abundaCulture

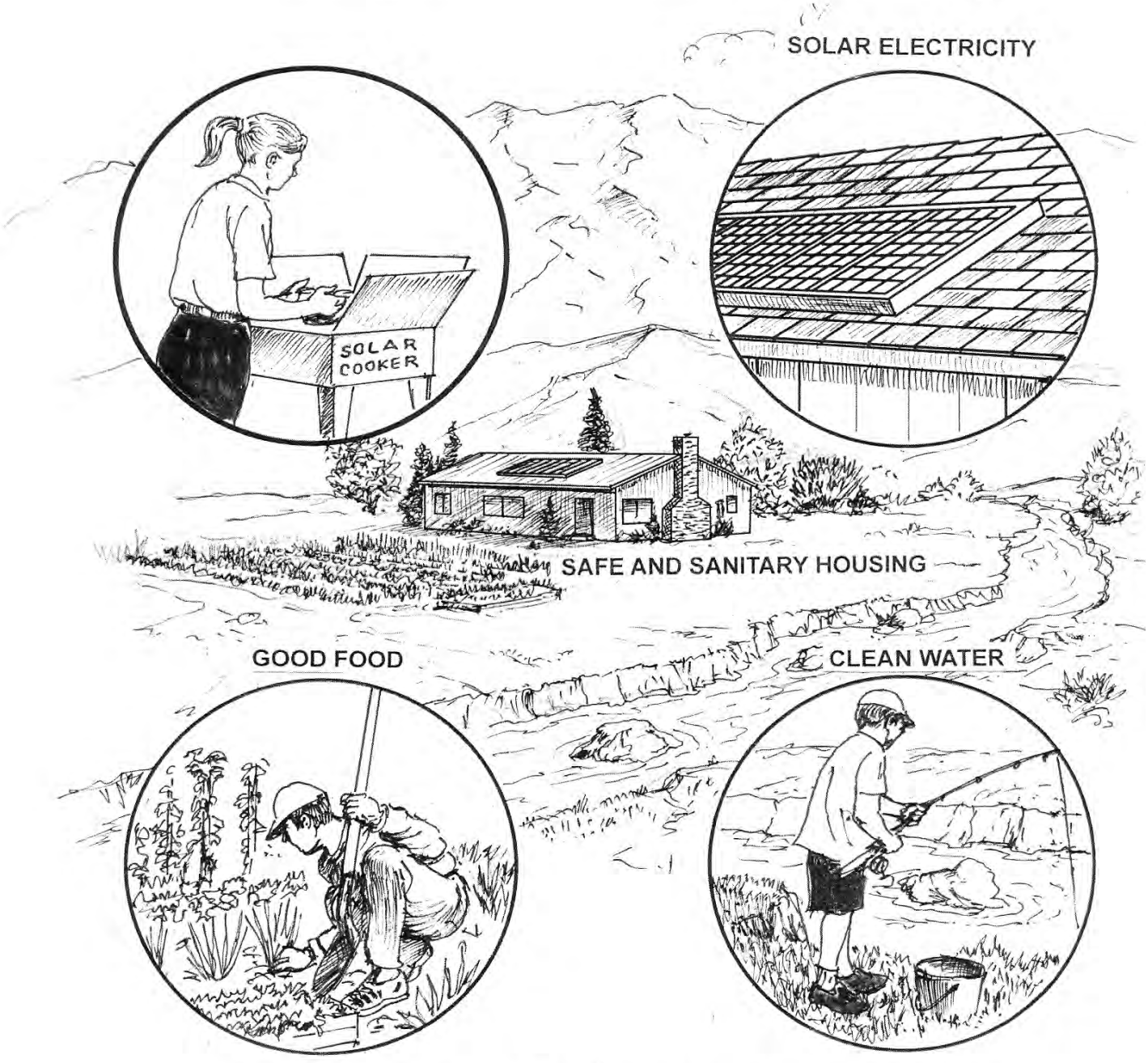
Training Manual

Shelter Energy Food Water Sanitation

Helping to meet the basic physical needs for energy, shelter, food, water and waste, in any environment, are tangible ways to begin relationships and demonstrate the love of Christ.

ABUNDACULTURE

Formerly: The Noah Project



PATHWAYS TO GOD'S ABUNDANCE

By Jack Dody

ABUNDACULTURE

Forward

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(unless otherwise noted, all Scripture references are taken from The New International Version ©1984.)

"Oh, Lord, my God, when I, in awesome wonder, consider
all the worlds thy hands have made . . . ." *How Great Thou Art* – Boberg

These words from the great Christian hymn attempt to describe the glory and power of the King of the Universe, the Creator of all things. He created a world overflowing with all of the things needed for a life of plenty. There is potentially more food than we need. Exactly the same amount of life-giving water flows on the planet as existed in the days immediately following creation. Resources for building homes are found everywhere, and the energy available on the earth far surpasses our needs. The Bible contains instructions regarding the stewardship of God's creation which, if followed, would place our feet on the path to abundance.

But something is terribly wrong. More than a billion people on this planet are starving. Billions live in hovels surrounded by filth. Approximately two million people will die this year because they do not have access to clean water (United Nations, *Beyond Security,* executive summary, 2006). As individuals, we often do not follow God's instructions, and corrupt governments often neglect and abuse the people they rule. How can this be?

As we read the story of the Israelites, we see that God clearly states the conditions for experiencing abundance. Notice God's promises:

> Leviticus 26:3-5 If you follow My decrees and are careful to obey my commands, I will send you rain in its season, and the ground will yield its crops and the trees of the field their fruit. Your threshing will continue until grape harvest, and the grape harvest will continue until planting, and you will eat all the food you want and live in safety in your land.

However, we see that even the Chosen People couldn't live up to God's requirements for the abundant life. They sinned, and, as a result, did not experience the abundance that was promised. But God reached out to them to deliver them from their sins.

> Isaiah 1:18 "Come now, let us reason together," says the Lord. "Though

> your sins are like scarlet, they shall be a white as snow; though they are red as crimson, they shall be like wool."

God offered to restore the abundance of the Israelites, but it was conditional, as the next sentence indicates.

> Isaiah 1:19-20 If you are willing and obedient, you will eat the best from the land, but if you resist and rebel, you will be devoured by the sword. For the mouth of the Lord has spoken.

The people of Israel were rebellious. They were not willing to follow God's words. They were not obedient. And, as a general rule, they did not enjoy abundance. It should also be noted that acts of disobedience have a direct effect on all of creation.

> Isaiah 24:4,5 The earth dries up and withers, the world languishes and withers, the exalted of the earth languish. The earth is defiled by its people; they have disobeyed the laws, violated the statutes and broken the everlasting covenant.

> Romans 8:19-22 The creation waits in eager expectation for the sons of God to be revealed. For the creation was subjected to frustration, not by its own choice, but by the will of the One who subjected it, in hope that the creation itself will be liberated from its bondage to decay and brought into glorious freedom of the children of God . We know that the whole creation has been groaning as in the pains of childbirth right up to the present time.

As a follower of Jesus, I believe that men are not capable of following the Law of Moses. Sinful men cannot enjoy abundance because we cannot obey the commands of God. But God, in His mercy, sent Jesus to save us from sin. With the help of the Holy Spirit, we can have faith in Jesus and learn to follow God's instructions which lead to abundance. Without Jesus, we can have no true, lasting abundance! Of course, we can only follow God imperfectly until we are with Him in heaven, but through Jesus our imperfections are covered by grace. Thus, abundance is a gift from God, and He is the source of all good things. See how abundance is expressed in Psalm 65: 9-13:

> You (God) care for the land and water it; you enrich it abundantly.
> The streams of God are filled with water to provide the people with grain,
> for so you have ordained it.
> You drench its furrows and level its ridges;
> You soften it with showers and bless its crops.
> You crown the year with your bounty, and your carts overflow with abundance.
> The grasslands of the desert overflow;
> the hills are clothed with gladness.
> The meadows are covered with flocks and the valleys are mantled with grain; they shout for joy and sing. [my underlining]

Many would argue that, in fact, evil men often do enjoy abundance, while many righteous men live in poverty. Therefore they dismiss the idea that abundance comes from our Father in heaven. It is true that God does not provide abundance to all believers at all times. Sometimes He uses hardship to build our characters and test our faith. A good example is the story of Job. But if one looks at all of history, it is apparent that those people who consistently base their lives on biblical principles prosper far more than those who do not. Remember, after Job was tested, he was restored to abundance.

To bring clarity to the subject of abundance, we need to understand fully what the Bible says about the subject.

