

Livestock Watering Facility Design



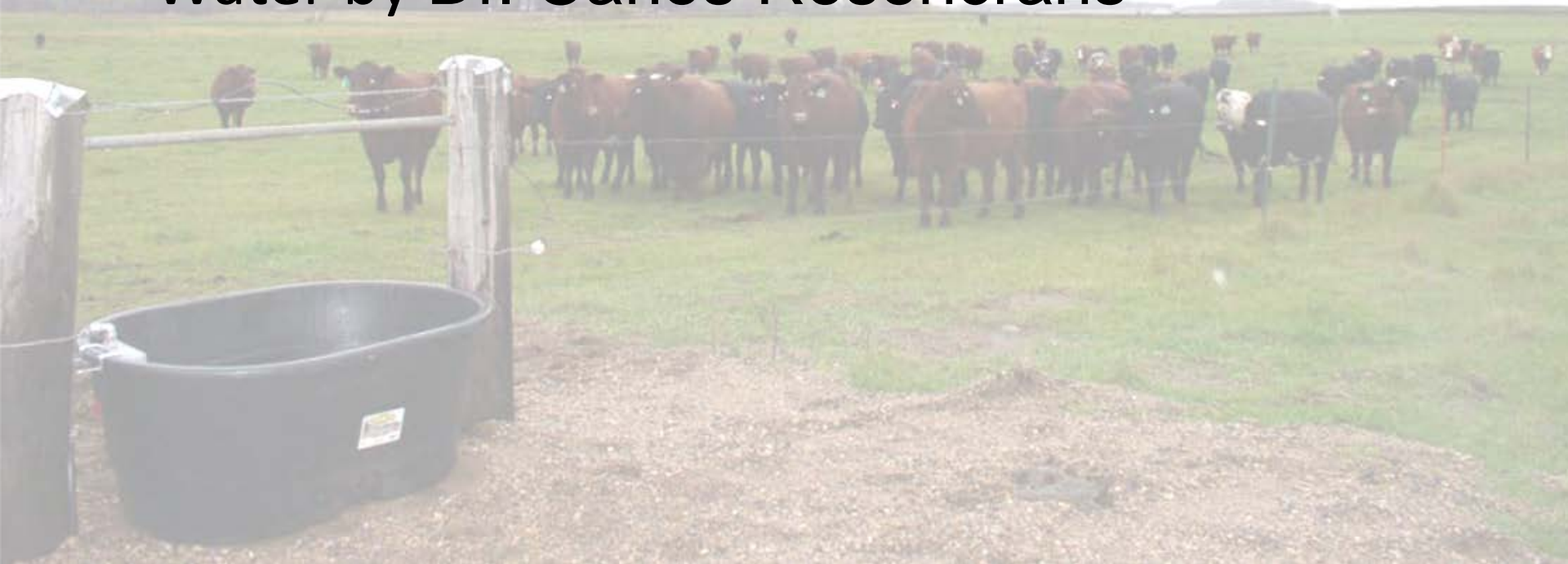
Bill Reck, PE

Environmental Engineer

NRCS - ENTSC

ENTSC Webinars

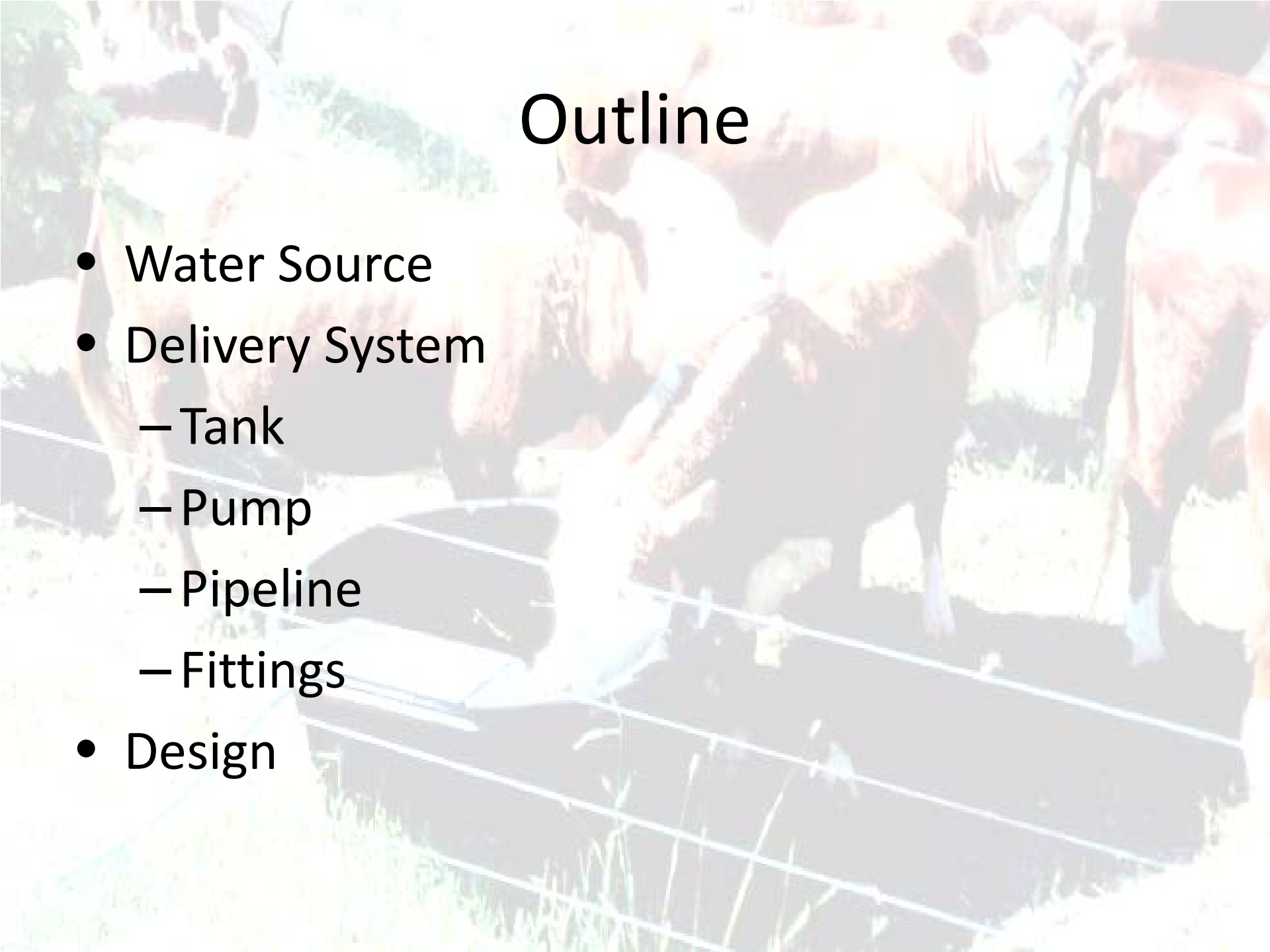
- Watering Facilities for Managed Grazing Systems by **Kevin Ogles and Michael Hall**
- Windmills and Water Pumps for Livestock Water by **Dr. Carlos Rosencrans**





Outline

- Water Source
- Delivery System
 - Tank
 - Pump
 - Pipeline
 - Fittings
- Design



Sources

- Spring
- Stream
- Pond or lake
- Well
- Municipal
- Rainfall



Looking at your primary source

- Is a municipal source available?
 - What is the cost?
- Is well water reliable?



