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Design Reviews and Install Issues

Presented for

Arizona Onsite Wastewater Recycling Association

April, 2025

Mark Gross

Reviewing the Plan

- Soil and Site Data
- Scale Drawing
- Elevations of components and slope of ground surface
- Tank size, material, and manufacturer
- Hydraulic profile
- Pump specifications
- Pump switch settings
- Pump dose volume

Soil Data

- Profile Description (NRCS method and description)
  - Depth
  - Color (Munsell Color Book)
    - With colors of redoximorphic features
  - Texture
  - Structure
  - Comments

Soil Sampling Methods

- Backhoe Pit
- Hand Auger
- Power Auger
- Split Spoon
- Hollow Core Auger

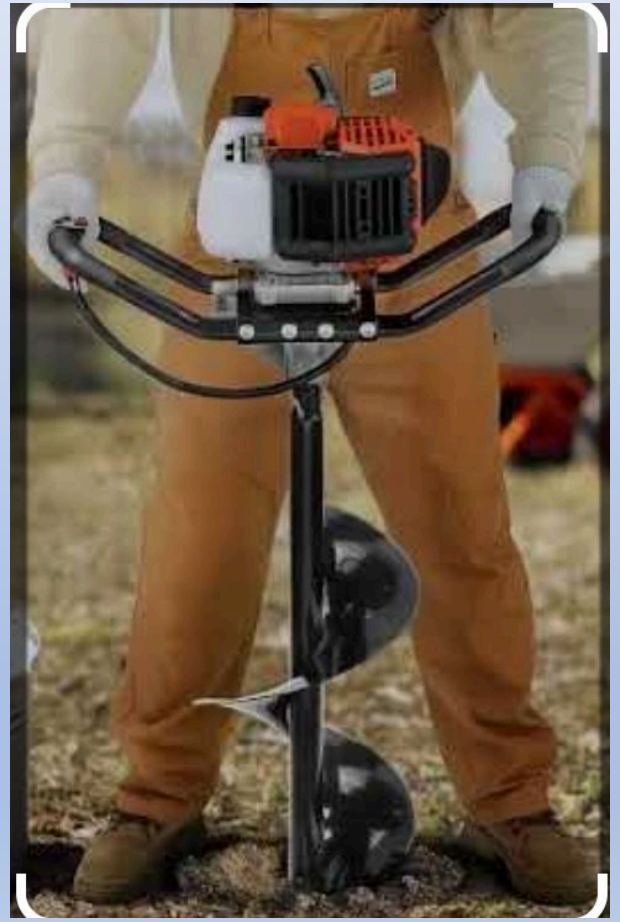
Backhoe pit

Note: This backhoe pit really should have a sloping end to provide access and egress.

Be aware of OSHA regulations regarding entering a pit of a particular depth:
OSHA requires employers to provide ladders, steps, ramps, or other safe means of egress for workers working in trench excavations 4 feet (1.22 meters) or deeper. The means of egress must be located so as not to require workers to travel more than 25 feet (7.62 meters) laterally within the trench.:

https://www.osha.gov/sites/default/files/publications/osha2226.pdf

Power Auger



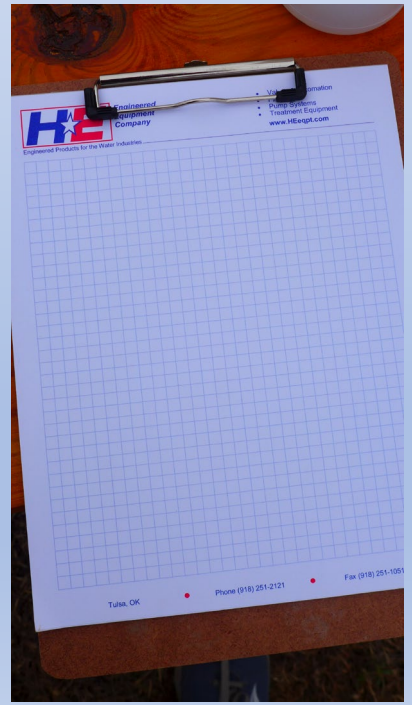
Split Spoon

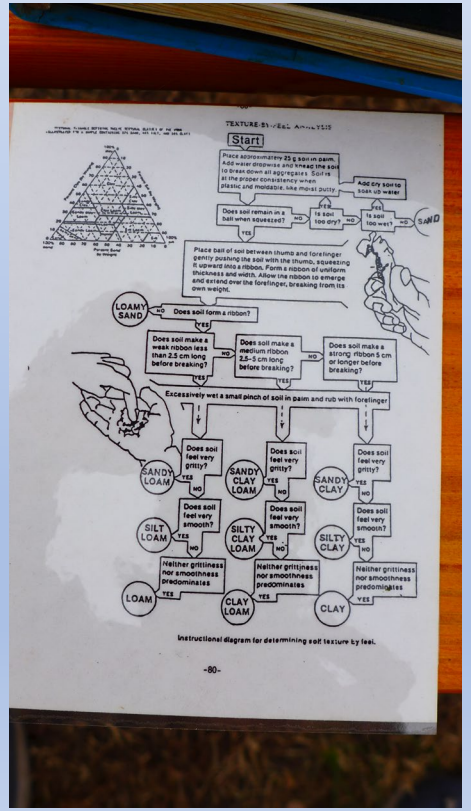
Hollow Core Auger

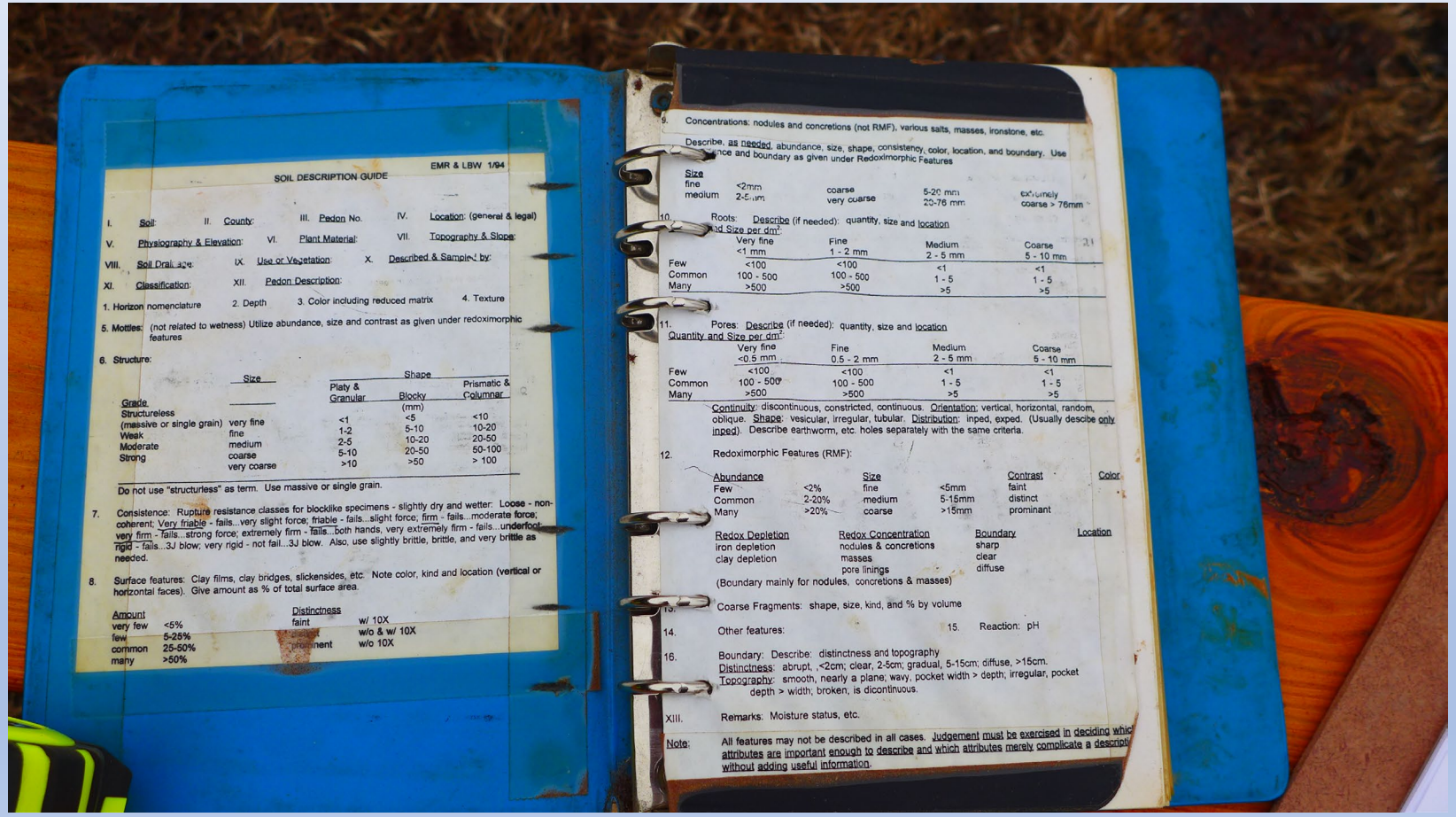
Note that the minimum area for soil description required by NRCS is 1 meter by 1 meter

- Gear for Soil Evaluation
  - Minimum 6 ft tape measure
  - Shovel and knife or tool for working soil face
  - Camera
  - Munsell color book
  - Water bottle
  - Field texturing guide
  - Soil description form
  - Clip board and paper or field book
  - Camera

Tools for soil evaluation







SOIL DESCRIPTION GUIDE

EMR & LBW 1/94

I. Soil: II. County: III. Pedon No. IV. Location: (general & legal)

V. Physiography & Elevation: VI. Plant Material: VII. Topography & Slope:

VIII. Soil Drainage: IX. Use or Vegetation: X. Described & Sampled by:

XI. Classification: XII. Pedon Description:

1. Horizon nomenclature 2. Depth 3. Color including reduced matrix 4. Texture

5. Mottles: (not related to wetness) Utilize abundance, size and contrast as given under redoximorphic features

6. Structure:

Grade	Size	Shape: Platy & Granular	Shape: Blocky (mm)	Shape: Prismatic & Columnar
Structureless (massive or single grain)	very fine	<1	<5	<10
Weak	fine	1-2	5-10	10-20
Moderate	medium	2-5	10-20	20-50
Strong	coarse	5-10	20-50	50-100
	very coarse	>10	>50	> 100

Do not use "structurless" as term. Use massive or single grain.