Biblical Principles Concerning Abundance

PRINCIPLE ONE: Abundance is a manifestation of God's character and a part of God's creation.

I define abundance as "more than enough." Abundance shows God's majesty, creativity, and generosity toward His people, and His affection for them. Any gardener or farmer can tell you that plants produce an abundant number of seeds. More than enough plants can spring from the seeds that God provides on each plant. Left untouched by man, most landscapes will soon be overgrown by plants and over-run by insects and animals if God provides enough rain.

> John 10:10 [Jesus speaking] I have come that they [God's people] may have life, and have it to the full.
>
> Acts 14:17 Yet he has not left himself without testimony: he has shown kindness by giving you rain from heaven and crops in their seasons; he provides you with plenty of food and fills your hearts with joy.

PRINCIPLE TWO: God commissioned men to take care of the garden. We are stewards of God's creation and He holds us responsible.

A patch of land that is overgrown by weeds and over-run by vermin is not very useful. Abundance comes about when men take seriously and act upon the biblical directive to "take care of the garden."

> Genesis 1:28 God blessed them and said to them, "Be fruitful and increase in number; fill the earth and subdue it. Rule over the fish of the sea and the birds of the air and over every living creature that moves on the ground."

Genesis 2:15 The Lord God took the man and put him in the Garden of Eden to work it and take care of it.

Psalm 8:4-8 What is man that You are mindful of him, the son of man that you care for him? You made him a little lower than the heavenly beings and crowned him with glory and honor. You made him ruler over the works of your hands; you put everything under his feet: all flocks and herds, and the beasts of the field, the birds of the air, and the fish of the sea, all that swim the paths of the seas.

Psalm 115:16 The highest heavens belong to the LORD, but the earth he has given to man.

Because of the Fall, God cursed the ground, and taking care of the garden became fraught with "painful toil." Abundance only occurs now by sweat and toil; but still occurs by God's gracious provision.

Genesis 3:17b Cursed is the ground because of you. . . .

Proverbs 28:19 He who works his land will have abundant food, but the one who chases fantasies will have his fill of poverty.

PRINCIPLE THREE: God provides everything needed for abundance.

I Corinthians 3:7 So neither he who plants nor he who water is anything, but only God, who makes things grow.

Genesis 1:29 Then God said, "I give you every seed-bearing plant on the face of the whole earth and every tree that has fruit with seed in it . . . ."

Psalm 145:15 &16 The eyes of all look to you, and you give them their food at the proper time. You open your hand and satisfy the desires of every living thing.

Psalm 104:14 & 15 He makes grass grow for the cattle, and plants for man to cultivate—bringing forth food from the earth: wine that gladdens the heart of man, oil to make his face shine, and bread that sustains his heart.

Genesis 9:3 Everything that lives and moves will be food for you. Just as I [God] gave you the green plants, I now give you everything.

Deuteronomy 8:7-9 For the Lord your God is bringing you into a good land—a land with streams and pools of water, with springs flowing in the valleys and hills; a land with wheat and barley, vines and fig trees,

> pomegranates, olive oil and honey; a land where bread will not be scarce and you will lack nothing….

Note: There are many things inherent in the design of the universe that make abundance possible: nutrients, processes, cycles, even gravity. A thoughtful study of photosynthesis, for instance, points to a Creator worthy of worship.

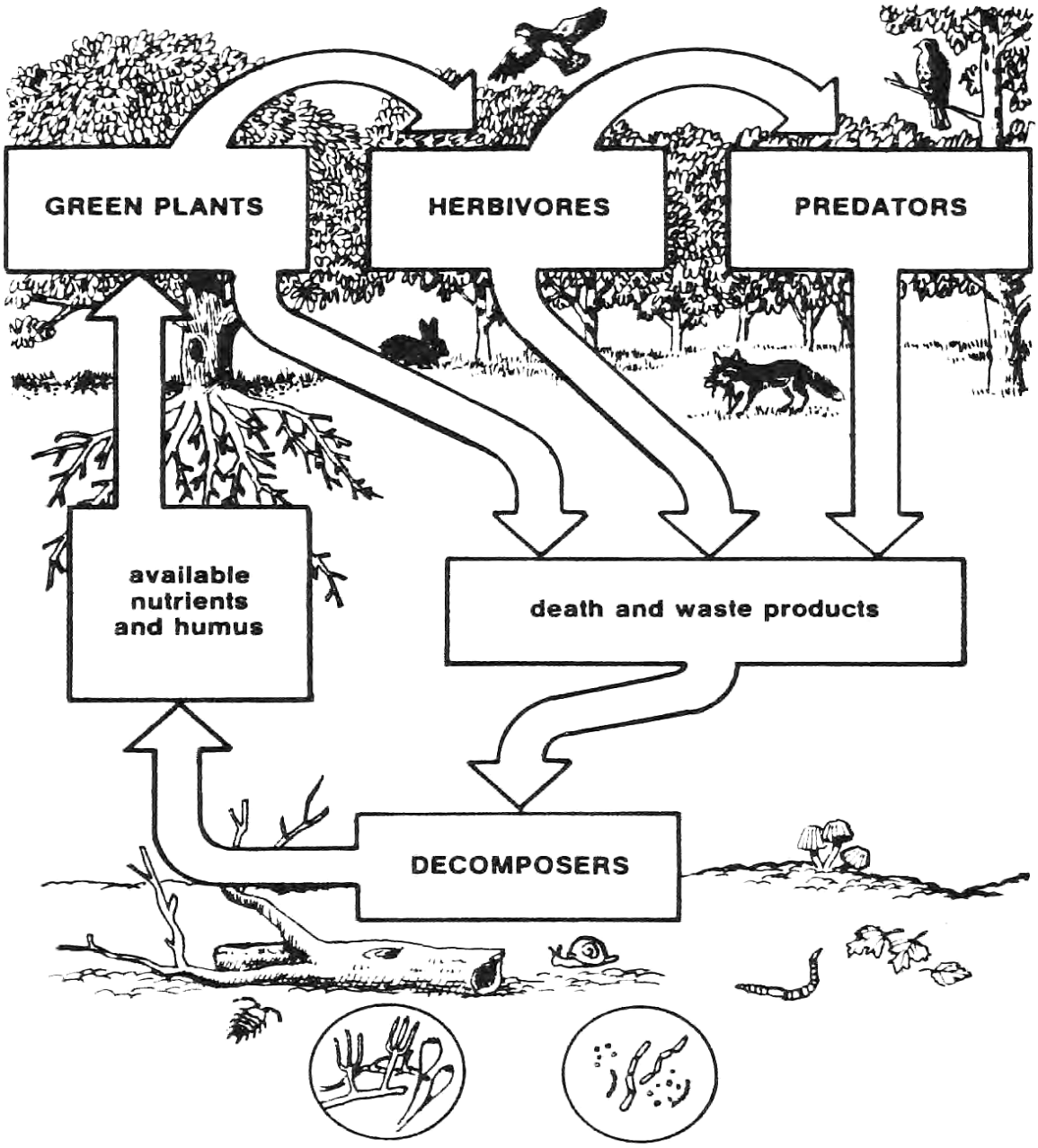
PRINCIPLE FOUR: God designed cycles and processes so that abundance would always be available to man.

Even though men are basically sinful beings—greedy, selfish, lazy and foolish—God's created order remains. Abundance is still possible because God's plans will not be thwarted by men. Creation points to a marvelous Creator. The more we know, the more we can appreciate the greatness of our God. He is not a figment of our imagination. He is real. And He's not far off. He is near. We can communicate with Him and know Him.

True science is the study of God's creation. An important component of taking care of God's creation is the study of the creativity and intelligence of His designs. The following illustrations are just a few of hundreds of cycles and processes that directly affect God's abundant provision.

Look at God's design and created order. He put the world in place.

