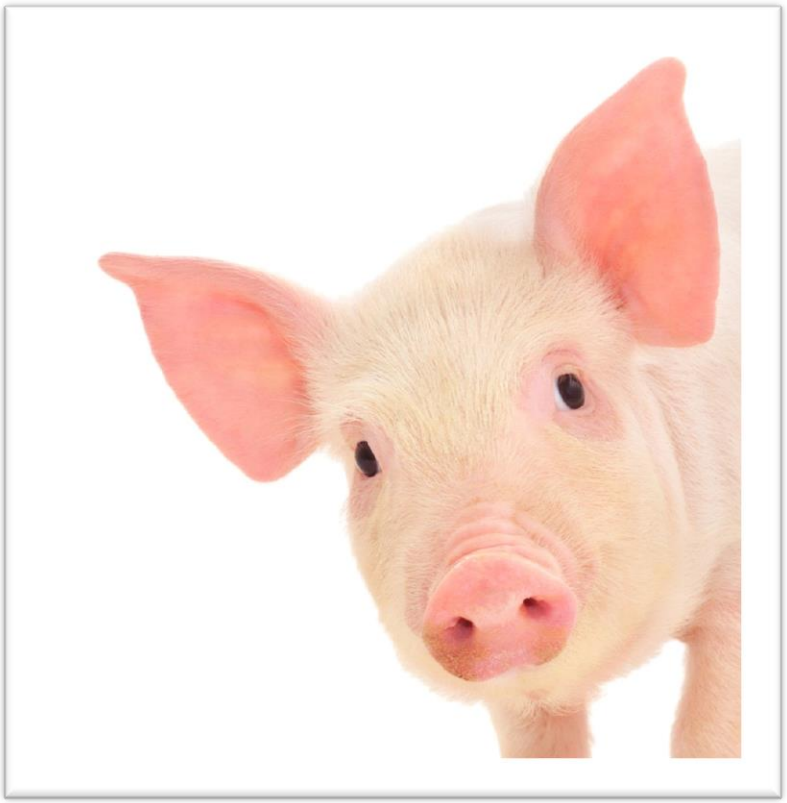
Water Sprinkling Equipment for Pig Trailers

Design Guidelines

December 2013



Swine Innovation Porc

PRAIRIE SWINE CENTRE

Research Profits Everyone

Design Guidelines

The following sections will guide you through the steps involved in the design of your trailer sprinkling equipment. Please note that these guidelines are very generic due to the wide variety of commercially available trailers. In order to get to a working design for your specific trailer, you will have to make choices based on the following sections.

(1) Water Flow Rate

Dr. Faucitano conducted his research on a 3-deck potbelly trailer with 125 litres [33 US gallons] of water sprinkled over a 5-minute period, roughly 1.15 L/m^2 [0.03 gal/ft^2] over a 5-minute period. This volume of water per unit area should be used as a guideline for the design of the sprinkling system, and guiding the nozzle choice. To facilitate the nozzle selection, it is assumed that the same amount of water per unit area can be used over a different time frame if the total design flow rate is different. The idea is to get roughly this amount of water in a reasonable time-frame so truck drivers do not have to wait too long to complete the process. See *(4) Total Flow Rate and Sprinkling Time Calculations* for sprinkling time calculation.

(2) Sprinkling Nozzle

The choice of sprinkling nozzles dictates the rest of the design. You should choose the nozzles according to their budget, needs and objectives. Several nozzle types are available on the Canadian market and the suppliers vary from province to province. Sprinkling nozzles are usually available at local hardware stores, but can also be ordered online.

Here is a list of the important nozzle parameters along with the specific objectives related to our design. The relative importance of each parameter with respect to the other will change according to the trailer type, the producer's budget and objectives.

- Operating Pressure

  Operating pressure will depend on the pressure available at the barn and also at the slaughterhouse. The selected operating pressure should be *less than* what can be supplied (using a pressure reducer to bring pressure down to desired value). **WARNING: The *static* pressure is not necessarily what can be supplied. You need to evaluate the *dynamic* pressure while water consumption is normal in the barn or at the slaughterhouse, and when you are drawing the water flow rate determined at (1).** Most nozzles work well at 140-170 kPa [20-25 psi] and most barns should be able to supply the necessary flow rate of around 275 kPa [40 psi]. However, available dynamic pressure at flow rate should be checked before going on with design.

