Livestock Watering Systems

Graves Mountain Training

8/23/2017

Raleigh Coleman, DCR-DSWC

Topics

- Water Sources
- Water Budgets
- Water Delivery Methods
- Case Studies

Livestock Watering Systems: Source of Water

- Wells
- Ponds
- Springs
- Streams

Let’s find these girls an alternative water source.

“Least-cost technically feasible”

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Wells

- The most commonly utilized water source for livestock watering systems
- Advantages:
  - Existing on many sites
  - Can be drilled where most convenient on the site (i.e. near power supply for pump)
  - Relatively low maintenance
  - Generally reliable (once drilled and yield is known)
  - Generally a good "default" when no other reliable sources on the site can be utilized
- Disadvantages:
  - Gambling on yield when drilling a new well
  - Expensive
  - Occasionally dry up or have problems
  - Groundwater table is dropping in areas of heavy use
  - Utilizing a homeowner's existing well


Protect the well head and electric meter from livestock damage

Declining Groundwater

FAUQUIER COUNTY GROUNDWATER RESOURCE ASSESSMENT AND MONITORING PROPOSAL
FOR LONG-TERM MANAGEMENT OF WATER RESOURCES

Prepared For:

Fauquier County Board of Supervisors
Warren Green Building
10 Hotel Street, Suite 208
Warrenton, VA 20186

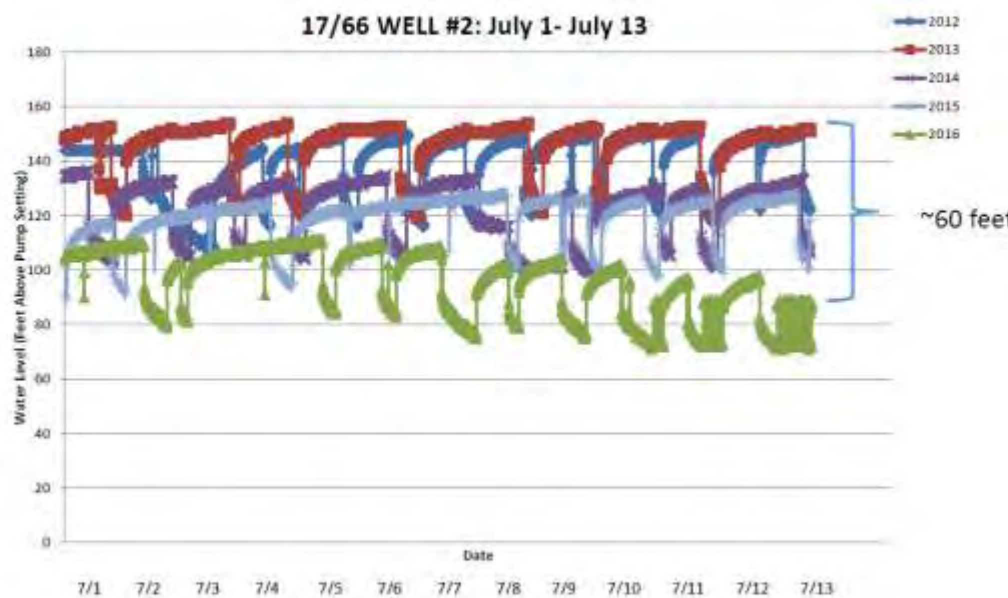
DRAFT

Prepared By:
Kurt J. McCoy
David L. Nelms
US Geological Survey

Virginia Water Science Center
1730 East Parham Rd
Richmond, VA 23228
Phone: (804) 261-2656

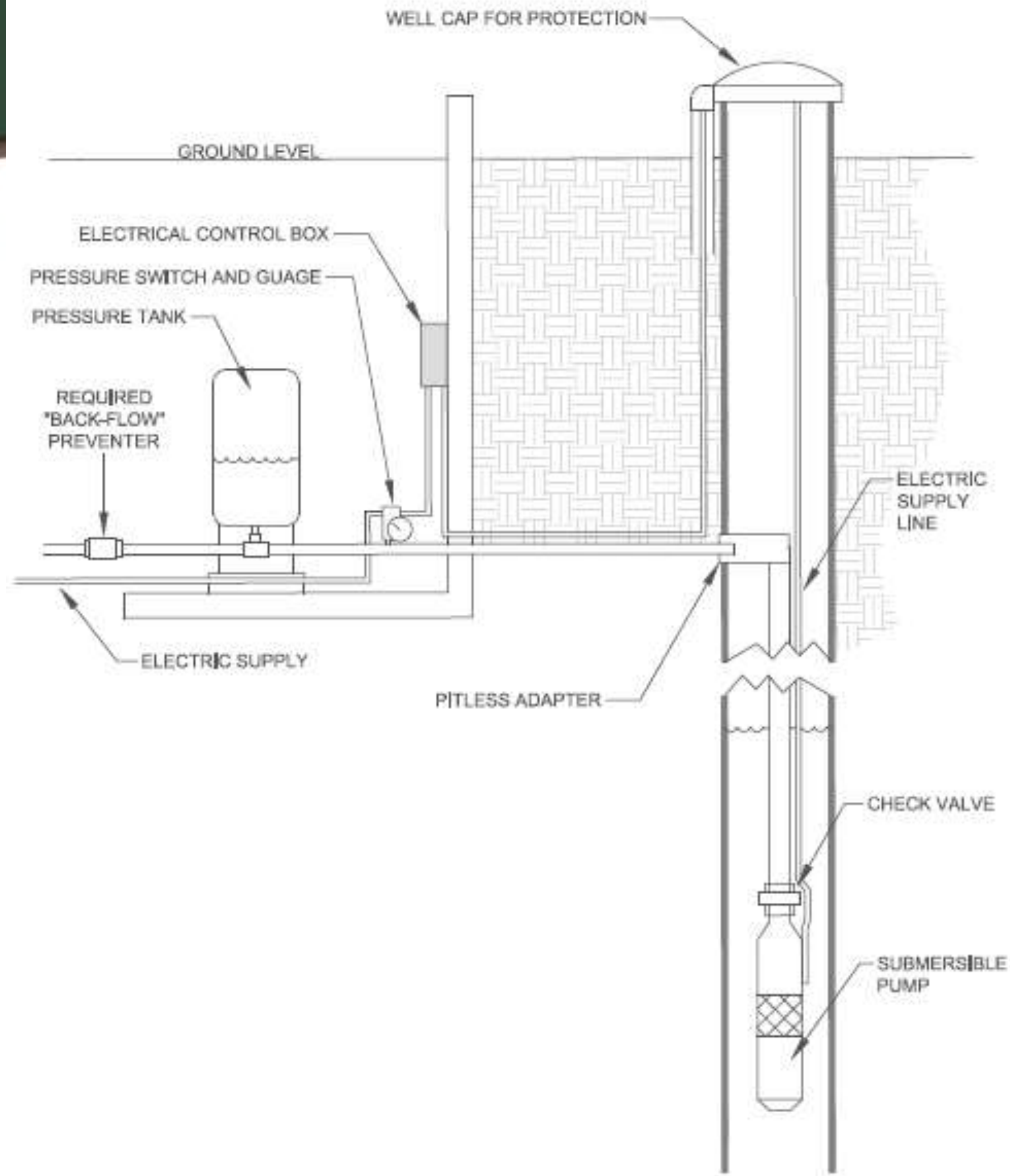
January 2016

FAUQUIER GROUNDWATER RESOURCE ASSESSMENT 1 Kurt J. McCoy (kjmccoy@usgs.gov) David L. Nelms (dlnelms@usgs.gov)



- According to the USGS, in 2010, 6.52 million gallons per day were used by Virginians for livestock water.

Typical Well



TYPICAL WELL DETAIL
NTS

Wells

CONSTRUCTION SPECIFICATION

VA-730. WATER WELL

1. SCOPE

This specification applies to drilled, driven, bored, jetted or dug wells developed to supply water from an underground source. It does not include pumps installed in the well, or above-ground installations such as pumping plants, pipelines or tanks.

2. REQUIREMENTS

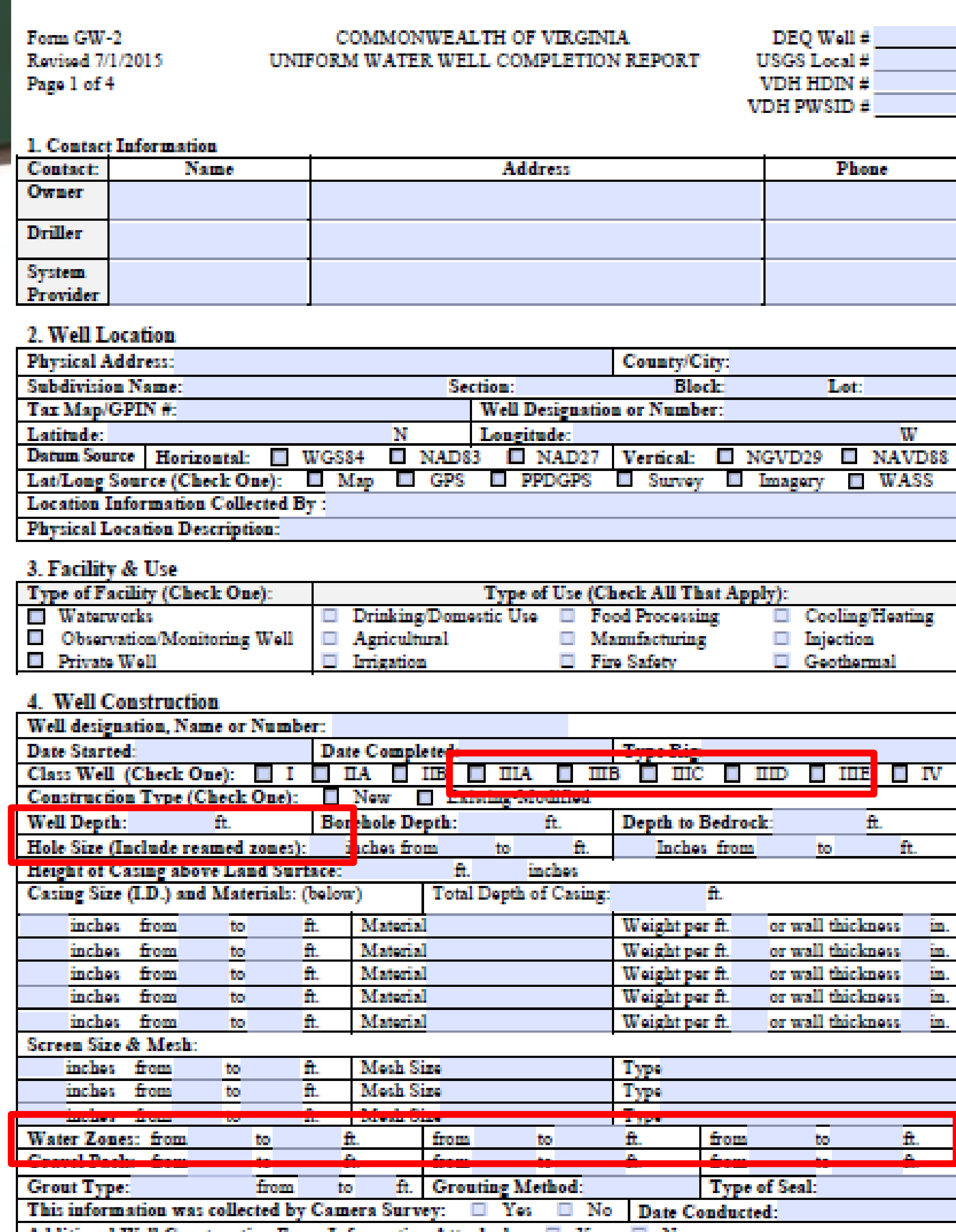
All wells will comply with all federal, state and local laws, ordinances and regulations. All wells will be constructed as Class III wells, as defined by the Virginia Department of Health Private Well Regulations.

3. SUBMITTALS

The Landowner will provide the NRCS or SWCD representative with a copy of the Commonwealth of Virginia Water Well Completion Report - Certificate of Completion/County Permit (DEQ form) or Uniform Water Well Completion Report (Department of Health form).

The Landowner will provide the NRCS or SWCD representative with a map showing the well location.

Some well drillers are still using the old "Water Well Completion Report." Recommend that they start using this one, which provides more information:


Form GW-2
Revised 7/1/2015
Page 1 of 4

COMMONWEALTH OF VIRGINIA
UNIFORM WATER WELL COMPLETION REPORT

DEQ Well #
USGS Local #
VDH HDIN #
VDH PWSID #

1. Contact Information

Contact:	Name	Address	Phone
Owner			
Driller			
System Provider			

2. Well Location

Physical Address: County/City:
Subdivision Name: Section: Block: Lot:
Tax Map/GPIN #: Well Designation or Number:
Latitude: N Longitude: W
Datum Source Horizontal: ☐ WGS84 ☐ NAD83 ☐ NAD27 Vertical: ☐ NGVD29 ☐ NAVD88
Lat/Long Source (Check One): ☐ Map ☐ GPS ☐ PPDGPS ☐ Survey ☐ Imagery ☐ WASS
Location Information Collected By :
Physical Location Description:

3. Facility & Use

Type of Facility (Check One):	Type of Use (Check All That Apply):		
☐ Waterworks	☐ Drinking/Domestic Use	☐ Food Processing	☐ Cooling/Heating
☐ Observation/Monitoring Well	☐ Agricultural	☐ Manufacturing	☐ Injection
☐ Private Well	☐ Irrigation	☐ Fire Safety	☐ Geothermal

4. Well Construction

Well designation, Name or Number:
Date Started: Date Completed: Type Rig:
Class Well (Check One): ☐ I ☐ IIA ☐ IIB ☐ IIIA ☐ IIIB ☐ IIIC ☐ IIID ☐ IIIE ☐ IV
Construction Type (Check One): ☐ New ☐ Existing-Modified
Well Depth: ft. Borehole Depth: ft. Depth to Bedrock: ft.
Hole Size (Include reamed zones): inches from to ft. Inches from to ft.
Height of Casing above Land Surface: ft. inches
Casing Size (I.D.) and Materials: (below) Total Depth of Casing: ft.
inches from to ft. Material Weight per ft. or wall thickness in.
inches from to ft. Material Weight per ft. or wall thickness in.
inches from to ft. Material Weight per ft. or wall thickness in.
inches from to ft. Material Weight per ft. or wall thickness in.
inches from to ft. Material Weight per ft. or wall thickness in.
Screen Size & Mesh:
inches from to ft. Mesh Size Type
inches from to ft. Mesh Size Type
inches from to ft. Mesh Size Type
Water Zones: from to ft. from to ft. from to ft.
Gravel Pack: from to ft. from to ft. from to ft.
Grout Type: from to ft. Grouting Method: Type of Seal:
This information was collected by Camera Survey: ☐ Yes ☐ No Date Conducted:

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COMMONWEALTH OF VIRGINIA
UNIFORM WATER WELL COMPLETION REPORT

DEQ Well #
USGS Local #
VDH HDIN #
VDH PWSID #

Well designation, Name or Number:

5. Disinfection

Well Disinfected: ☐ Yes ☐ No	Date:

6. Abandonment (*When abandoning a well, Sections 1 thru 6 are required to be completed)

Date Started:	Date Completed:	Type Rig:
Static Water Level (unpumped level measured): ft.		
Casing Size (I.D.) and Materials:	Casing Pulled: ☐ Yes ☐ No ☐ Uncased Well	
Depth of Fill:	Type and Source of Fill:	
Grout: From to Type:	From to Type:	
Method of permanently marking location:		

7. Pump Test

Static Water Level (unpumped level measured): ft.	
Date:	Method (Check One): ☐ Water Tape ☐ Airline ☐ Transducer ☐ Other
Stabilized measured pumping water level: ft.	
Date:	Method (Check One): ☐ Top of Well ☐ Top of Casing ☐ Surface Level
Test Pump Intake Depth: ft	Stabilized Yield: gpm after hours
Natural Flow: ☐ Yes ☐ No	Flow Rate gpm

8. Pump Data

Type:	Motor HP:
Production Pump Intake Depth: ft	Rated Capacity: gpm at ft TDH

9. Geologic Information

Formation:	Type Logs:
Lithology:	Cuttings:
Province:	Aquifer Test Performed:
Geologic Map Used:	
Water Quality Results Attached: Yes ☐ No ☐	

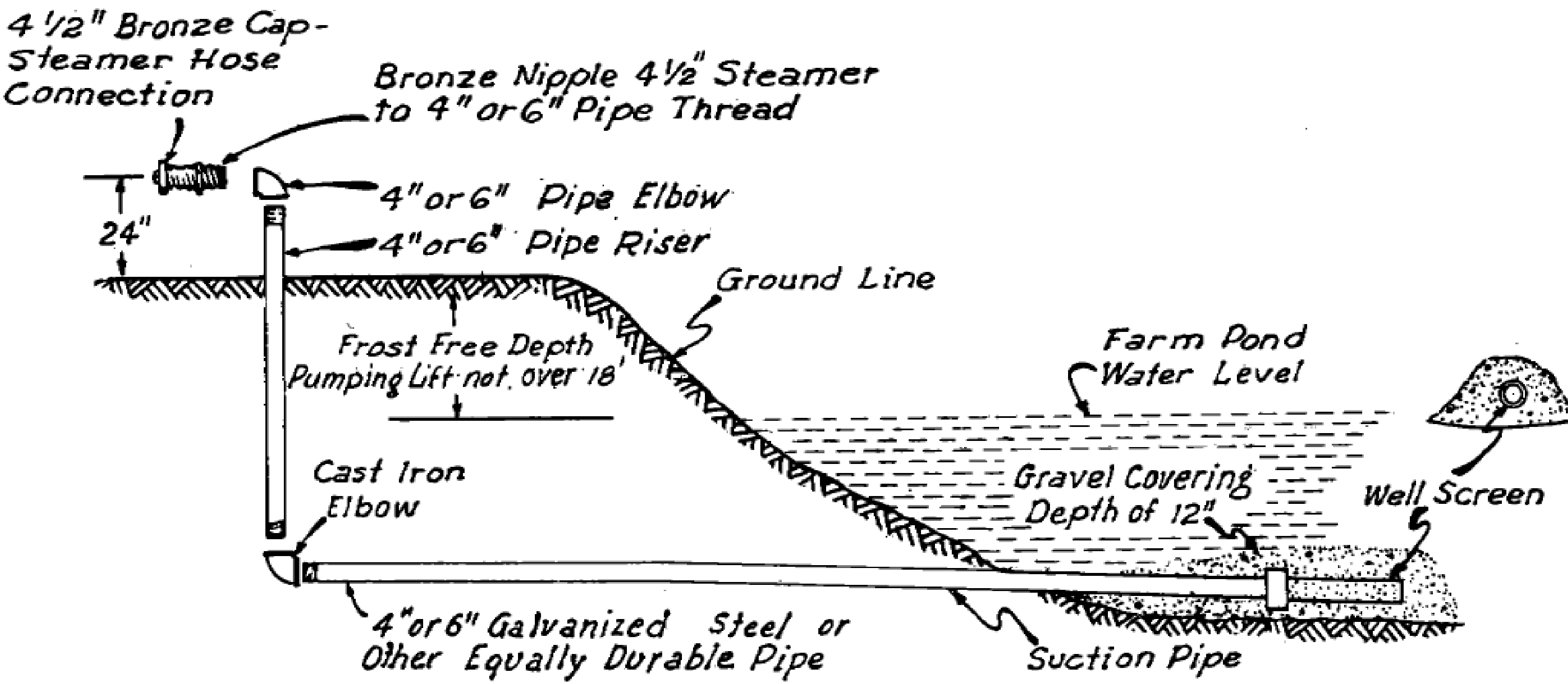
Comments:

Ponds (*Existing* Ponds)

- Rarely used as watering sources, but can be very reliable and more economical that installing a new well
- Advantages:
  - Less expensive and "risky" than spring development or stream pickups
  - Rarely will a reservoir be needed because the pond provides storage to meet the peak demand
  - Large change in grade over short distance at embankment is ideal for a hydraulic ram pump on remote sites
- Disadvantages:
  - May require more maintenance than a well
  - Landowner needs to maintain the dam – if the embankment or spillway blows out, the water source will be gone

EFH11

The pond-full water elevation is established and the waterline is staked at this elevation. The widths of the valley at this elevation are measured at regular intervals and these measurements are used to compute the pond-full surface area in acres. The surface area is multiplied by 0.40 times the maximum water depth at the dam. For example, a pond with a surface area of 3.2 acres and a depth of 12.5 feet at the dam would have an approximate capacity of 0.4 x 12.5 x 3.2 = 16.0 ac.ft. (1 acre-foot = 325,857 gallons). If a more accurate answer is required, the surface area at successive intervals of elevation may be determined and the average end-area method may be used to compute the volume.



(Not to scale)

WATER SUPPLY PIPES

A water supply pipe should be installed under or through the dam where water is to be used below the dam, such as for stockwater, irrigation, or filling a spray tank. This pipe usually is in addition to the principal spillway or trickle tube. The water supply pipe should have water-tight joints and be equipped with a suitable valve and strainer at its upper end. For small rates of flow, such as are needed to fill livestock or spray tanks, 1½-inch diameter steel pipe is generally used. Where larger rates of flow are required, such as for irrigation purposes, larger diameter pipe are commonly used. Water supply pipes should be provided with anti-seep collars to retard seepage. (See Figure 11-7 for a sketch of a stock watering facility.)

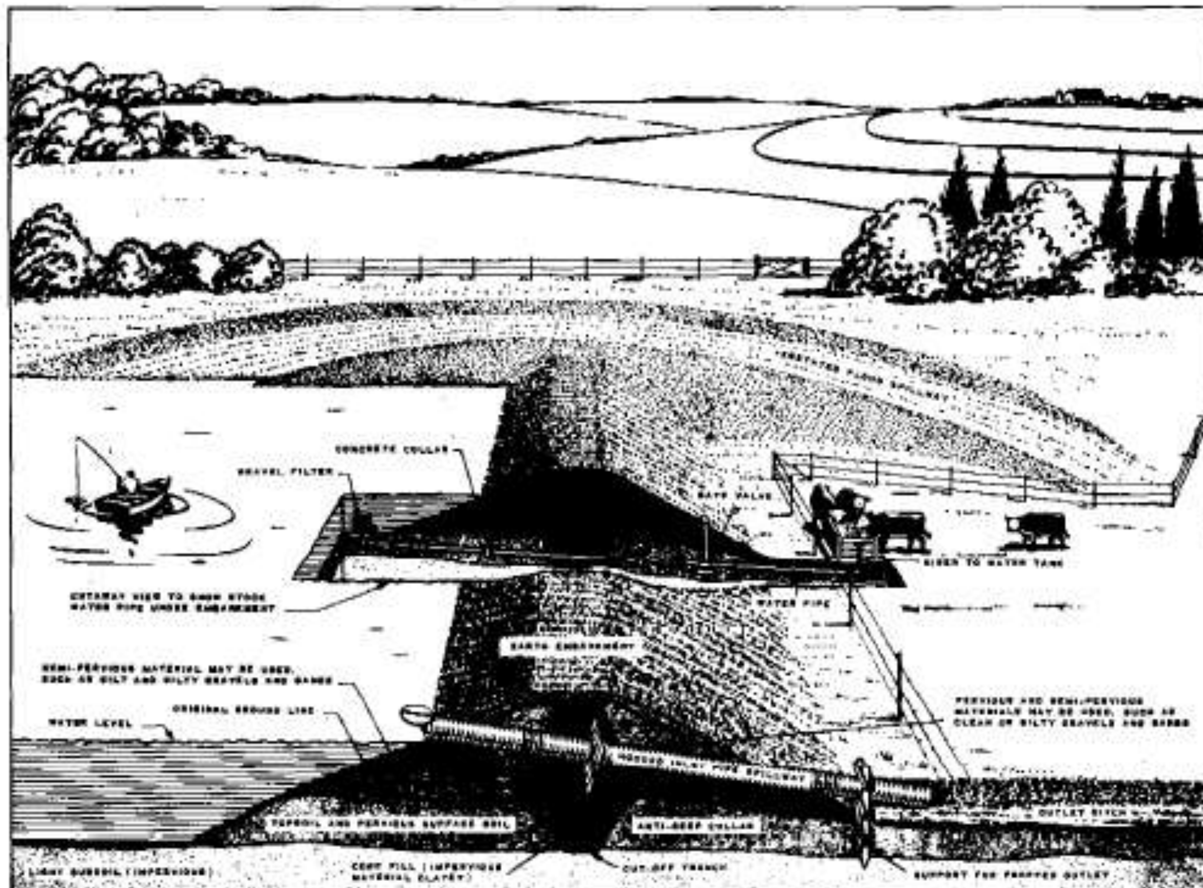


Figure 11-7 Embankment pond equipped with a stock watering facility

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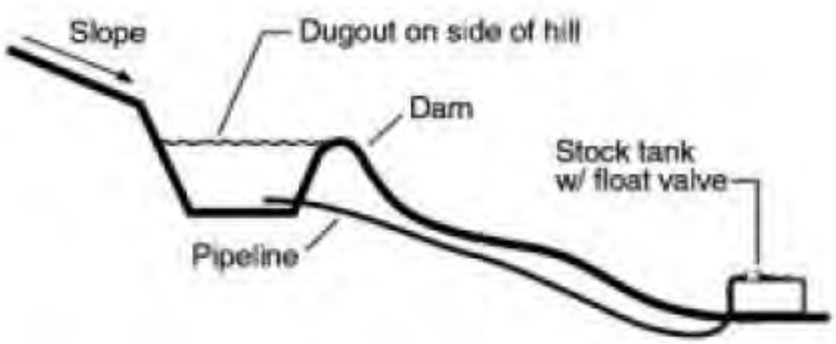
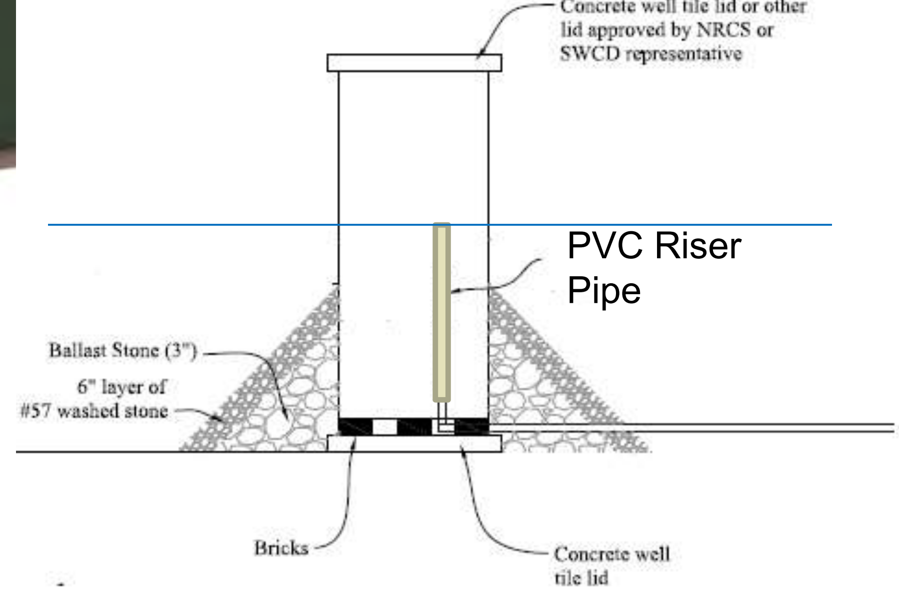
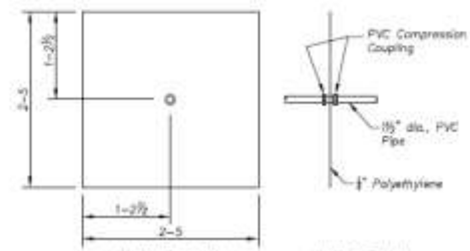
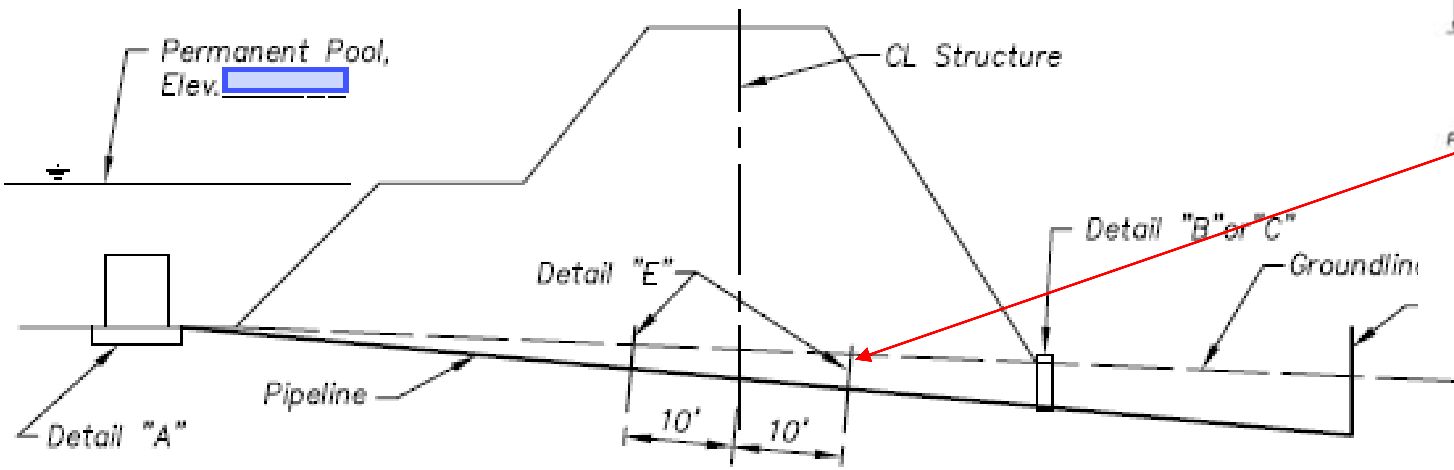


Figure 3 Gravity system.



***NOTE: Route new pipelines *around* the embankment.**





TYPICAL CROSS SECTION OF PIPELINE AND DAM

Not to scale

Sta. ______ on CL of Structure

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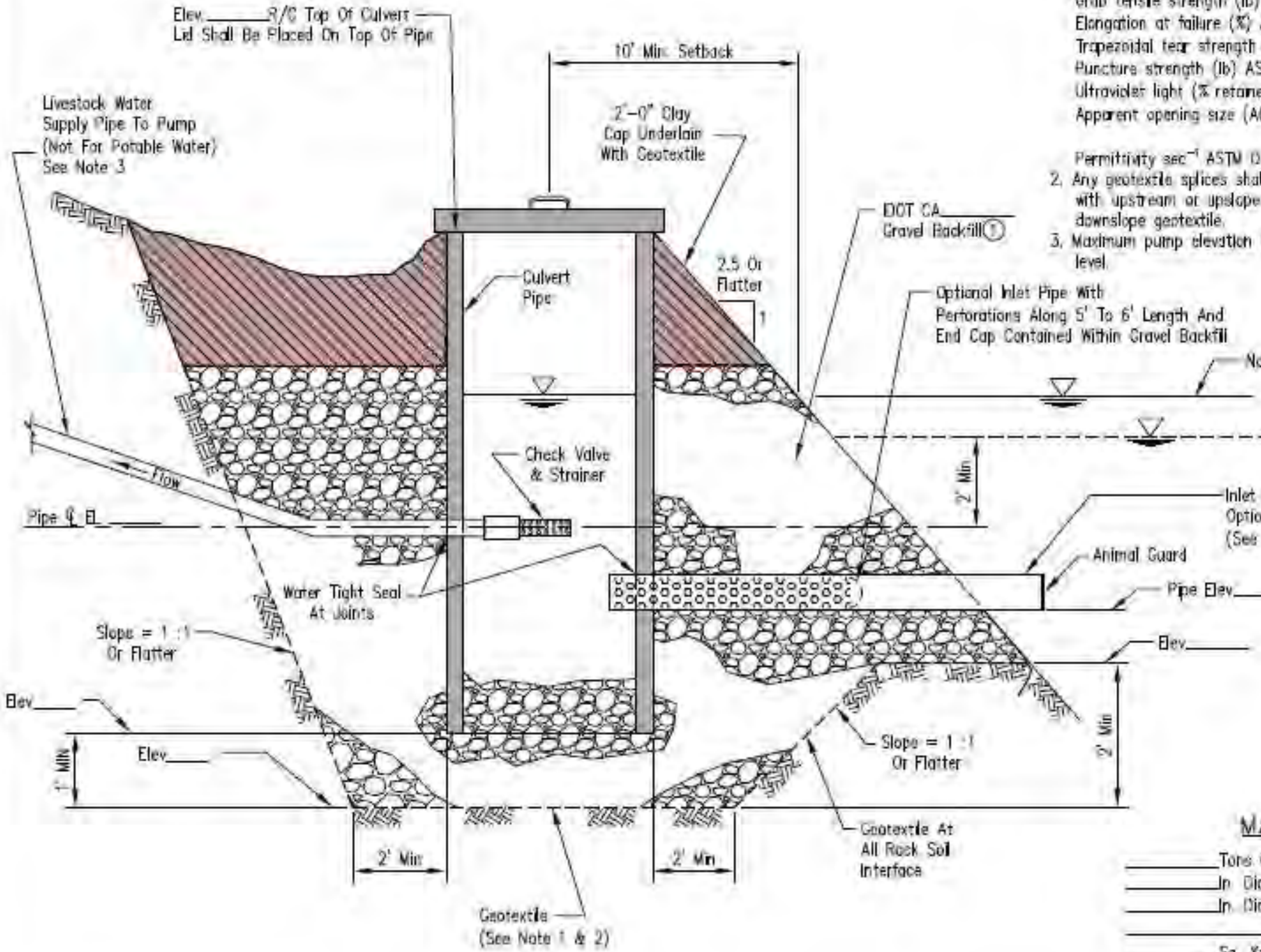
NOTE:

1. Geotextile (non-woven, needle punched) Minimum criteria:
   - Grab tensile strength (lb) ASTM D4632 ______ 202
   - Elongation at failure (%) ASTM D 4632 ______ ≥ 50
   - Trapezoidal tear strength (lb) ASTM D 4533 ______ 79
   - Puncture strength (lb) ASTM D 6241 ______ 433
   - Ultraviolet light (% retained strength) ASTM D 4355 _min 50
   - Apparent opening size (AOS) ASTM D 4751 ______ max 0.22 mm (US sieve size70)
   - Permittivity sec^{-1} ASTM D 4491 ______ min 0.70
2. Any geotextile splices shall overlap a minimum of 18 inches, with upstream or upslope geotextile overlapping the abutting downslope geotextile.
3. Maximum pump elevation 15feet higher than design low water level.



MATERIALS

______ Tons Of IDOT CA ______ Backfill①
______ In. Dia. Pipe Culvert ______ Feet High
______ In. Dia. Inlet Pipe ______ Feet Long
______ Pipe Material
______ Sq. Yd. Geotextile (See Note 1)

①Use Gradation CA 2, 3, 5, 7, or 8

LIVESTOCK WATERING FACILITY
POND SUMP

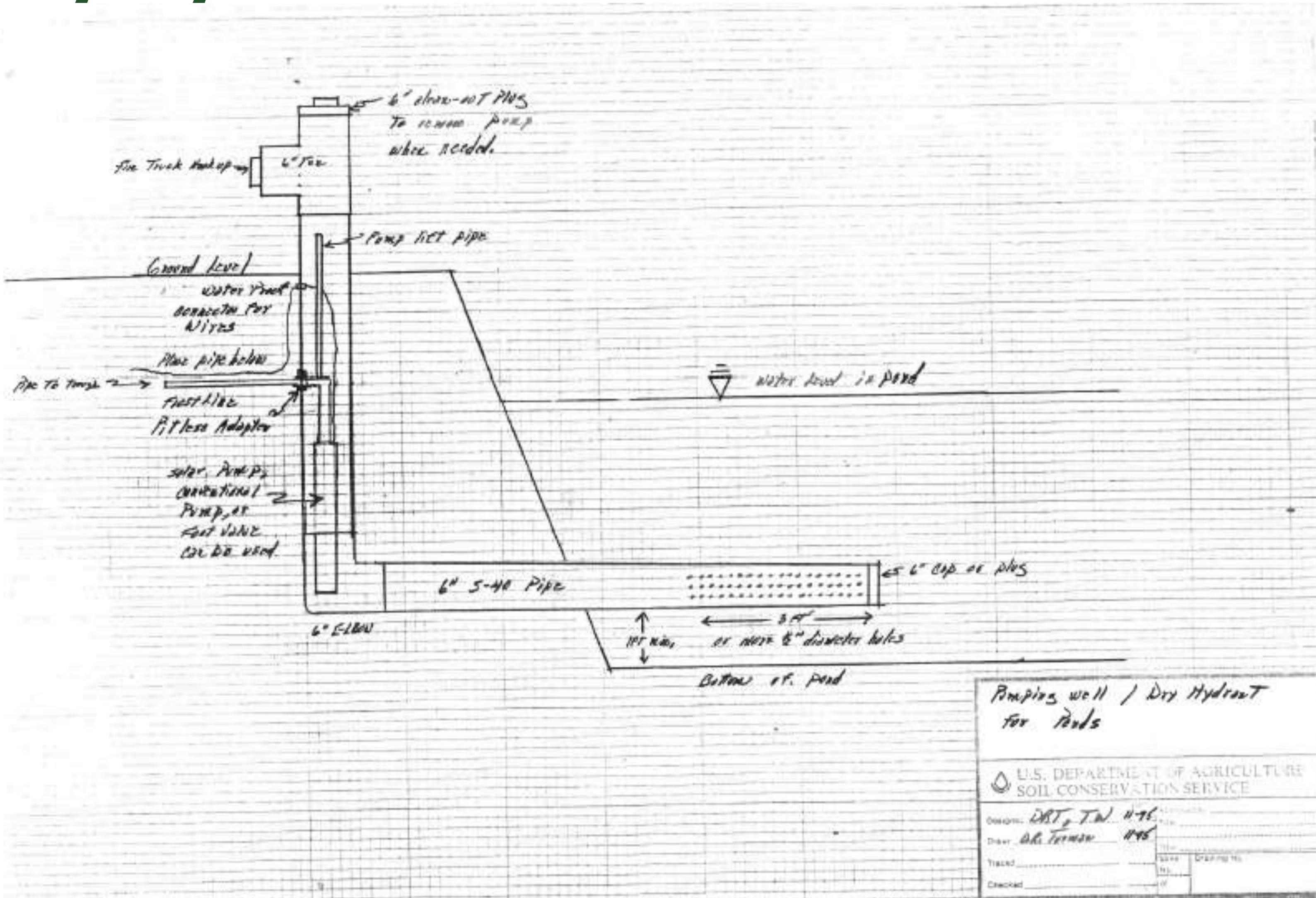
NRCS

File No. L-ENG-880

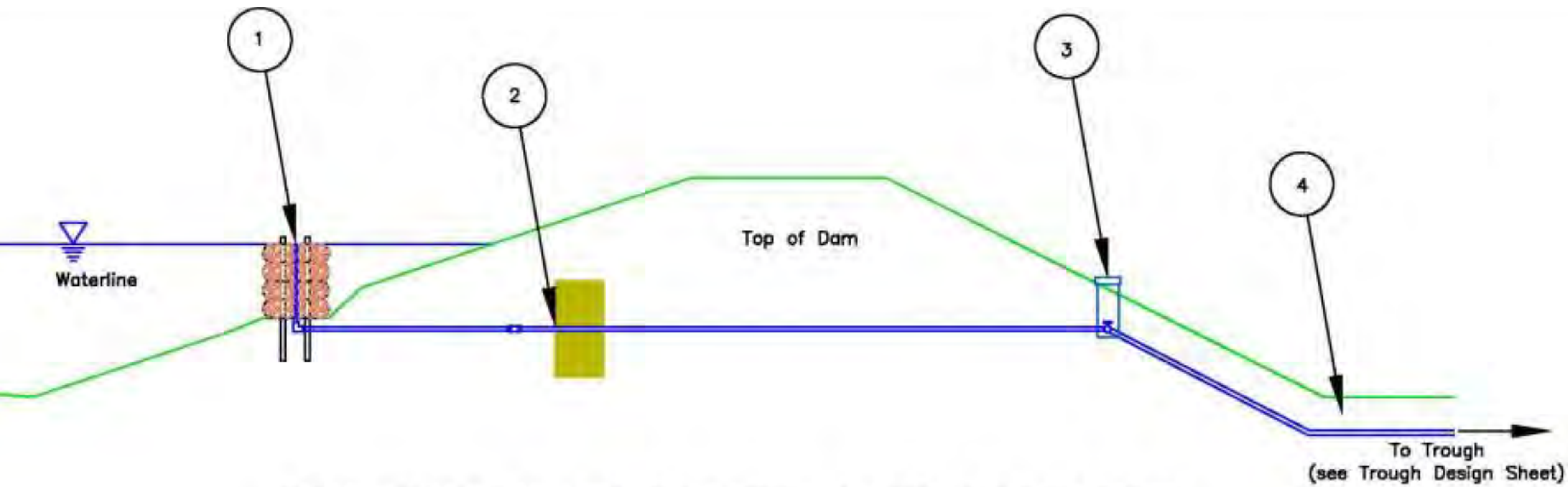
Drawing No.