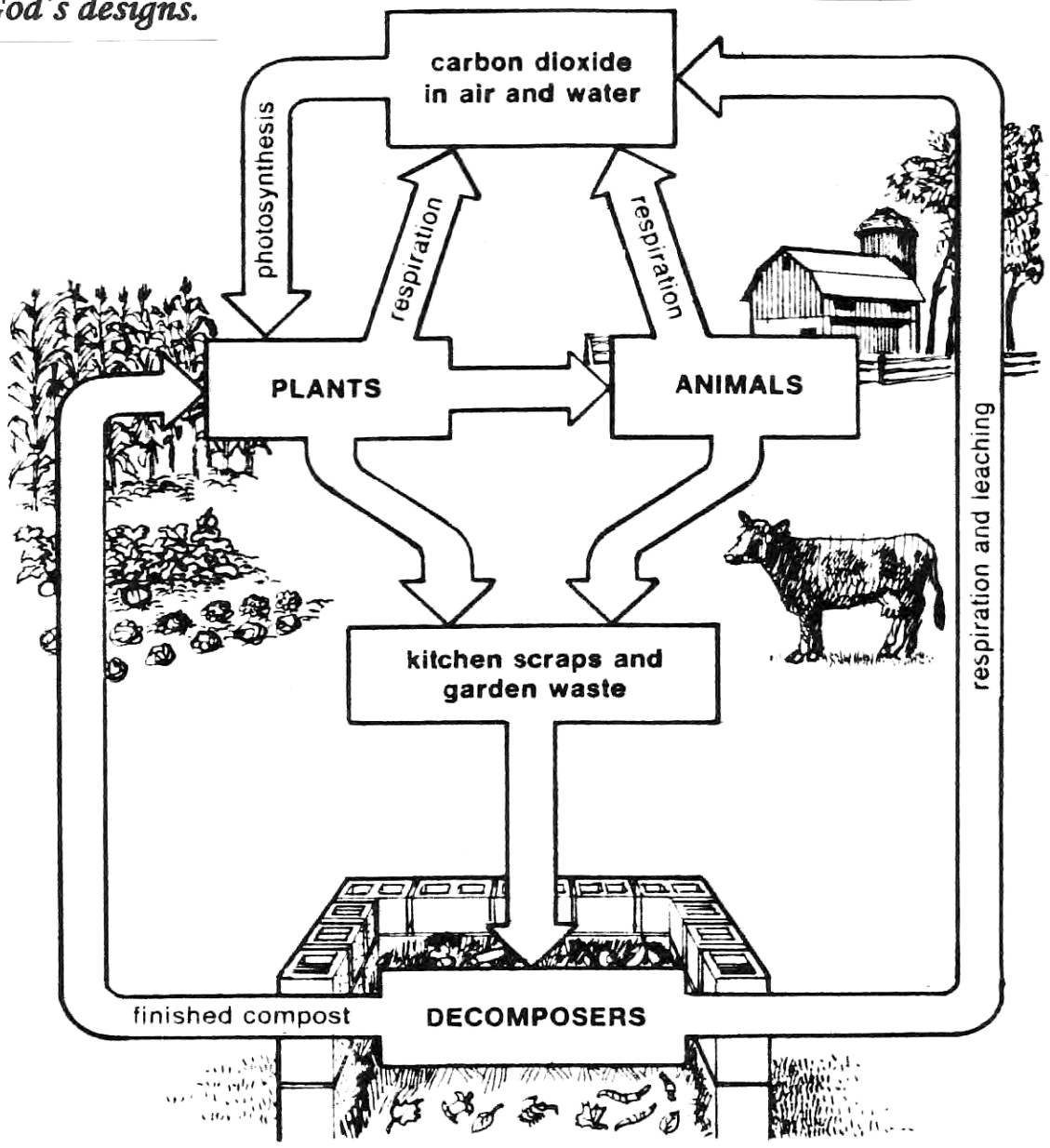
Romans 1:20 For since the creation of the world, God's invisible qualities—his eternal power and divine nature—have been clearly seen, being understood from what has been made, so that men are without excuse.



In the forest, nutrients are recycled through the natural decomposition of plant and animal waste.

Illustration from THE RODALE BOOK OF COMPOSTING, 1992

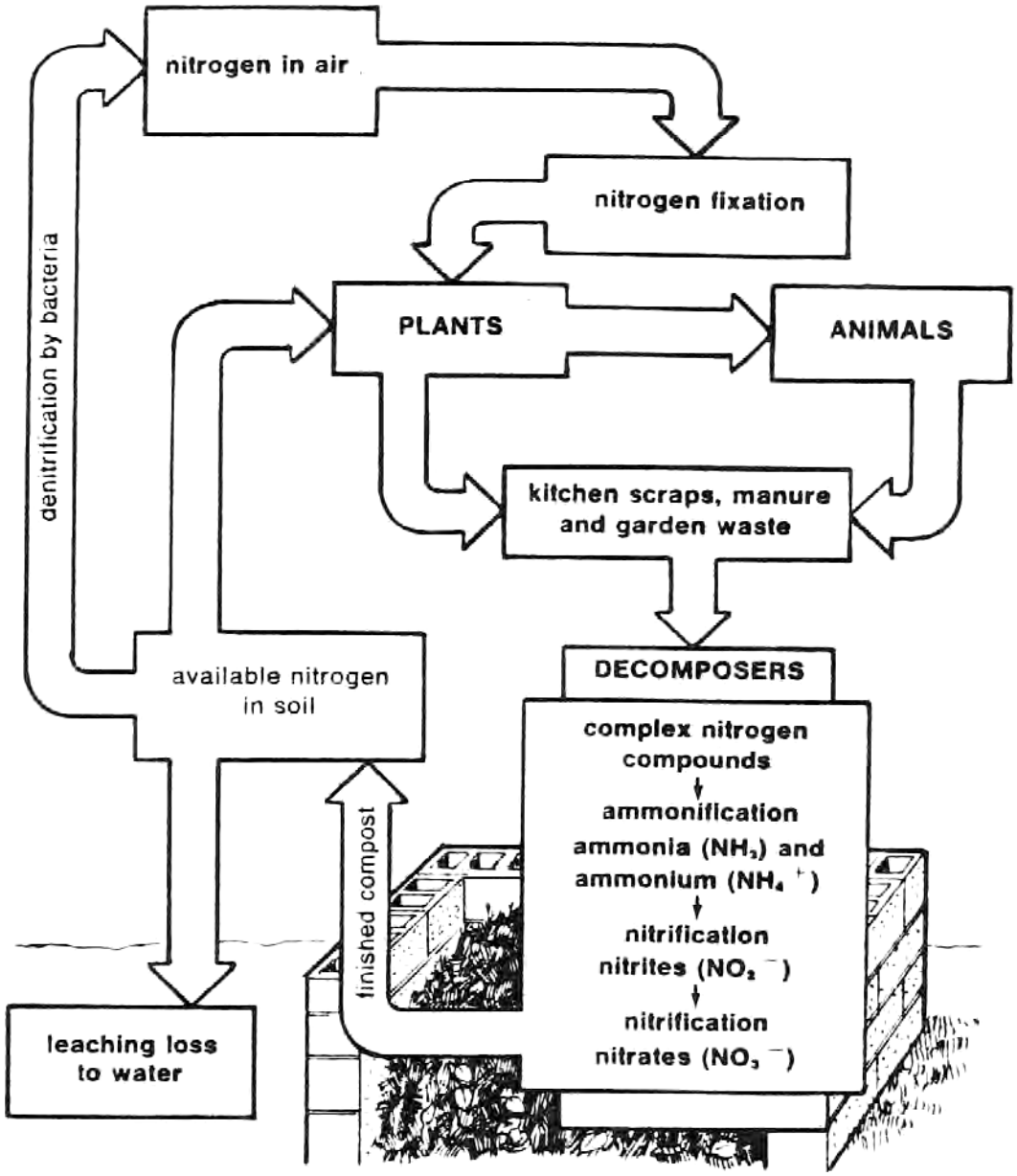
See how God has designed all natural processes! The path to abundance is in understanding these processes and cooperating with God's designs.



The carbon cycle. Green plants use carbon dioxide gas, water, and sunlight to make sugars and other carbon-containing compounds that animals use as food. Carbon compounds in plant and animal wastes provide food for decomposers in the compost pile. Materials that have passed through the decomposers' bodies and the microbial bodies themselves contain nutrients used by plants to continue the carbon cycle.