- Spraying Angle

  For a *permanent installation on non-movable floors*, having the sprinklers inside the trailer (hung from the ceiling of each deck, along the centerline of the trailer) would be a good idea. In this case, a 360-degree angle sprinkler is a good choice. It would reduce the number of sprinkling nozzles required and ensure a more uniform spraying pattern.
  For a *removable sprinkling system and/or a movable-deck trailer*, installing the system from the outside is a better option. If installing the watering system from the outside, 180-degree sprinklers should be used.

Funding for the project has been provided in part through Industry Councils from Agricultural Council of Saskatchewan (principal), the Conseil pour le développement de l'agriculture du Québec, Ontario Agricultural Adaptation Council and Agriculture and Food Council of Alberta Which deliver the Canadian Agricultural Adaptation Program (CAAP) on behalf of Agriculture and Agri-Food Canada.

- Spraying Radius

  The spraying radius will depend on the *operating pressure.* IMPORTANT: Check the spraying radius at operating pressure in the nozzle specifications sheet.

  If installing the sprinklers along the centerline of the trailer, the spraying radius should be at least half the width of the trailer so the water can cover the full width (typically 1.37m [8.5 feet]). Too large a spraying radius would waste water by shooting it onto the walls. **The recommended spraying radius range for sprinkling nozzles along the centerline of the trailer is between 1.30m and 1.60m [between 51'' and 63'']. **

  If installing the sprinklers from the outside, the spraying radius should be approximately half the width of the trailer so that all the trailer area is covered by having sprinklers on one or both sides. Installing sprinklers on both sides is ideal because it covers the whole area more uniformly. However, to save material and maintenance costs, you may choose to install sprinklers on one side of the trailer only. **If installing sprinklers on both sides, the recommended spraying radius range is between 2.44m and 2.74m [between 8.0 feet and 9.0 feet]. If installing the sprinklers on one side of the trailer, the recommended spraying radius range is between 2.59m and 2.74m [between 8.5 feet and 9.0 feet].**

- Spraying Flow Rate

  The spraying flow rate of an individual nozzle will depend on the *operating pressure*. It is important to check the flow rate at operating pressure in the nozzle specifications sheet.

  WARNING: Some sprinkling nozzles can be used in different angle configurations. If using those, make sure you look in the nozzle specifications sheet for the flow rate at *both* the operating pressure *and* the spraying angle.

- Spraying Height

  The spraying height is the height between the spraying nozzle and the horizontal plane at which the falling water reaches the desired radius. Spraying height is important because to get uniform water distribution, the spraying height has to be less than the distance between the nozzle and the animals or obstacles in the trailer. Otherwise, all the trailer areas holding animals will not get water.

  Warning: Some sprinklers shoot water upwards at an angle (overshoot). Overshooting should be taken into consideration in the design as it is not ideal to have water touch the ceiling before it falls. As a result, distance between the nozzles and the animals or obstacles is reduced. However, such sprinklers often have a smaller spraying height as water is dispersed above their vertical position.

  Spraying height is not always specified in the nozzle specifications sheet. You may have to test the nozzle before going on with the design.

- Nozzle Material

Funding for the project has been provided in part through Industry Councils from Agricultural Council of Saskatchewan (principal), the Conseil pour le développement de l'agriculture du Québec, Ontario Agricultural Adaptation Council and Agriculture and Food Council of Alberta Which deliver the Canadian Agricultural Adaptation Program (CAAP) on behalf of Agriculture and Agri-Food Canada.

Most cheap nozzles on the market are made of plastic. Plastic that is exposed to the sun can become brittle after a while. For this reason, UV-treated plastic nozzles (e.g. certain garden irrigation nozzles) are recommended. If using a more robust metal nozzle, make sure the droplet size is big enough. Metal nozzles are often used for misting instead of spraying (smaller droplet size).

- Nozzle Hole Diameter

  The nozzle hole diameter influences the flow rate. To get a wide spraying radius at low pressures (10-15 psi), the hole diameter is usually smaller. This can, however, cause the nozzle to clog more easily. Therefore, it is important to design the system with a reasonable pressure. Moreover, in case of nozzle hole clogging, the higher the pressure, the greater the chance it will unclog by itself.

