000 FC	Depends on sprinkler selection	LOW - HIGH

*Careful selection of pressure and sprinkler configuration must be taken into account to optimize droplet size.
**Throw Distance Varies with Pressure, Nozzle Size, Mounting Height and Hydraulic Conditions.

MOUNTING	RELATIVE THROW DIAMETER**	FEATURES & BENEFITS
Up Top or On Drops	50-74' (15.2-22.6M) 	
On Drops	42-54' (12.8-16.5M) 	
On Drops (flex hose) IMPORTANT! To properly install the N3000 Nutator and maintain warranty, it is necessary to mount with a minimum of 12" (30 cm) of reinforced flexible drop hose. Do not use slip over weights that are secured by the hose clamp.	44-52' (13.4-15.9M) 	
Up Top or On Drops	16-40' (4.9-12.2M) 	
On Drops	30-46' (9.1-14.0M) 	
Up Top or On Drops IMPORTANT! Do not use 3000FC with hose drops.	Depends on sprinkler selection 	

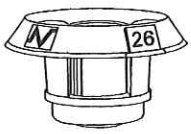
MODULARITY = ECONOMY & EFFICIENCY

Nelson 3000 Series Pivot Products are easy to change/inter-change to give you the best configuration for your ever-changing conditions.

A square thread fitting or a square thread Universal Regulator are a great way to connect sprinkler & hose

3TN NOZZLES

- Quick-Change
- Color-Coded
- Easily Identifiable

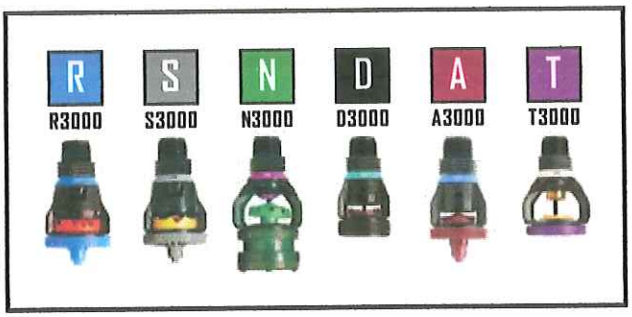


(Odd-numbered nozzles have a color marking the color of the next size nozzle.)

All 3000 Series Pivot Products Bodies have a **"CROP-GUARDED"** design to prevent hang-ups when the sprinkler is down in the crop.

The 3000 Series high-performance plates are engineered to provide the optimal droplet size for various conditions.

< 3000 series PIVOT PRODUCTS > modularity is key



This diagram reflects the modularity of Nelson's 3000 Series Pivot Products. Each sprinkler is made up of an assembly of a cap, plate, body, and nozzle. The 3TN Nozzle is interchangeable with all 3000 Series sprinklers. A variety of connection devices are available to link the sprinkler with a hose or rigid drop.

3/4" F x 3/4" F	Uni-Flo	Hi-Flo
6 PSI	9491-001	9071-001
10 PSI	9491-002	9071-002
15 PSI	9491-003	9071-003
20 PSI	9491-004	9071-005
25 PSI	9491-005	9071-006
30 PSI	9491-006	9071-007
40 PSI	9491-007	9071-008
50 PSI	9491-008	9071-009

3/4" F x Square Thread	Uni-Flo	Hi-Flo
6 PSI	9572-001	9611-001
10 PSI	9572-002	9611-002
15 PSI	9572-003	9611-003
20 PSI	9572-004	9611-005
25 PSI	9572-005	9611-006
30 PSI	9572-006	9611-007
40 PSI	9572-007	9611-008
50 PSI	9572-008	9611-009

1 lb. Modular Pivot Weight #10130
Fits on regulator or directly on body (except the N3000 Nutator)

Universal 3000 Pressure Regulator

R3000 Rotator®/ S3000 Spinner Body #9412

A3000 Accelerator/ D3000 Sprayhead Body #9428

Rotator® R3000

Rotator® Plates

D6 12° (Red) #8839
Orange #10598
Brown #10681
U4 8° (Blue) #8817
D4 8° (Green) #8844
White #10749

Rotator® Cap (Blue) #9539

PC-R3000 #10843-xxx

PC-S3000 #9926-001

Spinner S3000

Spinner Plates

D6 12° (Red) #8839
D8 21° (Yellow) #10361
D6 20° (Purple) #9583
(Beige) #11013

Spinner Cap (Gray) #9540

A3000 Accelerator

Accelerator Plate

Maroon #9906

Accelerator Cap (Maroon) #10402

3/4" Adapter #9410 or
3000 Series Connection (ST)

Hose Barb Fittings

Square Thread #9901 | MNPT #10148 | FNPT #10057

LEPA Options

HD3000 Hose Drag Adapter #9427

Bubbler Attachment for D3000 #10577

Dual Nozzle Clip #9742

Triple Nozzle Clip #11089

(Clips can be used with all 3000 Series Sprinklers and plates except the D3000 with the red plate)

3TN Nozzle
#9461-xxx

3000FC Nozzle
#10106-xxxx

flow control nozzle
requires rigid drop

N3000 Nutator®/
T3000 Trashbuster Body #10419

D3000 Sprayhead

Spray Plates

Orange #10683 | Turquoise #9591 | Purple #9550 | Yellow #9631 | Green #9543 | White #10971

Brown #10721 | Black #9541 | Blue #9493 | Gray #9542 | Red #9437

Flip-Over Spray Cap (Black) #9429

Spray Plate with Cap Assembly #10041-xxxx

PC-D3000
#9894-001

N3000 Nutator®

Nutator® Plates
*With Cap Only

Nutator® Cap Assembly (Green) *#10319-001

Nutator® Cap Assembly (Blue) *#10319-002

T3000 Trashbuster

Rotator® Plates

U4 8° (Blue) #8817

D4 8° (Green) #8844

Rotator® Cap (Blue) #9539

Spray Plates

Black #9541 | Blue #9493

Yellow #9631 | Green #9543

Trashbuster Cap (Purple) #10133

Spray Plate with Cap Assembly #10324-xxx

> UNIVERSAL FLO 3000 series PRESSURE REGULATORS

The function of a pressure regulator in center pivot sprinkler design is to fix a varying inlet pressure to a set outlet pressure, regardless of changes in the system pressure due to hydraulic conditions, elevation changes, pumping scenarios, etc. The benefits include a uniform depth of water application, controlled sprinkler performance (droplet size and throw distance), and flexibility in system operation. Specify Nelson's Universal Flo 3000 Series Regulator in your sprinkler package.

WIDE FLOW RANGE

The Nelson Universal Pressure Regulator has a flow up to 12 GPM (2.7 M^3/H) at 15 PSI (1.0 BAR) and above.

PATENTED PLUG RESISTANT DESIGN

Improved plug-resistance with a new single-strut seat design in both the Hi-Flo and Universal Flo models.

EXTENDED PERFORMANCE & PRECISION ACCURACY

Precision components coupled with an internally lubricated o-ring minimize frictional drag and hysteresis.

PATENTED DAMPENING SYSTEM

A patented o-ring dampening system handles severe pressure surges to withstand water hammer.

CHEMICALLY RESISTANT MATERIALS

UNIVERSAL 3000 SERIES CONNECTION

Integral adapter connects directly into all Nelson 3000 Series Sprinklers.

1 LB. WEIGHT FOR FLEXIBLE HOSE DROPS

The modular weight fits onto all Nelson Pressure Regulators. When pressure regulators are not used, the weight fits securely on the body of 3000 Series sprinklers (not to be fitted directly on the N3000 Nutator). The 1 lb. Modular Pivot Weight is designed for Nelson 3000 Series products operating at 20 PSI (1.4 BAR) and below.

TECHNICAL TIPS FOR REGULATING SYSTEMS

IMPORTANT: Allow approximately 5 PSI (.35 BAR) extra pressure in order for the regulator to function properly. For example, the minimum design pressure for a 20 PSI (1.4 BAR) pressure regulator is 25 PSI (1.7 BAR).

IMPORTANT: If your system is designed with Nelson sprinklers, use Nelson Pressure Regulators. Individual manufacturers' pressure regulator performance varies. Interchanging could result in inaccurate nozzle selection.

> 3000 series PIVOT ACCESSORIES

3TN DUAL & TRIPLE NOZZLE CLIPS

SAVE WATER WITH SMART TOOLS. Nelson 3000 Series sprinklers can be equipped with two or three nozzles using the 3TN Dual Nozzle Clip or 3TN Triple Nozzle Clip. These allow you to precisely match crop water requirements through the season. During germination, lower system flow rates lessen the intensity of water droplets to maintain proper soil structure and reduce runoff. Adjust the system flow as crop water requirements change.

- Change system flow quickly and accurately.
- No more fumbling with or dropping nozzles.
- Meet differing in-season demands:
  - — Germinate at LO, Irrigate at HI
  - — Irrigate at HI, Chemigate at LO

NOTE: Do not operate in down-in-the-crop applications, or with the D3000 Chemigation Plate.

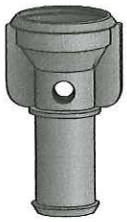
NEW! 3TN TRIPLE NOZZLE CLIP

LEPA APPLICATIONS

D3000 SPRAYHEAD WITH BUBBLER CLIP

Transform the D3000 Sprayhead into a LEPA Bubbler by inverting the D3000 Cap and attaching a bubbler clip to the D3000 Body. (Not to be used with second spray plate.)

HD3000



HD3000 HOSE DRAG ADAPTER

For (LEPA) low energy precision application, utilize the 3/4" hose drag adapter on the 3000 Series to apply a hose drag or a drag sock. With LEPA, the plant canopy remains dry and water is applied directly to the furrow — typically every other furrow. Pressure regulators are generally a necessity for good LEPA uniformity of nozzle discharge.