Illustration from THE RODALE BOOK OF COMPOSTING, 1992

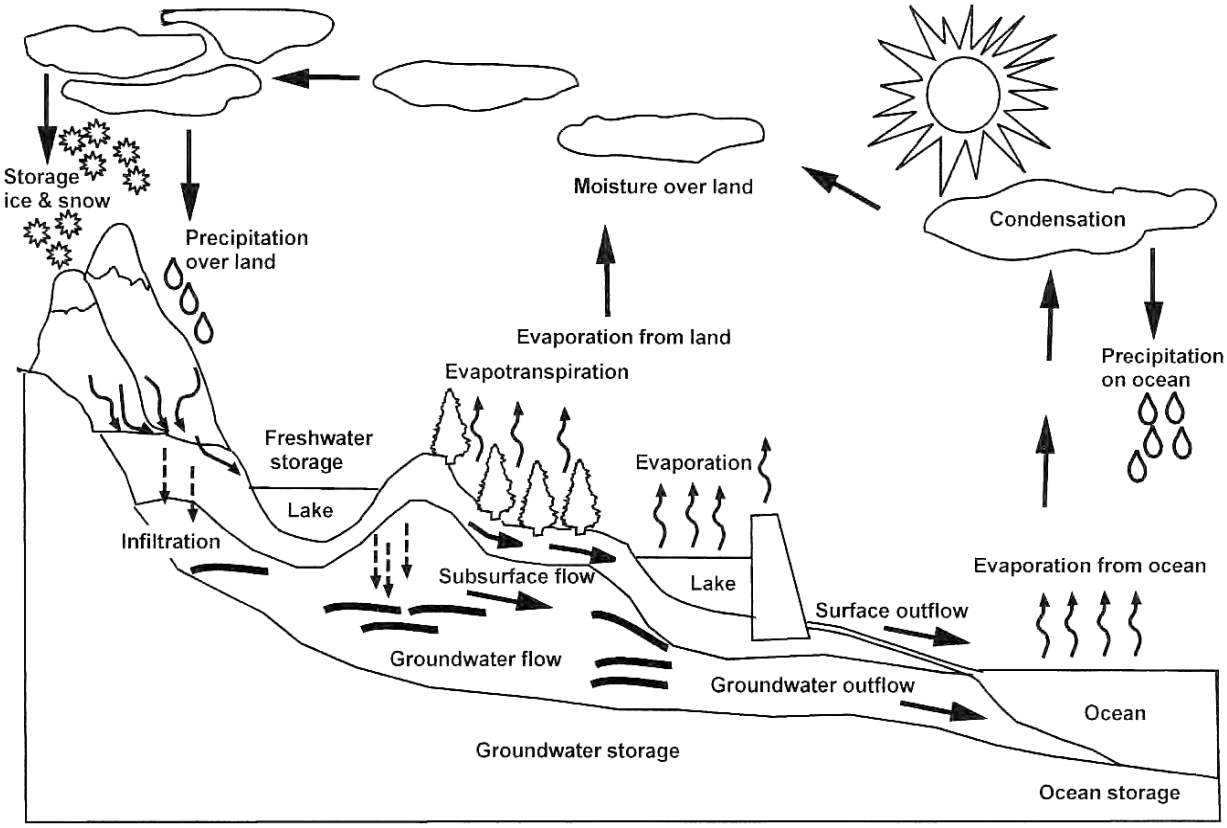
These cycles and processes are God's doing – they didn't just happen. God's wisdom and creativity should cause us to worship and praise Him.



The nitrogen cycle. Shortage of available nitrogen is often a limiting factor in plant growth, since plants can't make use of abundant atmospheric nitrogen gas. (So-called nitrogen-fixing plants rely on symbiotic bacteria.) Composting plant and animal wastes exposes the nitrogen they contain to nitrogen-fixing microorganisms and decomposers that break it down into forms available to plants.

Illustration from THE RODALE BOOK OF COMPOSTING, 1992

The Hydrologic Cycle



Job 36: 27+28 He [God] draws up the drops of water, which distill as rain to the streams; the clouds pour down their moisture and abundant showers fall on mankind.

Illustration by Don Childers

Cycles of the Seasons

God created a proper time, a proper season, for all activities.

> Ecclesiastes 3:1 & 2 There is a time for everything, and a season for every activity under heaven…a time to plant and a time to uproot….
>
> Genesis 1: 14 & 15 And God said, "Let there be lights in the expanse of the sky to separate the day from the night, and let them serve as signs to mark seasons and days and years, and let them be lights in the expanse of the sky to give light on the earth." And it was so.
>
> Psalm 104:19 The moon marks off the seasons, and the sun knows when to go down.
>
> Proverbs 20:4 A sluggard does not plow in season; so at harvest time he looks but finds nothing.

Animals act according to the seasons.

> Jeremiah 8:7 Even the stork in the sky knows her appointed seasons, and the dove, the swift and the thrush observe the time of their migration.

The provision of God comes in season.

> Psalm 145:15 & 16 The eyes of all look to you, and you give them their food at the proper time. You open your hand and satisfy the desires of every living thing.
>
> Song of Songs 2:11-13 See! the winter is past; the rains are over and gone. Flowers appear on the earth, the season of singing has come, the cooing of doves is heard in our land. The fig tree forms its early fruit; the blossoming vines spread their fragrance….

PRINCIPLE FIVE: God expects His people to share their abundance. The abundance we experience will be in direct proportion to our generosity.

> Proverbs 11:24-26 One man gives freely, yet gains even more; another withholds unduly, but comes to poverty. A generous man will prosper; he who refreshes others will himself be refreshed. People curse the man who hoards grain, but blessing crowns him who is willing to sell.
>
> Leviticus 19:9-10 When you reap the harvest of your hand, do not reap to the

very edges of your field or gather the gleanings of your harvest. Do not go over your vineyard a second time or pick up the grapes that have fallen. Leave them for the poor and the alien. I am the Lord your God.

Luke 6:38 [Jesus speaking] Give, and it will be given to you. A good measure, pressed down shaken together and running over, will be poured into your lap. For with the measure you use, it will be measured to you.

II Corinthians 9:6 Remember this: whoever sows sparingly will also reap sparingly….

II Corinthians 8:13-15 Our desire is not that others might be relieved while you are hard-pressed, but that there might be equality. At the present time your plenty will supply what they need, so that in turn their plenty will supply what you need. Then there will be equality, as it is written, "He who gathered much did not have too much, and he who gathered little did not have too little."

Proverbs 28:27 He who gives to the poor will lack nothing, but he who closes his eyes to them receives many curses.

When God's people have experienced more than enough, we are to share with others. We are to share our knowledge of, and our love for, the Creator God. And we are to share the products of His blessings. In gratitude we express how great our creator is and how the intricacies of creation manifest a God who we can get to know through Jesus, who is Emmanuel, God with us.

PRINCIPLE SIX: God, through His Word, provides wisdom and guidance that leads to abundance.

Using the wisdom provided by God in His Word, and knowledge gained by careful study of creation, a servant of God can successfully "take care of the garden" and produce abundant, useful crops that are not over-run by destructive pests.

Psalm 111:10 The fear of the Lord is the beginning of wisdom; all who follow his precepts have good understanding.

Deuteronomy 8:18 But remember the Lord your God, for it is He who gives you the ability to produce wealth, and so confirms His covenant, which He swore to your forefathers, as it is today.

Proverbs 10:22 The blessing of the Lord brings wealth, and He adds no trouble to it.

II Timothy 3:16,17 All scripture is God-breathed and is useful for teaching, rebuking, correcting and training in righteousness, so that the man of God may be thoroughly equipped for every good work. [my underlining]

PRINCIPLE SEVEN: Only God will, in His time, restore the earth to its full glory. We are to be faithful stewards, working toward restoration until He returns.

Colossians 1:15-20 He [Jesus] is the image of the invisible God, the firstborn over all the creation. For by Him all things were created: things in heaven and on earth, visible and invisible, whether thrones or powers or rulers or authorities; all things were created by Him and for Him. He is before all things, and in Him all things hold together. And He is the head of the body, the church; He is the beginning and the firstborn from among the dead, so that in everything He might have the supremacy. For God was pleased to have all His fullness dwell in Him, and through Him to reconcile to Himself all things, whether things on earth or things in heaven, by making peace through His blood shed on the cross.
[underlining mine]

[For a fascinating bit of science, google LAMININ.]

Psalm 104:24-30 How many are Your works, O Lord! In wisdom You made them all; the earth is full of Your creatures. There is the sea, vast and spacious, teeming with creatures beyond number—living things both large and small. There the ships go to and fro, and the leviathan, which You formed to frolic there. These all look to You to give them their food at the proper time. When You give it to them, they gather it up; when You open Your hand, they are satisfied with good things. When You hide Your face, they are terrified; when You take away their breath, they die and return to dust. When You send Your Spirit, they are created, and You renew the face of the earth. [underlining mine]

Revelation 22:1-5 Then the angel showed me the river of the water of life, as clear as crystal, flowing from the throne of God and of the Lamb down the middle of the great street of the city. On each side of the river stood the tree of life, bearing twelve crops of fruit, yielding its fruit every month. And the leaves of the tree are for the healing of the nations. No longer will there be any curse. The throne of God and of the Lamb will be in the city, and His servants will serve Him. They will see His face, and His name will be on their foreheads. There will be no more night. They will not need the light of a lamp or the light of the sun, for the Lord God will give them light. And they will reign for ever and ever. [underlining mine]

Note: I don't know if God makes a “new heaven and earth” from the old one, or if He creates, from nothing, a new heaven and earth. Only He is capable of creating a new heaven and earth, regardless of how He does it.