- Droplet Size

  Dr. Faucitano research used a droplet size of between 900 and 1000 microns (900 microns = $900 * 10^{-6}$m). This is considered a coarse droplet size. Nozzle selection in this design should match that droplet size.

Conclusion on Nozzle Selection: Before selecting your nozzles you should first become familiar with the parameters mentioned above. According to your needs, preselect one or few nozzles and then test them at the operating pressure to validate the design.

(3) *Nozzle Layout in Trailer*

The next step is to plan the nozzle installation layout, according to the chosen sprinkling nozzle and the configuration of the trailer. Refer to section (2) for selecting a suitable sprinkling nozzle type. Each trailer deck should be analyzed individually because the configuration can change from deck to deck in a same trailer.

The following figures show the three possible layouts. Table 1 then gives the distances used to position the sprinkling nozzles in the trailer as a function of your nozzle selection, chosen configuration, and deck length.

Funding for the project has been provided in part through Industry Councils from Agricultural Council of Saskatchewan (principal), the Conseil pour le développement de l'agriculture du Québec, Ontario Agricultural Adaptation Council and Agriculture and Food Council of Alberta Which deliver the Canadian Agricultural Adaptation Program (CAAP) on behalf of Agriculture and Agri-Food Canada.

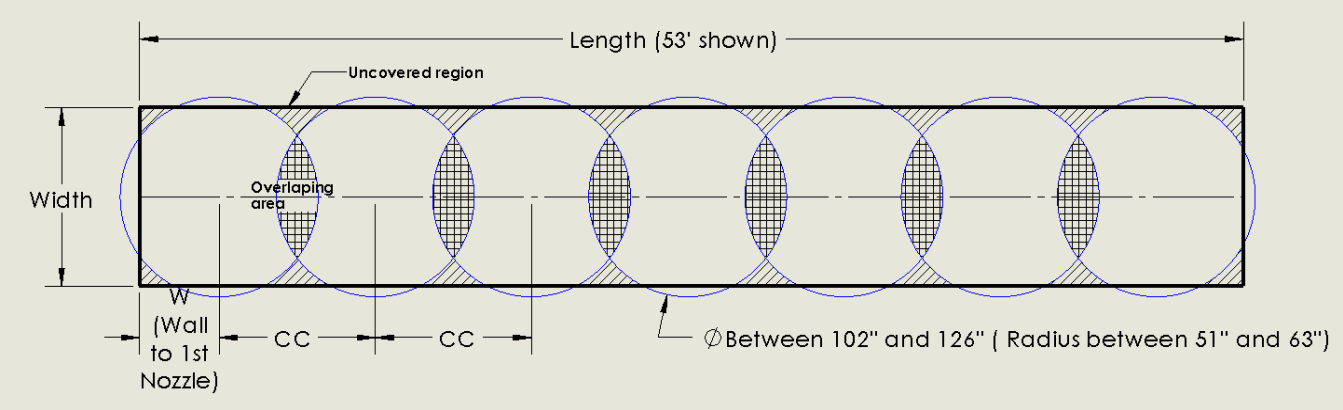


Figure 1 Layout for positioning sprinklers along the centerline of the trailer

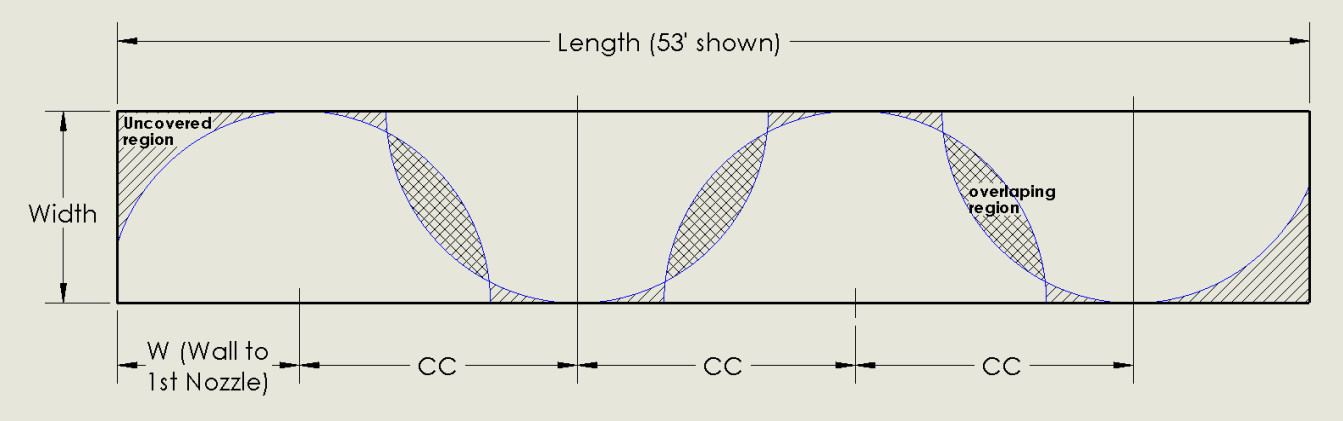


Figure 2 Layout for positioning sprinklers on both sides of the trailer

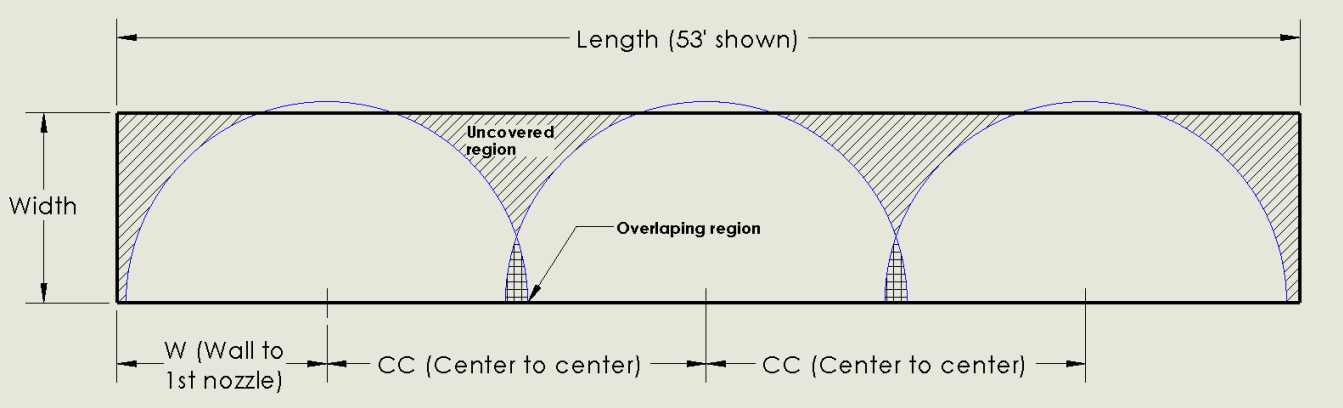


Figure 3 Layout for positioning sprinkler on one side of the trailer

