Dewey On-Site Wastewater Treatment

ABCC Projects

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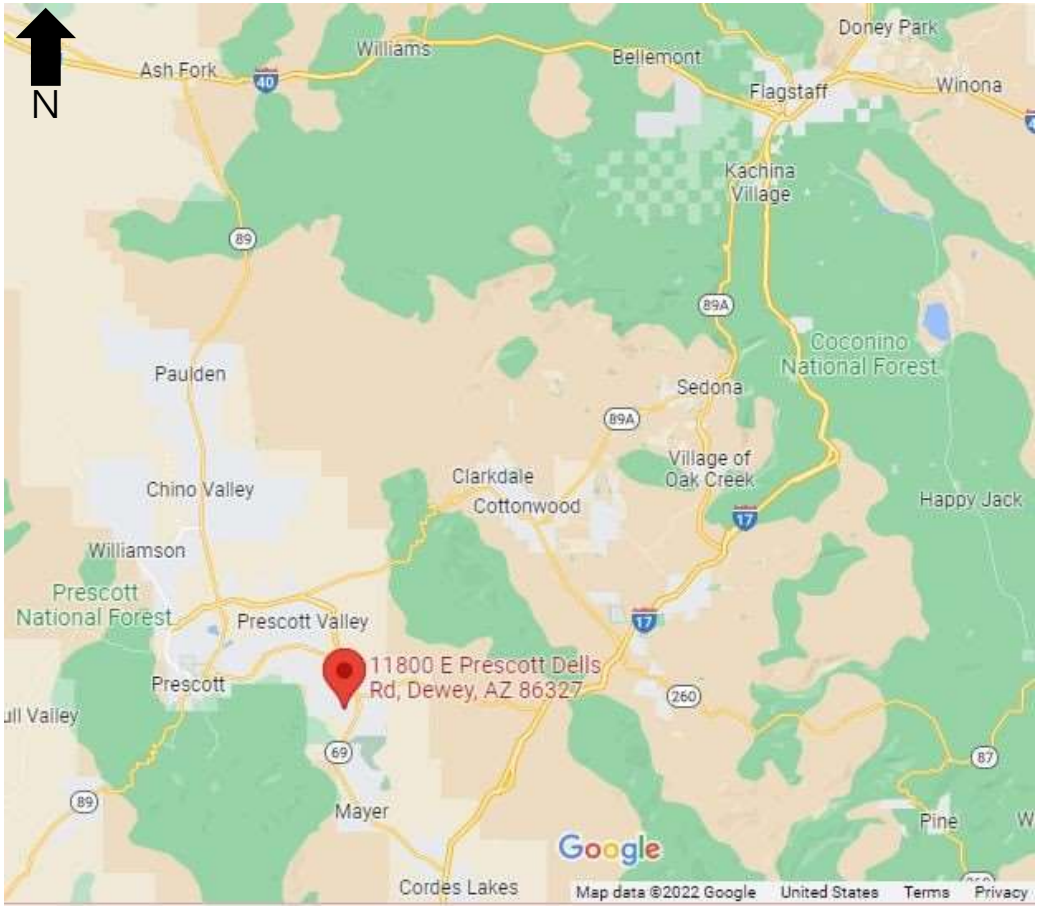
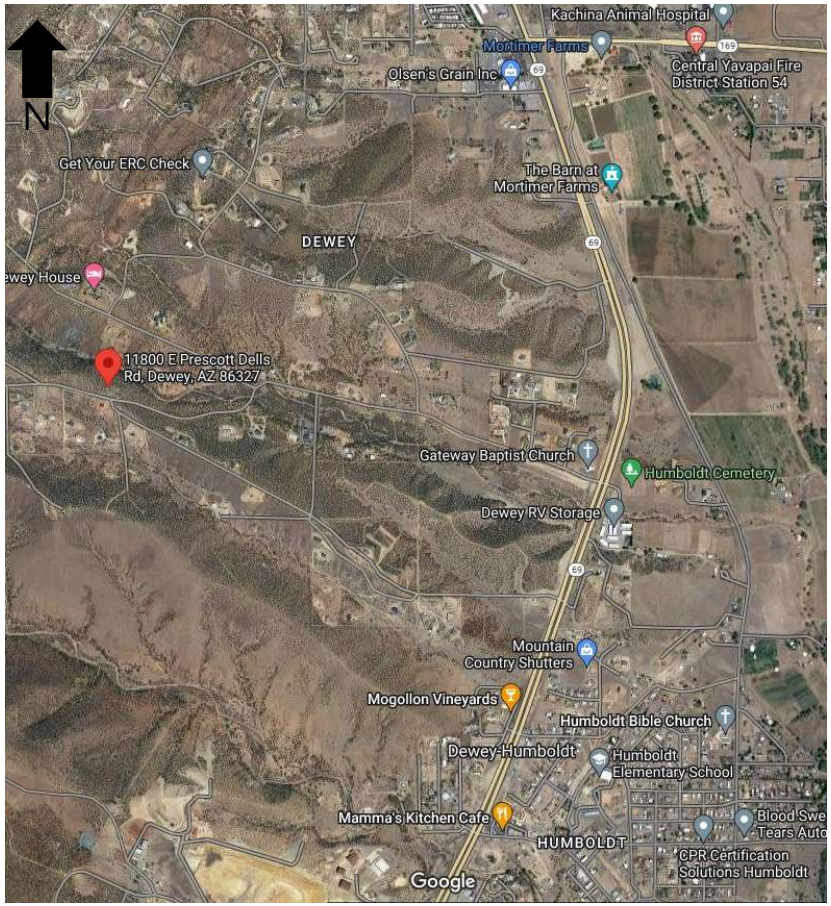
CENE 486C 12/9/2022

Site: Location within Arizona





Figures 1 and 2. Location of Site with respect to highways and Dewey-Humboldt

Site: Fly over View

Figure 3. Google Earth view of Site

Project Overview

- Single family home located in Dewey, AZ
- Objective 1: Provide an on-site wastewater treatment system
- Objective 2: Reuse wastewater for irrigation on-site

- Client: Taylor Layland
- GI/TA: Dr. Jeffrey Heiderscheidt

Figure 4. Lakeside Prefab Cabin

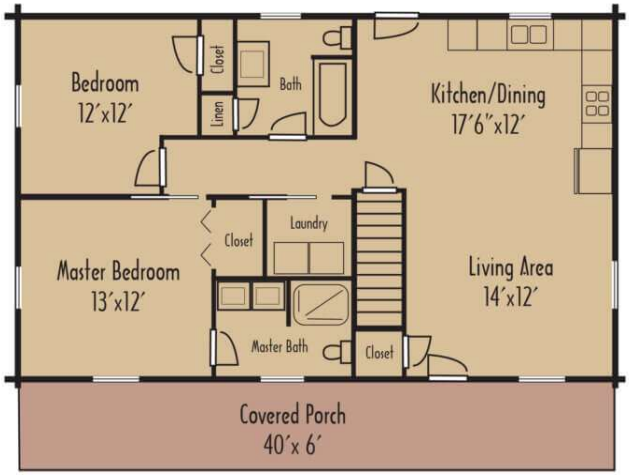


Figure 5. Lakeside Prefab Floorplan

Research of Codes

- Regulations Footnotes
  - Report holds all codes footnoted to specific design area
- Arizona Administrative Code Title 18
  - Part B and Part D: Treated water requirements
  - Part A and Part D: Design standard parameters
  - Part E: Permitting