7. Consistence: Rupture resistance classes for blocklike specimens - slightly dry and wetter: Loose - non-coherent; Very friable - fails...very slight force; friable - fails...slight force; firm - fails...moderate force; very firm - fails...strong force; extremely firm - fails...both hands, very extremely firm - fails...underfoot; rigid - fails...3J blow; very rigid - not fail...3J blow. Also, use slightly brittle, brittle, and very brittle as needed.

8. Surface features: Clay films, clay bridges, slickensides, etc. Note color, kind and location (vertical or horizontal faces). Give amount as % of total surface area.

Amount		Distinctness	
very few	<5%	faint	w/ 10X
few	5-25%	[illegible]	w/o & w/ 10X
common	25-50%	prominent	w/o 10X
many	>50%		

9. Concentrations: nodules and concretions (not RMF), various salts, masses, ironstone, etc.

Describe, as needed, abundance, size, shape, consistency, color, location, and boundary. Use abundance and boundary as given under Redoximorphic Features

Size

fine	<2mm	coarse	5-20 mm	extremely
medium	2-5mm	very coarse	20-76 mm	coarse > 76mm

10. Roots: Describe (if needed): quantity, size and location

Quantity and Size per dm²:

	Very fine <1 mm	Fine 1 - 2 mm	Medium 2 - 5 mm	Coarse 5 - 10 mm
Few	<100	<100	<1	<1
Common	100 - 500	100 - 500	1 - 5	1 - 5
Many	>500	>500	>5	>5

11. Pores: Describe (if needed): quantity, size and location

Quantity and Size per dm²:

	Very fine <0.5 mm	Fine 0.5 - 2 mm	Medium 2 - 5 mm	Coarse 5 - 10 mm
Few	<100	<100	<1	<1
Common	100 - 500	100 - 500	1 - 5	1 - 5
Many	>500	>500	>5	>5

Continuity: discontinuous, constricted, continuous. Orientation: vertical, horizontal, random, oblique. Shape: vesicular, irregular, tubular. Distribution: inped, exped. (Usually describe only inped). Describe earthworm, etc. holes separately with the same criteria.

12. Redoximorphic Features (RMF):

Abundance		Size		Contrast	Color
Few	<2%	fine	<5mm	faint	
Common	2-20%	medium	5-15mm	distinct	
Many	>20%	coarse	>15mm	prominant	

Redox Depletion	Redox Concentration	Boundary	Location
iron depletion	nodules & concretions	sharp	
clay depletion	masses	clear	
	pore linings	diffuse	

(Boundary mainly for nodules, concretions & masses)

13. Coarse Fragments: shape, size, kind, and % by volume

14. Other features: 15. Reaction: pH

16. Boundary: Describe: distinctness and topography

Distinctness: abrupt, <2cm; clear, 2-5cm; gradual, 5-15cm; diffuse, >15cm.

Topography: smooth, nearly a plane; wavy, pocket width > depth; irregular, pocket depth > width; broken, is dicontinuous.

XIII. Remarks: Moisture status, etc.

Note: All features may not be described in all cases. Judgement must be exercised in deciding which attributes are important enough to describe and which attributes merely complicate a description without adding useful information.

Observations

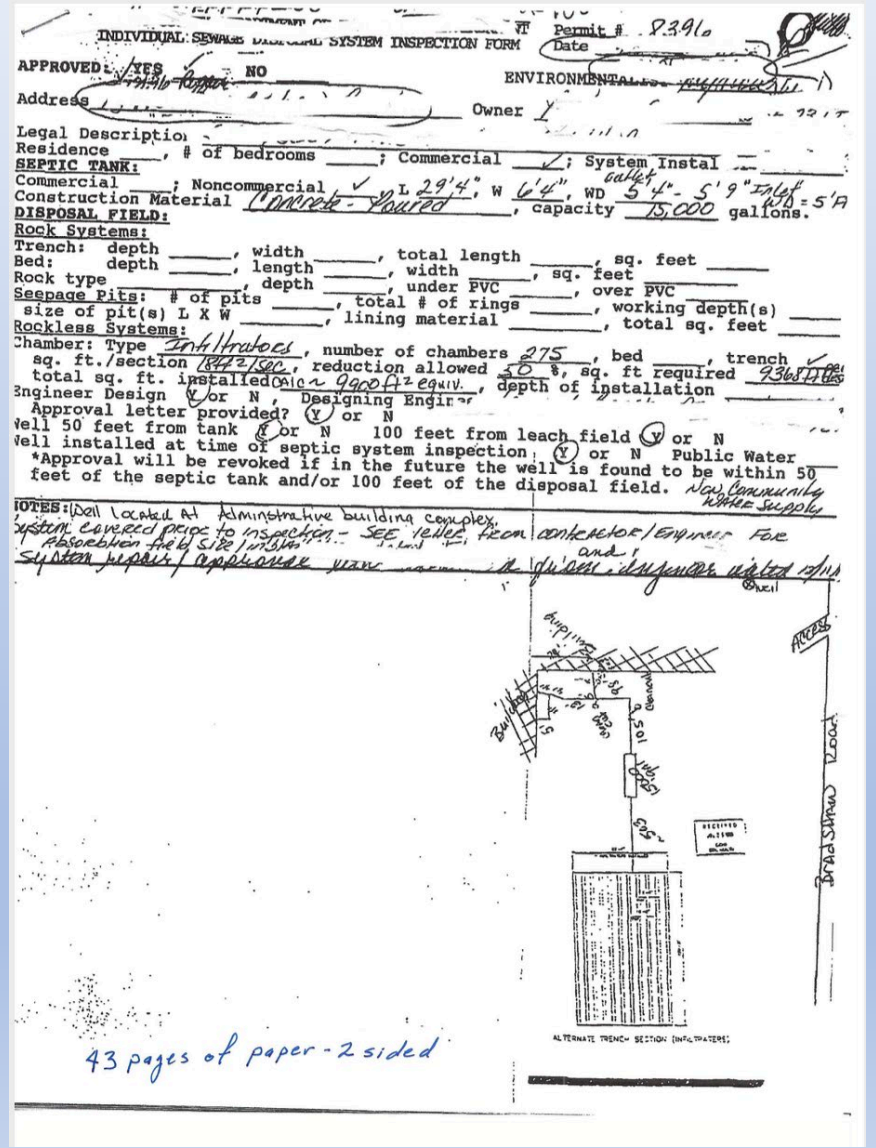
- Soil Horizons and depth
- Soil texture
- Soil structure and strength
- Depth to redoximorphic features
- Depth to limiting horizon – clay, rock, hard pans

Site Data

- Available area – lot or parcel size
- Setback requirements – sometimes municipalities have setback requirements that may be more stringent that regulatory agency setbacks
- Easements
- Well location – including the neighbor’s wells
- Surface water location
- Landscape position where appropriate

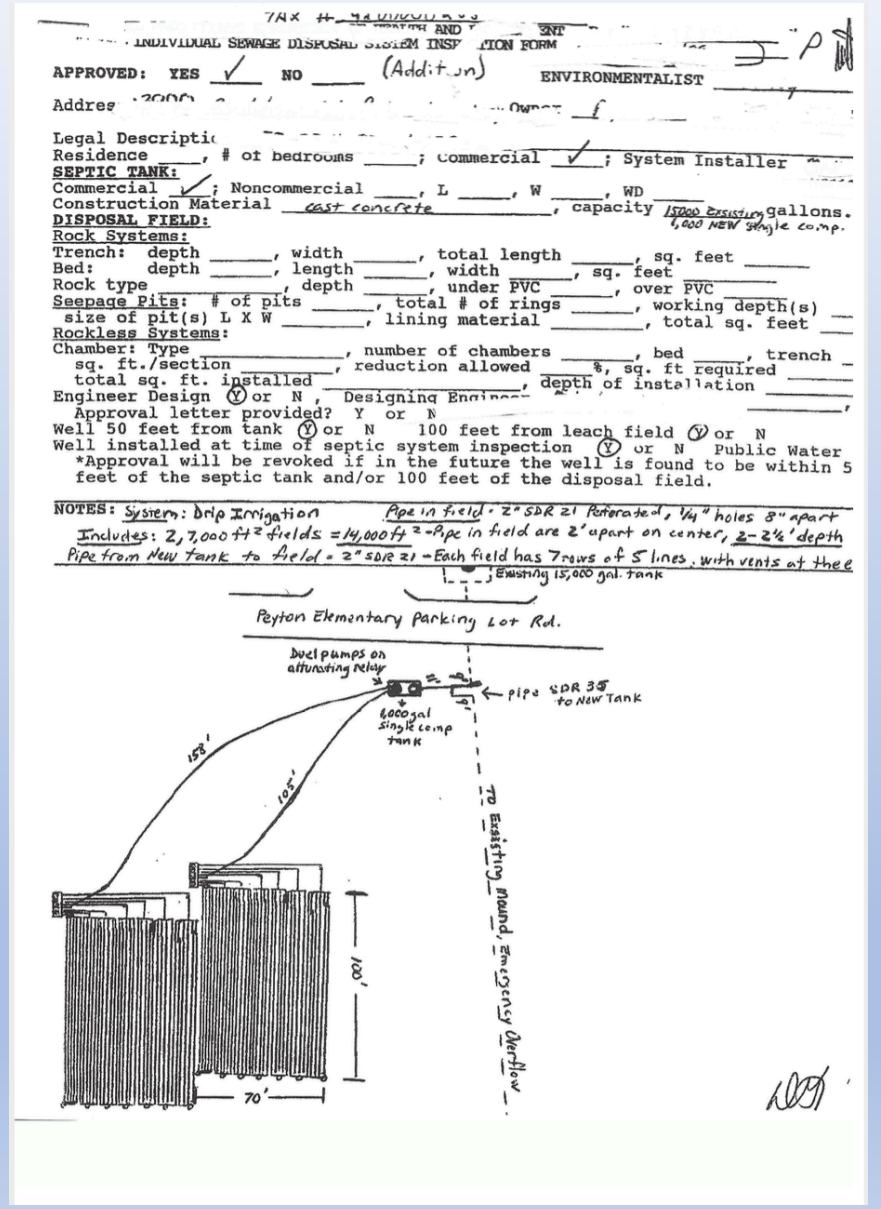
Example of Drawing from a Permit:

- No scale
- 43 pages (double-sided) of permit documents, and this is one of two drawings

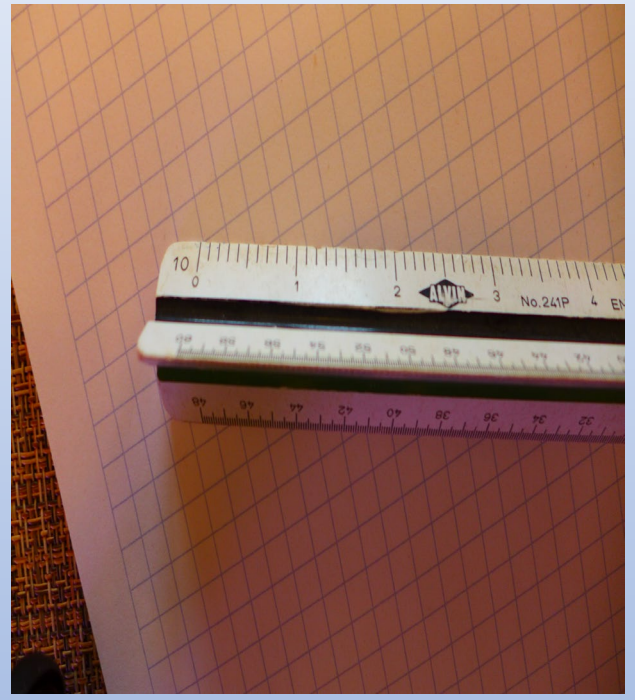


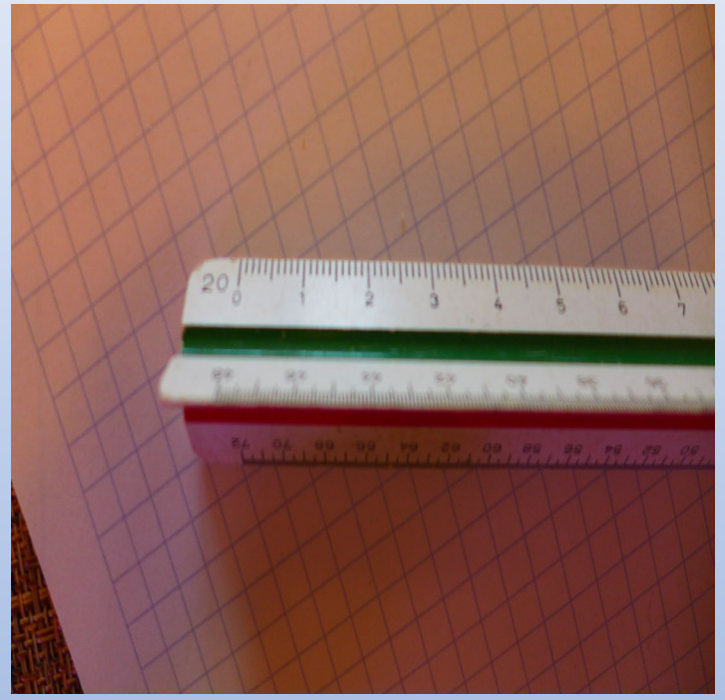
Another Permit Drawing

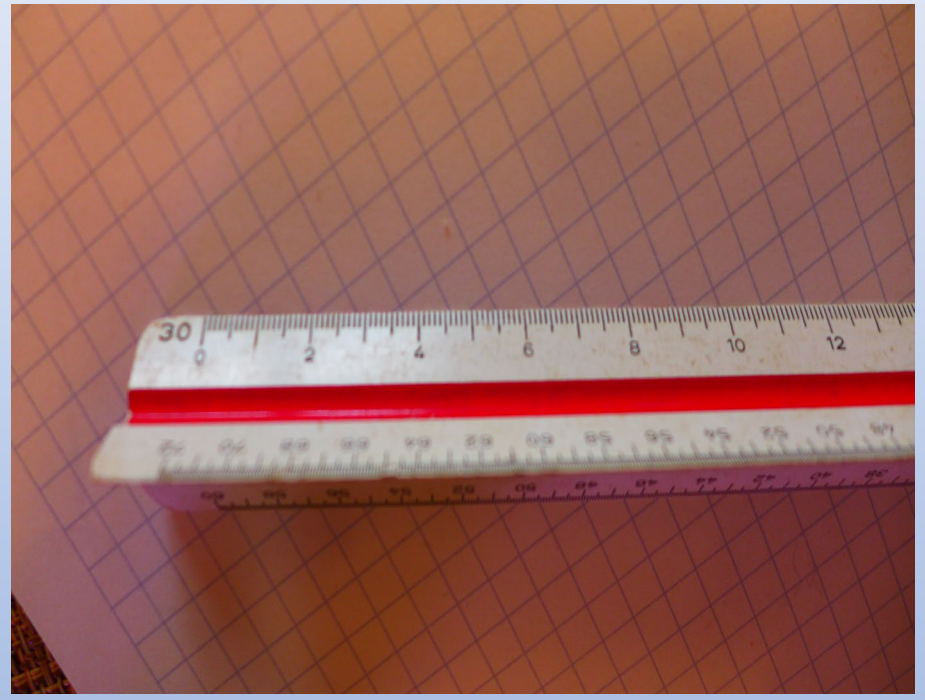
- No Scale
- The permit says it's drip irrigation
- It's really non-pressurized distribution