Funding for the project has been provided in part through Industry Councils from Agricultural Council of Saskatchewan (principal), the Conseil pour le développement de l'agriculture du Québec, Ontario Agricultural Adaptation Council and Agriculture and Food Council of Alberta Which deliver the Canadian Agricultural Adaptation Program (CAAP) on behalf of Agriculture and Agri-Food Canada.

Table 1: Layout parameters as function of the deck length and sprinkling radius

Sprinklers Configuration	Sprinkling Radius	Deck Length (ft)	Number of Sprinklers	CC (Centre to Centre Distance, in inches)	W (Wall to Nozzle Distance, in inches)	Overlap at median radius (inches)
Sprinklers on the centerline of the trailer	4'3'' to 5'3''	53	6	102	63	12
		48	6	96	48	18
		46	6	90	51	24
		42	5	102	48	12
		38	5	90	48	24
		34	4	102	51	12
		32	4	96	48	18
		30	4	90	45	24
Sprinklers on both sides of the trailer	8'6'' to 9'	53	4	155.5	84.75	24
		48	4	136	84	40
		46	4	126	85	48
		42	3	155.5	96.5	24
		38	3	141	87	36
		34	2	183.5	112	0
		32	2	174	105	8
		30	2	155.5	102	24
Sprinklers on one side of the trailer	8' to 9'	53	4	156	84	48
		48	3	186	102	18
		46	3	180	96	24
		42	3	168	84	36
		38	3	144	84	60
		34	2	202	103	2
		32	2	186	99	18
		30	2	168	96	36

(4) *Total Flow Rate and Sprinkling Time Calculations*

Sprinkling time will be adapted to your design in order to supply roughly 1.15 L/m^2 [0.03 gal/ft^2] as in Dr. Faucitano's research. Once you know how many sprinklers to use in your design, the operating pressure and consequently the flow rate of each individual nozzle, you can calculate the sprinkling time using the following formula. Sprinkling time should be around 5 minutes. Too short a sprinkling period will cause the animals to become too wet and too long a sprinkling period will cause the truck driver to lose time.