Page 1 of 1

Dry Hydrant

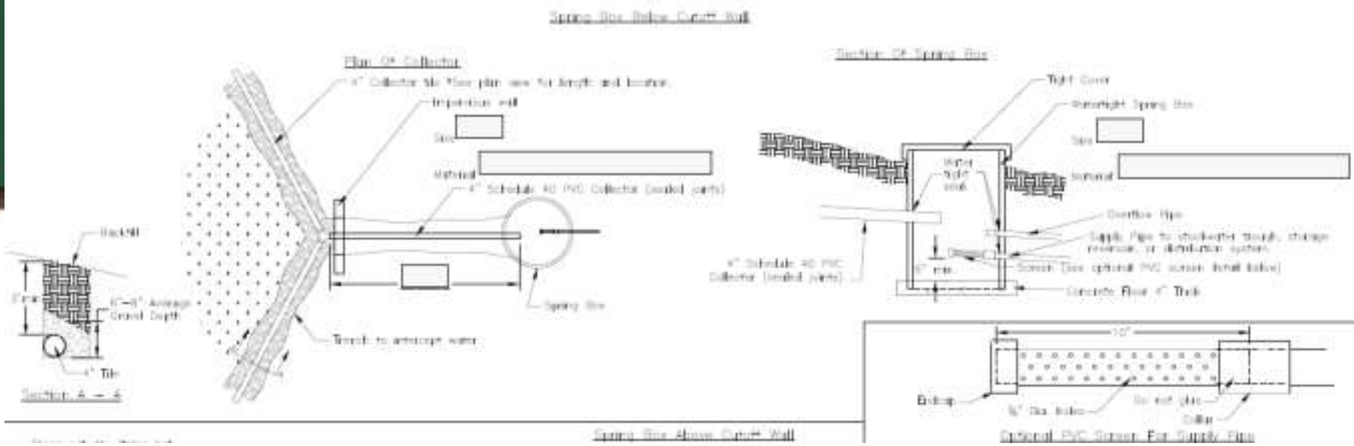


6" clean-out Plug To remove pump when needed.
Fire Truck hookup
6" Tee
Pump lift pipe
Ground level
Water Proof connection for wires
Place pipe below frost line
Pipe To Trough
Pitless Adapter
Solar Pump, conventional Pump, or Foot Valve can be used.
water level in pond
6" S-40 Pipe
6" cap or plug
6" Elbow
1 ft min.
3 ft or more ½" diameter holes
Bottom of pond
Pumping well / Dry Hydrant for Ponds
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE



TYPICAL PIPELINE INSTALLATION FOR WATERING FACILITIES AT EXISTING PONDS

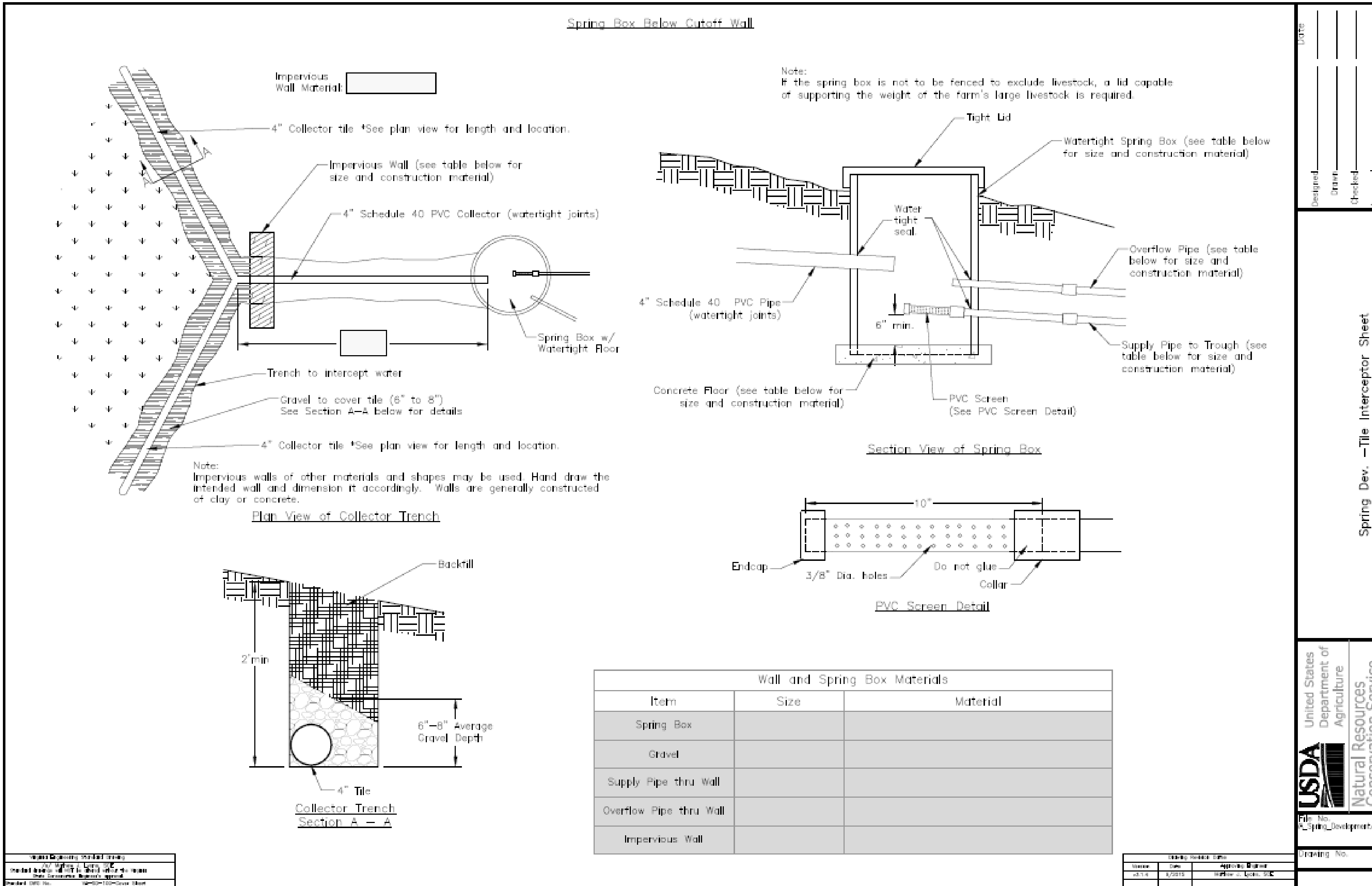
Virginia Department of Conservation & Recreation



Springs

- Rarely used as watering sources, but can be very reliable and more economical that installing a new well
- Advantages:
  - Often the only source of water on remote sites
- Disadvantages:
  - Most "good" springs have already been developed
  - Seeps are very difficult to judge
  - Environmental requirements make then not feasible in many cases (25% of flow, no flow-through systems)
  - Require a fair amount of engineering experience and ESPECIALLY an experienced contractor
  - May go dry when water is needed the most

Spring Box BELOW Cutoff Wall

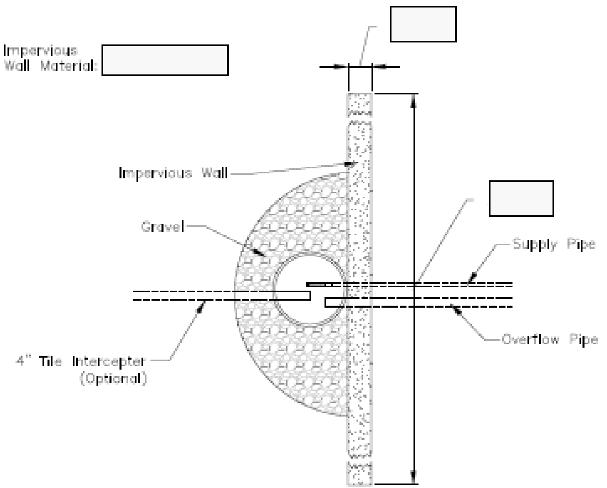


Wall and Spring Box Materials

Item	Size	Material
Spring Box		
Gravel		
Supply Pipe thru Wall		
Overflow Pipe thru Wall		
Impervious Wall		

Spring Box ABOVE Cutoff Wall

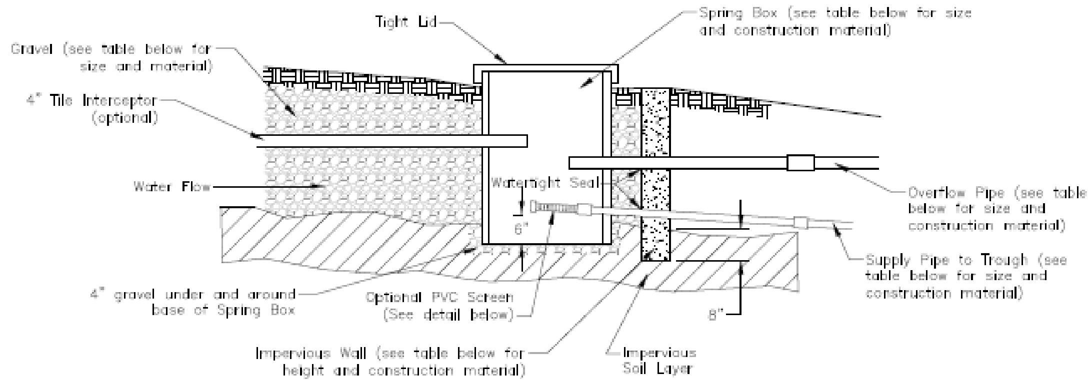
Spring Box Above Cutoff Wall



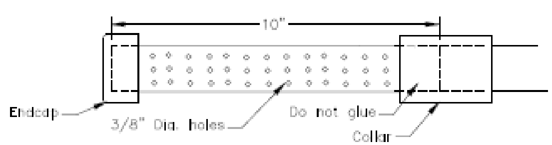
Note:
Impervious walls of other materials and shapes may be used. Hand draw the intended wall and dimension it accordingly. Walls are generally constructed of clay or concrete.

Plan View of Spring Box

Note:
If the spring box is not to be fenced to exclude livestock, a lid capable of supporting the weight of the farm's large livestock is required.



Section View of Spring Box



PVC Screen For Supply Pipe

Wall and Spring Box Materials		
Item	Size	Material
Spring Box		
Gravel		
Supply Pipe thru Wall		
Overflow Pipe thru Wall		
Impervious Wall		

Spring Dev. – Straight Wall

United States Department of Agriculture
Natural Resources Conservation Service

File No.
Drawing No.
Sheet of

United States Department of Agriculture

Subject:	ENG – Guidance for Spring Developments	**Date:**	January 10, 2017
To:	Anton Schaeffer, Area Engineer, Harrisonburg Sharyl Ogle, Area Engineer, Christiansburg Sean Kimmel, Area Engineer, Farmville Bill Widner, Area Engineer, Smithfield	**File Code:**	210-11

The purpose of this memorandum is to provide guidance on planning, designing and installing spring developments in accordance with Virginia Conservation Practice Standard (CPS) Spring Development (Code 574). This guidance also applies to the re-development of existing spring developments.

Springs can provide a reliable source of water in certain situations. However, there are environmentally sensitive areas that need to be examined when developing them. In order to maintain engineering quality and consistency, it is imperative that we are consistently using the same process and applying the same criteria. Below are items that need to be addressed for any spring development or re-development:

All bullets apply to all spring developments regardless of whether or not wetlands are involved.

- The Area Engineer and the Area Resource Soil Scientist will work together to provide assistance to field staff in the planning and design of all spring developments.
- A wetland determination is needed to verify if wetlands are present at or around the spring development location.
- Complete the Wetlands attachment (attached) to the CPA-52 to document the planned spring development. All requirements in the Wetland attachment must be met.
- Perform a water budget analysis to determine the flow rate of the spring and the demand for livestock water. The flow rate of the spring should be determined during the driest part of the year, typically in the summer months.
- No more than ¼ of the flow from the spring can be removed. This is to ensure that no more than ¼ of the original wetland is drained in accordance with the Food Security Act of 1985.
- Flow-through (cascading) systems will not be allowed. When feasible, automatic valves, float valves, etc. must be used to direct water (in excess of the amount for livestock needs) back to the spring head and through the entire wetland.

Streams

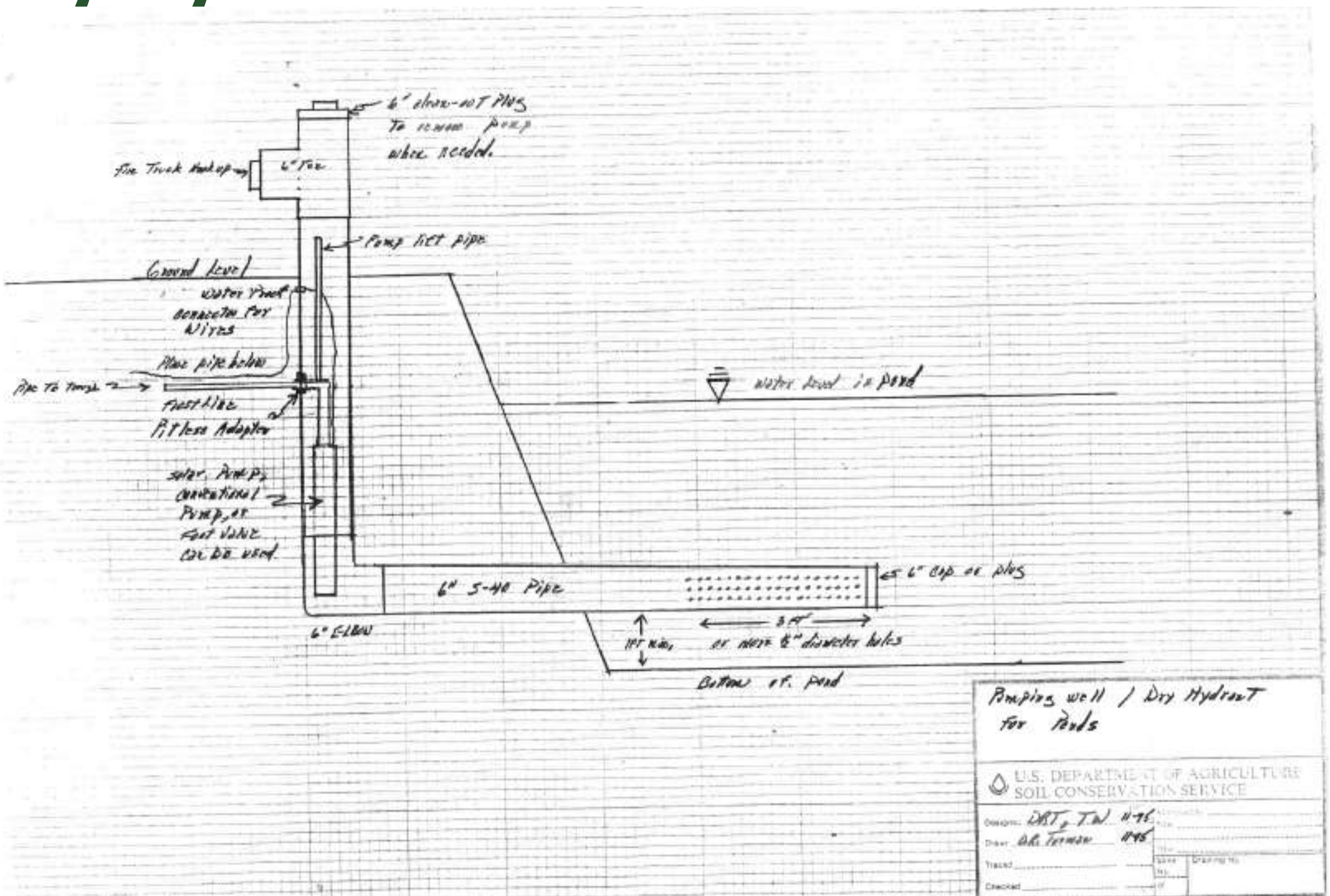
- Rarely used as watering sources, but in *limited* applications, they can be developed as a water source

- Advantages:
  - May be the only water source available
- Disadvantages:
  - Maintenance, maintenance, maintenance!
  - Usually only possible on the largest of streams (depth of water/reliability, sediment/channel issues)
  - Streams may dry up during the driest part of the year

Photo Credit: Virginia DGIF

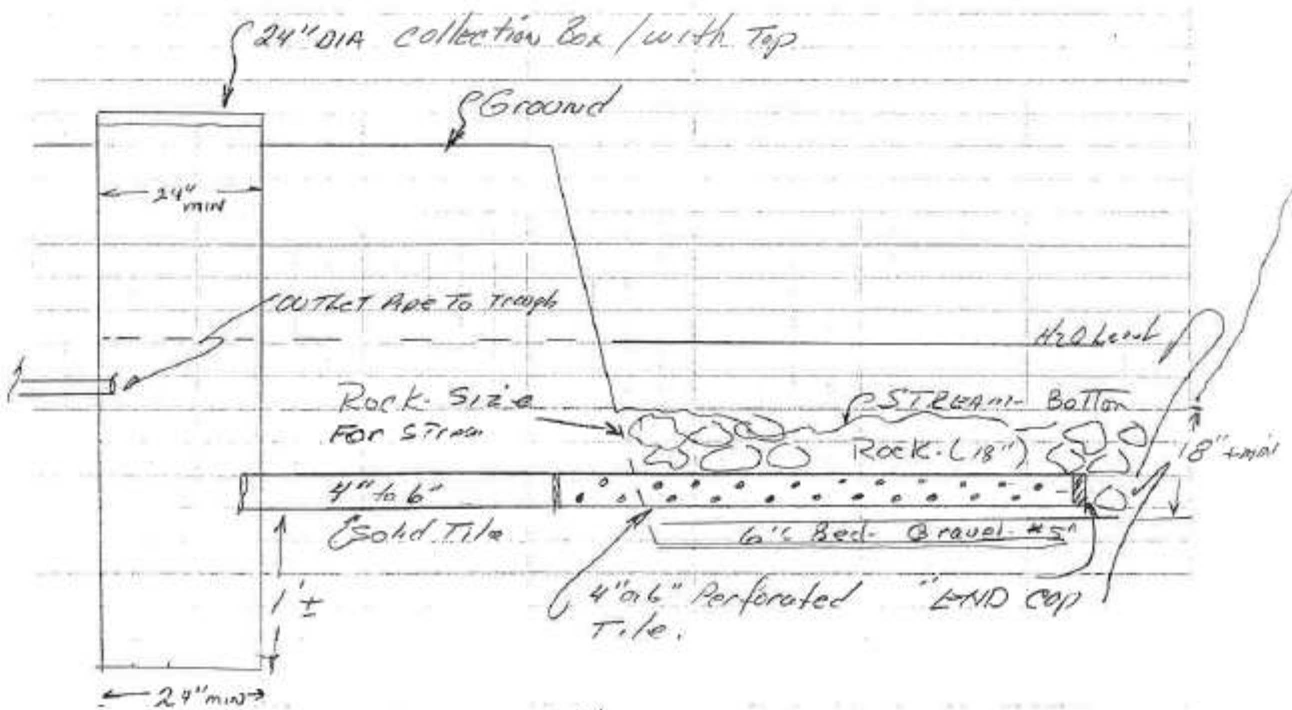
Would the Rose River (out front at Graves Mountain Lodge) make a good source for a dry hydrant or stream pick-up?

Dry Hydrant



6" clean-out Plug
To remove pump
when needed.
Fire Truck hookup
6" Tee
Pump lift pipe
Ground level
Water Proof
connector for
Wires
Place pipe below
Pipe To trough
Frost line
Pitless Adapter
solar pumps,
conventional
Pump, or
Foot valve
can be used.
6" ELBOW
6" S-40 Pipe
water level in pond
6" cap or plug
3 ft
or more ¼" diameter holes
Bottom of pond
Pumping well / Dry Hydrant
for Ponds
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Designed
Drawn
Traced
Checked

Stream Pick-Up



Note

1. Place Geotextile Fabric on Botton Stream and then place #57 For Bedding of Pipe
2. Need To place Rock Around pipe by Hand
3. Need To Check with C.O.E For Permit

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Normally a cow drinks by inserting its muzzle approximately 1 to 2 inches into the water with her head inclined at about a 60° angle (Figure 1).

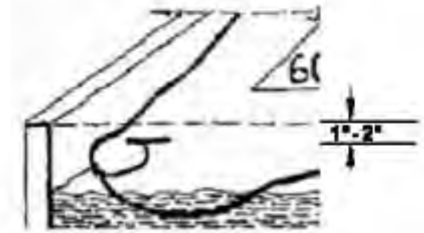
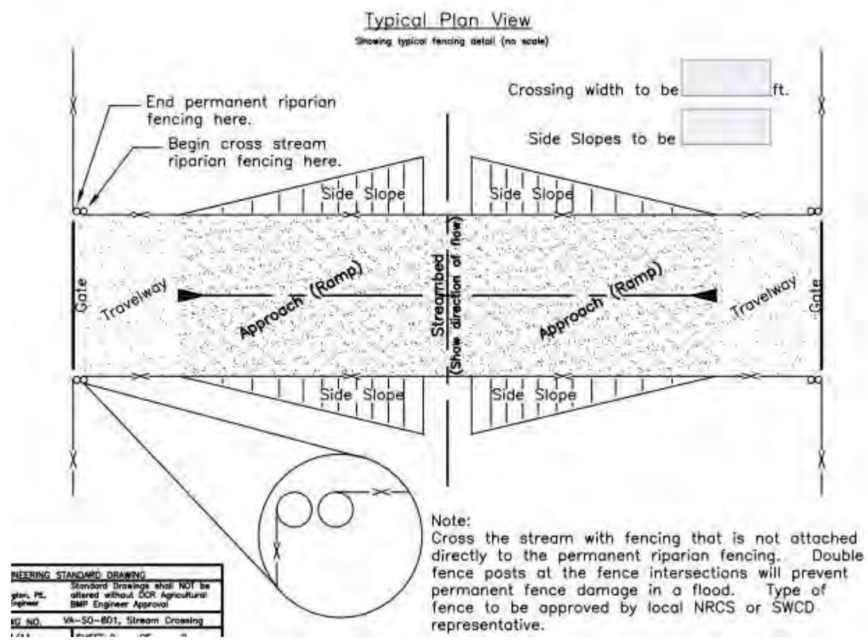


Figure 1. The position of cow muzzle during drinking. Metzner (CIGR, 1994)

Limited Access

- A hardened limited access into a body of water (stream, pond, or spring-fed stream) is generally a reliable least-cost alternative for remote sites
- Advantages:
  - All projects with "stream exclusion" would theoretically have a water source that could become a limited access (unless intermittent)
  - "foolproof" water source (not dependent on power)
- Disadvantages:
  - Require maintenance (may be damaged during heavy stream flows)
  - Less water quality benefit than total stream exclusion
  - Cattle may push each other around inside the limited access



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See CPS 614 Watering Facility:

Watering Ramps

Where livestock or wildlife will drink directly from a pond or stream, use a watering ramp to provide a stabilized access to the water. Evaluate the existing and proposed fences, grazing patterns, shoreline slope, and water depth when choosing the optimum location for the ramp.

Width. Make the ramp wide enough to accommodate the expected usage but not less than 12 feet.

Length. Extend the ramp into the stream or pond far enough to achieve the desired depth during the driest times of the year.

Surface drainage. Divert surface runoff from the approach to the ramp.

Slope. Make the slope of the watering ramp consistent with planned animal usage but not steeper than 3:1.

Side slopes. Make all side slope cuts and fills stable for the soil materials on the site. Make the side slopes of cuts or fills in soil materials no steeper than 2 horizontal to 1 vertical (2:1). Make rock cuts or fills no steeper than 1.5 horizontal to 1 vertical (1.5:1).

Foundation. Where necessary, prepare the foundation by removal and disposal of material that are not adequate to support the design loads.

Surface material. Use the criteria in NRCS CPS *Heavy Use Area Protection (Code 561)* to design the ramp surface. The selected material must be of adequate quality to withstand underwater conditions.

Access. Use fencing or other barriers to delineate the boundaries of the ramp. Use Virginia NRCS CPS *Fence (Code 382)* for the design and construction of a fence. Barriers must be of sufficient size, strength, and quality to meet the intended use of the facility. Do not use electric fencing in the area immediately adjacent to the water.

Ramps in Streams. Use the criteria in Virginia NRCS CPS *Stream Crossing (Code 578)* for the design and construction of a ford crossing except as noted above.

Locate the watering ramp so that it does not impede the movement of aquatic organisms in the stream.

Ramps in Ponds. A minimum water depth of 3 feet, measured from the designed permanent water level, is recommended. Where the pond depth is greater than 3 feet at the ramp location, it may be necessary to excavate the ramp into the pond bank to provide a stable base at the lower end. Extend the ramp a minimum of 0.5 feet above the designed permanent water level.

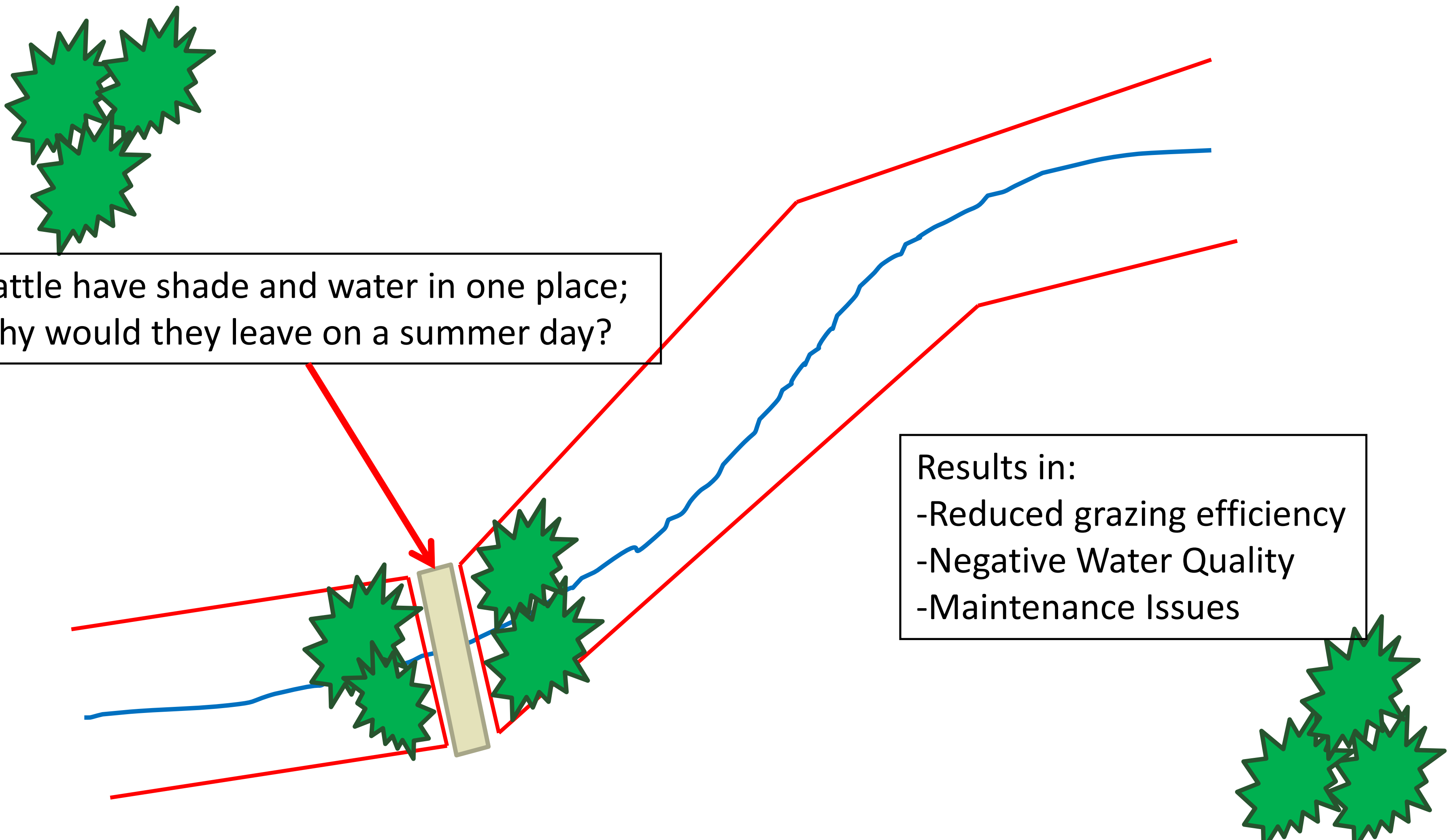
6:1 maximum if also serving as a stream crossing. 6:1 or flatter recommended.

From CPS 614:

Avoid locating watering ramps in shady places where possible.

Limited Access in Shade:

Cattle have shade and water in one place; why would they leave on a summer day?



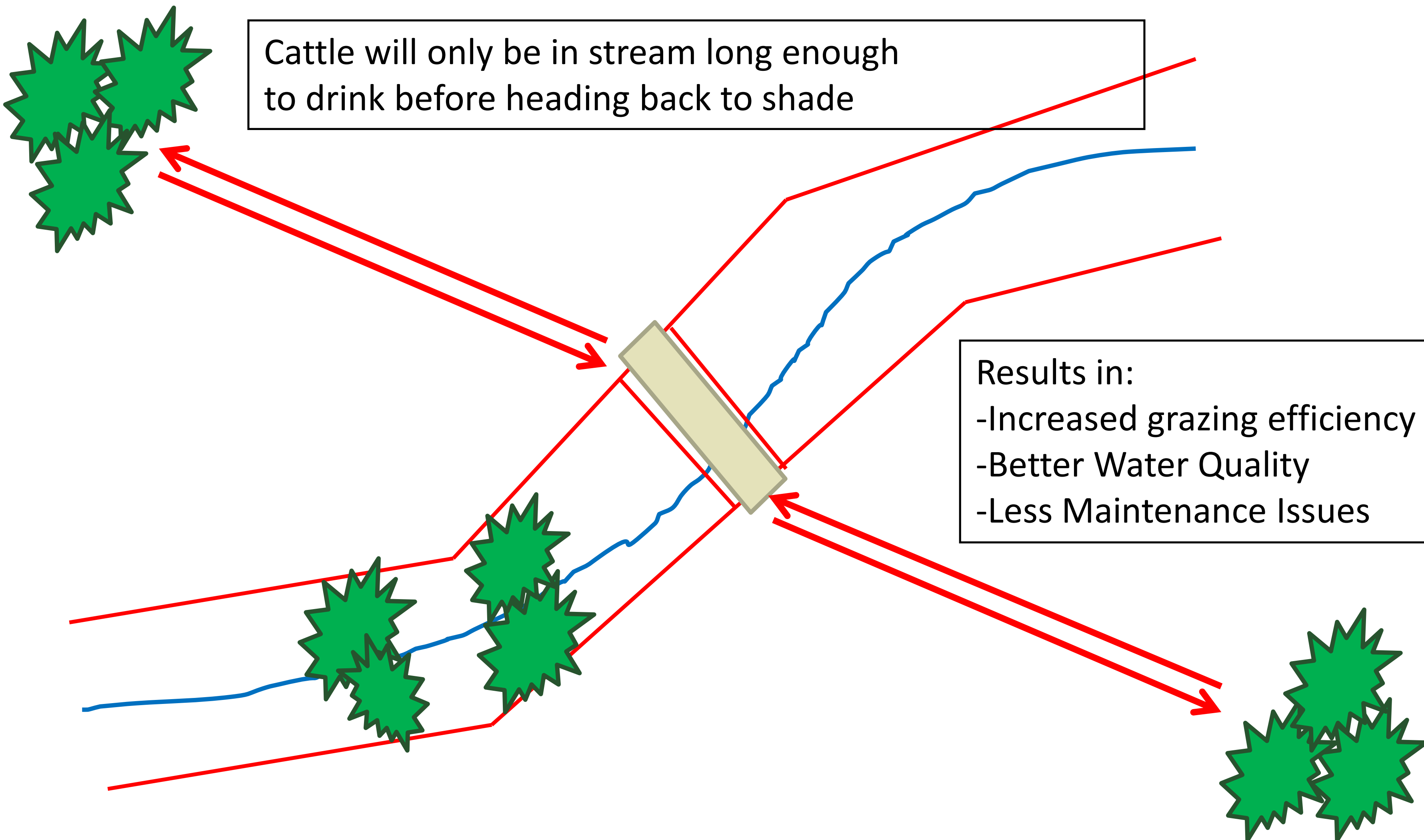
Results in:

-Reduced grazing efficiency

-Negative Water Quality

-Maintenance Issues

Limited Access Outside of Shade:



From CPS 614:

It is difficult to put a fence in the middle of a stream. Where possible, extend the fence completely across the stream. Swinging gates can be used to restrict animal movement.

Water Quality Impact?

NOTE: This particular limited access was NOT installed for cost-share.

Site Inventory: Gathering Information

- What water sources do the livestock currently have access to?
- What water sources are also available (or could be created)?
- What is the yield of existing water sources? Measure the source flow rate.
- Where is electricity available?
  - Pumps need power!
- Is there any existing infrastructure that can be tapped into?
  - Housing for pressure tank (if applicable)
  - Existing pipeline (what length, type, diameter, depth?)
  - Etc.
- Where do watering facilities need to be provided?
- What type of & how many livestock need water?
  - Is there more than one group?

Virginia Department of Conservation & Recreation

Inventory Checklist

- You can take this checklist with you on site visits
- Found on Page A-I of the VA NRCS Watering Facility Design Note (DN-614)

DN-614-A-1

Watering System Resource Inventory Checklist

Client: ____________ Assisted by: ____________

Tract: ____________ Date: ____________

County: ____________

A. Livestock to be Served:

Type of Animal	Number of Animals	Average Age	Average Weight	Maximum Daily Water Consumption/Animal (gpd)

How many times a day do the animals drink? ____________

Time needed to water herd: ____________

Notes on grazing season and system: ____________

Trough type preference: ____________

B. Water Resources:

Water Source (well, spring, pond, stream, public)	Estimated Yield (gpm)	Comments on Quality	Comments on Reliability

C. Energy Resources

Energy Source (utility-supplied electricity, wind, solar, other)	Comments on Preference, Accessibility, or Practicality

D. Soil Resources:

Comments on wetlands, rock outcrops, abrasive soils, soil depth, or other soil features influencing pipeline or trough placement. Use this space, Soil Investigation Form 538, or note in the field book.

E. Site Limitations

Diameter and material of any existing pipeline: ____________

Note utilities, property lines, or other areas to avoid in a sketch in the field book or back of this page. Emphasize the importance of contacting Miss Utility at 811.

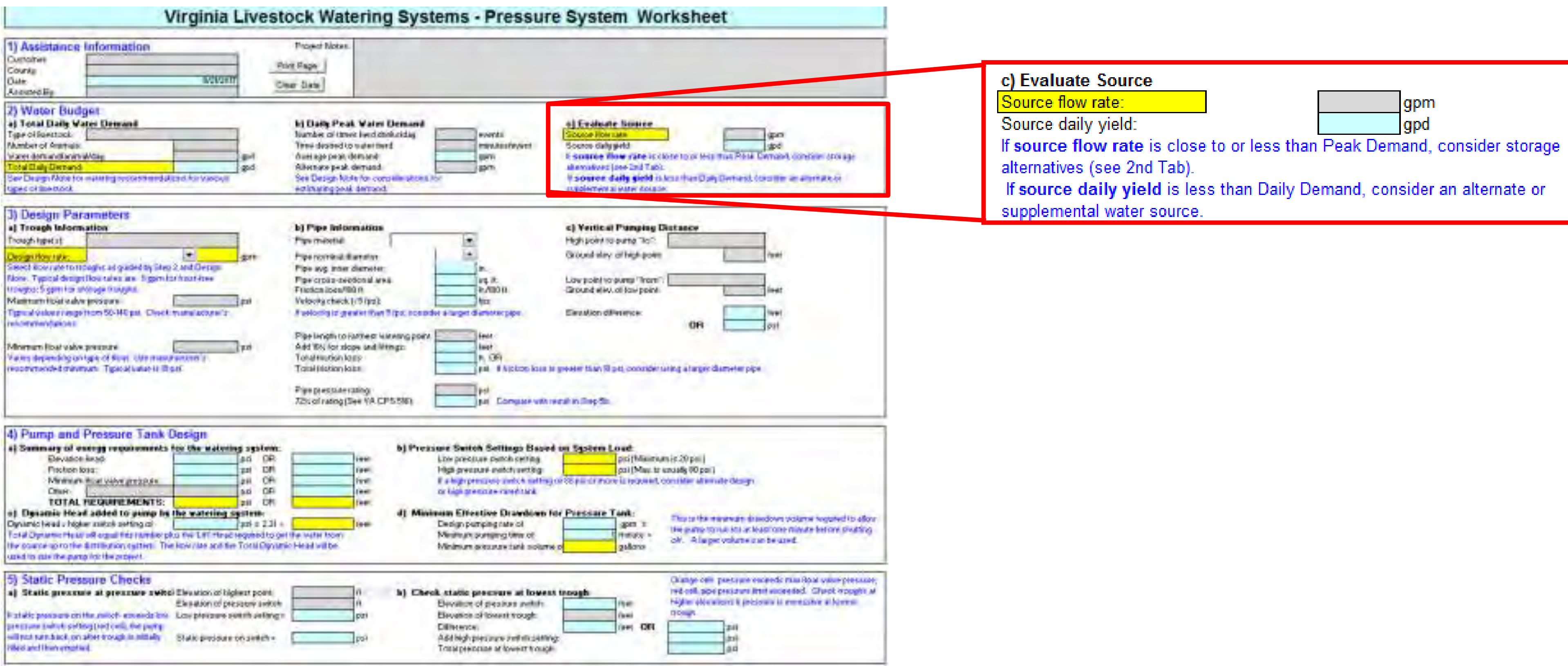
Site Inventory: Specifics for Water Sources

- Wells:
  - What is the yield? What is the pumping rate? (More to come.)
  - Has it ever gone dry?
- Ponds:
  - Is the dam in good condition?
  - Is the principal spillway in good condition?
  - Does the water level fluctuate throughout the year?
  - Is there a significant influx of sediment into the pond? (Look at the inflow areas, color of water)
- Springs
  - Has the spring ever gone dry?
  - Is the spring a true spring (point source) or a seep?
  - Are you at the head of the spring (where it comes out of the ground)?
- Streams
  - Are the banks and bed stable?
  - Are there consistently deep pools?
  - Is there a significant sediment load in the stream?

Is there anything in the contributing drainage area that would make the water unsafe for livestock consumption?

Source Flow Rate

- Measured in gallons per minute (gpm)
- Will be entered into *Livestock Watering Systems Worksheet* to see if the source produces enough water in a 24-hour period to be able to serve as the livestock water source



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Measuring the Source Flow Rate

- A container of known volume and a pipe are indispensable tools!
  - As simple as a gallon milk jug and piece of 2”x3” gutter downspout
- Should be measured during the dry part of the year when the water table is at its lowest (usually August)
- Landowners who have been long-time residents of their properties may have a good feel for the reliability of a given water source, but have they measured it during the “dog days” of summer?
- Springs: Remember, we are only allowed to used 25% of the source daily yield
- Ponds: Measure the outflow from the pond when the pond is at its normal water level and long enough after a storm event that you are only measuring its base flow
- Streams: Stream pickups or dry hydrants require significant base flow
- If all the livestock currently rely on a given water source exclusively, it may be sufficient (but not always – especially if we can only utilize 25% of it)

1. Form dam to funnel entire flow into a collection pipe

2. Begin collecting water in a container of known volume

3. Time how long it takes for the container to fill

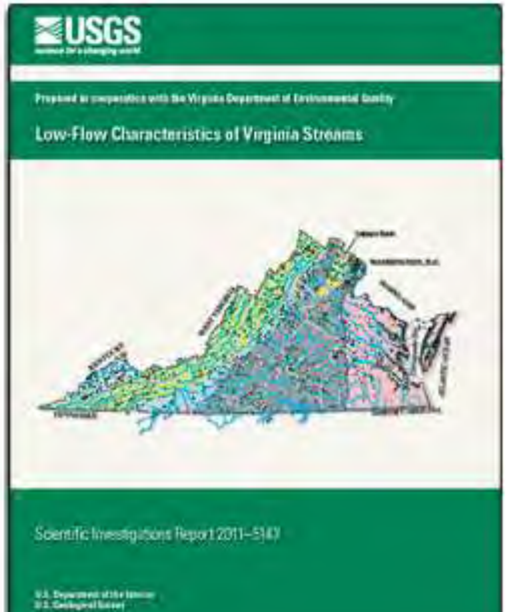
- **Example:** It takes 15 seconds to fill a one-gallon container.

$$\frac{1 \text{ gallon}}{15 \text{ seconds}} \times \frac{60 \text{ seconds}}{1 \text{ minute}} = 4 \text{ gallons per minute}$$

Measuring Flow Rate in Channels

- Q = AV
- USGS StreamStats: “Low Flows Region Statistics”
  - Compare rough estimate of current flow level vs. “Low Flows”

Low Flows Region Statistics				
Statistic	Value	Unit	Prediction Error (percent)	Equivalent years of record
M1D1 11Y	0.21	ft3/s	110	
M1D1 25Y	0.13	ft3/s	130	
M1D1 43Y	0.0926	ft3/s	160	
M1D1 67Y	0.0658	ft3/s	180	
M1D2Y	0.0458	ft3/s	210	
M4D1 11Y	0.47	ft3/s	130	
M4D1 25Y	0.35	ft3/s	150	
M4D1 43Y	0.27	ft3/s	170	
M4D1 67Y	0.21	ft3/s	190	



Wells: *Yield* vs. *Pumping Rate*

- The *yield* of a well and the *pumping rate* out of the well are two different things
- Yield: natural recharge rate of the well
  - Determined during drilling
  - Found on the "Water Well Completion Report"
  - Ask local Health Department office for copy of the report if landowner does not remember the yield
- Pumping rate: the rate that water is pumped *from* the well
  - May be greater than, equal to, or less than the yield!
  - Concern: We don't want to pump the well dry (bad for pump, bad for livestock)

Pumping Rate vs. Yield	Okay?
Pumping Rate < Yield	Yes
Pumping Rate = Yield	Yes (assuming there is some storage)
Pumping Rate > Yield	??? (need to perform calculations)

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How do we determine the yield?

- Landowner's Memory or Records
- May be recorded on the cap of the well
- Health Department
- Project Records (if extending a cost-shared project)
- Are you adding to an existing system that already serves the livestock in question? (i.e. not adding any demand to the system)
- Well yield test:

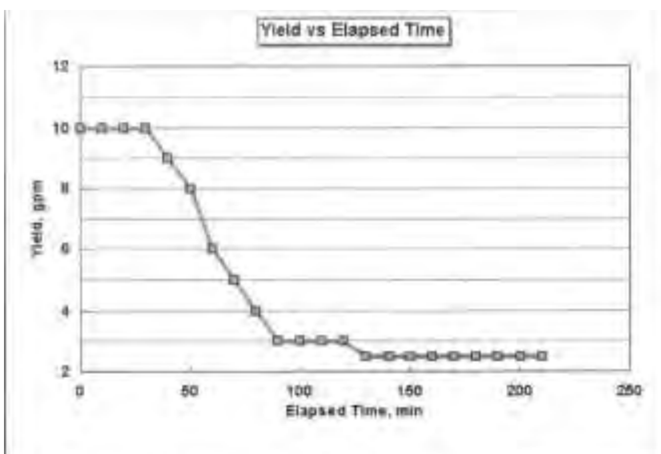

Figure 5. Yield versus elapsed time during the pump test of the water well

Form GW-2
Revised 7/1/2015
Page 2 of 4

COMMONWEALTH OF VIRGINIA
UNIFORM WATER WELL COMPLETION REPORT

DEQ Well #
USGS Local #
VDH HDIN #
VDH PWSID #

Well designation, Name or Number:

5. Disinfection
Well Disinfected: ☐ Yes ☐ No | Date:

6. Abandonment (*When abandoning a well, Sections 1 thru 6 are required to be completed)
Date Started: | Date Completed: | Type Rig:
Static Water Level (unpumped level measured): ft.
Casing Size (I.D.) and Materials: | Casing Pulled: ☐ Yes ☐ No ☐ Uncased Well
Depth of Fill: | Type and Source of Fill:
Grout: From to Type: From to Type:
Method of permanently marking location:

7. Pump Test
Static Water Level (unpumped level measured): ft.
Date: | Method (Check One): ☐ Water Tape ☐ Airline ☐ Transducer ☐ Other
Stabilized measured pumping water level: ft.
Date: | Method (Check One): ☐ Top of Well ☐ Top of Casing ☐ Surface Level
Test Pump Intake Depth: | Stabilized Yield: gpm after hours
Natural Flow: ☐ Yes ☐ No | Flow Rate gpm

8. Pump Data
Type: | Motor HP:
Production Pump Intake Depth: ft | Rated Capacity: gpm at ft TDH

9. Geologic Information
Formation: | Type Logs:
Lithology: | Cuttings:
Province: | Aquifer Test Performed:
Geologic Map Used:
Water Quality Results Attached: Yes ☐ No ☐

Comments:

Water Budgets

Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:		Project Notes:
County:		Print Page
Date:	8/17/2017	Clear Data
Assisted By:		

2) Water Budget

a) Total Daily Water Demand

Type of livestock:		
Number of Animals:		
Water demand/animal/day:		gpd
Total Daily Demand:		gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

Number of times herd drinks/day		events
Time desired to water herd:		minutes/event
Average peak demand:		gpm
Alternate peak demand:		gpm

See Design Note for considerations for estimating peak demand.

c) Evaluate Source

Source flow rate:		gpm
Source daily yield:		gpd

If **source flow rate** is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).

If **source daily yield** is less than Daily Demand, consider an alternate or supplemental water source.

- First step in designing any system: Is the water source adequate?
- Evaluate the source on a 24-hour basis: Does the source produce enough water in 24 hours to meet the livestock requirements in that 24-hour period?
- Compare “Total Daily Demand” vs. “Source Daily Yield”
- “Source Daily Yield” MUST be greater than “Total Daily Demand”

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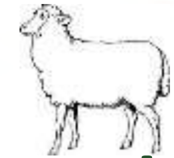


Water Budgets: Determining Daily Demand

- See DN-614, A-2
- If utilizing existing wells, be sure to account for the other demands on the well!
  - ESPECIALLY Washwater for Dairies
  - Household use
- A well may be adequate for its current demands, but adding livestock may be beyond its capacity

Water Quantity Guidelines for Various Livestock

Type of Livestock		Estimated Daily Water Consumption per Animal (gallons per day)	References
Cattle	Beef adult	15	VA USDA-NRCS Introduction to Conservation Engineering
		8-12	Structures and Environment Handbook (MWPS, 1987)
	Calf	5	VA USDA-NRCS Introduction to Conservation Engineering
		1 to 1.5 gal/100 lb body weight	Structures and Environment Handbook (MWPS, 1987)
	Beef cow/calf pair	20	VA USDA-NRCS Introduction to Conservation Engineering
		8-18	National Range and Pasture Handbook (USDA-NRCS, 1997)
	Growing steers/ pregnant heifers	6-18	National Range and Pasture Handbook (USDA-NRCS, 1997)
	Heifer	10-15	Structures and Environment Handbook (MWPS, 1987)
	Milking cow	30	VA USDA-NRCS Introduction to Conservation Engineering
		10-30	National Range and Pasture Handbook (USDA-NRCS, 1997)
		35-45	Structures and Environment Handbook (MWPS, 1987)
	Dry cow	20	VA USDA-NRCS Introduction to Conservation Engineering
		20-30	Structures and Environment Handbook (MWPS, 1987)
Swine	Swine	4	VA USDA-NRCS Introduction to Conservation Engineering
	Finishing swine	3-5	Structures and Environment Handbook (MWPS, 1987)
	Nursery	1	Structures and Environment Handbook (MWPS, 1987)
	Gestating sow	6	Structures and Environment Handbook (MWPS, 1987)
	Sow and litter	8	Structures and Environment Handbook (MWPS, 1987)
Other Grazing Mammals	Horse	12	Structures and Environment Handbook (MWPS, 1987); VA USDA-NRCS Introduction to Conservation Engineering
		8-12	National Range and Pasture Handbook (USDA-NRCS, 1997)
	Llama	4	VA USDA-NRCS Introduction to Conservation Engineering
	Sheep, Goat	3	VA USDA-NRCS Introduction to Conservation Engineering
		2	Structures and Environment Handbook (MWPS, 1987)
		1-4	National Range and Pasture Handbook (USDA-NRCS, 1997)
Poultry	100 chicken layers	9	Structures and Environment Handbook (MWPS, 1987)
	100 turkeys	15	Structures and Environment Handbook (MWPS, 1987)
General	1000 lb live weight (AU)	30	Indiana USDA-NRCS IN-ENG-Pipeline-4-08.xls

Working Backwards:

The water source needs to be evaluated to make sure it can meet the daily water demand for the herd. For example, 100 beef cow-calf pairs consuming a total of 2000 gallons per day require a water source yielding more than 1.4 gallons per minute (with continuous gravity flow or a pump running 24 hours a day):

$$Minimum\ required\ source\ flow\ rate = \frac{daily\ demand\ (gal/day)}{source\ flow\ duration\ \left(\frac{hrs}{day}\right) \times\ 60min/hr}$$

$$= \frac{2000\ gal/day}{24\frac{hrs}{day} \times\ 60\ min/hr} = 1.4\ gpm$$

- Note: If the source is a spring development, we can only use 25% of the flow, so the minimum required source flow rate for this example would be 1.4gpm / 0.25 = 5.6gpm.

Water Budgets

- The water budget is analogous to a money budget

Water	Money
Source Daily Yield	Salary/Regular Deposits
Daily Demand	Expenses
Storage	Bank Account

- Difference: Time Scale (Daily vs. Monthly)
- You can’t spend more money than you earn (without credit cards), no matter how much money your bank account *can* hold
- Similarly, you can’t use more water than the source produces, no matter how much storage you have
  - A reservoir alone will not solve the source daily yield < daily demand problem!

Options if Source Daily Yield < Daily Demand

If daily yield is less than daily demand, then an alternate or a supplemental source of water will need to be used or the number of animals served will need to be reduced.

- Is there another water source that can be used instead?
- Is there another water source that can be tied in so that both water sources contribute?
- Can a limited access to the stream also be installed?

Example: Inadequate Well

2) Water Budget

a) Total Daily Water Demand

Type of livestock:	beef cattle	
Number of Animals:	50	
Water demand/animal/day:	20	gpd
Total Daily Demand:	1000	gpd

See Design Note for watering recommendations for various types of livestock.