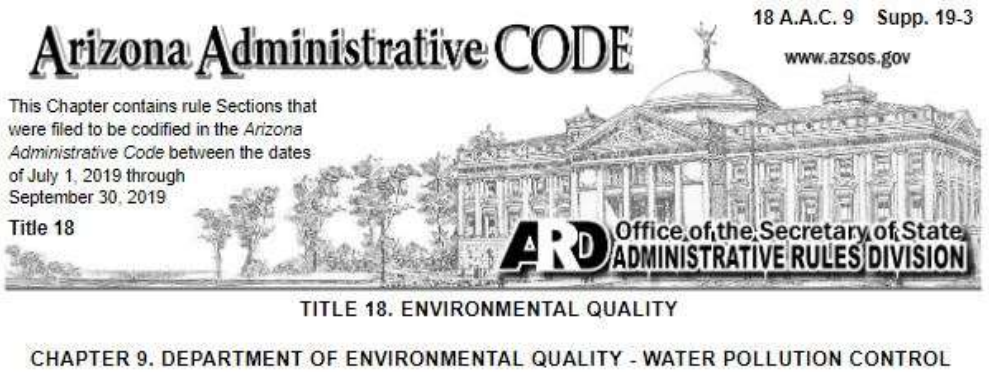


Figure 6. Arizona Administrative Code-Title 18 Heading

Site Investigation

- Unable to gain site access, data gathered from other sources
- Topographic data from Yavapai County GIS
- Soil characterization data from NRCS Web Soil Survey

Soil Absorption Rate		
sandy loam, loam, or silt loam and the structure moderate or strong		
SAR		
Trench, Chamber, Pit	0.6	gal/day/ft^2
Bed	0.4	gal/day/ft^2

Table 1. Soil Adsorption

Engineering Properties–Yavapai County, Arizona, Western Part														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
MkF—Moano very rocky loam, 15 to 60 percent slopes														
Moano	70	D	0-2	Gravelly loam	GC-GM, SC-SM, GC, SC	A-4, A-6	0- 0- 0	0- 5- 10	65-70-75	55-60-65	40-50-60	35-40-45	25-30-35	5-10-15
			2-9	Gravelly loam	GC-GM, SC-SM, GC, SC	A-4, A-6	0- 0- 0	0- 5- 10	65-70-75	55-60-65	40-50-60	35-40-45	25-30-35	5-10-15
			9-16	Unweathered bedrock	—	—	—	—	—	—	—	—	—	—

Figure 7. NRCS Web Soil Survey data Table

Design Flow

- Design Flow
  - Fixtures determined by client and with an image of Prefab house

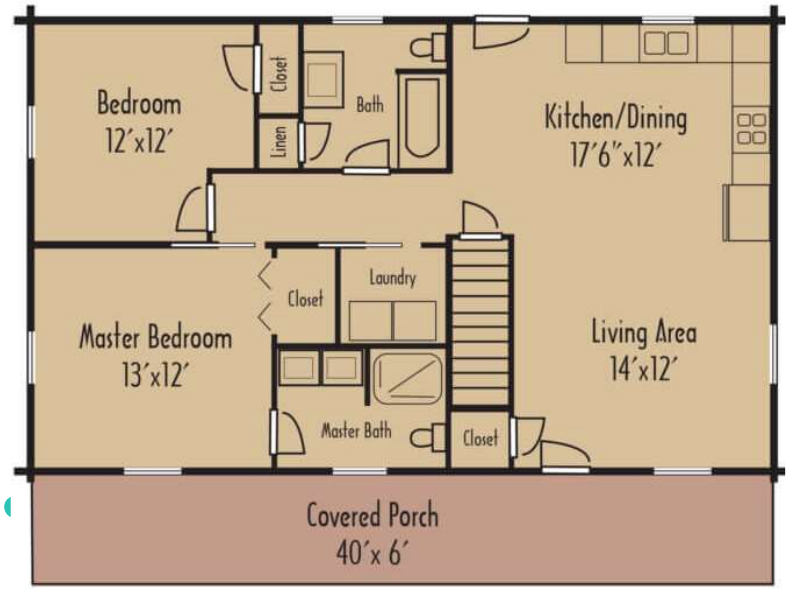


Figure 5. Lakeside Prefab Floorplan

Design Flow		
Bedrooms	2	
Fixture Count		Multiplier
Bathtubs	2	2
Toilets	2	1
Clothes Washer	1	2
Sink w/ Dishwasher	1	2
Total Fixtures	10	
14 or less?	Yes	
Design Volume	1000	gal
Design Flow	350	gal/day