Solve Wheel Track Problems with Part-Circle Sprinklers

PROBLEM:

Excessive water in the wheel tracks can cause slippage of the tires, causing the system to slow down in wet areas and steep slopes — increasing the application depth in relation to other parts of the fields. Deep wheel track ruts are also detrimental to the equipment and harvesting efficiency.

SOLUTION:

Nelson part circle sprinklers direct the water off of the pivot structure at the towers and away from the wheel track to prevent deep wheel track ruts. Overall field uniformity can be maintained by preventing excessive slippage of the tires, and maintaining a uniform speed of travel.

PC-R3000

PC-S3000

PC-D3000

HOSE BARB FITTINGS

USER-FRIENDLY. Easy installation of hose barb into $^{3}/_{4}$" flexible hose.

EASY THREAD INSTALLATION. The convenience of the $^{15}/_{16}$" Hex Adapter is unique to Nelson fittings. Secure fittings using $^{15}/_{16}$" deep well socket or open end wrench.

ELIMINATE ADDITIONAL FITTINGS.

3/4" FNPT

3/4" MNPT

3000 ST
(#9901 — square thread for 3000 Series)

SAVE WATER, SAVE ENERGY AND DO A BETTER JOB OF IRRIGATING WITH NELSON 3000 SERIES PIVOT PRODUCTS.

NELSON ON BOARD

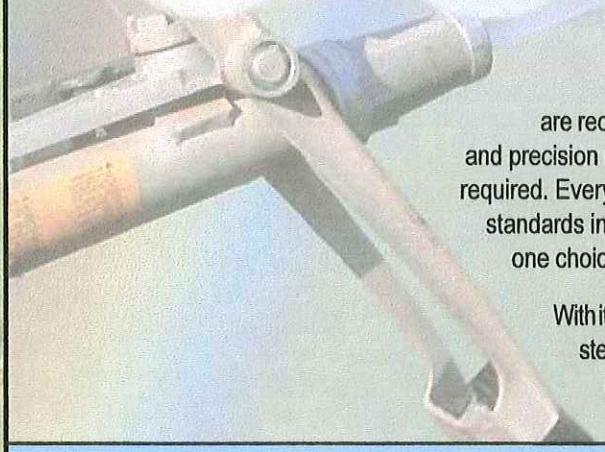
> IMPACT and BIG GUN SPRINKLERS

P85AS
20 GPM-125 GPM
(4.5 M³/H-28.4 M³/H)

SR75
30 GPM-160 GPM
(6.8 M³/H-36.3 M³/H)

SRNV100
50 GPM-300 GPM
(11.4 M³/H-68.2 M³/H)

SR100
50 GPM-300 GPM
(11.4 M³/H-68.2 M³/H)



BIG GUN SPRINKLERS. In the field of large-volume sprinklers, Nelson Big Guns® are recognized the world over as the leader in quality and performance. They are engineered and precision manufactured for heavy-duty reliability and long wear life with minimum maintenance required. Every Nelson Big Gun® is subjected to the toughest inspection testing and quality control standards in the industry. The SR (Slow Reverse) series of Big Guns® is far and away the number one choice for center pivot end gun use around the world.

With its proven dual arm drive and patented dual drive spoon, the SR gun reverses at the same slow, steady speed as it drives forward. This greatly reduces the vibration and whipping action of the old fast reverse system, which puts excessive stress and strain on the carrying device.

PLASTIC IMPACT SPRINKLER PACKAGES

F44AAB

Save Inventory & Cost – The F44AAB requires only one model of sprinkler to cover from pivot point to end gun.
Save Water & Energy – The 8° low angle body minimizes wind exposure and oper-ates at low pressure for optimum efficiency.
Heavy Duty – Featuring a Seal-Lock™ Bearing design, wear life is extended in tough field conditions. Engineering grade plastic provides durability. *Select standard or Nelson FCN® flow control nozzles.*

BRASS IMPACT SPRINKLER PACKAGES

F33AA

Wide Coverage & Overlap - 15° trajectory maximizes throw distance, while keeping the water pattern down out of the wind.
Extended Wear Life – Precision manu-factured from the highest quality materials available. Features the Seal-Lock™ Bearing design for extended wear life in tough field conditions.

Select standard or Nelson FCN® flow control nozzles.

Nelson Irrigation Corporation
848 Airport Rd., Walla Walla, WA 99362 USA
Tel: 509.525.7660 Fax: 509.525.7907 info@nelsonirrigation.com
Nelson Irrigation Corporation of Australia Pty. Ltd.
35 Sudbury Street, Darra QLD 4074 info@nelsonirrigation.com.au
Tel: +61 7 3715 8555 Fax: +61 7 3715 8666
WWW.NELSONIRRIGATION.COM

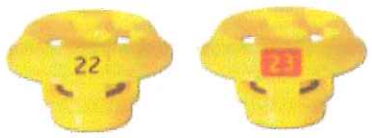
These products may be covered by one or more of the following U.S. Patent Nos. 3744720, 3559887, 4796811, 4809910, RE33823, DES312865, 5415348, 5409168, 5439174, 5588595, 5671774, 6688539, 7025287, 7140595 and other U.S. Patents pending or corresponding issued or pending foreign patents.

NELSON ON BOARD

Nelson Irrigation Corporation's worldwide network of professional dealers provides customized water application solutions.

> 3000 Series 3TN Nozzle System > U.S. Units (GPM)

- Quick-Change
- Color-Coded
- Precision Accuracy
- High Wear Resistance



The nozzle sizing system is based on 128th inch increments, i.e. 3TN Nozzle #22 has an orifice diameter of 22/128th inches while 3TN Nozzle #23 has an orifice diameter of 23/128th inches. Odd numbered nozzles have a color box around the number marking. This color box denotes the color of next larger nozzle size.

# Color Stripe	#9 Light Blue Beige	#10 Beige	#11 Beige Gold	#12 Gold	#13 Gold Lime	#14 Lime	#15 Lime Lavender	#16 Lavender	#17 Lavender Gray	#18 Gray	#19 Gray Turquoise
PSI	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
6	0.34	0.42	0.50	0.61	0.71	0.82	0.95	1.08	1.22	1.36	1.53
10	0.44	0.54	0.65	0.79	0.92	1.06	1.23	1.40	1.58	1.75	1.97
15	0.53	0.66	0.79	0.96	1.13	1.29	1.51	1.71	1.93	2.14	2.41
20	0.62	0.76	0.92	1.11	1.30	1.49	1.74	1.98	2.23	2.48	2.79
25	0.69	0.85	1.02	1.24	1.46	1.67	1.95	2.21	2.50	2.77	3.12
30	0.76	0.93	1.12	1.36	1.59	1.83	2.14	2.42	2.74	3.03	3.41
40	0.87	1.07	1.29	1.57	1.84	2.11	2.47	2.80	3.16	3.50	3.94
50	0.97	1.20	1.45	1.76	2.06	2.36	2.76	3.13	3.53	3.91	4.41

# Color Stripe	#20 Turquoise	#21 Turquoise Yellow	#22 Yellow	#23 Yellow Red	#24 Red	#25 Red White	#26 White	#27 White Blue	#28 Blue	#29 Blue Dark Brown	#30 Dark Brown
PSI	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
6	1.70	1.84	2.04	2.22	2.44	2.64	2.87	3.07	3.35	3.58	3.83
10	2.19	2.38	2.64	2.86	3.16	3.41	3.70	3.97	4.32	4.62	4.94
15	2.69	2.91	3.23	3.50	3.86	4.17	4.53	4.86	5.29	5.66	6.06
20	3.10	3.36	3.73	4.05	4.46	4.82	5.23	5.61	6.11	6.53	6.99
25	3.47	3.76	4.17	4.52	4.99	5.38	5.85	6.27	6.83	7.30	7.82
30	3.80	4.12	4.56	4.96	5.47	5.90	6.41	6.87	7.48	8.00	8.56
40	4.39	4.76	5.27	5.72	6.31	6.81	7.40	7.94	8.64	9.24	9.89
50	4.90	5.32	5.89	6.40	7.06	7.61	8.28	8.87	9.66	10.33	11.06

# Color Stripe	#31 Dark Brown Orange	#32 Orange	#33 Orange Dark Green	#34 Dark Green	#35 Dark Green Purple	#36 Purple	#37 Purple Black	#38 Black	#39 Black Dk. Turquoise	#40 Dark Turquoise	#41 Dk. Turquoise Mustard
PSI	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
6	4.06	4.36	4.65	4.94	5.20	5.47	5.84	6.18	6.52	6.85	7.26
10	5.24	5.63	6.00	6.37	6.72	7.06	7.54	7.97	8.42	8.85	9.37
15	6.41	6.89	7.35	7.81	8.23	8.65	9.24	9.77	10.31	10.84	11.48
20	7.40	7.96	8.49	9.01	9.50	9.98	10.67	11.28	11.91	12.51	13.26
25	8.28	8.90	9.49	10.08	10.62	11.16	11.92	12.61	13.31	13.99	14.82
30	9.07	9.75	10.39	11.04	11.64	12.23	13.06	13.81	14.58	15.33	16.23
40	10.47	11.26	12.00	12.75	13.44	14.12	15.08	15.95	16.84	17.70	18.75
50	11.71	12.59	13.42	14.25	15.02	15.79	16.86	17.83	18.81	19.79	20.96

# Color Stripe	#42 Mustard	#43 Mustard Maroon	#44 Maroon	#45 Maroon Cream	#46 Cream	#47 Cream Dark Blue	#48 Dark Blue	#49 Dark Blue Copper	#50 Copper
PSI	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
6	7.60	7.96	8.33	8.73	9.12	9.58	9.96	10.31	10.77
10	9.81	10.28	10.75	11.27	11.77	12.36	12.86	13.31	13.91
15	12.01	12.59	13.17	13.80	14.41	15.14	15.75	16.30	17.03
20	13.87	14.54	15.20	15.93	16.64	17.49	18.19	18.82	19.67
25	15.51	16.25	17.00	17.81	18.61	19.55	20.33	21.05	21.99
30	16.99	17.80	18.62	19.51	20.38	21.42	22.28	23.05	24.09
40	19.61	20.56	21.50	22.53	23.54	24.73	25.72	26.62	27.82
50	21.93	22.98	24.04	25.19	26.31	27.65	28.76	29.76	31.10

This flow data was obtained under ideal test conditions and may be adversely affected by poor hydraulic entrance conditions, turbulence or other factors. Nelson Irrigation makes no representation regarding sprinkler flow rate accuracy under various plumbing and drop pipe conditions.