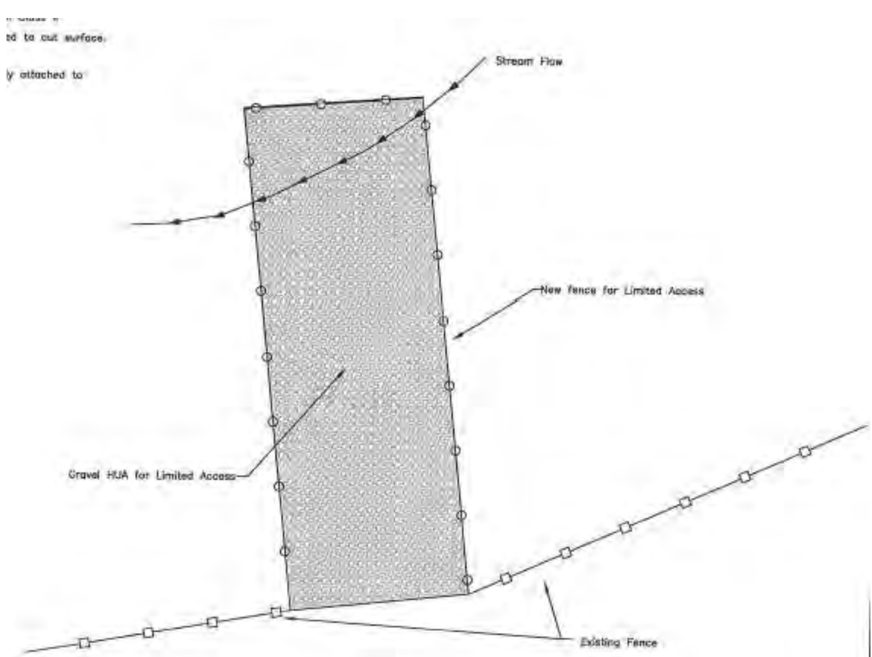
c) Evaluate Source

Source flow rate:	0.5	gpm
Source daily yield:	720	gpd

If **source flow rate** is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).

If **source daily yield** is less than Daily Demand, consider an alternate or supplemental water source.

- Can a limited access to the stream also be installed?



Also, ensure pump has dry run protection.

Two-pronged approach to source adequacy:

- Once you've determined that the source produces enough water to meet the total DAILY demand, you have to determine if it will be able to meet the PEAK demand of the livestock
  - Don't want to run out of water DURING a drinking event

Adequate Source?

1. Yield (Source Flow Rate)

2. Ability to meet peak demand

-Source may be strong enough alone

-If not, STORAGE

What is the peak demand?

- Caused by the “herd” drinking habits of cattle
- All come to drink at the same time
- Need to have adequate recharge available to the trough
- Rules of Thumb:
  - 2gpm per hole of frost-free trough
  - 5gpm for storage troughs

Cattle Watering Behavior Facts

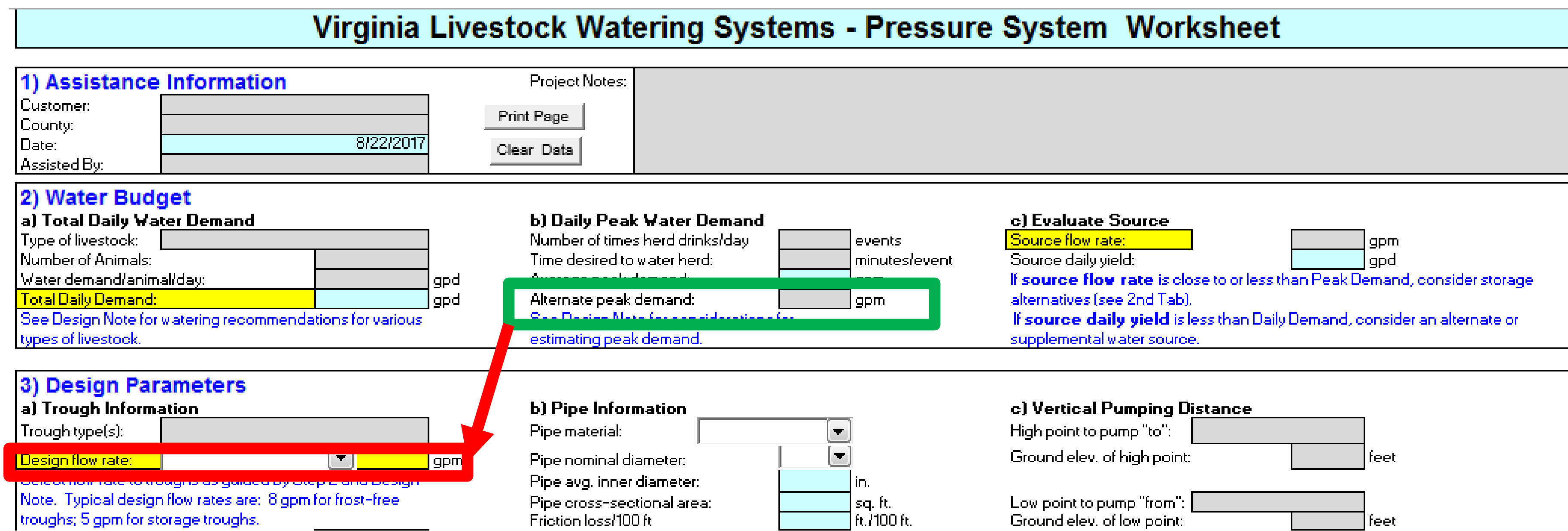
- They drink 1 to 2 gallons per minute
- They drink for 2 to 3 minutes per drinking event
- So they can drink 6 gallons per drinking event per animal on 'high side'
- 2 to 5 drinking events per day - MU

Slide borrowed from "Solar Powered Water Systems for Grazing Operations" webinar presentation by Kevin Ogles, Grazing Lands Specialist, USDA-NRCS

Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

Important Distinction:

- DN614-I-2: The daily water demand will determine if a water source is adequate, while peak water demand governs sizing of system components.
  - Pipeline size, pumping rate (if a pump is used), etc.
- **Peak Demand → Design Flow Rate**



Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:
County:
Date: 8/22/2017
Assisted By:

Project Notes:

Print Page

Clear Data

2) Water Budget

a) Total Daily Water Demand

Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd
See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

Number of times herd drinks/day events
Time desired to water herd: minutes/event
Alternate peak demand: gpm
See Design Note for considerations for estimating peak demand.

c) Evaluate Source

Source flow rate: gpm
Source daily yield: gpd
If **source flow rate** is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).
If **source daily yield** is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

a) Trough Information

Trough type(s):
Design flow rate: gpm
Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

b) Pipe Information

Pipe material:
Pipe nominal diameter:
Pipe avg. inner diameter: in.
Pipe cross-sectional area: sq. ft.
Friction loss/100 ft ft./100 ft.

c) Vertical Pumping Distance

High point to pump "to":
Ground elev. of high point: feet
Low point to pump "from":
Ground elev. of low point: feet

Example: Is extra storage needed for this project?

Water Source: Well, Yield = 3gpm

Troughs: 4-hole frost-free

2) Water Budget

a) Total Daily Water Demand

Type of livestock:	Cow/Calf Pairs	
Number of Animals:	65	
Water demand/animal/day:	25	gpd
Total Daily Demand:	1625	gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

Number of times herd drinks/day	3	events
Time desired to water herd:	60	minutes/event
Average peak demand:	9.0	gpm
Alternate peak demand:	8	gpm

See Design Note for considerations for estimating peak demand.

c) Evaluate Source

Source flow rate:	3	gpm
Source daily yield:	4320	gpd

If **source flow rate** is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).

If **source daily yield** is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

a) Trough Information

Trough type(s):		4-Hole Frost-Free	
Design flow rate:	Alternate Peak Demand	8.0	gpm

Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

b) Pipe Information

Pipe material:		
Pipe nominal diameter:		
Pipe avg. inner diameter:		in.
Pipe cross-sectional area:		sq. ft.
Friction loss/100 ft		ft /100 ft

c) Vertical Pumping Distance

High point to pump "to":		
Ground elev. of high point:		feet
Low point to pump "from":		
Ground elev. of low point:		feet

- Storage *might* be needed, since we are planning to pump at 8gpm to meet the peak demand, but the well yield is only 3gpm
- Need more info on the well to determine how much water is stored in the well

Example: Is extra storage needed for this project?

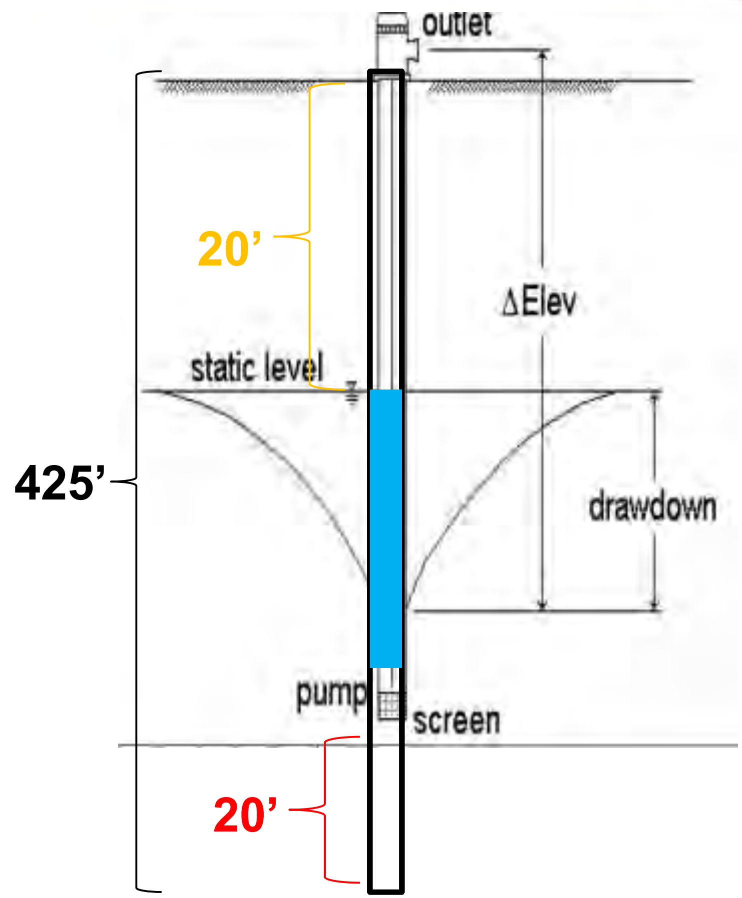
Additional Well Info:

Bore-Hole Depth: **425’**

Diameter: **6”**

Static Water Level: **20’**

Planned Pump Height: **20’** from bottom



How much water is stored in this well?

Depth of Water Available to Pump =

Well Depth – Static Water Level – Pump Height – Pump Length

425’ - 20’ - 20’ - 3’ = **382’** of water

DN-614-B-4

Water Storage in Well Casing or Pipe

Water storage volume in the well casing may be significant enough to justify using the source when peak demand is close to the supply rate. Storage per foot of depth is tabulated below for well diameters ranging from 2 inches to 9 feet.

Well Diameter	Storage per Foot of Depth (gallons)
2"	0.163
3"	0.367
4"	0.653
5"	1.02
6"	1.47
8"	2.61
10"	4.08
1'	5.87
2'	23.50
3'	52.87
4'	94.00
5'	146.87
7'	287.86
9'	475.86

382ft. X 1.47gal/ft. = **561**gal stored in well

2) Water Budget

a) Total Daily Water Demand

Type of livestock:	Cow/Calf Pairs	
Number of Animals:	65	
Water demand/animal/day:	25	gpd
Total Daily Demand:	1625	gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

Number of times herd drinks/day	3	events
Time desired to water herd:	60	minutes/event
Average peak demand:	9.0	gpm
Alternate peak demand:	8	gpm

See Design Note for considerations for estimating peak demand.

1625gpd / 3 events = 545 gallons per event

There is enough water stored for one drinking event (especially considering we haven't factored in 3gpm recharge *during* the event), but what about subsequent events? **Will the well recover in time?**

Well Budget: 3 events

Water Well Budget									
Assumptions:									
Recharge Rate (Well Yield): 3gpm									
382ft. of storage = 561 gallons of storage in the well									
65 cow/calf pairs @ 25gpd = 1625 gpd									
1625gpd / 3 events = 545 gal/event @ 8gpm delivery rate = 68min/event									
Description	Water in Well (gal)	Time Start	Time Stop	Total Time (min)	Delivery Rate (*From* Well, gal)	Recharge Rate (To Well, gal)	Net Per Min (gal)	Total Net (gal)	Water in Well (gal)
Drinking Event 1	561	9:00	10:08	68	-8	3	-5	-340	221
Recharge	221	10:08	12:00	112	0	3	3	336	557
Drinking Event 2	557	12:00	13:08	68	-8	3	-5	-340	217
Recharge	217	13:08	15:00	112	0	3	3	336	553
Drinking Event 3	553	15:00	16:08	68	-8	3	-5	-340	213
Recharge	213	16:08	18:04	116	0	3	3	348	561

The well maintains 213+ gallons in storage, and recovers by 6:04pm. There is no need for additional storage.

Well Budget: 2 events

NOTE: Assuming *fewer* drinking events is generally *more* conservative and will help ensure that enough storage is available. Animal behavior is difficult to predict!

Water Well Budget

Assumptions:

Recharge Rate (Well Yield): 3gpm

382ft. Of storage = 561 gallons of storage in the well

65 cow/calf pairs @ 25gpd = 1625 gpd

1625gpd / 2 events = 815 gal/event @ 8gpm delivery rate = 102min/event

Description	Water in Well (gal)	Time Start	Time Stop	Total Time (min)	Delivery Rate (*From* Well, gal)	Recharge Rate (*To* Well, gal)	Net Per Min (gal)	Total Net (gal)	Water in Well (gal)	
Drinking Event 1	561	9:00	10:42	102	-8	3	-5	-510	51	
Recharge	51	10:42	2:00	198	0	3	3	594	645	*Cap at 561
Drinking Event 2	561	14:00	15:42	102	-8	3	-5	-510	51	
Recharge	51	15:42	18:32	170	0	3	3	510	561	

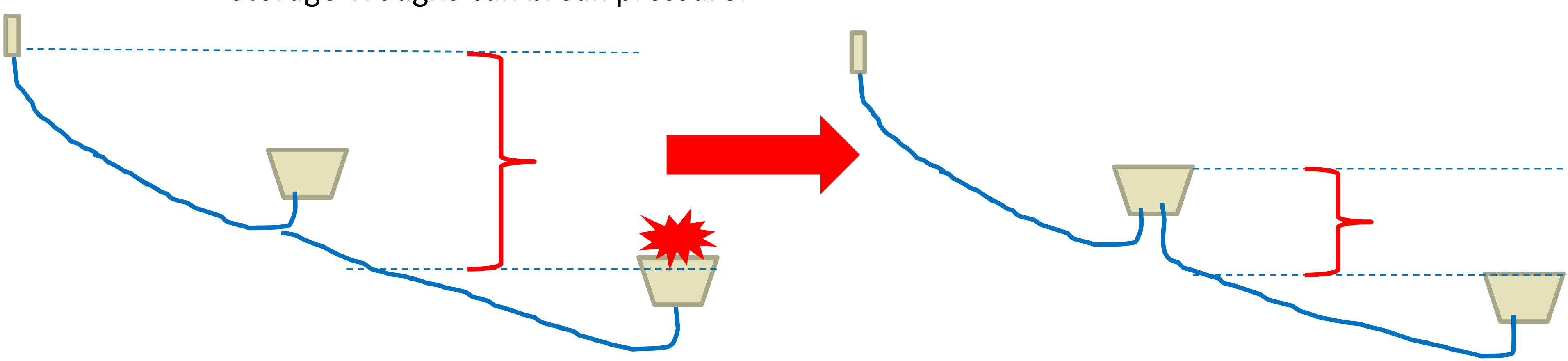
The well maintains 51+ gallons in storage, and recovers by 6:32pm. There is no need for additional storage.

Storage

- If your peak demand cannot be met by the source, here is where storage becomes critical!
- A reservoir (or storage in the well) is needed when the source *daily* yield is adequate, but the source recharge rate alone is not adequate to “keep up” with the livestock when they come to drink

Reservoirs

- Storage for Peak Demand
  - Low-Yielding Source
  - Pumps that cannot meet peak demand (e.g. solar, hydraulic ram)
- Sediment Settling (e.g. for spring developments)
- NOT purely for pressure reduction (there are more cost-effective ways of reducing pressure)
  - Pressure Reducing Valves
  - Storage Troughs can break pressure:



Make sure reservoirs are bedded level and with a granular backfill to keep them from settling. Recommend plumbing with a galvanized pipe out to 10’ from the reservoir to keep PVC from shearing off if it settles. Outlet pipe must be graded to drain.

Water Delivery

- How will the water get from the source or reservoir to the point of use?
- Three principle methods:
  - Gravity
  - Pressure (Pumps)
  - Hybrid (Pressure/Pump + Gravity)

Gravity

- Rely on gravity to move the water through the system to watering facility
- Static pressure increases at 1psi per every 2.31feet of fall
- Pressure resets to zero when the system is open to the atmosphere

Maximum flow rate is computed based on equations from EFH Chapter 3:

$$Q_{max}\,(cfs) = A \times \sqrt{\frac{2gH}{K_p L}} \times \left(450\ \frac{gpm}{cfs}\right) \times F$$

where:

Q_{max} = maximum flow rate the pipe can carry (cfs)
A = cross-sectional area of the inside of the pipe (ft^2)
g = gravitational constant = 32.2 ft/s^2
H = elevation head (ft)
K_p = head loss coefficient
L = pipe length (ft)
450 = unit conversion factor
F = float valve efficiency factor = 0.8 with float valves; = 1 without float valves.

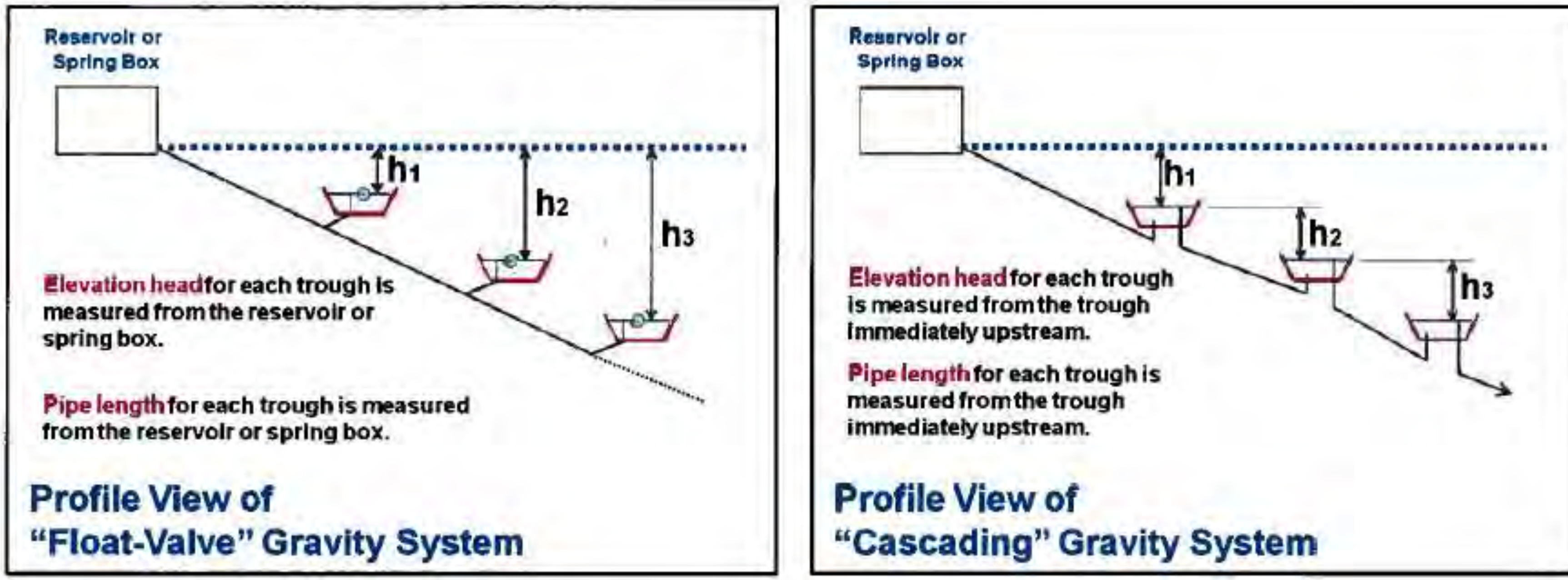


Figure I-5. Float Valve vs. Cascading Trough Arrangements.

- In gravity systems, troughs must be located far enough below the water source to generate enough pressure for float valves to operate efficiently
- Frost-Free Troughs:

  5psi min. x 2.31ft/psi = 11.55ft. between source and float valve

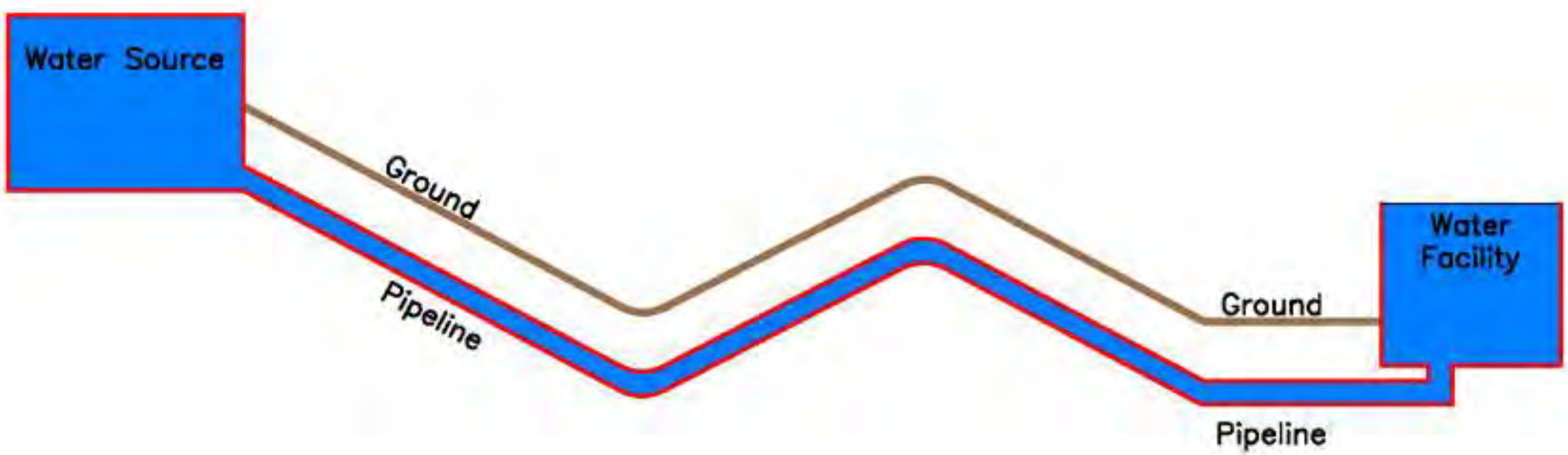
  → Need 14ft. between source and ground at trough

Air Locks

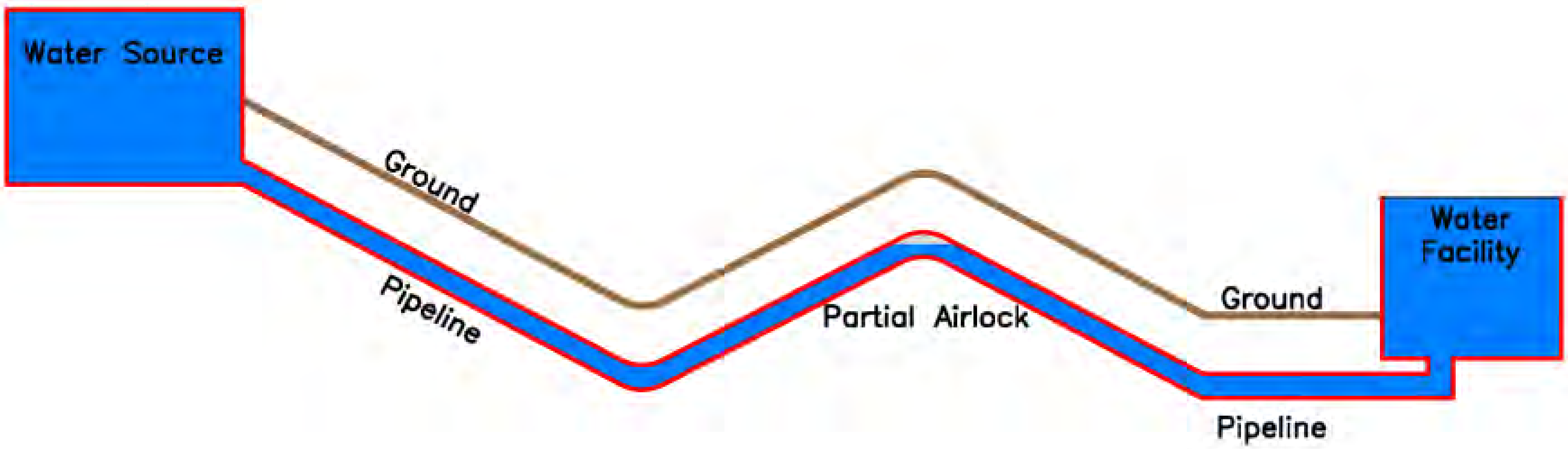
- One of the major considerations in installing gravity pipelines is air-locking.
- Air locks can be partial or total; that is, they can either completely block flow, or they can partially block the flow, reducing the desired flow rate. The following sketches illustrate total and partial air locks:

Note: Air Lock slides borrowed from Virginia NRCS.

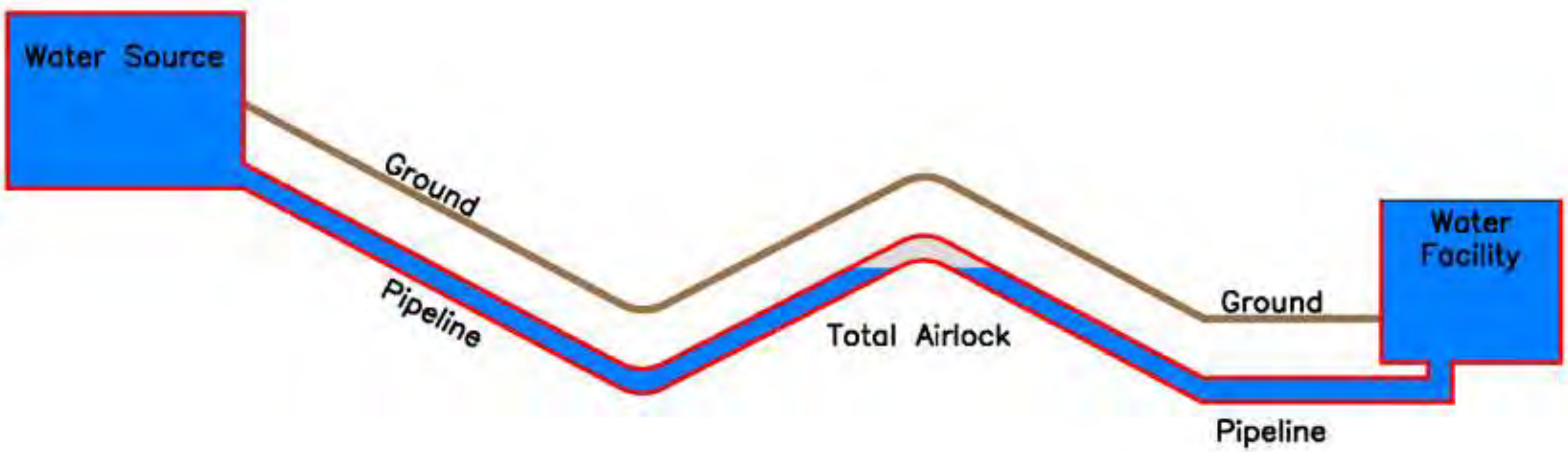
Pipeline installed with a high place in the line.



Partial Air Lock



Total Air Lock



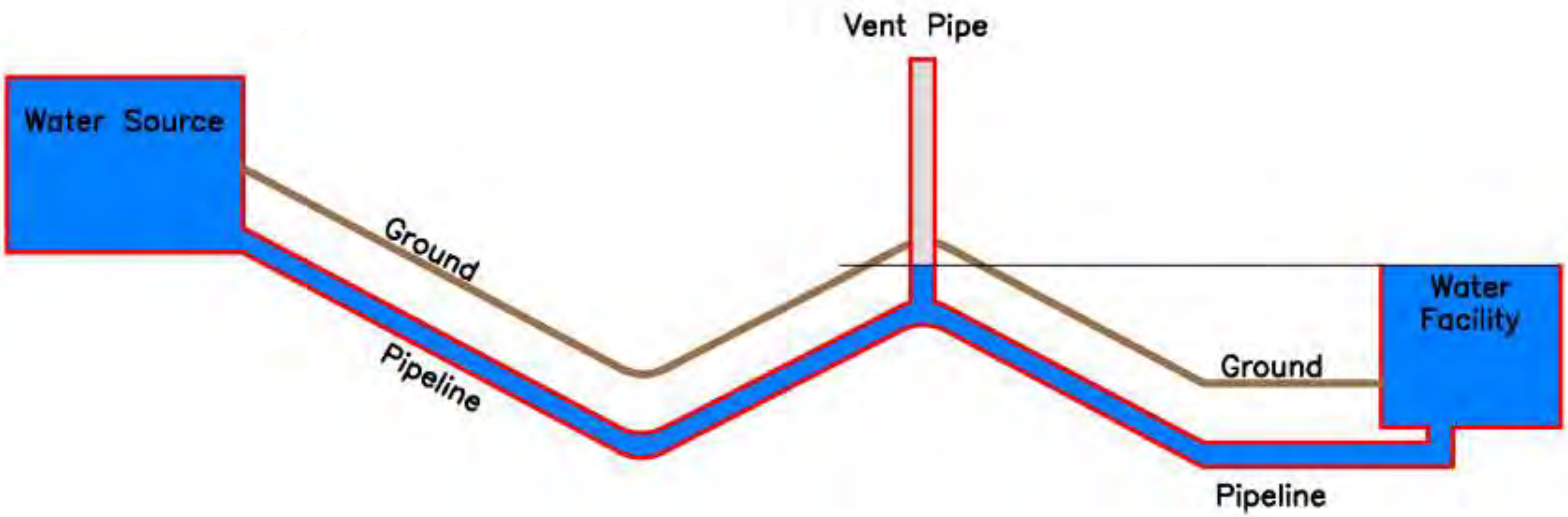
Preventing Air Locks

- The occurrence of an air lock in a pipeline can be prevented in a number of ways:
  - Install the pipeline on a continuous grade without undulations or high points - the topography may make such an installation impractical.
  - Ensure that air does not enter the pipeline - while this is obvious, in a practical sense, it is probably not possible to completely prevent air from entering a pipeline.
  - Ensure that the flow velocity is sufficient to flush any air out of the line.
  - Adding a vent pipe or water trough at the high spot is a possible solution

Prevention is always the best cure here. Airlocks should be discussed with the landowner and the contractor **BEFORE** the pipeline is installed.

From the "Pipeline Detail" Design Sheet:

4. All pipelines with gravity flows shall be graded to prevent unvented crests in the pipelines. These areas in the pipeline will cause the pipeline to air lock and not flow.



Vent Pipe
Water Source
Ground
Pipeline
Water Facility
Ground
Pipeline

What if all of the troughs are not at lower elevations than the water source?

PUMP SYSTEMS

Conventional

Solar-Powered

Hydraulic Ram

~~Nose, Sling, Windmill~~

Not commonly used/recommended

NATURAL RESOURCES CONSERVATION SERVICE

VIRGINIA CONSERVATION PRACTICE STANDARD

PUMPING PLANT

(No.)

CODE 533

CRITERIA

General Criteria Applicable to All Purposes

Pump requirements. Design flow rate, range of operating heads, and pump type shall meet the requirements of the application.

Selection of pump materials shall be based on the physical and chemical qualities of the

material being pumped and manufacturer's recommendations.

Electrical wiring shall meet the requirements of the National Electrical Code.

CHECK DATA

1. As-built plans including dimensions, types and quantities of materials installed, and variations from design. Include justification for variations.
2. Certifications for practices needing a PE design.
3. Locations of appurtenant practices.
4. Adequacy of vegetation and/or ground cover.
5. Complete as-built section of Cover Sheet.

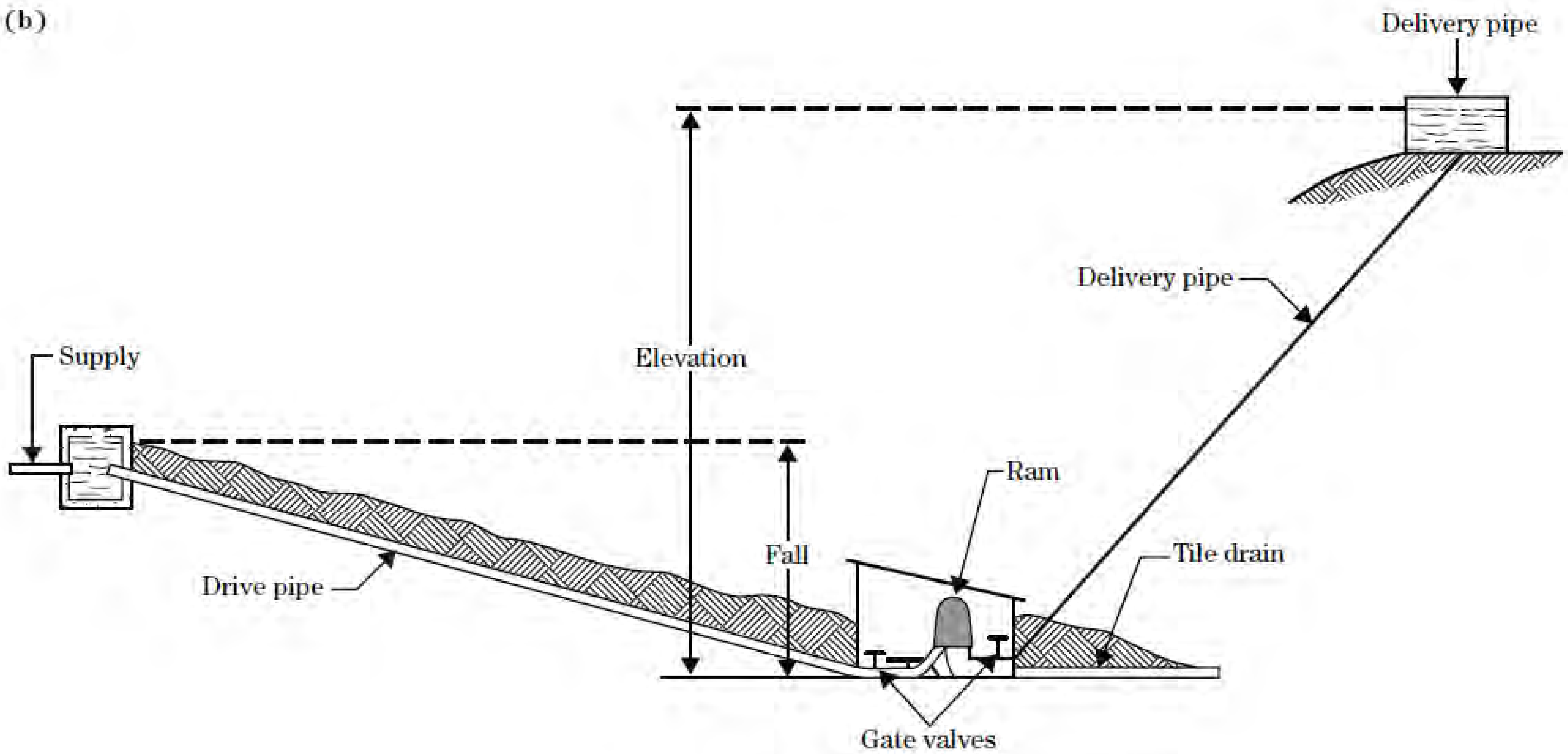
Sling Pumps

- Not commonly used or recommended
- Uses energy of moving water to force water to a higher elevation
- Operate from a flowing stream (at least 2.5 ft deep, velocity >1.5 ft/sec)
- Flow rates of 1-2gpm with lift capacity up to 50ft.
- Rotates the pump body forcing water through a coil inside into a pipe
- Limitations:
  - debris damage/clogging (frequent checking required)
  - must be strongly secured to prevent being washed away

Nose Pumps

- Animal-powered pumps
- Deliver ~1pt. Of water every time the animal pushes a paddle with its nose
- Only serves one animal at a time (limited to small herd sizes)
- Calves or other animal types may not be able to operate
- May freeze in winter
- Low lift capacity (15-20ft. max.)
- Only over short distances (<200ft.)

Hydraulic Ram Pumps



Sketch of typical ram installation

Hydraulic Ram Pumps

Hydraulic rams—A hydraulic ram is an automatic pump operated by water power. It uses the power developed by the surge of a quantity of falling water to force a much lesser amount of water to an elevation above the source of supply. Figure 12–15a shows a typical hydraulic ram in cross section, and figure 12–15b shows the general configuration of a hydraulic ram used for a stream development.

The volume of water that a ram can pump depends on the fall between the supply and the ram, the height the water is to be raised from the ram to the reservoir, and the quantity of water available. If the water supply is limited, a ram must be selected that will operate with the minimum quantity of water available. If the water supply is ample, the ram size is governed by the quantity of water needed daily.

Manufacturers build rams that operate successfully on flows of 1.5 gallons per minute or more with at least 2 feet of head.

The number of gallons of water delivered per minute to a given point can be estimated with the following formula:

$$D = \frac{VFe}{E}$$

where

- D = volume in gallons per minute that the ram will deliver
- V = water supply available in gallons per minute
- F = fall in feet between the water supply and the ram
- E = vertical elevation in feet that water is to be lifted above the ram
- e = ram efficiency (use 0.6 in the absence of specific data)

Source: EFH12

Hydraulic Ram Pumps

To determine if a ram is practical, collect the following information:

- number of gallons per minute that the spring, artesian well, or stream, will deliver
- number of gallons per day desired from the ram
- available fall, in feet, from the water supply to the ram
- elevation, in feet, to which water is to be raised above the ram
- pipeline distance, in feet, from the ram to the point of discharge
- pipeline distance, in feet. from the source of water to the ram

From CPS 533:

Water powered pumps (hydraulic rams). Pumping units shall be sized according to flow rate, lift, fall, and efficiency. Bypass water shall be returned to the stream or storage facility, without erosion or impairment to water quality.

Buildings and accessories. Pumps shall be securely mounted on a solid foundation such as pilings or concrete. Foundations shall be

Hydraulic Ram: Design Considerations

- Ideal Application: Pumping from Ponds at Dam
  - Lots of fall, short distance
- Typically, pump to a reservoir at the high point in the system in order to be able to meet the peak demand
  - Rams have a very low pumping rate, but pump 24 hours a day
  - Reservoir should hold the 24-hour demand
- Advantages:
  - No power required
  - Pump itself relatively inexpensive
- Disadvantages:
  - Valves wear out because of 24/7 operation
  - Inlets clog if attempting in a stream
  - Trough locations still somewhat limited (must be lower than reservoir)

Solar Systems: Design Considerations

- Typically, pump to a reservoir at the high point in the system in order to be able to meet the peak demand
  - The sun isn't always shining!
  - Reservoirs typically sized to hold 3-days worth of storage for livestock
- Advantages:
  - No grid power required
- Disadvantages:
  - Expensive
  - Trough locations still somewhat limited (must be lower than reservoir)

When windmill, solar, or other potentially unreliable power source is used, supply additional daily water storage volume (3-5 days), provide a battery back-up system or provide an alternate water source. Use of a float valve on a system with one of these types of power supply may not be practical.

Solar System

Linear Current Booster (LCB)

An electronic device that conditions the voltage and current of a PV array to match the needs of a DC-powered pump, especially a positive displacement pump. It allows the pump to start and run under low sun conditions without stalling. It is also called a pump controller. (See Pump Controller, Volt, and Direct Current (DC).)

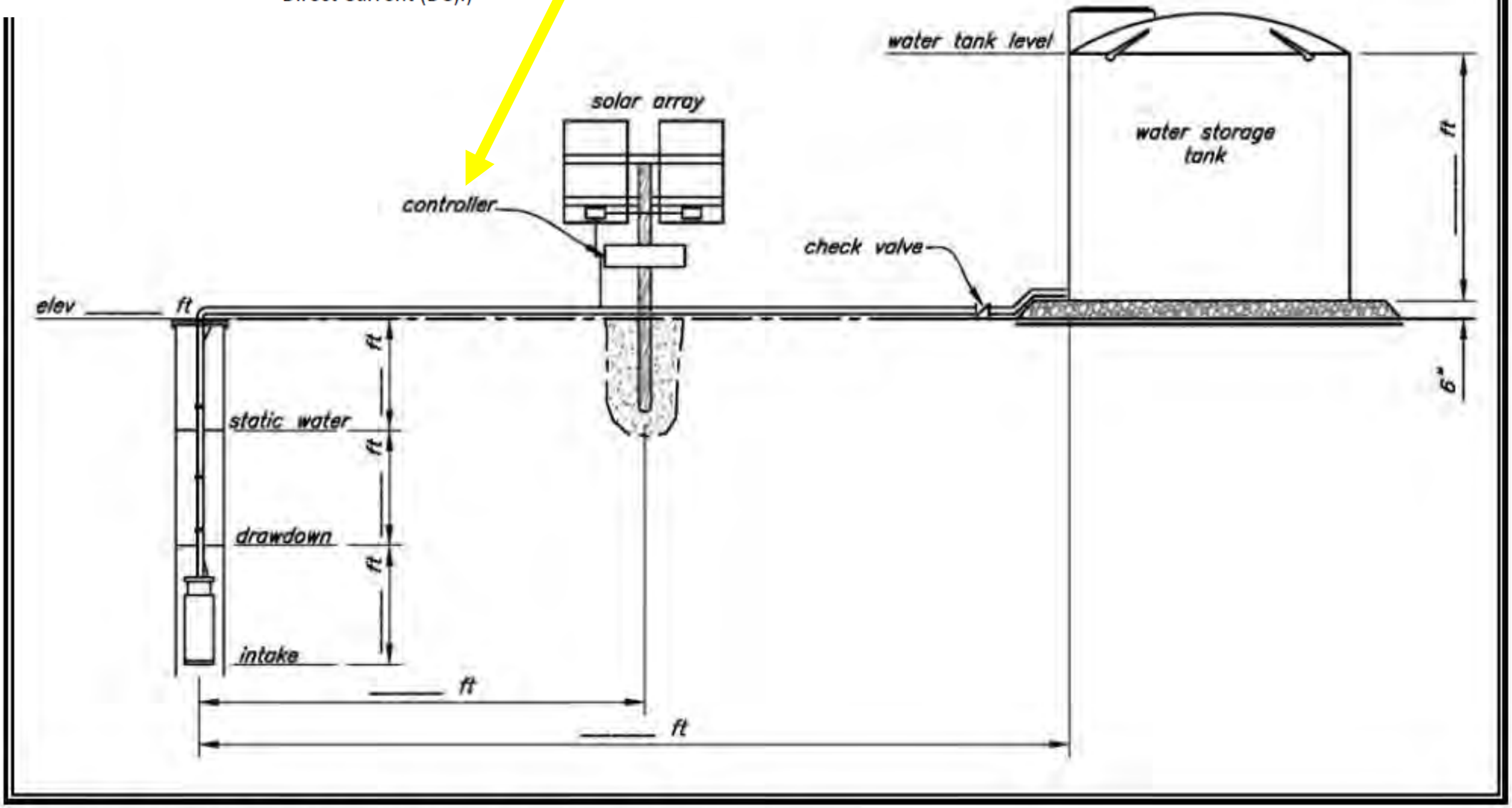
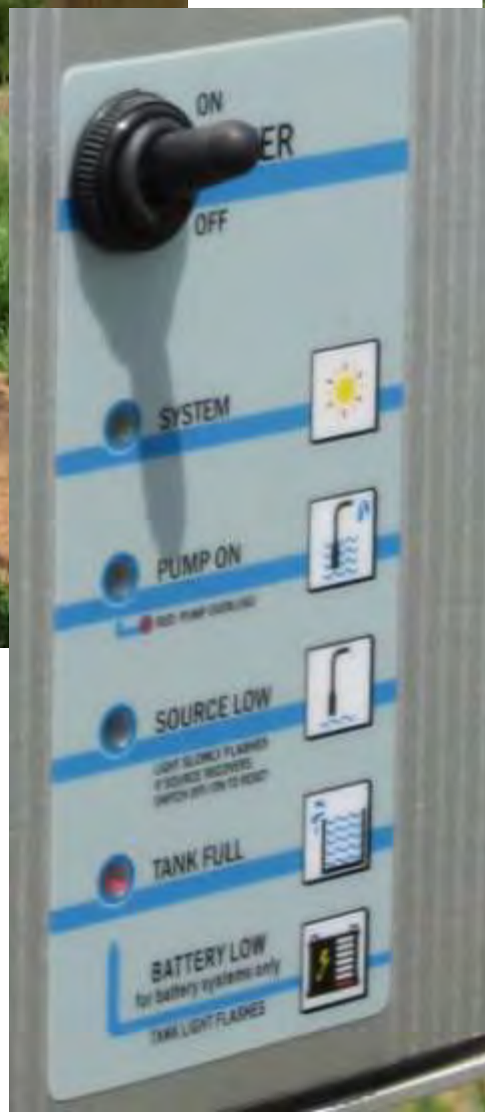


Figure 9 *– Typical well installation with pertinent parameters.*

DCR
Virginia Department of Conservation & Recreation







Virginia Department of Cons

Water Level Indicator

- Rod is sitting on a float in the underground reservoir

- Farmer can see water level from a distance and knows when he might need to supplement with another water source (e.g. limited access)

DCR
Virginia Department of Conservation & Recreation

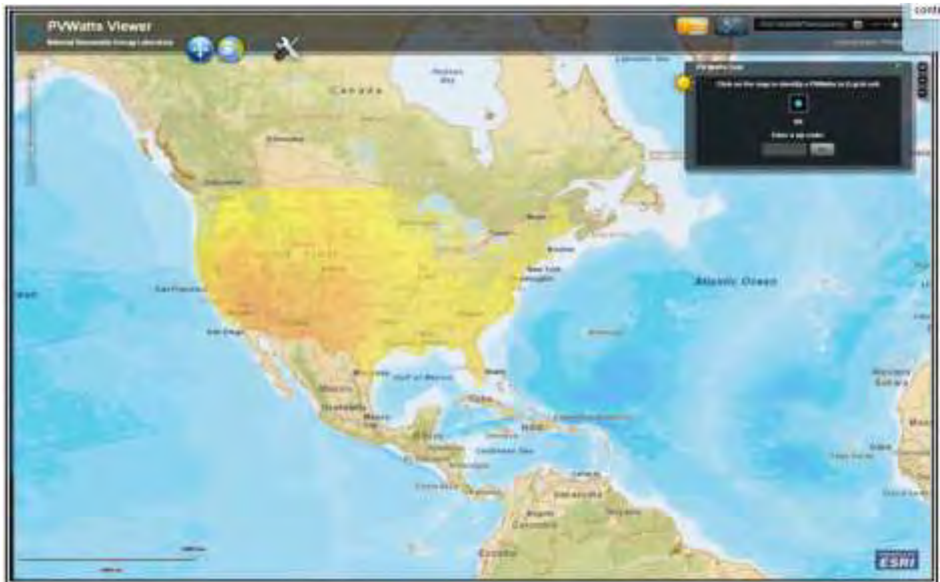
Solar Systems

From CPS 533:

Photovoltaic panels. The photovoltaic array shall be sized based on average data for the location and the time of year pumping occurs, according to manufacturer's recommendations. The photovoltaic array shall provide the power necessary to operate the pump at the design flow rate, with the appropriate service factor considering a minimum panel degradation of 10 years. Fixed arrays shall be oriented to receive maximum sunlight. Panel tilt angle shall be based on the location latitude and time of year for power requirements. Panels shall be mounted securely to resist movement by environmental factors.