Scale……

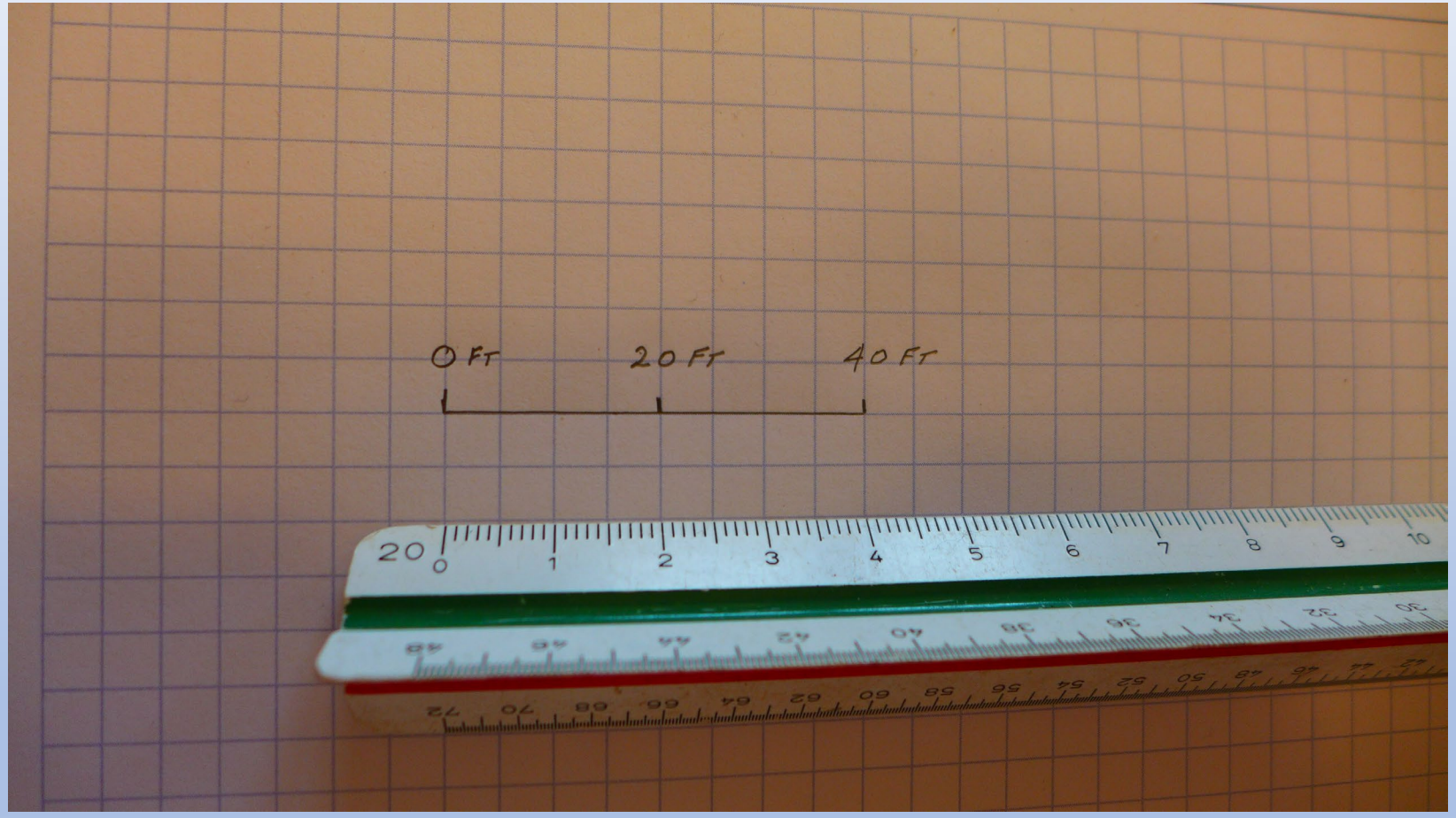






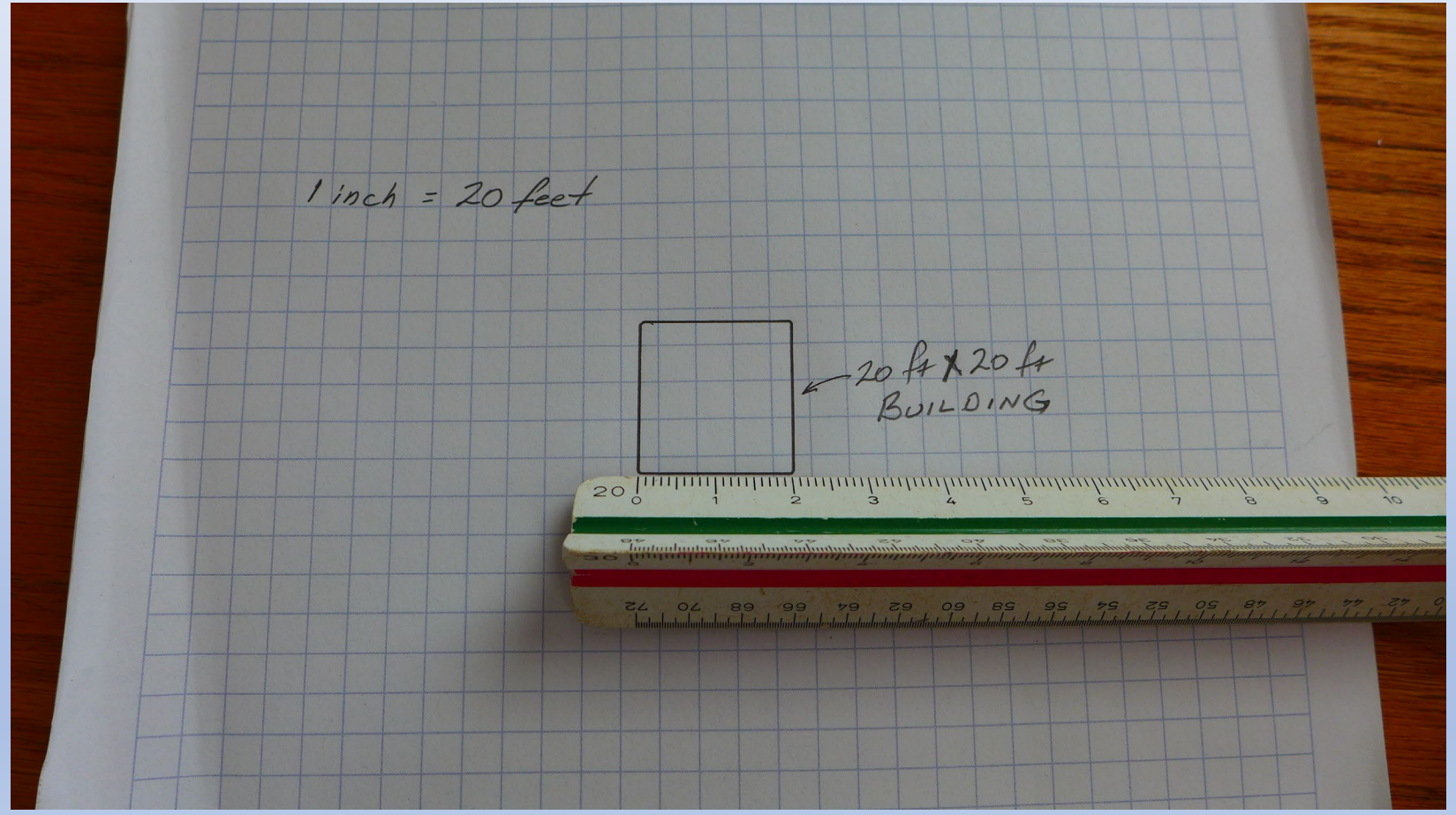
There are different marks (sides) on an engineer’s scale
The sides are 10, 20, 30, 40, 50, and 60 scales

Graphic Scale

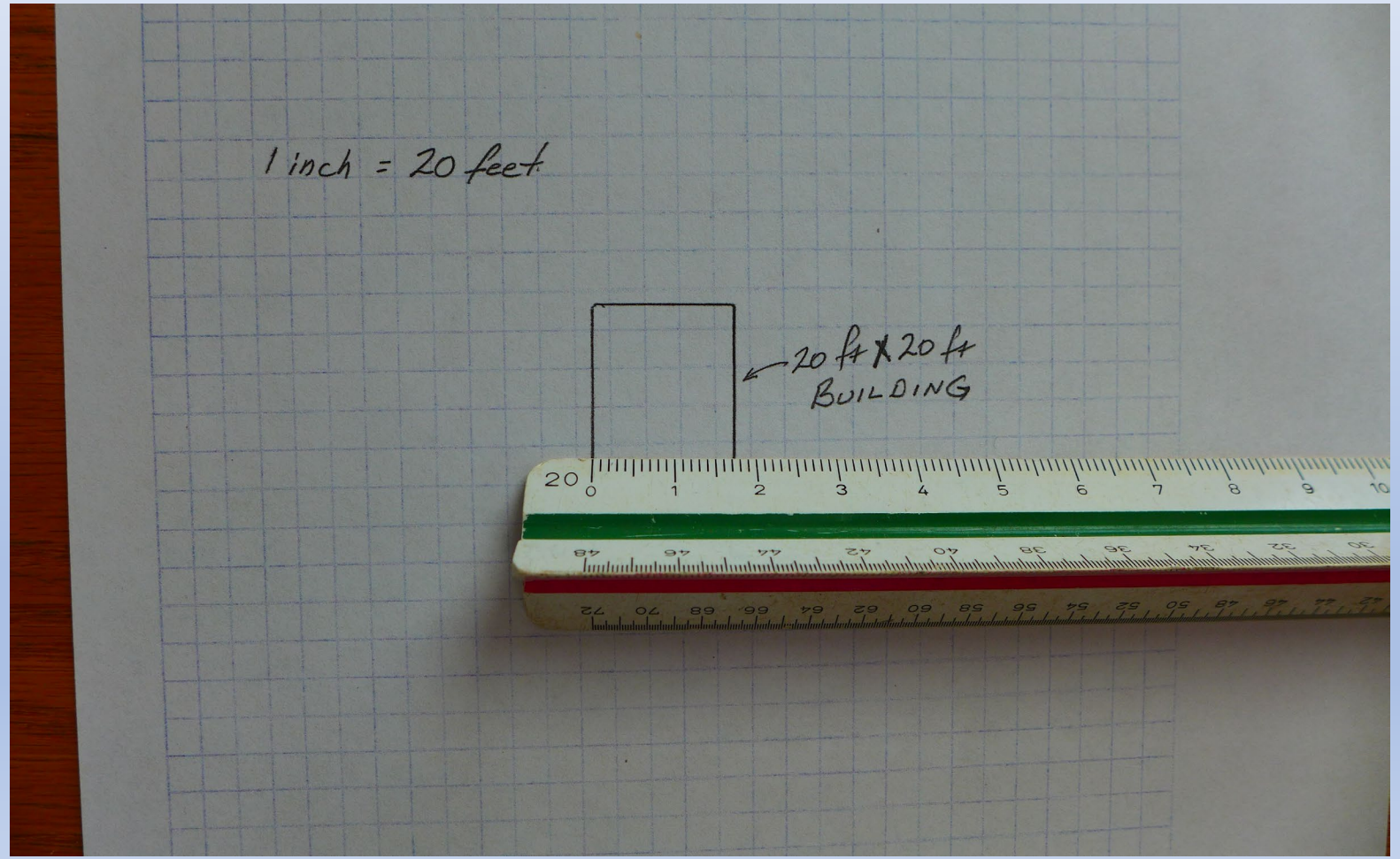


With a graphic scale, the scale is reduced or enlarged at the same amount as the drawing

Written Scale – Full size. The scale is correct



The document has been reduced to 85%. Now the written scale is not correct. 1 inch is no longer equal to 20 feet.



Elevations and Slope

- Every plan should have a benchmark shown.
- The benchmark should be located at a point that won’t change
- Some examples:
  - A concrete pad for a transformer
  - Driveway corner
  - A spike in a power pole
  - Top of a fencepost that isn’t expected to move

Elevations

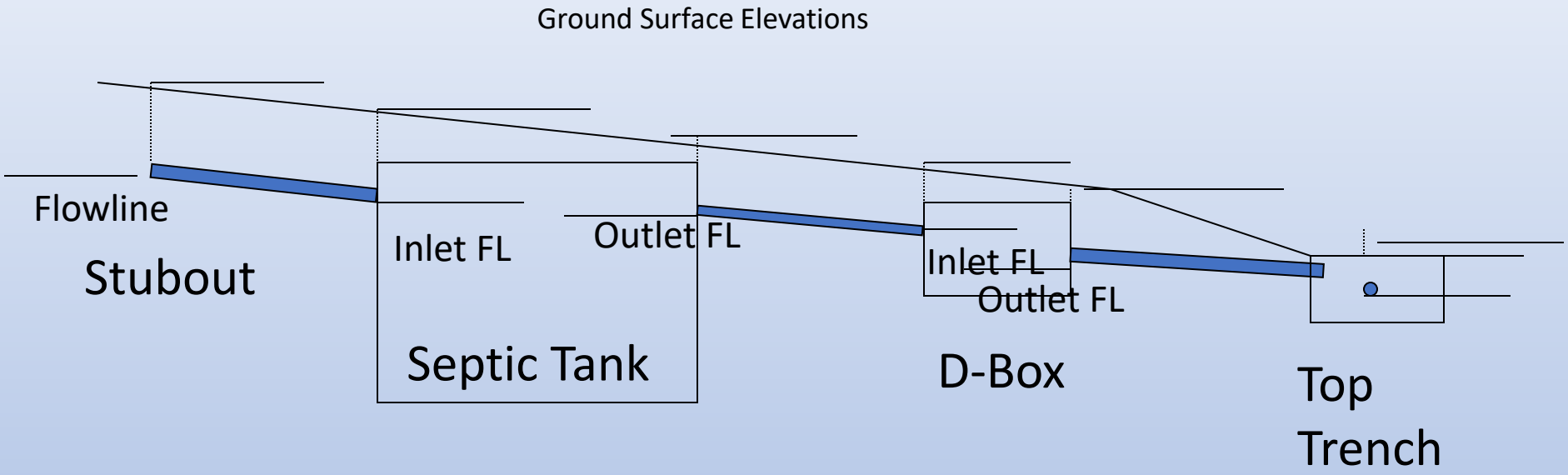
- How you prefer to see elevation data can be up to you
  - Elevation referenced to the benchmark
  - Rod readings – not everyone is comfortable calculating elevations using back sights, forward sights, and turning points
  - Elevation above mean sea level – that might be difficult, depending upon the site and the instrumentation