NELSON
Nelson Irrigation Corporation
848 Airport Rd., Walla Walla, WA 99362 USA
Tel: 509.525.7660 Fax: 509.525.7907 info@nelsonirrigation.com
Nelson Irrigation Corporation of Australia Pty. Ltd.
35 Sudbury Street, Darra QLD 4074 info@nelsonirrigation.com.au
Tel: +61 7 3715 8555 Fax: +61 7 3715 8666

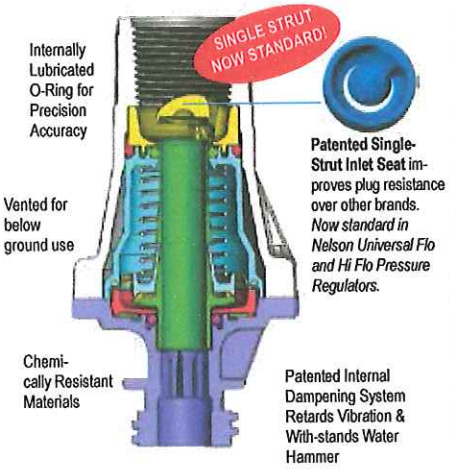
WWW.NELSONIRRIGATION.COM

PRESSURE REGULATION

improved plug-resistant design

precision accuracy in tough field environments

Cut-away of Pressure Regulator



TECHNICAL TIPS FOR REGULATING SYSTEMS

IMPORTANT: Allow approximately 5 PSI (.35 BAR) extra pressure in order for the regulator to function properly. For example, the minimum design pressure for a 20 PSI (1.4 BAR) pressure regulator is 25 PSI (1.7 BAR).

IMPORTANT: If your system is designed with Nelson sprinklers, use Nelson Pressure Regulators. Individual manufacturers' pressure regulator performance varies. Interchanging could result in inaccurate nozzle selection.

NELSON

SAVE WATER, SAVE ENERGY AND DO A BETTER JOB OF IRRIGATING

NELSON'S UNIVERSAL FLO AND HI FLO REGULATORS

The function of a pressure regulator is to fix a varying inlet pressure to a set outlet pressure, regardless of changes in the system pressure due to hydraulic conditions, elevation changes, pumping scenarios, etc. The benefits include a uniform depth of water application, controlled sprinkler performance (droplet size and throw distance), and flexibility in system operation.

FEATURES & BENEFITS:

SINGLE STRUT SEAT DESIGN STANDARD WITH UNIVERSAL FLO. The new "single-strut" technology in the Universal Flo regulator minimizes "hair-pinning" of debris around the inlet seat, providing more plug resistance for systems operating in dirty water condtions.

PATENTED DAMPENING SYSTEM. The patented o-ring dampening system of all Nelson pressure regulators handles severe pressure surges to withstand water hammer.

WIDE FLOW RANGE. The Nelson Universal Pressure Regulator has a flow up to 12 GPM (2.7 M^3/H) at 15 PSI (1.0 BAR) and above.

EXTENDED PERFORMANCE AND PRECISION ACCURACY. Precision components coupled with an internally lubricated o-ring minimize frictional drag and hysteresis.

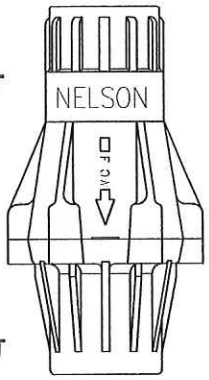
PRECISION MANUFACTURED. Made of the toughest chemically resistant materials. 100% tested for accuracy.

UNIVERSAL 3000 SERIES CONNECTION OPTION. Integral adapter connects directly into all Nelson 3000 Series Pivot Sprinklers and creates an easy to assemble, economical pivot sprinkler package.

> UNIVERSAL FLO and HIGH FLO – CONNECTIONS & PERFORMANCE

PIPE THREAD CONNECTION

INLET
3/4" FNPT

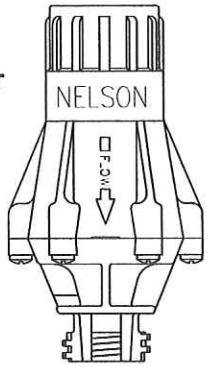


OUTLET
3/4" FNPT

3000 SERIES PIVOT CONNECTION

(Integral adapter for 3000 Series Pivot Products)

INLET
3/4" FNPT

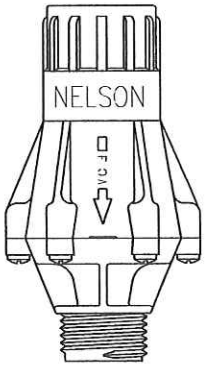


OUTLET
3000 ST

HOSE THREAD CONNECTION

(Connections for Micro/Drip)

INLET
3/4" FHT



OUTLET
3/4" MHT

ORDERING SPECIFICATIONS: When ordering Nelson Pressure Regulators specify Pressure, Flow (Universal Flo or Hi Flo) & Connection (Inlet x Outlet). (Example: 10 PSI Hi Flo 3/4"FNPT x 3/4"FNPT.) **More connection options available — please contact Nelson factory for more information.**

UNIVERSAL FLO REGULATOR

PSI	BAR	GPM	M³/HR	CONNECTIONS AVAILABLE ■ 3/4" FNPT 3/4" FNPT	3/4" FNPT 3/4" ST	3/4" FHT 3/4" MHT
6	0.41	0.5-8	0.11-1.82	■	■	■
10	0.70	0.5-10	0.11-2.27	■	■	■
15	1.0	0.5-12	0.11-2.72	■	■	■
20	1.4	0.5-12	0.11-2.72	■	■	■
25	1.7	0.5-12	0.11-2.72	■	■	■
30	2.0	0.5-12	0.11-2.72	■	■	■
40	2.8	0.5-12	0.11-2.72	■	■	■
50	3.4	0.5-12	0.11-2.72	■	■	■

HI-FLO REGULATOR

PSI	BAR	GPM	M³/HR	CONNECTIONS AVAILABLE ■ 3/4" FNPT 3/4" FNPT	3/4" FNPT 3/4" ST
6	0.41	4-16	.91-3.63	■	■
10	0.70	4-16	.91-3.63	■	■
15	1.0	2-20	.45-4.54	■	■
20	1.4	2-20	.45-4.54	■	■
25	1.7	2-20	.45-4.54	■	■
30	2.0	2-20	.45-4.54	■	■
40	2.8	2-20	.45-4.54	■	■
50	3.4	2-20	.45-4.54	■	■

APPLICATION NOTES

Nelson Pressure Regulators can be used in a variety of applications (e.g. Center Pivot, Solid Set, Tree & Vine). Choose the proper pressure rating for your application.

Performance Tables. Contact the Nelson factory for detailed performance information.

Design Considerations. Maintain a 5 PSI (0.35 BAR) threshold above the nominal spring rated pressure.

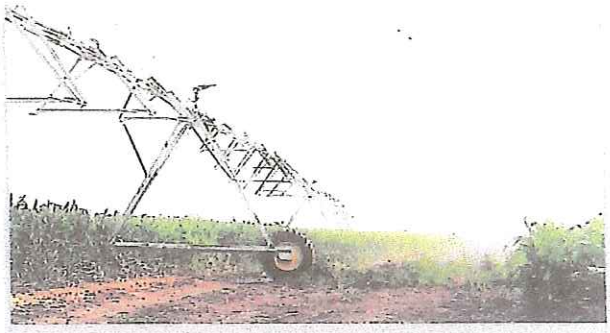
CAUTION! Pressure regulators should be installed downstream from all shut-off valves.

NELSON
Nelson Irrigation Corporation
848 Airport Rd., Walla Walla, WA 99362 USA
Tel: 509.525.7660 Fax: 509.525.7907 info@nelsonirrigation.com
Nelson Irrigation Corporation of Australia Pty. Ltd.
35 Sudbury Street, Darra QLD 4074 Info@nelsonirrigation.com.au
Tel: +61 7 3715 8555 Fax: +61 7 3715 8666

Ebert Irrigation Info

WASTE WATER MANAGEMENT

The choice is simple.