Spring



Stream



Pond



Well

- Well Driller Report
 - Delivery rate
 - Drawdown depth
- Condition

STATE OF NORTH CAROLINA
BOARD OF WATER WELL CONTRACTORS
400 S. BULLINGTON ST. DURHAM, N.C. 27601-1001
WELL DRILLER'S REPORT
(This report shall accompany the Well Driller's Report of Water Well Construction and shall be retained in the files of the well.)

1. WELL OWNER
 Name: JULIUS
 Address: PO BOX 21

2. WELL LOCATION
(Indicate by location that agrees with other location.)
 MAPS
 County: WAKE
 Section: 34
 Township: 02 North Range: 11E of 12E W.

3. PROPOSED USE
 Domestic Irrigation Industrial Mining
 Stock Commercial Other: None

4. METHOD DRILLED
 Case Reverse Circulation Shot
 Hand Drilled Other: None

5. WATER QUALITY
(Indicate water sample collected)
 Chemical Analysis? Yes No
 Bacteriological Analysis? Yes No
(This is for information only.)

6. WELL CONSTRUCTION
 Diameter at top: 8 1/2" inches Depth: 112 feet
 Casing: Steel Plastic Concrete
 Precast Special Other

Drill pipe length: Diameter: Feet: Pounds
21 feet 4 inches 8 feet 875 lbs
1 ft 4 inches 1 ft 1 lb
1 ft 4 inches 1 ft 1 lb

Was deflector used? Yes No
 Backwash pipe at base? Yes No
 Was casing set open end? Yes No
 Was casing cemented around? Yes No
 Depth of: _____ Diameter: _____
 Size of: _____ at top: _____ feet to _____ feet
 Diameter: _____ at top: _____ feet to _____ feet
 Size of: _____ at top: _____ feet to _____ feet
 Diameter: _____ at top: _____ feet to _____ feet
(Indicate that, length, etc.)
 Type of seal: Impregnated Gravel packed Other: _____
 Depth of seal: _____ feet _____ inches _____ feet
 Quantity of seal: _____ tons _____ cubic feet
 Is other casing: _____
 Well seal composition: _____
 If other specify: _____
 Has casing been tested? Yes No
 Was well backfilled upon completion? Yes No

7. WATER LEVEL
 Static water level: _____ feet
 Working depth: _____ feet
 Water level at _____ month _____ day
 Community: None Public Other
 Other specify: _____

8. WELL TEST DATA
 Pump Draw Draw + P
 Pumping well down to surface
 _____ gpm _____ ft draw _____ no pumping _____ gpm
 _____ ft draw _____ no pumping _____ gpm
 _____ ft draw _____ no pumping _____ gpm

9. WELL LOG

Section	Depth	Feet	ft
SOFT CLAY	0	17	
CLAY	17	21	
SOFT CLAY	21	33	
SOFT CLAY SAND STRATUM	33	39	
SOFT CLAY SAND STRATUM	39	59	
SOFT CLAY CLAY	59	70	
SOFT CLAY CLAY	70	75	
SOFT CLAY CLAY	75	80	
SOFT CLAY	80	87	
SOFT CLAY CLAY	87	100	
SOFT CLAY	100	112	
SOFT CLAY	112	112	

(This section shall be retained)

10. DATE COMPLETED 1-11-11

11. WAS WELL PLUGGED OR ABANDONED?
 Yes No

12. REMARKS

13. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.
 Signature: _____
 Date: _____
 License No. WEL 002 Expires 1/1/11

Watering Trough/Tank Size

- Large Tank
 - Large herd
 - Large paddocks
 - Rough terrain
 - Slow delivery of water
- Small Tank
 - Small herd
 - Small paddocks
 - Rapid delivery of water



Trough Size

- Is flow rate limited?
- Total Daily Demand
 - # animals * animal demand (gpd)
 - Size for percentage of demand (50% typical)
- Peak water demand
 - Daily Demand / # events / event time (gpm)
 - Size for an event

Kinds of Tanks

- Portable
- Permanent
- Frost proof
- Robust



Portable Tank



Portable Tank



Permanent Tank



Permanent Tank



Frost Proof



Frost Proof



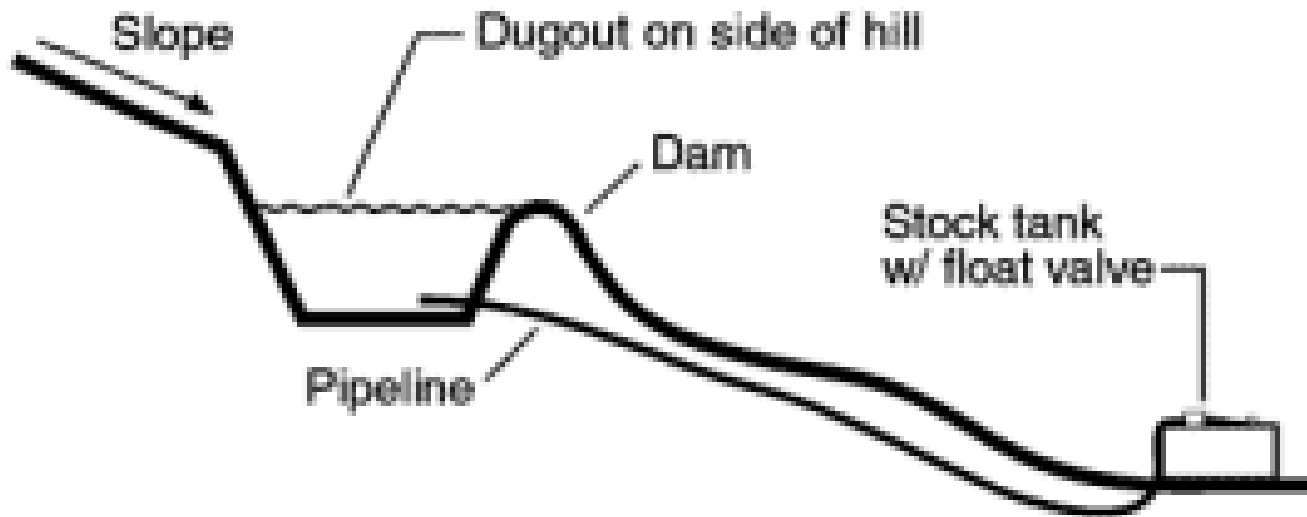
Pipeline system pumping options

- Gravity feed systems
- Solar powered pumps
- Windmill pumping systems
- Gas or diesel powered pumps
- Electric powered pumps
- Municipal water supply