Shoot elevations. Flag components in the field

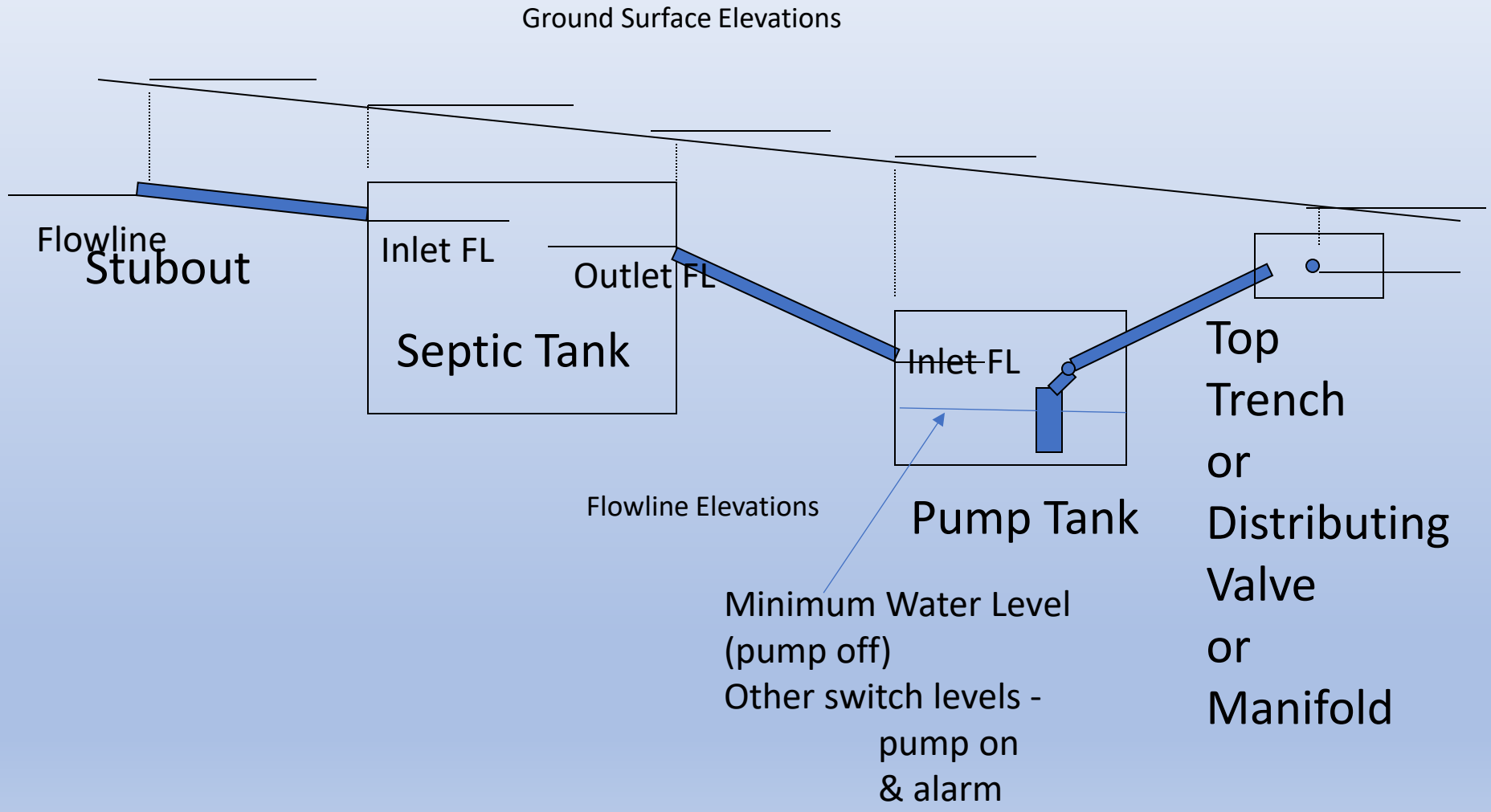
Elevation data can be gathered by a single person

Inlet and Outlet Elevations of Components

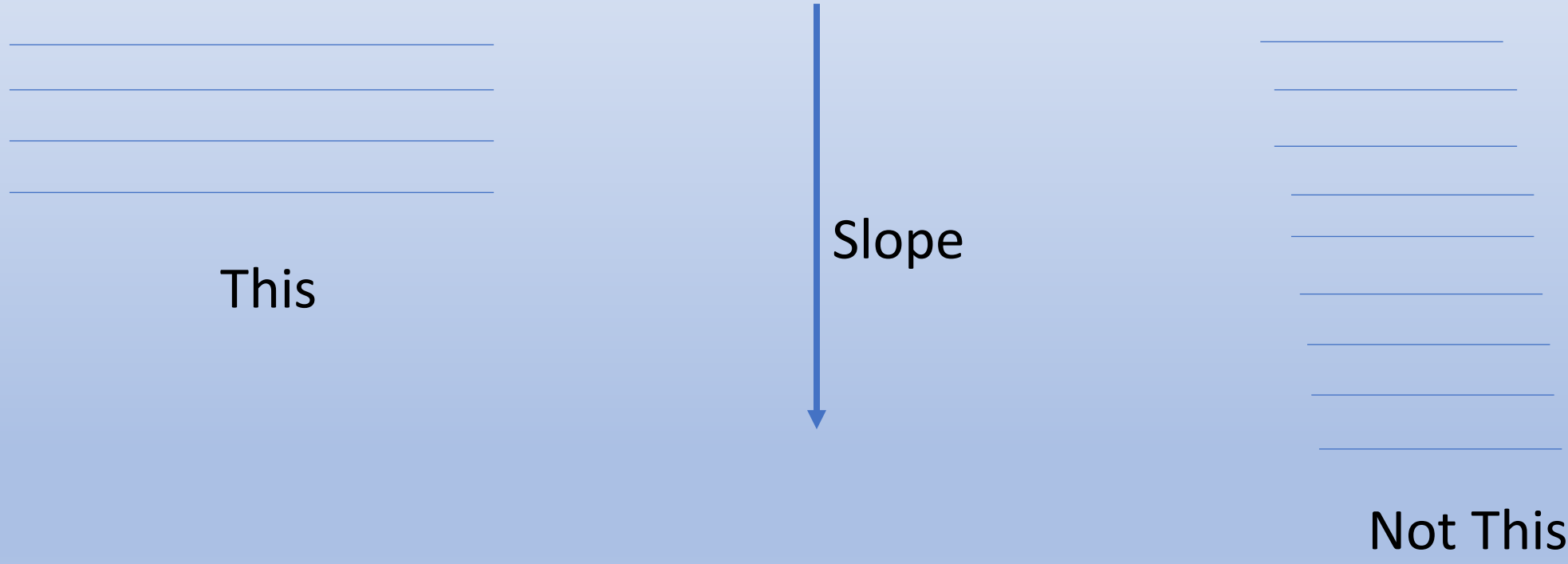
- Cleanout in the gravity pipe between the house and the septic tank
- Inlet to the septic tank (flow line, also called the ”invert”
- Outlet of the septic tank (invert)
- Inlet to the distribution box (invert)
- Outlet of the distribution box (invert)
- Inlets and outlets of each pipe to each trench
- Top of gravel where gravel is used
- Top of chamber where chambers are used
- Bottom surface of the trench – the infiltrative surface



Hydraulic Profile


Ground Surface Elevations
Flowline
Stubout
Inlet FL
Outlet FL
Septic Tank
Inlet FL
Flowline Elevations
Pump Tank
Top
Trench
or
Distributing
Valve
or
Manifold
Minimum Water Level
(pump off)
Other switch levels -
pump on
& alarm

Linear Loading Rate
Longer, but fewer trenches along the contour are More effective than fewer shorter trenches



E.J. Tyler and L.K. Kuns, Designing with Soil: Development and Use of a Wastewater Hydraulic Linear and Infiltration Loading Rate Table

Tanks

- Structurally Sound
- Water-Tight
- Cast-in flexible inlet and outlet fittings (boots)
- Compaction under the tank(s)
- Risers with cast-in riser adapters or cast-in risers

- My opinion and experience is that polyethylene (plastic) tanks are inappropriate for use as septic tanks. They deform – EVERY one I've ever seen.

Leaky Tank

Collapsed Tank

Deformed Tank

Deformed tank

Effluent filters: is one specified in the design?

Risers

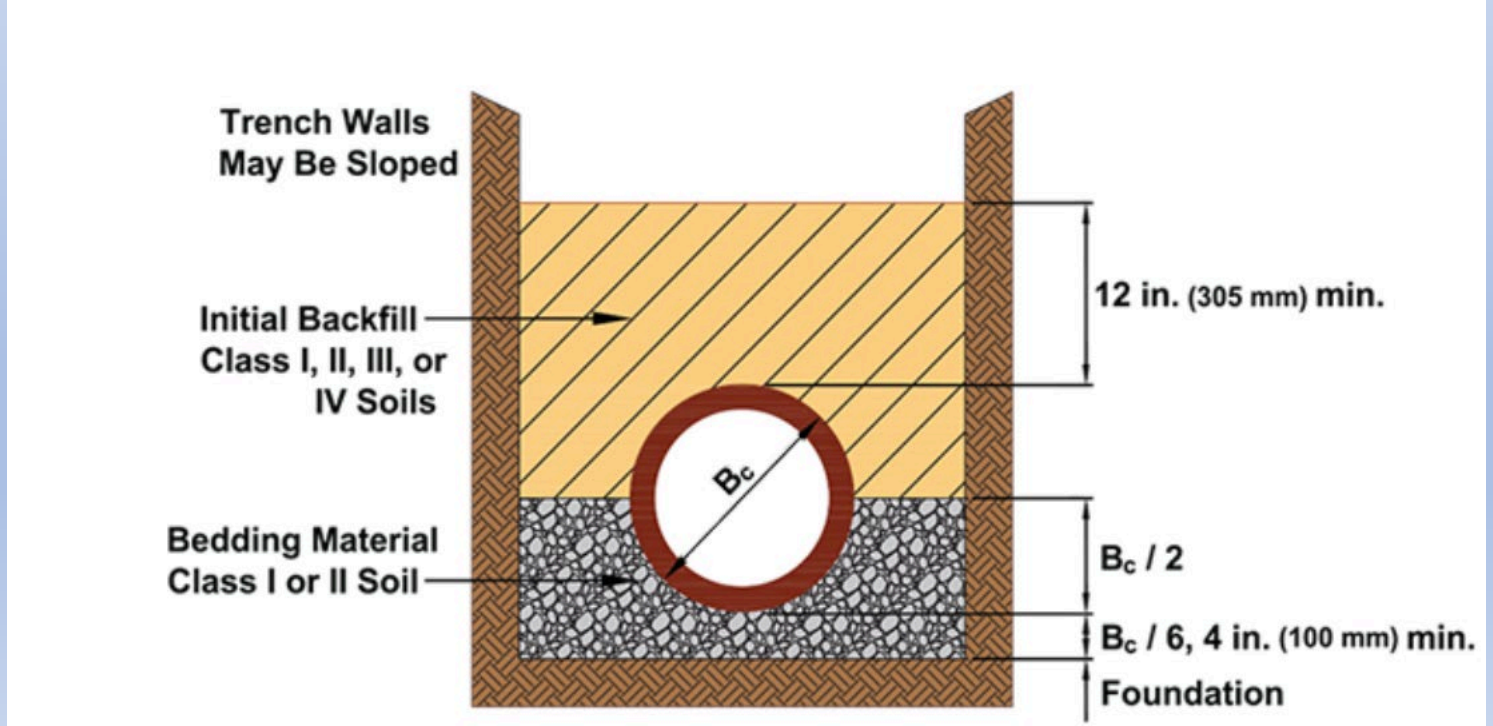
- Structurally sound
- Durable
- Water-tight, including the connections to the tank
- Lockable and child-safe
- Over both the inlet and outlet

Water-tight riser being tested while tank is tested

Not secure or water-tight risers

Pipe Installation

- Compacted bedding to the haunches
- Select Backfill – no rocks
- Joints – solvent welded or gasketed



Pipe Size …. The nominal diameter is neither the inside diameter nor the outside diameter

- Schedule 40
- Schedule 80
- SDR 35
- AWW C900
  - The pipe outside diameter is the same, but the inside diameter is different for different pressure classes – that can affect the head loss in the pipe and therefore pump selection and performance. Particularly for long runs.