Slurry Sprinkler Package

Low Drift Drop Sprinkler Package

CERTIFIED ISO 9001 QUALITY

IRRIGATION EXCELLENCE SINCE 1955 50 YEARS

THREE-IN-ONE

ATTACH THE NEW NELSON SPRINKLER CONVERTER TO THE A3000 CAP & PLATE ASSEMBLY AND CHOOSE FROM A VARIETY OF SUPPLEMENTAL APPLICATIONS

IRRIGATE

A3000
Accelerator

+

SPRAY

D3000
Spray Plate

and

LEPA

D3000
Bubbler Clip

or

CHEMIGATE

D3000
Chemigation Plate

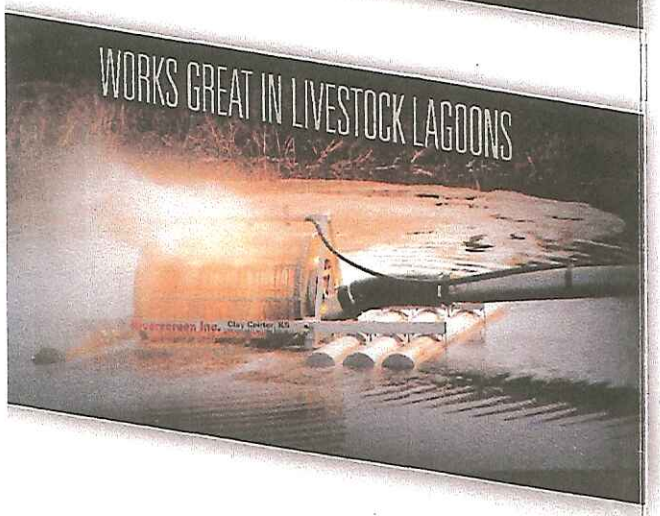
SPRINKLER TECHNOLOGY FOR THE FUTURE

nelsonirrigation.com — nelsonproducts.info

NELSON

A ROTATING, WATER-DRIVEN, SELF-CLEANING SCREEN THAT DEPENDABLY DELIVERS GOOD WATER FROM DEPTHS AS LOW AS 4".

Draws from more than 35 sq. ft. of screening area. 4", 6", 8", 10" and 12" models available to fit your suction line.



The ideal solution for any operation which depends on river or canal water sources for pivot irrigation systems. Riverscreen is built for shallow water pumping to prevent sand problems.

Standard on all Riverscreen models is #8 304 stainless steel mesh. Other sizes available upon request. The optional power drive unit keeps drum turning in slow moving currents (uses approx. 6 gpm).

Steve Peterson of Clay Center, KS uses three River Screens on the Republican River to keep seven pivot systems running. "I would be in a lot of trouble with leaves and trash getting into the pump without these screens," he states. Riverscreen's low-maintenance operation means every owner has similar experiences and comments.

Riverscreen™

Optional Lifting Boom

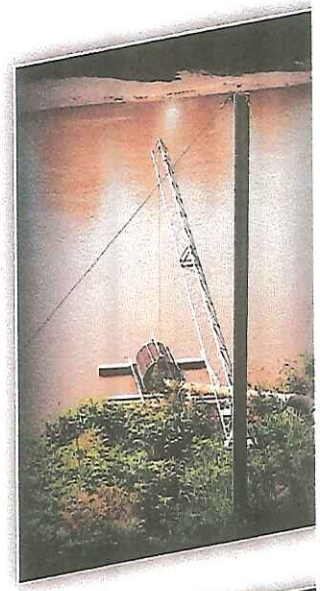
Galvanized for long life

Heavy 6" upright main pipe

Trussed boom for greater strength

Brake winch for ease of operation

Quick latch hook for easy hookup



Optional Power Drive

Keeps drum turning even in slow moving current or still water

Only requires 6 gpm

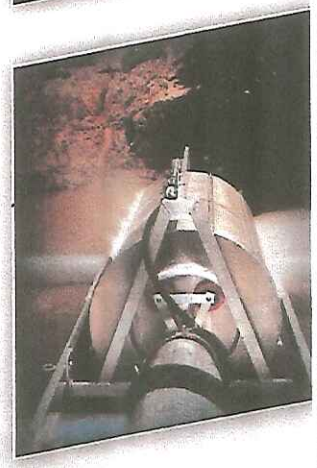


EXHIBIT 3A

ANSI/ASAE S572.1 MAR2009
Spray Nozzle Classification by Droplet Spectra

American Society of
Agricultural and Biological Engineers

STANDARD

ASABE is a professional and technical organization, of members worldwide, who are dedicated to advancement of engineering applicable to agricultural, food, and biological systems. ASABE Standards are consensus documents developed and adopted by the American Society of Agricultural and Biological Engineers to meet standardization needs within the scope of the Society; principally agricultural field equipment, farmstead equipment, structures, soil and water resource management, turf and landscape equipment, forest engineering, food and process engineering, electric power applications, plant and animal environment, and waste management.

NOTE: ASABE Standards, Engineering Practices, and Data are informational and advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. The ASABE assumes no responsibility for results attributable to the application of ASABE Standards, Engineering Practices, and Data. Conformity does not ensure compliance with applicable ordinances, laws and regulations. Prospective users are responsible for protecting themselves against liability for infringement of patents.

ASABE Standards, Engineering Practices, and Data initially approved prior to the society name change in July of 2005 are designated as 'ASAE', regardless of the revision approval date. Newly developed Standards, Engineering Practices and Data approved after July of 2005 are designated as 'ASABE'.

Standards designated as 'ANSI' are American National Standards as are all ISO adoptions published by ASABE. Adoption as an American National Standard requires verification by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by ASABE.

Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

CAUTION NOTICE: ASABE and ANSI standards may be revised or withdrawn at any time. Additionally, procedures of ASABE require that action be taken periodically to reaffirm, revise, or withdraw each standard.

ASABE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA ph. 269-429-0300, fax 269-429-3852, hq@asabe.org

ANSI/ASAE S572.1 MAR2009
Approved March 2009 as an American National Standard

Spray Nozzle Classification by Droplet Spectra

Developed by the ASAE Pest Control and Fertilizer Application Committee; approved by the Power and Machinery Division Standards Committee; adopted by ASAE August 1999; reaffirmed February 2004; revised March 2009; approved as an American National Standard March 2009.

Keywords: Chemicals, Drop size, Droplet, Fertilizer, Nozzle, Spray

1 Purpose and scope

1.1 This Standard defines droplet spectrum categories for the classification of spray nozzles, relative to specified reference fan nozzles discharging spray into static air or so that no stream of air enhances atomization. The purpose of classification is to provide the nozzle user with droplet size information primarily to indicate off-site spray drift potential and secondarily for application efficacy.

1.2 This Standard defines a means for *relative nozzle comparisons only based on droplet size.* Other spray drift and application efficacy factors, such as droplet discharge trajectory, height, and velocity, air bubble inclusion; droplet evaporation; and impaction on target are examples of factors not addressed by the current Standard.

2 General

2.1 Liquid flow rate, liquid pressure, and physical changes to nozzle geometry and operation can affect the nozzle classification. A given nozzle can be classified into one or more droplet size categories, depending on the selection of flow rate, operating pressure, and other operational conditions.

2.2 Generally the Standard is based on spraying water through the reference nozzles and nozzles to be classified. However, spray liquid properties may affect droplet sizes and should be considered by the end user. Besides water, a surfactant-water mixture, with a dynamic surface tension of 40±2 dynes/cm at 10 to 20 ms, such as 9% (wt/wt) isopropanol or 0.1% (v/v) Surfynol™ TG-E surfactant in water should be sprayed through the nozzles to be classified (1) that are claimed to reduce spray drift, or (2) that utilize pre-orifices or internal turbulence chambers *especially for cases near a threshold between classification categories.* If differing classifications (see 6 Nozzle classification procedures for statistical basis) are determined for water versus a mixture of water and surfactant, the finer of the two classifications should be reported.

2.3 Presentation of nozzle classification categories to nozzle users should use the standard category terms from 3.3. The presentation may use the symbols or color codes identified in 3.3, provided the corresponding standard category terms are identified in the presentation.

3 Reference flat spray nozzles

3.1 The droplet spectra produced by single, elliptical orifice reference nozzles with specified, (1) liquid mixture (water), (2) liquid flow rates, (3) operating pressures, and (4) spray angles, all of which are specified by this Standard (see 3.5), establish the threshold of division between nozzle classification categories.

3.1.1 Reference nozzle sets should be periodically checked, through laser droplet size testing, for consistency in droplet size production.

3.2 Reference nozzles shall not be subjected to wear-inducing conditions that could alter orifice size, shape, smoothness, flow rate, or spray angle.

3.3 Classification categories, symbols, and corresponding color codes are the following:

Classification category	Symbol	Color code
Extremely fine	XF	Purple
Very fine	VF	Red
Fine	F	Orange
Medium	M	Yellow
Coarse	C	Blue
Very coarse	VC	Green
Extremely coarse	XC	White
Ultra Coarse	UC	Black

3.4 Reference flow rate and operating pressure are specified for each reference nozzle, since droplet size spectra from pressure atomizers are affected by flow rate and operating pressure. The included angle of the fan spray, nominal rated flow rate, reference flow rate, and reference operating pressure are specified (see 3.5). It should be noted that a nozzle body strainer, or screen, *is not used* for any nozzle tip in this Standard.

3.5 Classification category thresholds, nozzle spray angles, nominal rated flow ratings at 276 kPa (40 psi), reference flow ratings, and reference operating pressures are shown in Table 1.

4 Droplet sizing

4.1 The droplet spectra from the reference nozzles, and from nozzles to be classified, should be measured with a laser-based instrument. Commercial droplet sizing instruments typically use either (1) laser diffraction, (2) laser imaging, or (3) laser-based phase-Doppler techniques. Instrument use should minimize the measurement of interactions that could occur between the instrument and droplets in-flight in the spray. Instrument technologies other than laser-based may be used provided that accuracy and repeatability are comparable with that of laser instruments.

4.1.1 Verification or calibration to known standards of any measurement method is essential. Instrument particulars, such as size range configuration, obscuration, multiple scattering, verification, droplet path angle, calibration, and repeatability, shall be addressed such that accurate and repeatable day-to-day measurements are obtained.

4.2 Nozzles are oriented to discharge the spray to allow for scanning the entire spray plume by the laser instrument. The height of the laser below the nozzle, or the distance between the nozzle discharge and measurement point, should range from 200 mm (8 in.) to 500 mm (20 in.). However, exceptions to this distance range may be necessary to reduce fouling of the instrument lens.

4.3 Droplet size measurement must ensure that a representative, cross-sectional sample of the spray plume is obtained. Acceptable methods include traversing the nozzle through the laser during data sampling, or by calculating droplet sizes by merging data of multiple readings from representative samples of the spray plume. The method chosen should be consistent between reference nozzles and nozzles being classified. ASTM Standards addressing instrument use and spray sampling should always be consulted for best measurement procedures.

