Appropriate Technology for the Small Rural Water System: If the Shoe Fits

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Learning objectives:

- Exploration of technology appropriateness
- Understanding of a process to select the most appropriate technology
- Realization of the role of expectation in establishing technology satisfaction
- Exposure to the need to keep technology levels up-to-date.

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To keep the discussions enjoyable and engaging, we are using ***footwear*** as a metaphor for ***appropriate technology selection***. Most of us don't purchase new shoes every day so we both decide what to purchase and select what to wear based upon daily needs. We can think of shoe purchases as long-term need and shoe wearing as short-term need. Fashionability is then a question of how well a particular pair of shoes fits the wearer's needs. It is not a measure of how "cool[1]" they make you look.

We can all think of a time when our ***footwear*** did not match the immediate need, such as stepping in a puddle with new tennis shoes or dancing in snow shoes until we had blisters.

[1] Crazy, cool, insane, urban dictionary
http://www.urbandictionary.com/define.php?term=sick

Introduction

This guide is a facilitation tool for small water systems to weigh the appropriateness of possible technology solutions. You may find that only certain portions of this guide apply to a specific water system. Using this guide successfully is dependent upon someone knowledgeable from the public water system or an outside technical assistance provider to assist in identifying the best possible path to proceed and then applying portions of this guide to lead forward on that path.

Having worked as an engineer in both Africa and the Himalayan country of Nepal, RCAC's Jay Mashburn, the author of this guide, has applied appropriate technologies that were a combination of local resource identification and artful ingenuity. Jay has also worked more than a decade with small rural water and wastewater systems in the rural West and is continually impressed with solutions that best match local resources and leverage the residents' creativity.

Jay once worked for a Norwegian engineering firm where he was struck by the way project and strategic documents ended with the phrase "and have fun." This guide is an attempt to make the process of selecting the best possible solution to a water system's technical needs enjoyable. This guide is humor based to allow for the wiggle room of imagination.

A difficult economic environment means many small rural water systems are struggling to survive. Small systems are not just mini-versions of large water system environments. Technological solutions for them are not just a scaling down of large system innovations. The lack of economies of scale makes some excellent large system solutions much less favorable as they are scaled down. Small systems need to put the time in to discover what is best for their needs. We hope this guide aids you in your commitment as key players in protecting public health and ensuring community sustainability.

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How to use this guide . . .

Small rural water system leadership, usually volunteers, are often so busy that they must react to, rather than prevent, the daily problems that walk through the door or call on the phone. If this state continues it makes it increasingly difficult to be able to marshal resources and assets to proactively prevent future problems. Asset management program development is too often put off for another day. The decision making tools needed to determine appropriateness of technologies is a part of asset management. It walks hand in hand with beginning to work towards actively managing a system's assets. Technology decision making can be a window of opportunity to make significant progress toward creating an increase in the utility's overall sustainability. This is because sustainability and efficiency should be appropriately scaled for the technology selection criteria.

This guide is a collection of process related activities for a system to begin discussing the information needed to make appropriate technology selections. The intent is to increase awareness on both the explicit and implicit issues related to technology choices. There can then be a discussion of all the resources needed to best manage, operate and maintain each technology option.

This guide facilitates a process for consensus-based decision making. The guide is designed so a group does not need to work through it from cover to cover. Instead, the group is provided with a methodical approach that can be tailored to community needs; this tool offers systems a way to look at areas of decision making for technology selection. Activity 2 is the exercise intended to capture this technology selection information for your system.

Section 4 provides a step-by-step process. Do not skip over or mix the order of steps. Some people in your work group may already know the best solution. Still take the time to have them share their insights to inform the entire group as you work through the process. Reaching step 10 together by making the considerations explicit helps prevent overlooking critical information. It also helps prevent the desire to later revisit decisions.

On the following pages is a matrix of the activities, their purpose, learning objectives and documents to be saved during the process. Use this matrix to select activities that are relevant to your situation. Activities are ordered within sections, but sections are not ordered in importance or chronology.

	Activity	Purpose	Learning objective	Output
Introduction	Partner Activity 1: Warm-up pairs' discussion of shoe differences Page 8	• Ice breaker • Demonstrate that we use different decision making criteria	• Sensitize participants that others may operate with different values so a process to build agreement is needed	
	Group Activity 1: Technology to write your system name and sign-in to a training session Page 8	• Demonstrate basic brainstorming technique • Practice creating decision making criteria • Practice using a criteria matrix in selecting an option	• Expose participants to a technique to organize criteria for option selection	
Section 1	Group Activity 2: Typical shoe purchase considerations: How do you decide which shoes to buy? Page 11	• Demonstrates that not all criterion is of equal value • Practice weighting criteria importance	• Aid participants in applying a technique that will allow them to input the importance of individual criteria in the selection process	1. Weighted criteria
	Group Activity 2 continued Other possible shoe change considerations: How do you decide when to purchase your shoes? Page 12	• Demonstrate that there are different criteria being used to decide when to take action • Discuss how the amount of resources available influences the decision of when to take action	• Sensitize participants that the need to take action may need to be discussed to build agreement on when to take action • Sensitize participants that the need/speed to take action is influenced inversely by the resources available	
	Group Activity 3: Typical technology considerations: How do you decide which option to buy? Page 13	• Discuss the technology purchase information that is needed for well informed decision making • Rank information / criteria importance • Check if information influences the outcome	• Inculcate participants in the application of information / criteria importance, sequencing and duration into technology selection	1. Matrix of information/ criteria arranged in importance, set in sequence and categorized by long or short-term.
	Group Activity 3: continued from Page 15	• Place needs into the TMF categories • Describe possible measures used to evaluate needs • Discuss the data required to evaluate specific needs	• Assist participants in articulating specific needs and creating measures to use in evaluating those needs	1. Matrix of needs, measure used to evaluate them and required data

	Activity	Purpose	Learning objective	Output
Section 2	Group Activity 4: Technology confused or mis-concept-ed? Page 16	• Discuss existing technology misconceptions that selection groups may encounter	• Allow participants time to form responses to common misconceptions	
	Group Activity 5: Technology analysis process Page 18	• Describe 4 basic steps to ground truth technology claims	• Show participants a process to validate claims	
	Partner Activity 2: Technology and shoe testing interface Page 19	• This activity builds upon Group Activity 3 • Opportunity to revisit earlier data	• How to articulate the focus of data analysis needed	
Section 3	Partner Activity 3: What should I pack? Page 20	• Brainstorm non-technologies	• Introduce participants to the concept of non-technology solutions	
	Partner Activity 4: Horse shoes Page 21	• Identify areas to apply low technology or non-technology solutions	• Aid participants in recognizing low or no technology opportunities	
Section 4	Group Activity 6: Appropriate technology process steps Page 22	• Outline a process for implementing appropriate technology applications	• Show participants a step-by-step process to get the most appropriate technology in place	
	Group Activity 7: Specific needs discussion Page 23	• Practice using the table from Group Activity 3 • Ranking of shoe or actual water system data	• Provide an opportunity to work on ranking as a group	
	Group Activity 8: Ordering your decisions Page 24	• Exploration of the decision making process as a chronologically ordered sequence	• Demonstrate to participants the chronological ordering of decisions	
	Group Activity 9: Decision timing Page 25	• Provide experience using a decision timing technique	• Provide participants with a hands-on opportunity to practice decision timing	1. Decision timing flip chart
	Group Activity 10: Narrowing your options Page 26	• Demonstrate how importance multiplier can add fidelity in the selection process	• Provide participants with a method to create more fidelity in decision making for critical data	
	Partner Activity 5: College shoe design competition Page 27	• Provide a collaborative design experience	• Show participants that good design is the product of multiple perspectives	

	Activity	Purpose	Learning objective	Output
Section 5	Group Activity 11: Teen shoe fads Page 30	• Demonstrate the change of local norms over time	• Provide participants a framework to discuss local cultural change and identification of non-changing influences	
Section 6	Group Activity 12: Water pumping appropriate technology Page 33	• Discuss technology option resource consumption • Discuss technology evolution rates and the deficiency from best available technology over time	• Aid participants to distinguish technology options • See differing technology development rates and its effect on the difference between what was installed and the newest technology	
Section 7	No specific Asset Management activity is included. Please refer to the U.S. EPA resources like the Check Up Programs for Small Systems (CUPSS) and Asset Management: A Handbook for Small Water Systems-STEP Guide Series at: http://water.epa.gov/type/drink/pws/smallsystems/managementhelp.cfm			
Section 8	Group Activity 13: Comparing wine bottle opener fads Page 36	• Discuss technology as a combination of components, each with its own costs and benefits	• Aid participants in seeing options as a combination of differing value components	
	Participant Activity 6: Technology option as a group of components Page 37	• Provide a method to distinguish value added for each component	• Aid participants in discussing the value of different components	
	Participant Activity 7: Technology component updating Page 37	• Discuss updating specific technology components rather than the entire grouping	• Aid participants in discussing the updating of components as needed	
	Group Activity 14: Board of Directors presentation Page 38	• Discuss the appropriateness of selection criteria being used	• Revisit criteria to ensure that it remains appropriate to the decision being made • Allow participant to revisit and add selection criteria	

Alternative warm-up group activities:

Partner Activity 1: Warm-up pair's discussion of shoe differences

Find a partner. Observe their shoes and your own. If your partner is not wearing any shoes, be sure to be polite enough to compliment their pedicure. Together create a list in the differences between your footwear. Now see if you can list the causes of those differences.

Typical daily shoe selection considerations: How do we decide which shoes to wear?

- Where you are going
- What you will be doing
- How much each pair of shoes costs
- How old particular shoes are
- How often particular shoes are worn
- The weather
- How much you are taking with you on a trip
- Comfort
- Ease of putting on or tying
- How fast you want to be moving (roller skates, skis)
- What you want to be standing on
- If you are moving vertically or horizontally (climbing shoes)
- What you are riding (spurs)
- Specialized work to be performed (sheetrock stilts vs. roofer shoes)

Group Activity 1: Technology to write your system name & sign-in to a training session

As a group, first brainstorm a list of possible ways to sign-in for this session. Remember that during brainstorming, don't take time to evaluate ideas or explain in detail. Next, remove ideas that are a repeat of the same thing. If several ideas are very close, group them together. The purpose of this activity is to create the longest possible list of options.

Example: Writing technology options to sign-in to a training session

- ☐ In blood
- ☐ Pencil
- ☐ Chalk
- ☐ Ball point pen
- ☐ Mud
- ☐ Charcoal

Now brainstorm a set of criteria that you can use to decide which technology is the best. Again, try and create the longest possible list of criteria that might be useful.

Example: Criteria

How many miles or feet will it write? Who much does it cost?

Select your three best criteria and three best sign-in options. This can be done either as dot-voting or as a show of hands. Discuss as a group which technology would be the best based upon your criteria.