- Not DWV pipe – the outside diameter is different, and it’s thin-walled

Pipe Material

- Corrosion-resistant
  - PVC
  - ABS
  - Polyethylene

Pump Selection

- Calculations
  - Minimum Required Flow
  - Static Head
  - Head Loss in pipe and fittings
  - Residual Head
- System Curve and Performance Curve

Pump Selection

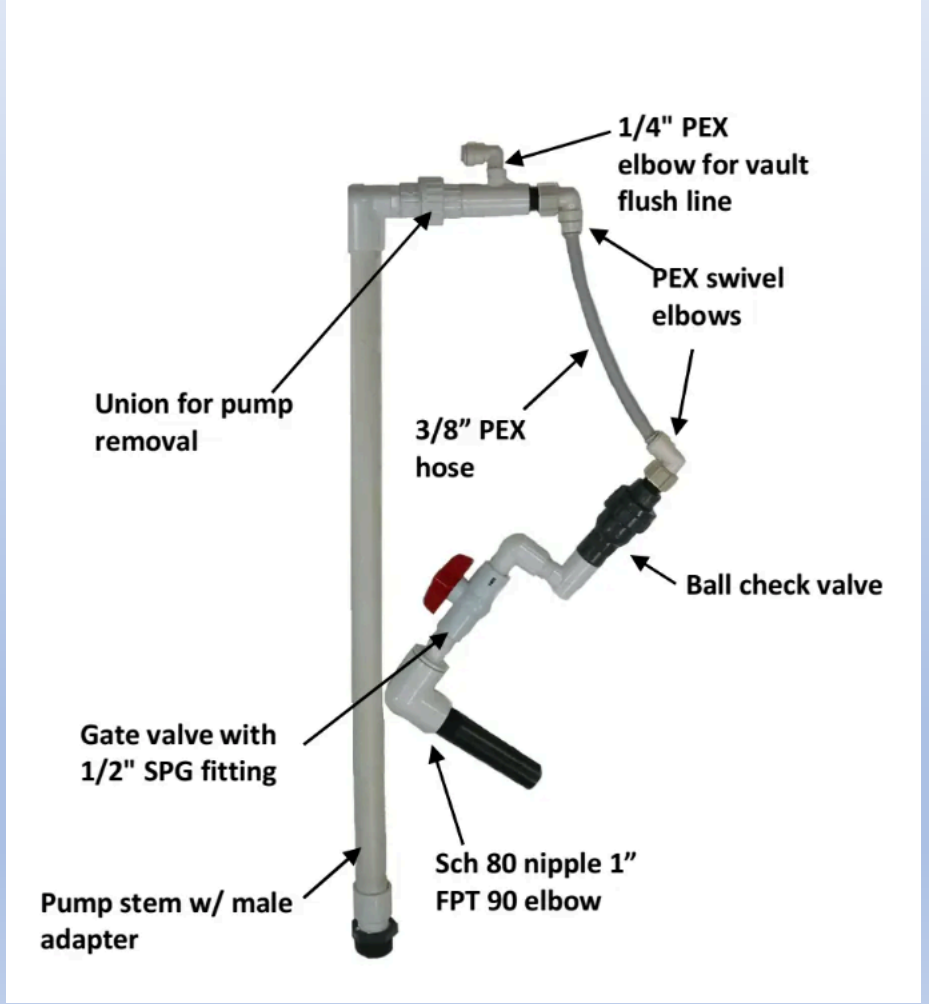
- Make
- Model
- Horsepower
- Duty Point
- Voltage
- Amperage (starting amps, full load amps)
- Wire Size for long wire runs

Example: Zoeller model 140 effluent pump,
1 Horsepower, 115 VAC, capable of 20 gpm, at 22.7 ft TDH,
with 20 ft cord and switch
Full load amps: 12 amps

Note: For the same power draw, and the same wire length, stranded wire has less voltage drop than solid wire

Pump Discharge Assembly Material

- Flexible hose or rigid pipe
- Corrosion resistant (no steel, even if it's galvanized)



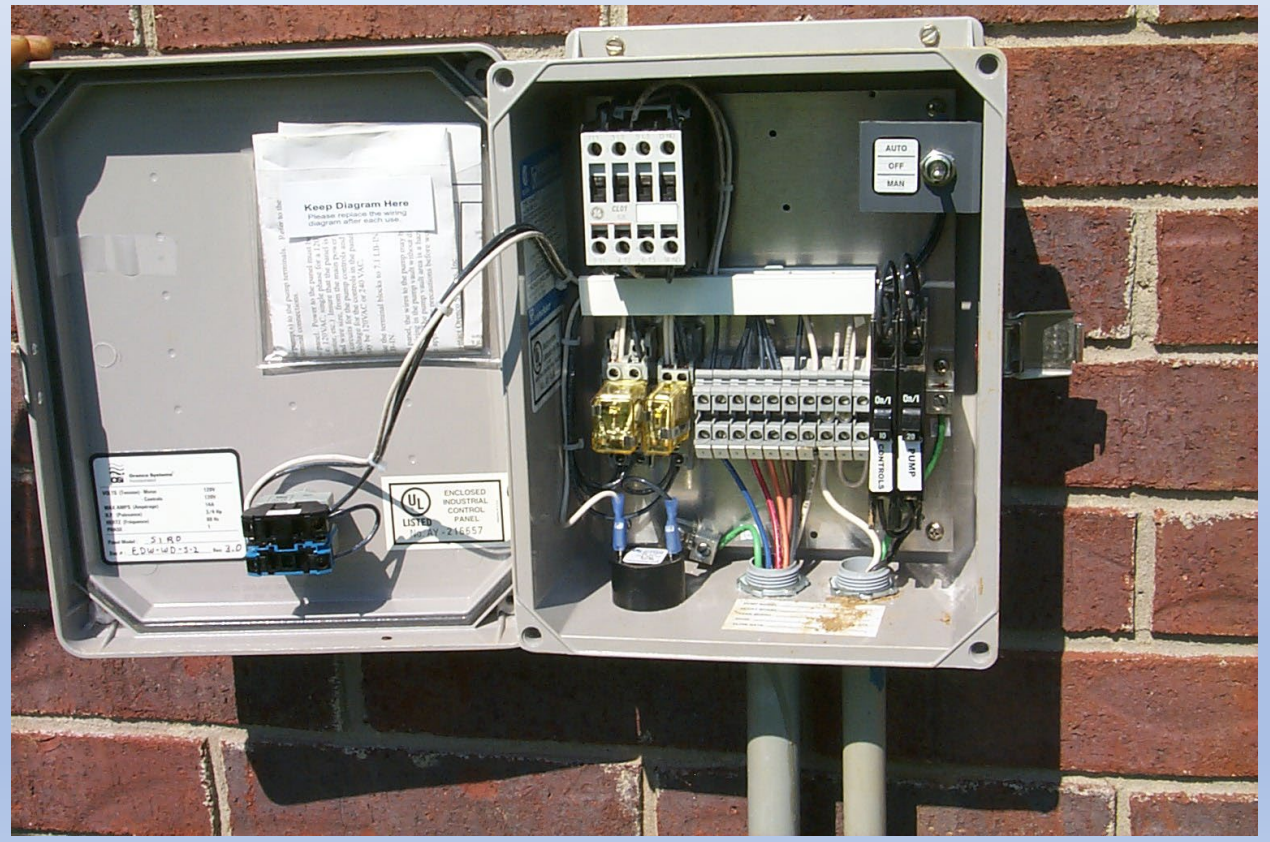
The union should be upstream of the valve

Pump Discharge Components

- Check Valve
- Anti-Siphon valve
- Shut off valve in the correct position
- Union or disconnect in the correct position
- Alternating valve
- Adapters
- Anti-siphon valve, if needed
- K-rain valves need to be at a high point between the pump and the outlet to the soil dispersal system or they won't cycle

Electrical Components

- Use a control panel
- Watertight junction box
- Seal conduit between pump tank and control panel
- Use a cycle counter
- Use a cycle timer
- Do you want separate circuits for the pump and the audio/visual alarms? Separate circuits from the house to the panel or separate circuits inside the panel?