Funding for the project has been provided in part through Industry Councils from Agricultural Council of Saskatchewan (principal), the Conseil pour le développement de l'agriculture du Québec, Ontario Agricultural Adaptation Council and Agriculture and Food Council of Alberta Which deliver the Canadian Agricultural Adaptation Program (CAAP) on behalf of Agriculture and Agri-Food Canada.

SI Units:

$$\frac{Number\ of\ nozzles\ \times Nozzle\ individual\ flow\ rate\ (in\ Litres)}{25} = Sprinkling\ time\ (in\ minutes)$$

Imperial Units:

$$\frac{Number\ of\ nozzles\ \times Nozzle\ individual\ flow\ rate\ (in\ US\ Gallons)}{6.6} = Sprinkling\ time\ (in\ minutes)$$

(5) *Water Lines*

A water line is the piping system that connects all the sprinklers for a deck that are on the same side of the trailer.

Two precautions can be taken in order to ensure a uniform sprinkling flow rate throughout the trailer areas. The first one consists of selecting pipes with an adequate diameter and the second one of designing the layout so that the pressure at each first nozzle of each line is roughly the same.

Pipe Size and Material

First, it is important to minimize the pressure loss between nozzles on the same line so that the pressure difference is not too large between each of them. Example, a bad design would be one where the pressure loss between the sprinklers is too large and the first nozzle on the line is supplying much more water than the last nozzle on the line. The diameter of the water lines influences the pressure loss between the sprinklers. The water flow rate of each individual sprinkling nozzle (which depends on the operating pressure) will also influence the pressure loss. This parameter is taken into account in the calculations so you do not have to care about it.

If you are positioning the sprinkling nozzles on one side only and if there are four or more sprinklers on the same line, use ¾-inch piping. Similarly, if you work with a sprinkling nozzle configuration along the centreline of the trailer, it is also recommended that you use ¾-inch piping. This will ensure that the pressure is similar at all sprinkling nozzles and that water is distributed uniformly throughout the trailer area. In all other cases, it is possible to use half inch pipes without compromising water uniformity. Pipe material does not greatly affect the design. However, bear in mind that galvanized steel will cause a greater pressure drop than stainless and stainless steel will cause a greater pressure drop than PVC.

Water Lines Installation

The last step to ensure a uniform sprinkling flow rate throughout the trailer is to design the configuration so that the pressure at each first nozzle of each line is roughly the same. This can be achieved by choosing the position of the water inlet point (where the farm/plant hose connects to the sprinkling system) to be roughly at the same distance from every first nozzle of the lines it supplies. The following figures show how to set it up.

Figure 4 shows how to install the sprinklers on one side of the trailer. Note that for a one-side configuration, the water inlet can be positioned at either end of the trailer. In order to make sure that all lines have roughly the same pressure, put the water inlet so that the pipe length between each line and the water inlet is similar.

Funding for the project has been provided in part through Industry Councils from Agricultural Council of Saskatchewan (principal), the Conseil pour le développement de l'agriculture du Québec, Ontario Agricultural Adaptation Council and Agriculture and Food Council of Alberta Which deliver the Canadian Agricultural Adaptation Program (CAAP) on behalf of Agriculture and Agri-Food Canada.