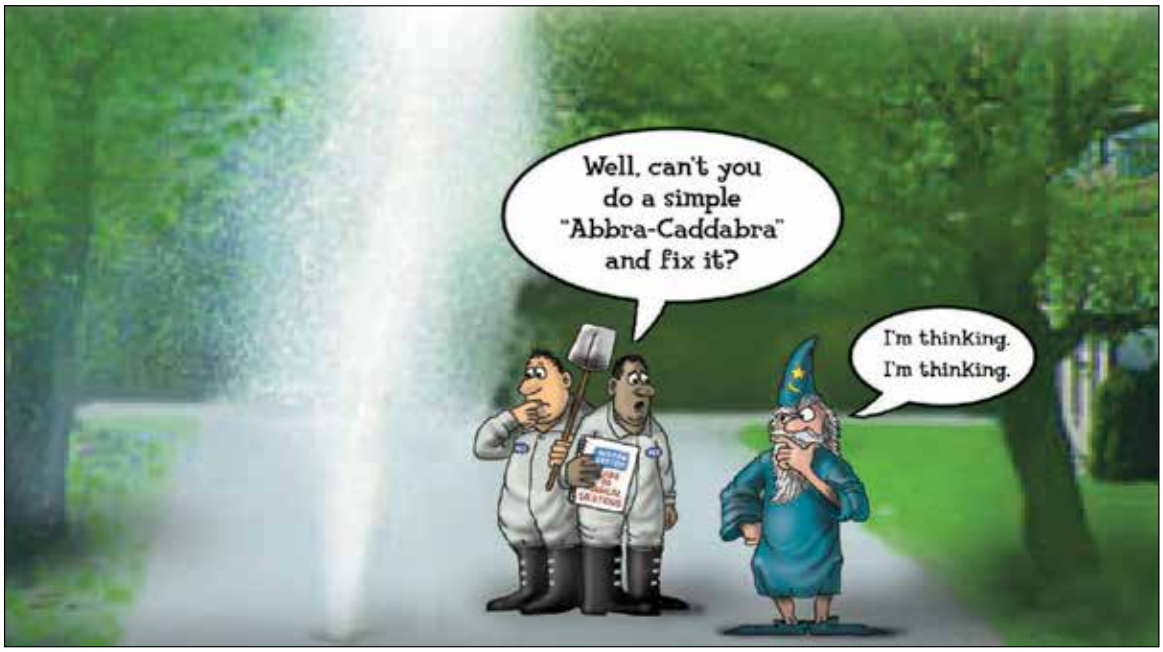
	Criteria 1	Criteria 2	Criteria 3
Option 1			
Option 2			
Option 3			

1 What is Appropriate Technology?

But what is appropriate technology? Rural utilities don't usually search for appropriate technology. They search for solutions that fix problems and satisfy needs. When the process works, rural utility problem solving and appropriate technology are often times one in the same. Other times, they differ in aspects of convenience, accessibility, total cost or required planning. The term (appropriate technology) is most commonly used to describe simple technologies suitable for use in developing nations or less developed rural areas of industrialized nations.[2] We often think of the first half of this definition and overlook the second. This guide is intended to aid small rural water systems with a process to identify appropriate technologies.

Small community water systems have fewer available resources to understand and respond to changes than larger systems. Appropriate technology for small rural water systems is not simply a scaling down of large system technology. Some aspects cannot be reduced in equal proportions. For example, if a specialized skill is needed to operate equipment, the cost of acquiring that skill will be the same whether the staff will be performing the function full-time or just one hour per week.

Water quality science in America is continually improving. Drinking water quality standards and regulations increase in consideration of new scientific findings and understanding. Increasing water quality standards create a need to increase both water treatment and distribution quality. As water quality requirements increase, the bar for what is appropriate drinking water production and delivery technology keeps increasing. Large water systems are often the leaders in researching and incorporating new technologies. Some have even developed their own culture of innovation and change management.



[2] *Healing Appalachia; Sustainable Living Through Appropriate Technology*, Al Fritsch & Paul Gallimore, The University Press of Kentucky, 2007.

Appropriate technology needs are encountered every day on large and small farms across America. Farmers get the concept of appropriate technology. They buy it, build it and live it. If you question the creativeness of farmers or the genius of their application of technologies refer to *Farm Show Magazine and* their website, *www.farmshow.com*. Rumor has it that entire farm vehicles have been built from baler wire and duct tape. In most cases the original vehicle was slowly replaced part by part over time until the entire thing was nothing but wire and tape. Home grown solutions can contain very elegant simplicity. Caution should be used when applying this to a public water system, as performance dependability is needed to protect public health and the environment.

On a serious note, we will investigate a method to help achieve the farmers' appropriate balance of finances, labor and technology, or 'triple bottom line.' This is a more common way of thinking of appropriate technology. If you use an internet search engine like *www.google.com,* you will get search results based upon the application of low tech solutions locally available and low cost materials, but a more systematic approach is needed.

Sometimes these are old appropriate technologies from developed counties where appropriateness shifted. For example, solar water heaters were first available in 1891.[3] There was a very long period that solar water heating technology was not widely implemented or improved. This is an example of when the graph (on page 32) of technology advancement over time would be flat rather than inclined. Events like the 1970s oil crisis, however, influence technological innovation and implementation. Rooftop solar water heaters around the world demonstrate that progress. Still the oldest forms of solar water heaters remain in use.

Appropriateness is a measure of how well the proposed solution matches the actual need. The solution will need to fit within the available resources. However, it is important to state that required resources may be greater than what is considered available. This will be discussed more in Section 5 in why public outreach is needed to bridge the difference in what customers need to pay and what they want to pay.

Regulatory compliance is a big consideration in the application of appropriate technology. It is also a place where small systems have big resources at their disposal. The process of achieving regulatory compliance is sometimes thought of as the seeking and receiving primacy agency permission. This perspective may lead to unneeded conflict and/or delays. A proactive approach to communicating with your primacy agency can allow you to leverage the extensive scientific and engineering knowledge for better informed decision making. The earlier in the process the primacy agency is contacted the greater the value of their input. They can share information or perspectives on the creation of a needs statement that will save you time and increase your chances of obtaining the best possible solution.

This is the shoe equivalent of being able to ask professional coaches and referees what basketball shoes to purchase.

In shoe shopping, our shoe purchase is influenced by our daily shoe wearing choices. We tend to purchase the types of shoes that we will wear, unless we are purchasing shoes for a very specific need, like being in the wedding party of an old friend.

[3] John Perlin and Ken Butti , The Story of Solar Electricity, A Golden Thread, *http://www.californiasolarcenter.org/history_solarthermal.html*

Group Activity 2: Typical shoe purchase considerations

How do you decide which shoes to buy?

Divide into small groups of 5-7 members. As a group discuss the importance of each of the shoe purchasing questions below. ***Please focus on discussing the importance of the question or the information it provides and not the question itself.***

As a group, decide which of the questions will provide information that is more important to the purchase of shoes. ***Note that some questions influence/inform how you answer another question.*** Later you will be ranking the questions in the order or sequence that they should be answered. *Please hold on to this work to be used later.*

1 = Most important; 10 = Least important

_____ Do you purchase shoes based upon cost?

_____ Do you purchase shoes based upon how they make you appear?

_____ Do you purchase shoes based upon what you will be doing while wearing them?

_____ Do you purchase shoes based upon how comfortable they are?

_____ Do you purchase shoes based upon their reputation?

_____ Do you purchase shoes based upon the weather/season?

_____ Do you purchase shoes based upon what you do for a living?

_____ Do you purchase shoes based upon what your friends are wearing/local culture?

_____ How long do you intend to own the shoes?

_____ Do you purchase shoes because shoe shopping is fun?

Group Activity 2 *continued:* Other possible shoe change considerations

How do you decide when to purchase your shoes?

(✓) Check the considerations that you would use if you are purchasing new shoes; if you are purchasing a new 12th pair of shoes; a 3rd pair or your ONLY pair.

12 pairs	3 pairs	1 pair	
☐	☐	☐	Odor of current shoes
☐	☐	☐	A day when you have nothing else planned, so you go shoe shopping
☐	☐	☐	A big "SALE" banner on the store
☐	☐	☐	Family & friends urge you to update your wardrobe
☐	☐	☐	Your toes show
☐	☐	☐	A change in fashion
☐	☐	☐	Your old shoes have fallen apart
☐	☐	☐	The type of shoe needed for your new job
☐	☐	☐	Motivation: like you are ruining your good shoes
☐	☐	☐	You feel awkward in what you are wearing
☐	☐	☐	What is available locally (19th century Holland = wooden shoes)
☐	☐	☐	What the salesclerk recommends
☐	☐	☐	Style
☐	☐	☐	Safety
☐	☐	☐	Water proof
☐	☐	☐	Comfort
☐	☐	☐	Cost
☐	☐	☐	Durability
☐	☐	☐	Fashion statement

12 pairs	3 pairs	1 pair	
☐	☐	☐	Warmth
☐	☐	☐	What your family will let you be seen in (funeral shoes)
☐	☐	☐	What the popular people wear
☐	☐	☐	The environment (carbon footprint)
☐	☐	☐	Social justice
☐	☐	☐	Desire to have fun
☐	☐	☐	Protection from disease
☐	☐	☐	Height of the shoe
☐	☐	☐	Age of the shoe
☐	☐	☐	Weight of the shoe
☐	☐	☐	Sport being played
☐	☐	☐	_____
☐	☐	☐	_____
☐	☐	☐	_____

Total ✓ ___ ___ ___

Now discuss reasons why your considerations are different based on the number of pairs owned ***changes your considerations.***

Group Activity 3: Typical technology considerations *(Continued from page 12, continued on page 15)*

How do you decide which option to buy?