Photovoltaic cells—Solar power can be used to power water pumps if suitable arrays can be deployed and provide enough power for the design needs. Power storage and alternate power sources are additional criteria that must be met if photovoltaic arrays are employed. Technical guidance for design of solar-powered systems can be obtained from the NRCS State conservation engineer. An example guide is the NRCS Technical Note No. 28, Design of Small Photovoltaic (PV) Solar-Powered Water Pump Systems (*http://www.or.nrcs.usda.gov/technical/engineering/environmental_engineering/data/SolarTechNote100929.pdf*).

http://pvwatts.nrel.gov/



Solar System – Layout Considerations

- Proximity of pump to panels & controller (length and gauge of wire $$$)
- Line of site from panels to sun
  - South-facing
  - Clear view

It is also important to consider potential vandalism and theft when locating PV panels and pump systems. Unfortunately, since most solar panel systems are located in remote areas on open landscapes, the risk of vandalism and/or theft can be significant. If possible, panels, tanks, and controllers should be located away from roads and public access, as well as where features in the landscape (rolling hills, escarpments, wind blocks, etc.) can provide a maximum of shielding from public view. The use of trees, bushes, or other types of vegetation for shielding is acceptable. However, care should be taken to situate the panels far enough to the south and west of tall trees and other types of vegetation to reduce the potential for their obstruction by shadows during peak solar insolation hours.

Purchasing Solar Components

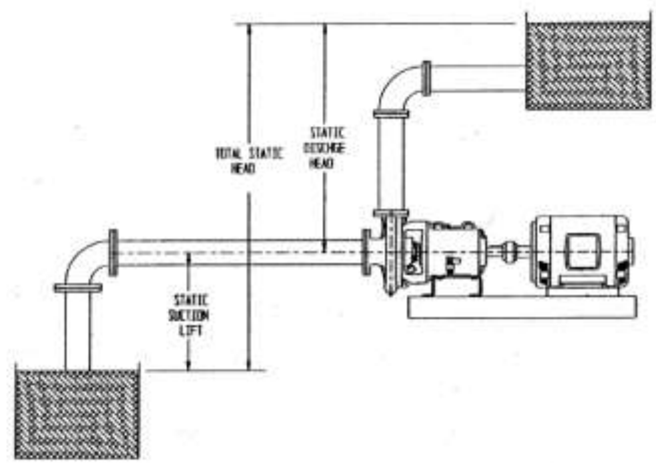
- Recommend purchasing the pump, pump controller, and solar array from the same supplier!
- The supplier will ensure that the components will work with one another.

PUMPS

- Example of a 4” submersible pump (typical pump type in a 6” drilled well)
- Pumps are “sized by others” but we need to be able to explain how the contractor should be using our worksheet to size the pump

"Conventional" Systems

- i.e. Pumps connected to electric grid
- Less expensive than solar when close to grid
- Typically: 4" Submersible Pumps
- Jet pumps also an option



What controls when the pump is on or off?

PUMP CONTROLLERS

4 Commons Pump Controller Options:

Pressure Switch

Timer

Float Switch

Constant Pressure/ Variable Frequency

PUMP

Pressure Switch

- Most common method of pump control (especially in houses)
- Requires a pressure tank (must be sized appropriately!)
- Easy to install and replace
- Turn pump on when pressure drops to low setting
- Turn pump off when pressure rises to high setting
- The default assumption on the Virginia NRCS "Pressure System Worksheet"
- Make sure that the switch settings given by worksheet are commonly available

b) Pressure Switch Settings Based on System Load:

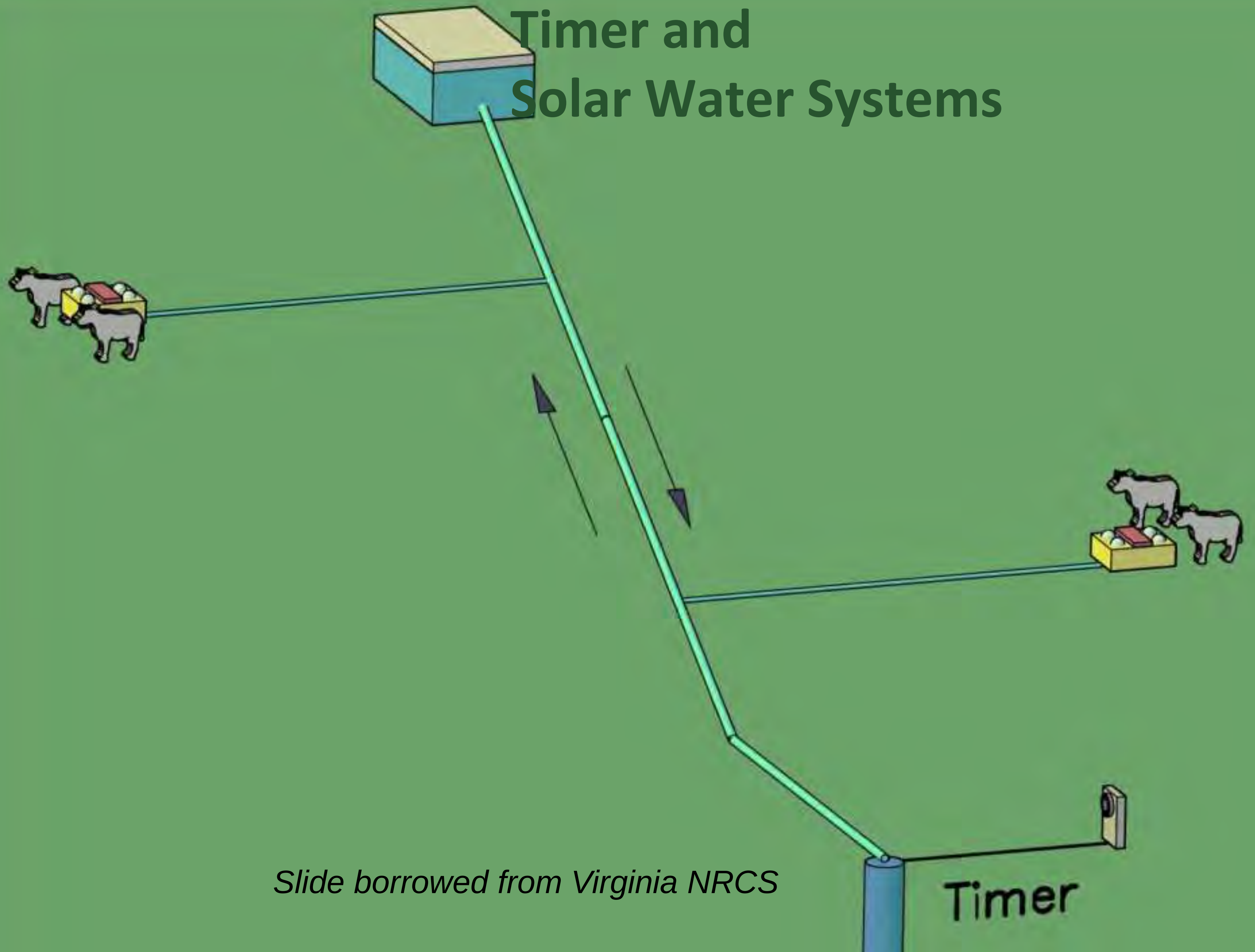
Low pressure switch setting:		psi (Minimum is 20 psi.)
High pressure switch setting:		psi (Max. is usually 80 psi.)

If a high pressure switch setting of 80 psi or more is required, consider alternate design or high pressure-rated tank.

Timer

- Turns the pump on and off at specified, changeable intervals (normally once or twice per day)
- Most common application: controlling pumps in low-yielding wells (pump to reservoir)
  - Reservoir must be at high point in the system
  - Troughs are supplied via gravity-flow from reservoir
- Reservoir must have an overflow – otherwise the pump will burn up or pipes will burst!
- Timer may need to be adjusted throughout the year to match the changing livestock water requirements

Timer and
Solar Water Systems



Slide borrowed from Virginia NRCS

Example 6 – Reservoir System on Timer

DN-614-II-18

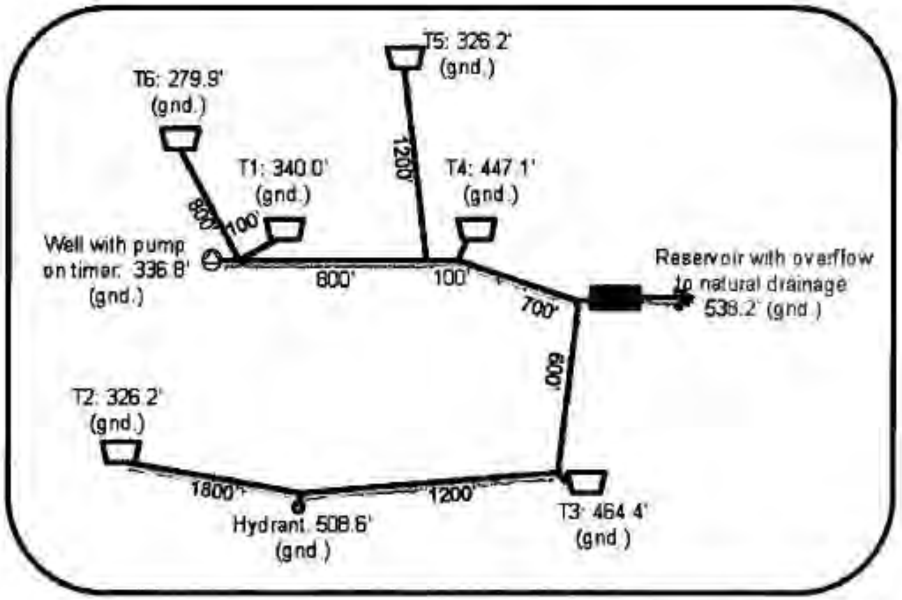


Figure II-15. Layout for Example 6 – Reservoir System on Timer

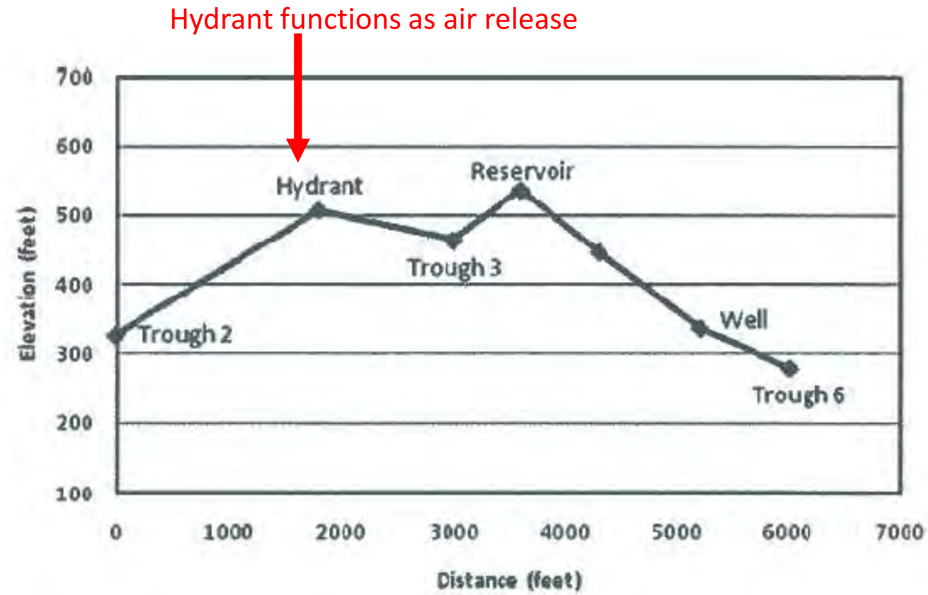
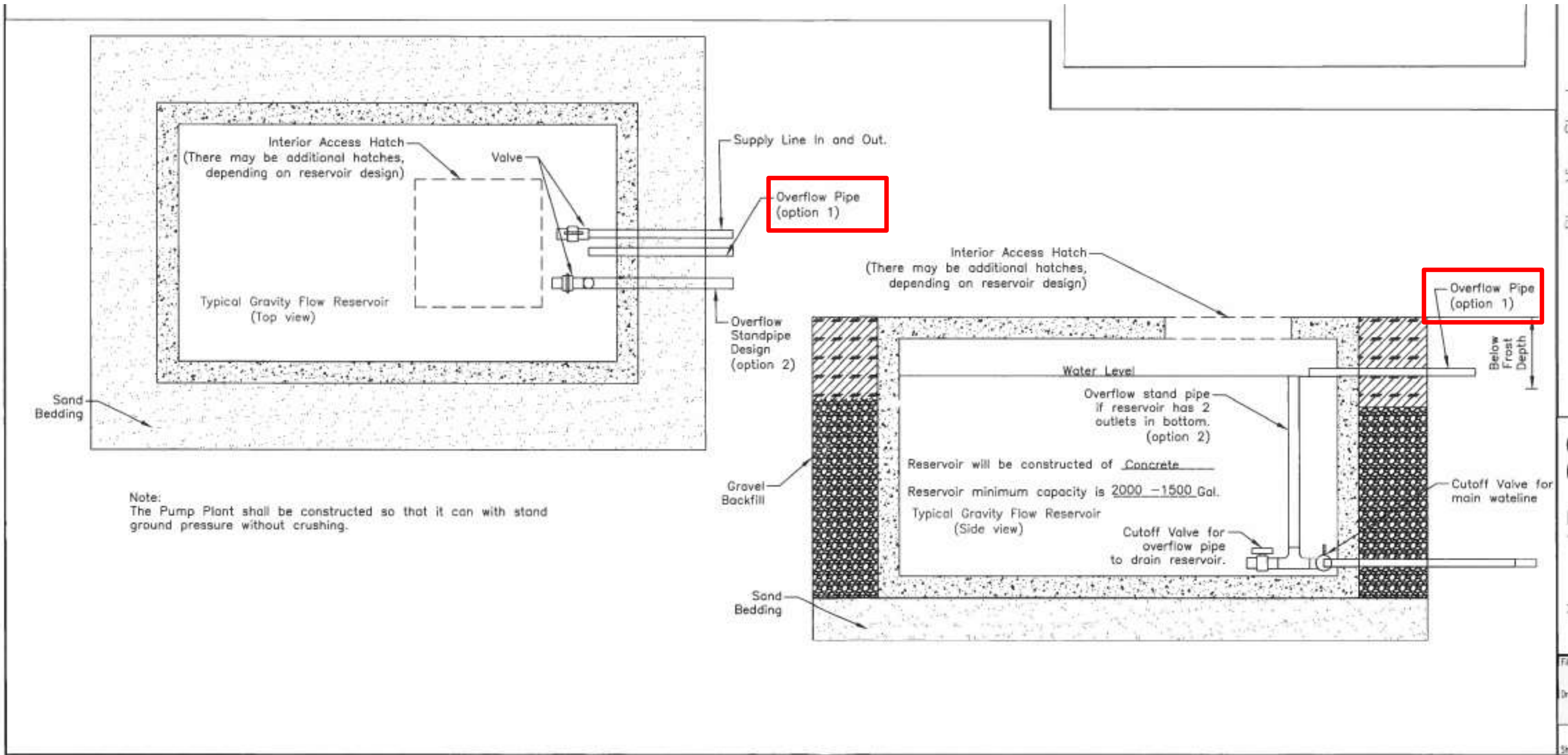


Figure II-16. Profile for Example 6.

With Timer: Reservoir must have an overflow!



Float Switch (in Reservoir)

- Turns the pump on when water drops below a set level
- Turns the pump off once the water level reaches the "full" level
- Typically control the pump in the well
- Water moves from the reservoir to troughs by gravity or a second (pressure-switch controlled) pump in the reservoir

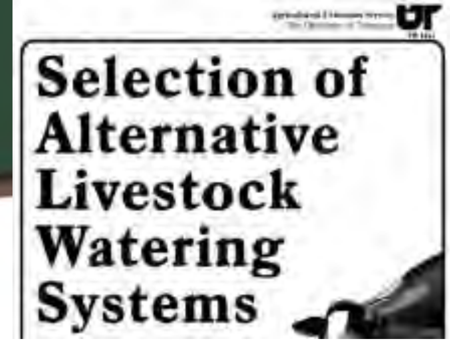

Selection of Alternative Livestock Watering Systems

Table 1. Comparison of Alternative Livestock Watering Systems						
System Type	**Initial* Cost**	**Operating Cost**	**Maintenance**	**Reliability**	**Ability to Freeze-Proof**	**Water Flow Potential**
Direct Access (Ponds & Streams)	Low	Low	Med	High	Med	High
Gravity Flow (Tank Systems)	Low	Low	Low	High	Med	Med
Utility Power (AC Electric)	Med	High	Med	High	High	High
Solar (DC Electric)	High	Med	Med	Med	High	Low
Ram Pump (Water Storage)	Med	Low	Med	High	Med	Low
Sling Pump (Water Storage)	Med	Low	High	Med	Med	Low
Nose Pump (Mechanical)	Low	Low	Low	Med	Low	Low

* Cost comparisons assume an available water source is already present and are based on individual system cost and not a per-animal basis.

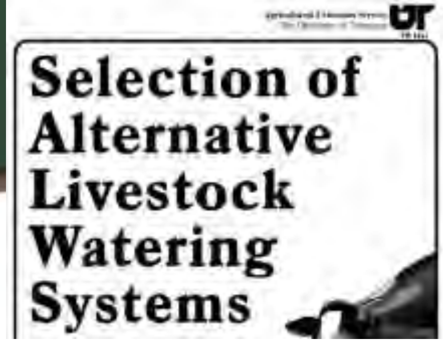

Selection of
Alternative
Livestock
Watering
Systems

Table 2 - Installation Considerations for Alternative Livestock Watering Systems

System Type	Considerations
Direct Access (Ponds & Streams)	Water source should be within reasonable distance from pasture location (preferably < 2000 feet) and must supply water year round.
Gravity Flow (Tank Systems)	Water source must be located at a higher elevation than livestock watering area. (10 feet suggested minimum elevation head).
Utility Power (AC Electric)	Utility electric power must be within a reasonable distance to water source. (Distance limit depends upon pump current requirements).
Solar (DC Electric)	Clear view of horizon for solar panel location. Area out of flood plain for construction of freeze-proof dry housing for electronic components and batteries.
Ram Pump (Water Storage)	Water source must be located at a higher elevation than pump set (> 10 feet), and adequate flow from spring or stream must exist (> 10 GPM).
Sling Pump (Water Storage)	Stream with adequate velocity (> 1.5 ft/sec) and depth (> 30 inches) nearby.
Nose Pump (Mechanical)	Pump must be located < 15 feet higher than water source.

"Constant Pressure" Pump Controller

- Maintain a constant pressure in the system
- Pump is constantly running, but pump controller varies its speed (pumping rate) depending on demand
- Pressure tanks may be smaller than those for pressure switches
- More up-front expense than pressure switch set-up
- More difficult to fix than a simple pressure switch!

Variable Frequency Drives. The owner shall inform the electric power provider that a Variable Frequency Drive will be installed prior to installation, and be responsible for following requirements of the electric power provider.

The Variable Frequency Drive shall be protected against overheating.

The Variable Frequency Drive control panel shall provide the read out display of flow rate or pressure.

This system is set to 62psi.

What is the minimum pressure setting for a constant pressure system?

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:

Elevation head:	10.4	psi	OR	24	feet
Friction loss:	4.4	psi	OR	10	feet
Minimum float valve pressure:	10	psi	OR	23	feet
Other:		psi	OR		feet
TOTAL REQUIREMENTS:	24.8	psi	OR	57	feet

c) Dynamic Head added to pump by the watering system:

Dynamic head = higher switch setting of 40 psi x 2.31 = ~~92~~ feet 58

Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

b) Pressure Switch Settings Based on System Load:

Low pressure switch setting:	20	psi (Minimum is 20 psi.)
High pressure switch setting:	40	psi (Max. is usually 80 psi.)

If a high pressure switch setting of 80 psi or more is required, consider alternate design or high pressure-rated tank.

d) Minimum Effective Drawdown for Pressure Tank:

Design pumping rate of	8.0	gpm x
Minimum pumping time of	1	minute =
Minimum pressure tank volume of	8.0	gallons

This is the minimum drawdown volum[e for] the pump to run for at least one minu[te before shutting] off. A larger volume can be used.

If the controller is set at 25psi (and is at the same elevation as the well), what is the actual "Dynamic Head added to the pump by the watering system"?

25psi x 2.31ft/psi = 58ft of head

Sizing pumps???

Pumps are “sized by others” (meaning that the “others” who are installing the system are the ones that pick the appropriate pump), but we need to be able to explain how the contractor should be using our worksheet to size the pump.

PUMP SIZING

- Contractor will select a pump to pump the desired pumping rate (gpm) at the TOTAL dynamic head of the system

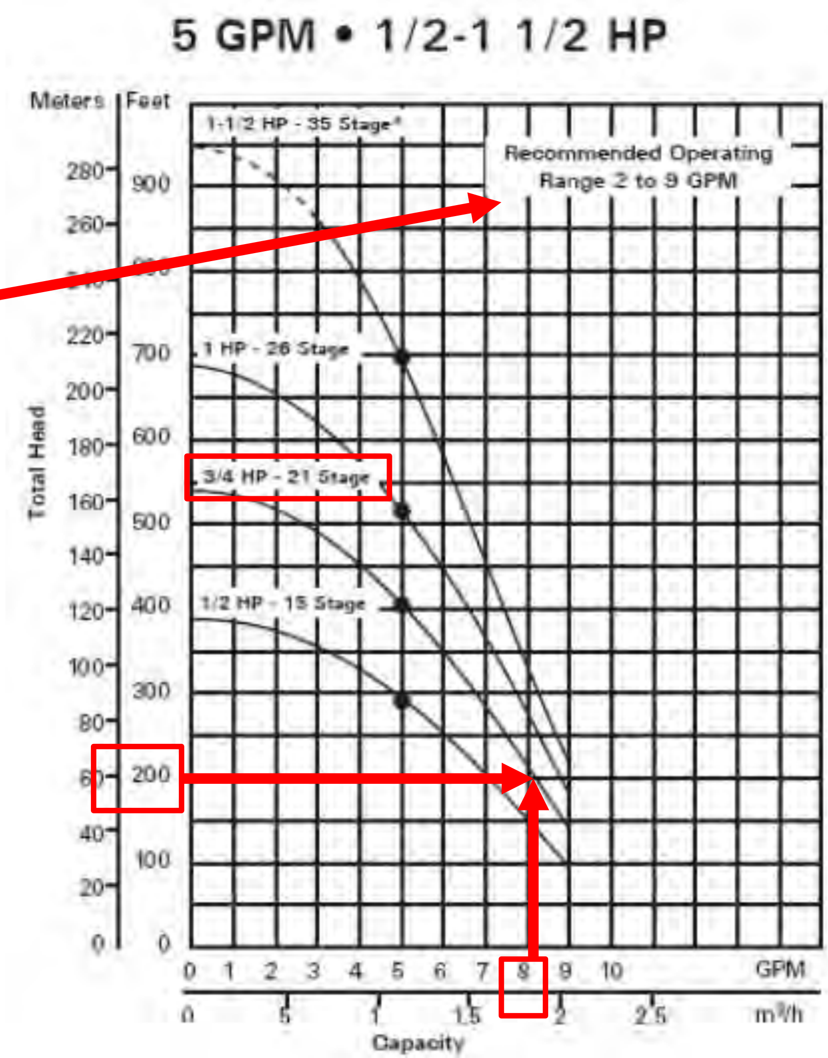
GPM @ TDH

- Every pump has a “pump curve” and will pump different flow rates at different head levels
- We provide the “above ground” head on our worksheets; contractor will add this to the “lift head” to determine the “total dynamic head”

Example Pump Curve

- These 5gpm pumps of varying horsepower can operate at pumping rates of 2gpm – 9gpm depending on the total head on the pump.

- Example: The pump for a system will have a “Total Head” of 200ft. Will any of these 5gpm pumps pump at 8gpm?
  - YES: the ¾ HP pump will work



Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:
County:
Date: 3/1/2017
Assisted By:

Project Notes:

Print Page

Clear Data

2) Water Budget

a) Total Daily Water Demand

Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

Number of times herd drinks/day events
Time desired to water herd: minutes/event
Average peak demand: gpm
Alternate peak demand: gpm

See Design Note for considerations for estimating peak demand.

c) Evaluate Source

Source flow rate: gpm
Source daily yield: gpd

If **source flow rate** is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).

If **source daily yield** is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

a) Trough Information

Trough type(s):
Design flow rate: gpm

= Pumping Rate

Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

Maximum float valve pressure: psi

Typical values range from 50-140 psi. Check manufacturer's recommendations.

Minimum float valve pressure: psi

Varies depending on type of float. Use manufacturer's recommended minimum. Typical value is 10 psi.

b) Pipe Information

in.
Pipe cross-sectional area: sq. ft.
Friction loss/100 ft ft./100 ft.
Velocity check (<5 fps): fps

If velocity is greater than 5 fps, consider a larger diameter pipe.

Pipe length to farthest watering point: feet
Add 10% for slope and fittings: feet
Total friction loss: ft. OR
Total friction loss: psi If friction loss is greater than 10 psi, consider using a larger diameter pipe.

Pipe pressure rating: psi
72% of rating (See VA CPS 516): psi Compare with result in Step 5b.

c) Vertical Pumping Distance

High point to pump "to":
Ground elev. of high point: feet

Low point to pump "from":
Ground elev. of low point: feet

Elevation difference: feet
OR psi

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:

Elevation head:		psi	OR		feet
Friction loss:		psi	OR		feet
Minimum float valve pressure:		psi	OR		feet
Other:		psi	OR		feet
TOTAL REQUIREMENTS:		psi	OR		feet

c) Dynamic Head added to pump by the watering system:

Dynamic head = higher switch setting of psi x 2.31 = feet

Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

b) Pressure Switch Settings Based on System Load:

Low pressure switch setting: psi (Minimum is 20 psi.)
High pressure switch setting: psi (Max. is usually 80 psi.)

If a high pressure switch setting of 80 psi or more is required, consider alternate design or high pressure-rated tank.

d) Minimum Effective Drawdown for Pressure Tank:

Design pumping rate of gpm x
Minimum pumping time of 1 minute =
Minimum pressure tank volume o gallons

This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure switc

Elevation of highest point: ft
Elevation of pressure switch: ft
Low pressure switch setting = psi

Static pressure on switch = psi

If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:

Elevation of pressure switch: feet
Elevation of lowest trough: feet
Difference: feet OR psi
Add high pressure switch setting: psi
Total pressure at lowest trough: psi

Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

Virginia Livestock Watering Systems - Pressure-Energy/Gravity Flow Worksheet

1) Assistance Information

Customer:
County:
Date: 3/1/2017
Assisted By:

Print Page
Clear Data

Project Notes:

2) Water Budget

a) Total Daily Water Demand

Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

No. of times herd drinks/day: events
Time desired to water herd: minutes/event
Average peak demand: gpm
Alternate peak demand: gpm

See Design Note for considerations for estimating peak demand.

c) Evaluate Source

Source flow rate: gpm
Source daily yield: gpd

If **source flow rate** is close to or less than Peak Demand, consider storage alternatives.
If **source daily yield** is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

See Design Note or EFH Ch. 12 for guidance on pipe size selection.

a) Trough Information

Trough type(s):
Design flow rate: gpm

Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

Maximum float valve pressure, if applicable: psi

Typical values range from 75-140 psi. Check manufacturer's recommendations.

Minimum float valve pressure, if applicable: psi

Varies depending on type of float. Use manufacturer's recommended minimum. Typical value is 10 psi.

b) Pipe Information

Pipe material:
Pipe nominal diameter:
Pipe avg. inner diameter: in.
Pipe cross-sectional area: sq. ft.
Kp (head loss coefficient):
Velocity check (<5 fps): fps

If velocity is greater than 5 fps, consider a larger diameter pipe.
Note: For flows greater than design flow, velocities will be greater.

Pipe pressure rating: psi
72% of rating (See VA CPS 516): psi

c) Gravity System Parameters

Reservoir gnd elev or spring box outlet elev: ft
Reservoir depth below ground (typically 6'): ft
Reservoir bottom (elev for computing head): ft

d) If Pumping to a Reservoir

Pumping rate should not exceed source rate.

Desired pumping rate to reservoir: gpm
Pumping duration required to meet daily demand: min/day
Ground elevation of water source: ft.
Elevation head: ft.
Static pressure in pipe (check against max. allowed): psi

Dynamic Head Calculations:

Pipe length to reservoir: ft
Add 10% for slope, fittings: ft
Friction loss/100': ft/100 ft
Total friction loss: ft

Note: If total friction loss exceeds 23.1 ft (10 psi), consider choosing a larger pipe diameter.

Dynamic Head added to pump by pressure component of system: Friction + elev. head: ft. OR psi

4) Flow and Static Pressure Checks

TROUGH ELEVATIONS:

Enter trough elevations from survey data. For cascade-type systems, enter trough elevations in order from highest to lowest.

Trough ID and Type	Trough Ground Elev. (ft)	Estimated Water Surface Elev. (ft)

Trough water surface elevation is assumed to be 2 ft above ground elevation.

CALCULATIONS FOR FLOAT-VALVE SYSTEMS:

Troughs are tee-ed off from the main line, with flow to each trough controlled by a float valve. Pipe length is measured from the reservoir or spring box.

Pipe Length from Reservoir or Spring Box to Trough (ft)	Head from Reservoir or Spring Box (ft)	Maximum Flow Rate (gpm)	Static Pressure (psi)

Flow calculations assume a float valve efficiency of 80%. For flow rates less than the design rate (yellow cells), consider modifying the system or using storage troughs (such as HETT or concrete). If static pressures exceed the manufacturer's recommended maximum for the float valve, consider using a pressure reducer, adjusting the orifice, or relocating the trough. If static pressures are less than the recommended minimum (red cells), consider moving the trough to a lower elevation. Cells are coded orange for static pressures exceeding either maximum recommended

CALCULATIONS FOR CASCADING SYSTEMS:

Troughs are connected in series by way of their overflow pipes. Pipe length for Trough 1 is measured from the spring box. Subsequent lengths are measured from the previous trough.

Sub-System	Pipe Length from Trough above (ft)	Head from Upper Trough (ft)	Max. Flow Rate (gpm)
Spring box - T1			
T1-T2			
T2-T3			
T3-T4			
T4-T5			
T5-T6			
T6-T7			
T7-T8			
T8-T9			
T9-T10			

Air lock can be a problem in spring-fed systems due to dissolved oxygen. Use a minimum diameter of 1-1/2" for pipe grades between 0.5-1.0%. Use a minimum pipe diameter of 2" for pipe grades less than 0.5%. See EFH Ch. 12.

Print Page
Clear Data

For flow rates less than the design rate (yellow cells), consider modifying the system or using larger volume troughs. If trough inflow rate exceeds trough outflow rate (red cells), a flow restrictor, larger pipe diameter, or change in trough location may be necessary. This may not be an issue if source flow rate is always less than the maximum flow possible.

Example

d) If Pumping to a Reservoir: Pumping rate should not exceed source rate.

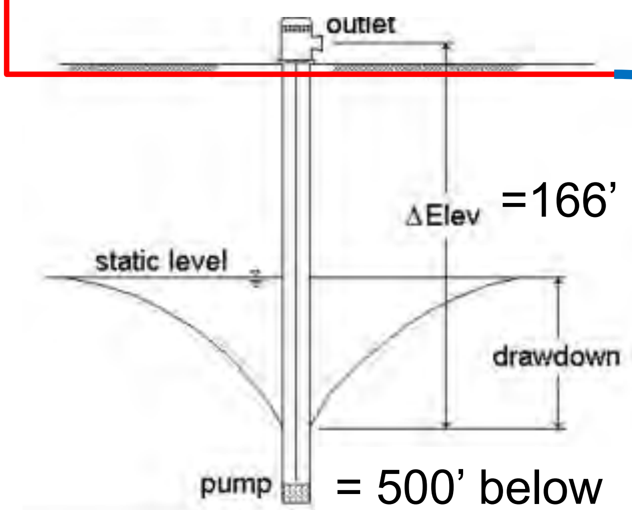
Desired pumping rate to reservoir:	6	gpm
Pumping duration required to meet daily demand:	333	min/day
Ground elevation of water source:	1016	ft.
Elevation head:	309.0	ft.
Static pressure in pipe (check against max. allowed):	133.8	psi
Dynamic Head Calculations:		
Pipe length to reservoir:	500	ft
Add 10% for slope, fittings:	550	ft
Friction loss/100':	0.3	ft/100 ft
Total friction loss:	1.8	ft

Note: If total friction loss exceeds 23.1 ft (10 psi), consider choosing a larger pipe diameter.

Dynamic Head added to pump by pressure component of system:	Friction + elev. head:	311	ft
		OR	
		134.5	psi

"Above-Ground" Head = **311ft.**

(*Our* calculation)



=166'

= 500' below surface

"Lift" Head = Elevation Head + Friction Loss IN WELL

Elevation Head = 166' (Surface Elevation – Pumping Level)

Friction Loss: 500' 1" PE pipe @ 6gpm = 13'

Lift Head = 166' + 13' = **179'**

(*Contractor's* calculation)

TOTAL Dynamic Head = Above-Ground + Lift

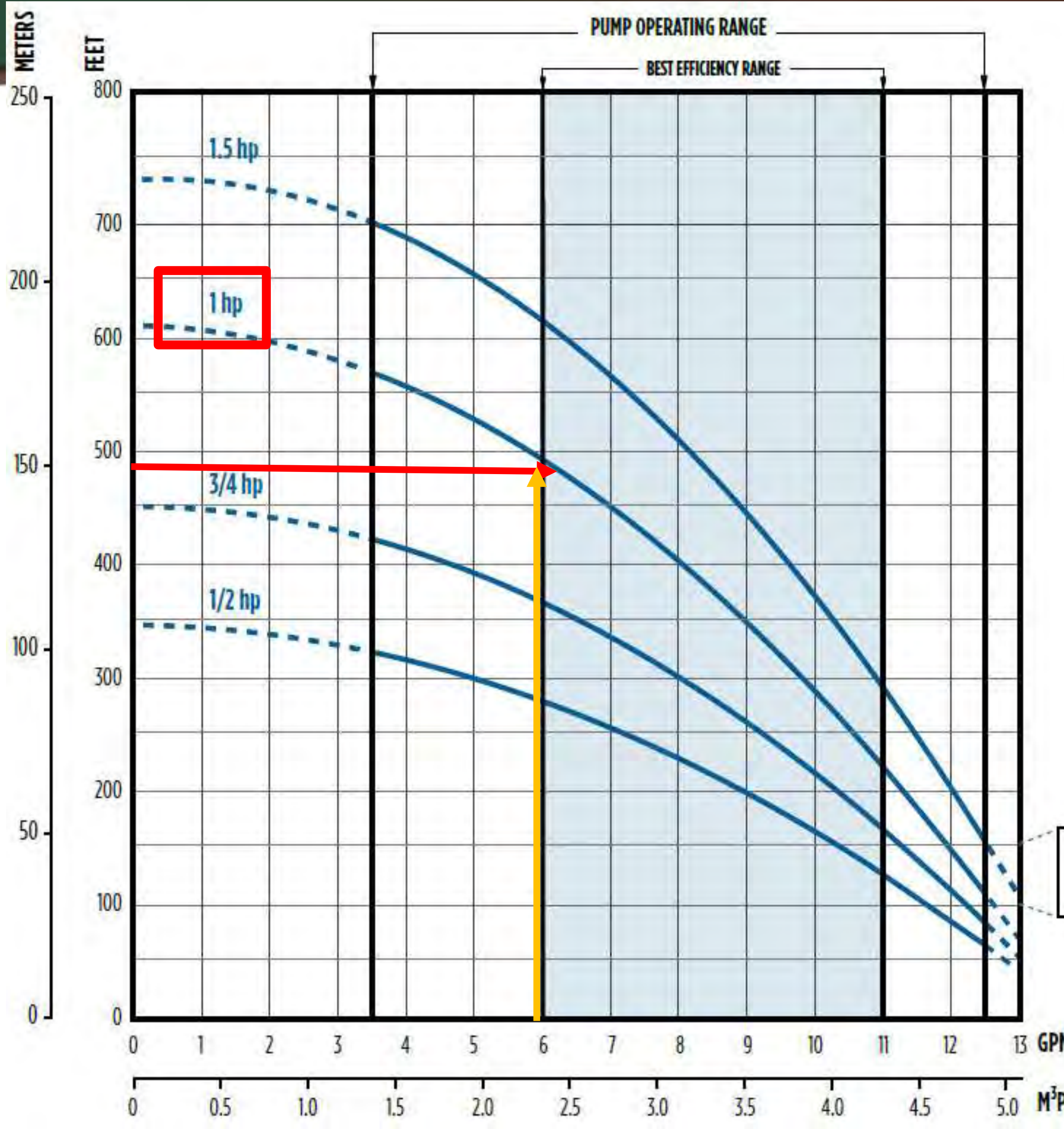
= 311' + 179' = **490'**

Contractor tells the pump supplier:

"I need a pump that will pump **6gpm** at **490ft.** of total dynamic head."

10 GPM Submersible Pump Curves

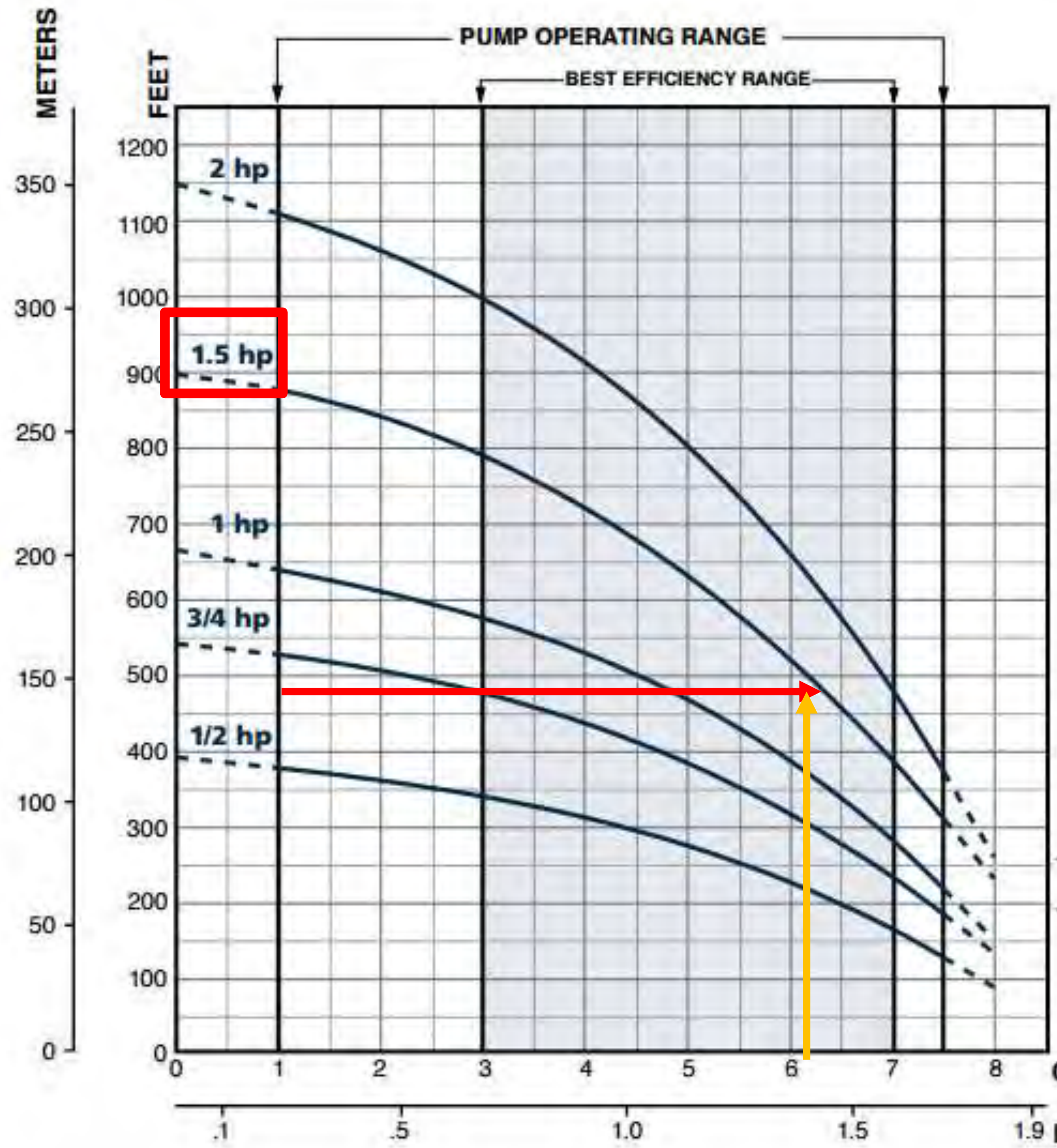
- 490' of head
- 6gpm
- Use the 1hp, 10gpm pump



5 GPM Submersible Pump Curves

- 490’ of head
- 6gpm

The 1.5hp 5gpm pump is the closest fit.



Sizing Pressure Tanks

NOTE: This is a separate example from the pump sizing example.

From "Pressure System Worksheet":

d) Minimum Effective Drawdown for Pressure Tank:

Design pumping rate of	8.0	gpm x
Minimum pumping time of	1	minute =
Minimum pressure tank volume o	8.0	gallons

This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

Effective Drawdown Volume = Total Tank Volume x Drawdown Factor

Drawdown factor depends on pressure switch settings.

Assume 40/60 pressure switch settings. What is the minimum tank size?