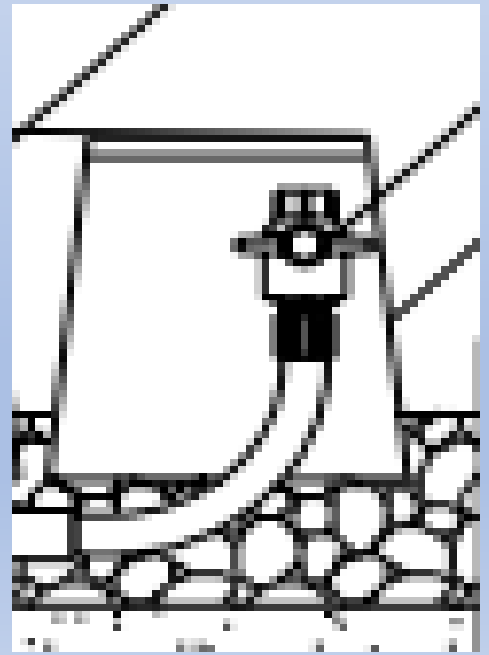

Keep Diagram Here
Please replace the wiring diagram after each use.
AUTO
OFF
MAN
ENCLOSED INDUSTRIAL CONTROL PANEL
CONTROLS
PUMP

Don’t do this….
Piggyback plug in an outlet inside the tank

Or Either of These……

Pressurized Distribution Systems

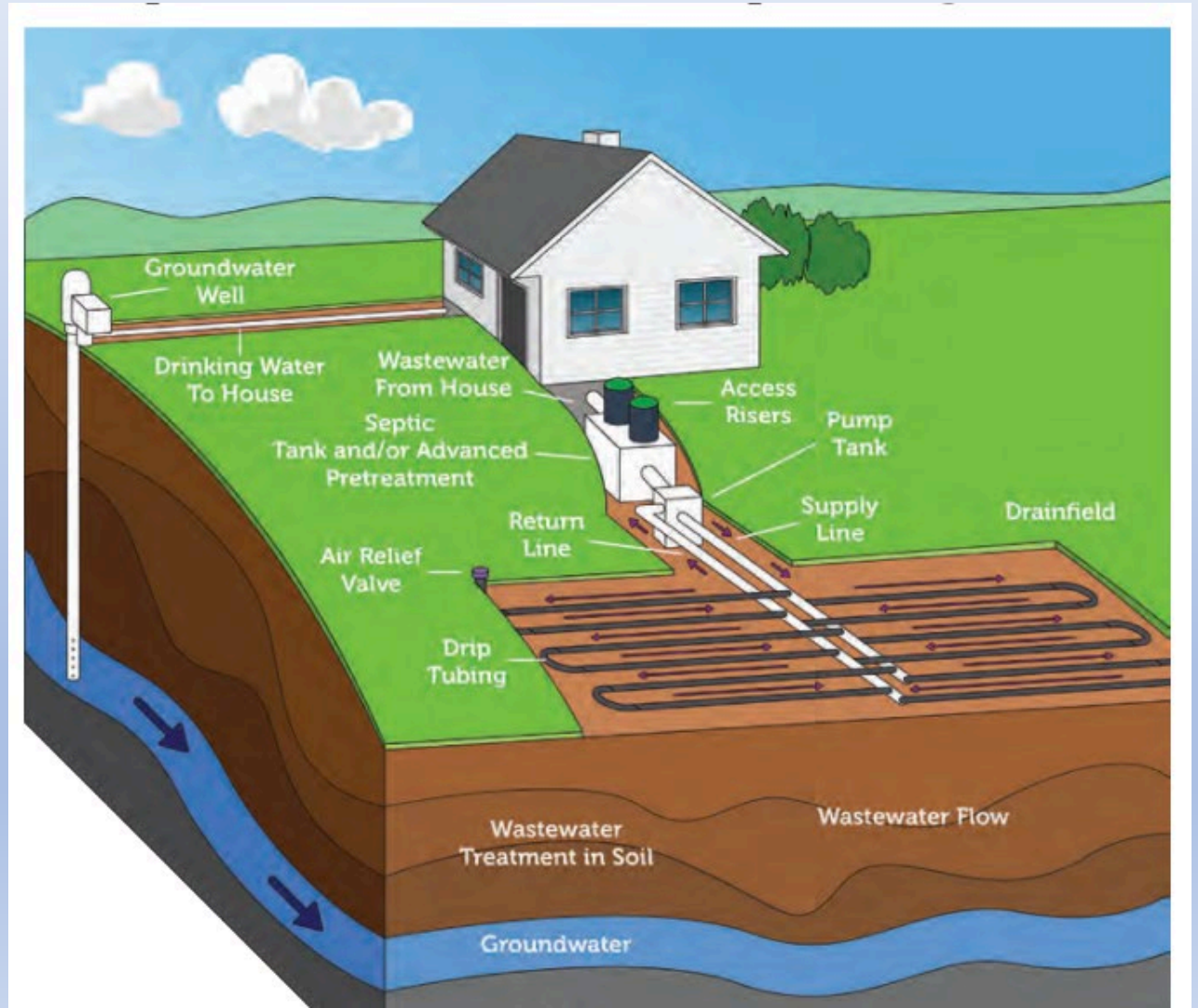
- End-of Line cleanouts
- May want to use end-of-line valves, but ball valves are expensive
- Some installers are going to threaded caps or threaded plugs
- Valve boxes



Drip Irrigation Systems

- Filter
- Filter flush
- Field flush
- Run time and flush calculations (there are only 24 hours or 1440 minutes per day)
- Return piping
- Control panel
  - Audio-visual alarm
  - Alarms on Separate circuits from the house or separate circuits inside the panel?

Drip Irrigation System



Advanced Treatment Systems

- Third-party sampling and analysis
- Field data is good – using third-party sampling and analysis
- Need specifications and cut sheets for permit review
- Should have an installation manual
- Should have a start-up procedure
- Should have an Operation and Maintenance manual

Equipment for Final Inspection

- The permit plus
  - Level and Rod
  - Tape Measure at least 100 ft
  - (Roller wheel) if you have one
  - Clipboard and field book or paper
  - Camera

Pre-construction Inspection

Observations

- Check soil pit to verify permit application data
- Spot check some elevations
- Landscape position
- Setbacks

Blank Slide

Certification for Designers

- Some states require certification for onsite wastewater system designer.
- The certification is in addition to other registrations such as engineering registration, soil classifier registration, etc.
- Certification requires training and examination with regard to soil, pumps and controls, basic measurements such as elevations and distance, rules and regulations, and permitting
- Continued certification requires continuing education and annual fees
- Some states require designers to carry a bond

Certification for installers

- Some states require Certification for installers
- The certification is in addition to the state contractor’s license
- Certification requires training including pumps and controls
- Continued certification required continued education and annual fees
- Some states require installers to carry a bond

A way to get professionals up to speed

- At the University of Arkansas, we used a significant portion of our onsite wastewater research funding, and some extension funding for Technology Transfer.
- The approach was to train and equip the Environmental Health Specialists (Sanitarians) rather than the practitioners
- That way, the regulators would have the knowledge and skills and could pass that along to the practitioners.
- The regulators would not be intimidated by more knowledgeable practitioners

Technology Transfers

- 4 days including Classroom soil and septic systems
  - Classroom discussion of water movement through soil – “crust limited” and “soil limited”
  - Hand texturing practice with standards
  - Field work with pits - lots

- Some basic design concepts and skills
  - Reading a scale and scale drawings
  - Using an engineer’s level and calculating elevations or using rod readings
  - Laying out and flagging a basic gravity system in the field

Technology Transfers

- New Technology and Research
  - Onsite Wastewater Project Research from Arkansas
  - Onsite Wastewater Project Research from other universities
  - Onsite Wastewater Project Research from conferences
  - Some of the EHS personnel attended onsite wastewater conferences ASAE, NOWRA, etc.

Costs

- The Department of Health paid for EHS travel expenses
- The Onsite Wastewater Project paid instructors' expenses
- The Onsite Wastewater Project work with ADH to arrange for field sites.
- The Tech Transfers were moved around the state so the Health Department regions were covered and local soil types were covered

Participants

- Every participant attended twice
- We tried to bring the first-timers in to team with the second-timers

Audience Discussion

“Installation, Inspection, and Operation and Maintenance”

Is Tomorrow at 3:00

BLANK SLIDE

Installation, Final Inspection and Operation and Maintenance Issues

Presented for:

Arizona Onsite Wastewater Recycling Association

April, 2025

Mark Gross

Final Inspection

Are the components visible and accessible?

Tanks	Discharge assembly
Risers	Control panel
Distribution box	Wiring
Pump tank	Junction box
Soil dispersal system Slope Depth Elevation	Benchmark
Pump meets specs from design	

Shoot Elevations of Components

- Stubout from house
- Septic tank inlet and outlet
- D-box inlet and outlets
- Soil Dispersal piping ends and middles
- Distributing valve (K-Rain, HydroTech)
- Manifold

Tank water tightness and other

- Tank has been filled with water about 2-3” into the riser and soaked if it’s concrete
- Tank has flexible fittings (boots) for inlet and outlet
- Is the effluent filter installed if it was specified?

- Note: Do not fill more than a few inches into the riser. It can lift the lid off the tank. Really.

Check the D-box

- Pour water into it and see if it distributes evenly as nearly as you can tell

Check pipe bedding and backfill

- Is the pipe bedded with select material – no rocks or organic debris such as stumps, wood, trash?
- Is the bedding compacted to prevent pipe deflection?
- What is the planned or existing backfill material?
- Pipe slope?

Pumped Systems

- Check pump wiring
- Check the pump discharge assembly
  - Is the disconnect in the correct position?
  - Is there a shutoff valve in the correct position?

- Check the junction box
- Check the control panel
- Discharge pipe outlet – flexible grommet or hub

Pumped Systems – run the pump

- Does the pump operate properly?
- Do the timer and counter operate?
- Does the D-box distribute?
- Pressurized distribution – check the “squirt height”
- Is the squirt height the same on all lines?
- Does the anti-siphon valve work properly?
- Does the K-rain valve cycle?

Pumped Systems

- Are the timer settings correct and do they match the design?
- Does the audio/visual alarm operate
- Do the level switches operate properly?
- Is the conduit sealed between the junction box and the control panel?