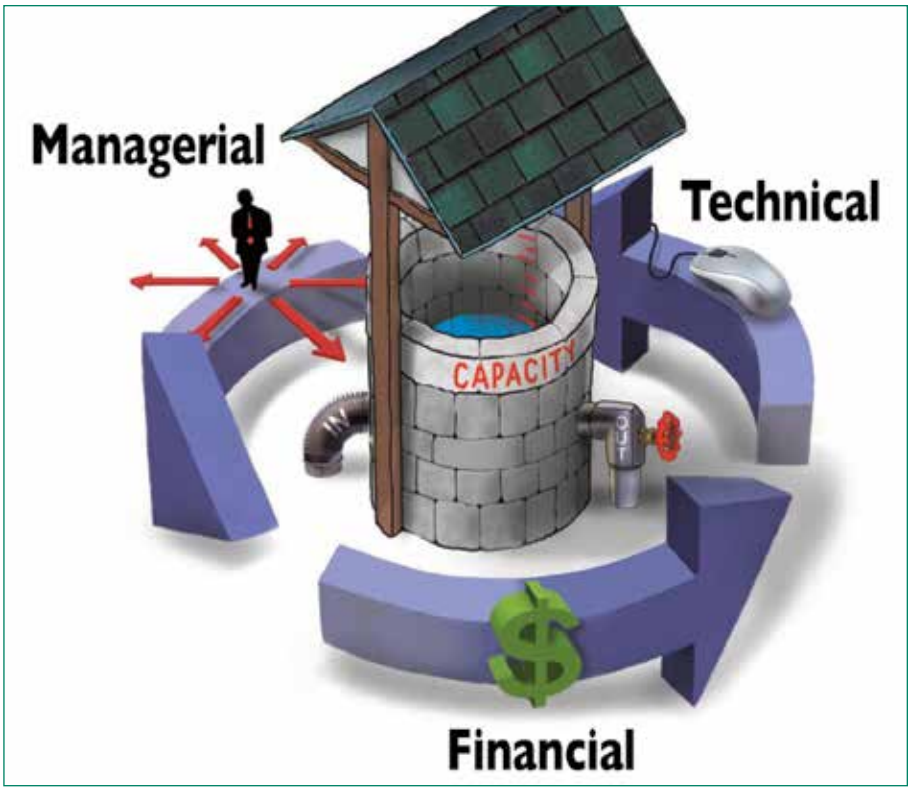
In the same small groups of 5-7 members, discuss the importance of each technology purchasing question below. ***Please focus on discussing the importance of the question or the information it provides and not the question itself.***

As a group decide which of the questions will provide information that is critical to the purchase of technology. Note that some questions inform other questions. That is, some questions' answer will influence/inform how you answer another question. Now place the questions in the order or sequence that they should be answered using arrows. Then list if the consideration addresses a long-term need, short-term need, or both.

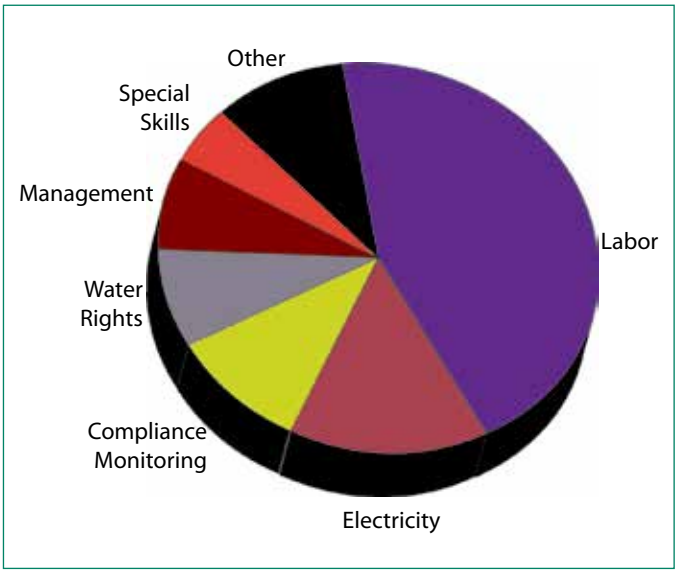
1 = most important; 12 = least important

Do you purchase technology based upon . . .	Long/Short/Both
_____ Capital or up-front cost?	_____
_____ Operational cost?	_____
_____ Its interface with existing technology?	_____
_____ Complexity of operations?	_____
_____ Availability of spare parts?	_____
_____ The experience of other small systems?	_____
_____ The ease of repair?	_____
_____ Reliability?	_____
_____ The newest/highest level of sophistication available?	_____
_____ The recommendations of a contracted study, pilot project or blue-ribbon vetted committee of experts?	_____
_____ Meeting current regulatory compliance?	_____
_____ Meeting upcoming regulations?	_____

Is there a pattern of long-term vs. short-term in your ranking of considerations?



The three U.S. Environmental Protection Agency (EPA) capacity development categories are technical, managerial and financial. These categories are helpful to separate out different aspects of community utility service needs. Keep in mind that some aspects will influence or create needs in others. For example, a small rural utility might have a chronically underfunded financial need for capital replacement. If this goes unaddressed for multiple years the lack of resources influences maintenance and operations equipment replacements. The eventual outcome is experienced as physical component failure. In this example, financial influenced managerial which influenced technical considerations. The use of the EPA categories allows us to backtrack back to the contributing causes of a problem. The EPA categories can all be considered long-term.



Appropriate technology, in its simplest application, is asking; "How can we most economically and simply satisfy a specific need?" Cost and simplicity may align or be in tension. A specific need or group of needs will define the appropriate technology.

Use the EPA capacity development categories on the next page (Group Activity 3) to question both the need and its cause. Please work to make both the definitions of need and the measures of evaluation as specific as possible.

"The difference between the almost right word and the right word is really a large matter — it's the difference between the lightning bug and the lightning."

Mark Twain letter to George Bainton
10/15/1888

Group Activity 3: *(Continued from page 13); Also used in Group Activity 7: Specifc Needs Discussion*

Need	Measure used to evaluate need	Needed data	Influence score (1-10 possible)
TECHNICAL			
Operational performance specifics:	Production quantity & quality (sampling results)	*e.g.; sampling results*	
Operations knowledge specifics:	Operator certification sophistication*		
Maintenance specifics:	Reliability, repairability & accessibility		
Specific supplies and tools:	Access to specialized parts and tools		
Technical support specifics:	Access to adequate expertise		
Technology interface specifics:	How well components work together		
MANAGERIAL			
Allocation of labor, materials & equipment specifics:	Resources are available when and in the specific types needed	*e.g.; listing of work and production stoppages, delays & their causes*	
Quality control specifics:	Performance dependability		
Ability to respond to abnormal events specifics:	Redundancy		
Efficiency specifics:	Resource use optimization		
Planning & analysis specifics:	Thoughtfulness of response to need		
Public outreach specifics:	Customer acceptance & support		
Legality specifics:	No conflicts to Federal, State or local law*		
FINANCIAL			
Revenue to operate and maintain specifics:	Budgeting of revenue against expenses	e.g.; *Initial cost + operating cost + salvage value / life span*	
Future replacement of capital investments specifics:	Resource accumulation correspondent to capital deterioration		
Financial planning specifics:	Ability to quantify probable future needs and resources		

* A regulatory requirement = anything less is against the law

2 Appropriate Technology Misconceptions

There are no shortcuts to implementing appropriate technology. That is not to say that sometimes folks just happen upon the right answer. This detailed decision making process is not needed for small scale or short duration issues. However, we have all seen that barefoot swimmer suffering the hot sands of the beach to reach the water. Woe to the poor absent minded farmer who stands at the church door with his barn boots on as his family tries to wave him into their pew before the first hymn.

Technology is just the vehicle used to achieve a desired need or satisfaction. Technology is not an end itself. It is only the ***means*** for achieving the ends.

Group Activity 4: Technology confused or mis-concept-ed?

Working as a group, list your best response to the following appropriate technology misconceptions:

1. The salesman said that it would exceed all required standards. _____

   _____

2. It was cheapest so we can just buy another if it doesn't last. _____

   _____

3. This is the way we used to do it. _____

   _____

4. This solution is much simpler, like a 1960s pickup truck, back when you could fix things. _____

   _____

5. The most expensive is the most reliable. _____

   _____

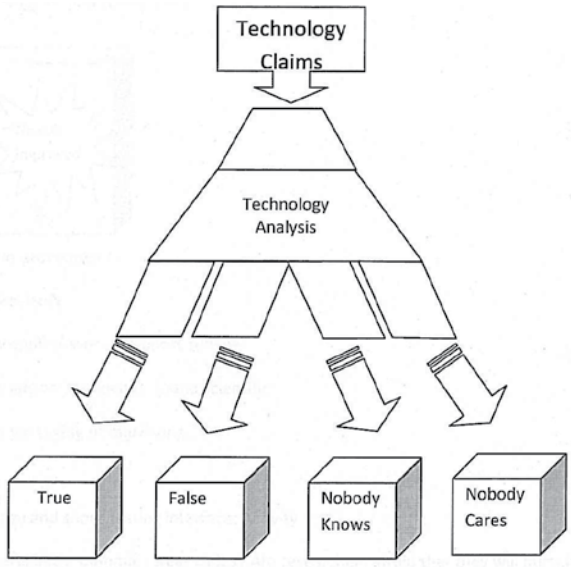
Possible responses to the above misconceptions include:

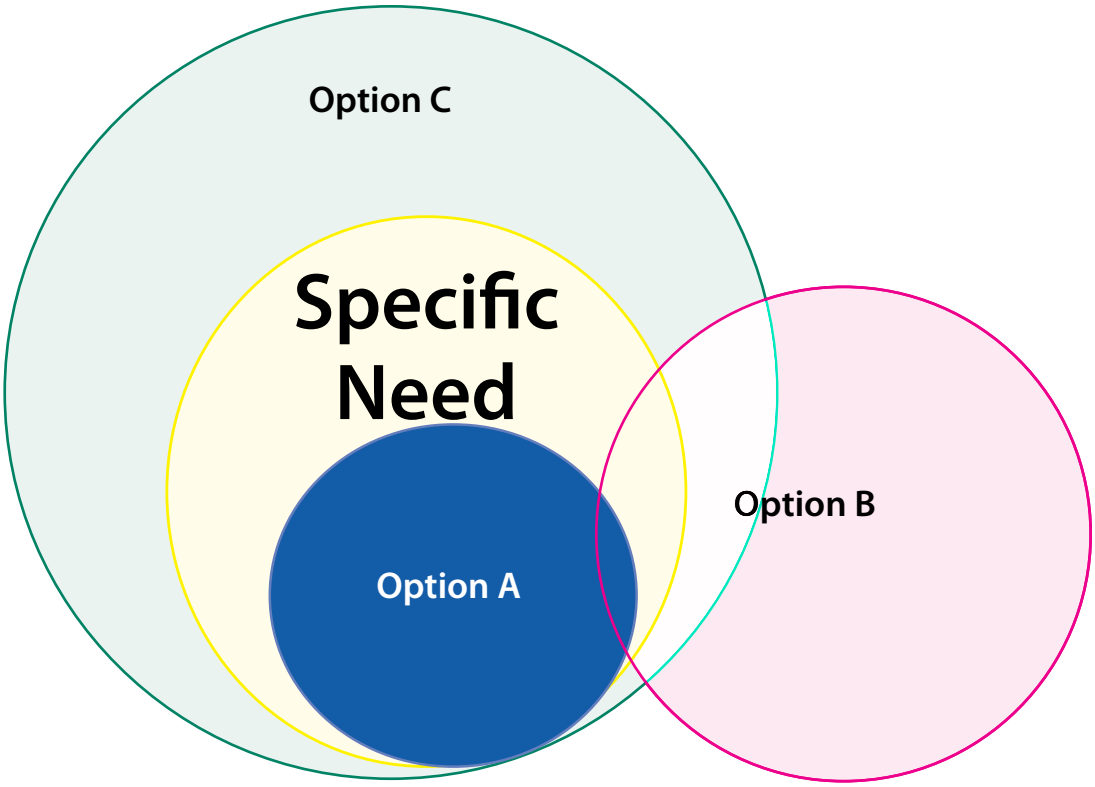
1. Technology approval is a combination of point in time performance and reliability of performance over a much longer time period.
2. Cost needs to include all the components of full life cycle analysis.
3. There is evolution of best practices when methods are updated to include additional considerations or reflect general experience.
4. Technology patterns do not translate well for one type of application, like transportation, as they might for other applications.
5. Quality and performance reliability are not directly proportional to cost.