Table 2. Design Flow Table

Topographic Map

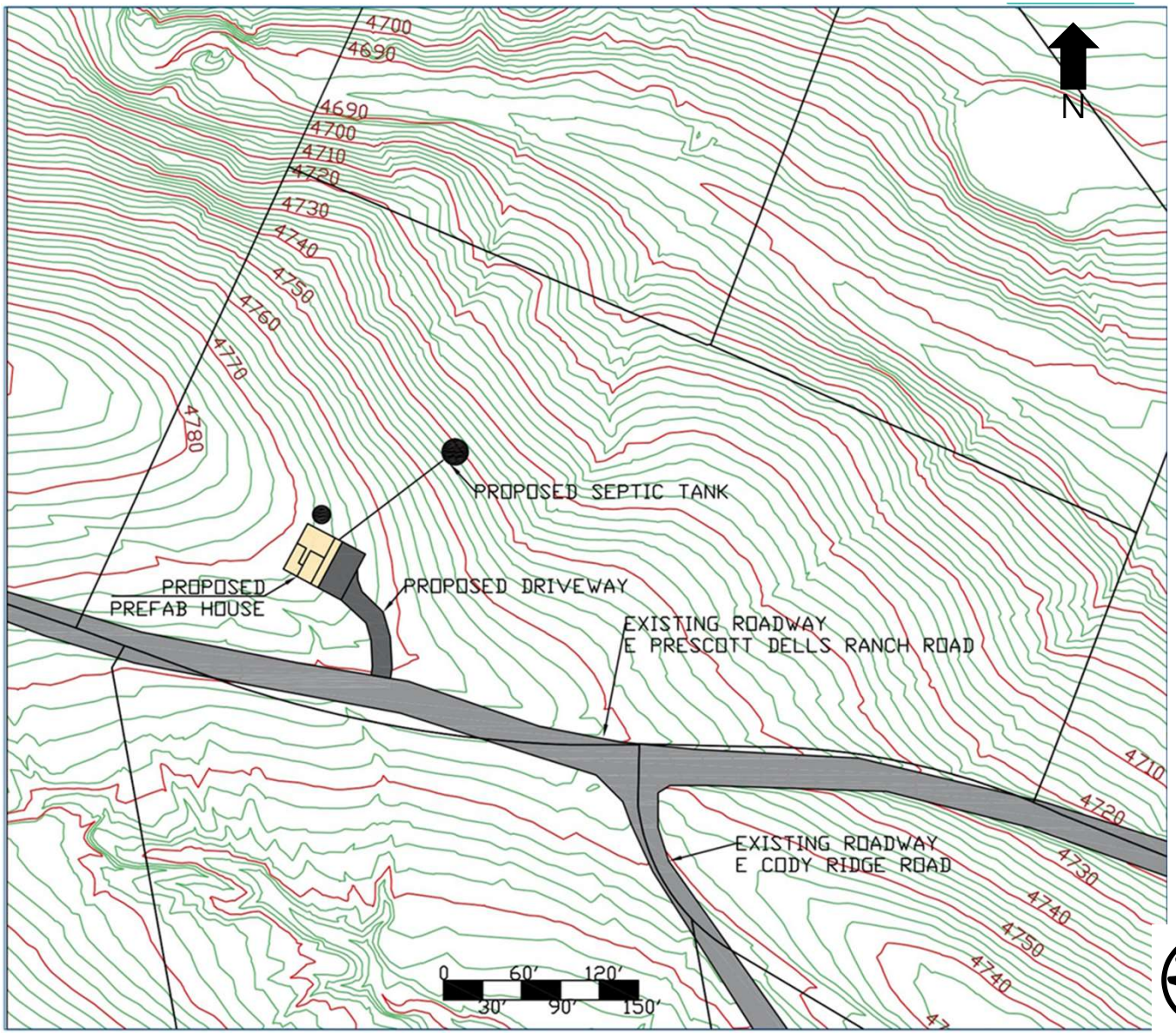


Figure 8. ABCC Topographic Map

Alternatives Overview

Figure 9. Septic System

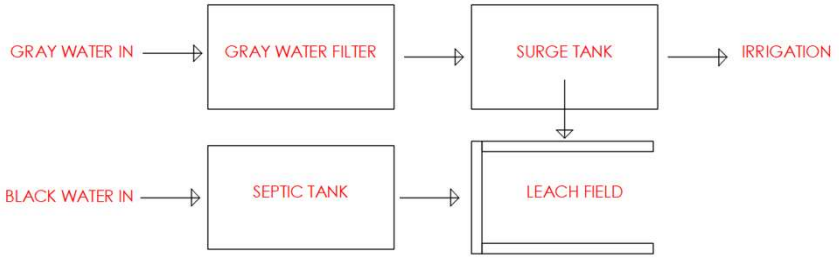


Figure 10. Gray Water System

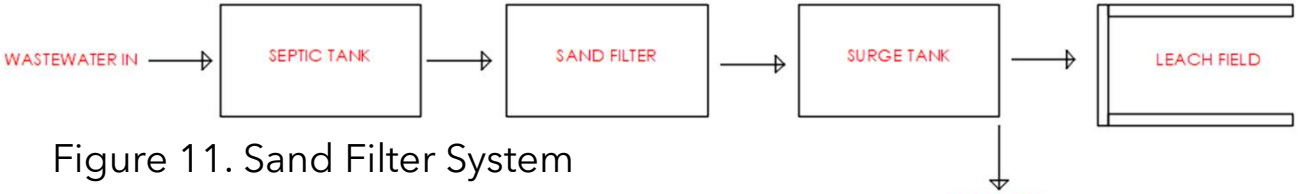


Figure 11. Sand Filter System

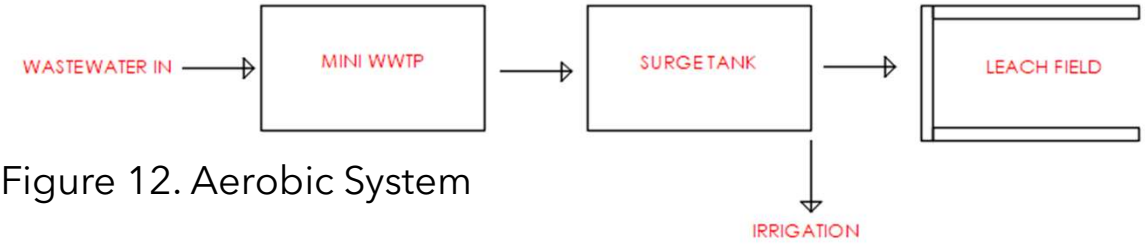


Figure 12. Aerobic System

Alternatives: Septic System

- 1000-gallon volume
- 350 gallons per day
- 2 tank openings for easy access to each chamber
- Small underground footprint
- 4.5′ x 8′ x 5′