Table 1 – Classification category threshold values for flat spray nozzles

Classification category threshold	Nozzle spray angle (°)	Nominal rated flow rate[1]		Reference flow rate[2]		Reference operating pressure[3]	
		(L/min)	(gpm)	(L/min)	(gpm)	(kPa)	(psi)
XF / VF	IP-16[4], 30	0.075	0.032	0.036	0.010	550	79.8
VF / F	110	0.38	0.10	0.48	0.13	450	65.3
F / M	110	1.14	0.30	1.18	0.31	300	43.5
M / C	110	2.27	0.60	1.93	0.51	200	29.0
C / VC	80	3.03	0.80	2.88	0.76	250	36.3
VC / XC	65	3.78	1.00	3.22	0.85	200	29.0
XC / UC	65	5.68	1.50	4.92	1.30	150	21.7

[1]Nominal rated flow rate is at 276 kPa (40 psi) and is for nozzle size confirmation only; for IP-16 nominal rating is 0.75L/m at 6895 kPa (1000psi).
[2]Reference flow rate is the actual rate used and has a tolerance of ±0.04 L/min (±0.01 gpm). Reference flow rate was determined for this Standard from $Q=k\sqrt{P}$. The orifice coefficient (k) for each single, elliptical orifice reference nozzle is calculated from the nominal rated condition. IP-16 data is from the manufacturer MeeFog™. The reference operating pressure (P) is listed in the above table. Tolerances for the reference operating pressure are described in the following footnote.
[3]Reference operating pressure is the hydraulic pressure used to obtain the reference flow rate and should be within a tolerance range of ±3.4 kPa (±0.5 psi) of the value tabled above. If the tolerance reference flow rate at the tolerance reference operating pressure cannot simultaneously be achieved, a different nozzle tip should be selected. All pressures are measured with a test gage with a minimum accuracy of 2 kPa (0.25 psi) (accuracy grade =3A). Test pressure is obtained via a capillary tube connected to a tee that accommodates the nozzle body to minimize flow restrictions and potential pressure drop between the capillary and nozzle tip. No nozzle strainer is present in the nozzle body.
[4]IP-16 is a pin deflector fog nozzle from MeeFog™.

4.4 A minimum of three separate, replicate measurements shall be averaged to establish the cumulative volume-versus-droplet size spectra relationship, including values of $D_{v0.1}$, $D_{v0.5}$, and $D_{v0.9}$. The exact number of replicate measurements shall be determined based on the desired standard deviation and resulting resolution in classification (see 6).

4.5 Tap water is the test liquid for reference nozzle droplet sizing determinations. Exceptions to using water alone for nozzles to be classified are specified in 2.2. Ambient temperature and measurement technique should result in negligible droplet evaporation.

5 Reference graph of classification droplet spectra

5.1 A reference graph for nozzle classification shall be established from droplet size spectra measurements obtained for all of the reference nozzles. Droplet diameter (microns) is plotted versus the cumulative spray volume (fraction or percent) (ordinate) for five reference nozzles as an example reference graph. These curves define the classification thresholds between categories.

5.2 Cumulative volume for the reference graph shall range from 10 to 90 percent. The graph can be simplified by using computed values of $D_{v0.1}$, $D_{v0.5}$, and $D_{v0.9}$. An example reference graph developed from measurements averaged from three types of laser instruments is shown in figure 1.

5.3 Droplet spectra measurements for (A) reference nozzles *and* (B) nozzles to be classified shall be performed with the same (1) instrument, (2) measurement method, (3) sampling technique, (4) scanning technique, (5) operator; and (6) similar environmental condition. Any deviation in these six factors may void the accuracy of the classification. The reference graph shall be verified before and after measurements are taken to classify nozzles. The frequency of graph verification should ensure that repeatable classification results are obtained throughout testing.

6 Nozzle classification procedures

6.1 Sprays from nozzles to be classified are measured on the same analyzer at the same settings as for the reference nozzles (see 5 Reference graph of classification droplet spectra). Nozzle classifications are determined from plotting cumulative volume versus droplet size spectra, namely the computed values of $D_{v0.1}$, $D_{v0.5}$, and $D_{v0.9}$ onto the reference graph. The classification is determined based on where the droplet size spectra fall on the reference graph relative to the reference nozzles. *One standard deviation of each reference nozzle measurement above each threshold curve determines the actual upper limit for the classification category falling below the threshold curve.*

6.2 Steps of the procedure include:

1. Calibrate or verify the droplet sizing instrument (see 4 Droplet sizing)
2. Calibrate flow rate from reference nozzles to achieve reference discharge flow rate (see specifications in 3.5)

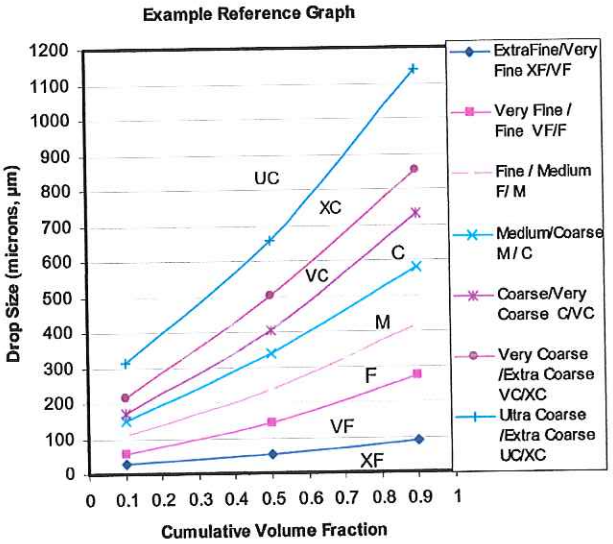


Figure 1 – Sample reference graph developed from measurements averaged from three types of laser instruments. NOTE: To view figure in color please go to http://www.asabe.org/standards/images/s572images.html

3. Measure droplet spectra from the reference nozzles (see 3 Reference flat spray nozzles)
4. Plot the reference graph (see 5 Reference graph of classification droplet spectra)
5. Measure the droplet spectrum for the nozzle, pressure, flow rate, geometry, and operational combination to be classified
6. Plot the measured droplet spectrum on the reference graph
7. Determine the classification based on the category where the measured spectrum falls - *taking into account one standard deviation of the reference nozzle measurement above the threshold curve as the statistical basis for decisions involving classifications close to the reference curves. One standard deviation above the reference curve is the upper limit for the corresponding lower category.*

6.3 The measured droplet spectrum for a given nozzle/pressure combination should fall in a single classification category, without intercepting or crossing a reference threshold curve. In the event a reference threshold division is intercepted or crossed, the finer of the classification categories shall be reported to indicate the smallest droplet size of the categories involved, ignoring the region of Dv0.9 to not penalize narrow droplet size distribution atomizers. *Again, the standard deviation in measurement accuracy of the threshold curve should be taken into account, even when curves cross threshold curves (see 6.1 and 6.2).*

Annex A
(informative)
Additional spray solution for nozzles claimed to reduce drift

Surfactant source

1.1 Surfynol™ TG-E surfactant as noted in 2.2 as a means of obtaining the specified surfactant–water mixture is available from Air Products and Chemicals Inc., Allentown, PA. 800-345-3148

Annex B
(informative)
References

The following standards contain provisions that pertain to this Standard. All standards are subject to revision, and users of this Standard are encouraged to apply the most recent edition of the standards indicated below.

ASAE S327.3, *Terminology and Definitions for Agricultural Chemical Applications*

ASTM E1260, *Standard Test Method for Determining Liquid Drop Size Characteristics in a Spray Using Optical Non-Imaging Light-Scattering Instruments*

ASTM E1296, *Standard Terminology Related to Liquid Particle Statistics*

MEASUREMENT OF SPRINKLER DROPLET SIZE

D. W. DeBoer, M. J. Monnens, D. C. Kincaid

ABSTRACT. *Droplet distributions for rotating spray–plate sprinklers were measured using a laser technology and a flour methodology. In general, both methods produced comparable results. The flour method tended to produce d_{25}, d_{50} and d_{75} values that were on the average about 0.20 mm (about 15% of the d_{50} value) larger than laser values. However, the 0.20 mm difference is consistent with what would be expected when nozzle pressure differences used with the two methods are considered. Both methods can be used to estimate droplet distributions from rotary spray–plate irrigation sprinklers for practical field application purposes.*

Keywords. *Droplets, Sprinkler, Laser, Flour method, Distributions, Irrigation.*

Information regarding droplet sizes from irrigation sprinklers has many beneficial uses. Large droplets can cause soil crusting problems because of kinetic energies associated with those droplets, while droplets at the smaller end of the spectrum can be subject to drift from an intended target area. In addition, d_{50} values (volume mean droplet diameter) are often used as a primary parameter to describe droplet distributions. Thus, such information can be of value to the sprinkler irrigation industry.

Droplet size data sets are expensive or time–consuming to obtain. Laser technology (Kincaid et al., 1996) can be used to acquire droplet distribution information in a relatively short time, but the capital investment is substantial or the equipment may not be readily available. In contrast, a labor–intensive method that uses baking flour as a droplet catchment medium was used extensively before the advent of the laser technology (Kohl, 1974). Researchers with limited capital budgets can substitute labor for capital by using the flour method.

Of course, the paramount question relates to the accuracy of both methods. One way to gain an insight into the matter is to perform a comparison study between the two methods. Researchers at South Dakota State University and the USDA–ARS in Idaho have been conducting droplet studies on various irrigation sprinklers during the past several years. Independent results for a common set of sprinklers and operating conditions were selected for the investigation.