Technology can not eliminate need. **Technology will satisfy one need by creating a new set of needs.** This point is crystal clear in the bedtime story of Cinderella and the glass slipper technology salesman. Cinderella knew that his claims of living happily ever after seemed too good to be true. Still she forked out the money and purchased a glass slipper. She was very excited about the salesman's claim that a free Prince Charming was included with every pair. She, being a girl who believed in fairy tales, had no idea that Prince Charming was going to require: royal clothing (not included), royal food (not included), royal housing (not included) and royal servants (not included). It seemed that a lot of unexpected resources are required for "happily ever after" stories.

The same is true in small rural drinking water delivery; long term success (happiness) is dependent upon accessing, effectively managing and efficiently using the needed resources.

Small rural systems need a process to analyze 'too good to be true' technology.





Group Activity 5: Technology analysis process

Step 1: Clearly document the facts of the technology claim

Step 2: Self assess the claim accuracy by

—checking with other systems with a similar situation

—checking with the state engineer or regulatory agency

—checking with drinking water professional networks like RCAC, AWWA, Rural Water Association, RCAP, etc.

Step 3: Contract for professional services if needed to investigate, analyze data, perform modeling and/or articulate to confirm or disprove claim. Remember that contracted professional services may be able to save you money in the long run even if your decision is to not install a particular technology.

Beware of claims of ***New & Improved***:

What is the improvement?

- New science
- New applications or support service
- New jargon intended to sound scientific
- New packaging or marketing

Step 4: Compare the technology's attributes to your exact needs (Activity 2). How closely does the technology option match your need?

Partner Activity 2: Technology and shoes testing interface

Why do crash test dummies wear shoes? Are researchers afraid that they will hurt their feet? Why the heck do researchers paint crash test dummies' shoes?

A. To also test different shoe types as a crash analysis control

B. To accurately represent what humans will be wearing during a crash

C. To make shoe scuffs on the automobile's interior

(Answer at bottom of page)

Compare your crash test dummy shoe needs to specific shoe attributes.

Need: Test a new all terrain vehicle (ATV) that will be used by rural water system operators for distribution system O&M activities.

First, list all of the characteristics related to foot safety that you would need to test. For example: foot entrapment, ease of getting in and out of vehicle, work done with feet in vehicle/accelerator, etc. Next, list the attribute of each shoe option; cost, typical usage, weight, level of protection, etc.

Work boot shoe technology option: _____

_____

_____

Running shoe technology option:_____

_____

_____

Dress shoe technology option: _____

_____

_____

Correct Answer: (c) The shoe paint leaves scuffs, marks and smudges that can be analyzed.

3 Appropriate Non-Technology

There are alternatives to the application of technology. Strategies, programs and mechanisms that manage demand can be more cost effective than technology that increases supply. An example is implementation of a water conservation program rather than construction of a new water storage facility.

- ☐ Hiring needed skills or seeking training to acquire knowledge in lieu of technology to perform the same analysis
- ☐ Programs that manage demand to reduce peaks and prevent the need to increase capacity to accommodate those peaks
- ☐ Protocols and procedures that maximize the performance of already installed technology

Technical expertise required to work within community facilities often times creates a bias within us to think of technical solutions before other options. When searching for possible solutions we may need to force ourselves to list possible non-technology solutions along with the technologies.

Partner Activity 3: What should I pack?

What are the possible footwear and non-footwear planning options? You have decided to go backpacking in the Rocky Mountains. The hike you and your friends decided upon will be up and downhill around a beautiful peak. The trek will take several days so you want to take the lightest possible shoes. Still you will need the shoes to do some very rugged hikes. The trail will cross several very deep creeks where there is no bridge. The trail winds through a very large swamp. The trail will cross over three passes that will be snow covered with very icy footing.

Brainstorm list of possible footwear	Brainstorm list of non-footwear solutions
1. Hiking boots	1. Take off boots to cross streams
2.	2.
3.	3.
4.	4.
5.	5.

Shoeless Joe Jackson

According to Jackson, he got his nickname during a mill game played in Anderson, South Carolina. Jackson suffered from blisters on his foot from a new pair of cleats, and they hurt so much that he had to take his shoes off before he went to bat. As play continued, a heckling fan noticed Jackson running to third base in his socks, and shouted "You shoeless son of a gun, you!" and the resulting nickname "Shoeless Joe" stuck with him throughout the remainder of his life.[4]

There should always be the possibility of using nontechnology like Shoeless Joe did to solve small rural water problems. For example, a vigorous water conservation/customer education program may prove to be a more appropriate solution than construction of new infrastructure to satisfy need. Remembering that water conservation could actually be a hybrid of both technology and nontechnology components. However, at the end of the day a truly successful conservation approach needs to both upgrade technology and change customers attitudes and behaviors.

Partner Activity 4: Horse shoes

The nontechnology shoes could include the debate about shoeing or not shoeing horses. Wild horses don't wear shoes. Domestic horses do because of the surfaces they work on, extra weight they carry and the fact that they don't travel large distances over rough terrain each day in search of food. What actually determines when a horse needs shoes ***is what the horse does.***

Please create a list of activities or processes that can be done in a small rural water system with technology, little technology or no technology:

Example: monitoring storage tank levels

_____

_____

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_____

_____

_____

Now discuss what the trade-offs are between the options.

[4] "Chicago Historical Society" *www.chicagohs.com*.

4 Appropriate Technology Process Steps

The table used for Activity 3 (continued on page 13) is a good tool for comparing technology options. For a large project or program a more formal search for the most appropriate technology process may be needed.

Group Activity 6: Appropriate technology process steps

First define appropriateness and then define possible technologies:

Step 1. Form, build, select, recruit or invent a workgroup or committee

Step 2. Draw a picture, define or articulate the need or problem to be addressed

Step 3. Mobilize partners, stakeholders, community or beneficiaries

Step 4. Gather input via research, town meetings, canvassing, surveys or interviews

Step 5. Articulate the scope of possible solutions or work to be done

Step 6. List possible selection criteria

Step 7. Rank importance of selection criteria and/ or components

- **Option a.** Most important > least important
- **Option b.** Bracketology (pairing options against each other like teams in a sports tournament). Each pair is voted on and just one advances to the next round of voting. An example can be downloaded as an Excel spreadsheet at: *http://myexceltemplates.com/tournament-bracket-excel-template/*
- **Option c.** Weighted points

Step 8. Research and draft possible appropriate technology and nontechnology solutions

Step 9. Rank researched solutions based upon the selection criteria

Step 10. Select top solution

Step 11. Double-check and check in more detail top solution

Step 12. Check for consensus on top solution

Step 13. Action plan for implementation

Group Activity 7: Specific needs discussion

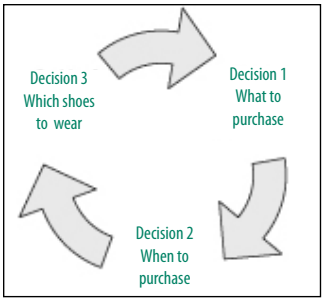
Remain in table groups of 5-7 members. Discuss as a group the possible needs of the Courtside Water System.

Background: Courtside is a small rural town located in the heart of Basketball Valley. The Courtside Water System supplies the normally joyful residents with drinking water. Courtside is a groundwater system that extracts water from two shallow wells that are under the influence of surface water. The water is treated (chlorinated) at each well house and stored in a single storage tank. Water quality test results indicate action is needed to mitigate the formation of disinfection by-products (DBPs) in the distribution system.

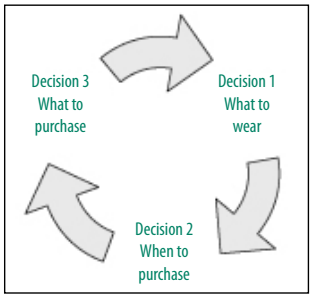
Using the activity sheet from Group Activity 3, page 15, first fill in the additional 3rd column on the "needed data" that would be needed to actually define and describe each aspect of a drinking water system need. Secondly fill in the 4th column (Influence) rating the importance of each category. If you need practice to be able and fill in column 4, please refer to the shoe purchase data below and discuss each column's importance. Rating the level of importance will allow grouping of high importance, moderate importance and low importance needs. This activity identifies what data is highly important in order to articulate a specific need. It is important to note that a clear statement of the problem aids the process of finding the best solution.

Shoe purchase data

- ☐ What is available locally (19th century Holland = Wooden shoes)
- ☐ What the sales clerk recommends
- ☐ Style
- ☐ Safety
- ☐ Water proof
- ☐ Comfort
- ☐ Cost
- ☐ Durability
- ☐ Fashion statement
- ☐ Warmth
- ☐ What your family will let you be seen in (funeral shoes)
- ☐ What the popular people wear
- ☐ The environment (carbon footprint)
- ☐ Social justice
- ☐ Desire to have fun
- ☐ Protection from disease
- ☐ Height of the shoe
- ☐ Age of the shoe
- ☐ Weight of the shoe
- ☐ Sport being played