Maximum System Pressure (cut-out) PSIG / (kPa) / bar	Mimimum System Pressure (cut-in) – PSIG / (kPa) / bar													
	20 (138) 1.38	25 (173) 1.72	30 (207) 2.06	35 (242) 2.41	40 (276) 2.76	45 (311) 3.10	50 (345) 3.45	55 (380) 3.80	60 (414) 4.16	65 (449) 4.48	70 (483) 4.83	75 (518) 5.17	80 (552) 5.51	85 (587) 5.86
30 / (207) / 2.06	0.21													
35 / (242) / 2.41	0.26	0.19												
40 / (276) / 2.76	0.34	0.26	0.17											
45 / (311) / 3.10	0.39	0.32	0.24	0.16										
50 / (345) / 3.45	0.44	0.37	0.30	0.22	[illegible]									
55 / (380) / 3.80	0.47	0.41	0.34	0.28	[illegible]	0.14								
60 / [illegible]	[illegible]	[illegible]	[illegible]	0.32	0.26	[illegible]	0.13							
65 / (449) / 4.48	0.53	0.48	0.42	0.36	0.30	0.24	0.18	0.12						
70 / (483) / 4.83	0.58	0.50	0.45	0.40	0.34	0.29	0.23	0.17	0.11					
75 / (518) / 5.17		0.53	0.48	0.43	0.38	0.32	0.27	0.22	0.16	0.11				

40/60 Drawdown Factor = 0.26

Min. Total Tank Volume = $\frac{\text{Effective Drawdown Vol.}}{\text{Drawdown Factor}}$

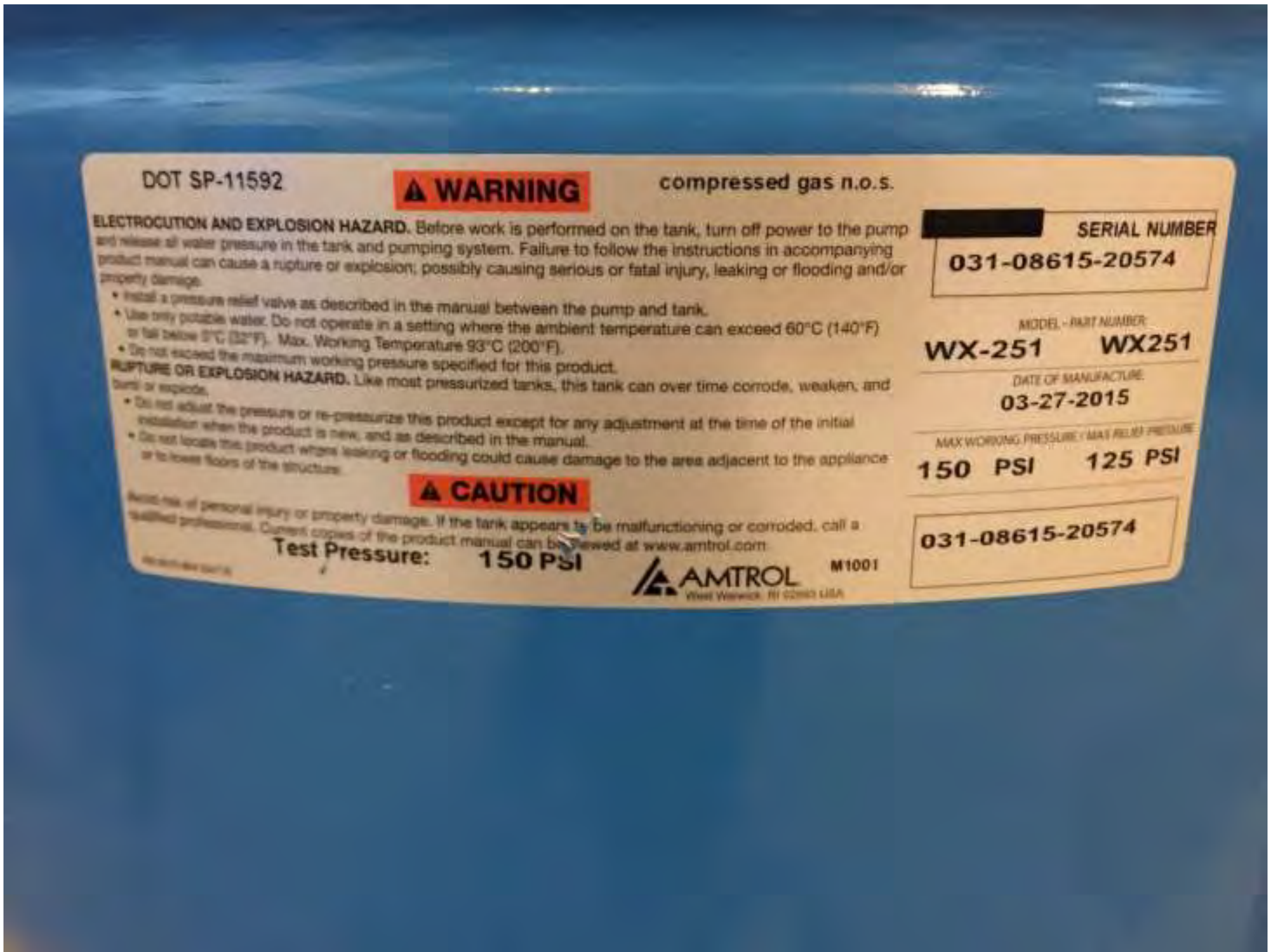
Minimum Total Tank Volume = 8 gallons / 0.26
=31 gallons

The tank must have a total volume of at least 31 gallons to let the pump run for at least a minute.

Drawdown Factors

Maximum System Pressure (cut-out) PSIG / (kPa) / bar	Mimimum System Pressure (cut-in) – PSIG / (kPa) / bar																		
	20 (138) 1.38	25 (173) 1.72	30 (207) 2.06	35 (242) 2.41	40 (276) 2.76	45 (311) 3.10	50 (345) 3.45	55 (380) 3.80	60 (414) 4.16	65 (449) 4.48	70 (483) 4.83	75 (518) 5.17	80 (552) 5.51	85 (587) 5.86	90 (621) 6.20	95 (656) 6.55	100 (690) 6.89	105 (725) 7.24	110 (759) 7.58
30 / (207) / 2.06	0.21																		
35 / (242) / 2.41	0.28	0.19																	
40 / (276) / 2.76	0.34	0.26	0.17																
45 / (311) / 3.10	0.39	0.32	0.24	0.16															
50 / (345) / 3.45	0.44	0.37	0.30	0.22	0.15														
55 / (380) / 3.80	0.47	0.41	0.34	0.28	0.21	0.14													
60 / (414) / 4.16	0.50	0.44	0.38	0.32	0.26	0.19	0.13												
65 / (449) / 4.48	0.53	0.48	0.42	0.36	0.30	0.24	0.18	0.12											
70 / (483) / 4.83	0.56	0.50	0.45	0.40	0.34	0.29	0.23	0.17	0.11										
75 / (518) / 5.17		0.53	0.48	0.43	0.38	0.32	0.27	0.22	0.16	0.11									
80 / (552) / 5.51			0.50	0.46	0.41	0.36	0.31	0.26	0.21	0.15	0.10								
85 / (587) / 5.86				0.48	0.43	0.39	0.34	0.29	0.24	0.20	0.15	0.10							
90 / (621) / 6.20					0.46	0.42	0.37	0.32	0.28	0.23	0.19	0.14	0.09						
95 / (656) / 6.55						0.44	0.40	0.35	0.31	0.27	0.22	0.18	0.13	0.09					
100 / (690) / 6.89							0.42	0.38	0.34	0.30	0.26	0.21	0.17	0.13	0.09				
105 / (725) / 7.24								0.41	0.37	0.33	0.29	0.25	0.20	0.16	0.13	0.08			
110 / (759) / 7.58									0.39	0.35	0.31	0.27	0.24	0.20	0.16	0.12	0.08		
115 / (794) / 7.92										0.38	0.34	0.30	0.26	0.23	0.19	0.15	0.11	0.08	
120 / (828) / 8.27											0.36	0.33	0.29	0.25	0.22	0.18	0.15	0.11	0.07
125 / (863) / 8.62												0.35	0.32	0.28	0.25	0.21	0.18	0.14	0.11

In keeping with current industry standards, drawdown factors are based on Boyle's law. Actual drawdowns will vary depending upon system variables including the accuracy and operation of the pressure switch and gauge, actual precharge pressure, and operating temperature of the system.


DOT SP-11592
WARNING
compressed gas n.o.s.
ELECTROCUTION AND EXPLOSION HAZARD. Before work is performed on the tank, turn off power to the pump and release all water pressure in the tank and pumping system. Failure to follow the instructions in accompanying product manual can cause a rupture or explosion, possibly causing serious or fatal injury, leaking or flooding and/or property damage.
• Install a pressure relief valve as described in the manual between the pump and tank.
• Use only potable water. Do not operate in a setting where the ambient temperature can exceed 60°C (140°F) or fall below 0°C (32°F). Max. Working Temperature 93°C (200°F).
• Do not exceed the maximum working pressure specified for this product.
RUPTURE OR EXPLOSION HAZARD. Like most pressurized tanks, this tank can over time corrode, weaken, and burst or explode.
CAUTION
Test Pressure: 150 PSI
AMTROL
M1001
[redacted]
SERIAL NUMBER
031-08615-20574
MODEL - PART NUMBER
WX-251
WX251
DATE OF MANUFACTURE
03-27-2015
150 PSI
125 PSI
031-08615-20574

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Pressure tanks and pressure switches need to be housed where they will be dry and will not freeze. High humidity environments (e.g. underground) will also shorten the lifespan of the pressure switch.

Considerations for Evaluating an *Existing* Pumping Plant

Information to Gather: Existing Systems

- Age and condition of pumping plant
- Existing Pumping Rate
- Existing Pressure Switch Settings
- Length and diameter of existing pipeline
  - Evaluate for Friction Loss
- Existing Elevations
  - Existing elevations need to be considered for the *"High point to pump "to""* and *"Elevation of lowest trough"*

Existing Pumping Rate

- Why does the existing pumping rate matter?
  1. Is the pumping rate sufficient to supply the livestock?
  2. **Should be used to determine friction loss (size the pipeline) if the existing pump will be used**
- How to determine:
  - If the well was installed recently, the pumping rate may be listed on the "Water Well Completion Report" at the Health Dept.
    - Look for the pump capacity (different from well yield)
  - Manual Pumping Rate Test:
    - Find a hydrant (something with a full flow orifice) near the pumping plant
    - Open the hydrant up and wait for the pressure tank to empty
    - Once the tank is empty and the switch engages the pump, begin collecting the water in a container of known volume
    - Time how long it takes to fill the container
    - Divide the gallons filled by the time it took (in minutes) to come up with the pumping rate in GPM
- Where to input into worksheet:
  - "Alternate Peak Demand" → "Design Flow Rate"
  - Also document well yield on worksheet

Pressure Switch Settings with Existing Pumps

1) Complete the "Pressure System Worksheet" using the existing pumping rate
2) What pressure switch requirements are generated by the worksheet?
3) If the worksheet calls for pressure switch settings that are higher than the existing settings, the total head on the pump will increase, and the contractor/plumber will need to evaluate the impact on the pump
   - This process is for planning purposes: Do we need to plan for a new pump?
   - Sizing pumps is beyond the scope of our responsibility
   - Leave it up to the professionals!

Pressure Switch Settings Cont’d

- Increasing the head on the pump will reduce its pumping rate
- If you don’t have info on the pump (model #), you won’t know how the pumping rate will be affected

Existing System: at 290ft. of head, **5gpm** pumping rate

Ex. Pump, New Switch: Increase pressure switch from 20/40 to 40/60, a net increase of 20psi.

20psi * 2.31ft/psi = 46.2ft ≈ 46ft of head

New total head on pump: 290ft. + 46.2ft. **= 336ft.**

New Pumping rate: **$3^1/_3$ gpm**

?

Just remember: use the existing pumping rate as the “design flow rate” if using an existing pumping plant.

(Or, if the existing pump rate is inappropriate, plan for a new pump.)

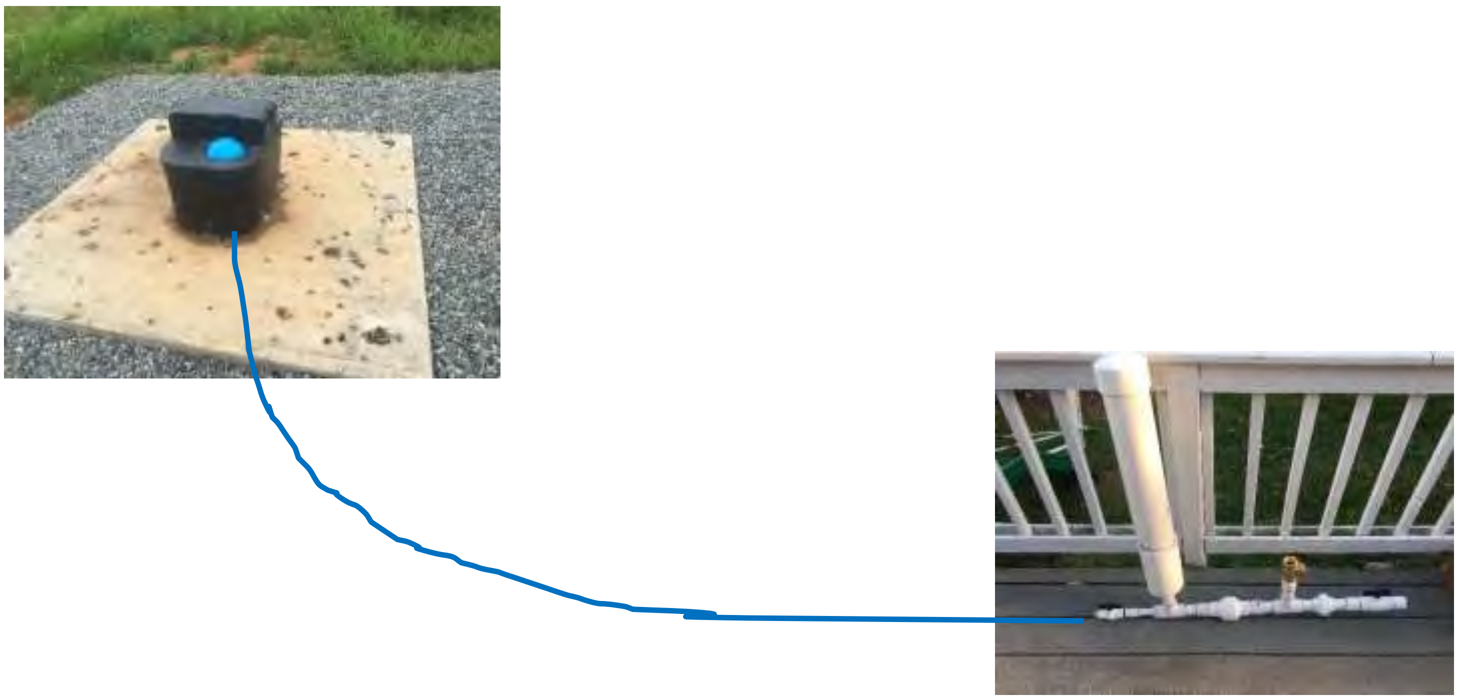
Important Point for Existing Pumps:

Don’t confuse *flow rate* and *pressure!*

- A high flow rate does NOT necessarily mean there is too much pressure
- Pressure is governed by the pressure switch
- A high flow rate (pumping rate) can actually mean there will not be ENOUGH pressure to overcome the higher friction loss associated with higher flow rates during the dynamic condition
- Friction loss is a REAL pressure loss

POP QUIZ

- What is wrong with this set-up?

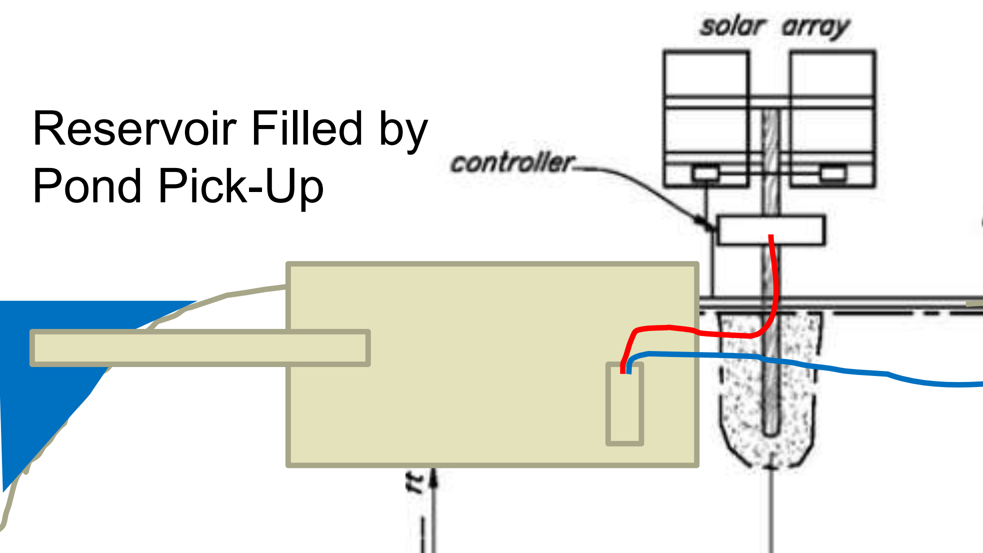


Ram Pump

POP QUIZ

- What is wrong with this set-up?

Reservoir Filled by Pond Pick-Up



Solar-Powered Pump in Reservoir

Case Study #1: Multiple Sources Tied Together

- Originally designed as a pressure system, drilling a new well

2) Water Budget

a) Total Daily Water Demand

Type of livestock:	Beef	
Number of Animals:	100	
Water demand/animal/day:	20	gpd
Total Daily Demand:	2000	gpd

See Design Note for watering recommendations for various types of livestock.

c) Evaluate Source

Source flow rate:	1	gpm
Source daily yield:	1440	gpd

If **source flow rate** is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).

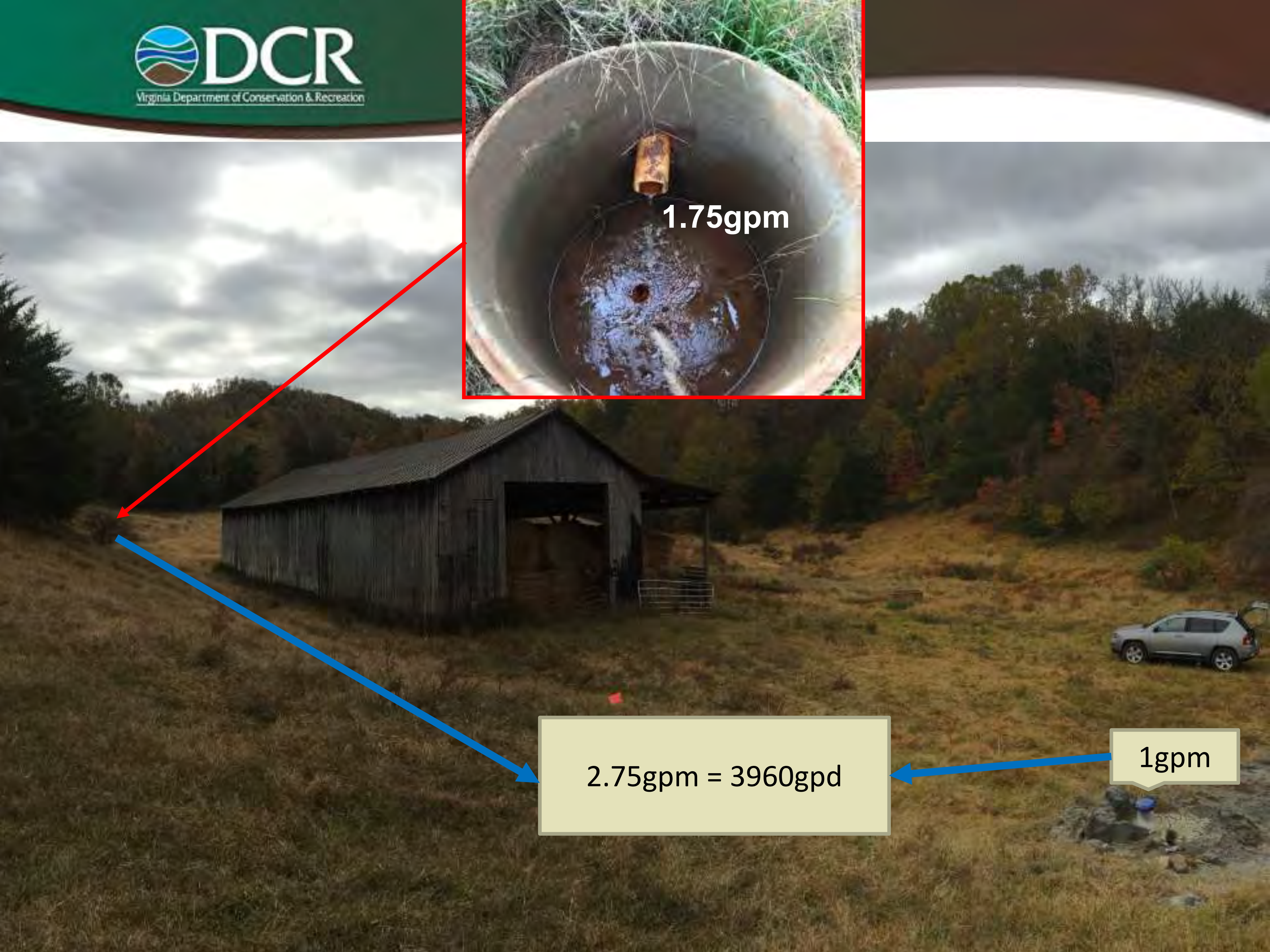
If **source daily yield** is less than Daily Demand, consider an alternate or supplemental water source.

2000gpd demand > 1440gpd supply

***Well alone is insufficient**

7. Pump Test

Static Water Level (unpumped level measured): ft.					
Date:	Method (Check One):	☐ Water Tape	☐ Airline	☐ Transducer	☐ Other
Stabilized measured pumping water level: 31 ft.					
Date:	Method (Check One):	☐ Top of Well	☐ Top of Casing	☐ Surface Level	
Test Pump Intake Depth: ft	Stabilized Yield: gpm after hours				
Natural Flow: ☑ Yes ☐ No	Flow Rate 1 gpm				


1.75gpm
2.75gpm = 3960gpd
1gpm

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Water Budget/Reservoir Sizing

Assuming 3 drinking events:

Assumptions:									
Reservoir Recharge Rate from Well + Spring Development: 2.75gpm									
1200 gallon reservoir = ~1000gallons of storage									
100 brood cows/pairs @ 20gpd = 2000 gpd									
2000gpd / 3 events = 667gal/event @ 12gpm delivery rate = 56min/event									
Description	Water in Reservoir	Time Start	Time Stop	Total Time (min)	Delivery Rate (From Reservoir)	Recharge Rate (To Reservoir)	Net Per Min	Total Net	Water In Reservoir
Drinking Event 1	1000	9:00	9:56	56	-12	2.75	-9.25	-518	482
Recharge	482	9:56	12:00	124	0	2.75	2.75	341	823
Drinking Event 2	823	12:00	12:56	56	-12	2.75	-9.25	-518	305
Recharge	305	12:56	15:00	124	0	2.75	2.75	341	646
Drinking Event 3	646	15:00	16:47	56	-12	2.75	-9.25	-518	128
Recharge	128	16:47	22:04	317	0	2.75	2.75	871.75	999.75

Note: This is a conservative method to ensure reservoir size is adequate, since the well pump will likely be designed to pump 2gpm (since that is the bottom end of the pumping range for 5gpm pumps). The well is also checked to make sure that it will be adequate and will not be pumped dry to refill the reservoir.

Water Budget/Reservoir Sizing

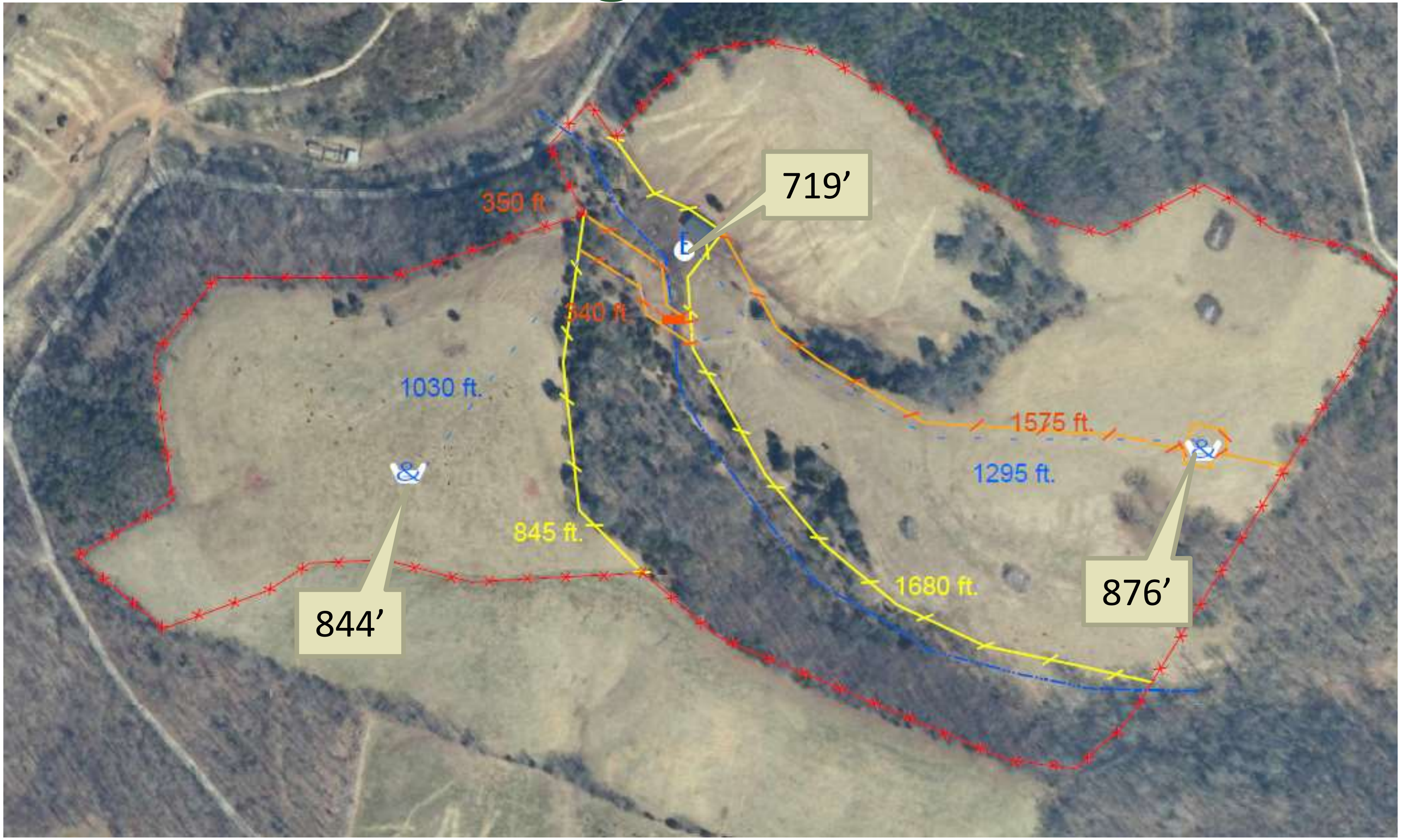
Assuming 2 drinking events:

Assumptions:									
Reservoir Recharge Rate from Well + Spring Development: 2.75gpm									
1200 gallon reservoir = ~1000gallons of storage									
100 brood cows/pairs @ 20gpd = 2000 gpd									
2000gpd / 2 events = 1000gal/event @ 12gpm delivery rate = 84min/event									

Description	Water in Reservoir	Time Start	Time Stop	Total Time (min)	Delivery Rate (From Reservoir)	Recharge Rate (To Reservoir)	Net Per Min	Total Net	Water In Reservoir
Drinking Event 1	1000	9:00	10:24	84	-12	2.75	-9.25	-777	223
Recharge	223	10:24	14:00	216	0	2.75	2.75	594	817
Drinking Event 2	817	14:00	15:24	84	-12	2.75	-9.25	-777	40
Recharge	40	15:24	23:13	349	0	2.75	2.75	959.75	999.75

Note: This is a conservative method to ensure reservoir size is adequate, since the well pump will likely be designed to pump 2gpm (since that is the bottom end of the pumping range for 5gpm pumps). The well is also checked to make sure that it will be adequate and will not be pumped dry to refill the reservoir.

Another Challenge: Elevation



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Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:	J Carter Farm
County:	Nelson
Date:	11/3/2016
Assisted By:	TCT

Project Notes: Planned well to 2 frost free troughs. All pipeline will 2". "Source flow rate" is a combination of the well flow rate (1.25gpm) and spring development flow rate (approx. 1.75gpm). The existing spring development will supply a reservoir by gravity flow, and the well pump will be on a float switch to the reservoir. The pump calculations in Section 4 below are for the pump in the reservoir to supply water to the troughs. 5 ft. will be added to total dynamic head on this pump because the pump will be 5ft. below the elevation of the pressure switch. NOTE: Pressure tank with an 80/100 switch will need to have a total volume of at least 71 gallons and be rated to a working pressure of 100psi

2) Water Budget

a) Total Daily Water Demand

Type of livestock:	Beef	
Number of Animals:	100	
Water demand/animal/day:	20	gpd
Total Daily Demand:	2000	gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

Number of times herd drinks/day:	3	events
Time desired to water herd:	60	minutes/event
Average peak demand:	11.1	gpm
Alternate peak demand:	12	gpm

See Design Note for considerations for estimating peak demand.

c) Evaluate Source

Source flow rate:	3	gpm
Source daily yield:	4320	gpd

If **source flow rate** is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).

If **source daily yield** is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

a) Trough information

Trough type(s):	6-Ball Frost-Free	
Design flow rate: Alternate Peak Demand	12.0	gpm

Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs, 5 gpm for storage troughs.

Maximum float valve pressure:	80	psi

Typical values range from 50-140 psi. Check manufacturer's recommendations.

Minimum float valve pressure:	10	psi

Varies depending on type of float. Use manufacturer's recommended minimum. Typical value is 10 psi.

b) Pipe information

Pipe material:	Plastic: SCH 40 PVC	
Pipe nominal diameter:	2"	
Pipe avg. inner diameter:	2.047	in.
Pipe cross-sectional area:	0.0229	sq. ft.
Friction loss/100 ft:	0.3	ft./100 ft.
Velocity check (<5 fps):	1.2	fps

If velocity is greater than 5 fps, consider a larger diameter pipe.

Pipe length to farthest watering point:	1214	feet = 404+... = 1046 (Reservoir Pump to Trough #2)
Add 10% for slope and fittings:	1335.4	feet
Total friction loss:	5	ft. OR
Total friction loss:	2.0	psi

If friction loss is greater than 10 psi, consider using a larger diameter pipe.

Pipe pressure rating:	280	psi
72% of rating (See VA CPS 516):	202	psi

Compare with result in Step 5b.

c) Vertical Pumping Distance

High point to pump "to":	Highest Trough (#2)	
Ground elev. of high point:	876	feet
Low point to pump "from":	pressure tank	
Ground elev. of low point:	720	feet
Elevation difference:	156	feet
OR	67.5	psi

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:

Elevation head:	67.5	psi	OR	156	feet
Friction loss:	2.0	psi	OR	5	feet
Minimum float valve pressure:	10	psi	OR	23	feet
Other:		psi	OR		feet
TOTAL REQUIREMENTS:	79.5	psi	OR	184	feet

b) Pressure Switch Settings Based on System Load:

Low pressure switch setting:	80	psi (Minimum is 20 psi.)
High pressure switch setting:	100	psi (Max. is usually 80 psi.)

If a high pressure switch setting of 80 psi or more is required, consider alternate design or high pressure-rated tank.

c) Dynamic Head added to pump by the watering system:

Dynamic head = higher switch setting of 100 psi x 2.31 = 231 feet + 5 ft = 236 ft (Pump is 5 ft below pressure switch)

Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

d) Minimum Effective Drawdown for Pressure Tank:

Design pumping rate of	12.0	gpm x
Minimum pumping time of	1	minute =
Minimum pressure tank volume of	12.0	gallons

This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure switch:

Elevation of highest point:	876.0	ft
Elevation of pressure switch:	720	ft
Low pressure switch setting =	80	psi
Static pressure on switch =	67.5	psi

If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:

Elevation of pressure switch:	720	feet			
Elevation of lowest trough:	844	feet			
Difference:	-124	feet	OR	-53.7	psi
Add high pressure switch setting:				100	psi
Total pressure at lowest trough:				46.3	psi

Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

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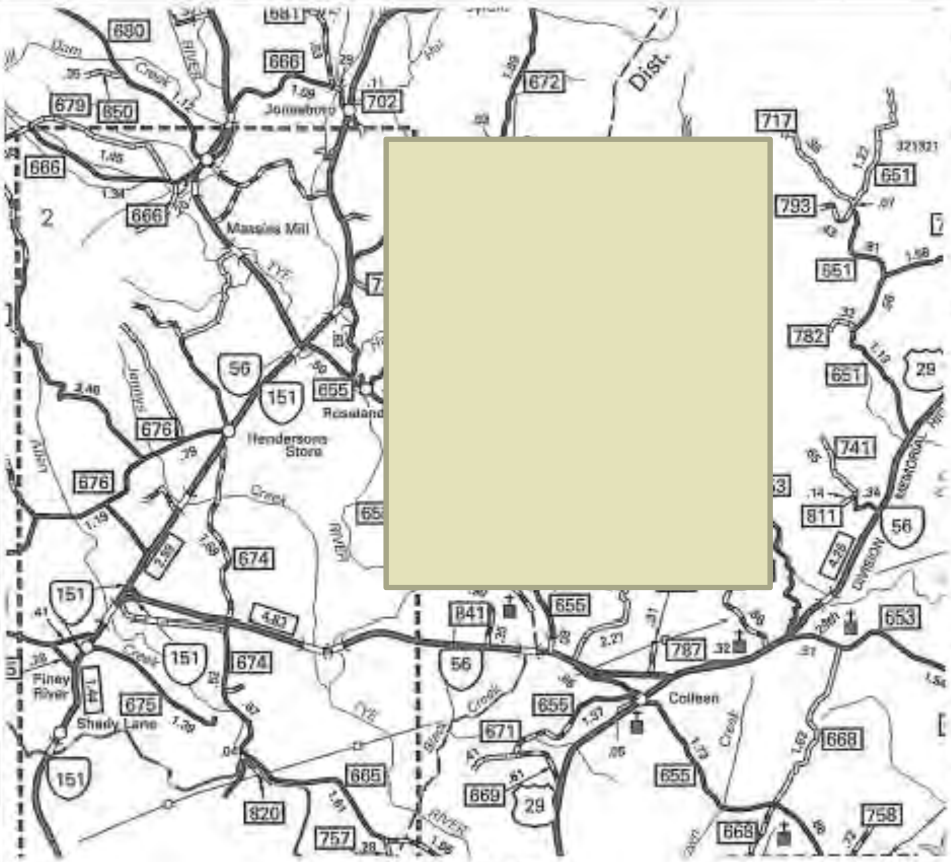


Site Location Map

Scale 1 inch = No Scale feet

Notes

1. The landowner/operator is responsible for obtaining and complying with all permits and easements. This includes all federal, state and local permits.
2. The landowner/operator is responsible for checking and complying with all local ordinances that may affect the project.
3. MISS UTILITY (Virginia telephone number 811) must be contacted at least 3 working days before construction begins. The landowner/operator is responsible for ensuring that the contractor contacts MISS UTILITY. The contractor must be able to provide the MISS UTILITY ticket number within 24 hours upon request by the NRCS/SWCD representative. The landowner/operator is responsible for locating any buried utilities (water lines, electric lines, telephone lines, gas lines, sewer lines, etc.) in the work area that are not covered by the MISS UTILITY program.
4. NRCS/SWCD makes no representation of the existence or nonexistence of utilities. The presence or absence of utilities on the construction drawings does not assure that there are or are not utilities in the work area.
5. The contractor is responsible for knowing and following the appropriate safety standards required by the Virginia Safety and Health Codes Board.
6. The landowner/operator shall notify the local NRCS/SWCD representative at least one week prior to beginning construction, and at all other times specified in this construction plan and attached specifications.
7. Any deviation from these construction drawings and specifications without written approval from NRCS/SWCD representative may result in in failure of this practice to meet NRCS Standards and the withdrawal of technical assistance for this project.
8. Prior to beginning construction, the cover sheet must be signed by the landowner/operator, the contractor, and the NRCS/SWCD representative. The landowner/operator is responsible for informing the contractor of these responsibilities by providing the contractor a copy of this cover sheet. The contractor must sign the cover sheet acknowledging that these responsibilities are understood and the landowner/operator must return the signed cover sheet to the NRCS/SWCD Representative. If requested by NRCS/SWCD, the landowner/operator shall arrange for a meeting between the contractor and NRCS/SWCD to review the construction drawings and specifications prior to construction.

The SWCD Representative for this project is:

The SWCD office telephone number is:

Benchmark Descriptions

TBM # Assumed Elev.
Description:

n/a

TBM # Assumed Elev.
Description:

n/a

Acknowledgment Signatures

These construction drawings and attached specifications have been reviewed. I understand what is required. (Sign and date below)

Landowner/Operator

Contractor

SWCD Representative

Engineering Job Class: IV

811 Know what's below. Call before you dig.

"As Built" Documentation

Certified By and Date

Practice Completion Date

Index of Sheets

Sheet No.	Title
1	Cover Sheet
2	Plan View
3	Pipeline Detail
4	Pipeline Profile
5	Reservoir Detail
6	Frost-Free Trough Detail
7	Miscellaneous Details
Attachments	Pressure System Worksheet
	Plan Map
	NRCS Practice Standards
	Construction Specs., O&M Agreement

Specification Table

No.	Title
VA-705	Pollution Control
VA-706	Seeding
VA-707	Site Preparation
VA-708	Salvaging & Spreading Topsoil
VA-711	Removal of Water
VA-721	Excavation
VA-730	Well
VA-731	Concrete Construction
VA-745	Plastic Pipe
VA-772	Watering Facility
VA-795	Geotextile

Table of Estimated Quantities

Item	Unit	Quantity
Fence	LF	4790
2" PVC-Schedule 40	LF	2400
2" PVC-Schedule 80 or Galvanized	LF	60
6-Ball Frost Free Automatic Trough	EA	2
Earth Tube or Corrugated Plastic Pipe	EA	2
3500 PSI Concrete	CY	7
6" x 6" 6/6 Gauge Welded Wire	SF	100
1-2" size stone (VDOT#57/357) ***EXTRA needed to bed reservoir	TON	24
Non-Woven Geotextile Filter Fabric	LF	80
Pump, pressure tank, pressure switch, shelter	EA	1
Class 3 Well with Pump and Float Switch	EA	1
Seed, Straw, and Mulch for Disturbed Area	AC	0.5
1,200 gallon Concrete Reservoir	EA	1
Misc. cutoff/drain valves, valve boxes, plumbing fittings	JOB	1

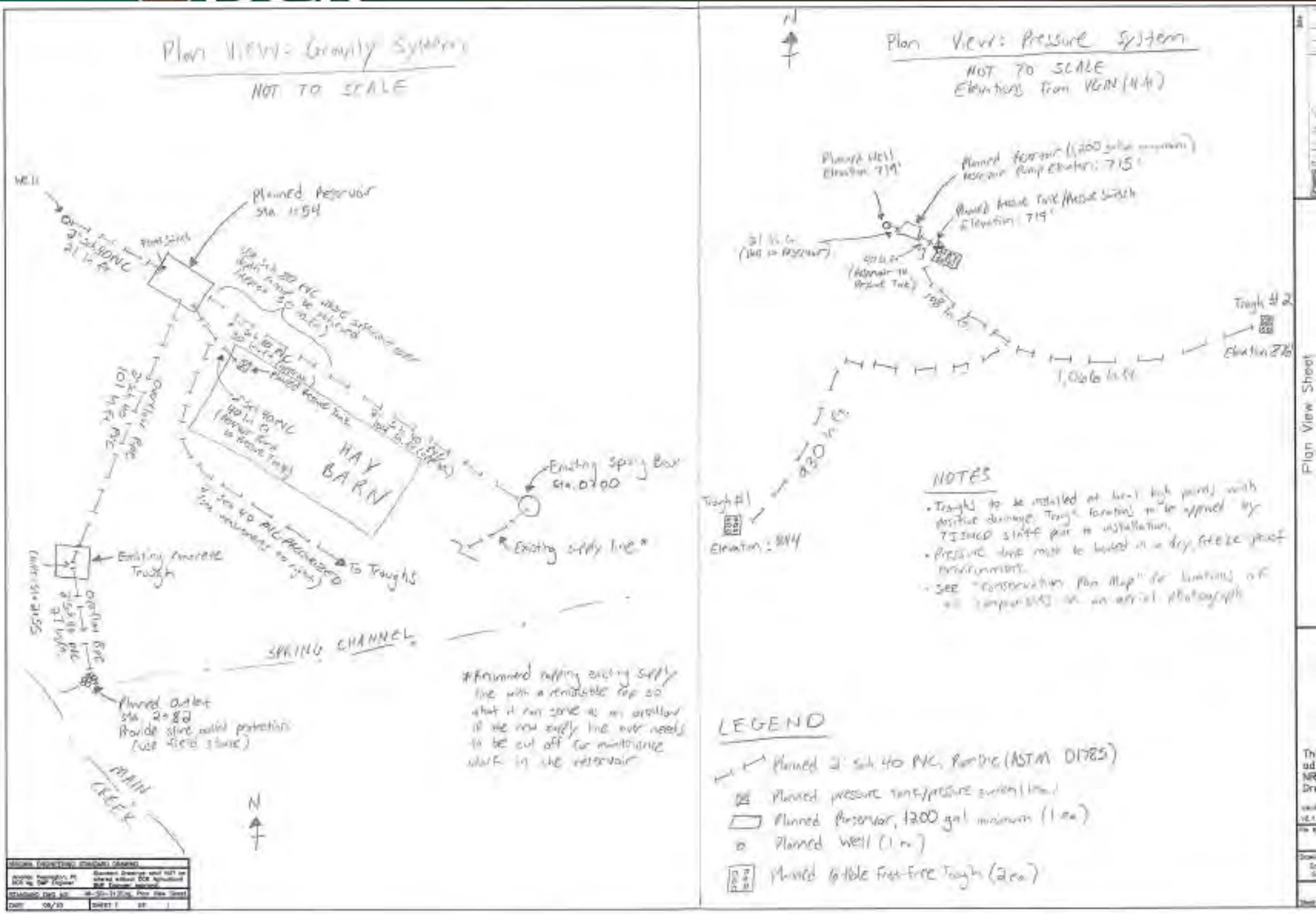
Engineering Design Cover Sheet

DCR

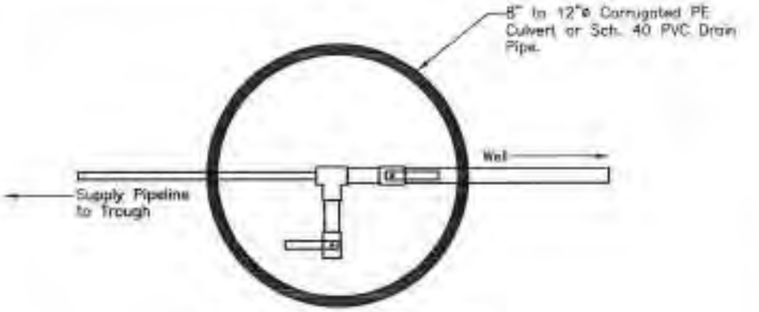
This drawing adapted from NRCS Standard Drawing VA-SO-100 v2.4.0

Sheet 1 of 7

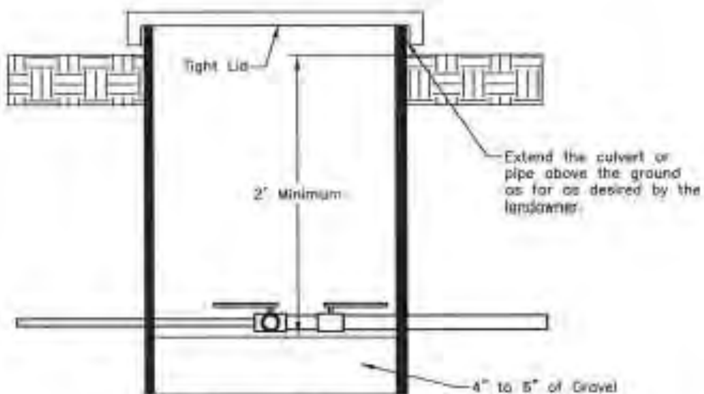
DCR



Plan View: Gravity System
NOT TO SCALE
Planned Reservoir
Sta. 1+54
HAY BARN
Existing Spring Box
Sta. 0+00
Existing supply line*
To Troughs
Existing Concrete Trough
SPRING CHANNEL
Planned outlet
Sta. 2+82
Provide stone outlet protection
(use field stone)
MAIN CREEK
N
*Recommend capping existing supply line with a removable cap so that it can serve as an overflow if the new supply line ever needs to be cut off for maintenance work in the reservoir
Plan View: Pressure System
NOT TO SCALE
Elevations from VGIN (ft)
N
Planned Well
Elevation: 719'
Planned Pressure Tank/Pressure Switch
Elevation: 719'
Trough #2
Trough #1
Elevation: 844
1,066 lin ft
430 lin ft
NOTES
- Troughs to be installed at local high points with positive drainage. Trough locations to be approved by TISWCD staff prior to installation.
- Pressure tank must be located in a dry, freeze proof environment.
- See "Conservation Plan Map" for locations of all components on an aerial photograph
LEGEND
Planned 2" sch 40 PVC, Pipeline (ASTM D1785)
Planned pressure tank/pressure switch (1 ea.)
Planned Reservoir, 1200 gal minimum (1 ea.)
Planned Well (1 ea.)
Planned 6-Hole Frost-Free Trough (2 ea.)
Plan View Sheet



Trough Supply Line Drain Detail
Top View
Not to Scale



Trough Supply Line Drain Detail*
Side View
Not to Scale

*Recommend one per trough

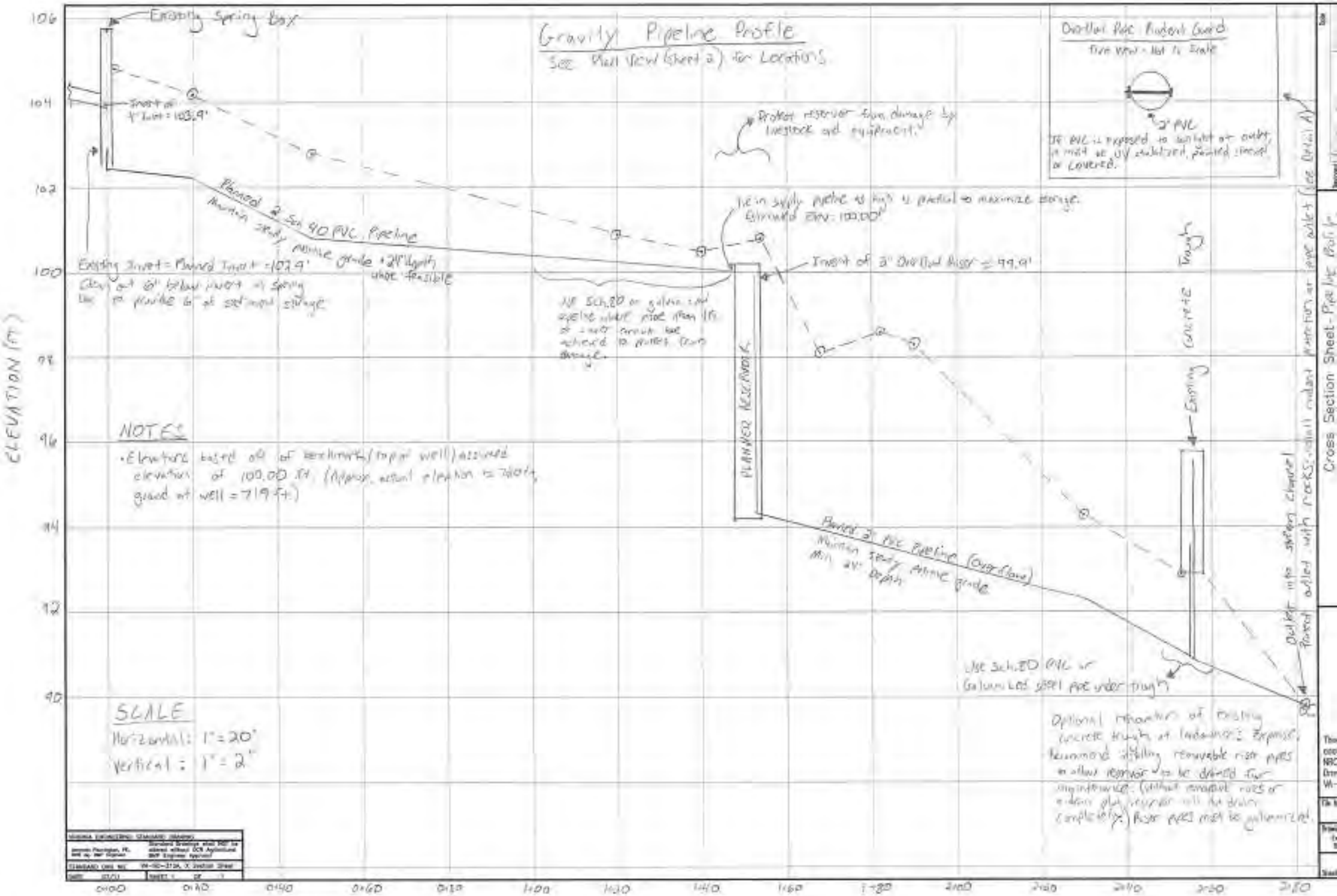
Design Parameters	
Estimated Total Daily Demand =	2000 Gal
Estimated Supply Rate (State as an assumed value if the well has not been completed) =	4320 GPD
Estimated Peak Demand =	12 GPM

Watering Trough(s)	
Type of Trough =	6-Hole Frost-Free Trough
Number of Troughs =	2
Note: All troughs are to be installed on short lateral pipelines (Supply Pipeline) with a shut-off valve and drain valves for supply pipeline	
Additional Trough Notes: Pressure reducers, high pressure float valves, etc.	