Gravity feed pumping systems



Gravity feed pumping systems

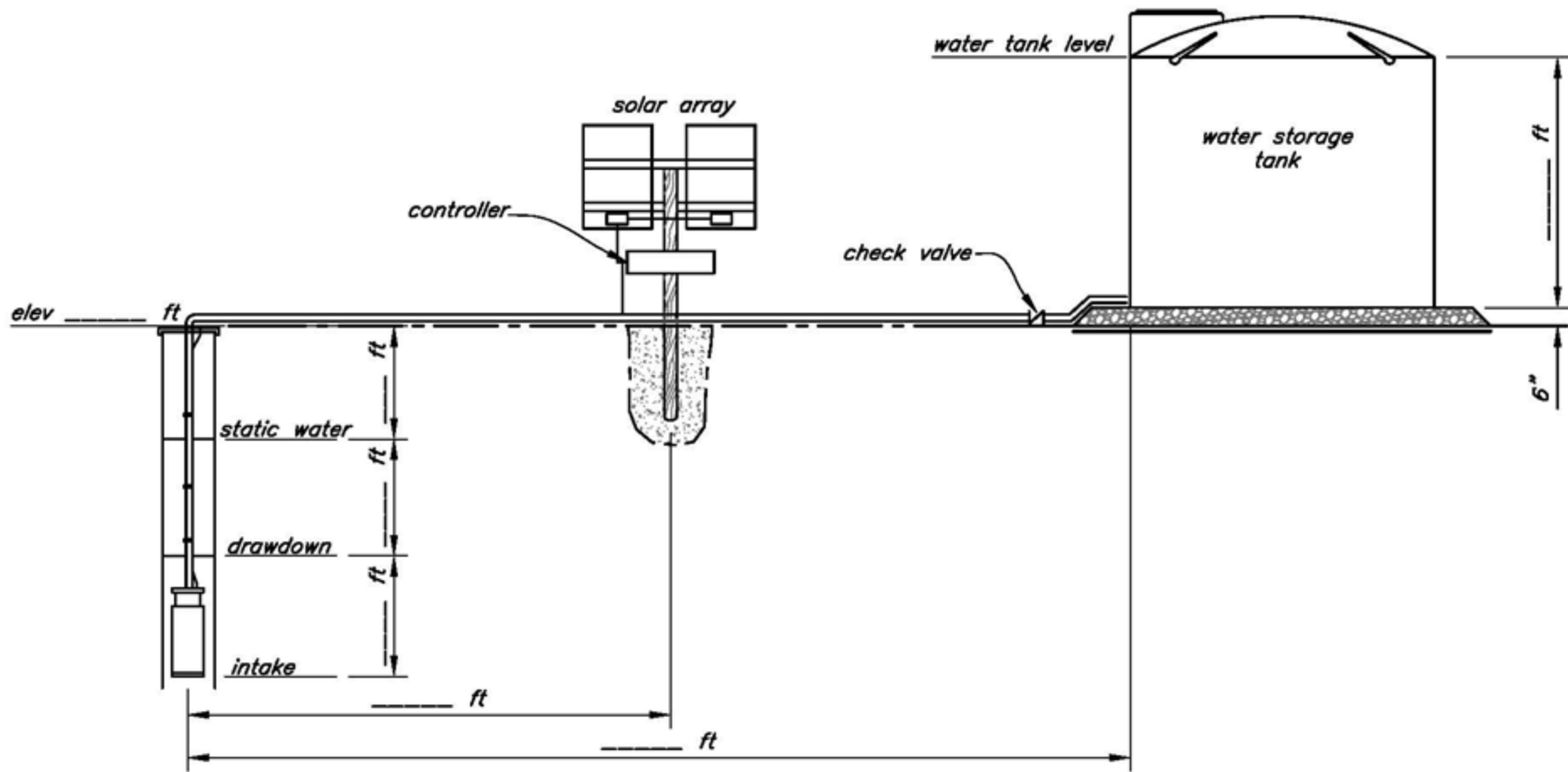


Solar Pumps

- Remote locations – no electric
- Low maintenance
- Expensive
- Not easily portable
- 3 Day Water Reserve







Windmill

- Can power a generator, piston pump, or air compressor
- 3 day water reserve needed



Gas or diesel powered pumps





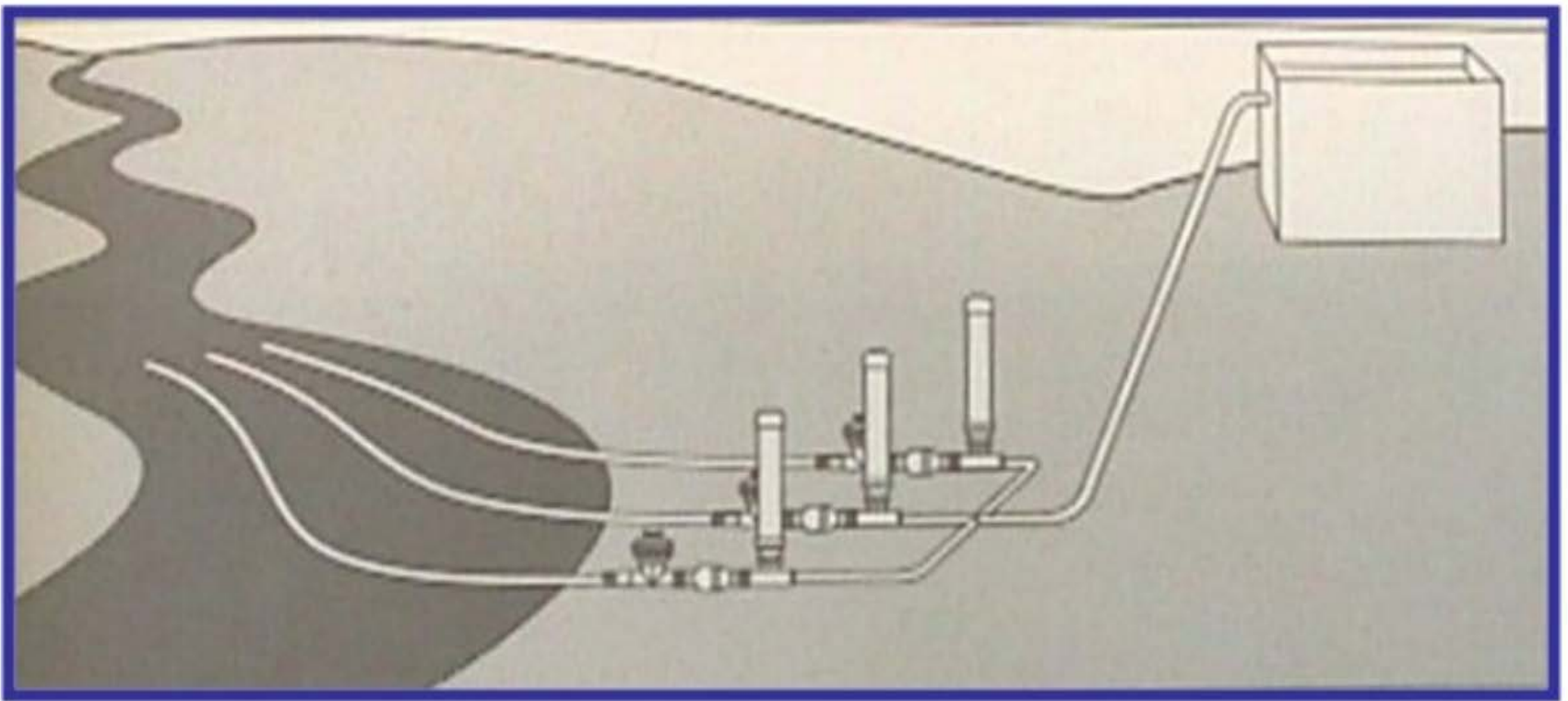
Nose pumps



Nose Pump

- Animals must be trained
- Portable
- No power required
- Less than 300 feet to source
- Lift less than 30 feet
- Large animals only