Decision Process A



Decision Process B

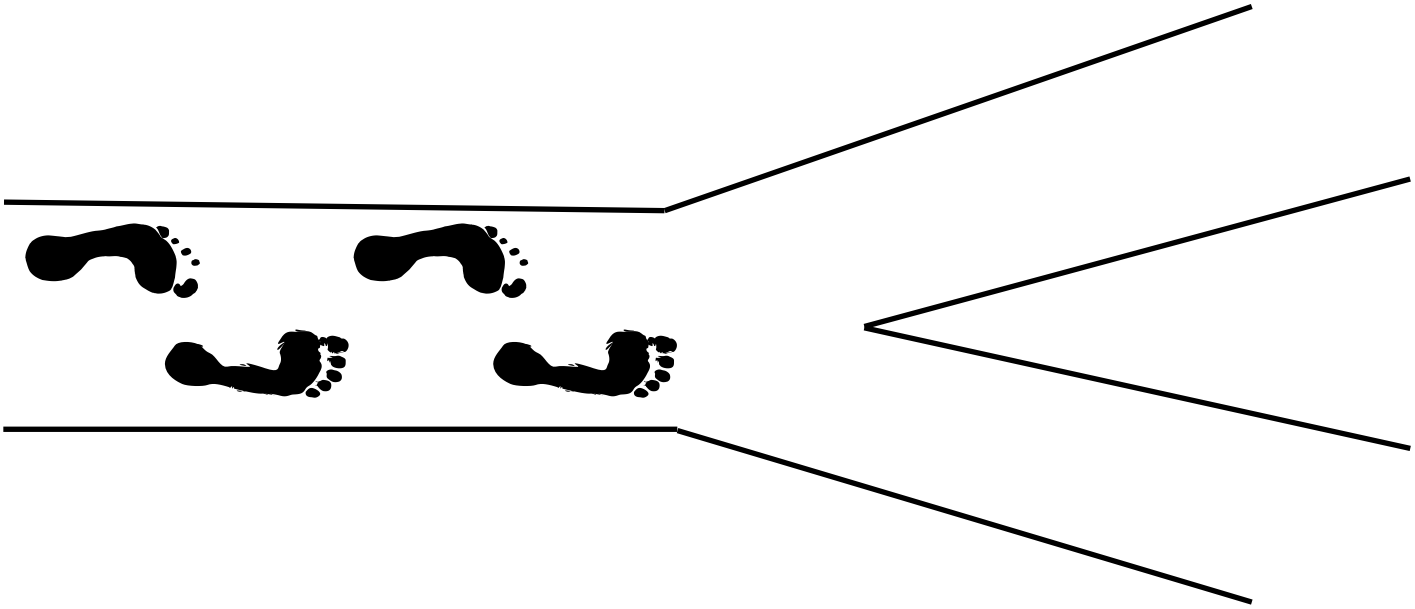
Both of these decision processes have advantages. All three questions have a satisfaction of need component. However, the way each decision may inform subsequent decisions creates a different cumulative ability to satisfy need. Decision Process A has more advantages in its ability to manage change and allows for the best possible daily shoe sporting. What one is wearing today may be dependent upon what was purchased rather than being dependent upon what is usually worn. The latter contains a bias for keeping everything the same unless there is a known problem. Better options will not be considered unless a problem arises, creating predictable performance.

The best shoes to purchase may not be the ones that you wear to the shoe store.

Group Activity 8: Ordering your decisions

Please remain in the same discussion groups. Each of the questions in Group Activity 2 (page 11) represents a decision. You previously have discussed the order of each question/decision. The timing of questions/decisions are also very important. Please discuss each decision's process relationship to the others and place them into chronological order for a decision making process that is specific to your system.

1st decision, 2nd decision, 3rd decision, etc.



Upgrades and improvements to infrastructure technology are much more complex than deciding upon a shoe purchase. There are very specific needs creating windows of opportunity for making needed advancements and updates. There is a specific process used for infrastructure projects. If the project is going to be using public funds there is a formalized process with specific conditions that will have to be met. Professional services might be needed for portions of this process. To ensure the utmost efficiency and effectiveness from the professional services, a system can identify the decisions that will need to be made and agreed upon as a decision tree or decision timeline.

Knowing when decisions are going to be made or setting automatic decisions allows everyone to plan for the needed decision making information gathering. An example of an automatic decision is: if we don't hear from a specific party by a specific date, we will check one more time by telephone before ruling them out as a project collaborator. As mentioned earlier, attention to detail can be very important.

The lack of some critical project data or decisions may not cause a problem until a later project phase, but it may require that an entire re-do of earlier work and decisions is needed. For example, a scope of work is drafted that does not take into account regulatory approval by the primacy agency. The project moves forward to the approval phase but then must be completely re-designed or even need a new study. Another example, a project is designed with features that are not constructible. A redesign or retrofit will be required. All of these situations involve additional costs or resources that were not anticipated.

Group Activity 9: Decision timing

Draw the phases in the table below on a flip chart. Write one of the specific "needed data" from the table you developed during Group Activity 3 (page 13) on a sticky note. Please put just one "needed data" per sticky note. As a group, discuss where to place the notes on the Project Phases/Timeline. For a real project you will want to add projected start and finish dates for each phase. Remember that phases can be concurrent or overlapping.

Project Phases Timeline

Realization of need	Create scope of work	Request for Proposals (RFP) for professional services	Professional study, review or investigation	Project design	Project approval by primacy agency	RFP for construction	Project construction	Project operation

Narrowing your options or limiting them is a good thing.

We often think that the difficulty in making a decision is rooted in the limited number of options. If only there was a perfect solution. However, using a process to limit options can increase decision making efficiency. A group process of narrowing options is not a straight line. Multiple rounds of selection or prioritization might be needed. Each of these rounds is fraught with conflict or some sense of loss.

Appropriate technology is not that one thing that does everything poorly. Resist the pressure to combine multiple projects. The 4th column of the matrix that you prepared in Group Activity 3 (page 15) has a weighting that can be used for narrowing options. Each technology option can be given a total score. The scores of all technologies can be compared and discussed by a selection committee or panel. The number ranking allows for a discussion of what is most important to your project.

Even in the world of shoe selection narrowing options can be helpful. How long would it take to get dressed each day if you had 3,000 pairs of shoes to choose from like Imelda Marcos, the former First Lady of the Philippines (1965-86).[6]

[6] *http://www.cnn.com/2006/WORLD/europe/11/07/day.numbers/index.html CNNNews*

Group Activity 10: Narrowing your options

As a group, using the grid below, discuss the 4th column (Influence) of Group Activity 3 (page 15). In the original discussion, the community of Courtside gave all options a ranking of 1-10. Now understanding that some things are more critical, assign each column an importance factor. That is to say if some data has a low importance, the factor will be just "one (1)." If other data is very important, decide how many times more important. Now you will take the importance number and multiply it times the original score, and write the total in the total score column.

Need	Influence consideration	Influence score (1-10 possible)	Importance multiplier	Total score
TECHNICAL				
Operational performance specifics:				
Operations knowledge specifics:				
Maintenance specifics:				
Specific supplies & tool specifics:				
Technical support specifics:				
Technology interface specifics:				
MANAGERIAL				
Allocation of labor, materials & equipment specifics:				
Quality control specifics:				
Ability to respond to abnormal events specifics:				
Efficiency specifics:				
Planning & analysis specifics:				
Public outreach specifics:				
Legality specifics:				
FINANCIAL				
Revenue to operate & maintain specifics:				
Future replacement of capital investments specifics:				
Financial planning specifics:				
TOTAL SCORE				

Partner Activity 5: College shoe design competition

Lots of engineering schools compete in robot, vehicle or structure design competitions. However, you have qualified for the first ever ***shoe design competition***. The team will be specifically made up of the following members: (Assign someone to each of the listed roles. They will participate in the design process looking at things from that perspective.)

- **Architecture student**: the shoe designer
- **Materials engineering student**: will look at the actual materials used in the shoe
- **Fashion design student**: will ensure that the shoe has an eye popping appearance
- **Human locomotion student**: will ensure that the shoe is actually functional and fits to the human body, bending where the foot bends and allowing easy movement
- **Business student**: will ensure that the shoes costs are within a specified range
- **College athlete**: will be wearing the shoe in an individual competitor event where the shoe's performance will be critical to his or her performance
- **College students' parents**: will be actually constructing the shoes. You may assign specialized knowledge or skills as needed in shoe construction

Map out or write down the process you will use to design the shoe. Please include:

- ☐ Needed decision points, including who needs to be involved in the decision
- ☐ Design, construction and testing timing
- ☐ Specific tasks for individuals
- ☐ Project milestones or points where design, construction and testing progress can be measured

Standard Appropriate Technology Process

1. Identify need
2. Refine definition of need
3. Construct criteria to express the best possible satisfaction of the need
4. Gather data on possible solutions to satisfy need
    a. Use professional services
    b. Use industry experts advice
    c. Use operations staff experience
    d. Use regulatory agency council
5. Use criteria to rank options
6. Ground truth top ranking options by visiting this option's implementation somewhere or contacting the users
7. Build it, buy it or rent it

5

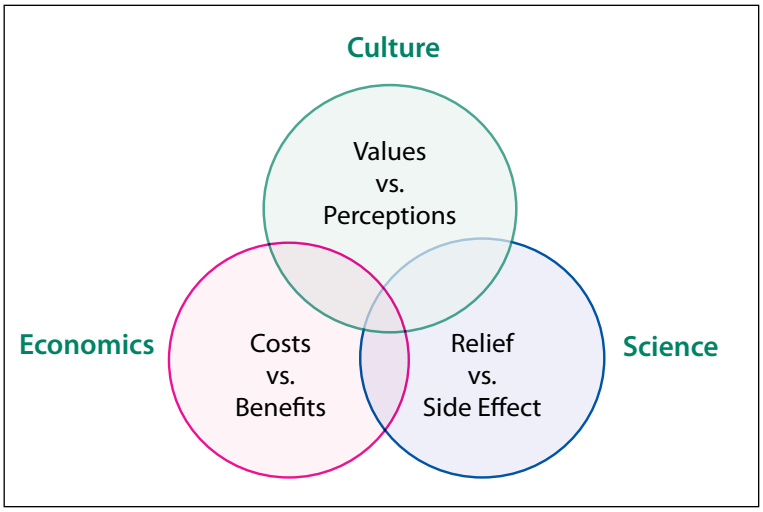
Appropriate Technology Expectations

The complete cost of technology is not just an economic question. It is also a question of expectations or cultural norms. How far did the average American walk each day in the beginning of the 1900s? How many pairs of shoes did that American have in the beginning of the 1900s? How far does the average American walk each day today? How many shoes does the average American have today? The number of shoes we own and the amount we are willing to pay for each pair have increased. These increases have not been based solely upon shoe need.

Rural utilities' technological solutions are more than just a situational application of technology. That is to say that small rural water systems are in the business of satisfying basic human needs. Human ***need*** is difficult to define because ***want*** is often times confused for ***need***.

Human want is influenced by a range of scientific, cultural and economic factors. When want is explained as need, then we need to also consider these factors. For example, most water customers do not define the amount of water they need each day as the two or so gallons that is needed for basic human functions. Lots of other needs and wants are included.

The public engagement or outreach process is handled by first dividing the community into audiences. Audiences are defined by how they will be affected by the project outcomes. Each audience or grouping of affected people will receive similar benefits and/or costs from the project. These benefits and/or costs should be included into a message. The message is really your request for them to make a trade of new costs for benefits. This is an education process so resist the temptation to only consider benefits. No option is right for everyone. You are seeking to raise acceptance to a level that everyone can live with. The culture, science, economics diagram is a useful way of grouping benefits and costs. Benefits and costs can also be divided into immediate and future categories.



What will really happen if no action is taken = natural consequences. Public engagement should always contain a factual statement of what will happen if the project or program is not implemented. To do this, you need a statement of how the world will change because of the existence of the project.