Conclusion

"Then sings my soul, my savior God to thee: How great Thou art!
How great Thou art!"
How Great Thou Art – Boberg

True abundance occurs when God's people, in obedience and dependence on Him, take care of His creation with wisdom and diligence and are blessed with more than enough, enabling them to share with others and to bring glory to the creator God. Without faith in Jesus, the Creator of the universe, and help from the Holy Spirit, it is impossible to understand and implement God's directives that lead to abundance.

ABUNDACULTURE IS NOT A UTOPIAN IDEA

Lest you think that Abundaculture offers a utopian viewpoint or guarantees an easy life of luxury, look at Habakkuk 3:17-18:

> "Though the fig tree does not bud and there are no grapes on the vines, though the olive crop fails and the fields produce no food, though there are no sheep in the pen and no cattle in the stalls, yet I will rejoice in the Lord, I will be joyful in God my Savior."

Remember, Abundaculture is about who God is and what he wants us to do to honor Him. It's all about our relationship to Him. Sometimes our best efforts will not be blessed. We may miss God's direction. We may be affected by the sins of others. Sometimes our lack of success just won't make sense to us because we cannot understand what God is doing.

So that you won't lose hope, please see Habakkuk 3:19:

> "The Sovereign Lord is my strength; he makes my feet like the feet of a deer, he enables me to go on the heights."

In other words, regardless of our circumstances, we must remain focused upon and faithful to our God, accepting His blessing and His discipline. He loves us and wants good things for His children.

ABUNDACULTURE™

Abundaculture™ is a word coined to describe God's pathway to abundance. Abundaculture™ is an integrated system that allows a child of God, in dependence upon the Holy Spirit, to access God's abundance in providing energy, housing, clean water, good food, and sanitary living conditions for himself and to share with others.

Abundaculture™ does not advocate self-sufficiency or sustainability. God directs His people to depend upon Him and upon each other. We embrace God's all-sufficiency. “He is our source of everything and in Him we find increase.” (from *Farming God's Way*)

Abundaculture™ is an amalgamation of ideas collected over four decades. Due credit is given to the following pioneers:

Bryan Oldreive – *Farming God's Way*
Don Richards – *Environment and Resource Stewardship*
Michael Reynolds – *Earthships*
Brad Lancaster – *Rainwater Harvesting*
Bill Mollison – *Permaculture*

...and to those homesteaders who search for a better way and who are willing to share their ideas.

Throughout this training manual you will find Steps on the Pathway to Abundance. Use these steps in your quest for God's abundance in your life.

STEPS ON THE PATHWAY TO ABUNDANCE

Use the following as a checklist on your journey to abundance:

GENERAL INFORMATION

- ☐ First and foremost, acknowledge Jesus as God and Savior. Acknowledge your dependence upon Him. Without faith in the Creator of the universe, and help from the Holy Spirit, it is impossible to understand and implement God's directives that lead to abundance. Without faith in Christ, true abundance is not possible.

Genesis 26:12 *Isaac planted crops in that land and the same year repeated a hundredfold, because the Lord blessed him.*

- ☐ Constantly renew the mind by studying God's Word and His creation. Ask God for wisdom.

Psalm 111:10 *The fear of the Lord is the beginning of wisdom; all who follow His precepts have good understanding.*

II Timothy 3:16,17 *All Scripture is God-breathed and is useful for teaching, rebuking, correcting and training in righteousness, so that the man of God may be thoroughly equipped for every good work.*

- ☐ Conserve resources, including human energy. Realize that all resources are a gift from God and must be handled with care.

- ☐ Increase productivity with careful, diligent work. Plant on time. Harvest on time. Prepare for the future.

Proverbs 27:23-27 *Be sure you know the condition of your flocks, give careful attention to your herds; for riches do not endure forever, and a crown is not secure for all generations. When the hay is removed and new*

growth appears and the grass from the hills is gathered in, the lambs will provide you with clothing, and the goats with the price of a field. You will have plenty of goats' milk to feed you and your family and to nourish your servant girls.

Proverbs 21:5 *The plans of the diligent lead to profit as surely as haste leads to poverty.*

Proverbs 28:19 *He who works his land will have abundant food, but the one who chases fantasies will have his fill of poverty.*

II Thessalonians 3:10 *If a man will not work he shall not eat.*

- Study God's creation and cooperate with God's natural cycles:
  - The Carbon Cycle
  - The Hydrological Cycle
  - The Hydrogen Cycle
  - The Nitrogen Cycle
  - The Cycles of the Seasons

- Establish and protect property rights. If your property (including land) can be confiscated, it is very difficult to create generational abundance.

Numbers 26:52-53a *The Lord said to Moses, "The land [the promised land] is to be allotted to them [the Israelites] as an inheritance…."*

Numbers 27:1-11 Note the importance placed on the ownership of land. It is part of God's commandments to Moses.

Zechariah 3:9-10 *"…and I [God] will remove the sin of this land in a single day. In that day each of you will invite his neighbor to sit under his vine and fig tree," declare the Lord Almighty.*

(God's plan is for His people to have private ownership of their property.)

(A more detailed study of God's thoughts on land ownership can be found in Leviticus 25:10, 13-14, 23-34. Also see Palestine: Land of Promise by Walter Lowdermilk.)

- Strive for excellence. Excellent work leads to abundance.

Colossians 3:23-24 *Whatever you do, work at it with all your heart, as*

working for the Lord, not for man, since you know that you will receive an inheritance from the Lord as a reward. It is the Lord Christ you are serving.

II Corinthians 9:6 *Remember this: whoever sows sparingly will also reap sparingly….*

II Corinthians 9:8 *And God is able to make all grace abound to you, so that in all things at all times, having all that you need, you will abound in every good work.*

- Share abundance and teach others the pathways to abundance.

Matthew 25:34-36 *[Jesus speaking] Then the King will say to those on His right, "Come, you who are blessed by My Father; take your inheritance, the kingdom prepared for you since the creation of the world. For I was hungry and you gave Me something to eat, I was thirsty and you gave Me something to drink, I was a stranger and you invited Me in, I needed clothes and you clothed Me, I was sick and you looked after Me, I was in prison and you came to visit Me.*

Luke 6:38 *[Jesus speaking] Give, and it will be given to you. A good measure, pressed down, shaken together and running over, will be poured into your lap. For with the measure you use, it will be measured to you.*

- **Start at home, today! Don't wait for the government or anyone else. Do it yourself with God's help.**

- **Finally, never forget God!**

I Corinthians 3:7 *So neither he who plants nor he who waters is anything, but only God who makes things grow.*

Deuteronomy 8:10-14 *When you have eaten and are satisfied, praise the Lord your God for the good land he has given you. Be careful that you do not forget the Lord your God, failing to observe his commands, his laws and his decrees that I am giving you this day. Otherwise, when you eat and are satisfied, when you build fine houses and settle down, and when your herds and flocks grow large and your silver and gold increase and all you have is multiplied, then your heart will become proud and you will forget the Lord your God….*

APPROPRIATE TECHNOLOGY

What is Appropriate Technology?
Definition: A science or technology considered reasonable and suitable for a particular purpose, that conforms to existing cultural, economic, environmental, and social conditions (dictionary.com)
Appropriate Technology is a way to solve problems on the mission field using methods and materials that are:

Available

Affordable

Acceptable

SOLAR ARK is a name we have coined for the homes we design. SOLAR ARKS use passive solar design, renewable energy such as photovoltaics and biomass, roof water catchment systems and cisterns, high intensity gardens and composting toilets.

Jack Dody has been developing Appropriate Technology for more than 35 years. He has trained missionaries serving in more than 100 countries. He and his wife live in an off-the-grid home that employs many of the Appropriate Technologies which he shares with his students. The writings and training manuals developed by Jack are available on-line at no charge at *christianhomesteaders.org.*

Due to variability of local conditions, materials, skills, site and so forth, the author can assume no responsibility for personal injury, property damage, or loss from actions inspired by information in this workbook. You are responsible for consulting with experts, engineers and code enforcement people whenever prudent.

Mission Statement

The purpose of our ministry is to help missionaries, homesteaders and homeschoolers succeed. Through education and example, we show missionaries how they can meet their own physical needs and the needs of the people they serve, no matter how difficult their circumstances.

We help develop strategies for safe, comfortable living space with dependable electricity, clean water, good food and sanitary waste disposal.