HYDRAULIC RAMS-

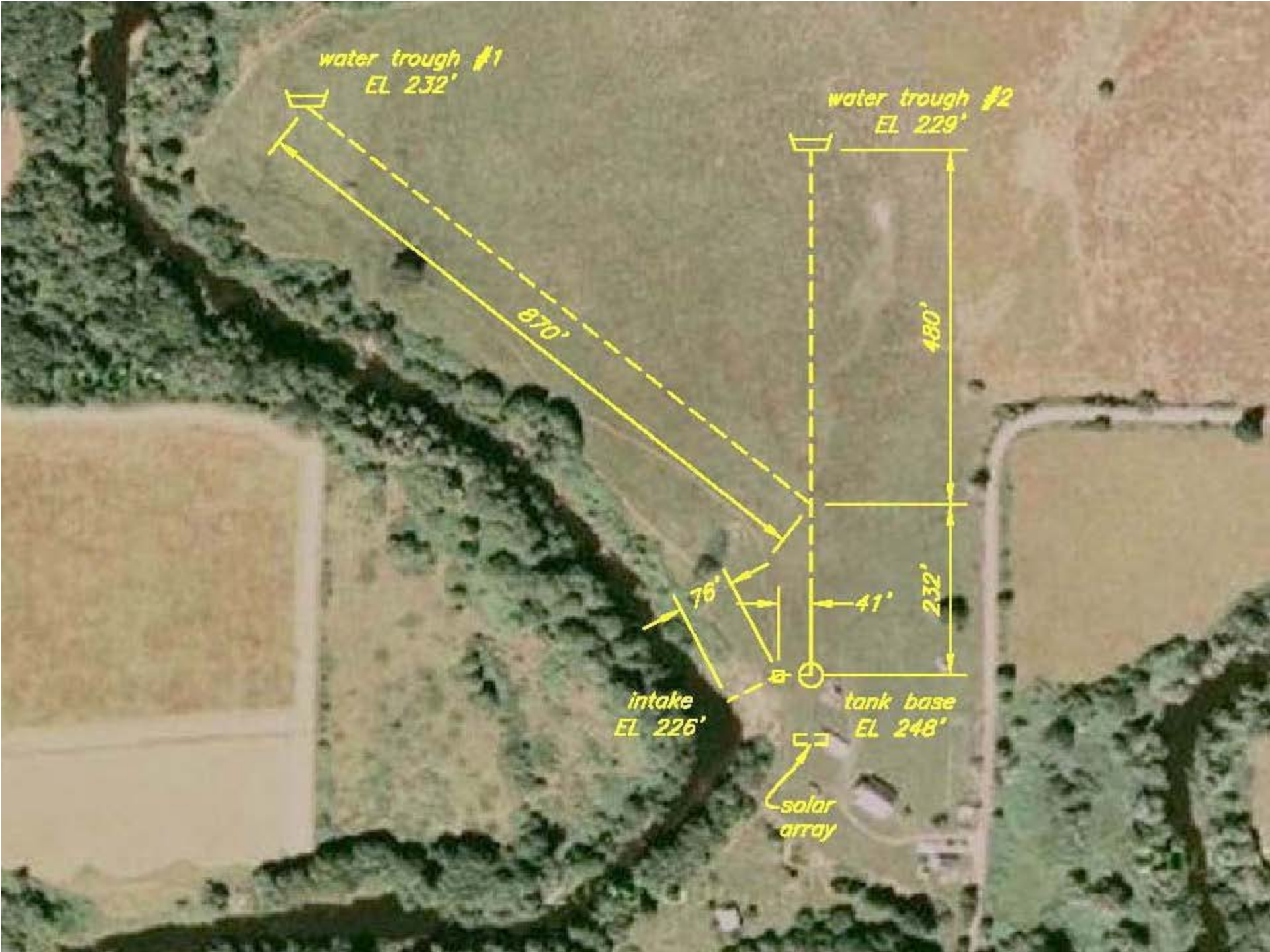
Energy (head) from flowing water boosts a small amount of water to higher elevations. No outside energy is used.

Hydraulic Ram Pump

- Remote locations
- Can lift up to 250 feet or long distance
- Not portable
- Need frost protection
- Economical to operate
- Costly

Design

- Location
- Livestock
- Seasonal vs Annual
- Single or Multiple Troughs
- EFT
- State developed design tools



water trough #1
EL 232'

water trough #2
EL 229'

870'

480'

76'

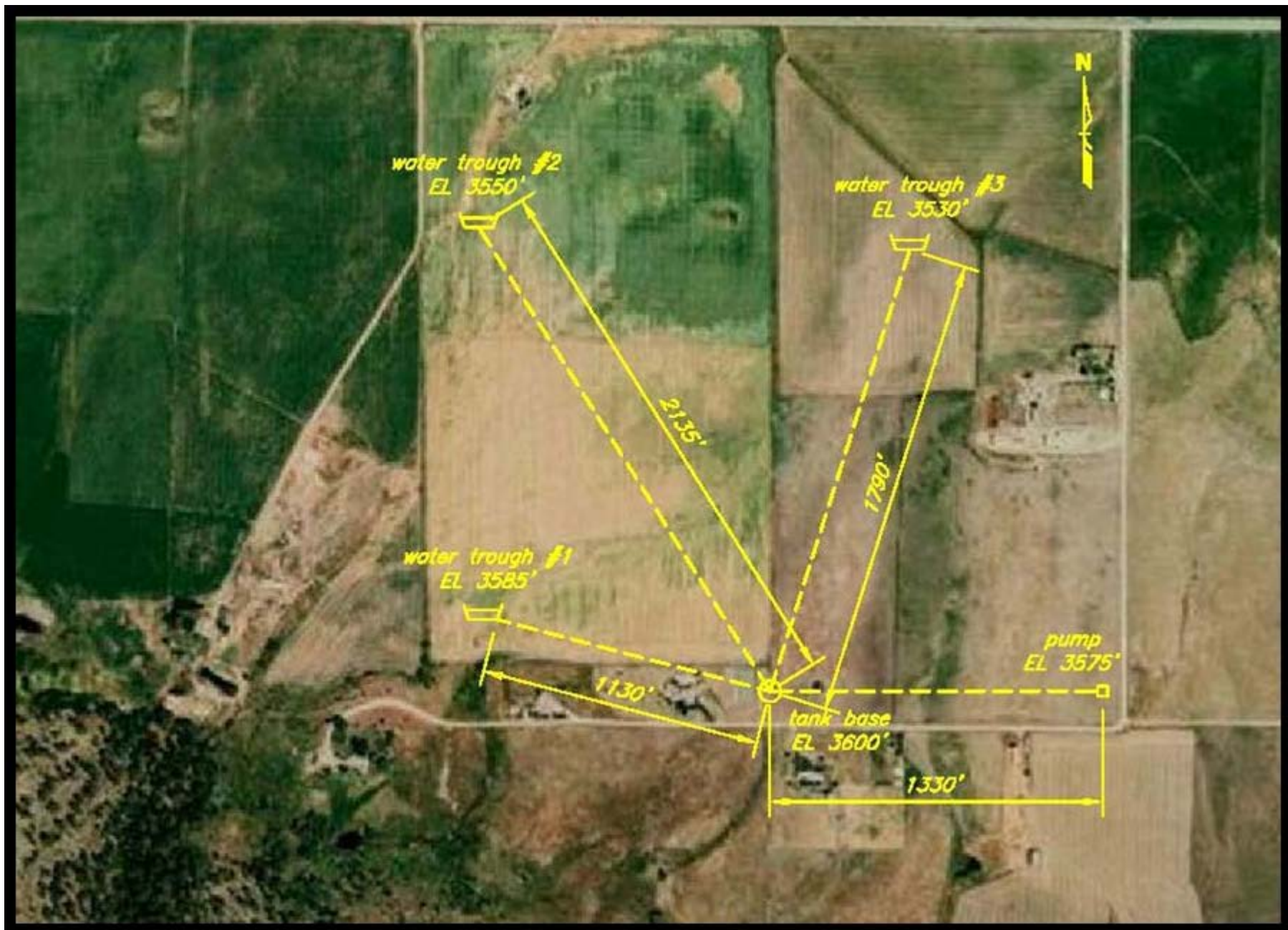
41'