The objective of this article is to report the findings of a comparison study in which the laser method and the flour method were independently used to estimate droplet distributions for a set of rotating spray–plate sprinklers.

Article was submitted for review in January 2000; approved for publication by the Soil & Water Division of ASAE in September 2000.

The work reported was supported by the South Dakota Agricultural Experiment Station and is published with the approval of the Director as Journal Article No. 3169. Trade names and company names are included for the benefit of the reader and do not imply endorsement or preferential treatment of the product listed by South Dakota State Univ. or the USDA–Agricultural Research Service.

The authors are **Darrell W. DeBoer,** ***ASAE Member Engineer,*** Professor, Dept. of Agricultural and Biosystems Engineering, South Dakota State Univ., Brookings, S. Dak.; **Micheal J. Monnens,** Program Engineer, Engineering Extension, South Dakota State Univ., Brookings, S. Dak.; and **Dennis C. Kincaid,** ***ASAE Member Engineer,*** Agricultural Engineer, USDA–Agricultural Research Service, Kimberly, Idaho. **Corresponding author:** Darrell W. DeBoer, Dept. of Agricultural and Biosystems Engineering, PO Box 2120, South Dakota State Univ., Brookings, SD 57007; phone: (605) 688–5141; fax: (605) 688–6764; e–mail: darrell_deboer@sdstate.edu.

EXPERIMENTAL PROCDEURE

IRRIGATION SPRINKLERS

Rotating plate sprinklers (Rotator Series R–30 and Spinner Series S–30) manufactured by the Nelson Corporation (Walla Walla, Wash.) were used in the study. Water flows from a circular orifice in the form of a water jet that discharges onto a grooved spray plate, inducing plate rotation. Grooves on the plate split the discharge jet into smaller jets. Components of the sprinklers are illustrated in Figure 1. While both sprinklers are similar in structure and operation, the Rotator spray plate rotates from 1 to 10 rpm (depending on nozzle discharge and velocity) producing water jets, while the Spinner spray plate rotates from 100 to 600 rpm producing droplets.

Nominal nozzle pressures and other sprinkler details are presented in Table 1. Spray plates with four and six grooves were used in the investigation along with 4.8, 6.4, and 9.5 mm (3/16, 1/4, and 3/8 in.) nozzle diameters. Comparable spray plates were employed for all tests. A 9.9–mm nozzle was used in the flour method tests, instead of the 9.5–mm nozzle used for the laser method investigation. An analysis of flour method data indicated that changes in nozzle pressure had a statistically significant influence on d_{50} values but nozzle diameter differences had a minimal influence. Nominal nozzle pressures of 100 and 200 kPa (14.5 and 29.0 psi) were used. However, actual values for the laser method were 108 and 206 kPa, while the flour method values were closer to 96 and 196 kPa. Results from a companion study (not reported in this article) indicated that the flour method pressure values used in the study would be expected to produce d_{50} data that were about 0.2 mm larger than d_{50} data associated with the laser method pressure values.

Manufacturer–recommended nozzle diameters and pressures for the two sprinklers are shown in Figures 2 and 3. Tests conducted on the Rotator sprinklers were within recommended conditions except for the 9.5–mm nozzle diameter. The 200–kPa nozzle pressure was substantially above the maximum recommended pressure for the Spinner sprinkler, which tended to produce smaller droplets than desired for field conditions but which did not adversely affect droplet measurement comparisons.

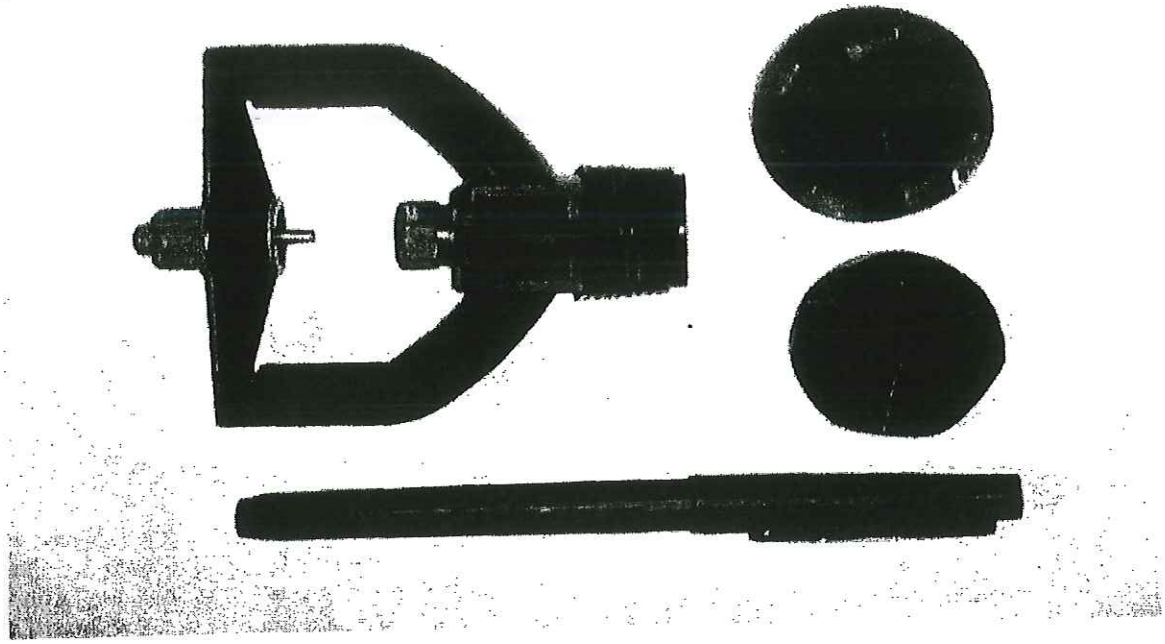


Figure 1. Rotating spray–plate sprinkler assembly and components.

Table 1. Sprinklers and operating conditions used in the study.

	ID*	Sprinkler	Spray Plate	Nozzle Pressure (kPa)	Nozzle Diameter (mm)
1	R42048	Rotator	4 groove	200	4.8
2	R42064	Rotator	4 groove	200	6.4
3	R62048	Rotator	6 groove	200	4.8
4	R61064	Rotator	6 groove	100	6.4
5	R62064	Rotator	6 groove	200	6.4
6	R62095	Rotator	6 groove	200	9.5 (9.9)
7	S61048	Spinner	6 groove	100	4.8
8	S62048	Spinner	6 groove	200	4.8
9	S61064	Spinner	6 groove	100	6.4
10	S62064	Spinner	6 groove	200	6.4

*R = Rotator, 4 = 4 groove, 20 = 200 kPa and 48 = 4.8mm

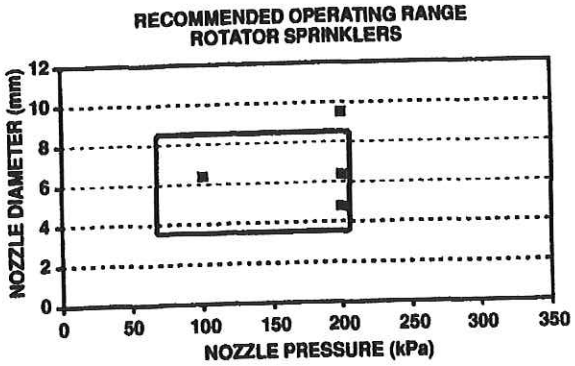


Figure 2. Manufacturer's recommended minimum and maximum nozzle diameters and operating pressures for Rotator sprinklers within the box. Symbol positions indicate nozzle sizes and pressures used in the study.

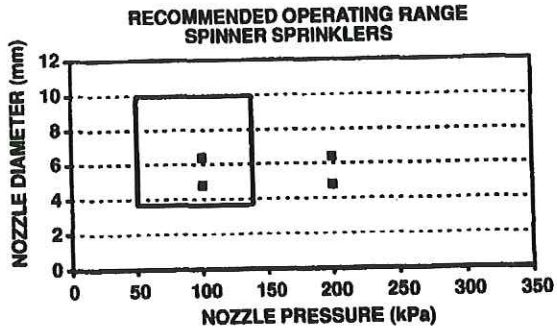


Figure 3. Manufacturer's recommended minimum and maximum nozzle diameters and operating pressures for Spinner sprinklers within the box. Symbol positions indicate nozzle sizes and pressures used in the study.

Sprinklers were positioned 3.0 m above the droplet measurement plane for the laser method tests and 2.5 m for the flour method tests. This elevation difference did not affect droplet size distributions from the sprinklers but would be expected to have some influence on the radius of water throw and the positioning of droplet sizes along the wetted radii.

Droplet Size Measurements

Laser–optical measurements of droplet diameters were made with a Particle Measuring System (Boulder, Colo.) Model GBPP–100S that has the ability to measure droplet sizes from 0.2 to 13 mm in 0.2–mm increments. Details of

the experimental procedure for the measurement of sprinkler droplets by the laser method are given in Kincaid et al. (1996) and Solomon et al. (1991). A total of 10,000 droplets were measured at each radial position.

The flour method of Laws and Parsons (1943) as adapted by Kohl (1974) was used to obtain the independent droplet data set for comparison purposes. Measured droplet sizes ranged from 0.33 to 5.95 mm in 0.08–mm increments for the smallest droplets to a 1.01–mm increment at the upper end of the measurement range. Relatively few droplets were measured, as compared to the laser study, because the flour catchment pans could only be exposed to the irrigation water for a short time to insure individual droplet integrity.

Measurements were made at 1–m radial intervals to 8 m for the laser method and at 1–m intervals to the edge of the wetted area for the flour method. However, smaller intervals were used at the outer edge of the wetted area for the flour method where water application rate variations were large over small changes in radial distances. Composite droplet size distributions for each sprinkler test were developed from area–weighted droplet measurements. Only one unreplicated set of test data was collected.