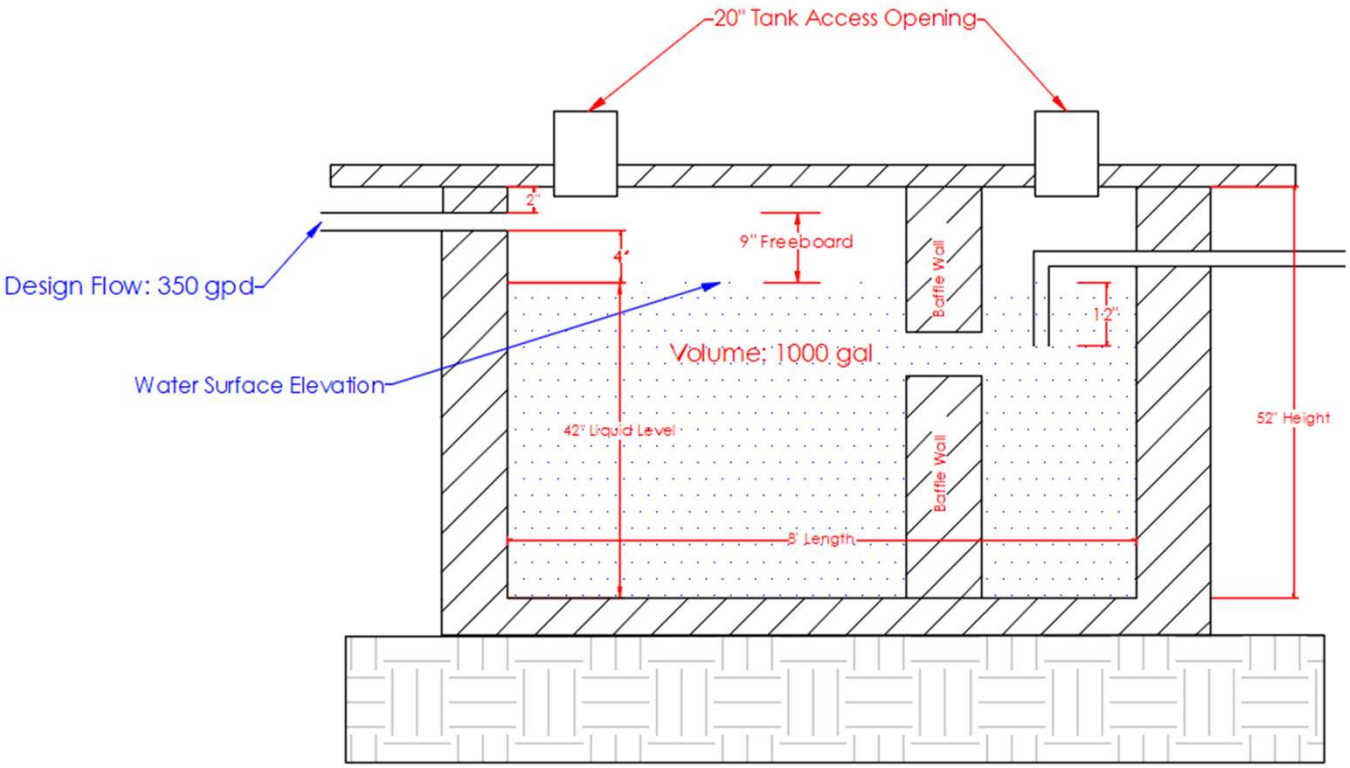


Figure 13. Septic System

Alternatives: Septic System

- Pros
  - Very ease to use
  - Lowest cost system (~$4500)
  - Low maintenance
  - Is used for other alternatives
- Cons
  - No irrigation effluent (Failure of Objective 2)

Figure 9. Septic System Block Diagram

Alternatives: Gray Water System

- Runs in parallel to septic tank
- Handles 75% of design flow (262.5 gpd)
- 0.6-1.18mm Sand Filter with Surge Tank with biofilter boxes
- Small System Footprint, 5′ x 8′

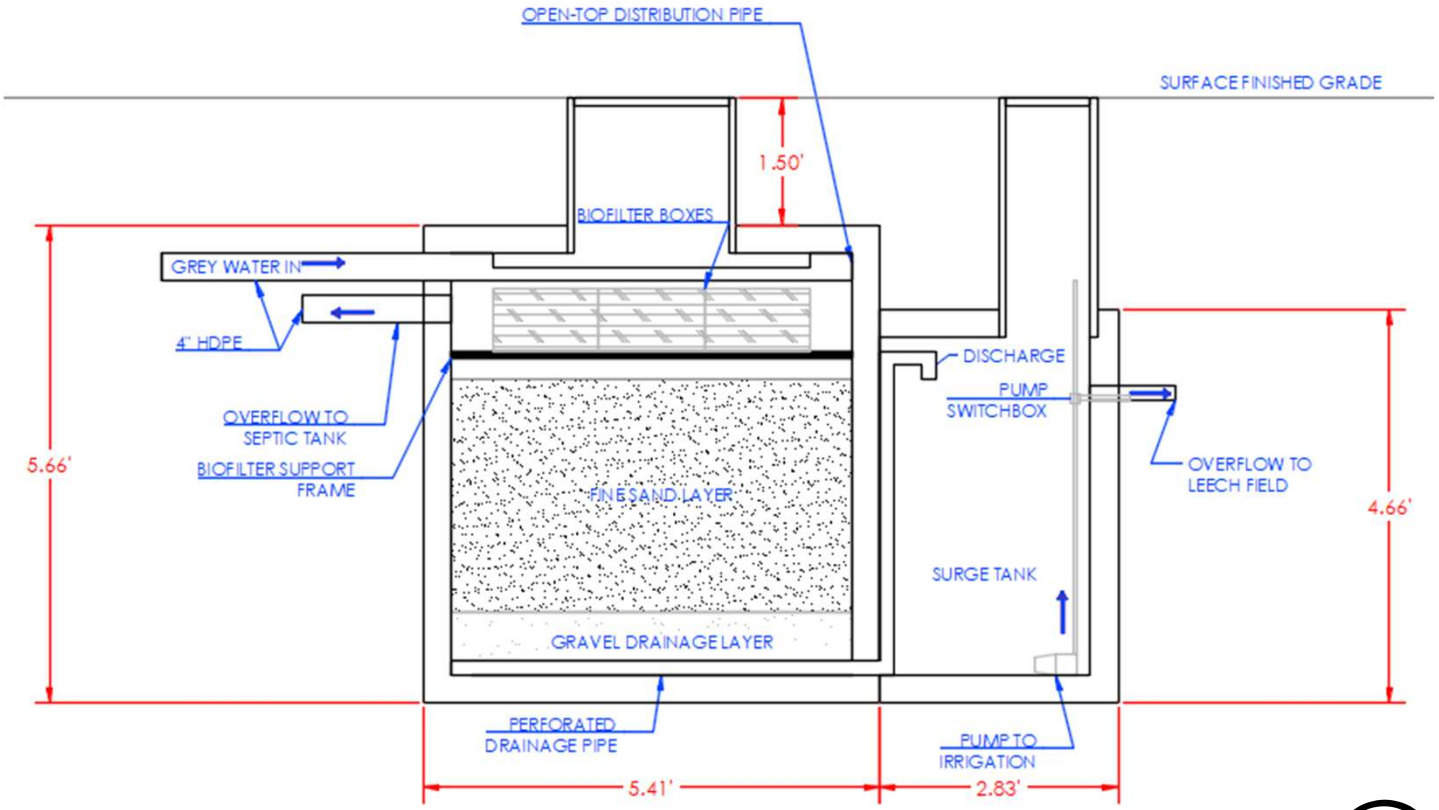


Figure 14. Gray Water Filter

Alternatives: Gray Water System

- Pros
  - No permits needed for AAC
  - No chance for accidental fecal contamination
- Cons
  - More hands-on maintenance
  - Requires in-house pipe separation

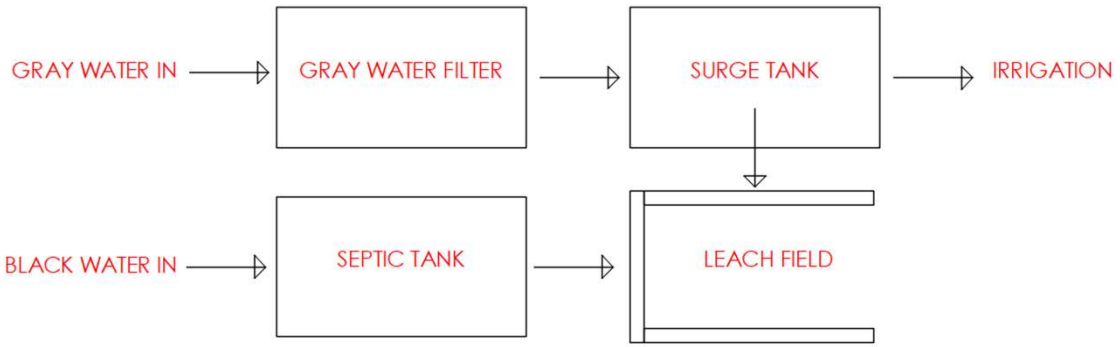


Figure 10. Gray Water Block Diagram

Alternatives: Sand Filter

- Runs in series with septic tank
- Compact sand filter measuring 15′ x 15′
- Fine sand is used in the filter 0.25-0.75mm
- High quality effluent averaging 5 mg/L of BOD and TSS