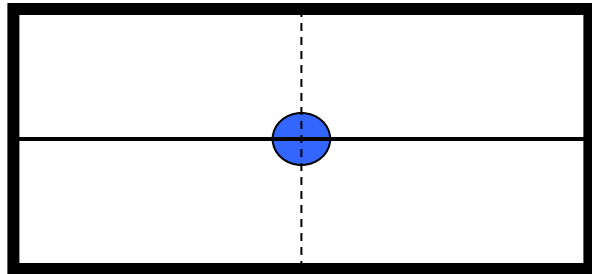
232'

intake
EL 226'

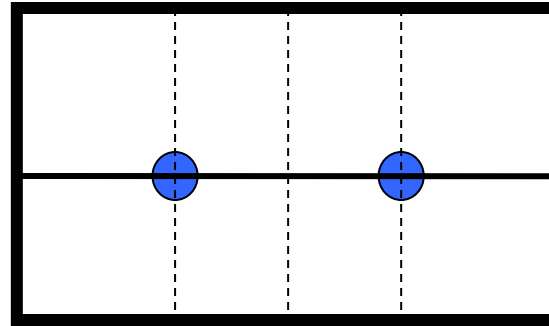
tank base
EL 248'

solar
array

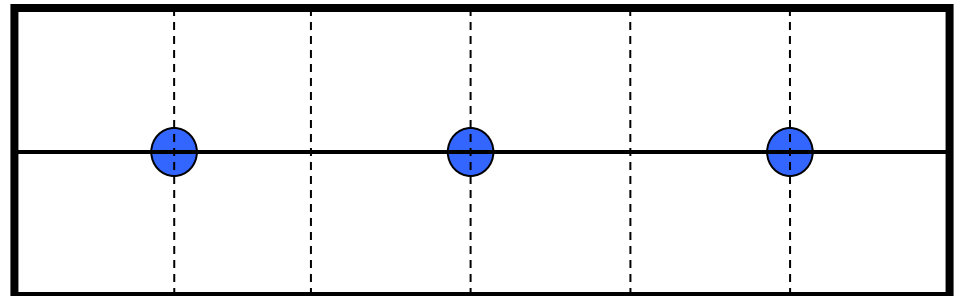




4 Paddocks sharing One tank



8 Paddocks sharing Two tanks



12 paddocks sharing Three tanks

Design Flow Rate

- Source Limited
 - Well or spring
- Peak Demand
 - Water the herd in a short period of time



Pipe & Pump Design

- Calculate TDH
- Size Pump





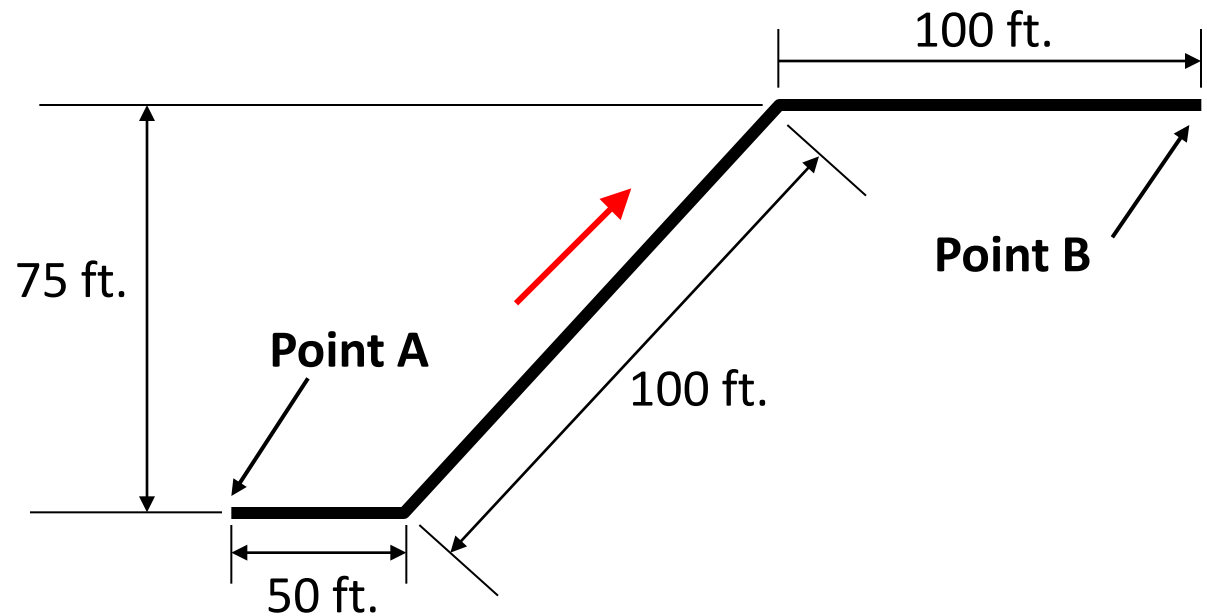
PRESSURE or HEAD

4 Main Considerations

- 1) To offset **Elevation** difference between source and delivery point
- 2) To compensate for **Friction** losses in the mainline delivery system
- 3) System **Operational Requirements**
- 4) Other **Minor** losses

Elevation & Distance

- Elevation Difference
- Distance





Pressure vs Elevation

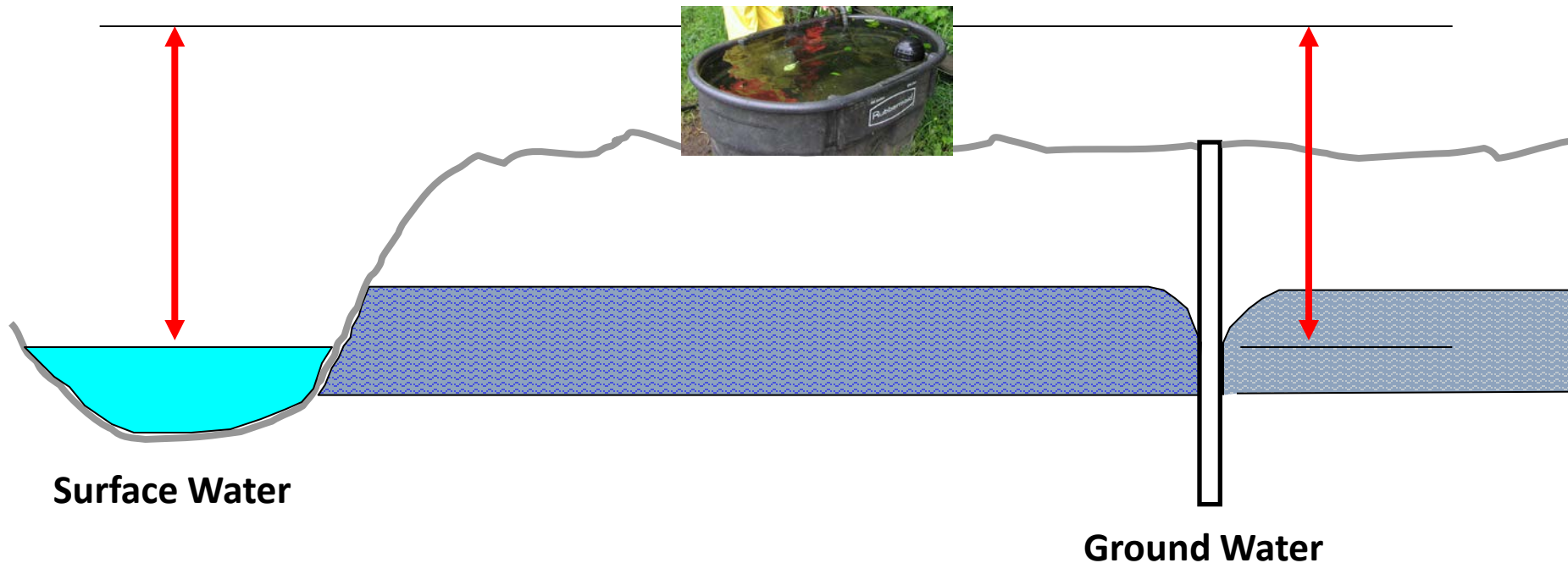
- 1 foot of elevation change = 0.433 psi change
- Lack of pressure can occur going uphill
- Excessive Pressure can occur going downhill

