Sun Valley Water & Wastewater Project

Solutions and Advancements in Water and Wastewater Engineering

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Project Understanding

Introduction

- Sun Valley Ranch: self-sustaining retreat owned by Christopher Fernandes
- Needs water and wastewater facilities

Background Information

- 10-acre
- SV population 300-350
- Sandy loam soil
- No exisiting infrastructure
- No relief over 5’

Figure 1: Horned Toad Found On-Site
Source: Sara Bateman

Project Understanding

Client Requirements

- Non-intrusive
- Easy to incorporate for the average Arizona resident
- Inexpensive
- Meets Navajo County codes

Figure 1: Horned Toad Found On-Site
Source: Sara Bateman

Evaluation of the Wastewater System Options

Criteria & Constraints	Weight	Stabilization Ponds		Composting Toilets & Graywater Reuse		Septic Tanks	
		Ranking	*Score*	*Ranking*	*Score*	*Ranking*	*Score*
Non-intrusive	0.10	1	0.10	2	0.20	1	0.10
Cost	0.25	2	0.50	2	0.75	2	0.50
Operation & Maintenance	0.15	1	0.15	1	0.15	3	0.45
Lifetime	0.05	3	0.15	3	0.15	3	0.15
Sustainability	0.05	3	0.15	3	0.15	3	0.15
Construction	0.05	3	0.15	3	0.15	2	0.10
Expansion	0.10	2	0.20	3	0.30	1	0.10
Startup & Shutdown	0.05	1	0.05	3	0.15	2	0.10
Effectiveness	0.20	2	0.40	2	0.40	3	0.60
Overall Scores			1.85		**2.40**		2.25

Where: 1= poor, 2= sufficient, 3= very well
Ranking*Weight = Score

Evaluation of the Water System Options

Criteria & Constraints	Weight	Well		Importation	
		Ranking	*Score*	*Ranking*	*Score*
Non-intrusive	0.05	1	0.05	3	0.15
Cost	0.3	1	0.30	2	0.6
Operation & Maintenance	0.2	2	0.40	3	0.6
Lifetime	0.05	3	0.15	3	0.15
Sustainability	0.05	2	0.10	2	0.1
Construction	0.05	1	0.05	3	0.15
Expansion	0.2	1	0.20	2	0.4
Startup & Shutdown	0.1	2	0.20	3	0.3
Overall Scores			1.45		**2.45**
Where: 1= poor, 2= sufficient, 3= very well Ranking*Weight = Score					

Selected Alternatives

Importation

Rainwater Harvesting

Composting

Graywater Reuse

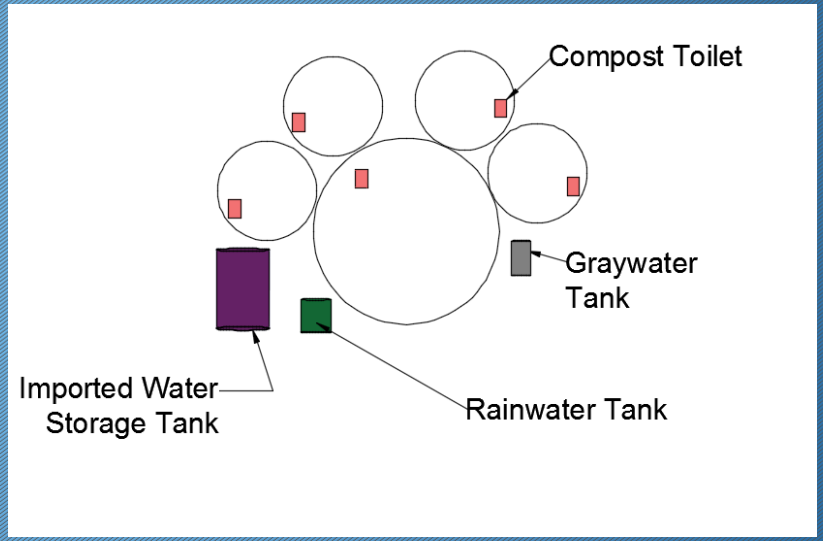

Figure 2: SVR Water & Wastewater Systems Layout

Importation

- Source: Holbrook
- Potable water that meets all federal and state laws
- Hiring local for water hauling service
- Will include:
  - Storage tank: 5000 gallons
  - Water tank: 1000 gallons