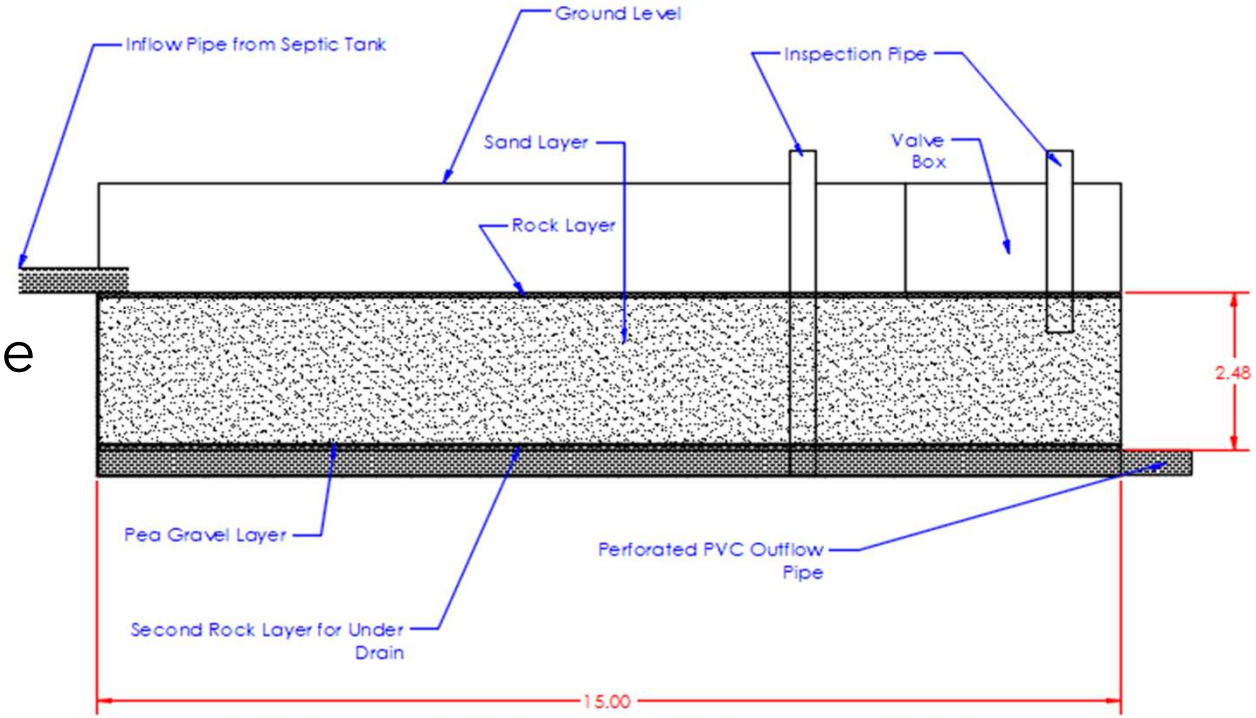


Figure 15. Sand Filter System

Alternatives: Sand Filter System

- Pros
  - Irrigation suitable effluent from septic water
  - Low construction cost
- Cons
  - Filter can clog
  - Regular maintenance required (every 3 months)

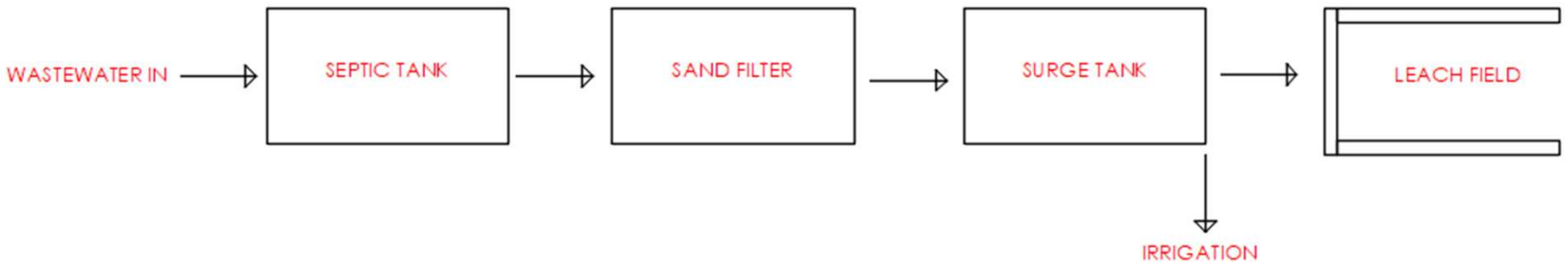


Figure 11. Sand Filter Block Diagram

Alternatives: Aerobic Wastewater Treatment system

- Three chamber Aerobic Septic system, handles 350 gpd
- Diffusion-Based System
- UV disinfection at the end of the system
- High Quality effluent averaging 12 mg/L BOD and 16 mg/L TSS