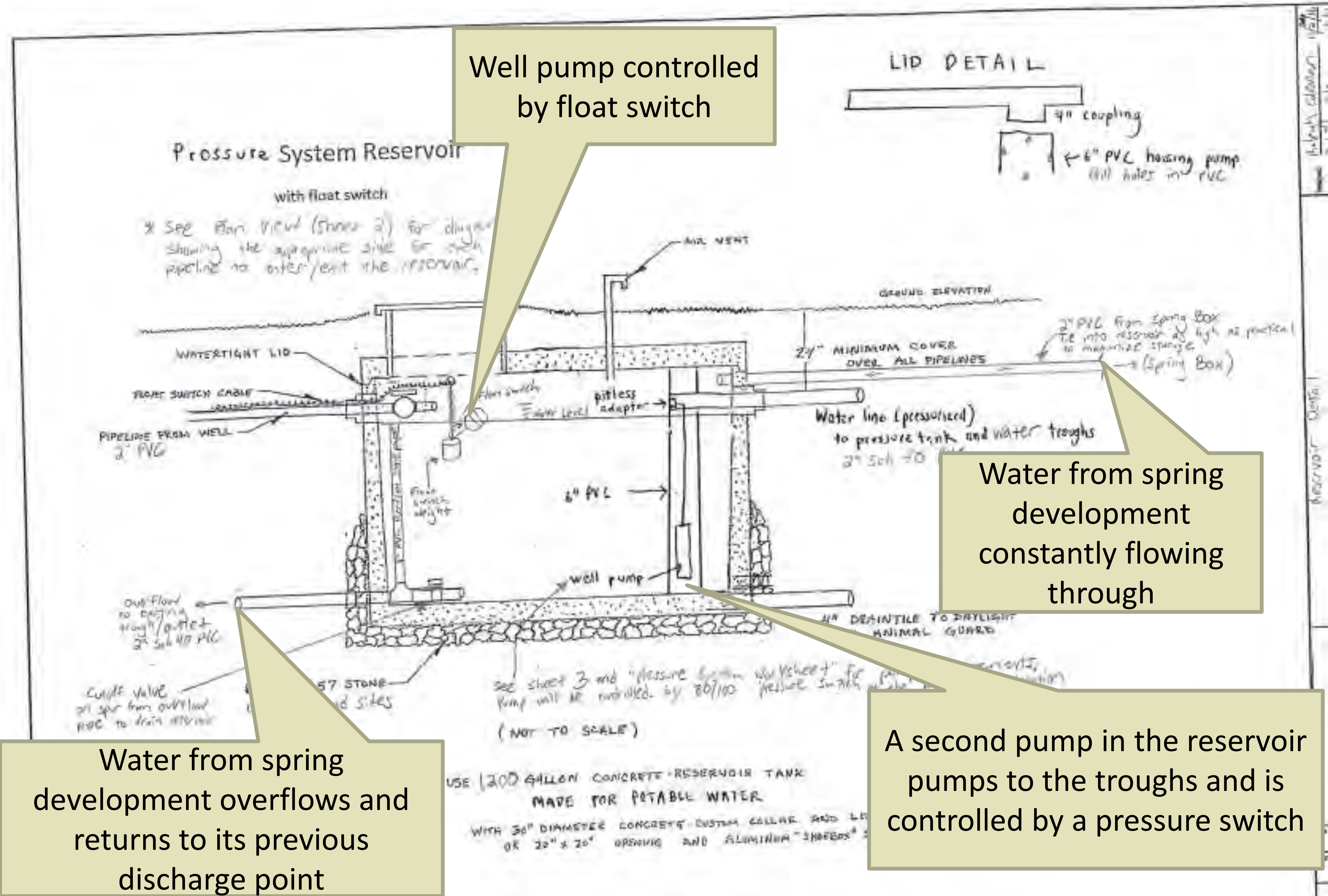
Pipeline Data	
Main Pipeline Diameter =	2 in
Main Pipeline Type (PE, SCH 40 PVC, etc.) and ASTM # =	SCH40 PVC (ASTM D1785) and SCH80 PVC
Supply Pipeline(s) (Short Laterals to Trough) Diameter =	2 in
Supply Pipeline Type (PE, SCH 40 PVC, etc.) and ASTM # =	SCH40 PVC (ASTM D1785) and SCH80 PVC
Additional Pipeline Notes: See standard notes below.	

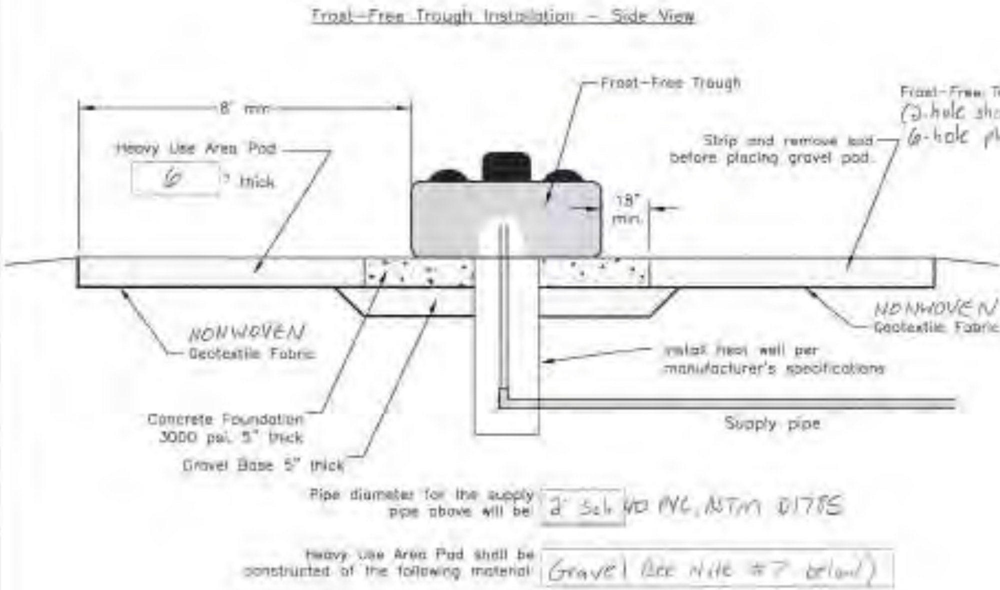
Pumping Plant Data *Calculations are for pump in reservoir.		
Above Ground Dynamic Head =	236 Ft	on pump in reservoir
Desired Pumping Rate =	12 GPM	
Pressure Required for Pumping Rate above =	- PSI	
For Systems Using Pressure Tanks... Pressure tank Minimum Effective Drawdown =	12 Gal	
For Systems Using Pressure Tanks... Pressure switch settings are =	80/100 xx/xx PSI	
For Systems using a Reservoir... Pumping Intervals per day =	Use Float Switch Ea	on well pump
For Systems using a Reservoir... Length of Pumping Intervals =	Use Float Switch Mins	
For Systems using a Reservoir... Reservoir Capacity (usually a 3 day supply) =	1,200 Gal	
Additional Notes: If multiple reservoirs are used, provide sufficient spacing to compact soil around each reservoir so that reservoir walls do not collapse. Overflow protection is required for reservoirs. Pressure tank must be housed in a dry, freeze-proof environment. See Sheet 5 and VA-773 for reservoir details.		

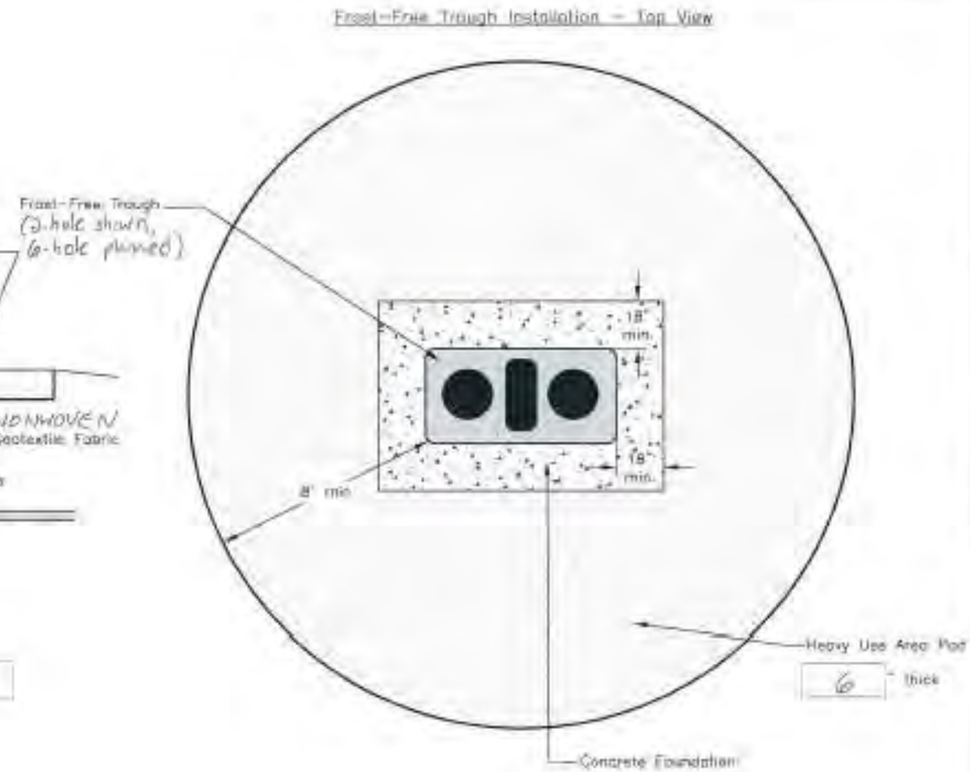
1. Install all pipelines according to Virginia Construction Specification Plastic Pipe (VA-745).
2. Protect all pipelines from frost, livestock, and equipment traffic. Where possible, install pipelines a minimum of two feet in the ground.
3. The pipe trench must be free of loose rocks before installing the pipeline. In rocky soils, bed the pipe in selected material free of rocks or the pipeline may be placed in a sleeve. The pipeline will be pressure tested at the working head prior to backfilling. Repair any leaks and repeat the test. Compact all backfill for underground pipes to the degree required to prevent the ditch from caving after construction.
4. Grade all pipelines with gravity flows to prevent unvented crests in the pipelines. These unvented crests will cause gravity pipelines to air lock and not flow.
5. Install sufficient cutoff valves in the pipeline to allow control of water flow to the watering facilities. Install valves in a housing that is frost proof, well drained, readily accessible and protected from livestock. A means of draining the water from pipelines not in use, will be provided.
6. Install a check valve (or backflow preventor, if required) to prevent water from flowing back into the water source from a watering facility.
7. Seed all disturbed areas at the rates given in Virginia Construction Specification Seeding (VA-706). If seeding is done outside recommended seeding dates, use a nurse crop.
8. Pressure tank must be rated to a working pressure of 100 psi and must have a total volume of at least 71 gallons with a 80/100 pressure switch


Gravity Pipeline Profile
See Plan View (Sheet 2) for Locations
Existing Spring Box
Overflow Pipe Rodent Guard
Not to Scale
2" PVC
Planned 2" Sch 40 PVC Pipeline
Follow grade
Protect reservoir from damage by livestock and equipment.
Invert of 2" Overflow Riser = 99.9'
PLANNED RESERVOIR
Concrete Trough
Existing
NOTES
•Elevations based off of benchmark (top of well) assumed elevation of 100.00 ft. (Approx. actual elevation = 719 ft.)
SCALE
Horizontal: 1" = 20'
Vertical: 1" = 2'
Cross Section Sheet - Pipeline Profile
ELEVATION (FT)
106
104
102
100
98
96
94
92
90
0+00
0+20
0+40
0+60
0+80
1+00
1+20
1+40
1+60
1+80
2+00
2+20
2+40
2+60
2+80

DCR


Pressure System Reservoir
with float switch
LID DETAIL
4" coupling
6" PVC housing pump
AIR VENT
GROUND ELEVATION
24" MINIMUM COVER OVER ALL PIPELINES
WATERTIGHT LID
FLOAT SWITCH CABLE
PIPELINE FROM WELL 2" PVC
pitless adapter
Water line (pressurized) to pressure tank and water troughs
6" PVC
well pump
4" DRAINTILE TO DAYLIGHT ANIMAL GUARD
57 STONE
(NOT TO SCALE)
USE 1200 GALLON CONCRETE RESERVOIR TANK MADE FOR POTABLE WATER
Well pump controlled by float switch
Water from spring development constantly flowing through
Water from spring development overflows and returns to its previous discharge point
A second pump in the reservoir pumps to the troughs and is controlled by a pressure switch





Frost-Free Trough Detail

Construction Notes

1. The ground under and around the trough location shall be cleared of all material not suited for the subgrade, including sod. All loose surface soil shall be removed to undisturbed material.
2. The concrete foundation for the trough shall extend a minimum of 18" past the edges of the trough. Concrete shall be 3000 psi, and installed a minimum of 5" thick. 6"x6" 6/6 gage welded wire mesh reinforcing shall be used in the 5" slab.
3. Position the heat well and pipelines per manufacturer's recommendations. The concrete foundation dimensions recommended by the manufacturer will be used <u>if the dimensions are larger than those in note 2</u>. The trough must be attached to the concrete foundation per manufacturer's recommendations.
4. A valve shall be installed in the supply pipeline to regulate flow to the trough. The valve should be installed in a housing that is frost proof, well drained, readily accessible and protected from livestock. A means of draining the supply pipeline between the valve and the trough shall be provided.
5. All backfill for pipelines under the trough shall be compacted to the degree required to prevent caving after construction. Backfill under the trough may be select compacted earthfill or granular fill such as VDOT #21 or crusher run.
6. The trough site shall be free draining.
7. A protective surface shall be placed around the trough. At the minimum, install geotextile fabric around the trough and then place VDOT #57, VDOT #21A or crusher run around the trough six inches deep. Other types of materials may be installed with approval of the designer. The protective surface shall extend at least 8 feet from each side of the trough.
8. Geotextile shall meet the Class I requirements for nonwoven geotextile in Virginia Construction Specification Geotextiles (VA-795). Class II may be used with engineers approval.
9. Seed all disturbed areas at the rates given in Virginia Construction Specification Seeding (VA-706).

* If seeding is done outside recommended seeding dates, a nurse crop is to be used.

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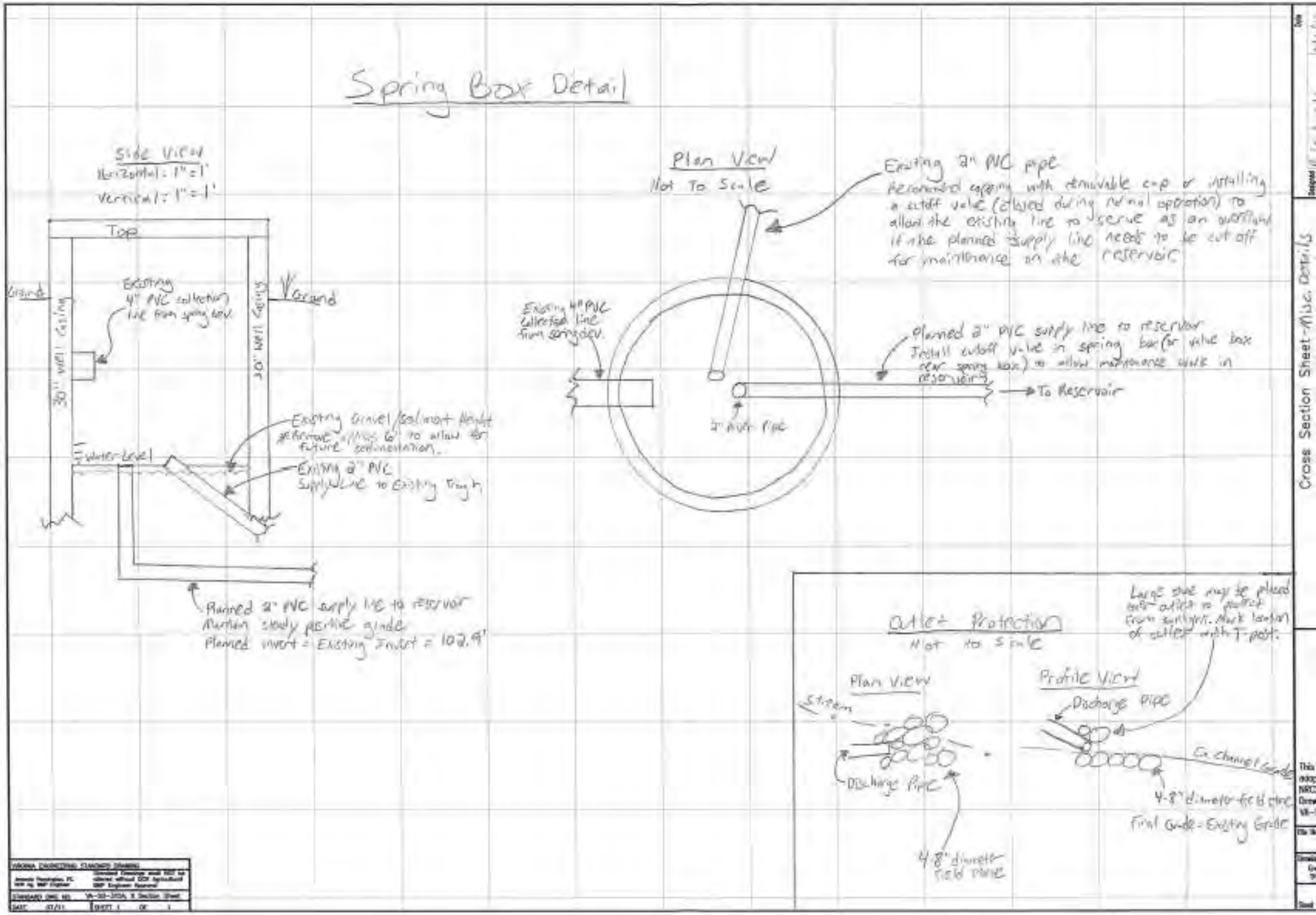
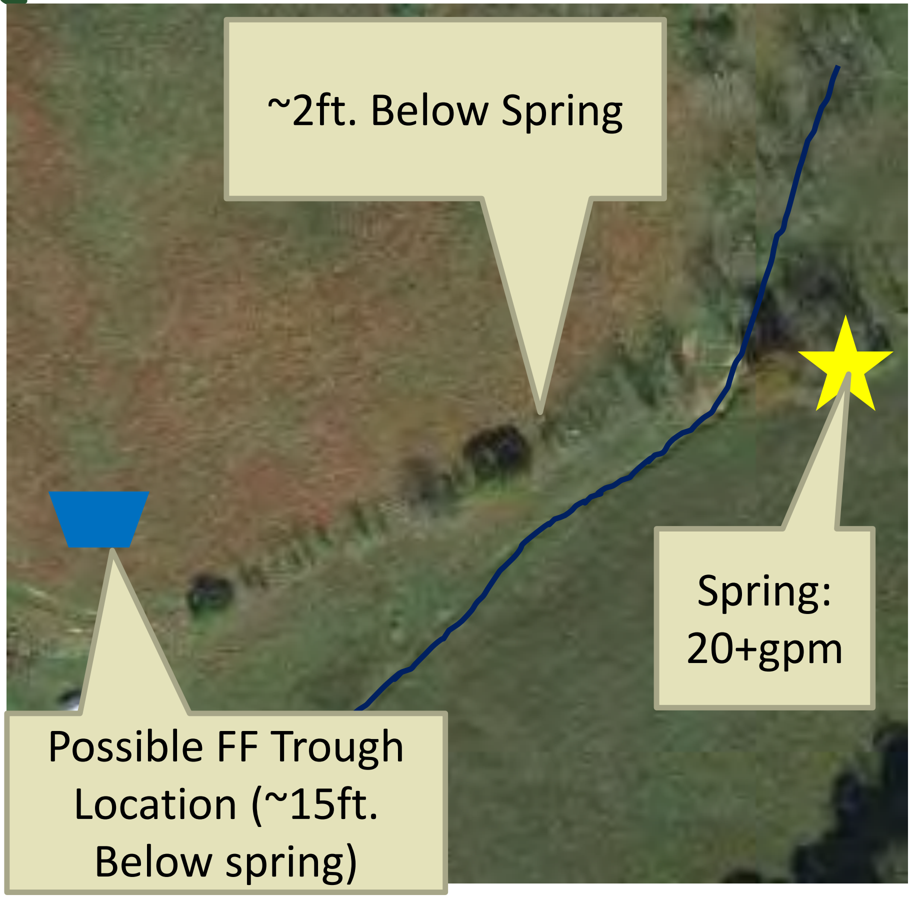
Virginia Department of Conservation & Recreation



Case Study #2: Meeting Spring Development Criteria with No Float Valve

- 35 cow/calf pairs
- Landowner trying to keep cost down
- Generating enough fall for a frost-free trough with float would've required much more pipe length



Source Flow Rate Evaluation

- Will the livestock use less than 25% of the daily yield of the spring?

2) Water Budget

a) Total Daily Water Demand

Type of livestock:	Cow/Calf	
Number of Animals:	35	
Water demand/animal/day:	25	gpd
Total Daily Demand:	875	gpd

See Design Note for watering recommendations for various types of livestock.

c) Evaluate Source

Source flow rate:	20	gpm
Source daily yield:	28800	gpd

If **source flow rate** is close to or less than Peak Demand, consider storage alternatives.

If **source daily yield** is less than Daily Demand, consider an alternate or supplemental water source.

25% of 28800gal = 7200gpd

875gpd << 7200gpd

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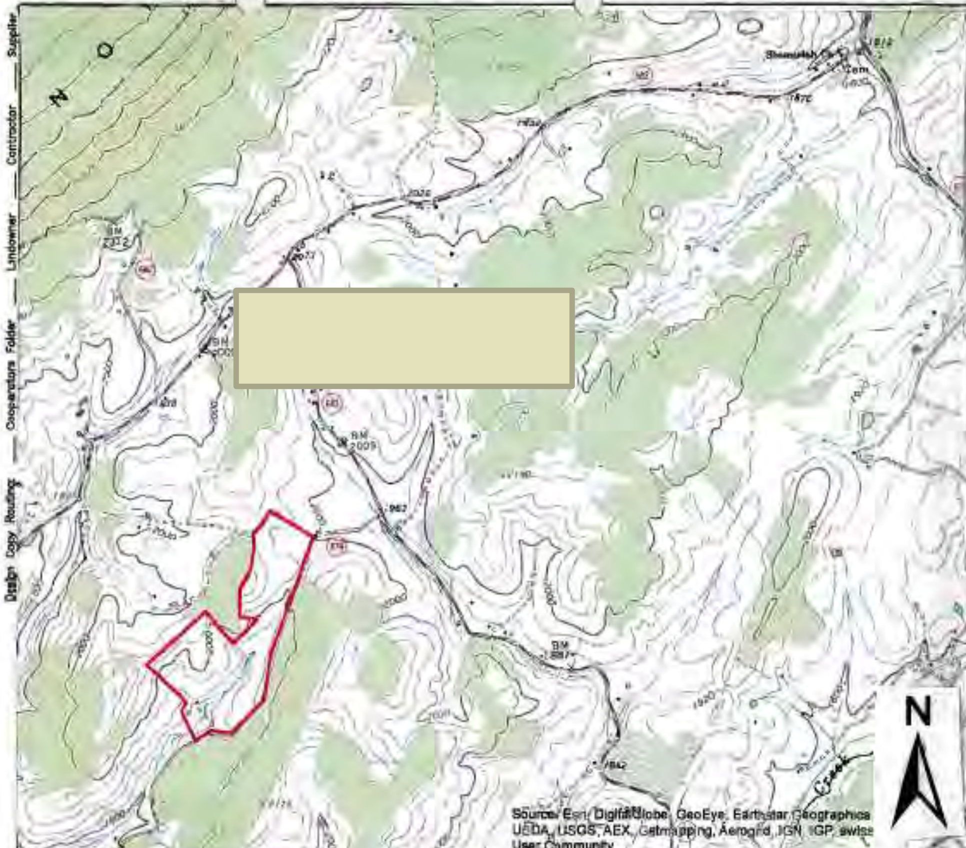
Virginia Department of Conservation & Recreation



Site Location Map

Scale 1 inch = 2000 feet

Notes

1. The landowner/operator is responsible for obtaining and complying with all permits and easements. This includes all federal, state and local permits.
2. The landowner/operator is responsible for checking and complying with all local ordinances that may affect the project.
3. MISS UTILITY (Virginia telephone number 811) must be contacted at least 3 working days before construction begins. The landowner/operator is responsible for ensuring that the contractor contacts MISS UTILITY. The contractor must be able to provide the MISS UTILITY ticket number within 24 hours upon request by the DCR/SWCD representative. The landowner/operator is responsible for locating any buried utilities (water lines, electric lines, telephone lines, gas lines, sewer lines, etc.) in the work area that are not covered by the MISS UTILITY program.
4. DCR/SWCD makes no representation of the existence or nonexistence of utilities. The presence or absence of utilities on the construction drawings does not assure that there are or are not utilities in the work area.
5. The contractor is responsible for knowing and following the appropriate safety standards required by the Virginia Safety and Health Codes Board.
6. The landowner/operator shall notify the DCR/SWCD representative at least one week prior to beginning construction, and at all other times specified in this construction plan and attached specifications.
7. Any deviation from these construction drawings and specifications without written approval from DCR/SWCD representative may result in failure of this practice to meet NRCS Standards and the withdrawal of technical assistance for this project.
8. Prior to beginning construction, the cover sheet must be signed by the landowner/operator, the contractor, and the DCR/SWCD representative. The landowner/operator is responsible for informing the contractor of these responsibilities by providing the contractor a copy of this cover sheet. The contractor must sign the cover sheet acknowledging that these responsibilities are understood and the landowner/operator must return the signed cover sheet to the DCR/SWCD Representative. If requested by DCR/SWCD, the landowner/operator shall arrange for a meeting between the contractor and DCR/SWCD to review the construction drawings and specifications prior to construction.

The SWCD Representative (include [redacted]
The SWCD office telephone numb [redacted]
The SWCD office address is:

Benchmark Descriptions

TBM #	1	Assumed Elev.	895.47
Description: Top of Rose Quartz rock 5 ft. left of spring box L.D.S.			
TBM #	2	Assumed Elev.	1840.45
Description: Nail in root of 16" DBH walnut tree, 25 ft. right of stream downstream of where small spring joins creek.			

Acknowledgment Signatures

These construction drawings and attached specifications have been reviewed I understand what is required. (Sign and date below)

Landowner/Operator

Contractor

SWCD Representative

Engineering Job Class: II

811 Know what's below. Call before you dig.

"As Built" Documentation

Certified By and Date

Practice Completion Date

Index of Sheets

Sheet No.	Title
1	Cover Sheet
2	Plan View
3	Pipeline Profile
4	Pipeline Detail
5	Spring Box Detail
6	Spring Drmt. Details
7	Concrete Trough Detail
	Attachments
	NRCS Construction
	specs. AND NRCS
	O+M agreements

Specification Table

No.	Title
VA-705	Pollution Control
VA-706	Seeding
VA-707	Site Preparation
VA-708	Salvaging & Spreading Topsoil
VA-711	Removal of Water
VA-721	Excavation
VA-723	Earthfill
VA-731	Concrete Construction
VA-745	Plastic Pipe
VA-761	Loose Rock Riprap
VA-772	Watering Facility
VA-795	Geotextile

Table of Estimated Quantities

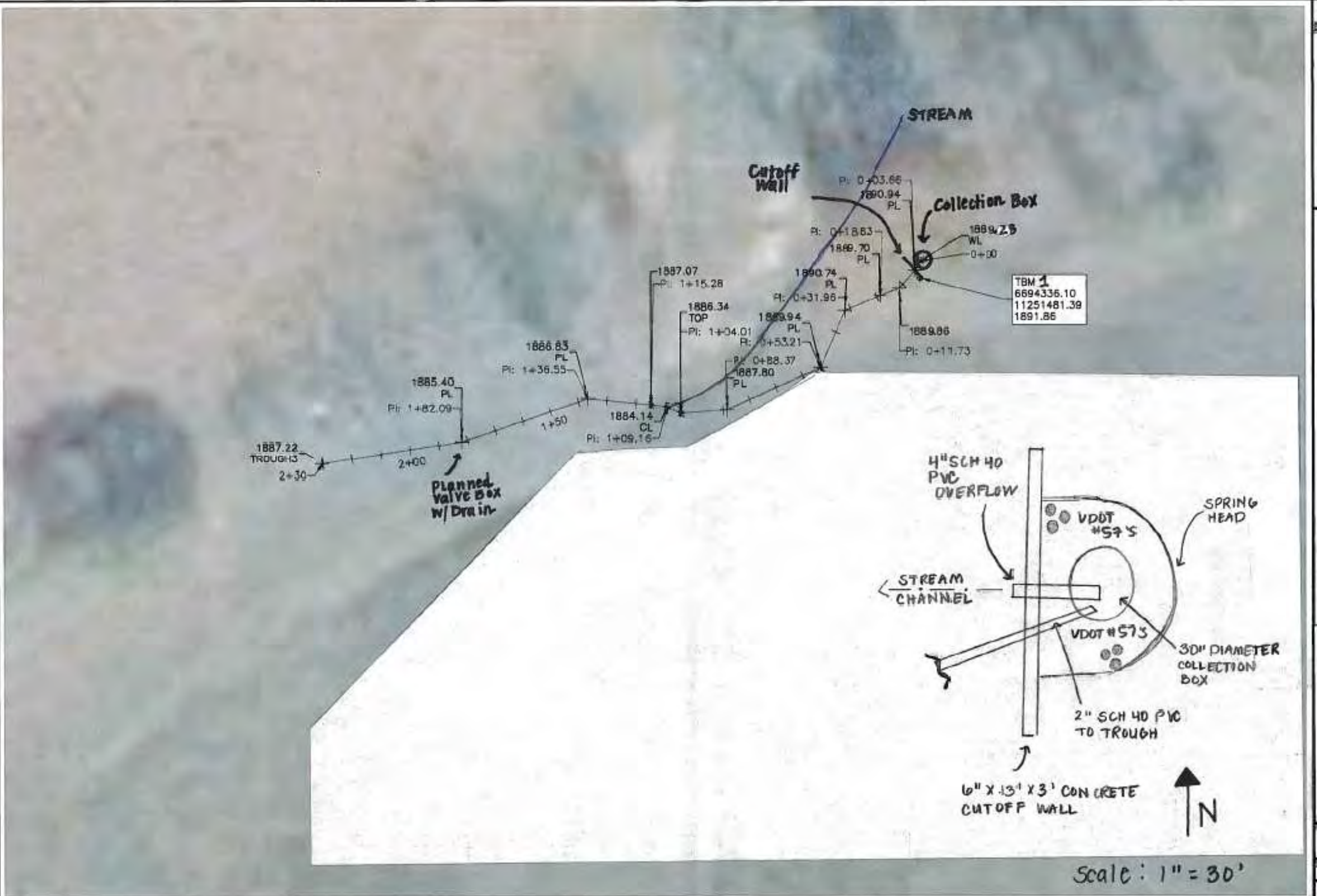
Item	Unit	Quantity
30" x 30" concrete well casing w/lid	EA.	1
2" sch. 40 PVC ASTM D1785 w/bell ends	LN. FT	240
3500 PSI concrete for cutoff wall	CU. YD.	0.75
VDOT #57 (CLEAN STONE) for collection area	TONS	6
4" Sch. 40 PVC ASTM D1785	LN. FT	5
250 Gallon concrete trough	EA.	1
6" x 6" 6/6 Gague welded wire mesh (For cut-off wall)	SQ. FT.	40
Valve box w/ ball valve	EA.	1
Non-woven Geotextile	SQ. FT.	480
VDOT #57, #21A, or crusher run for trough pad	TONS	18
Seed + Mulch to meet VA-706	JOB	1
Sch. 80 PVC or Galvanized steel pipe	LN. FT	10

Engineering Design Cover Sheet

This drawing adapted from NRCS Standard Drawing VA-SO-100 v2.4.0

Sheet 1 of 7

DCR


STREAM
Cutoff Wall
Collection Box
PI: 0+03.66
1890.94
PL
PI: 0+18.63
1889.70
PL
1889.28
WL
0+00
TBM 1
6694336.10
11251481.39
1891.86
1889.86
PI: 0+11.73
1890.74
PL
PI: 0+31.96
1889.94
PL
PI: 0+53.21
PI: 0+88.37
1887.80
PL
1887.07
PI: 1+15.28
1886.34
TOP
PI: 1+04.01
1884.14
CL
PI: 1+09.16
1886.83
PL
PI: 1+36.55
1+50
1885.40
PL
PI: 1+82.09
2+00
1887.22
TROUGH3
2+30
Planned Valve Box w/ Drain
4" SCH 40 PVC OVERFLOW
STREAM CHANNEL
VDOT #57'S
SPRING HEAD
VDOT #57'S
30" DIAMETER COLLECTION BOX
2" SCH 40 PVC TO TROUGH
6" X 13' X 3' CONCRETE CUTOFF WALL
N
Scale: 1" = 30'

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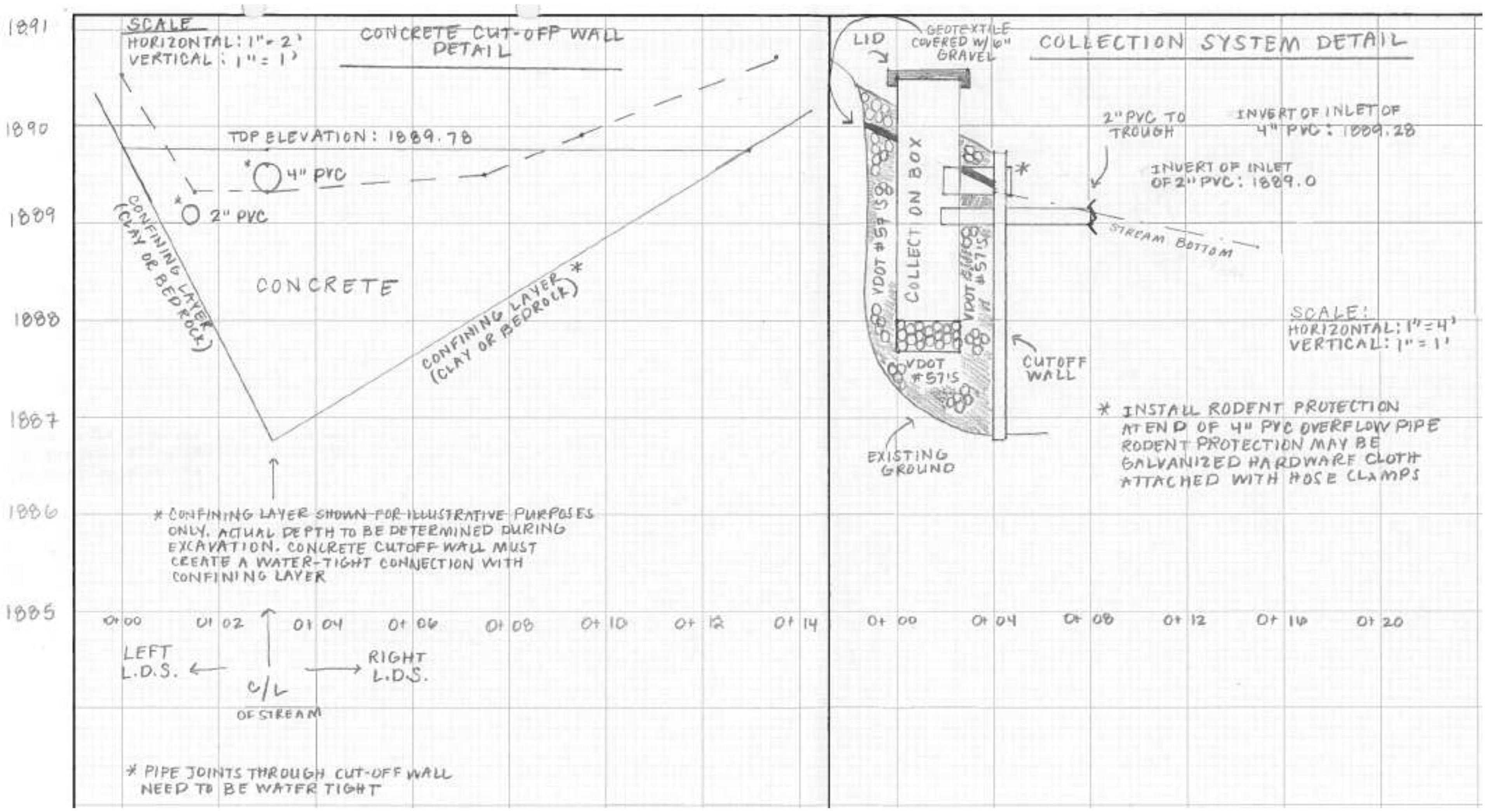
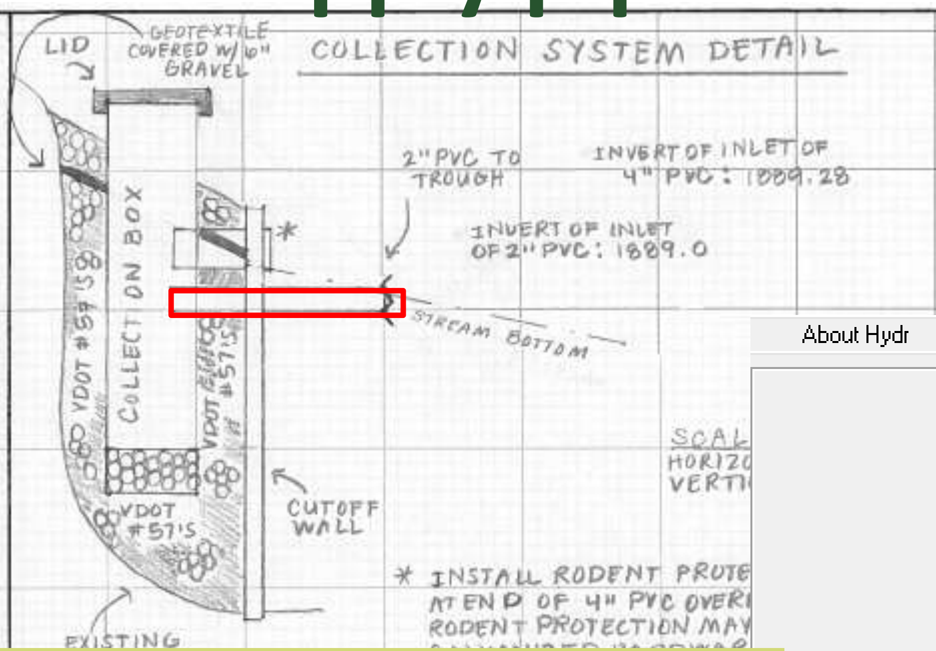
Virginia Department of Conservation & Recreation

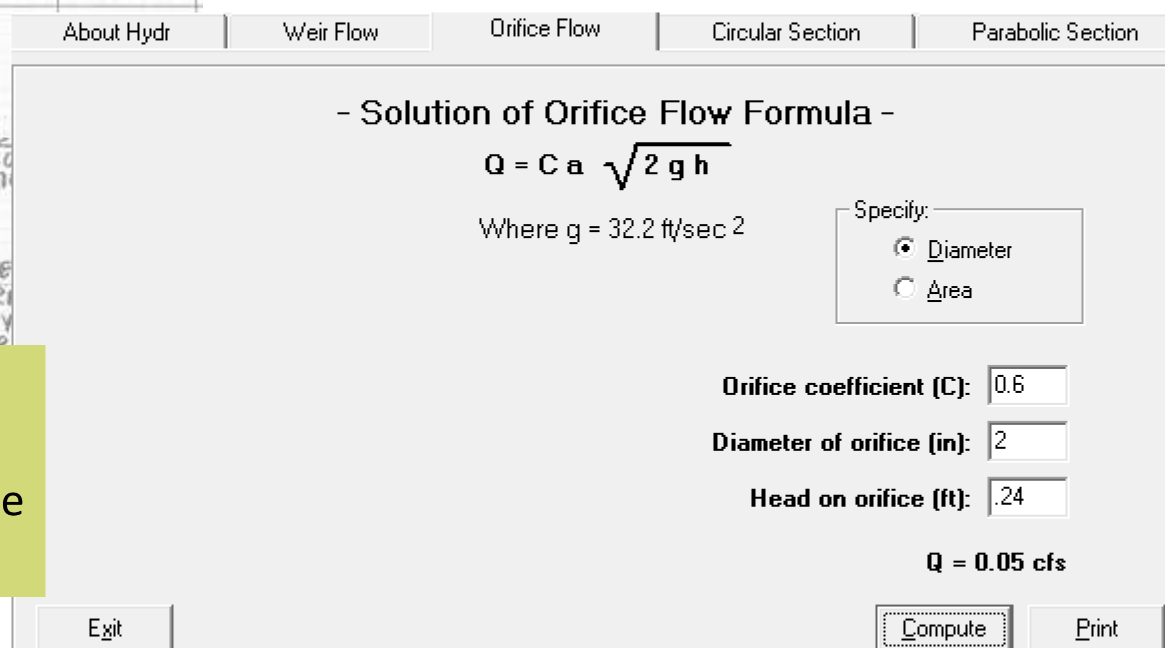


Virginia Department of Conservation & Recreation

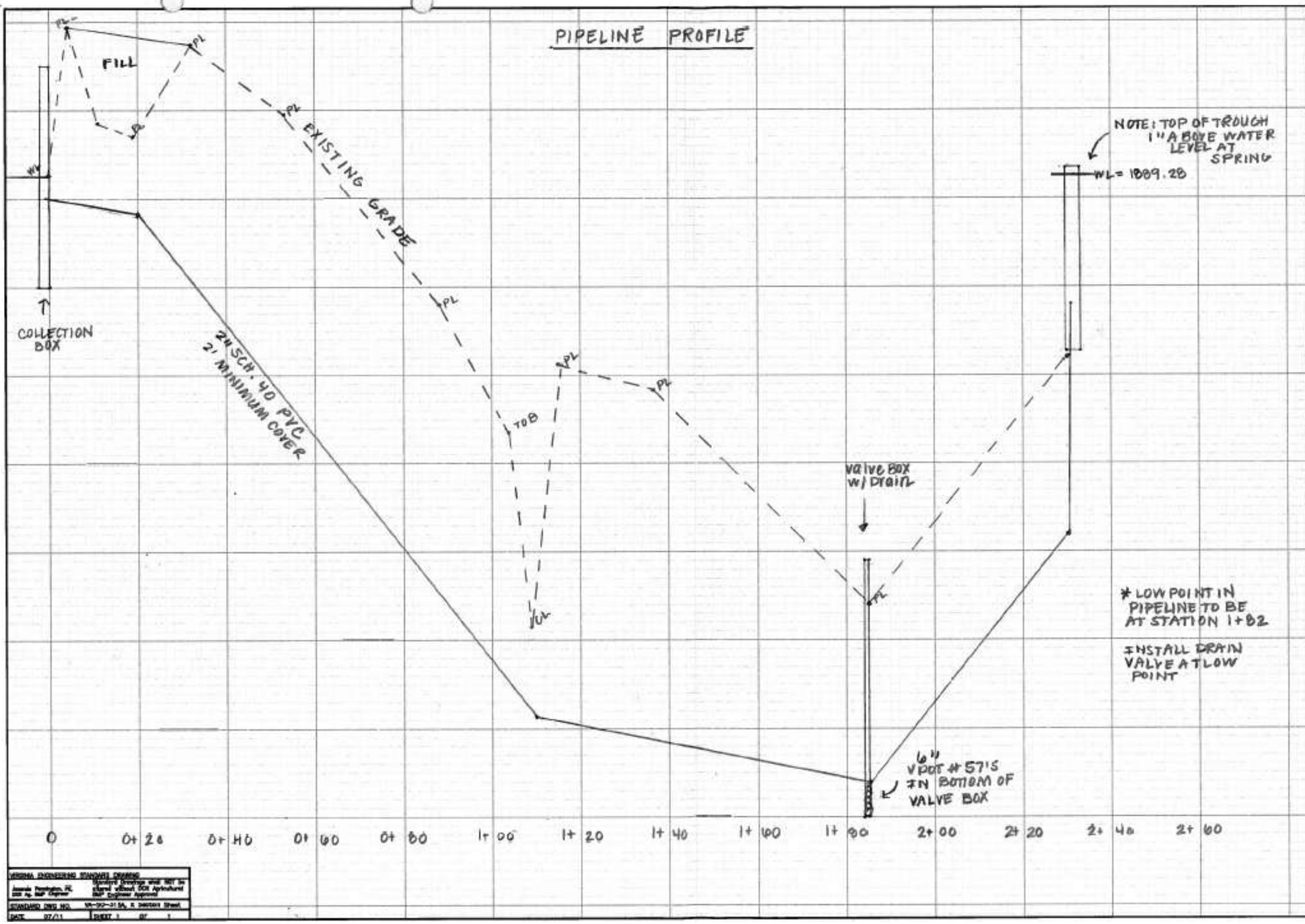
How much water can the orifice of the 2" supply pipe to the trough accept?