All appropriate technology selection needs to include a good 'null alternative'

description. Null alternative is a description of what will happen if nothing is done. You may need to describe what will happen in 5-years, 10-years or 30-years because of the long service life of drinking water infrastructure. The longer time ranges allow explanations for both the short- and long-term consequences.

Culture examples are:

- It has a taste or odor that I don't like
- Something is being added to my all natural water that is somehow not all natural
- It has been used other places so it must be good
- Confusion about why common sense solutions don't work for water processes

Science examples are:

- Disinfection kills pathogens
- Chlorine can form disinfection by products

Economic examples are:

- Option 1 is cheaper than option 2 to install, but option 2 is the cheapest to operate
- These are the technology solutions that we can find funding for implementation

All three of these aspects, Culture, Science and Economic, need to be considered when looking at appropriate technology options. The perspective of cultural acceptance is one that can be mitigated and managed. That is to say the involvement of customers and publication of the appropriate technology selection process steps and outcomes can save lots of resources later. Involvement and buy-in can be much more efficient than trying to sell and justify the project after it is implemented. It is important to know that because if customers are involved much earlier in an outreach process, you can see if the project will be accepted and then foster buy-in.

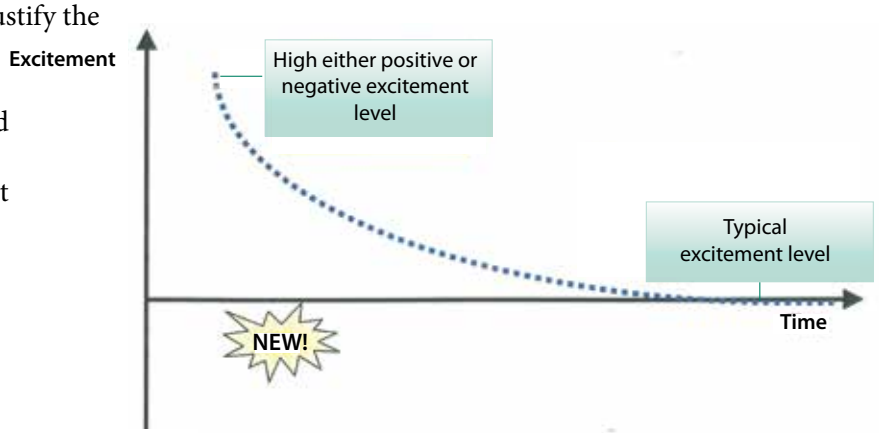
Public outreach as a project needs statement can be very effective. Describe the project by the need or needs that it aims to satisfy rather than the technology being implemented. The project needs statement and project description needs to be as factual as possible. A successful project can be beautifully implemented and still the customers are left dissatisfied because their expectations were much greater than the project scope. Good public outreach is targeted at understanding how the project will be perceived by specific groups or audiences and then using language that best describes the project as realistically as possible. Remember that your customers are very busy people and your description needs to be as brief as possible, if you want them to take the time to read or hear it.

Norming

Information alone cannot keep the positive excitement high over time or reduce the negative excitement as quickly as possible.

Perception of convenience or inconvenience

The specific event is defined by the customer rather than in terms of the utility. The water system may have been working on a project for multiple years, but the event for Mr. Jones is the day he sees a backhoe digging up the street in front of his house. To Mr. Jones the utility has not been doing anything on the issue and is now finally doing something. Regular and frequent information exchanges with customers helps your customers and customer communities to take information and assimilate it over time thus helping to mitigate the negative effects of excitement spikes.



6 Keeping up with Appropriate Technology

Appropriate technology is informed by cultural context and history. We need to understand both where things are and where they have come from to have a sense of where they are headed. It is easy to disregard conflict created by change as a manifestation of 'small town politics.' Appropriate technology needs to also fit local culture norms and values. If public cultural change or acceptance is needed for implementation of an appropriate technology it is easy to involve folks before decisions are finalized rather than selling them on a decision that they do not understand. Community culture is not constant and customers will need assistance in articulating shared values. Cultural values have even changed in the world of small town footwear. For example, shoe history 'pumps' started as men's shoes and were called "pompes." There have been laws to ban certain shoes like "excess in bootes" by pilgrims in 1628 and pointy shoes by the University of Paris back in the 13th century.[6] The most interesting 'pump' shoe innovation was the Reebok "Pumps," a basketball shoe with an air pump built into the tongue to increase jumping distances.

Group Activity 11: Teen shoe fads

As a group, draw a graph of how shoes worn by teenagers in your community have changed over time (shoe fads of 60s, 70s, 80s, etc.).

- ***How*** are they different?
- ***Why*** are they different?
- ***When*** are they different?
- ***Where*** are they different?

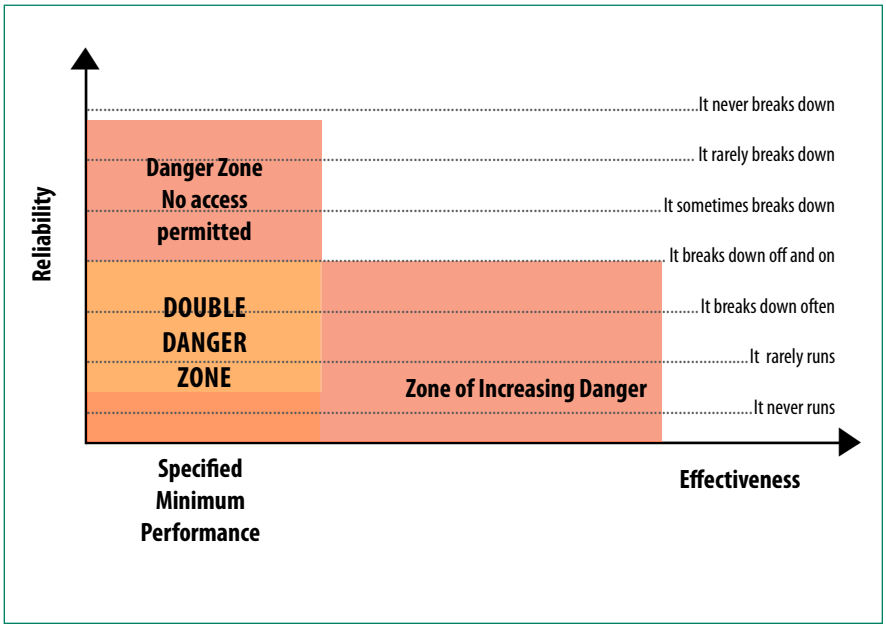
[6] *History of Heels, http://users.powernet.co.uk/wingett/History1.htm*

What is appropriate today will not necessarily be appropriate forever. Keeping up with the most appropriate technology for a water system's needs is a process. The process can be initiated when you are presented a new need or a new understanding that changes your perception of existing need. This could be explained as "you will know when the time is right to update." Yes, you will know if you have a process or mechanism for reviewing need. Some need will come to you and some need you will need to find. Some things will break down and need to be replaced. ***This is that need that will come and find you.*** A portion of the use of appropriate technology for small rural water systems is proactively asking the question; is what we have still appropriate? ***This is the need you will need to find.***

Here is where appropriate technology and operator certification interface. Small rural systems need to keep up with technology improvements and new science. Well selected outside training sessions, conference attendance and course participation are all avenues that both educate operators and expose them to the current best practices and technologies. It is very hard for small systems to set aside the resources needed to undertake the task of revisiting what is most appropriate. It is difficult to work in proactive ways to prevent future problems when current problems are already knocking at the door and demanding your attention. There are others in the industry that can guide you through the process of quickly revising "is what we have still appropriate?" Small systems should avail themselves of these opportunities even when they lead to the answer that nothing needs to be done.

The water system operators, managers, boards and decision makers of rural America need to implement appropriate technology to meet both current and future standards. It is not possible to always anticipate future standards, but when it can be done the cost of current implementation may provide substantial savings over future investments. There are other factors that can make this relationship reverse, resulting in appropriateness of current technology. The result would be that putting off a technology upgrade could save a system money in more expensive operations. A system may want to check the appropriateness of their existing technology before searching for new technology. This interaction may not be large enough to jeopardize sustainability, but it greatly impacts operational effectiveness and efficiency. **This publication hopefully provides guidance on how to tease an exact enough definition of need to allow for the application of an appropriate technology.**

Too often solutions fall into implementation categories of what will or will not get folks upset. The point of appropriate technology public outreach is to ensure that folks will or will not be getting upset based upon the facts. If they are not basing their reaction upon appropriateness criteria and are basing decisions upon their reaction, then the most appropriate solutions may not be achieved.



Technology advancement is often exponential over time. However, if the rate of technology advancement is assumed to be constant, then annual advancement will be constant. That advancement can be expressed in the unit "t."

Calculation of technology deficiency:

If technology is updated to the best available every year, then the amount of "best available technology deficiency" represented on the graph is:

$$\frac{1 \text{ year} \times 1 \text{ t}}{2} = 0.5 \text{ t-years of deficiency}$$

For a period of 50 years, the total "best available technology deficiency" will be:

$$50 \times 0.5 = 25 \text{ t-years}$$

If technology is updated to the best available every five years then the amount of "best available technology deficiency" represented on the graph is:

$$\frac{5 \text{ years} \times 5 \text{ t}}{2} = 12.5 \text{ t-years of deficiency}$$

For a period of 50 years the total "best available technology deficiency" will be:

$$10 \times 12.5 = 125 \text{ t-years}$$

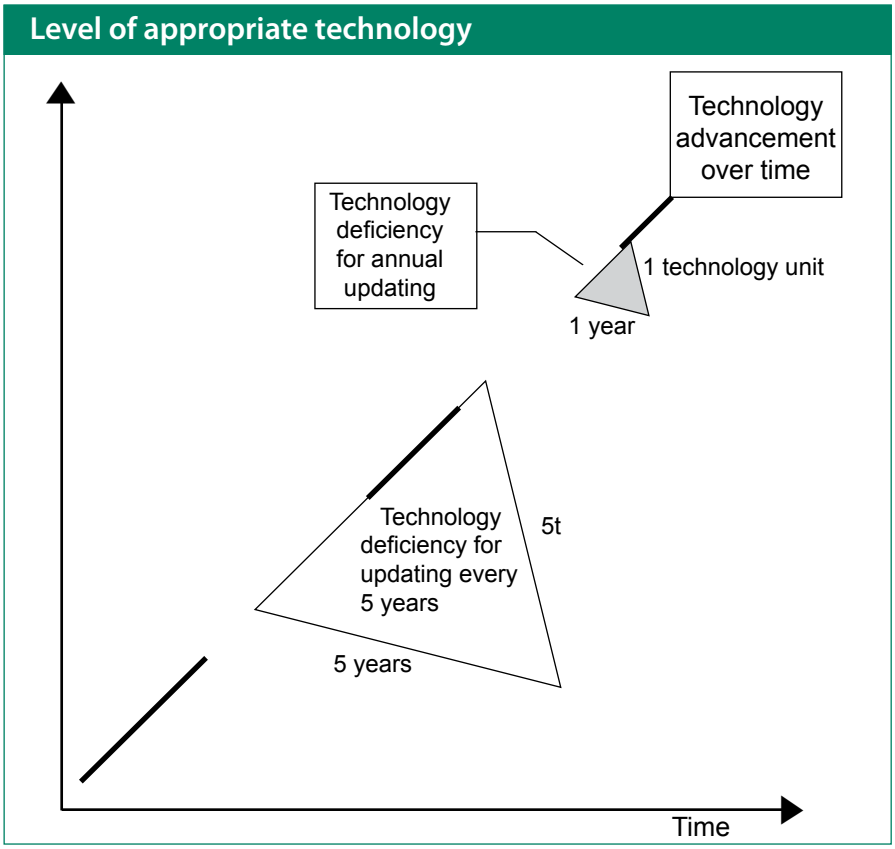
If technology is updated to the best available every five years then the amount of "best available technology deficiency" represented on the graph is:

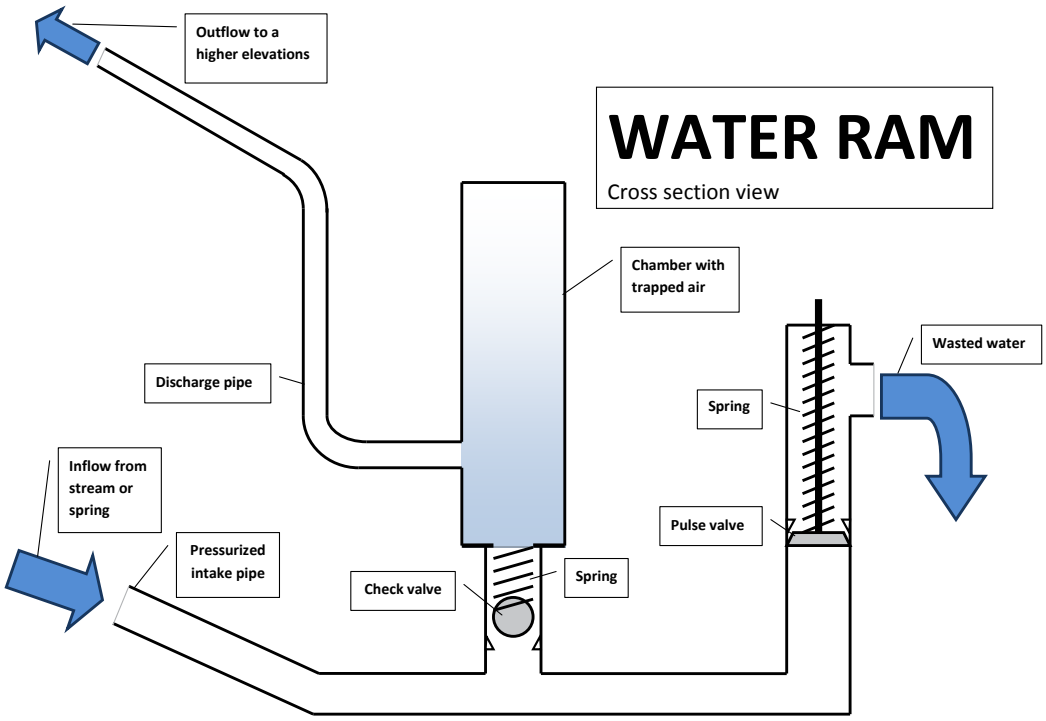
$$\frac{50 \text{ years} \times 50 \text{ t}}{2} = 1250 \text{ t-years of deficiency}$$

Therefore, for a period of 50 years, the total "best available technology deficiency" will be:

$$1 \times 1250 = 1250 \text{ t-years}$$

We often think of water and water systems as 50 year investments because they have a 50 year design life. However, waiting every 50 years to upgrade the technology within our systems causes great discrepancy in between the technology being used and the best available technology.





Group Activity 12: Water pumping appropriate technology

As a group, list the required resources for each of the possible water moving technologies:

- ☐ Water hand or foot pump
- ☐ Animal drive water screw
- ☐ Windmill
- ☐ Water ram (water powered water pump that uses 'water hammer' pressure)
- ☐ Electric pump
- ☐ Gasoline pump

Based on the resources required what would be some benefits of each technology?

Based upon the required resources, what would be some technology deficiency considerations of each technology?

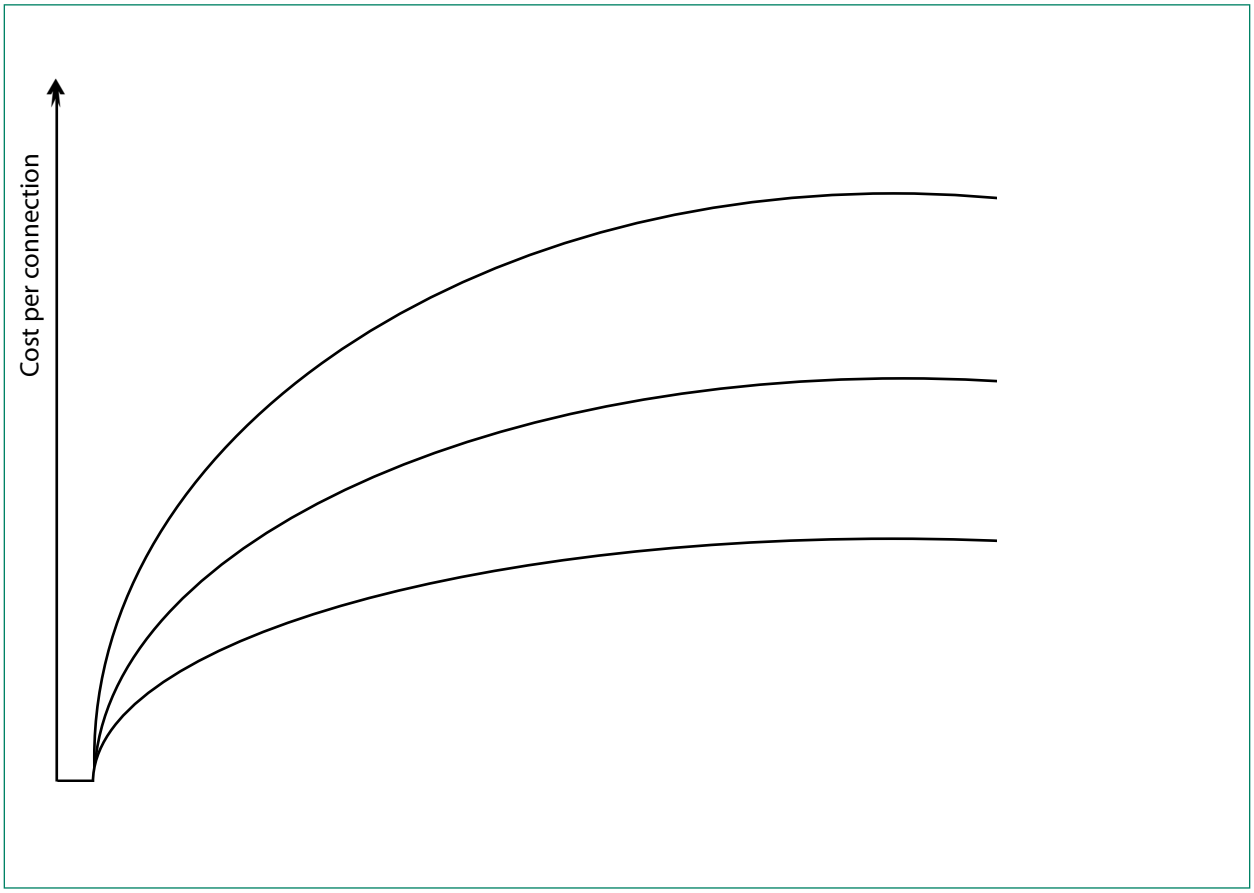
Why do these technologies have differing technology deficiency accumulation rates?

How would you use the concept of technology deficiency to set technology updates and technology selection strategies?

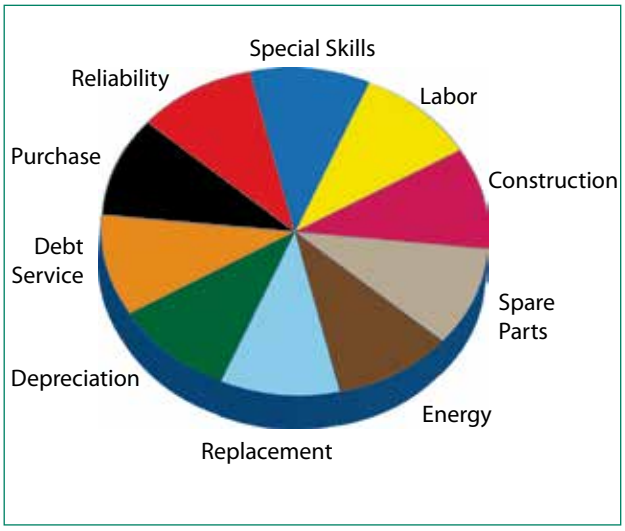
7 The Complete Cost of Appropriate Technology

Rural water system customers' expectations are also evolving. The problem is that everyone may be experiencing the change at different rates. Small rural water systems do not have the resources to measure attitudes and opinions on all needed changes. Each customer will measure the value of their water based upon a very personalized set of criteria. The utility needs to keep the customers as well informed as possible in the complete cost of water service. The first way this can be done is by annually evaluating system expenses and revenues.

Remember when comparing technologies that the per connection cost for an increase in technology sophistication is dependent upon the size of your system. One cannot simply divide by the number of connections to downsize the cost. Cost comparisons need to be looked at based upon the size of the system or project against others of the same sizing.