Drip irrigation systems

- Perform the manufacturer’s startup
- Does the pressurization cycle operate properly
- Does the field flush operate properly
- Does the filter flush operate properly
- Does the audio/visual alarm operate properly
- Are timer settings correct and do they match the design calculations

Proprietary Systems

- Go through the manufacturer's startup procedure – it should have been submitted with the permit application
- Blowers
- Aeration
- Mixing
- Venting
- Distribution over media
- Discharge

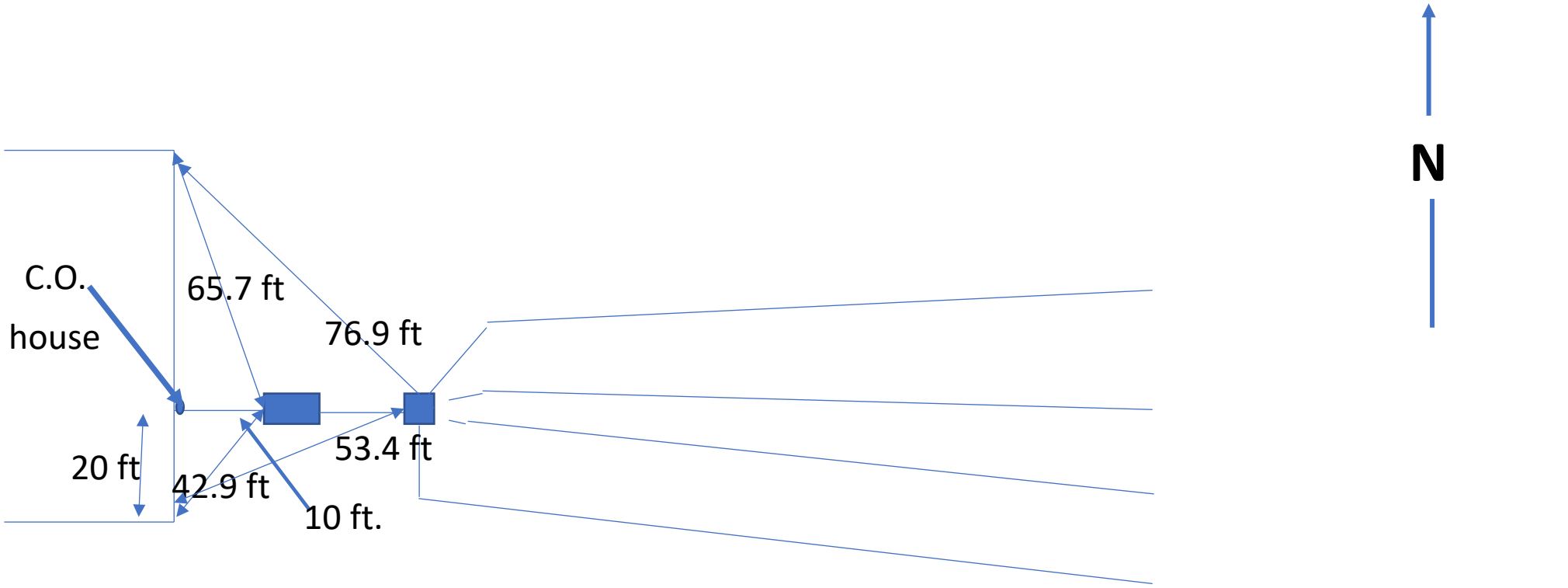
As-built, As-built, As-built!!!!

- Preparing an as-built sketch and/or drawing gives a record of how and where the system was actually built.

- When, in the future components need to be located for maintenance, inspection, and repair, they can be found without digging for exploration.
- Reference measurements to permanent and easily-identified objects. Such as the house corners
- Distances from two points locate an object


FIELD BOOK


LASERPLANE
500



Benchmark
NW Corner of transformer pad on SE corner lot 24
Assumed elevation 100.00

Operation and Maintenance

- Gravity Systems
- Pumped Systems
- Drip Irrigation Systems
- Advanced Treatment and Proprietary Systems

Note; Some states require training and certification for onsite system maintenance providers in addition to the manufacturers' training

Gravity Systems

- Most literature sources suggest pumping the septic tank every 5 years
- It depends upon the number of people in the house and the usage patterns
  - https://odl.orenco.com/documents/SepticTankSeptagePumpingIntervals_TechPapers_Orenco_NTP-TNK-TRB-1.pdf

If the distribution box is accessible, check distribution. If the distribution is uneven, consider “dial-a-flows.”


86795 Z
NORMAN, OK
(405)329-5365

Effluent Filter

- Clean the effluent filter by washing back into the inlet end of the septic tank

Serial Distribution or Alternating Systems

Rotate the alternating valve

Most climates: Full system in Winter and bypass in Summer

Rotate to full on Labor Day and back to bypass on Memorial Day

The benefit of resting a serial system

Pumped systems

- Check the cycle counter and timer and record the readings
- Compare the readings to the last readings
- Does the calculated number of cycles make sense for the time period?
- Does the calculated dose volume make sense?

Pumped Systems

- Operate the pump
- Check the level settings
- Does the D-box distribute evenly as near as you can tell?
- Does the pump cycle properly
- Do the cycle counter and timer work
- Some operators will check voltage and amperage draw when the pump runs.
- Does the audio/visual alarm work

Systems with a pump tank

- Check the sludge level in the pump tank
- If it’s a separate tank with a free fall from the septic tank to the pump tank, probably should go ahead and pump it when the septic tank is pumped

Pumped Systems – pressure dosed

- Check the squirt height
  - Use a clear acrylic or PVC pipe with a fitting that will thread into the end of line turn up.
  - Or use a threaded cap or plug with the appropriate size orifice
- Blow out the pressurized piping every 18 months

Drip irrigation systems

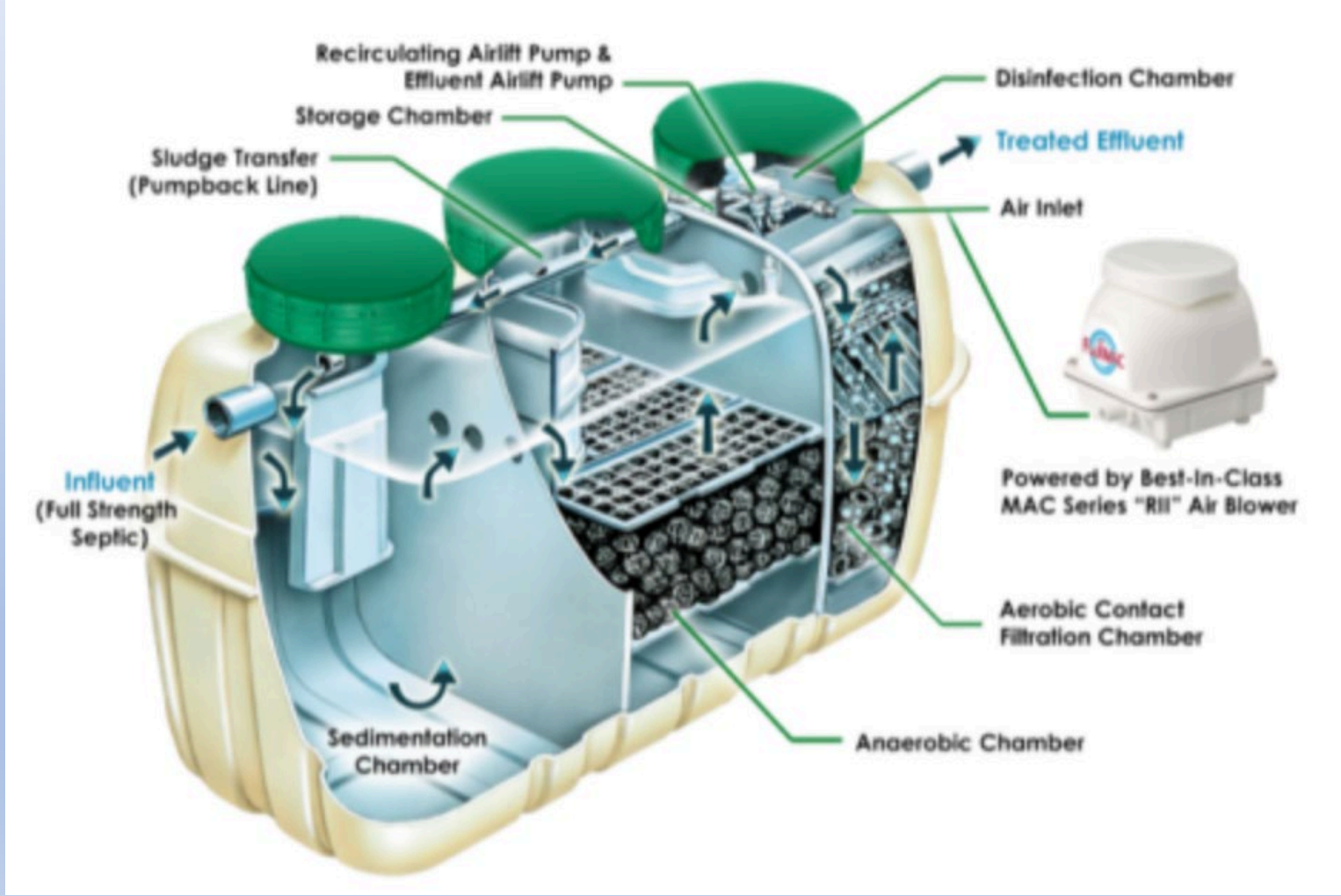
- Check the pump operation
- Counter and timer - read and record
- Calculate cycles and dose volumes
- Check the field flush and the filter flush
- Clean the filter

Advanced and Proprietary Systems

- Go through the manufacturer's Operation and Maintenance as specified in the O & M manual

- Note: some states have their approved products O&M manual on the state web site
- https://www.vdh.virginia.gov/content/uploads/sites/20/2019/01/Fuji-Clean-USA-Residential-OM-Manual-01-10-2019.pdf
- https://www.oregon.gov/deq/FilterDocs/norwecooperationmanual.pdf

Example O&M schedule for activated sludge system



Example O & M schedule for a hybrid fixed-film/activated sludge system

- 6-month service
  - Effluent sample
  - Inspection, servicing and cleaning, removal reinstallation and testing the aerator
- 12-month service
  - All service as 6 months plus clean the media
- 3-year service
  - All service as 12-month plus tank pumping if needed

Frequency: 6 months

- Outside environment check
- Blower box check
- Blower operation and blower alarm check
- Inspect air filter and diaphragm, change as needed
- Sample effluent check for pH, clarity and odor
- Check high water float switch
- Check inflow pipe
- Transfer scum from aeration chamber to sedimentation chamber
- Set Recirculation valve

Frequency: 6 months

- Check aeration balance control
- Check/set effluent airlift valve
- Backwash and sludge transfer
- Check/clean effluent airlift pipe
- Clean recirculation air lift pump
- Refill chlorinator
- Clean aeration pipes

Frequency: 2 years or as required

- Measure sludge and pump out as necessary

Example O&M schedule for media filter

- 6 months
- Annual

Frequency: 6 months

- Field sampling and observations: clarity, odor, oily film, foam
- Check control panel
- Inspect/Clean the recirculation pump system
- Measure scum and sludge in both tank compartments. Pump if needed
- Inspect and clean the media filter
- Inspect and clean the discharge pump system
- Inspect and Clean other system components
- Clean media sheets as needed
- Final safety check to ensure everything is reinstalled and secured

Audience Discussion