Whether you serve in the heart of the city or in rural areas, we help you create appropriate technologies for your family and for the people you will reach for Christ.

We help you answer two important questions:

1. How can you function effectively even in very difficult living conditions?
2. How can you use appropriate technology strategies to gain opportunities to share the love of Jesus.

THE BASIC PREMISES

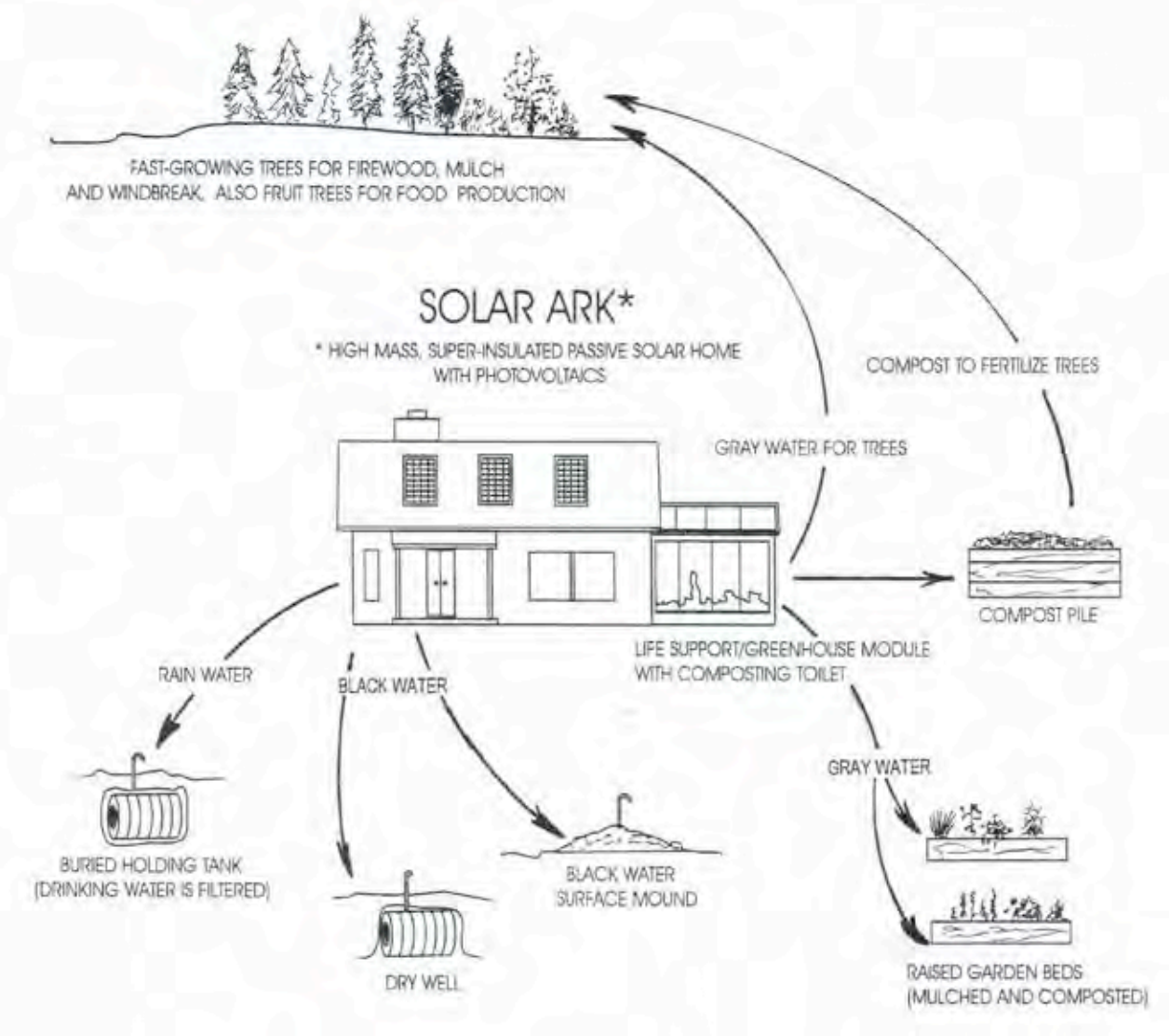
1. Every person longs for a safe, comfortable place to live, with clean water, good food and functional sanitation.
2. God provides all of these needs to and through His people. By sharing these things, we earn the right to share Christ.

Jack and Marilou Dody serve with EQUIP, International. Learn more about EQUIP at www.equipinternational.com. Or write to EQUIP at:

EQUIP
Box 1126
Marion, NC 28752
phone: 828-738-3891

ABUNDACULTURE*

*Co-Operating with God's Designs for Abundance



FOUR PRINCIPLES OF SOLAR ARK:

1. On-site Energy Production (Solar Electric and Firewood) Use passive solar designs.
2. On-site Water Collection and Water Conservation (Rainwater Catchment, Gray Water Systems)
3. On-site Food Production (Life Support / Greenhouse Module)
4. On-site Waste Recycling and Disposal (Composing Toilet, Blackwater Systems)

How to get Appropriate Technology help when you're on the field:

1. Google Abundaculture.org

2. Download the Abundaculture manual and read it carefully. The manual is available on our website at no charge. The manual is a PDF file. You will need Adobe Reader.

3. If you or your friends need more help, contact us

   for free consultation:

   jack@abundaculture.org

   You can phone us at 719-360-3075

   Write to: Jack Dody

   7639 Timberline Ct.
   Colorado Springs, CO 80920 USA

Synergy is important in the design and operation of Abundaculture. For our purposes, *synergy* is how all systems of your home work together. For example, if you catch water from your roof you can use a small, inexpensive pump to have a pressurized water system. If you use gray water for your trees and garden you will need a smaller, less expensive cistern and a simpler, less expensive black water disposal system. If you use a sawdust composting toilet you will not need water to flush your toilet. You will also be able to use your compost to fertilize your trees, creating firewood and food. If you carefully design your Solar Ark it can be smaller and less expensive. If the structure is smaller, a less expensive photovoltaic system can provide all your electrical needs. If your Solar Ark is carefully designed using proven passive solar principles, less electricity and firewood will be needed for comfort.

Before you build, think of how all systems will function synergistically.

The Solar Ark...

On-site energy production... (solar electric, firewood and passive solar design)

EMERGING WORLD ENERGY FACTS:
(from Home Power Magazine, Oct/Nov 2009, pp. 80-85)

2.4 billion people rely on burning biomass—wood, agricultural residues and dung—for cooking and heating.

Poor rural women reported two to three times more respiratory disease in their children and themselves compared to those with urban-traditional and middle class backgrounds.

1.6 billion people have no access to electricity. If it is available, the poor often cannot afford it.

"Every day enough [solar] energy strikes the United States to supply the nation's energy needs for one and half years!"

Colorado.edu/essence/texts/solar/htm

STEPS ON THE PATHWAY TO ABUNDANCE

ENERGY PRODUCTION

Matthew 5:45 He [God] causes His sun to rise on the evil and the good…

☐Use passive solar principles when designing your home
You will be warm in the winter and cool in the summer with less energy consumption.

☐Use photovoltaics to make electricity for your home.

☐Use direct solar for cooking whenever possible.

☐Use direct solar for hot water whenever possible.

☐Use direct solar for food preservation whenever possible.

☐Use direct solar for water purification whenever possible.

☐Create a woodlot for firewood.

Parts of a Simple Solar Electric System

Photovoltaic panels - Often called solar panels. Turns sunlight into electricity.

Charge controller-An electronic box that controls the charging of batteries.

Battery bank - One or more batteries used to store power from photovoltaic panels or any other power source.

Generator - A fuel-powered engine attached to a generator used to produce electricity.

Converter or battery charger - An electronic box that changes 120 volt alternating current to direct current, which can charge the battery bank.

Voltmeter - A meter used to monitor the voltage of the battery bank.

Inverter- An electronic box that changes 12 volt direct current to 120 volt alternating current.

Safety disconnect - A device that allows the user to break the connection between the battery bank and the appliances using electricity.

The Photovoltaic Panel

What it does
Turns sunlight into electricity

What it costs
About $6 per watt (as of 2009) (As low as $1.25 per watt in 2013)

Advantages
- Easy to wire.
- Expandable. Panels can be added as needs and budgets allow.
- Panels last for decades as they have no moving parts. (Panels on satellites launched in the 1960's are still functional.)

Disadvantages
Expensive. Initial cost per watt is much higher than grid electricity. Over time, photovoltaic panels are an excellent value.