Results

Several issues with regard to the experimental procedures used in this study need to be considered. First, commercial–run sprinklers were employed in the tests with different sets of sprinklers used at each study site. Second, operating conditions were controlled but were slightly different for each measurement method. In particular, operating pressures were approximately the same but were not identical. Third, the number of droplets measured by each method was vastly different: The flour method had a total droplet catch in the thousands, while the laser method dealt with droplet numbers in the hundreds of thousands.

Both measurement methods produced similar results, as illustrated in Figures 4 through 13. Two data sets with the largest differences (Figures 4 and 7) are representative of operational conditions that produced the largest droplet sizes and the flattest distribution relationships. One laser data distribution (Figure 10) has an uncharacteristic shape over the 1– to 2–mm diameter range that makes a valid comparison questionable for this sprinkler data set. The remaining seven data sets show good overall agreement between the two methods, with the flour method tending to indicate the presence of fewer small droplets than the laser method data would suggest.

A summary of d_{10}, d_{25}, d_{50}, d_{75}, and d_{90} values to the nearest 0.1 mm for both measurement methods and the differences between method values is presented in Table 2. Results for sprinkler S61048 (Figure 10) are not included because of the questionable laser values. Differences between the d_{10} values ranged from 0.0 to 0.2 mm (a positive value means that flour values are greater than laser values) and averaged 0.13 mm. Similar differences also are noted for

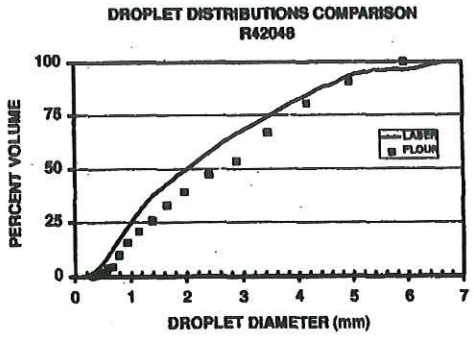


Figure 4. Comparison of droplet distributions from the laser method and the flour method for sprinkler R42048.

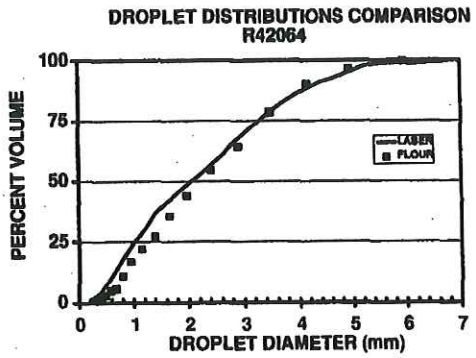


Figure 5. Comparison of droplet distributions from the laser method and the flour method for sprinkler R42064.

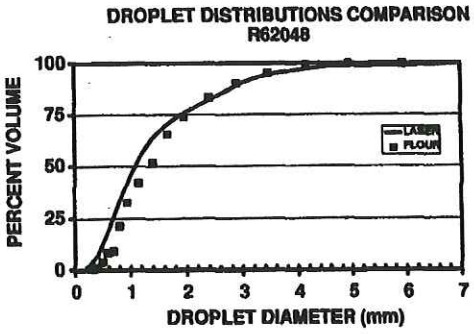


Figure 6. Comparison of droplet distributions from the laser method and the flour method for sprinkler R62048.

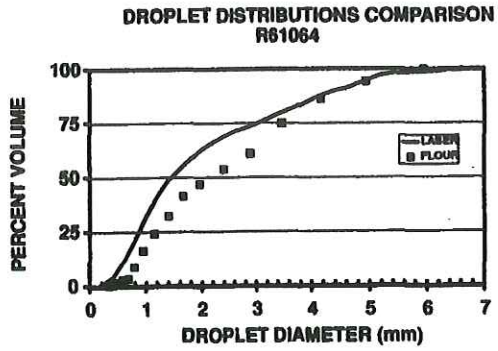


Figure 7. Comparison of droplet distributions from the laser method and the flour method for sprinkler R61064.

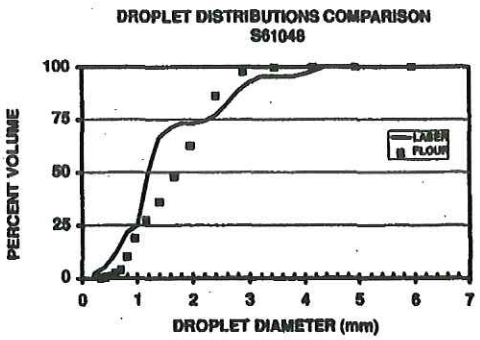


Figure 10. Comparison of droplet distributions from the laser method and the flour method for sprinkler S61048.

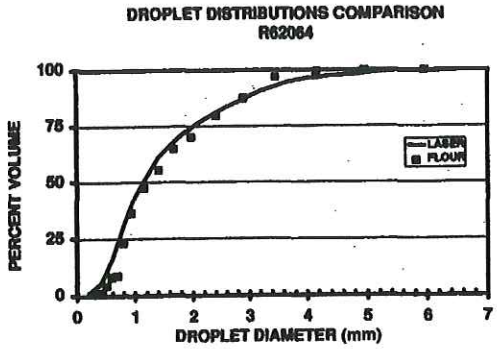


Figure 8. Comparison of droplet distributions from the laser method and the flour method for sprinkler R62064.

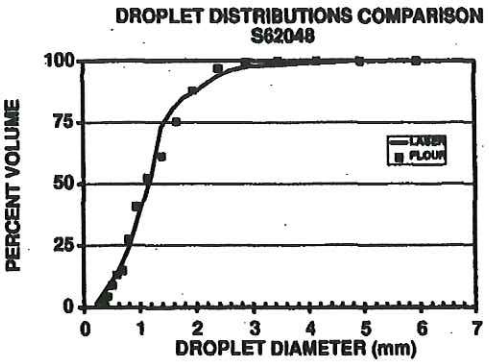


Figure 11. Comparison of droplet distributions from the laser method and the flour method for sprinkler S62048.

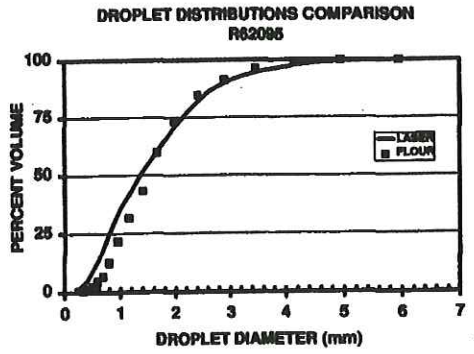


Figure 9. Comparison of droplet distributions from the laser method and the flour method for sprinkler R62095.

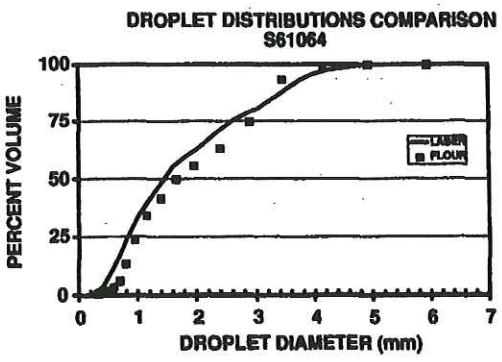


Figure 12. Comparison of droplet distributions from the laser method and the flour method for sprinkler S61064.

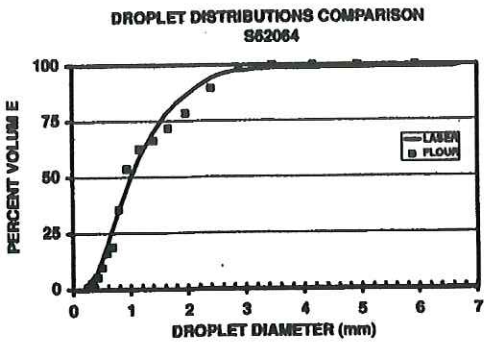


Figure 13. Comparison of droplet distributions from the laser method and the flour method for sprinkler S62064.

d_{25} values with a mean of 0.19 and a range of 0.0 to 0.3 mm. The d_{50} data sets had larger and more varied differences than any of the other difference data sets. Differences ranged from –0.1 to 0.7 mm with a mean of 0.18 mm. The d_{75} data set also had large difference variations ranging from –0.1 to 0.5 mm but with a mean of about 0.20 mm while the d_{90} data had a range of –0.2 to 0.2 with a mean of –0.06 mm.

On the average, the flour data tend to be from 0.15 to 0.20 mm larger than the laser data. This difference is consistent with what would be expected (for d_{50} values based on an unreported analysis) when the nozzle pressure differences used in the independent studies are considered. Based on the limited data sets presented in this article, a representative estimate for laser values can be obtained by simply reducing flour data values by 0.2 mm. This 0.2 mm represents about 20% of average d_{25} flour values, 13% of d_{50} values, and 8% of d_{75} values.

When one considers the lack of rigorous experimental protocol, droplet size distributions from the two measurement methods are similar enough to each other to support the conclusion that either method can be used to estimate droplet distributions from rotary spray–plate irrigation sprinklers. The laser and flour methods do not produce identical results, but they both produce comparable and reasonable results that are of sufficient quality for *practical field application* purposes.

References

Kincaid, D. C., K. H. Solomon, and J. C. Oliphant. 1996. Drop size distributions for irrigation sprinklers. *Trans. ASAE* 39(3): 839–845.

Kohl, R. A. 1974. Drop size distribution from medium-sized agricultural sprinklers. *Trans. ASAE* 17(4): 690–693.