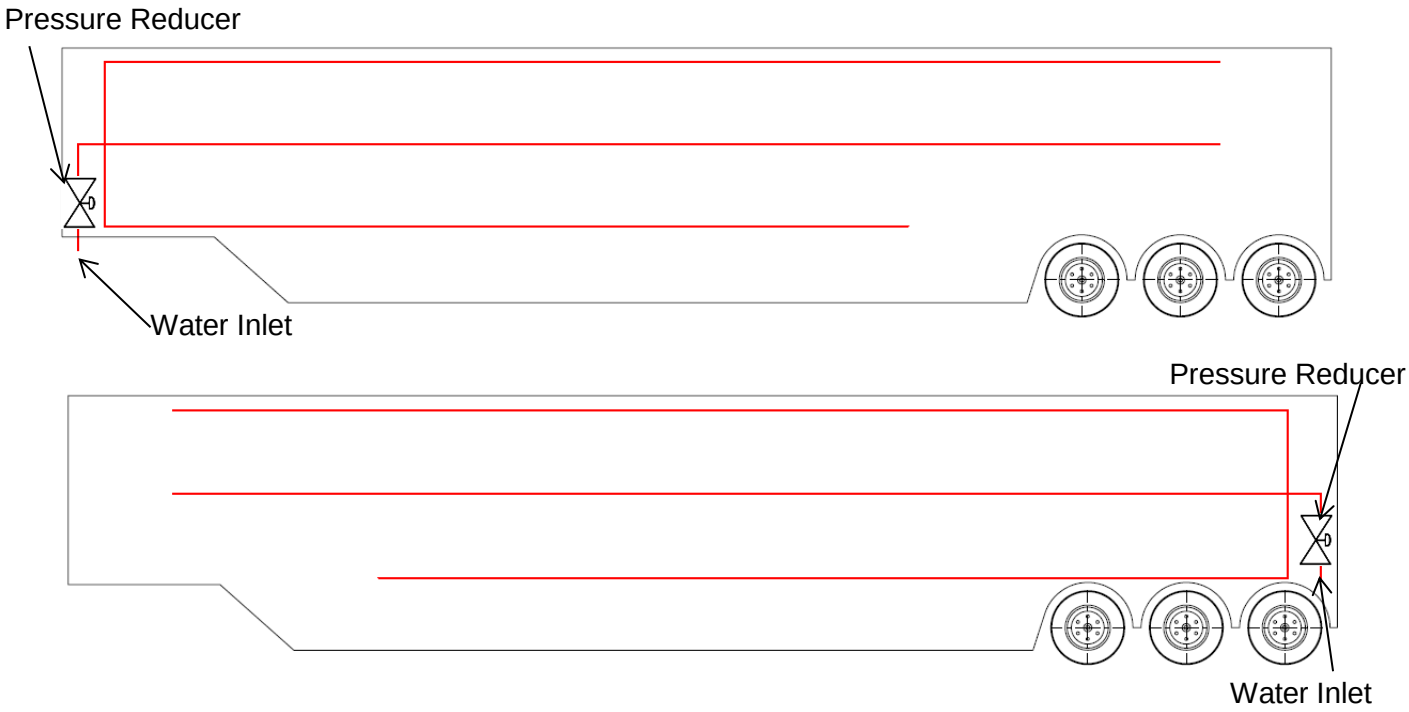


Figure 4 Possible layouts for water line configuration on one side and along the centreline of the trailer

Figure 5 shows the best solution for installing sprinklers on both sides of the trailer. It is the same as in figure 4. However, in the case of an installation on both sides of the trailer, a connecting pipe should link both sides and this pipe cannot go through the loading/unloading door of the trailer (at the back). Therefore, this linking pipe has to be at the end of the trailer that is the closest to the truck. Figure 6 shows the recommended configuration in a top view of the trailer. Also, because the water inlet should be positioned at an equal distance from every first nozzle of each water line, the water inlet should be positioned in the middle of the connecting pipe (See Figure 6).

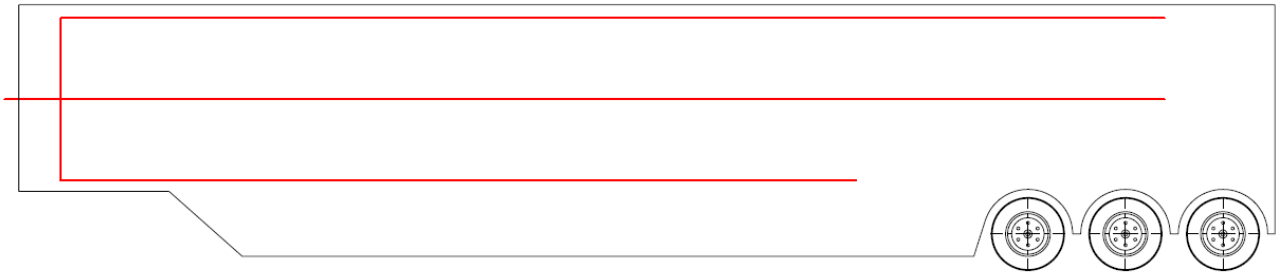


Figure 5 Layout for water line configuration on both sides of the trailer (side view)

Funding for the project has been provided in part through Industry Councils from Agricultural Council of Saskatchewan (principal), the Conseil pour le développement de l'agriculture du Québec, Ontario Agricultural Adaptation Council and Agriculture and Food Council of Alberta Which deliver the Canadian Agricultural Adaptation Program (CAAP) on behalf of Agriculture and Agri-Food Canada.