The Charge Controller

What it does
Controls the charging of the battery bank. Without the controller, the batteries could be overcharged and destroyed. Some controllers protect the batteries against being discharged too deeply.

What it costs
$30 - $100's Depending on the size of the system controlled.

New Information (2004)
The new MPPT (Maximum Power Point Tracking) controllers can boost available current from photovoltaic panels by as much as 30%. This is a tremendous boost in efficiency. Cost up to 30% more than standard controllers.

General Information
Some controllers can double as voltage meters.
Some controllers have a switch that will allow batteries to be equalized [see batteries].

The Battery Bank

What it does
The battery bank stores power for later use.

What it costs
Six-volt golf cart batteries are the most popular for small systems at $120 each (as of 2008). There are many types of batteries, varying greatly in price. Price for 2013: $123.41 – 13.50 core charge = $109.91

General Information
Batteries are very heavy. Remember this when you make your purchase. You may end up with a monster you cannot move. You may want to purchase very heavy batteries because they will be difficult to steal.

Recommendation
I recommend the 6-volt golf cart batteries for the following reasons:
1. They are affordable at about $120 (as of December 2008).
2. They are available just about everywhere.
3. They weigh about 65 pounds. This is a manageable weight for most people.
4. They are dependable and easy to maintain.

Safety Alert

When they are being charged or discharged, most batteries create explosive hydrogen gas. Batteries need to be contained in an airtight box built of 3/4-inch plywood that is vented to the outside with a 2-inch PVC pipe.

NOTE: My favorite solar expert for missionaries is Les Eldeen, He recommends DEKA golf cart batteries for price and reliability. (2009)

How to Keep Batteries Alive for Years and Years

(Credit for much of this list goes to Windy Dankoff of Dankoff Solar Products, Inc. 2003. I added several items. Jack)

Note: Don't let the length of this list scare you. I spend about one minute a day on my batteries. About every six months I do a thorough check of the battery bank. It's easy!

Though most consider lead-acid batteries the weak link in renewable energy systems, today's renewable energy batteries are better than ever, and so are the devices that regulate and protect them. Battery failures are rarely the fault of the batteries themselves! Follow these guidelines to avoid the vast majority of all battery problems.

1. Size the battery bank and PV array properly. The battery bank should have a five day load capacity at a minimum. The PV array, should produce (on average) 30% more energy than the load requires. (This is a best case scenario. You may not be able to afford such a perfect system. Jack)

2. Buy high-quality batteries selected for your needs. You get what you pay for! Good deep-cycle batteries can be expected to last for 5 to 15 years, and sometimes more. Cheap batteries can give you trouble in half that time.

3. Connect the two main cables to opposite corners of the battery bank and maintain symmetry in wire size and lengths. This will help to distribute current evenly through the bank.

4. Arrange batteries to maintain even temperature distribution throughout the bank. Avoid uneven exposure to heat sources. Leave at least ½-inch of air space around each battery to promote even cooling.

5. Prevent corrosion. Once corrosion gets hold, it is hard to stop. The good news—it is easy to prevent! Apply a non-hardening sealant to all of the metal parts of the terminals BEFORE ASSEMBLY. A product called NO-CO NCP2 battery corrosive preventative works well. Vaseline or bearing grease will also work.

6. Moderate the temperature. Batteries lose approximately 25% of their capacity at 30 degrees Fahrenheit, compared to a baseline of 77 degrees Fahrenheit. At higher temperatures they deteriorate faster.

7. Install the batteries over a floor drain, or in a space without a floor, so that they can be rinsed with water easily. Washing the battery tops about twice a year will remove accumulated moisture (acid spatter) and dust. (I couldn't put my batteries in an area with a drain. I wash them off with a damp paper towel.)

8. Avoid multiple parallel strings.

9. Use a charge controller, power center or battery charger with temperature compensation. Better yet, place the batteries in a room that is temperature regulated, i.e. heated, insulated, shaded and ventilated.

10. Use an inverter or charge controller with a low-voltage disconnect or get a separate one. Discharging a battery to exhaustion will cause immediate, irreversible loss of capacity and life expectancy.

11. Equalize lead acid batteries once a month. Equalizing means bringing the batteries to a boil at about 15.5 volts for a few hours. This helps remove sulphate from the battery cells. Some charge controllers automatically equalize the battery bank, Other controllers have an equalization switch. Sealed batteries are not equalized.

12. Install a System Monitor, at least a digital voltmeter. Would you drive a car with no dashboard? Metering is not just bells and whistles. I use a BCM-12 LED meter ($42). I purchased a digital voltmeter at Walmart in the car battery department. For $20, you'll know your battery voltage at a glance.

13. Add distilled water as needed. Most batteries require additional water every 6 to 12 months.

14. Avoid sealed marine batteries in solar applications. They can disintegrate and/or explode. ("Solar Power 101 : Batteries", Backwoods Home Magazine, May/June 2004)

16. Do not replace one battery at a time. Remove bad batteries and have a smaller battery bank until the entire bank can be replaced.

17. Get a hydrometer. It costs about $10. An hydrometer allows you to test each cell in your batteries. If a battery has bad cells it should be removed from the battery bank.

18. Cadmium sulfate is a battery additive that can dissolve sulfate crystals in liquid electrolyte batteries. You can find cadmium sulfate for batteries on the net.

19. This is the most important aspect of battery care! Check the voltage of the battery bank daily. The best time to check the battery bank is early in the morning before the sun hits the panels and before any energy is used. Your goal is not to go below 80% of full charge, or 12.46 volts. The batteries will last much longer if only the top 20% is used.

% of Charge	Voltage	Specific Gravity
100	12.70	1.265
90	12.58	1.249
80	**12.46**	**1.233**
70	12.36	1.218
60	12.28	1.204
50	12.20	1.190
40	12.12	1.176
30	12.04	1.162
20	11.98	1.148
10	11.94	1.134
0	11.90	1.120

These readings are correct at 75^{o} Fahrenheit.
Back Home Magazine, issue 56, p. 14

Batteries are the heart of your power system. They may demand your attention occasionally, but your relationship with them need not be a struggle. With proper installation, a little understanding, and some simple maintenance, your batteries will live long and healthy lives.

The Generator

What it does
Creates electricity using a fuel-driven engine attached to a generator.

What it costs
Depending on size, from a few hundred to several thousand dollars.

Fuel costs
According to Carole Howell, “You can count on going through 6.5 to 21 gallons of gasoline—or two to six 20-pound tanks of propane—[or 15 gallons of diesel fuel] every 24 hours….These figures represent generators from 1,600 to 7,000 watts and depending on how much you load the generator.”
Back Home Magazine, Jan/Feb 2014

Advantages
- Adds great flexibility to a small photovoltaic system. The photovoltaic system can be smaller and less expensive with the addition of a generator.
- Can be used to power tools during the construction of the homestead.
- Can be used to charge the battery bank during cloudy weather.

Disadvantages
- Fuel must be purchased and stored. Gasoline must be rotated regularly; it will last only a few months.
- Noisy and stinky.
- Must be carefully maintained.

Notes
Smaller gas-powered generators typically run at 3600 RPMS.
Larger diesel generators typically run at 1800 RPMS.
Good quality diesel generators can be run constantly and can last for years.
Small, gas-powered generators can be used intermittently - that is, a few hours at a time.

Sizing the generator

A generator that is too large will not work at capacity and will not last.
A generator that is too small will shut down under too great a load and will wear out prematurely.
Suggestion: If you need a small generator most of the time, buy a small generator and rent a larger one when you need it.

Here are some websites that will help you size your generator:
www.generatorsales.com/wattage-calculator.asp
www.generac.com/residential/sizer/
http://www.powerequipment.honda.com/generators/wattage-calculator

Safety alert

Generators create carbon monoxide and must not be used indoors.

If you want to wire your generator to your whole-house circuit box, hire a licensed electrician to help you. You risk causing bodily harm to yourself or others if the generator is not properly installed.

Operating Tips

1. To extend the life of a new unit do the following: Run the new unit for one hour, then drain the oil and replace with new oil. This will remove any metal shavings created during manufacturing. You may further extend engine life by using synthetic oil. If you use synthetic oil continue to change the oil at intervals suggested by the manufacturer. You may be surprised at how often oil changes are needed! Generators “throw” some oil, that is, some oil is used during operation. Check the oil before starting the generator, **every time**!

2. When you start the generator give it a few moments to "smooth out" before sending power to your charger or appliances. Spikes and dips in voltage can occur when the generator is first started and when it is shut down.