Head on Orifice:
Water Level: 1889.28
Center of 2" Pipe: 1889.04
Head = 1889.28-1889.04 = **0.24'**



Q = 0.05cfs*(7.48gal/cf)*(60sec/min) = **22.44gpm**
Therefore, the orifice will not limit the flow to the trough.


PIPELINE PROFILE
1891
1890
1889
1888
1887
1886
1885
1884
1883
1882
0
0+20
0+40
0+60
0+80
1+00
1+20
1+40
1+60
1+80
2+00
2+20
2+40
2+60
FILL
PL
WL
COLLECTION BOX
EXISTING GRADE
TOB
2" SCH. 40 PVC
2' MINIMUM COVER
Valve Box w/ Drain
6" VPOT # 57'S IN BOTTOM OF VALVE BOX
NOTE: TOP OF TROUGH 1" ABOVE WATER LEVEL AT SPRING
WL = 1889.28
* LOW POINT IN PIPELINE TO BE AT STATION 1+82
INSTALL DRAIN VALVE AT LOW POINT
VIRGINIA ENGINEERING STANDARD DRAWING
STANDARD DWG NO.
DATE 07/11
SHEET 1 OF 1

How much water can the supply pipe carry to the trough?

- Assume cattle have consumed water so that only 6” of water remains in the trough.
- Elevation difference between water level in spring and water level in trough is 1.6’.

recommended minimum. Typical value is 10 psi.

c) Gravity System Parameters

W/L @ Spring

~~Reservoir grnd elev or spring box outlet elev:~~	1889.28	ft
Reservoir depth below ground (typically 6'):	0	ft
Reservoir bottom (elev for computing head):	1889.28	ft

4) Flow and Static Pressure Checks

TROUGH ELEVATIONS:

Enter trough elevations from survey data. For cascade-type systems, enter trough elevations in order from highest to lowest.

Trough ID and Type	Trough Ground Elev. (ft)	Estimated Water Surface Elev. (ft)
T1: Storage	~~1885.7~~	1887.7
		W/L in trough
		when cattle have
		drank it down to
		6" off the bottom

Trough water surface elevation is assumed to be 2 ft above ground elevation.

CALCULATIONS FOR FLOAT-VALVE SYSTEMS:

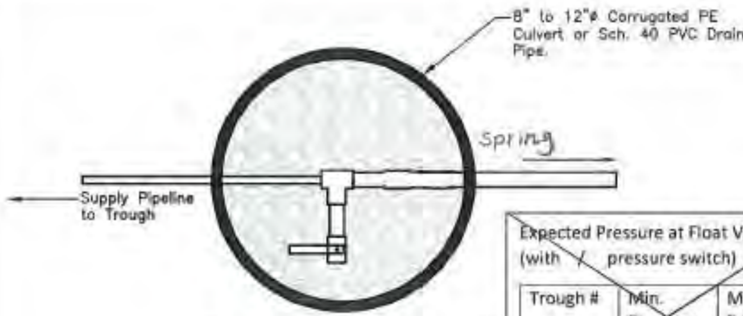
Troughs are tee-ed off from the main line, with flow to each trough controlled by a float valve. Pipe length is measured from the reservoir or spring box.

Pipe Length from Reservoir or Spring Box to Trough (ft)	Head from Reservoir or Spring Box (ft)	Maximum Flow Rate (gpm)	Static Pressure (psi)
230	1.6	13.7	1.5

Flow calculations assume a float valve efficiency of 80%. For flow rates less than the design rate (yellow cells), consider modifying the system or using storage troughs (such as HETT or concrete). If static pressures exceed the manufacturer's recommended maximum for the float valve, consider using a pressure reducer, adjusting the orifice, or relocating the trough. If static pressures are less than the recommended minimum (red cells), consider moving the trough to a lower elevation. Cells are coded orange for static pressures exceeding either maximum recommended float valve or pipe pressures.

Flow rate is 13.7gpm. This is much higher than the typical recommendation of 5gpm for storage troughs.

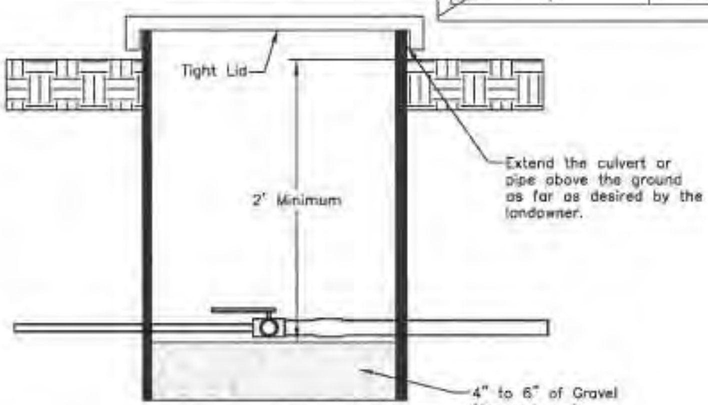
DCR



Trough Supply Line Drain Detail
Top View
Not to Scale

Expected Pressure at Float Valves:
(with / pressure switch)

Trough #	Min. Pressure	Max. Pressure
1		
2		
3		



Trough Supply Line Drain* Detail
Side View
Not to Scale

Design Parameters		
Estimated Total Daily Demand =	875	Gal
Estimated Supply Rate (State as an assumed value if the well has not been completed) =	30,000	GPD
Estimated Peak Demand =	5	GPM

Watering Trough(s)	
Type of Trough =	250 gal. concrete
Number of Troughs =	1
Note: All troughs are to be installed on short lateral pipelines (Supply Pipeline) with a shut-off valve and drain valves for supply pipeline	
Additional Trough Notes: Pressure reducers, high pressure float valves, etc.	Contractor to select appropriate float valves based on calculated static pressures (see chart to left).

Pipeline Data		
Main Pipeline Diameter =	2	in
Main Pipeline Type (PE, SCH 40 PVC, etc.) and ASTM # =	~~PE (160psi ASTM D2239) or~~ SCH40 PVC (ASTM D1785)	
Supply Pipeline(s) (Short Laterals to Trough) Diameter =	N/A	in
Supply Pipeline Type (PE, SCH 40 PVC, etc.) and ASTM # =	~~PE (160psi ASTM D2239) or SCH40 PVC (ASTM D1785)~~	
Additional Pipeline Notes: See standard notes below.		

Pumping Plant Data		
Above Ground Dynamic Head =		Ft
Desired Pumping Rate =		GPM
Pressure Required for Pumping Rate above =		PSI
For Systems Using Pressure Tanks... Pressure tank Minimum Effective Drawdown =		Gal ***
For Systems Using Pressure Tanks... Pressure switch settings are =	/	xx/xx PSI
For Systems using a Reservoir... Pumping intervals per day =		Ea
For Systems using a Reservoir... Length of Pumping Intervals =		Mins
For Systems using a Reservoir... Reservoir Capacity (usually a 3 day supply) =		Gal
Additional Notes: If multiple reservoirs are used, provide sufficient spacing to compact soil around each reservoir so that reservoir walls do not collapse. Overflow protection is required for reservoirs. Pressure tank must be housed in a dry, freeze-proof environment.		

1. Install all pipelines according to Virginia Construction Specification Plastic Pipe (VA-745).

2. Protect all pipelines from frost, livestock, and equipment traffic. Where possible, install pipelines a minimum of two feet in the ground.

3. The pipe trench must be free of loose rocks before installing the pipeline. In rocky soils, bed the pipe in selected material free of rocks or the pipeline may be placed in a sleeve. The pipeline will be pressure tested at the working head prior to backfilling. Repair any leaks and repeat the test. Compact all backfill for underground pipes to the degree required to prevent the ditch from caving after construction.

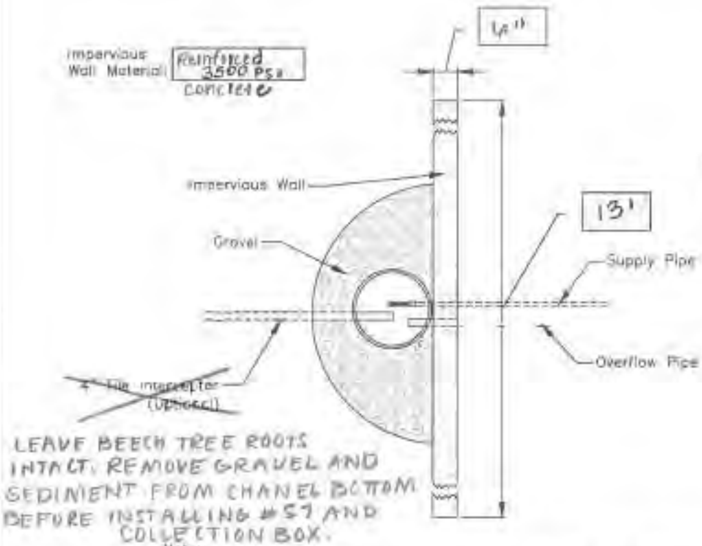
4. Grade all pipelines with gravity flows to prevent unvented crests in the pipelines. These unvented crests will cause gravity pipelines to air lock and not flow.

5. Install sufficient cutoff valves in the pipeline to allow control of water flow to the watering facilities. Install valves in a housing that is frost proof, well drained, readily accessible and protected from livestock. A means of draining the water from pipelines not in use, will be provided.

6. Install a check valve (or backflow preventor, if required) to prevent water from flowing back into the water source from a watering facility.

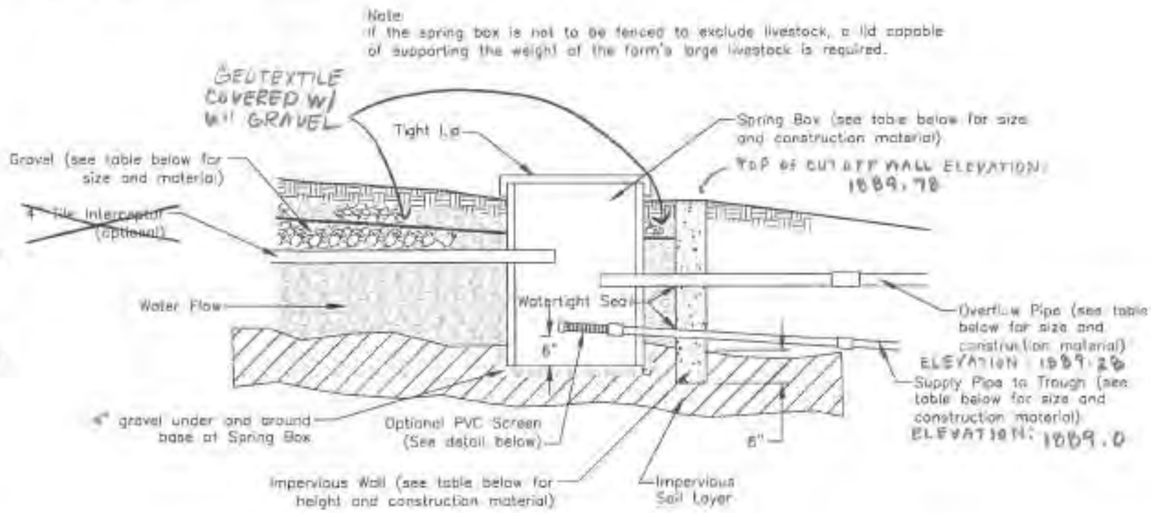
7. Seed all disturbed areas at the rates given in Virginia Construction Specification Seeding (VA-706). If seeding is done outside recommended seeding dates, use a nurse crop.

Spring Box Above Cutoff Wall



Note:
Impervious walls of other materials and shapes may be used. Hand draw the intended wall and dimension it accordingly. Walls are generally constructed of clay or concrete.

Plan View of Spring Box



Section View of Spring Box

PVC Screen For Supply Pipe

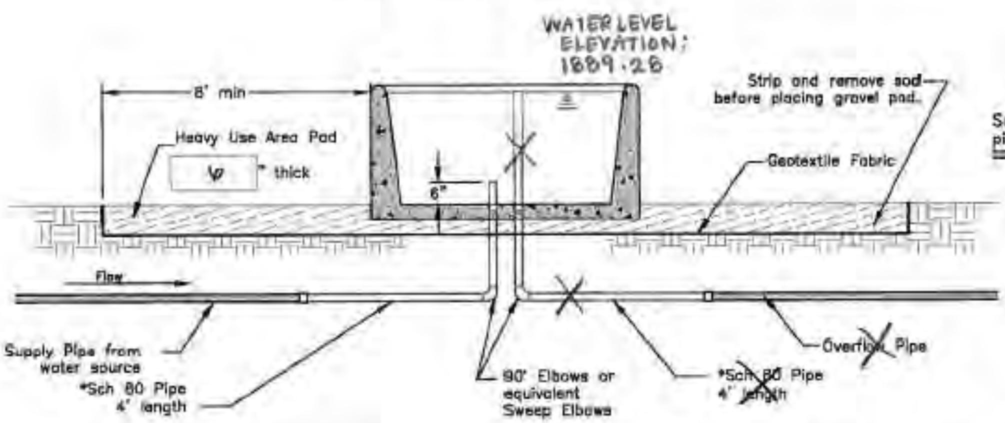
TO DRAIN TROUGH FOR WINTERIZATION OR MAINTENANCE, REMOVE PVC SCREEN AND COLLAR AND REPLACE WITH 90 DEGREE ELBOW AND 9" RISER PIPE, THEN OPEN DRAIN VALVE TO DRAIN LINE.

Wall and Spring Box Materials

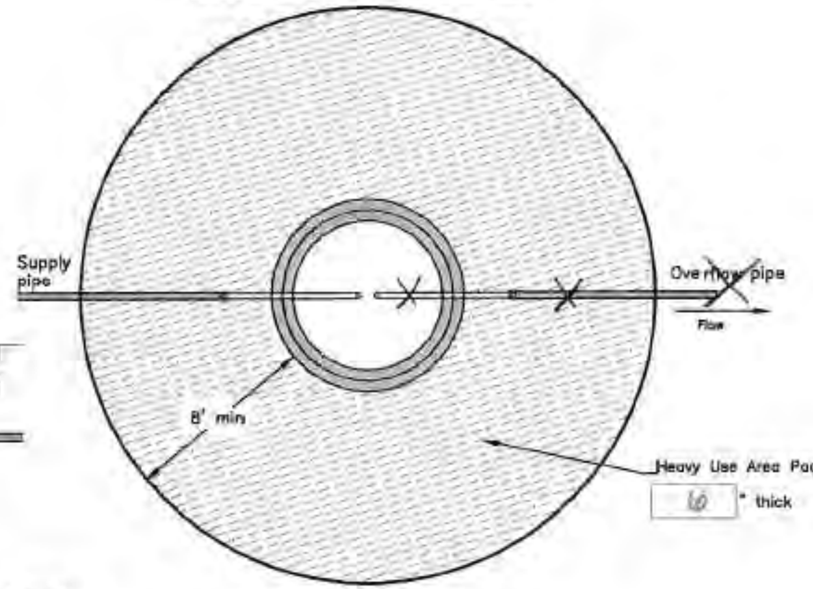
Item	Size	Material
Spring Box	30" x 30"	Concrete Well Casing
Gravel	D50 = .75" D100 = 1.5"	VDOT #57, Clean Stone
Supply Pipe thru Wall	2"	Sch. 40 PVC, ASTM D1785
Overflow Pipe thru Wall	4"	Sch. 40 PVC, ASTM D1785
Impervious Wall	6" x 13' x 3'	Reinforced 3500 PSI Concrete

Virginia Engineering Standard Drawing

Concrete Trough Installation– Side View



Concrete Trough Installation– Top View



*Note:
Schedule 80 PVC pipe or Galvanized Steel pipe is required under the trough. Sch 40 PVC may be used with granular backfill.

Pipe diameter for all pipes shown above will be: 2"

All pipe installed under the trough shall be constructed of the following material: Sch.80 PVC or Galvanized Steel

Supply ~~and Overflow~~ pipelines will be constructed of the following material: Sch. 40 PVC

Heavy Use Area Pad shall be constructed of the following material: VDOT #57, #21A or crusher Run

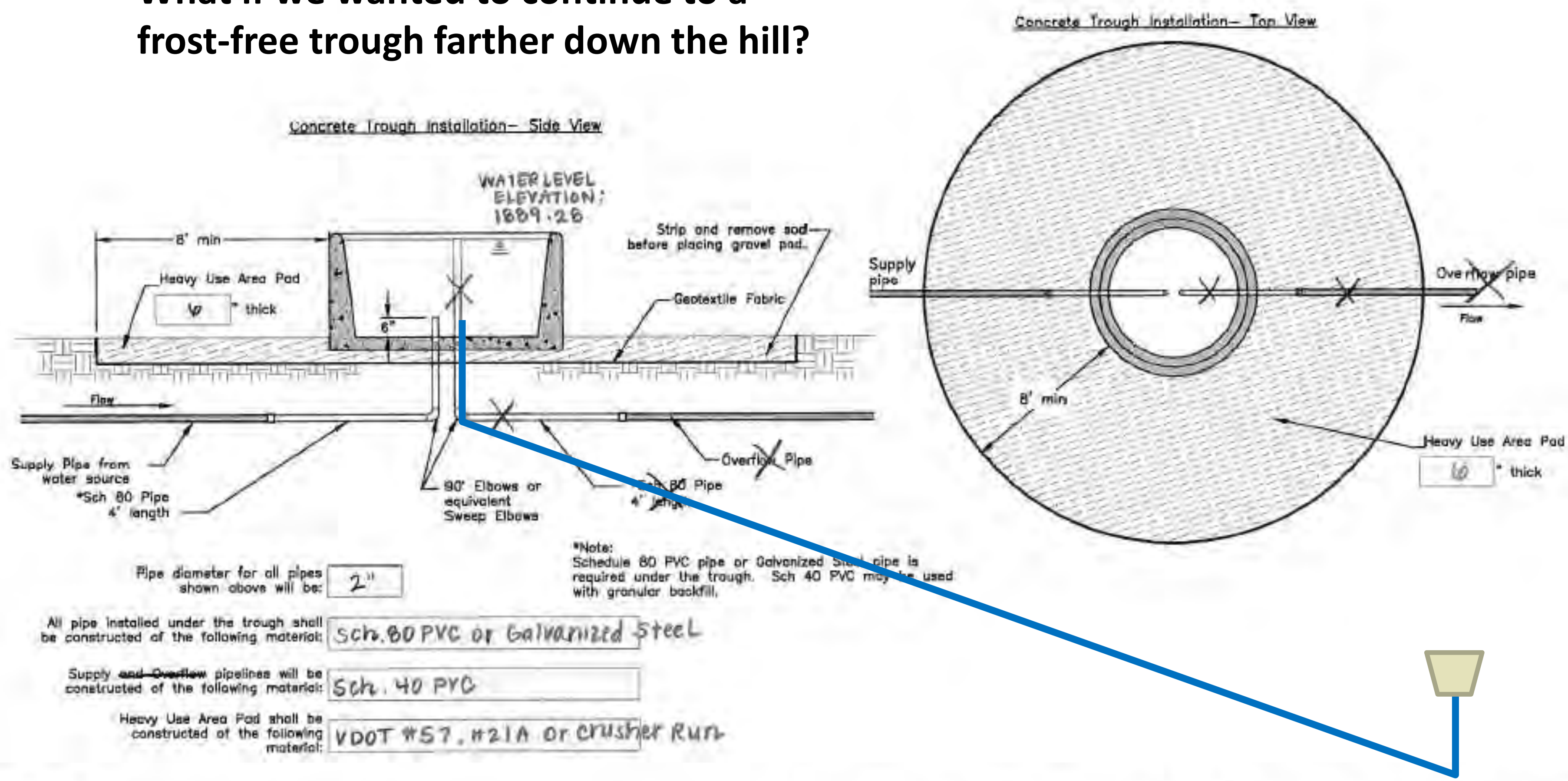
What if we wanted to continue to a frost-free trough farther down the hill?

Construction Notes

1. The ground under and around the trough location shall be cleared of all material not suited for the subgrade, including sod. All loose surface soil shall be removed to undisturbed material.
2. A valve shall be installed in the supply pipeline to regulate flow to the trough. The valve should be installed in a housing that is frost proof, well drained, readily accessible and protected from livestock. A means of draining the supply pipeline between the valve and the trough shall be provided.
3. All backfill for pipelines under the trough shall be compacted to the degree required to prevent caving after construction. Backfill under the trough may be select compacted earthfill or granular fill such as VDOT #21 or crusher run.
4. The trough site shall be free draining.
5. A protective surface shall be placed around the trough. At the minimum, install geotextile fabric around the trough and then place VDOT #57, VDOT #21A or crusher run around the trough, 6 inches deep (minimum). Other types of stone may be installed with approval of the designer. The gravel pad shall extend at least 8 feet from each side of the trough.
6. An overflow/drain line from the trough will be installed. The inlet for the overflow pipe shall be protected from blockage by algae or floating debris. The outlet shall be protected from livestock.
7. Geotextile shall meet the Class I requirements for nonwoven geotextile in Virginia Construction Specification Geotextiles (VA-795). Class II may be used with engineers approval.
8. Seed all disturbed areas at the rates given in Virginia Construction Specification Seeding (VA-706).

* If seeding is done outside recommended seeding dates, a nurse crop is to be used.

What if we wanted to continue to a frost-free trough farther down the hill?



Construction Notes

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7. Geotextile shall meet the Class I requirements for nonwoven geotextile in Virginia Construction Specification Geotextiles (VA-795). Class II may be used with engineers approval.
8. Seed all disturbed areas at the rates given in Virginia Construction Specification Seeding (VA-706).

* If seeding is done outside recommended seeding dates, a nurse crop is to be used.

DCR
Virginia Department of Conservation & Recreation

USDA
United States Department of Agriculture

Subject: ENG – Guidance for Spring Developments **Date:** January 10, 2017

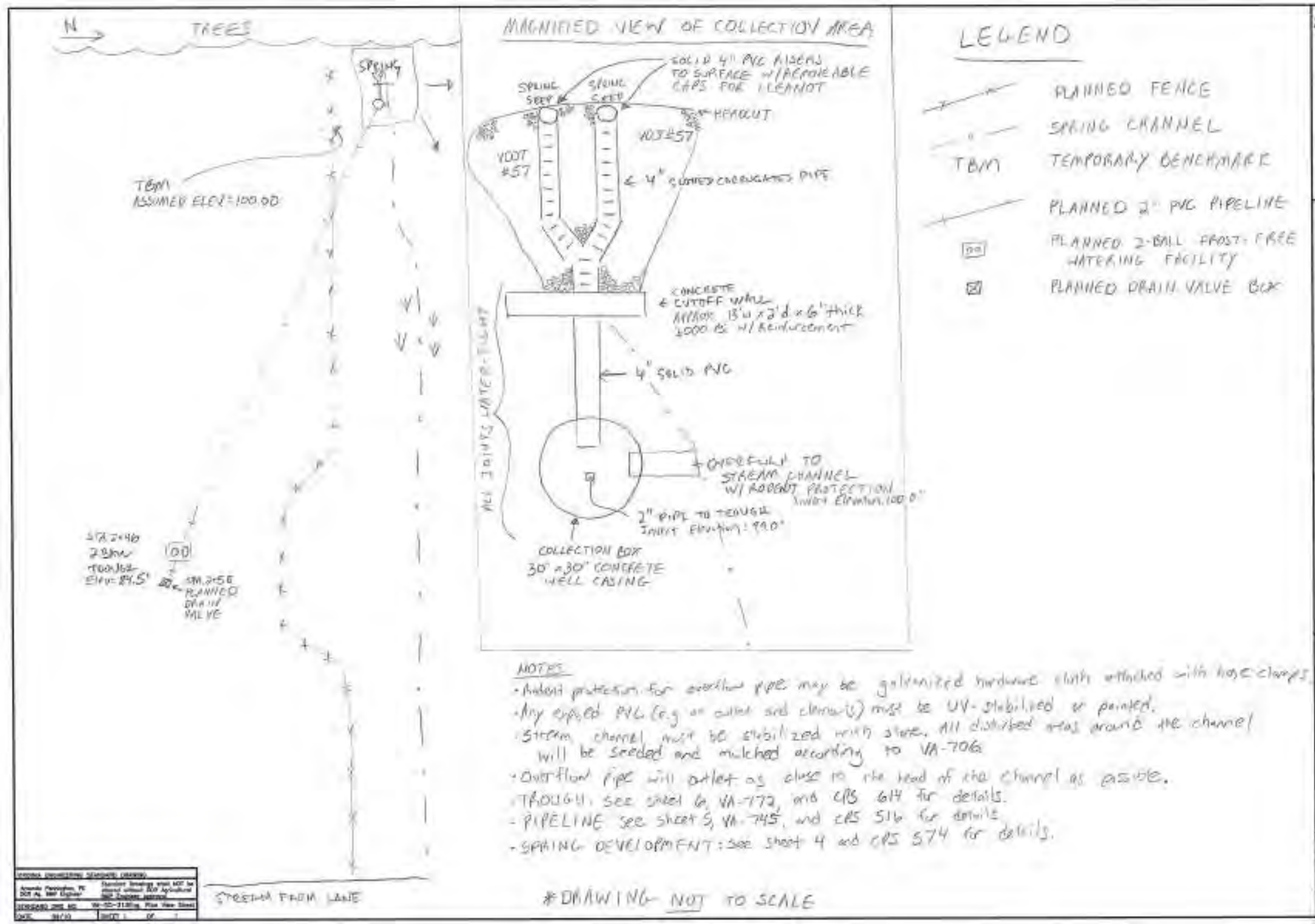
To: Anton Schaeffer, Area Engineer, Harrisonburg **File Code:** 210-11
Sharyl Ogle, Area Engineer, Christiansburg
Sean Kimmel, Area Engineer, Farmville
Bill Widner, Area Engineer, Smithfield

The purpose of this memorandum is to provide guidance on planning, designing and installing spring developments in accordance with Virginia Conservation Practice Standard (CPS) Spring Development (Code 574). This guidance also applies to the re-development of existing spring developments.

Springs can provide a reliable source of water in certain situations. However, there are environmentally sensitive areas that need to be examined when developing them. In order to maintain engineering quality and consistency, it is imperative that we are consistently using the same process and applying the same criteria. Below are items that need to be addressed for any spring development or re-development:

- The Area Engineer and the Area Resource Soil Scientist will work together to provide assistance to field staff in the planning and design of all spring developments.
- A wetland determination is needed to verify if wetlands are present at or around the spring development location.
- Complete the Wetlands attachment (attached) to the CPA-52 to document the planned spring development. All requirements in the Wetland attachment must be met.
- Perform a water budget analysis to determine the flow rate of the spring and the demand for livestock water. The flow rate of the spring should be determined during the driest part of the year, typically in the summer months.
- No more than ¼ of the flow from the spring can be removed. This is to ensure that no more than ¼ of the original wetland is drained in accordance with the Food Security Act of 1985.
- Flow-through (cascading) systems will not be allowed. When feasible, automatic valves, float valves, etc. must be used to direct water (in excess of the amount for livestock needs) back to the spring head and through the entire wetland.

Case Study #3: Spr. Dev.w/ Float Valve



DCR

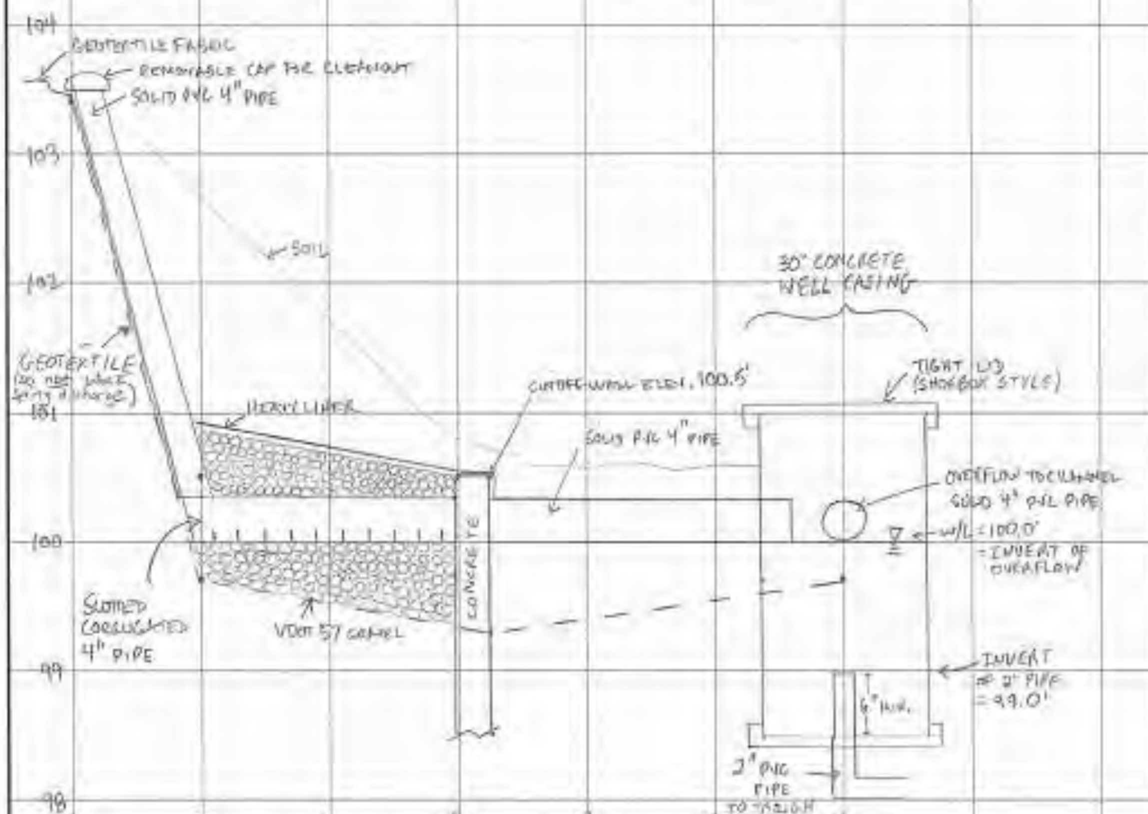

SYSTEM PROFILE
SCALE
HORIZONTAL: 1" = 20'
VERTICAL: 1" = 5'
PLANNED CUT-OFF WALL STA 0+06
PLANNED COLLECTION BOX STA 0+12
SEE SHEET 3 FOR DETAILS
EXISTING GRADE
PLANNED 2" SCH 40 PVC W/BELL ENDS
246 LN. FT.
PLANNED 2' BALL FROST-FREE TROUGH STA 2+46
PLANNED VALVE BOX STA 2+58
Recommended drain valve location. Cap 2" supply line in collection box and open ball valve in valve box to flush the line.
105
100
95
90
85
80
75
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
SURVEY STATION

DCR

SPRING DEVELOPMENT DETAILS

NOTES

- Pin geotextile to headcut area to keep soil out of collection area. Do not block spring discharge w/geotextile.
- 4" slotted pipe to be bedded in the middle of 12" of VDOT #57 clean stone.
- Cover stone and collection pipe with a heavy liner, such as 6mil plastic (to keep surface water out) overlaid with geotextile (to prevent plastic from getting punctured by backfill).
- After cutoff wall is poured, place stone in channel immediately downstream to provide a smooth transition to the stream channel.
- All joints downstream of cutoff wall (cutoff wall included) to be water tight.

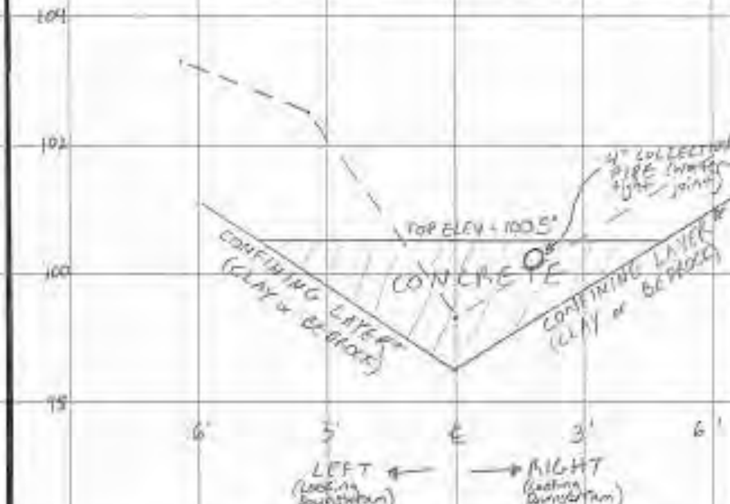


SCALE
HORIZONTAL: 1" = 2'
VERTICAL: 1" = 1'

SCALE
HORIZONTAL: 1" = 3'
VERTICAL: 1" = 2'

CONCRETE CUT-OFF WALL DETAIL

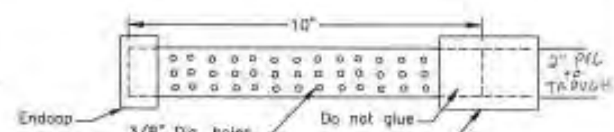
@ SYSTEM PROFILE STA. 0+06.5



* Confining layer shown above for illustrative purposes only. Actual depth to be determined during excavation. Concrete cutoff wall must create a water-tight connection with confining layer. Extend cutoff wall to confining layer on both sides at elevation 100.5'.

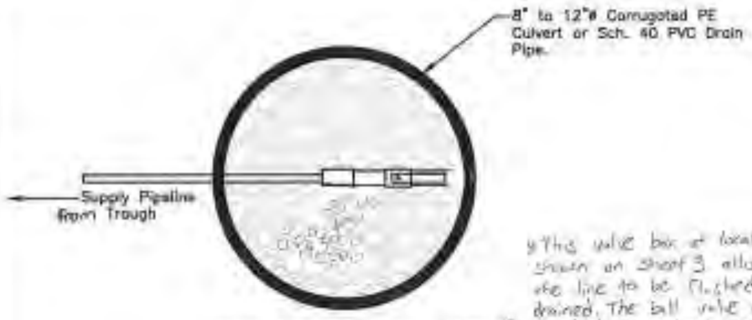
- Concrete installation must meet VA-731

SCREEN DETAIL



PVC Screen* Detail

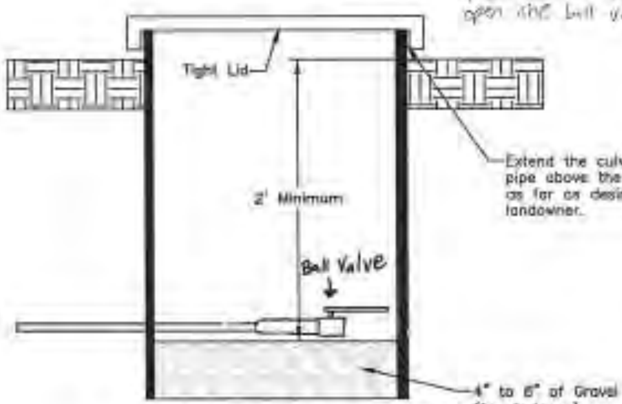
* Install vertically on 2" riser pipe in collection box to prevent spiders, frogs etc. from entering.



Trough Supply Line Drain Detail

Top View
Not to Scale

This valve box at location shown on Sheet 3 allows the line to be flushed + drained. The ball valve is closed during normal operation of the trough. To drain the line, cap the 2" riser pipe in the location box and open the ball valve.



Trough Supply Line Drain Detail

Side View
Not to Scale

Design Parameters		
Estimated Total Daily Demand =	60	Gal
Estimated Supply Rate (State as an assumed value if the well has not been completed) =	Bell	GPD
Estimated Peak Demand =	4	GPM

Watering Trough(s)	
Type of Trough =	2 BALL FROST FREE
Number of Troughs =	1
Note: All troughs are to be installed on short lateral pipelines (Supply Pipeline) with a shut-off valve and drain valves for supply pipeline	
Additional Trough Notes: Pressure reducers, high pressure float valves, etc.	

Pipeline Data		
Main Pipeline Diameter =	2	in
Main Pipeline Type (PE, SCH 40 PVC, etc.) and ASTM # =	Sch 40 ASTM D 1785	
Supply Pipeline(s) (Short Laterals to Trough) Diameter =	NA	in
Supply Pipeline Type (PE, SCH 40 PVC, etc.) and ASTM # =	NA	
Additional Pipeline Notes: Bell and point location (known spring)		

Pumping Plant Data	
Above Ground Dynamic Head =	Ft
Desired Pumping Rate =	GPM
Pressure Required for Pumping Rate above =	PSI
For Systems Using Pressure Tanks... Pressure tank Minimum Effective Drawdown =	Gal
For Systems Using Pressure Tanks... Pressure switch settings are =	xx/xx PSI
For Systems using a Reservoir... Pumping intervals per day =	Ea
For Systems using a Reservoir... Length of Pumping Intervals =	Mins
For Systems using a Reservoir... Reservoir Capacity (usually a 3 day supply) =	Gal
Additional Notes: If multiple reservoirs are used, provide sufficient spacing to compact soil around each reservoir so that reservoir walls do not collapse. Overflow protection is required for reservoirs	

1. Install all pipelines according to Virginia Construction Specification Plastic Pipe (VA-745).

2. Protect all pipelines from frost, livestock, and equipment traffic. Where possible, install pipelines a minimum of two feet in the ground.

3. The pipe trench must be free of loose rocks before installing the pipeline. In rocky soils, bed the pipe in selected material free of rocks or the pipeline may be placed in a sleeve. The pipeline will be pressure tested at the working head prior to backfilling. Repair any leaks and repeat the test. Compact all backfill for underground pipes to the degree required to prevent the ditch from caving after construction.

4. Grade all pipelines with gravity flows to prevent unvented crests in the pipelines. These unvented crests will cause gravity pipelines to air lock and not flow.

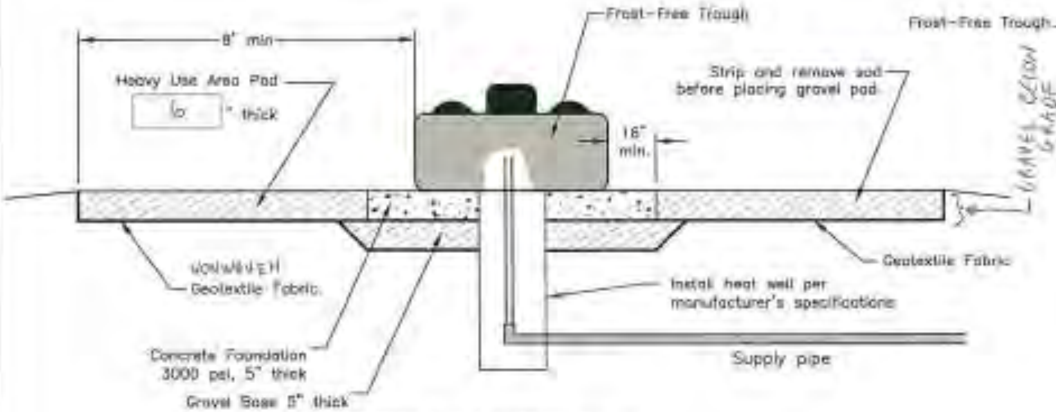
5. Install sufficient cutoff valves in the pipeline to allow control of water flow to the watering facilities. Install valves in a housing that is frost proof, well drained, readily accessible and protected from livestock. A means of draining the water from pipelines not in use, will be provided.

6. Install a check valve (or backflow preventer, if required) to prevent water from flowing back into the water source from a watering facility.

7. Seed all disturbed areas at the rates given in Virginia Construction Specification Seeding (VA-706). If seeding is done outside recommended seeding dates, use a nurse crop.

DCR

Frost-Free Trough Installation — Side View

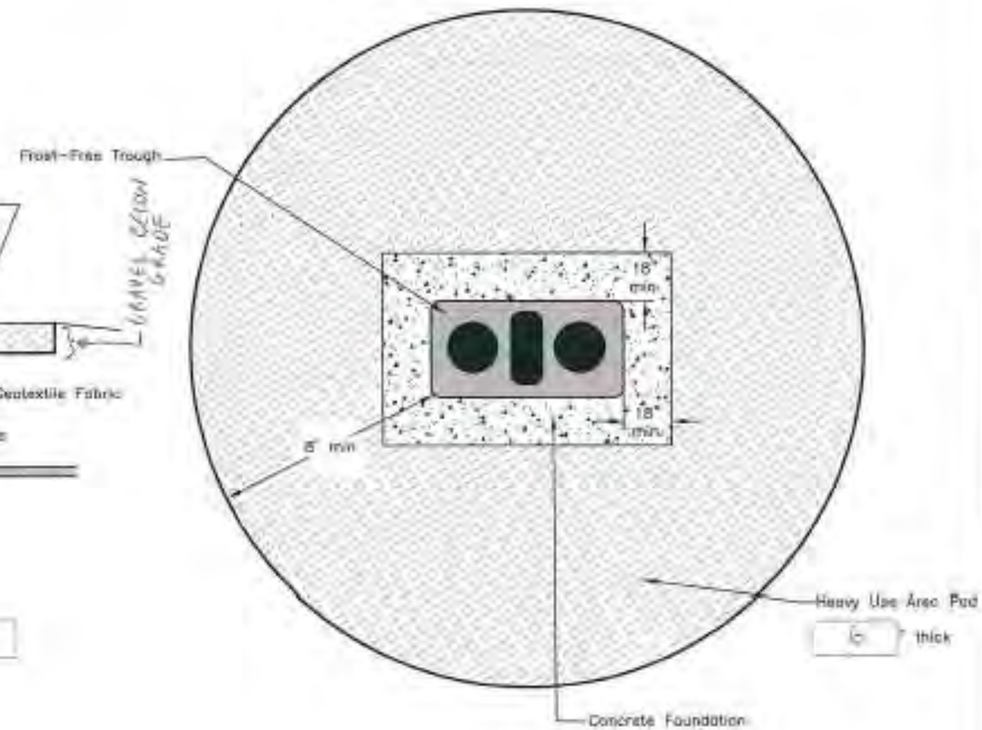


Pipe diameter for the supply pipe above will be: 2"

Heavy Use Area Pad shall be constructed of the following material: VDOT 57

*SELECT APPROPRIATE FLOAT VALVE FOR TROUGH.
STATIC PRESSURE @ TROUGH = 6.7 PSI

Frost-Free Trough Installation — Top View



Construction Notes

1. The ground under and around the trough location shall be cleared of all material not suited for the subgrade, including sod. All loose surface soil shall be removed to undisturbed material.
2. The concrete foundation for the trough shall extend a minimum of 18" past the edges of the trough. Concrete shall be 3000 psi, and installed a minimum of 5" thick. 6"x6" 6/6 gage welded wire mesh reinforcing shall be used in the 5" slab.
3. Position the heat well and pipelines per manufacturer's recommendations. The concrete foundation dimensions recommended by the manufacturer will be used if the dimensions are larger than those in note 2. The trough must be attached to the concrete foundation per manufacturer's recommendations.
4. A valve shall be installed in the supply pipeline to regulate flow to the trough. The valve should be installed in a housing that is frost proof, well drained, readily accessible and protected from livestock. A means of draining the supply pipeline between the valve and the trough shall be provided.
5. All backfill for pipelines under the trough shall be compacted to the degree required to prevent caving after construction. Backfill under the trough may be select compacted earthfill or granular fill such as VDOT #21 or crusher run.
6. The trough site shall be free draining.
7. A protective surface shall be placed around the trough. At the minimum, install geotextile fabric around the trough and then place VDOT #57, VDOT #21A or crusher run around the trough six inches deep. Other types of materials may be installed with approval of the designer. The protective surface shall extend at least 8 feet from each side of the trough.
8. Geotextile shall meet the Class I requirements for nonwoven geotextile in Virginia Construction Specification Geotextiles (VA-795). Class II may be used with engineers approval.
9. Seed all disturbed areas at the rates given in Virginia Construction Specification Seeding (VA-706).

* If seeding is done outside recommended seeding dates, a nurse crop is to be used.