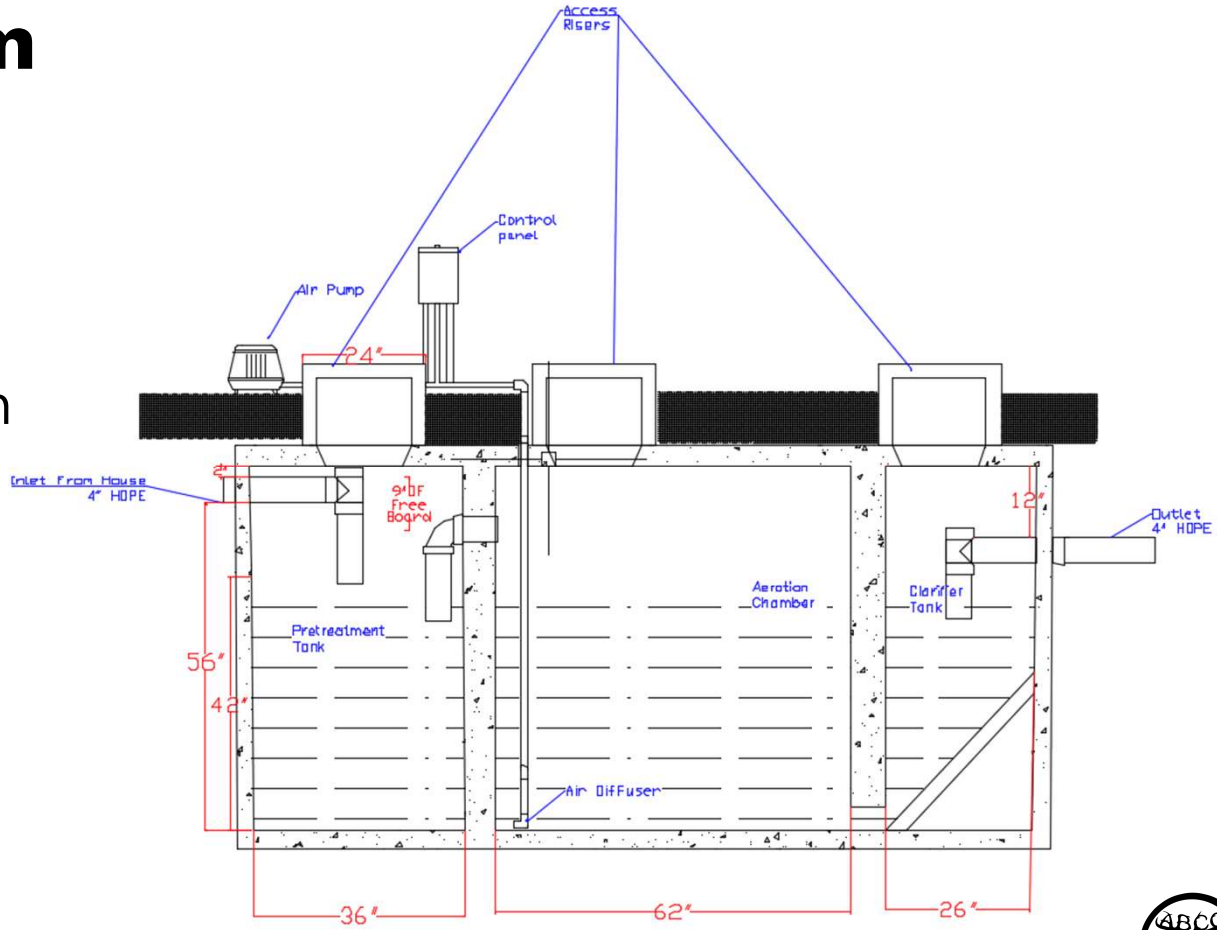


Figure 16. Aerobic Wastewater Treatment System

Alternatives: Aerobic Wastewater Treatment system

- Pros
  - Provides a higher level of treatment
  - Reduces ammonia discharge
- Cons
  - More expensive to operate
  - Mechanical parts can break
  - Requires more maintenance

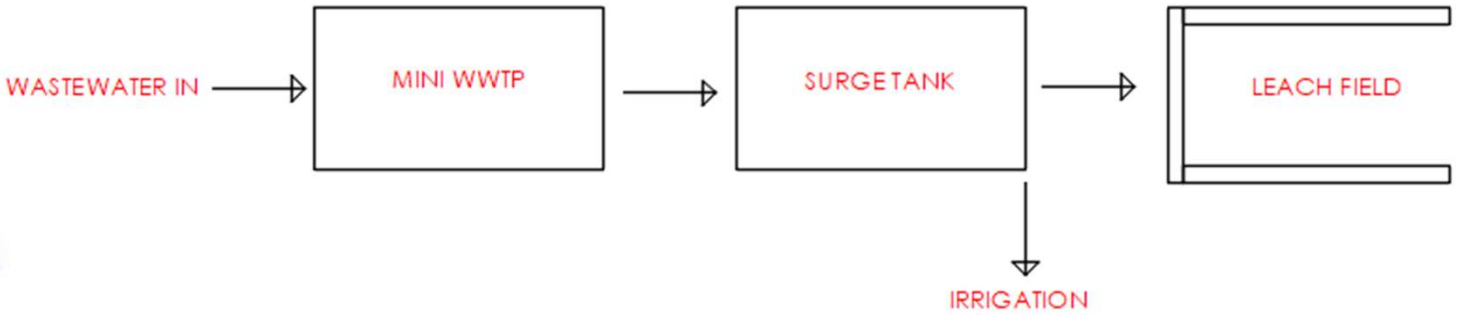


Figure 12. Anerobic wastewater treatment system Block Diagram

Design Decision Matrix

Design Decision Matrix												
	Score (0-10, 0=Bad, Low, Expensive, 10=Good, High, Cheap)											
	Septic System			Add.Greywater System			Add. Sand Filter			Mini WWTP		
Criteria	Given Score	Weight	Score after Weighting	Given Score	Weight	Score after Weighting	Given Score	Weight	Score after Weighting	Given Score	Weight	Score after Weighting
Cost of Installation	10	2	20	5	2	10	5	2	10	1	2	2
Cost of Maintenance	10	3	30	7	3	21	6	3	18	1	3	3
Maintenance Required	10	3	30	7	3	21	7	3	21	1	3	3
Treatment Quality	0	5	0	8	5	40	9	5	45	10	5	50
Ease of Use	10	2	20	7	2	14	9	2	18	1	2	2
Total Scores			100			106			112			60

Table 3 and 4. Design Decision Matrix

Score Weighting (Multiplies Score by value below)	
Cost of Installation	2
Cost of Maintenance	3
Maintenance Required	3
Treatment Quality	5
Ease of Use	2

Final Recommendation

- Final Recommendation based on Design Decision Matrix:
- Sand Filter in Series with Septic Tank