Figure 3: Importation Trailer & Tank [1]

Rainwater Harvesting

- Gravity fed system
- 1000 gallon tank
- Rainwater monthly yield =**3039 gal**
  - R(in) * C * A(ft^2) * C_R = Y(gal)
- Monthly landscape demand =**1977gal**
  - ET(in) * C * A(ft^2) = D(gal)
- Cumulative storage

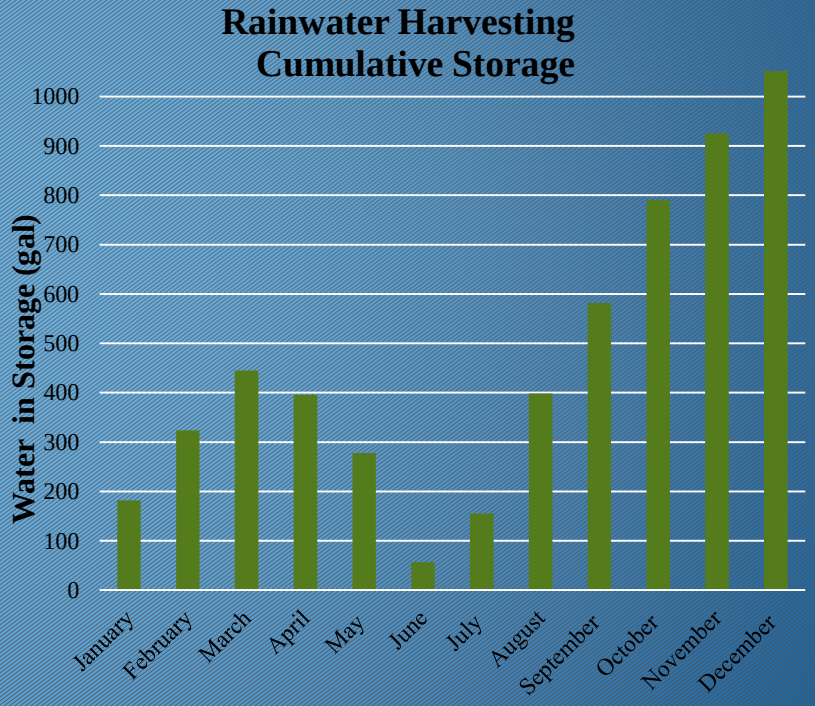

Figure 4: RW Harvesting Cumulative Storage

Composting Toilets

- 5 "Do it yourself" Models
  - Ventilation system
  - Polyethylene Barrel
  - Vector control
- System Sizing
  - Two Adults: 1 Active barrel +2 aging barrels=3 barrels Total

Figure 5: DIY Active & Aging Toilets [2]

Figure 6: DIY Model Composting Toilet [2]

Composting Toilets

- Indoor application

Figure 7: Above Ground Composting Barrel [2]