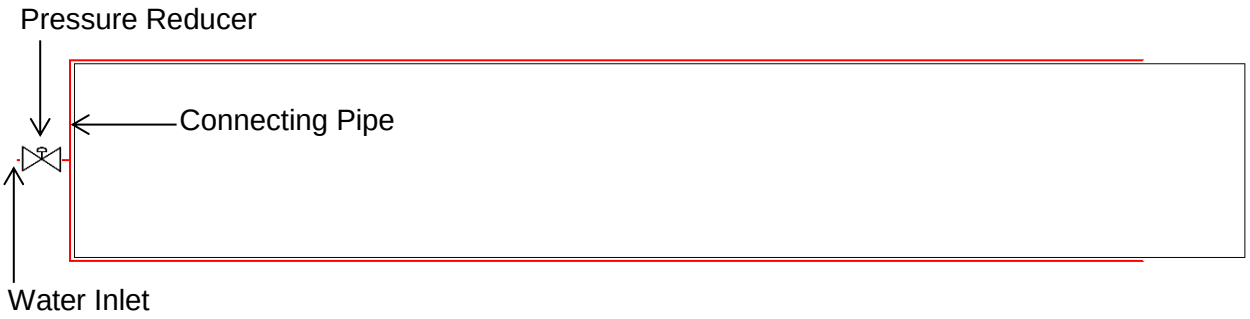


Figure 6 Layout for water line configuration on both sides of the trailer (top view)

Finally, figure 7 shows the recommended configuration (top view) for installing sprinklers at the centreline of the trailer. The side view of the configuration of sprinklers along the centreline of the trailer is the same as in figure 4. Note that for a configuration along the centreline of the trailer, the water inlet can be positioned at either end of the trailer as in figure 4. In order to make sure that all lines have as much roughly the same pressure, put the water inlet so that the pipe length between each line and the water inlet is similar.

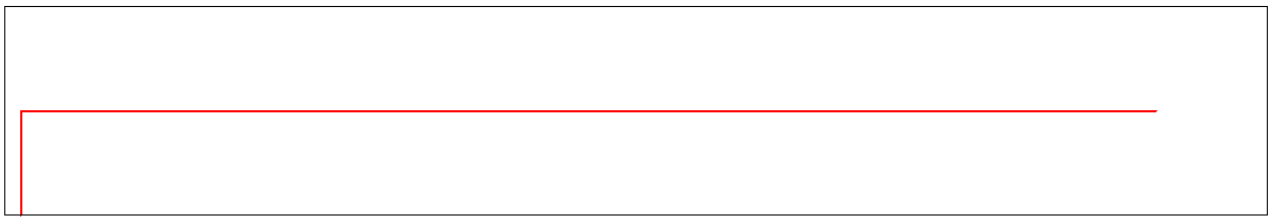


Figure 7 Layout for water line configuration along the centreline of the trailer (top view)

(6) *Other Hardware*

The last important thing is to have a pressure reducer where the farm/plant hose connects. This pressure reducer is important in order to get the full potential of the design. Sprinkling nozzles are designed to be optimal at their operating pressure and that pressure is purposely chosen to be less than the farm water pressure. Choose a pressure reducer with specifications meeting the pressure of the barn/plant, the desired pressure at the nozzles, the pipe diameter and the total flow rate (number of nozzles x water flow rate of nozzle @ operating pressure).

Funding for the project has been provided in part through Industry Councils from Agricultural Council of Saskatchewan (principal), the Conseil pour le développement de l'agriculture du Québec, Ontario Agricultural Adaptation Council and Agriculture and Food Council of Alberta Which deliver the Canadian Agricultural Adaptation Program (CAAP) on behalf of Agriculture and Agri-Food Canada.