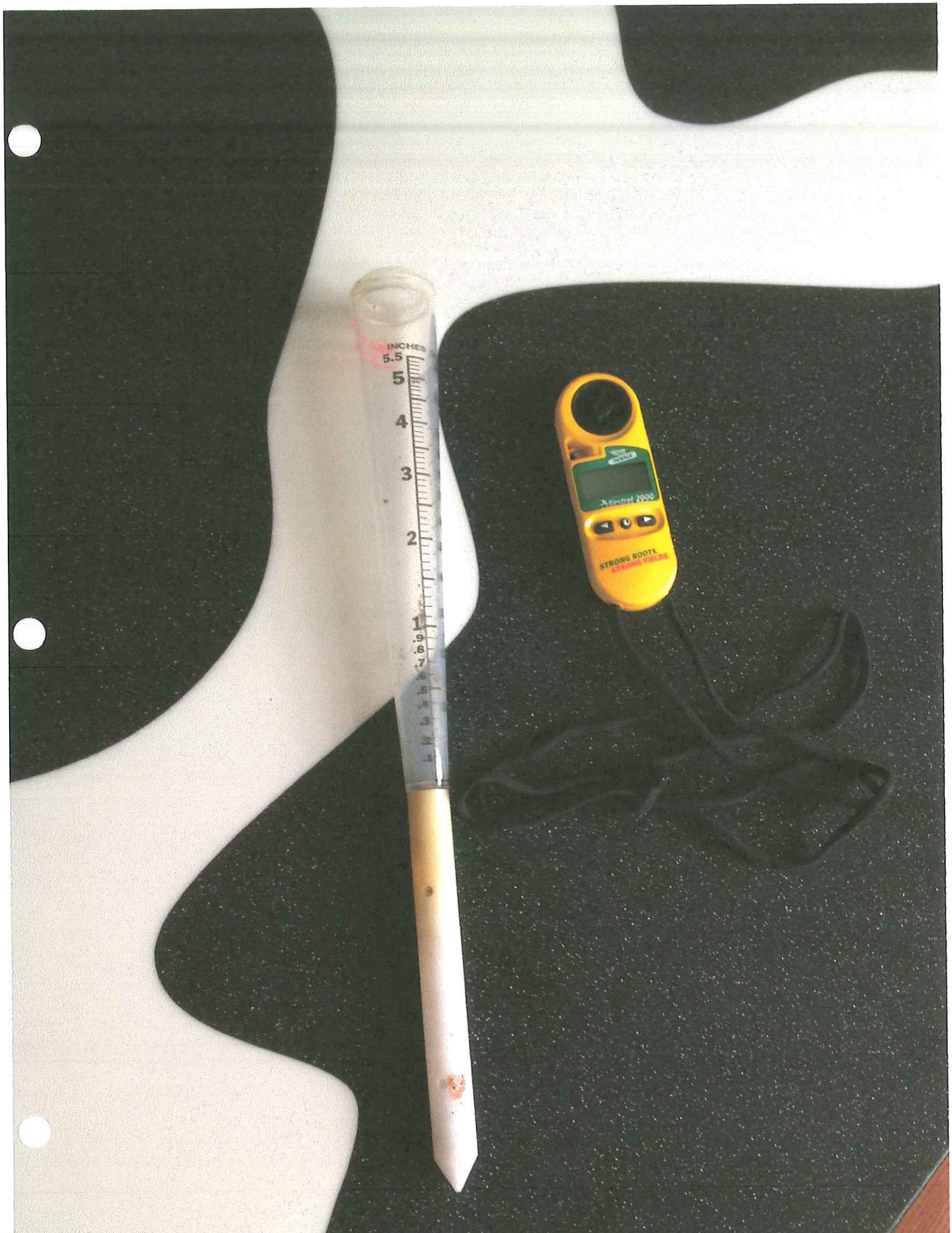
Laws, J. O., and D. A. Parsons. 1943. The relationship of raindrop size to intensity. *Trans. Am. Geophys. Union* 24: 452–460.

Solomon, K. H., D. F. Zoldoske, and J. C. Oliphant. 1991. Laser optical measurement of sprinkler drops sizes. In *Automated Agriculture for the 21st Century Proc.*, 87–96, St. Joseph, Mich.: ASAE.

Table 2. Droplet sizes (mm) for 10, 25, 50, 75 and 90% of sprinkler discharge volumes and differences (Δ) between the two methods.

	d_{10}			d_{25}			d_{50}			d_{75}			d_{90}		
Sprinkler	Laser	Flour	Δ	Laser	Flour	Δ	Laser	Flour	Δ	Laser	Flour	Δ	Laser	Flour	Δ
R42048	0.6	0.8	0.2	1.0	1.3	0.3	2.0	2.4	0.4	3.5	3.8	0.3	4.7	4.8	0.1
R42064	0.6	0.8	0.2	1.0	1.3	0.3	2.0	2.2	0.2	3.3	3.3	0.0	4.3	4.1	–0.2
R62048	0.5	0.6	0.1	0.7	0.9	0.2	1.0	1.2	0.2	1.9	2.0	0.1	3.0	2.9	–0.1
R61064	0.6	0.8	0.2	0.9	1.2	0.3	1.5	2.2	0.7	3.0	3.5	0.5	4.4	4.5	0.1
R62064	0.5	0.6	0.1	0.7	0.8	0.1	1.2	1.2	0.0	2.0	2.2	0.2	3.2	3.0	–0.2
R62095	0.5	0.7	0.2	0.8	1.0	0.2	1.4	1.5	0.1	2.2	2.1	–0.1	2.9	2.8	–0.1
S62048	0.5	0.5	0.0	0.8	0.8	0.0	1.2	1.1	–0.1	1.4	1.7	0.3	2.2	2.1	–0.1
S61064	0.6	0.7	0.1	0.8	1.0	0.2	1.4	1.6	0.2	2.6	2.9	0.3	3.6	3.4	–0.2
S62064	0.4	0.5	0.1	0.6	0.7	0.1	1.0	0.9	–0.1	1.6	1.8	0.2	2.2	2.4	0.2
Mean			0.13			0.19			0.18			0.20			–0.06

EXHIBIT 3B


INCHES
5.5
5
4
3
2
1
Kestrel 2000
STRONG ROOTS
STRONG FIELDS


DEKALB
Kestrel 2000
STRONG ROOTS.
STRONG YIELDS.®

EXHIBIT 4

Irrigation Application Record Sheet

Field_____ Crop_____

Date	Time	Pivot Operating Properly	Wind Speed (mph)	Evidence of Surface Runoff	Evidence of Offsite Drift	Tile Outlets Inspected	Notes: (Calibration info, Degree's of operation, General observations, Corrective actions, Drift monitoring locations)
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	
		Yes No		Yes No	Yes No	Yes No	

Monitoring of irrigation equipment needs to be completed at least every 2 hours when in operation.
Any deficiencies found during monitoring activities should be explained in the notes section.

EXHIBIT 5

Irrigation

Date: 6/10/2013
Farm: Irrigation
Grower: Ebert Enterprises, LLC 797
Area: 143.51 ac

N

One in = 995 feet

0 334 668 1002 1336 1669

Irrigation (143.51 ac)

Kewaunee County
Pierce & Ahnapee Townships
T24-25N - R25E
Sections 5, 6, 31, & 32

Map Reference — A - M

A - Jeff Swagel E7191 Breitlow Road Algoma WI 54201
920-487-9806 setback - 590ft 2 Adults
* Message left - call with any question/concerns

B- Randy Ebert E 5083 Cty K Algoma WI 54201
920-255-1893 setback - 730ft 7 Adults
occupants/employees - Marcos Rodriguez / Martin Rodriguez / / Antonio Calzada / Jerrardo Agredano / Juan Manuel Robles / / Jose Peres / Juan Sanchez
* Note: Satellite H2A farm / Employee Benefit Housing at this location

C- Shirley Nell E4957 Cty K Algoma WI 54201
920-487-5133 setback 2200ft 2 Adults 1 Minor
* Understands times have changed with farming - No Concern - - walks regularly - she likes idea of less road traffic

D- Henry + Carol Ebert E 5041 Hwy 54 Algoma WI 54201
920-487-2147 setback 2400ft 2 Adults
* parents - application/pivot site is rented from them.

E- Gary Breitlow E 5153 Hwy 54 Algoma WI 54201
920-487-2443 setback 2500 ft 2 Adults
* Dairy farmer - practices no-till + zone till conservation practices - All of his liquid manure is surface applied with no till -

Map Reference - continued

F- Leona Brietlow E 5286 Cty K Algoma WI 54201
920-487-3607 setback 760 ft 1-Adult
* Has concerns that her well water depth would be affected by other wells withdrawing large amounts of water for irrigation

G- Shirley Klatt N7254 Cty D Algoma WI 54201
920-487-3562 setback 610 ft 2-Adults
* Have rented Ag cropland from her or her family for 30 years

H- Henry Ebert N7221 Cty D Algoma WI 54201
920-487-2147 setback from well 235 ft 2-Adults 2-Minors
occupants - Omar Nolasco - Maria Nolasco
* The landlord (Henry) has agreed to a reduced setback from pivot - well setback

I- Henry Ebert N7179 Cty D Algoma WI 54201
920-487-2147 setback from well 230 ft 2-Adults
occupants - Manuel Gomez - Mercedes Gomez 2-Minors
* The landlord (Henry) has agreed to a reduced setback from pivot - well set back

Map Reference - continued

J- Scott Kliment N7154 Cty D Algoma WI 54201
920-487-3019 setback 1100 ft 2-Adults
* Very much opposed to the use of irrigation. - Very emotional - quotes: "ruining her dream home!" : "we r killing her" : "Its all about money"

K- Brian Berg N7094 Cty D Algoma WI 54201
920-487-5715 setback 960 ft 2Adults 2 minors
* message left - call with any questions/concerns

L- West side of Cty D - No House just outbuildings - well setback 1000 ft

M- Bill Iwen E5401 12th Road Algoma WI 54201
920-487-7215 setback 2000 ft 2-Adults
* Very much opposed to the use of irrigation One of the leaders of the enviromental activist group Kewaunee Cares