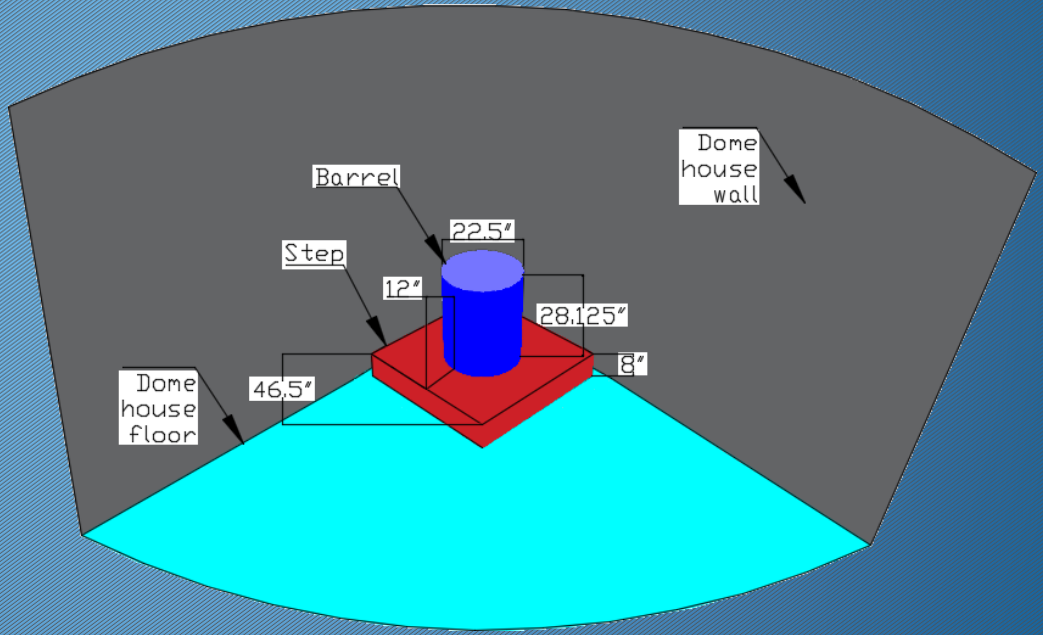

Figure 8: Indoor Composting Toilet with Step

Composting Toilets

- System sizing
  - 2 adults require 3 barrels (1 active barrel + 2 aging barrels)
- Total Barrel Capacity=55 gal
- Effective capacity (9" freeboard) = 41 gal per barrel
  - 0.5 gal per person per day, 2 people
  - **41 days to fill barrel**
- Design capacity- for active toilet
  - EC+0.5EC=62 days
  - Decomposition and drying of compost
- 4 months required for complete aging of compost

Figure 9: Compost [3]

Composting Toilets

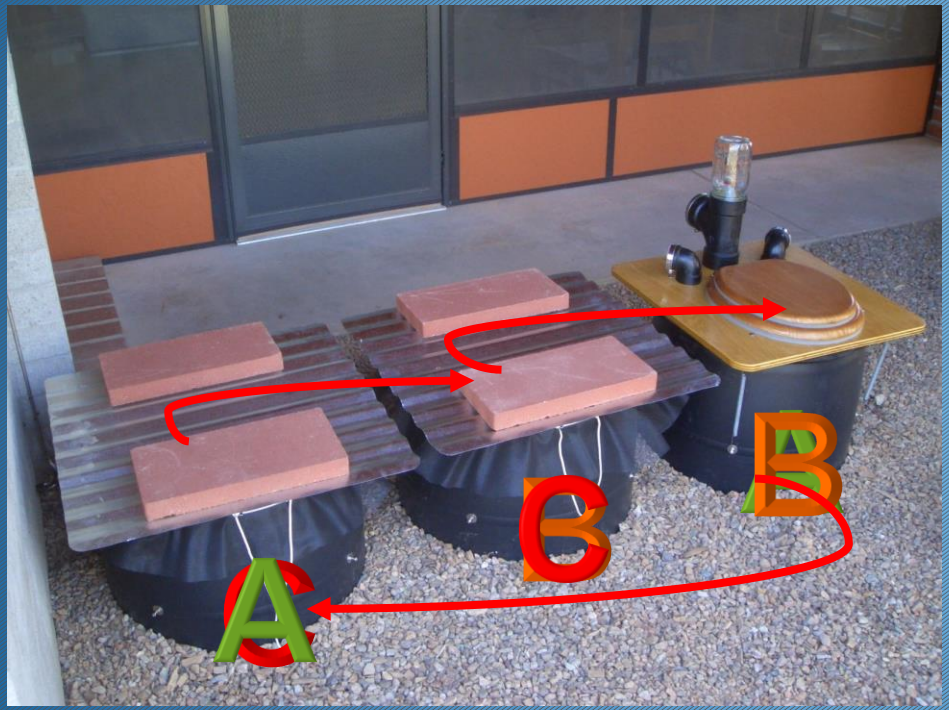

Figure 5: DIY Active & Aging Toilets [2]