Virginia Livestock Watering Systems - Pressure-Energy/Gravity Flow Worksheet

Virginia Department of Conservation & Recreation

1) Assistance Information

Project Notes: Spring development to supply water to one two-hole frost-free trough. Spring yield in mid-July is 0.6gpm. Livestock will use less than 10% of the spring's daily volume, and the collection box will overflow into the channel above the wetland area.

Print Page

Clear Data

2) Water Budget

a) Total Daily Water Demand

Type of livestock:	cattle	
Number of Animals:	3	
Water demand/animal/day:	20	gpd
Total Daily Demand:	60	gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

No. of times herd drinks/day:	3	events
Time desired to water herd:	20	minutes/event
Average peak demand:	1.0	gpm
Alternate peak demand:	4	gpm

See Design Note for considerations for estimating peak demand.

c) Evaluate Source

Source flow rate:	0.6	gpm
Source daily yield:	864	gpd

If **source flow rate** is close to or less than Peak Demand, consider storage alternatives.

If **source daily yield** is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

See Design Note or EFH Ch. 12 for guidance on pipe size selection.

a) Trough Information

Trough type(s):		2 ball float	
Design flow rate:	Alternate Peak Demand	4.0	gpm

Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

Maximum float valve pressure, if applicable: 80 psi

Typical values range from 75-140 psi. Check manufacturer's recommendations.

Minimum float valve pressure, if applicable: 5 psi

Varies depending on type of float. Use manufacturer's recommended minimum. Typical value is 10 psi.

b) Pipe Information

Pipe material:	Plastic: SCH 40 PVC	
Pipe nominal diameter:	2"	
Pipe avg. inner diameter:	2.047	in.
Pipe cross-sectional area:	0.0229	sq. ft.
Kp (head loss coefficient):	0.159	
Velocity check (<5 fps):	0.4	fps

If velocity is greater than 5 fps, consider a larger diameter pipe. Note: For flows greater than design flow, velocities will be greater.

Pipe pressure rating:	200	psi
72% of rating (See VA CPS 516):	144	psi

c) Gravity System Parameters

Reservoir gnd elev or spring box outlet el	100	ft
Reservoir depth below ground (typically 6'):		ft
Reservoir bottom (elev for computing hea	100	ft

d) If Pumping to a Reservoir:

Pumping rate should not exceed source rate.

Desired pumping rate to reservoir:		gpm
Pumping duration required to meet daily demand:		min/day
Ground elevation of water source:		ft.
Elevation head:		ft.
Static pressure in pipe (check against max. allowed):		psi

Dynamic Head Calculations:

Pipe length to reservoir:		ft
Add 10% for slope, fittings:		ft
Friction loss/100':		ft/100 ft
Total friction loss:		ft

Note: If total friction loss exceeds 23.1 ft (10 psi), consider choosing a larger pipe diameter.

Dynamic Head added to pump by pressure component of system:	Friction + elev. head:		ft.
		OR	
			psi

4) Flow and Static Pressure Checks

TROUGH ELEVATIONS:

Enter trough elevations from survey data. For cascade-type systems, enter trough elevations in order from highest to lowest.

CALCULATIONS FOR FLOAT-VALVE SYSTEMS:

Troughs are tee-ed off from the main line, with flow to each trough controlled by a float valve. Pipe length is measured from the reservoir or spring box.

Trough ID and Type	Trough Ground Elev. (ft)	Estimated Water Surface Elev. (ft)	Pipe Length from Reservoir or Spring Box to Trough (ft)	Head from Reservoir or Spring Box (ft)	Maximum Flow Rate (gpm)	Static Pressure (psi)
T1: Freeze-Proof	84.5	86.5	234	13.5	39.8	6.7

CALCULATIONS FOR CASCADING SYSTEMS:

Troughs are connected in series by way of their overflow pipes. Pipe length for Trough 1 is measured from the spring box. Subsequent lengths are measured from the previous trough.

Sub-System	Pipe Length from Trough above (ft)	Head from Upper Trough (ft)	Max. Flow Rate (gpm)
Spring box - T1			
T1-T2			

Air lock can be a problem in spring-fed systems due to dissolved oxygen. Use a minimum diameter of 1-1/2" for pipe grades bewteen

Case Study 4: Lake Pick-Up

- Very remote (no grid power)
- Only water source is still water
- Near stream entering lake
  - Challenge: Sediment

DCR
Virginia Department of Conservation & Recreat

South-Facing Slope

(but need panels to be above the shadow of the treeline)

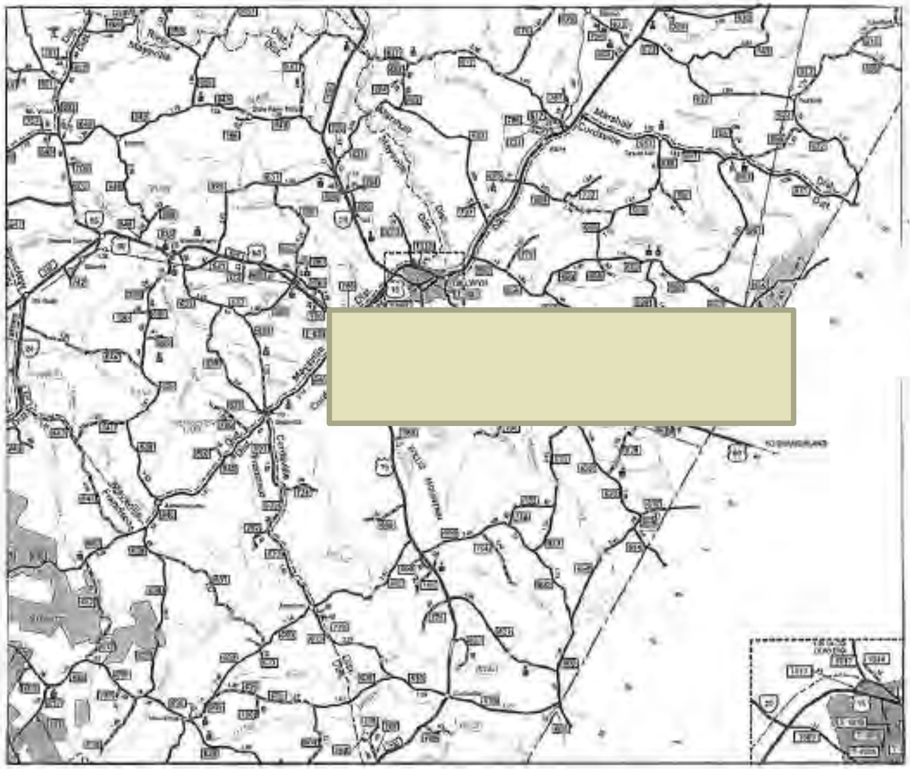
Sediment

Design Copy Routing: Cooperators Folder — Landowner — Contractor — Supplier

Notes

1. The landowner/operator is responsible for obtaining and complying with all permits and easements. This includes all federal, state and local permits.
2. The landowner/operator is responsible for checking and complying with all local ordinances that may affect the project.
3. MISS UTILITY (Virginia telephone number 811) must be contacted at least 3 working days before construction begins. The landowner/operator is responsible for ensuring that the contractor contacts MISS UTILITY. The contractor must be able to provide the MISS UTILITY ticket number within 24 hours upon request by the DCR/SWCD representative. The landowner/operator is responsible for locating any buried utilities (water lines, electric lines, telephone lines, gas lines, sewer lines, etc.) in the work area that are not covered by the MISS UTILITY program.
4. DCR/SWCD makes no representation of the existence or nonexistence of utilities. The presence or absence of utilities on the construction drawings does not assure that there are or are not utilities in the work area.
5. The contractor is responsible for knowing and following the appropriate safety standards required by the Virginia Safety and Health Codes Board.
6. The landowner/operator shall notify the DCR/SWCD representative at least one week prior to beginning construction, and at all other times specified in this construction plan and attached specifications.
7. Any deviation from these construction drawings and specifications without written approval from DCR/SWCD representative may result in in failure of this practice to meet NRCS Standards and the withdrawal of technical assistance for this project.
8. Prior to beginning construction, the cover sheet must be signed by the landowner/operator, the contractor, and the DCR/SWCD representative. The landowner/operator is responsible for informing the contractor of these responsibilities by providing the contractor a copy of this cover sheet. The contractor must sign the cover sheet acknowledging that these responsibilities are understood and the landowner/operator must return the signed cover sheet to the DCR/SWCD Representative. If requested by DCR/SWCD, the landowner/operator shall arrange for a meeting between the contractor and DCR/SWCD to review the construction drawings and specifications prior to construction.

The SWCD Representative (include t
The SWCD office telephone number
The SWCD office address is:



Site Location Map

Scale 1 inch = N/A feet

Benchmark Descriptions

TBM # 1 | Assumed Elev. 100
Description:
Top of stake next to 10in. DBH hardwood tree approx. 100ft. west of the collection box (approx. 20ft. from water's edge).

TBM # N/A | Assumed Elev. N/A
Description:
N/A

Acknowledgment Signatures

These construction drawings and attached specifications have been reviewed I understand what is required. (Sign and date below)

Landowner/Operator ____________________

Contractor ____________________

SWCD Representative ____________________

Engineering Job Class: IV

811 Know what's below. Call before you dig.

"As Built" Documentation

Certified By and Date ____________________

Practice Completion Date ____________________

Index of Sheets

Sheet No.	Title
1	Cover Sheet
2	Plan View
3	System Profile
4	Pipeline Detail
5	Collection System Detail
6	Trough Detail
7	Miscellaneous Details & Notes
Attachments	NRCS Construction Specifications
	NRCS Practice Standards
	NRCS O&M Agreements
	Watering System Worksheet

Specification Table

No.	Title
VA-705	Pollution Control
VA-706	Seeding
VA-707	Site Preparation
VA-708	Salvaging & Spreading Topsoil
VA-711	Removal of Water
VA-721	Excavation
VA-745	Plastic Pipe
VA-757	Concrete Pipe
VA-772	Watering Facility
VA-795	Geotextile

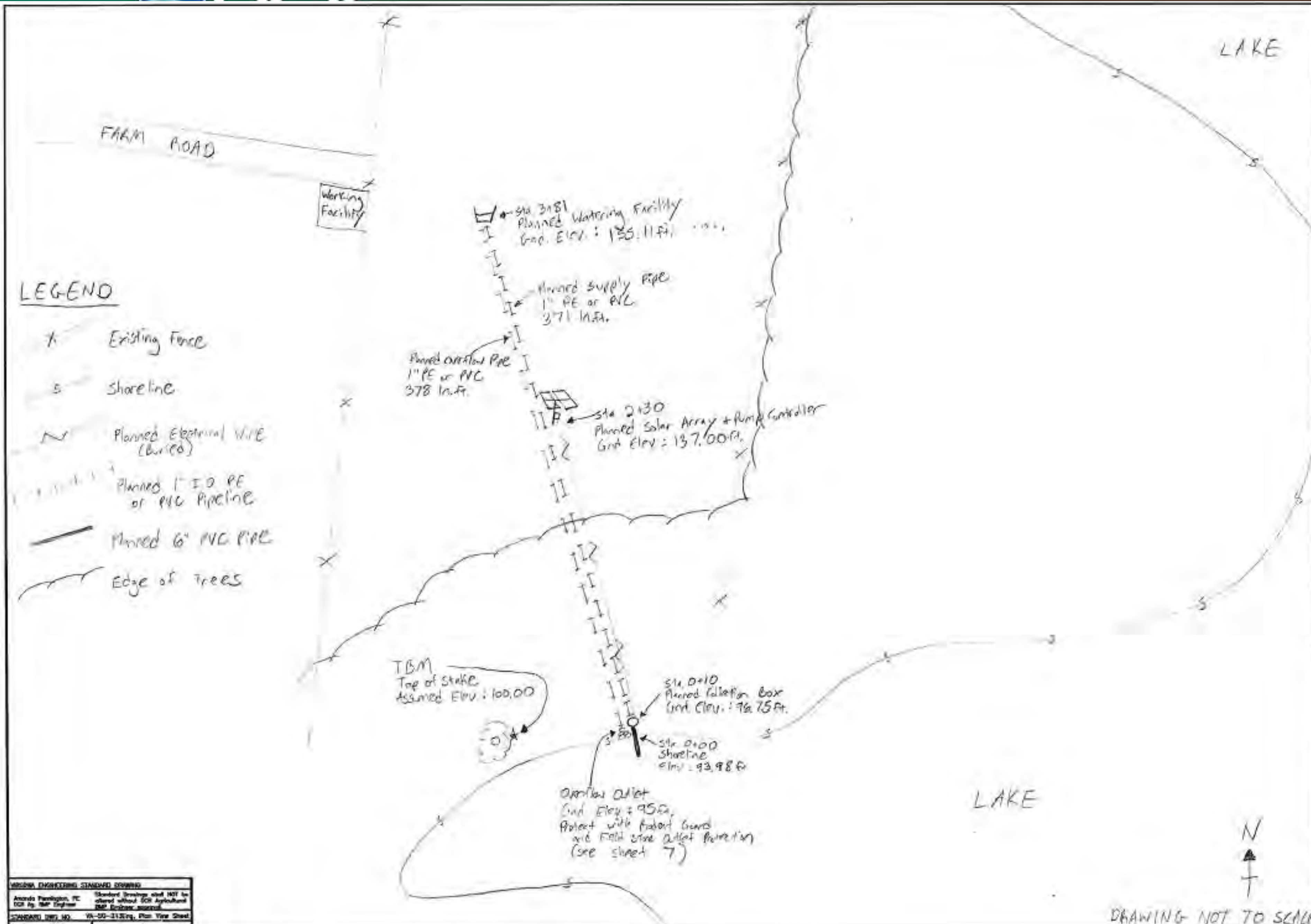
Table of Estimated Quantities

Item	Unit	Quantity
Solar Pump, Solar Array with Mounting Post, Pump Controller	EA	1
30" Concrete Well Casings	EA	3
6" Sch. 40 PVC Pipe	LN.FT.	36
T-Posts (See Sheets 5 & 7)	JOB	1
1" Diam. PE (ASTM D2239) or Sch. 40 PVC (ASTM D1785) Pipe	LN.FT.	749
500-gallon Concrete Water Trough with Riser Pipes	EA	2
Nonwoven Class I Geotextile (*Estimate is for sq.ft. of coverage)	SQ.FT.	480
VDOT #57, #21A, or Crusher Run Stone	TON	18
1" Diam. Sch. 80 PVC or Galvanized Steel Pipe (See Sheet 6)	JOB	1
Misc. Valves, Plumbing Fittings & Supplies	JOB	1
Seed, Mulch, Soil Ammendments to Stabilized Disturbed Area	JOB	1
Lid for Concrete Well Casing	EA	2

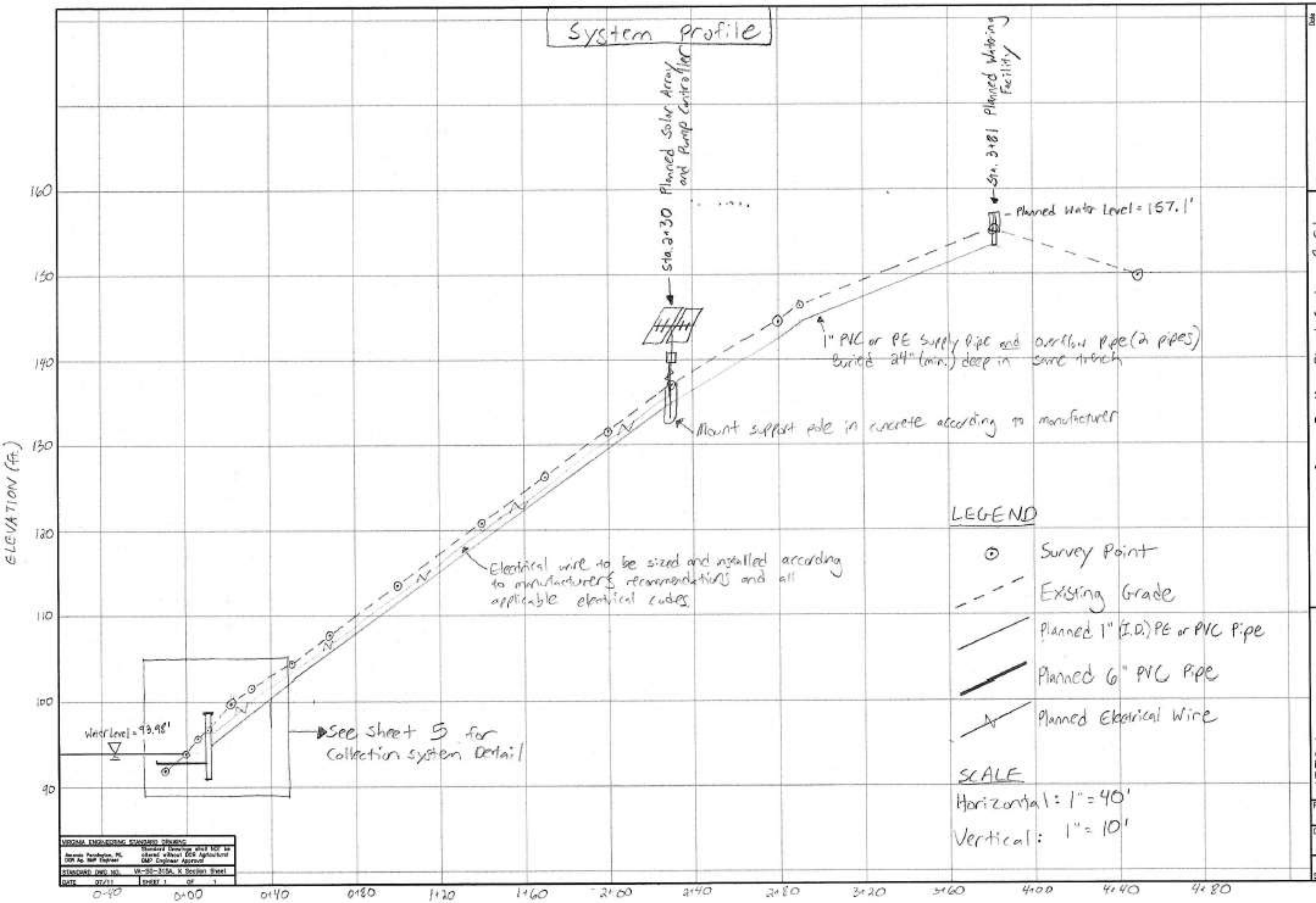
Engineering Design Cover Sheet

This drawing adapted from NRCS Standard Drawing VA-SD-100 V2.4.0

Sheet 1 of 7

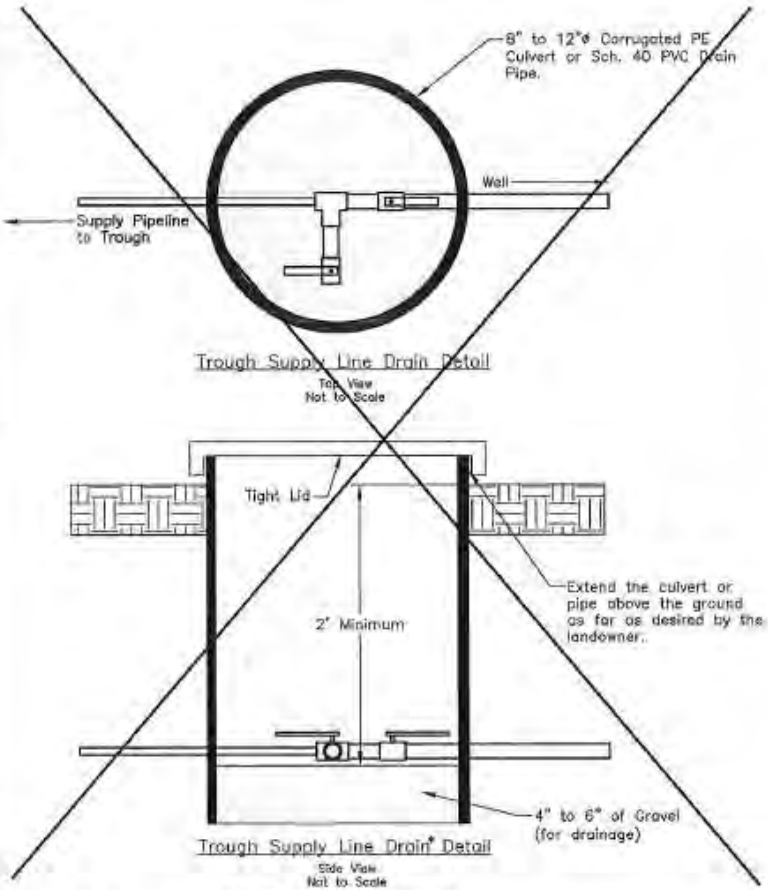


LAKE
FARM ROAD
Working Facility
Sta 3+81
Planned Watering Facility
Grd. Elev: 135.11 Ft.
LEGEND
Existing Fence
Shoreline
Planned Electrical Wire (Buried)
Planned 1" I.D. PE or PVC Pipeline
Planned 6" PVC Pipe
Edge of Trees
Planned Supply Pipe
1" PE or PVC
371 ln.ft.
Planned Overflow Pipe
1" PE or PVC
378 ln.ft.
Sta 2+30
Planned Solar Array + Pump Controller
Grd Elev: 137.00 Ft.
TBM
Top of Stake
Assumed Elev: 100.00
Sta 0+10
Planned Collection Box
Grd Elev: 96.75 Ft.
Sta 0+00
Shoreline
Elev: 93.98 Ft.
Overflow Outlet
Grd Elev ± 95 Ft.
Protect with Rodent Guard and Field Stone Outlet Protection
(see sheet 7)
LAKE
N
DRAWING NOT TO SCALE
VIRGINIA ENGINEERING STANDARD DRAWING
Amanda Pennington, PE
DCR Ag. BMP Engineer
Standard Drawings shall NOT be altered without DCR Agricultural BMP Engineer approval
STANDARD DWG. NO.
SHEET 1 OF 1



System profile
Planned Solar Array and Pump Controller
Sta. 2+30
Sta. 3+81 Planned Watering Facility
Planned Water Level = 157.1'
1" PVC or PE Supply Pipe and overflow Pipe (2 pipes) Buried 24" (min.) deep in same trench
Mount support pole in concrete according to manufacturer
Electrical wire to be sized and installed according to manufacturers recommendations and all applicable electrical codes
Water Level = 93.98'
See Sheet 5 for Collection system Detail
LEGEND
Survey Point
Existing Grade
Planned 1" (I.D.) PE or PVC Pipe
Planned 6" PVC Pipe
Planned Electrical Wire
SCALE
Horizontal: 1" = 40'
Vertical: 1" = 10'
ELEVATION (ft.)
160
150
140
130
120
110
100
90
0-40
0+00
0+40
0+80
1+20
1+60
2+00
2+40
2+80
3+20
3+60
4+00
4+40
4+80

DCR



*Recommend one per trough

Design Parameters	
Estimated Total Daily Demand =	300 Gal
Estimated Supply Rate (State as an assumed value if the well has not been completed) =	∞ GPD (Lake)
Estimated Peak Demand =	5 GPM

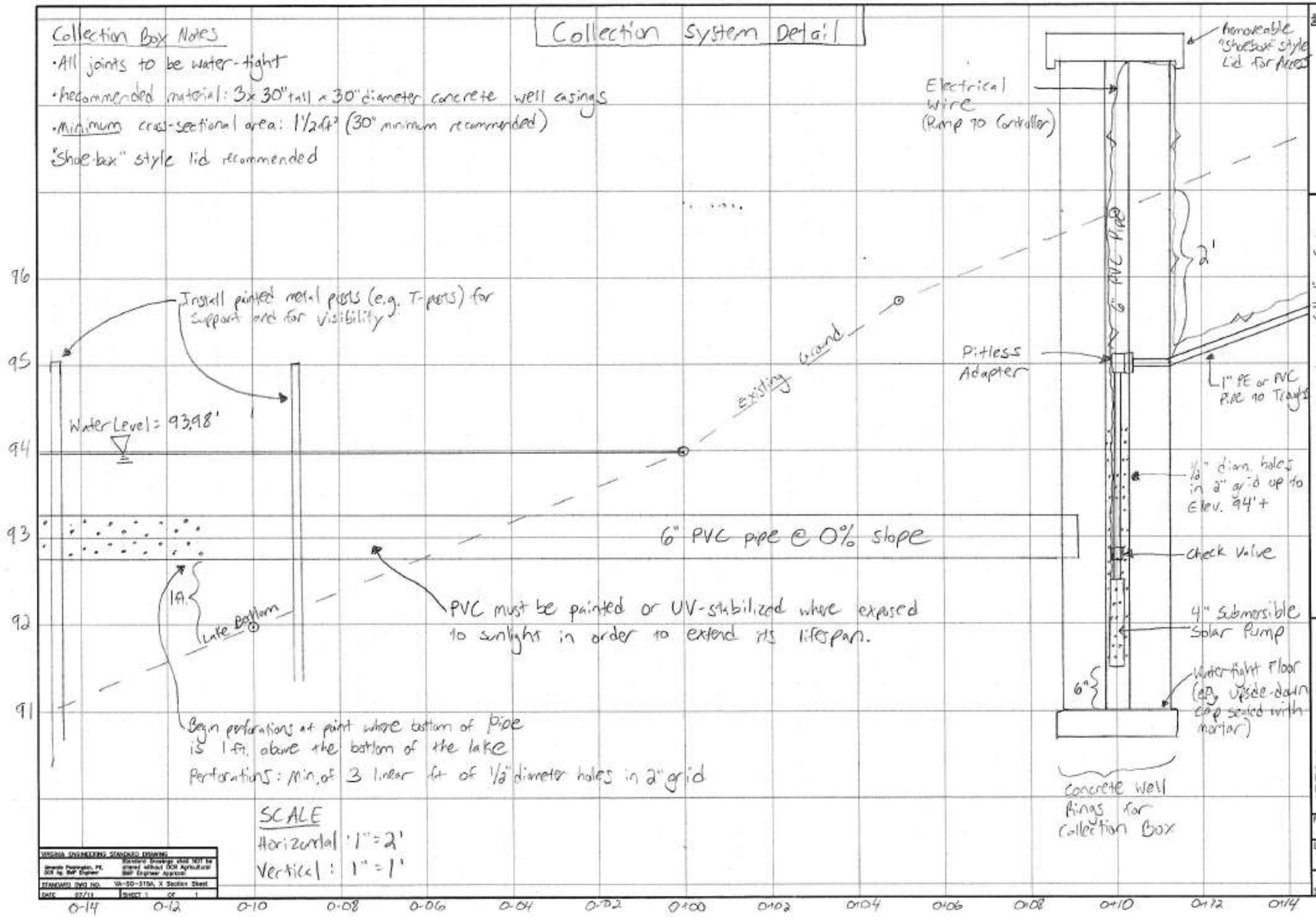
Watering Trough(s)	
Type of Trough =	Concrete Storage (500 gallon)
Number of Troughs =	2 in tandem
Note: All troughs are to be installed on short lateral pipelines (Supply Pipeline) with a shut-off valve and drain valves for supply pipeline	
Additional Trough Notes: * Pressure reducers, high pressure float valves, etc.	

Pipeline Data	
Main Pipeline Diameter =	1 in
Main Pipeline Type (PE, SCH 40 PVC, etc.) and ASTM # =	PE (160psi, ASTM D2239) or SCH40 PVC (ASTM D1785)
Supply Pipeline(s) (Short Laterals to Trough) Diameter =	N/A in
Supply Pipeline Type (PE, SCH 40 PVC, etc.) and ASTM # =	PE (160psi, ASTM D2239) or SCH40 PVC (ASTM D1785)
Additional Pipeline Notes: See standard notes below.	

Pumping Plant Data	
Above Ground Dynamic Head =	70 Ft
Desired Pumping Rate =	5 GPM
Pressure Required for Pumping Rate above =	– PSI
For Systems Using Pressure Tanks... Pressure tank Minimum Effective Drawdown =	N/A Gal
For Systems Using Pressure Tanks... Pressure switch settings are =	N/A xx/xx PSI
For Systems using a Reservoir... Pumping Intervals per day =	N/A Ea
For Systems using a Reservoir... Length of Pumping Intervals =	N/A Mins
For Systems using a Reservoir... Reservoir Capacity (usually a 3 day supply) =	(1000) Gal
Additional Notes: If multiple reservoirs are used, provide sufficient spacing to compact soil around each reservoir so that reservoir walls do not collapse. Overflow protection is required for reservoirs. Recommend buying panels, pump, and pump controller from same supplier.	

Install sand shroud on pump if recommended by supplier to extend lifespan.

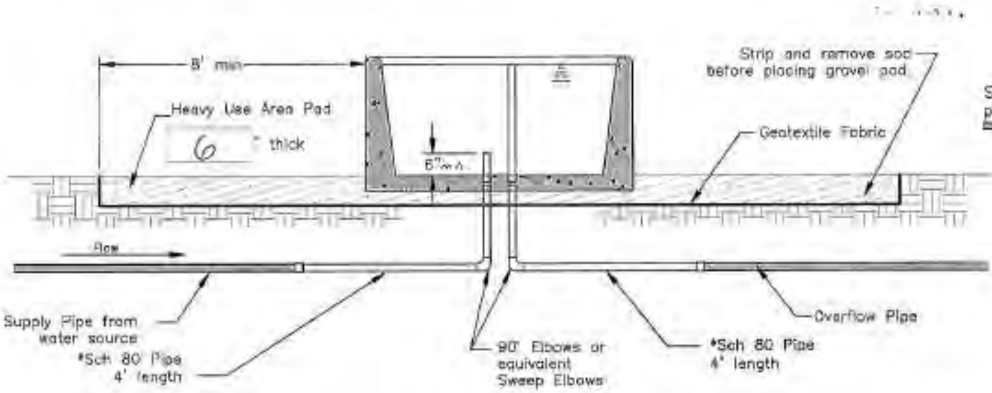
1. Install all pipelines according to Virginia Construction Specification Plastic Pipe (VA-745).
2. Protect all pipelines from frost, livestock, and equipment traffic. Where possible, install pipelines a minimum of two feet in the ground.
3. The pipe trench must be free of loose rocks before installing the pipeline. In rocky soils, bed the pipe in selected material free of rocks or the pipeline may be placed in a sleeve. The pipeline will be pressure tested at the working head prior to backfilling. Repair any leaks and repeat the test. Compact all backfill for underground pipes to the degree required to prevent the ditch from caving after construction.
4. Grade all pipelines with gravity flows to prevent unvented crests in the pipelines. These unvented crests will cause gravity pipelines to air lock and not flow.
5. Install sufficient cutoff valves in the pipeline to allow control of water flow to the watering facilities. Install valves in a housing that is frost proof, well drained, readily accessible and protected from livestock. A means of draining the water from pipelines not in use, will be provided.
6. Install a check valve (or backflow preventor, if required) to prevent water from flowing back into the water source from a watering facility.
7. Seed all disturbed areas at the rates given in Virginia Construction Specification Seeding (VA-706). If seeding is done outside recommended seeding dates, use a nurse crop.



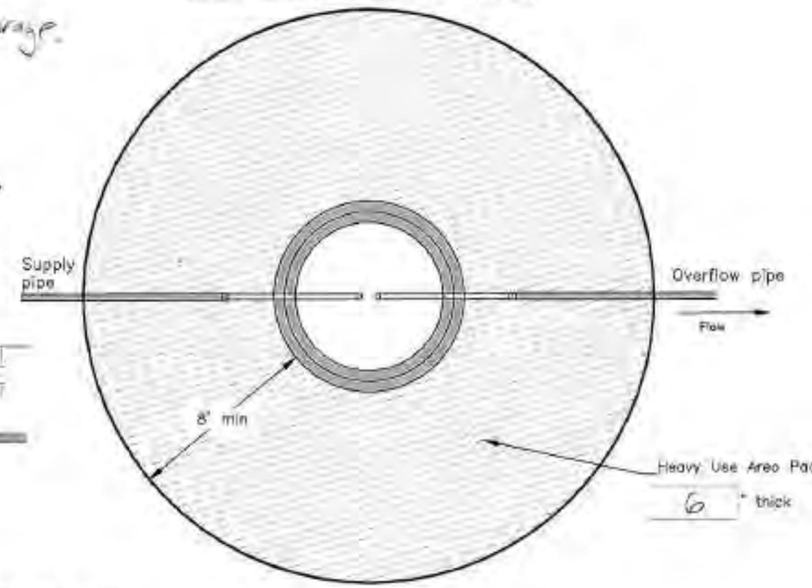
Collection System Detail
Collection Box Notes
·All joints to be water-tight
·Recommended material: 3x 30" tall x 30" diameter concrete well casings
·Minimum cross-sectional area: 1½ ft² (30" minimum recommended)
"Shoe-box" style lid recommended
Removable "Shoebox" style Lid for Access
Electrical wire (Pump to Controller)
6" PVC Pipe
2'
Install painted metal posts (e.g. T-posts) for support and for visibility
Existing Ground
Pitless Adapter
1" PE or PVC Pipe to Troughs
Water Level = 93.98'
½" diam. holes in 2" grid up to Elev. 94'+
6" PVC pipe @ 0% slope
Check Valve
1 ft.
Lake Bottom
PVC must be painted or UV-stabilized where exposed to sunlight in order to extend its lifespan.
4" Submersible Solar Pump
Water-tight Floor (e.g. upside-down cap sealed with mortar)
6"
Begin perforations at point where bottom of pipe is 1 ft. above the bottom of the lake
Perforations: Min. of 3 linear ft of ½" diameter holes in 2" grid
Concrete Well Rings for Collection Box
SCALE
Horizontal : 1" = 2'
Vertical : 1" = 1'
96
95
94
93
92
91
0-14
0-12
0-10
0-08
0-06
0-04
0-02
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
VIRGINIA ENGINEERING STANDARD DRAWING
STANDARD DWG NO.
VA-SD-315A, X Section Sheet
DATE
SHEET 1 OF 1

*NOTE: For solar systems, 3 days of water storage is recommended. Estimated daily demand of this livestock herd is 300 gallons. Standard concrete troughs hold 400-500 gallons, so two troughs may need to be installed to provide the 900 gallons of recommended storage. See sheet 7 for a multi-trough installation detail.

Concrete Trough Installation– Side View



Concrete Trough Installation– Top View



Pipe diameter for all pipes shown above will be: 1" min.

*Note:
Schedule 80 PVC pipe or Galvanized Steel pipe is required under the trough. Sch 40 PVC may be used with granular backfill.

All pipe installed under the trough shall be constructed of the following material: Sch 80 PVC, Galvanized steel (or Sch. 40 PVC w/granular backfill (sand or crusher run))

Supply and Overflow pipelines will be constructed of the following material: Sch 40 PVC (ASTM D1785) or 100psi (min) PE (ASTM D2239)

Heavy Use Area Pad shall be constructed of the following material: Crusher run, VDOT #57 or VDOT #21A

Construction Notes

1. The ground under and around the trough location shall be cleared of all material not suited for the subgrade, including sod. All loose surface soil shall be removed to undisturbed material.

2. A valve shall be installed in the supply pipeline to regulate flow to the trough. The valve should be installed in a housing that is frost proof, well drained, readily accessible and protected from livestock. A means of draining the supply pipeline between the valve and the trough shall be provided.

3. All backfill for pipelines under the trough shall be compacted to the degree required to prevent caving after construction. Backfill under the trough may be select compacted earthfill or granular fill such as VDOT #21 or crusher run.

4. The trough site shall be free draining.

5. A protective surface shall be placed around the trough. At the minimum, install geotextile fabric around the trough and then place VDOT #57, VDOT #21A or crusher run around the trough. six inches deep (minimum). Other types of stone may be installed with approval of the designer. The gravel pad shall extend at least 8 feet from each side of the trough.

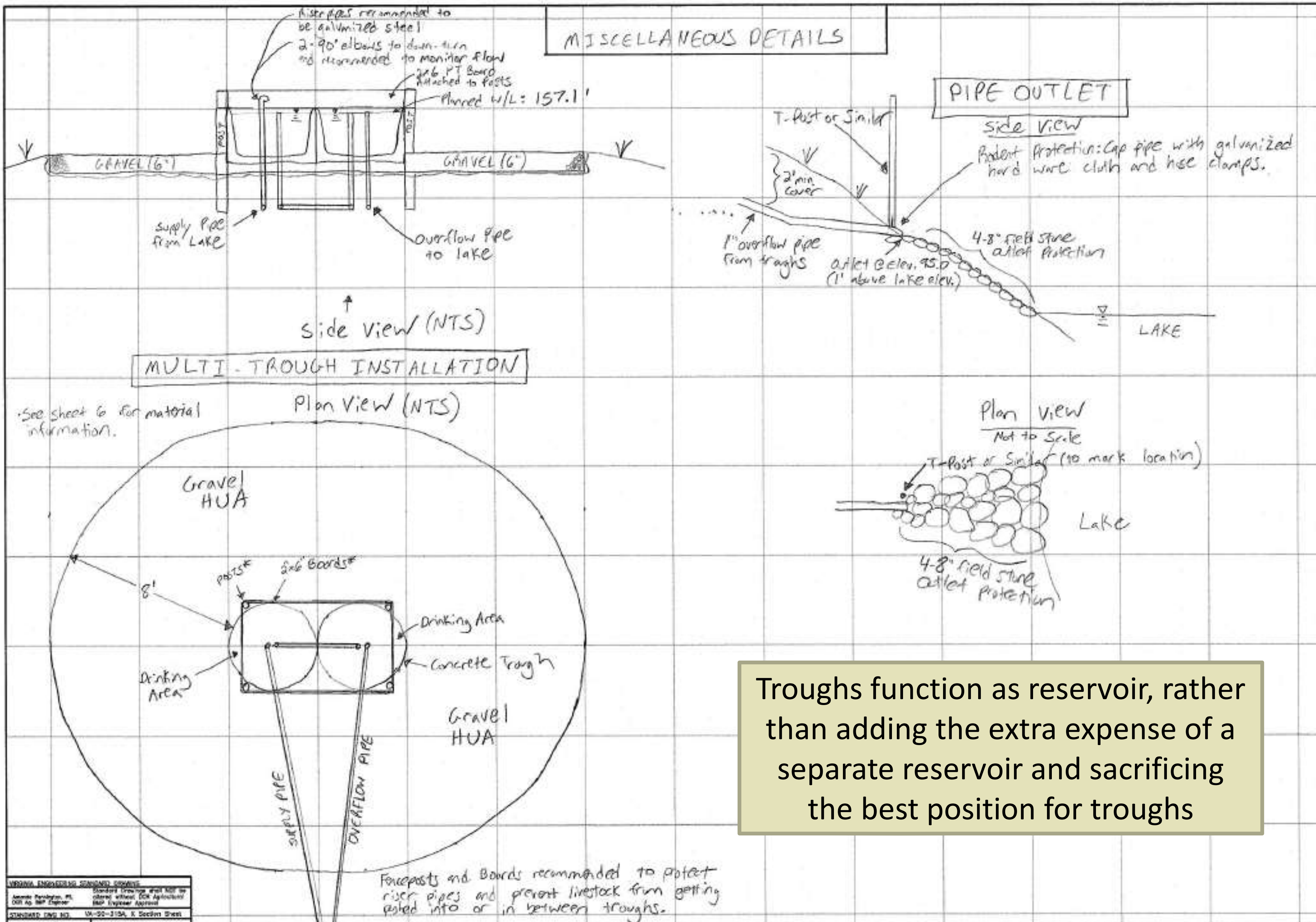
6. An overflow/drain line from the trough will be installed. The inlet for the overflow pipe shall be protected from blockage by algae or floating debris. The outlet shall be protected from livestock.

7. Geotextile shall meet the Class I requirements for nonwoven geotextile in Virginia Construction Specification Geotextiles (VA-795). Class II may be used with engineers approval.

8. Seed all disturbed areas at the rates given in Virginia Construction Specification Seeding (VA-706).

* If seeding is done outside recommended seeding dates, a nurse crop is to be used.

9. Trough(s) must meet requirements of VA-772. Half of a septic tank is NOT acceptable as a trough.



Troughs function as reservoir, rather than adding the extra expense of a separate reservoir and sacrificing the best position for troughs

Virginia Livestock Watering Systems - Pressure-Energy/Gravity Flow Worksheet

1) Assistance Information

Customer:	Whetstone
County:	Buckingham
Date:	8/21/2017
Assisted By:	RC

Print Page

Clear Data

Project Notes: Installing a pond pickup to pump from the lake using a solar pump to two storage troughs at the top of the hill. The troughs will function as a reservoir and will overflow back to the pond once they are full. Lake water level is 93.98. Ground elevation at troughs is 155.11 (water level will be 157.11). Troughs will hold roughly 3-days of storage (1000 gallons).

2) Water Budget

a) Total Daily Water Demand

Type of livestock:	Beef	
Number of Animals:	15	
Water demand/animal/day:	20	gpd
Total Daily Demand:	300	gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

No. of times herd drinks/dai	3	events
Time desired to water herd:	30	minutes/event
Average peak demand:	3.3	gpm
Alternate peak demand:	5	gpm

See Design Note for considerations for estimating peak demand.

c) Evaluate Source

Source flow rate:	10	gpm
Source daily yield:	14400	gpd

If **source flow rate** is close to or less than Peak Demand, consider storage alternatives.
If **source daily yield** is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

See Design Note or EFH Ch. 12 for guidance on pipe size selection.

a) Trough Information

Trough type(s):	Concrete Storage		
Design flow rate:	Alternate Peak Demand	5.0	gpm

Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

Maximum float valve pressure, if applicable: ____ psi

Typical values range from 75-140 psi. Check manufacturer's recommendations.

Minimum float valve pressure, if applicable: ____ psi

Varies depending on type of float. Use manufacturer's recommended minimum. Typical value is 10 psi.

b) Pipe Information

Pipe material:	Plastic: PE SIDR-PR	
Pipe nominal diameter:	1"	
Pipe avg. inner diameter:	1.049	in.
Pipe cross-sectional area:	0.0060	sq. ft.
Kp (head loss coefficient):	0.387	
Velocity check (<5 fps):	1.9	fps

If velocity is greater than 5 fps, consider a larger diameter pipe.
Note: For flows greater than design flow, velocities will be greater.

Pipe pressure rating:	100	psi
72% of rating (See VA CPS 516):	72	psi

c) Gravity System Parameters

Reservoir gnd elev or spring box outlet ele	155.11	ft
Reservoir depth below ground (typically 6	-2	ft
Reservoir bottom (elev for computing head	157.11	ft

d) If Pumping to a Reservoir

Pumping rate should not exceed source rate.

Desired pumping rate to reservoir:	5	gpm
Pumping duration required to meet daily demand:	60	min/day
Ground elevation of water source:	93.98	ft.
Elevation head:	63.1	ft.
Static pressure in pipe (check against max. allowed):	26.5	psi

Dynamic Head Calculations:

Pipe length to reservoir:	371	ft
Add 10% for slope, fittings:	408	ft
Friction loss/100':	1.7	ft/100 ft
Total friction loss:	7.1	ft

Note: If total friction loss exceeds 23.1 ft (10 psi), consider choosing a larger pipe diameter.

Dynamic Head added to pump by pressure component of system:	Friction + elev. head:	70	ft.
		OR	
		30.4	psi

4) Flow and Static Pressure Checks

TROUGH ELEVATIONS:

Enter trough elevations from survey data. For cascade-type systems, enter trough elevations in order from highest to lowest.

CALCULATIONS FOR FLOAT-VALVE SYSTEMS:

Troughs are tee-ed off from the main line, with flow to each trough controlled by a float valve. Pipe length is measured from the reservoir or spring box.

Trough ID and Type	Trough Ground Elev. (ft)	Estimated Water Surface Elev. (ft)	Pipe Length from Reservoir or Spring Box to Trough (ft)	Head from Reservoir or Spring Box (ft)	Maximum Flow Rate (gpm)	Static Pressure (psi)

Trough water surface elevation is assumed to be 2 ft above ground elevation.

Flow calculations assume a float valve efficiency of 80%. For flow rates less than the design rate (yellow cells), consider modifying the system or using storage troughs (such as HETT or concrete). If static pressures exceed the manufacturer's recommended maximum for the float valve, consider using a pressure reducer, adjusting the orifice, or relocating the trough. If static pressures are less than the recommended minimum (red cells), consider moving the trough to a lower elevation. Cells are coded orange for

CALCULATIONS FOR CASCADING SYSTEMS:

Troughs are connected in series by way of their overflow pipes. Pipe length for Trough 1 is measured from the spring box. Subsequent lengths are measured from the previous trough.

Sub-System	Pipe Length from Trough above (ft)	Head from Upper Trough (ft)	Max. Flow Rate (gpm)
Spring box - T1			
T1-T2			
T2-T3			
T3-T4			
T4-T5			
T5-T6			
T6-T7			
T7-T8			
T8-T9			
T9-T10			

Air lock can be a problem in spring-fed systems due to dissolved oxygen. Use a minimum diameter of 1-1/2" for pipe grades between 0.5-1.0%. Use a minimum pipe diameter of 2" for pipe grades less than 0.5%. See EFH Ch. 12.

Print Page

Clear Data

For flow rates less than the design rate (yellow cells), consider modifying the system or using larger volume troughs. If trough in-flow rate exceeds trough outflow rate (red cells), a flow restrictor, larger pipe diameter, or change in trough location may be necessary. This may not be an issue if source flow rate is always less than the maximum flow possible.

Final Thoughts

- Plan the least-cost technically feasible alternative
- Make sure system you are planning has realistic materials
- Keep in mind:
  - LWS Worksheet does NOT automatically check low points in pipeline
  - LWS Worksheet assumes pressure switch is at the same elevation as the well (for above-ground head on pump calculation)

Don’t be scared to ask for help!

Special Thanks To:

- Districts whose designs & projects were featured
- All of you in the audience!

Contact Information

Amanda Pennington, P.E.
District Engineering Services Manager
804-786-0113
Amanda.pennington@dcr.virginia.gov

Raleigh Coleman
Ag BMP Engineering Specialist
540-270-0039
Raleigh.coleman@dcr.virginia.gov