Elevation Difference between water source and point of distribution

Vertical distance between pumping water surface
and the field delivery point

(for troughs use the highest elevated trough position for conservative calculations)

Example 50 feet



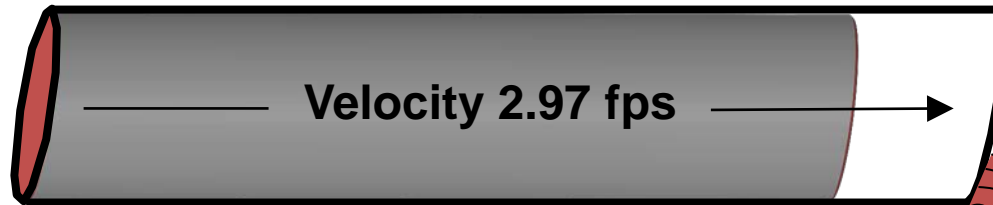
Pipeline

- PVC
- Steel
- HDPE

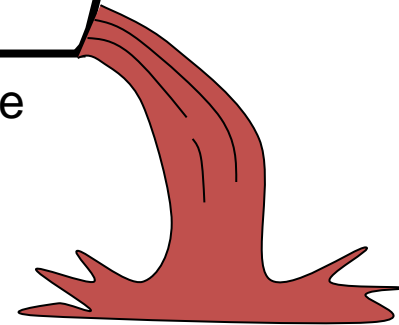


Velocity Effects on Friction Loss

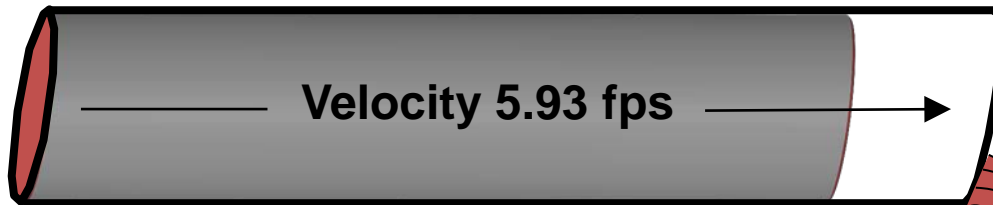
8 gpm - 1-in. Sch 40 PVC



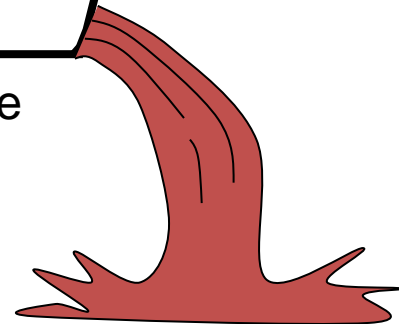
Pressure loss = 1.59 psi /100 ft. of pipe



16 gpm - 1-in. Sch 40 PVC



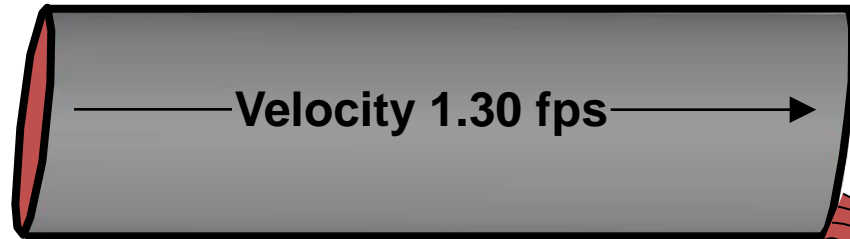
Pressure loss = 5.73 psi /100 ft. of pipe





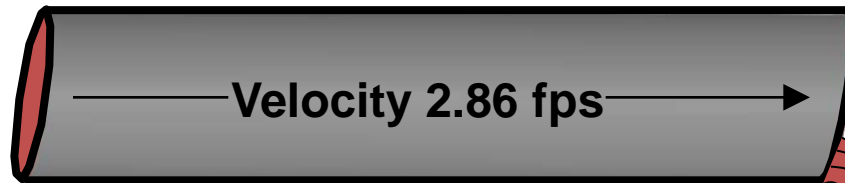
Inside Diameter Effects on Friction Loss

3.068 in. inside diameter
30 gpm – 3 in. Sch 40 PVC

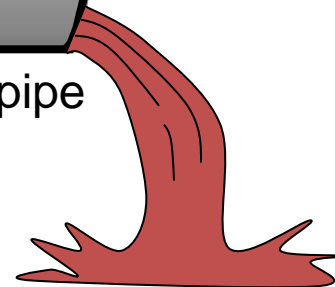
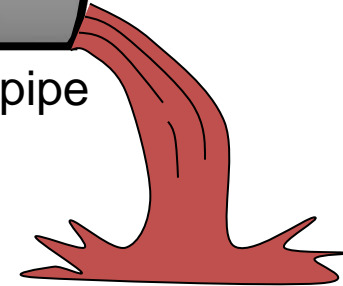


Pressure loss = 0.10 psi /100 ft. of pipe

2.067 in. inside diameter
30 gpm - 2 in. Sch 40 PVC



Pressure loss = 0.68 psi /100 ft. of pipe



Length Effects on Friction Loss

100 feet of pipe



Pressure loss = 2.40 psi/100 ft.
Pressure loss = 2.40 x 1 = 2.40 psi total

10 gpm - 1-in. Sch 40 PVC Pipe

200 feet of pipe



10 gpm - 1-in. Sch 40 PVC Pipe

Pressure loss = 2.40 psi/100 ft.
Pressure loss = 2.40 psi x 2.0 = 4.80 psi total

HDPE Pipe Strength

- 160 psi PS
- 200 psi PS
- As pipe temperature increases, the pipe loses strength