Figure 10: Dolly [4]

Composting Toilets

- Aeration in aging barrels
- Operation & maintenance
  - Odor control
  - Aeration

Figure 11: Air Flow in Aging Barrels[2]

Figure 12: Moth Balls Used for Odor Control [2]

Figure 13: Aeration Provided by Crank [2]

Composting Toilets

- Cover Material

Figure 14: Cover Material Samples for Composting Toilets [2]

Material	Volume of Water Passed Through Strainer	Water Absorbed
Sawdust	1/3 cup	75%
Horse manure	1/3 cup	66%
Wood Shavings	2/3 cup	33%
Straw	2/3 cup	33%

Composting Toilets

- Urine diversion system
  - Includes urinals

Figure 15: Urine Diversion System [2]

Figure 16: Urinal [2]

Graywater Reuse

- Water from sinks, showers, and clothes washer
- Storage tank
- Sent to plants using drip-irrigation system
- Fecal contamination concern

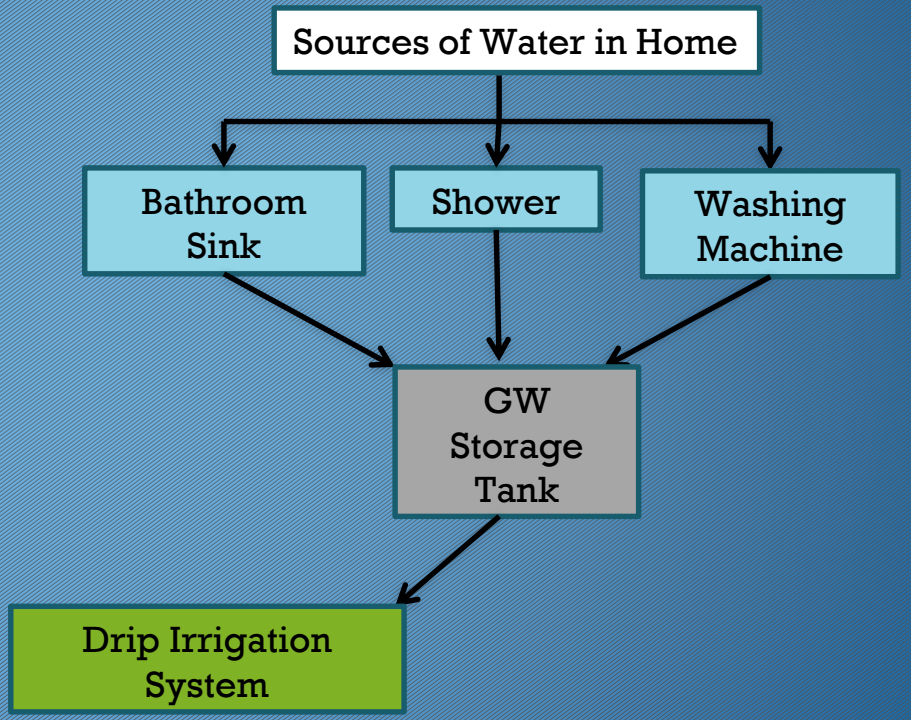

Figure 17: Gray Water Reuse in Sun Valley Ranch

Urine & Kitchen Sink Disposal

- Kitchen sink disposal
  - Composition
- Urine
  - Nitrogen & salt levels
  - Required dilution 10:1
- Application to plants