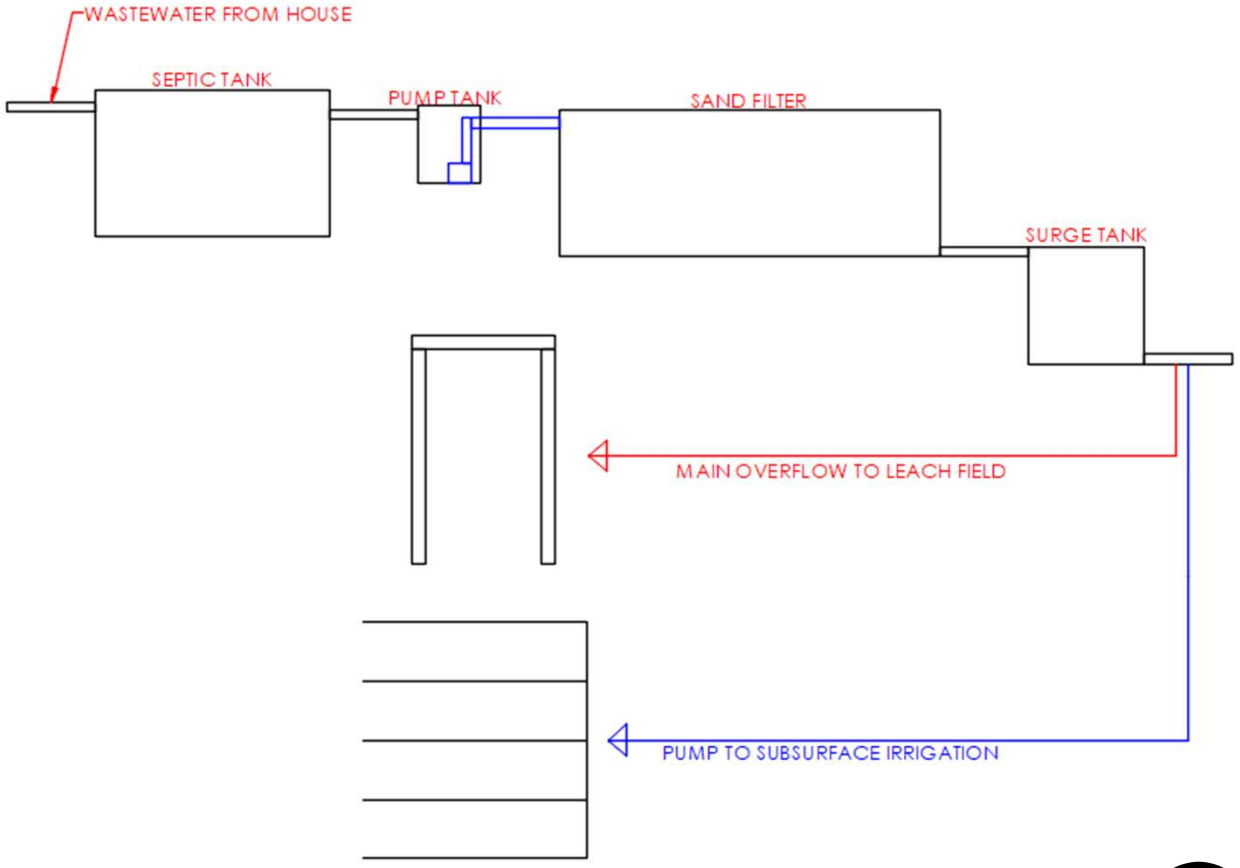


Figure 17. Full System Block Diagram

Surge Tank

- Collects effluent for irrigation
- Valve opens to release water to leach field
- Pump Controller empties tank in intervals
- Not the same as the Sand Filter Dosing Pump Tank

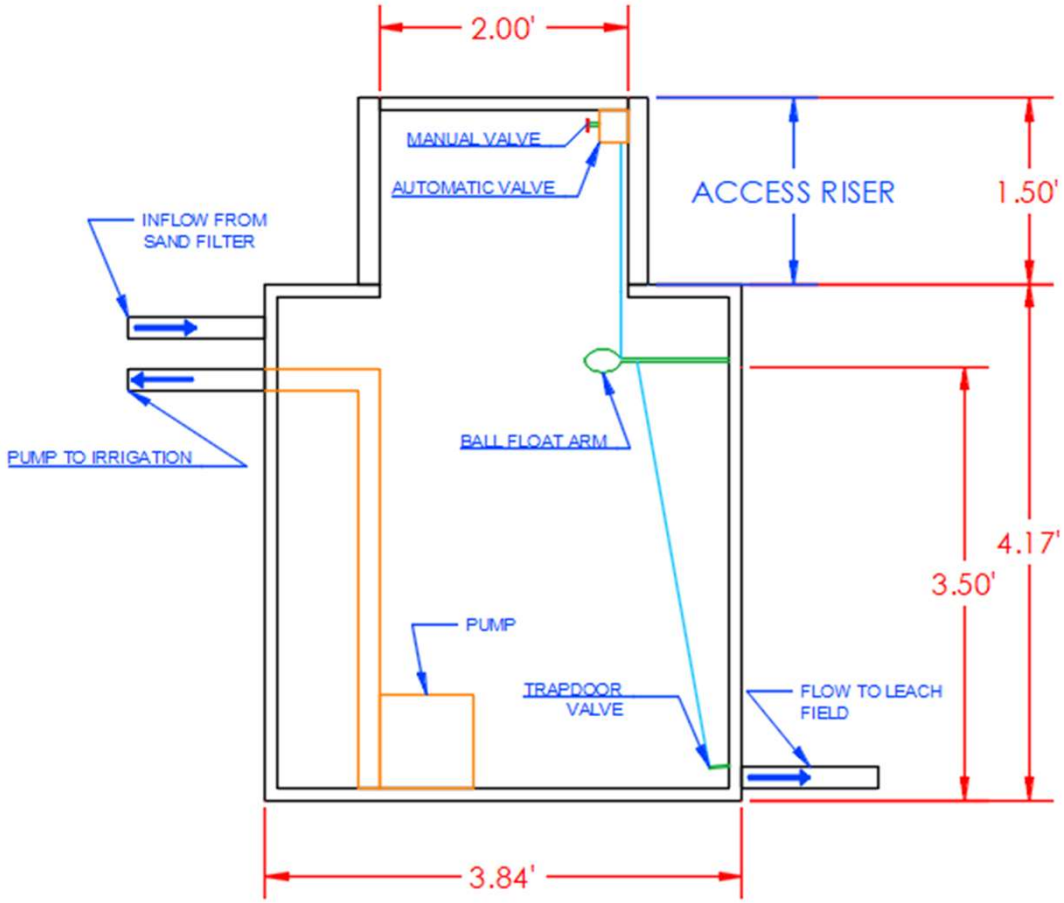


Figure 18. Surge Tank

Leach Field

- Overflow for treated water and discharge for septic water
- Designed for 350 gpd septic flow
  - 2-40ft Pipes
- 8 sqft of drainage area per 1ft of pipe