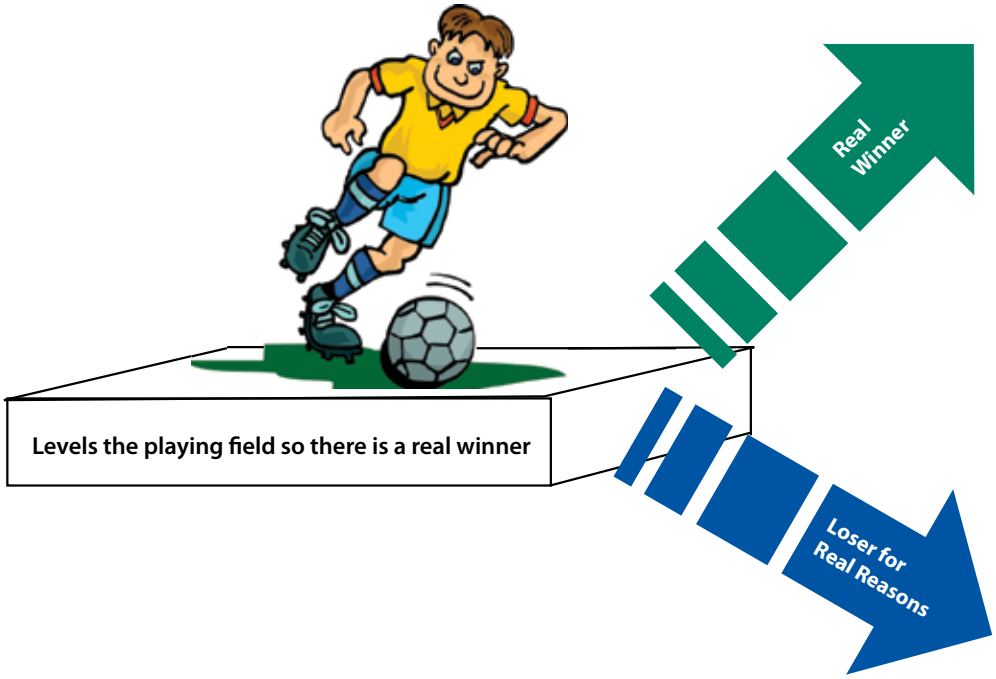


Life cycle analysis of technology options is used to compare costs. However, it is too large of a process for small systems to do without assistance. Please refer to an asset management guide on performing life cycle analysis or contract with a professional. Life cycle analysis can be used to level the playing field for all options.



Better technology that might provide a lower life cycle cost may be overlooked because it has a higher initial capital cost. The factors that need to be included in life cycle analysis are:

- ☐ Expected useful life
- ☐ Capital cost
- ☐ Operational cost
- ☐ Maintenance cost
- ☐ Manpower cost
  - ❍ Skills
  - ❍ Expertise
- ☐ Salvage value



8 Appropriate Technology Components

The selection of the best or most appropriate technology becomes complicated by the reality that sometimes technologies are only available in bundles or packages. Therefore, the most appropriate set of components cannot be selected. Only entire sets are offered so appropriateness then becomes a measurement of which set is the closest match to the exact needs of your system.

The first thing to do is to break each option into a listing of components. We can think of this like trying to sample a layer cake that has different layers. Each slice has either more positive benefits or negative detractions. You will use calculations of both the positives and the negatives to decide upon the appropriate slice size to choose.

Group Activity 13: Comparing wine bottle opener fads

As a group, list all of the required components that are included in each of these wine bottle openers.

Discuss the relationship of additional cost vs. additional benefit between each component?

- ☐ Manual cork screw
- ☐ Mechanical cork puller
- ☐ Electric corker

Each component of the set of components can be ranked in importance in the decision of appropriateness. However, consideration needs to be given to a particular component that may have one importance as a positive and a different importance as a negative. Some negative components may ultimately become 'deal breakers.' That is to say that if the component is not positive, the entire set is unacceptable.

Partner Activity 6: Technology options as a group of components

Specific component technologies	Importance of this component: 1-10	Is this component a positive or negative?	If negative, is this component a deal breaker?
Example: RO filter pressure sensor	4	positive	

We have been talking about the need to keep technology levels of performance current with increasing water quality standards. Can specific components be updated or expanded to meet future needs? Expandability has the benefits of being less expensive to integrate current needs so that it is easier for small systems to budget. The capital costs are able to be spread over multiple events rather than one very costly project.

Partner Activity 7: Technology component updating

Specific component technologies	Importance of this component: 1-10	Can this component be updated?	Can this component be expanded?
Example: Storage tank monitoring software	8	yes	yes

Group Activity 14: Board of Directors presentation

You have been asked to give a technical presentation on your water system to the State Drinking Water Agency's Board of Directors. You are nervous about public speaking so you spend days and days preparing your talk. You have charts, graphs, maps and even large glossy photos. You drive to the Agency Office and get ready to go inside when you realize that you forgot to put on shoes this morning. You look in the back of your pickup and see three old pairs of shoes. The shoes are a pair of rubber ditch boots, drugstore flip flops and old running shoes with some paint dribbled on them. Using lipstick you quickly draw three matrices on the windows of the car you just parked next to. As a group decide which shoes to wear. Taking the shoes off of a passerby is not an option.

SHOE OPTION: ditch boots			
Component:	**Importance of this component: 1-10**	**Is this component a positive or negative?**	**If negative, is this component a deal breaker?**
Waterproof			
Appearance			
Slip and Oil Resistance			
Odor			
SHOE OPTION: running shoes			
Component:	**Importance of this component: 1-10**	**Is this component a positive or negative?**	**If negative, is this component a deal breaker?**
Waterproof			
Appearance			
Slip and Oil Resistance			
Odor			
SHOE OPTION: flip flops			
Component:	**Importance of this component: 1-10**	**Is this component a positive or negative?**	**If negative, is this component a deal breaker?**
Waterproof			
Appearance			
Slip and Oil Resistance			
Odor			

Discuss as a group: Are you even using the right selection criteria: What would be the right criteria?

Layers of technology

Evaluation of each layer within a technology

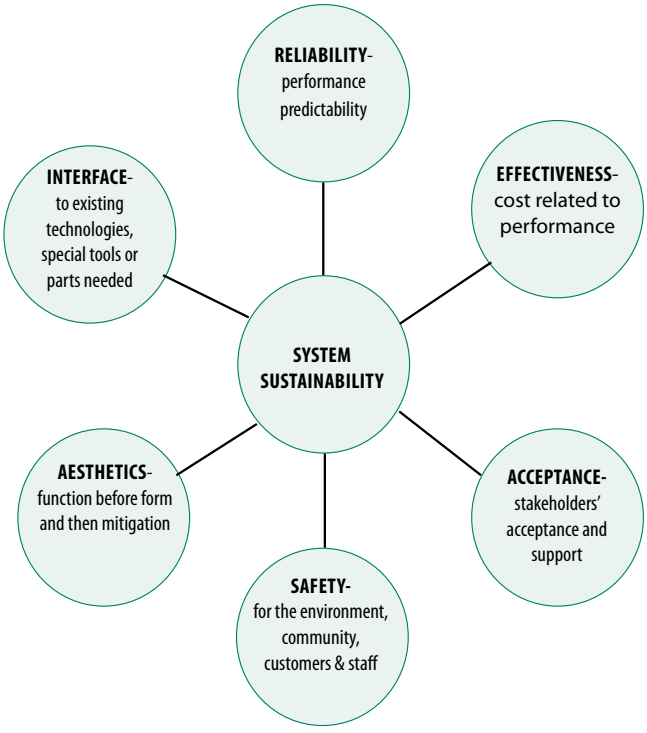
A technology is often a composition of options. Some are essential and must be included. Others options should be evaluated on their own for the ratio of benefit to cost. Options that provide more benefit than cost are 'value added' as an investment. The problem is that it is often difficult to evaluate benefits in equivalent units. It is even more difficult to predict change in each variable over time. It may be useful to look at the layers of a technology and to evaluate each one.

Some components are defined as being minimally allowable. Selecting an option with a lower reliability may save money, but may incur other costs for backups or redundancy. For example, drinking water treatment technologies that fall below the regulatory minimum specified performance standard will be out of regulatory compliance. However, it is not so clear in other areas when comparing the performance of a basic model to one including all of the bells and whistles. That is why so much time needs to be spent specifying "need." The more specific the list of needs created in Group Activity 3 (page 15), the easier it is to purchase only the level of technology that is needed.

When a clear definition of need is being used, then each layer of technology can be evaluated for its own ratio of cost to benefit. Some consumer products like automobiles are closely tracked for reliability. Infrastructure technology and products are usually not closely tracked. You or your hired professional will have to do your own reliability investigative work. This work may better be performed by a system operator than by a professional engineer.

An evaluation of needed effectiveness and reliability needs to be done. Reliability will deteriorate over time. As the expected life span end is neared or exceeded the exposure to danger or risk may gradually increase. However, it often times increases faster and faster as the unit reaches its design life or life expectancy. It is not a linear function and the old unit may be much more expensive to operate per unit of performance. Considering the long life of infrastructure, it is worth the time to assemble a workgroup or have your professional look into reliability. Nobody wants a pair of shoes that you have to keep stopping to tie over and over again. Whenever possible define the minimum allowable reliability. It may be defined as number of repairs per unit time or performance.

Technology reliability is a critical component of overall infrastructure sustainability. Poor reliability can put sustainability in question. Reliability is a product of sustainability because no technology is perfect. There needs to be performance monitoring protocols, maintenance schedules and capital replacement planning in place to get the most out of any technology. In the sustainability wheel below we can see the factors that add to system sustainability and are also influenced by system sustainability decision making. The cause of physical component failure can sometimes be traced to a lack of earlier sustainability based decision making. Any technology, appropriate or not, will function better for an institution that is using a sustainability based decision making process.



R Resources

National Center for Appropriate Technology
http://www.ncat.org/

Healing Appalachia; Sustainable Living Through Appropriate Technology by Al Fritsch & Paul Gallimore, The University Press of Kentucky, 2007

> ***Criteria for Selecting Appropriate Technology: Affordable, Earth-friendly, Community-enhancing & People-friendly;*** Selecting examples of appropriate technology is more difficult than one might first think. A variety of tools and activities may fit some of the characteristics and yet not be applicable to all time, place, or communities.
>
> ***Recommended Improvement Measures***; The feasibility study (FS) for a propose project must include a responsible chapter on the project O& M. Many FSs to date including those prepared by international consultants, include a chapter which is actually "fictional" in that it shows an O&M plan for the STP and other MSS components which is essentially a copy of IC practices.

Textbook of Appropriate Sewage Technology for Developing Countries by Harvey F. Ludwig, Herbert Fennerty, K.L. Sow & Kumar Mohit, South Asian Publishers Pvt. Ltd., 2005

> ***Appropriate technology*** is defined as any object, process, ideas, or practice that enhances human fulfillment through satisfaction of human needs. A technology is deemed to be appropriate when it is compatible with local, cultural, and economic conditions (i.e., the human, material and cultural resource of the economy), and utilized locally available materials and energy resources, with tools and processes maintained and operationally controlled by the local population.
>
> ***A cash flow projection*** is used to determine the amount of cash held by an enterprise at anytime. One use is to estimate how much cash is needed to start a project: At least enough initial cash is needed so the cash on hand never goes below zero.

Field Guide to Appropriate Technology by Barrett Hazeltine & Christopher Bull, Academic Press, 2003

Community Energy Workbook by Alice Hubbard & Clay Fong, the Rocky Mountain Institute, 1995

Cradle to Cradle by Frederic P. Miller, Agnes F. Vandome & John McBrewster (Ed.), Alphascript Publishing, 2009

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