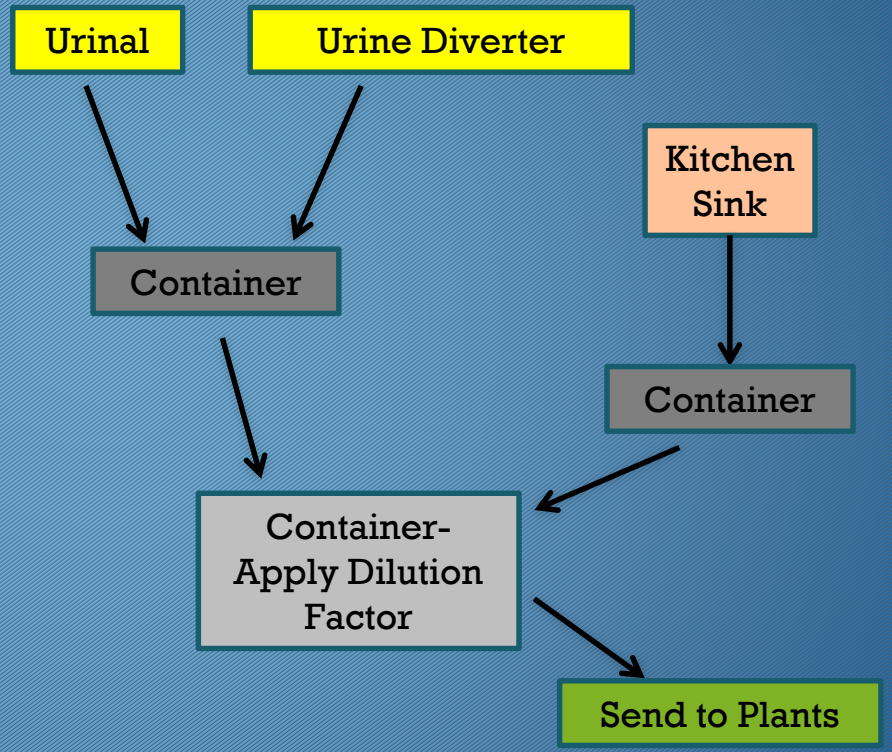

Figure 18: Urine & Kitchen Sink Water Handling

Project Cost Analysis

Project Costs				
1.0 Personal	**Classification**	**Hours**	**Rate, $/hr**	**Cost, $**
	PM	90.5	92	8,326
	ENG	89.5	132	11,814
	LAB	71.5	63	4,505
	AA	128.5	40	5,140
	Total Personnel	380		29,784
2.0 Travel	Site Visit	$0.56/mi		
	1 meeting @ 100 mi/meeting			56
3.0 TOTAL				**$29,840**

Implementation Cost Analysis

Cost Analysis					
	Quantity	Price	**Capital**		**Annual**
Importation				**Importation**	
On-site storage tank	1	$2,385	**$2,385**	Transportation	**$1,480**
Water hauling tank	1	$680	**$680**	Water hauling service	**$1,056**
Trailer	1	$5,000	**$5,000**	Water	**$177**
Rainwater harvesting				**Rainwater harvesting**	
Barrel	1	$875	**$875**	Operation & maintenance	**$264**
Composting toilets				**Composting toilets**	
DIY toilets	5	$325	**$1,625**	Operation & maintenance	**$528**
Urine diversion system	5	$40	**$200**		
Installation	5	$60	**$300**		
Graywater storage tank	1	$310	**$310**		
		TOTAL:	**$11,375**	**TOTAL:**	**$3,505**
Total capital & annual cost: $14,880					

Impacts

- Increasing population size in Sun Valley
- Norms associated with low tech ww handling, user-friendly
- National, state, and county regulations
- Ensuring health & safety
- Potential for worldwide use

Figure 19: Influence [5]

Acknowledgments

- Technical Adivsor: Dr. Charles Schlinger
- Client: Christopher Fernandes

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