PARR 160 IPS

POLY TECHNOLOGY
PARENT

EXCEL
1-1/4" X 300'
13330

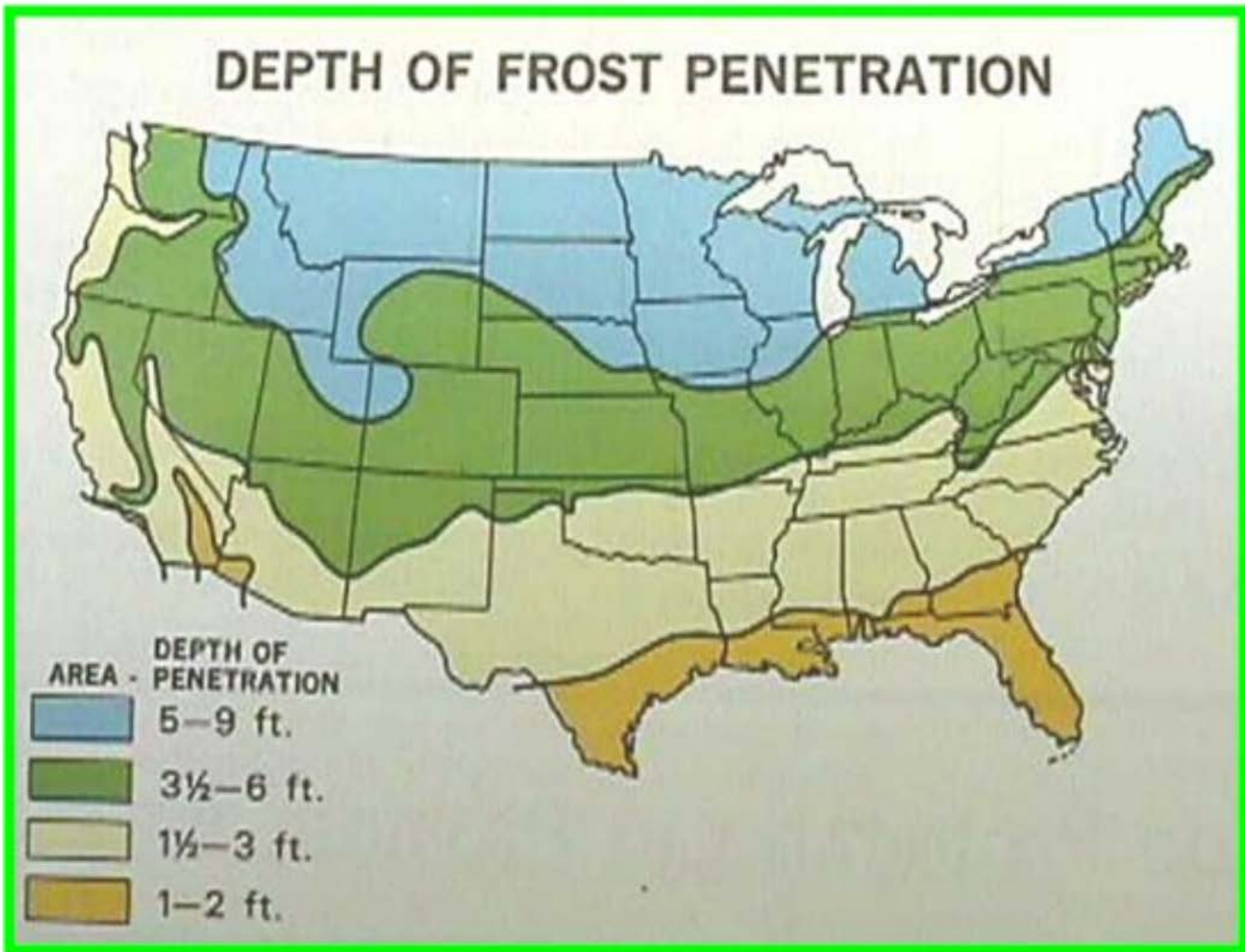


160 PSI PE3408
ASTM D2239 SIDR-9
IRON PIPE SIZE

NSF

160 PSI @ 75° 3408 POLYTECH PARR EXCEL LVMCNSD
C6 SIDR 9 ASTM D-2239
1 1/4" IPS 160
EXCEL LVMCNSD C6 SIDR 9 ASTM D-2239
L V M C N C S D
L V M C N C S D
L V M C N C S D
L V M C N C S D

Anything above frost depth, that is not completely drained, will break (HDPE is the only exception).



Installation

- HDPE expands and contracts 2-3 feet per 100 feet with temperature changes
- Provide slack in pipeline when installing
- Recommend laying out pipeline during the warmest part of the day and connecting during the coolest part of the day



----- 1" 100 PSI 73°F POLY TECHNOLOGY EXCEL [MFR] PE340B C-3 SIDR 15 ASTM D2239 -----

Shallow-burying pipeline



Roll of pipeline for livestock watering system



Minor losses

- Add 10 – 15% to pipe length
- Or add up the loss for each fitting

Fittings

- Flow control valve
- Check valve
- Air release valve
- Low pressure drains
- Tee
- Elbow
- Pressure Reducer





Pressure Loss in Fittings

$$H = k v^2 / 2g$$

H = Head Loss in Feet

K = resistance coefficient

V = average velocity of liquid flow in the pipe in feet per second

g = acceleration of gravity, 32.2 ft. per second

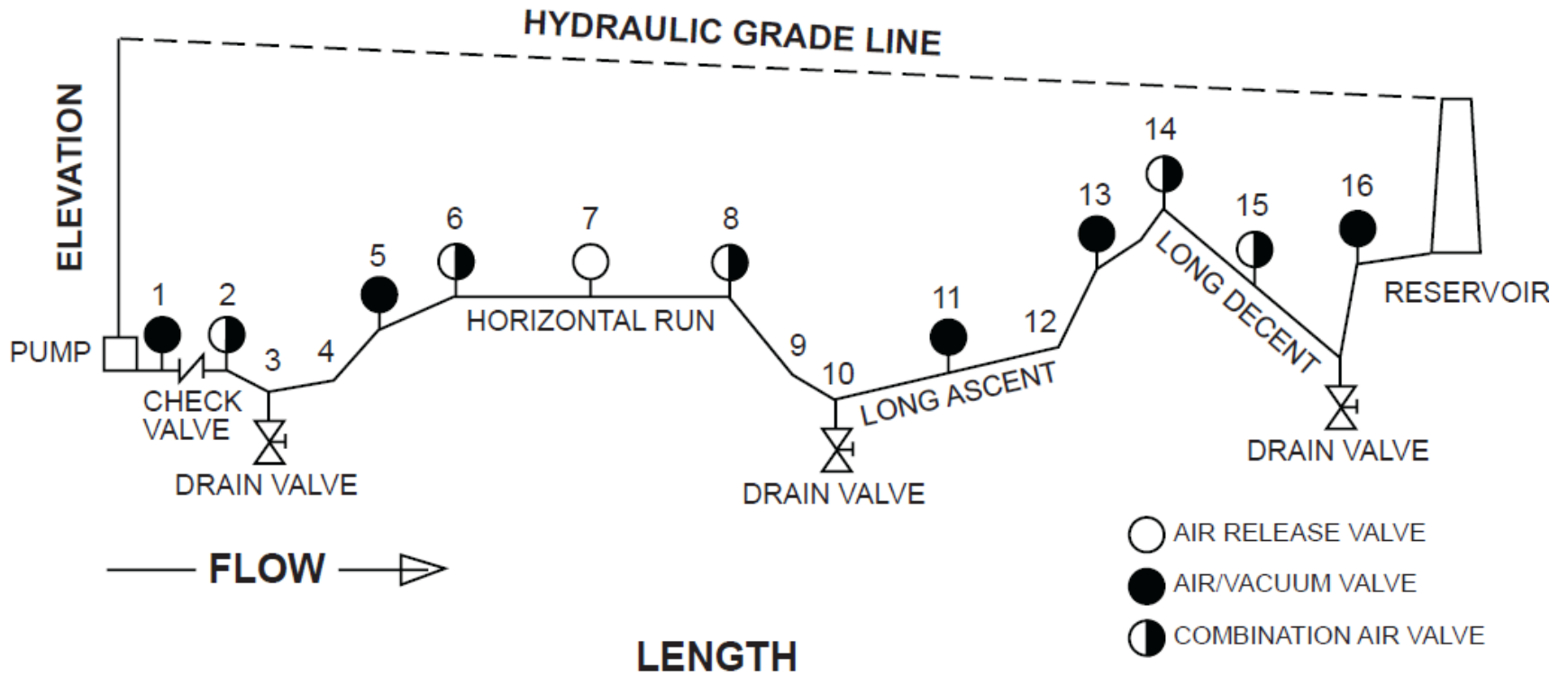
Head Loss Coefficients for Fittings and Special Conditions

where $H = kv^2/2g$

Nature of Resistance	Recommended k
Square edge entry	0.50
Projecting pipe at entry, or re-entrant pipe	1.00
90° large radius bends	0.25
90° short radius bends	0.50
Tees or crosses, straight flow	0.10
Tees or crosses, angle flow	1.50
Taper reducer (refer to smaller pipe)	0.25
Taper increaser (refer to smaller pipe)	0.15
Sudden contraction (refer to smaller pipe)	0.35
Sudden enlargement (refer to smaller pipe)	0.20
Foot valve	3.00
Globe valve, open	3.00 to 15.00
Gate valve	0.10
Angle valve, open	5.00
Alfa valve	3.00
45° short radius bends	0.38
Check valve ¹	3.00 to 10.00

Air in Pipelines

- Air in pressurized pipelines
 - efficiency is sacrificed
 - Pipe damage can occur
- Removal of air from a pipeline will not solve all surge and efficiency problems.
- The elimination of air can solve one of the most common causes of these problems.