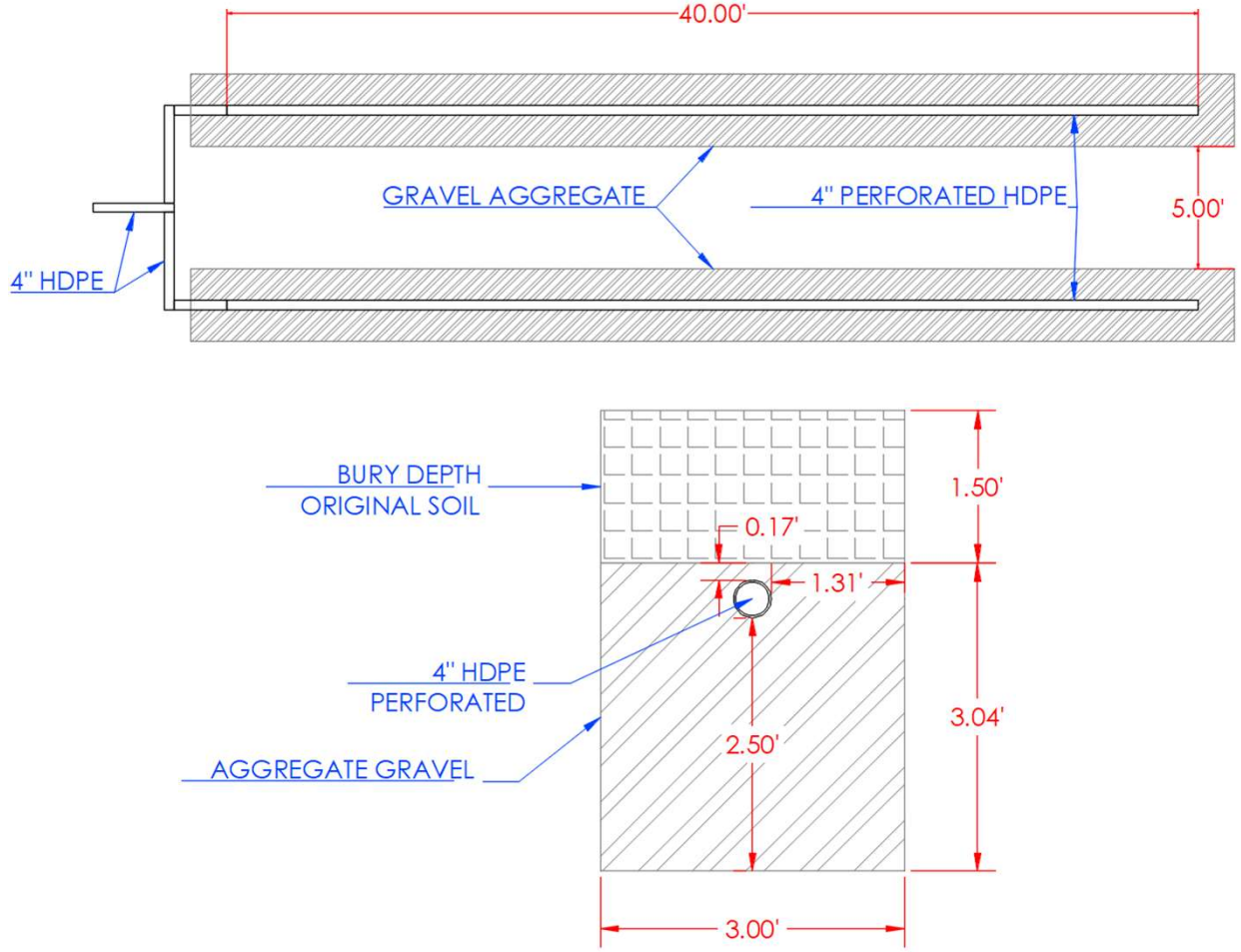


Figure 19 and 20. Leach Field

Site Plac

- Special note taken to use contours to advantage for gravity-fed system
- Two pumps needed: sand filter dosing and pump uphill to irrigation at house

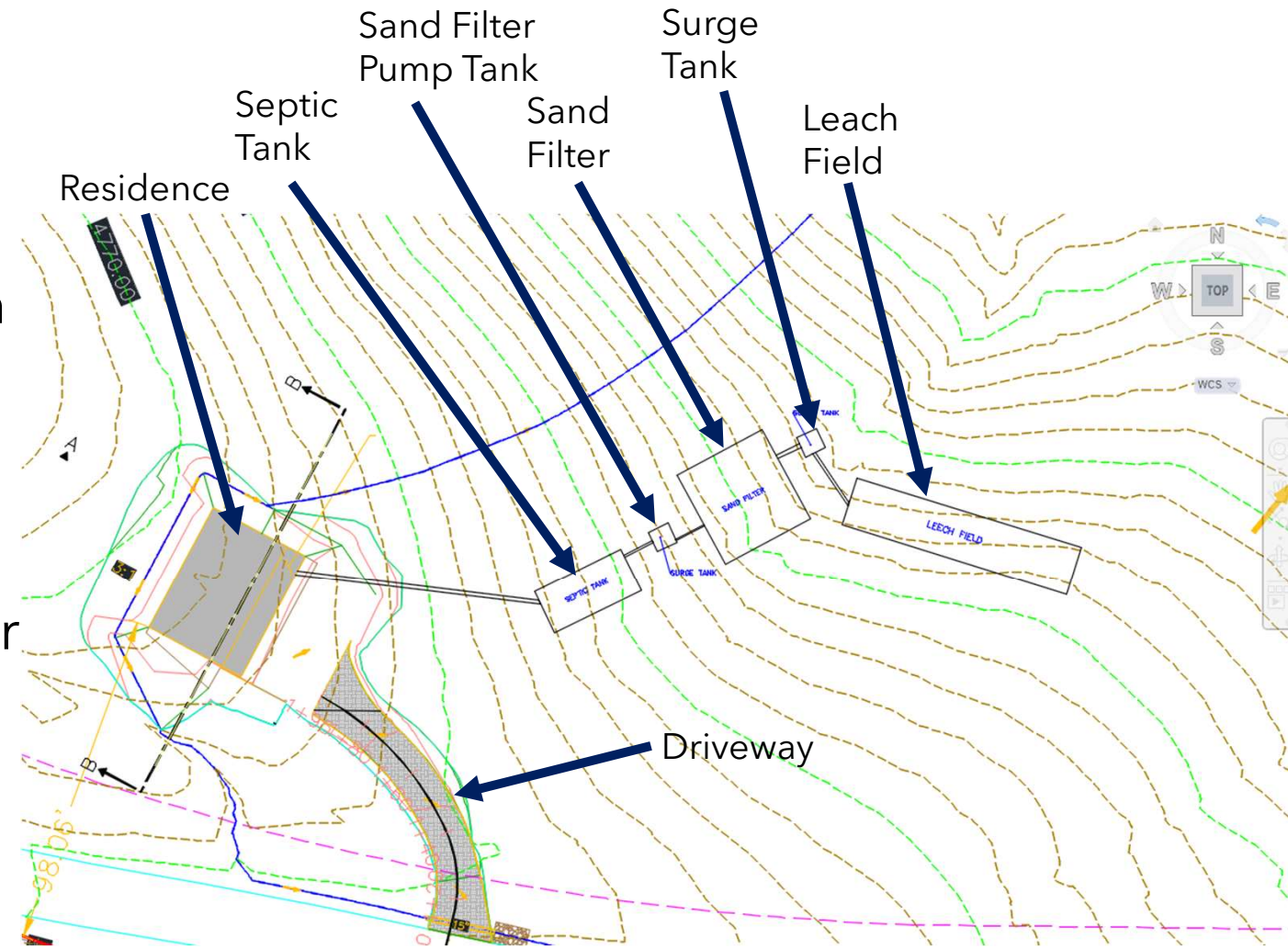


Figure 21. System in Place at Site

Impacts Analysis

Environmental

- + Low discharge rate mitigates environmental damage
- + Aquifer recharge
- + Reduced water use
- - Probability of harmful pollutant release (Ex: Pharmaceuticals)
- - Possible contamination of water sources (Deep aquifer, nearby ephemeral stream)

Social

- + Freedom to live anywhere without sewer access
- + Less reliance on city utilities
- + More water for others
- - Client must now actively think about their wastewater
- - Neighbors may have view changed
- - No extension of sewer line enforces septic systems for all new neighbors

Economic

- + No sewer fees for client
- + No expensive sewer extension
- + Reduced water cost
- - No sewer fees for city, Less water fees
- - Repair costs fall on client

Project Cost

- Very rough estimate of cost
- Labor included in septic tank and sand filter costs
- Extra labor cost for all other component's installation
- Total Cost: $16,559

System Cost			
Total Cost			$ 16,559
Items to be organized	**Units**	**Cost per unit**	**Cost**
Yavapai County GIS Fee	1	$ 100	$ 100
Yavapai County Permits	1	$ 750	$ 750
			$ -
2" HDPE (Ft)	150	$ 2	$ 287
4" HDPE (Ft)	400	$ 5	$ 2,148
Septic Tank	1	$ 4,500	$ 4,500
Sand Filter (Complete System)	1	$ 6,300	$ 6,300
Surge Tank	1	$ 500	$ 500
Surge Tank Control System	1	$ 374	$ 374
Water Level Controller		$ 90	
Pump (Lawn Sprinkler)		$ 234	
Ball Float and Valve		$ 50	
Labor	1	$ 1,600	$ 1,600

Table 5. System Cost

Sources

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Thank you for attention

Questions?