Air Release Valve



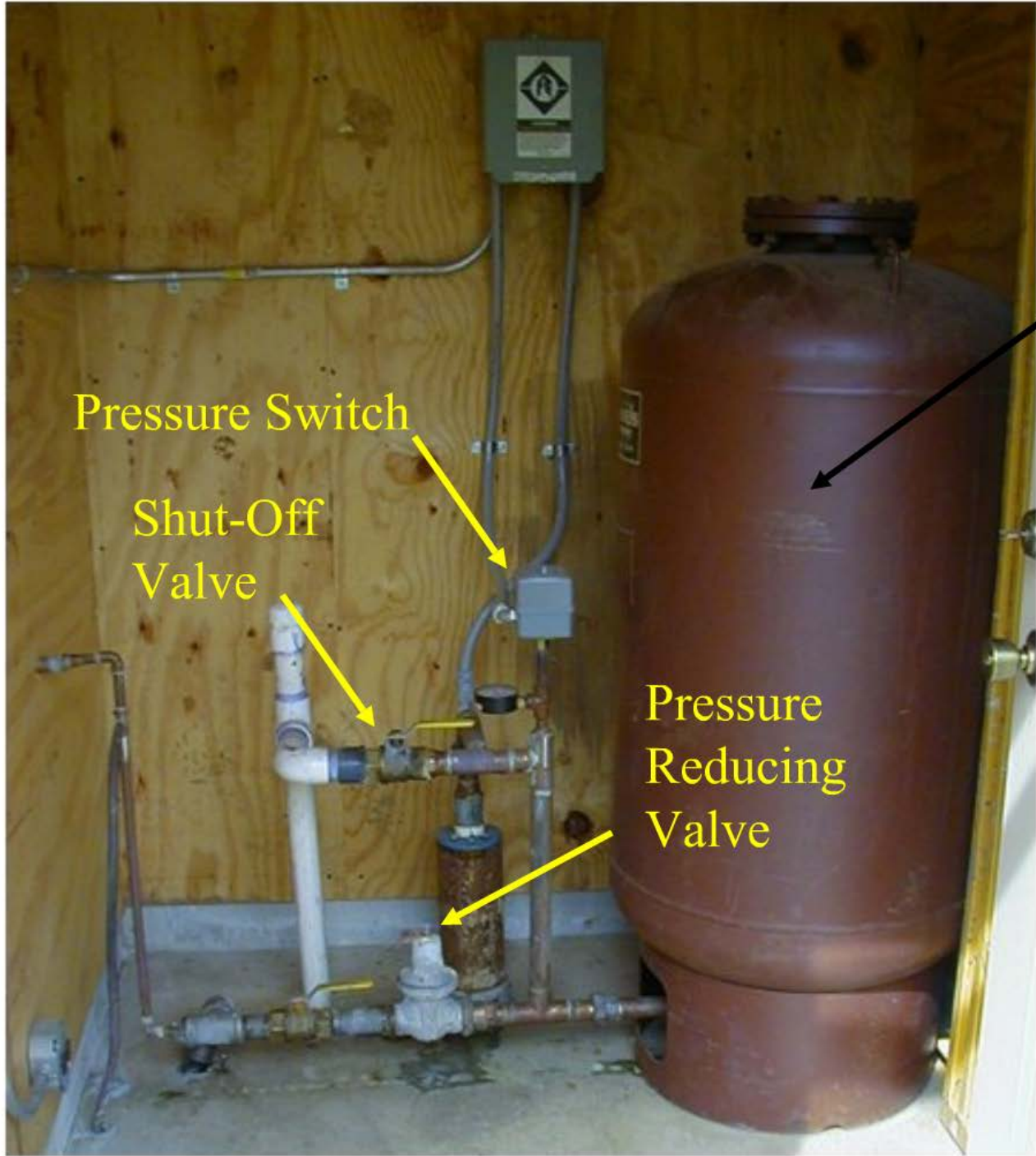


Location

- Air Valves: high points and at 1/4 mile intervals on pipelines with constant grades.
- Air release valve at the end of the line
- Vacuum Release valves: not needed on pipelines of less than 3-inch diameter for protection from collapse; however, they may be needed to insure complete drainage of the line.

Pressure Tanks

- Tank
- Switch
- Water hammer
- Storage
- Relationship of tank size to pump capacity
- Pump cycling



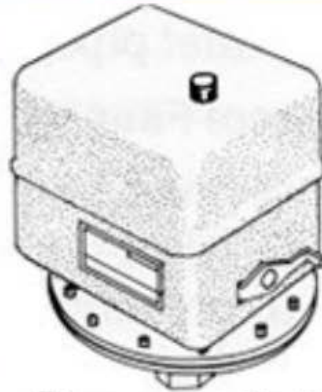
Pressure Tank

Pressure Switch

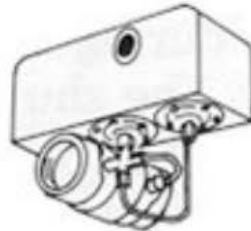
Shut-Off Valve

Pressure Reducing Valve

Pressure switch



**Pressure Switch
with Low Pressure
Cut-off**



**Low Flow
Cut-Off Switch**

Common Pressure Switch Settings

- 20/40 psi
- 30/50 psi
- 40/60 psi

Quick coupler tank connection





Quick coupler tank connection



Quick coupler tank connection



Aboveground pipeline with tee connection and shut-off valve



Float Valve Pressure

- What is the minimum float valve pressure?
 - Typical 10 psi
- Maximum?

Float Valve

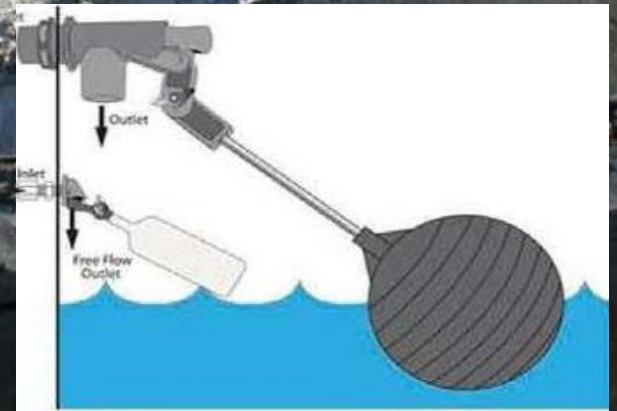


Tire tank with float

10 – 75 gpm
5 – 100 psi

Tire tank and valve

Orifice Size dependant





Max 4 gpm
10 – 75 psi

Pump Design

- Calculate TDH
- Size Pump





PRESSURE or HEAD

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- 4) Other **Minor** losses

Reference

- NEH Part 652 Irrigation Guide
 - Chapter 6
 - State Supplement – Section 5

Thanks

- Many pictures from
 - Jeff Duchene
 - Kevin Ogles
 - & Missouri and Oregon NRCS publications

Questions?