3. Keep the generator tuned up and running smoothly. A poorly running generator can damage your charger and appliances.

4. Disconnect charger or appliances from the generator before you

shut it down. Don't allow the generator to run out of gas while it is connected to a charger or appliances.

5. Generators tend to vibrate when running. This makes nuts, bolts and screws loosen. When you change the oil, remember to tighten all nuts, bolts and screws.

6. Inverter Generators. (2009) Honda, Yamaha and Robin offer new models with built-in, high quality inverters. These units are expensive, but produce high quality electricity for sensitive electronic gear.

The Converter/Charger

What it does
Changes 115-120 volt alternating current to 12 volt direct current, which can be used to charge the battery bank.

What it costs
Depending on size from $100 to several hundred dollars.

General information
A converter is coupled with a generator. The converter must be sized according to the size of the battery bank. The generator must be sized according to the size of the converter.

EXAMPLE: You calculate that a thirty amp converter will be large enough to charge your battery bank. A 3500 watt generator will be needed to power the thirty amp converter.

The Voltmeter

What it does
Meters the voltage of the battery bank.

What it costs
For a digital unit, approximately $10 - $100. An analog unit with bouncing arrows is worthless.

Why it is important
For long battery life, just the top 20% of the battery should be used. In order to determine the battery's stage of charge, a voltmeter is used. The voltmeter should be checked daily, in the morning, before the sun hits the photovoltaic panels and before the batteries are discharged by use.

NOTE: The voltmeter I use now is a BCM-12 LED meter. The cost was $42. At a glance you will always know exactly what is happening to your batteries. (2009)

The Inverter

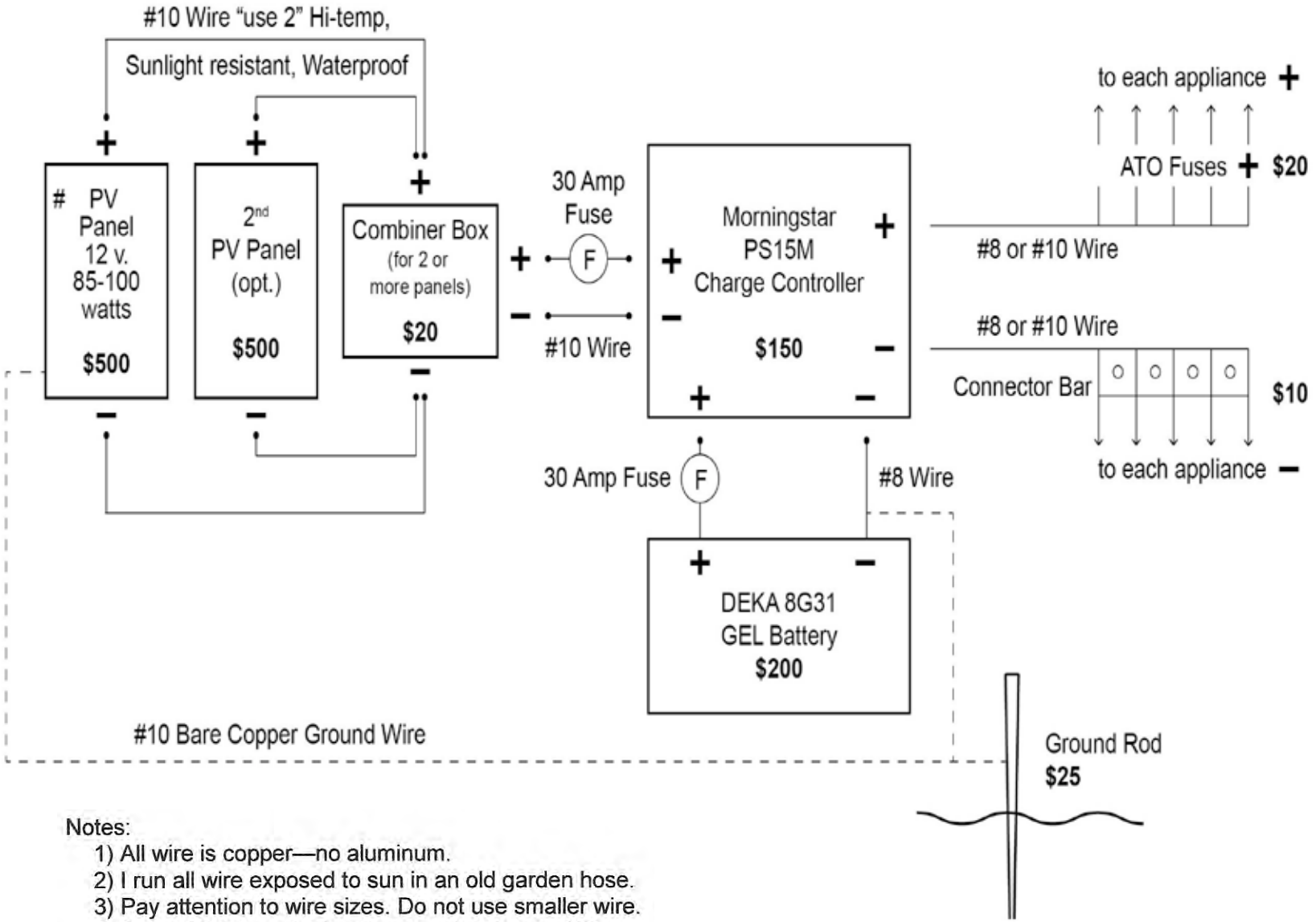
What it does
Changes direct current (DC) to alternating current (AC). Some inverters also double as battery chargers.

What it costs
Depending on size and quality, $100 to several $1000.

Why it is important
The inverter allows the use of standard AC products. Smaller wire can be used when using AC as opposed to DC.

Important information
Certain AC products will not work with inverter power, i.e., certain printers, certain computers, some stereo gear, some battery chargers for power tools, ceiling fans, etc. Call manufacturers with questions before you purchase or ask others who live off-the-grid.

Lightning Management
Proper grounding is the best way to avoid lightning problems.
As of January 25, 2013, Midnight Solar Lightning Arrestors are considered the best (cost $100). Any lightning arrestor and proper grounding can fail if the system sustains a direct hit. For a detailed explanation of grounding for solar applications, see Tech Tips for Living in Remote Locations by Tim See. Call New Tribes Mission to order: 573-317-8610



Notes:

1) All wire is copper—no aluminum.
2) I run all wire exposed to sun in an old garden hose.
3) Pay attention to wire sizes. Do not use smaller wire.
4) Cost of fuses and miscellaneous hardware: $50
5) Cost of wire: $50

Total cost with one panel: $1005
Total cost with two panels: $1525.

Installing a Small, 12 volt, Off-Grid Solar System 2009

I suggest this simple, inexpensive system as an excellent introduction to solar power. It can be expanded as needed and an inverter can be added.

Disclaimers: Information for a safe solar system is presented here. Do not substitute materials. I cannot take responsibility for creative ways you may decide to screw up.

This installation will not meet national electric code standards. If you must build to code, hang on to your wallet, and may God be with you.

Sources: The following ideas are from…

- *Low-Voltage Wiring* by Tom Moates, *Back Home Magazine*, September/October 2003, pp. 20-23.
- *Installing Your Own Small, Remote Off-Grid Solar System* by Jeffrey R. Yago*, Backwoods Home Magazine*, March/April 2009, pp. 35-40.
- and from 35 years of personal experience.

Why have a 12-volt system?

A. Cost. It is much less expensive. Inverters can cost thousands of dollars.

B. Simplicity. With a few components, your system is complete.

C. Efficiency. A 12-volt system is more efficient. For example, a single light bulb using AC pulled from an inverter can draw at least twice the battery current as a DC bulb drawing directly from the batteries.

D. Safety. A 12-volt system can be safer. It is difficult to electrocute yourself with 12 volts!

What is a "small" system?

In this case, a system with up to 400 watts of 12-volt photovoltaic panels.

Panel to Battery Ratios

Assuming that you will have at least five hours of bright sun on most days, it would be ideal to have 200 watts of panels to charge each battery, assuming the batteries are the ones suggested in these plans.

(One battery will store about 1 KWH of electricity when discharged to 50%)

You can use fewer panels per battery to start your system and work toward an ideal system as your budget allows. If you live in a cloudy place, you may need more panels per battery.

To keep your budget within reason, you can experiment with your battery to panel ratio. How you use your system will determine how many panels and batteries you need. I have 400 watts of panels and a 400 watt wind generator charging ten batteries. In sunny Colorado, this has worked well. I also use a generator and a battery charger about five or six times a year to assist my panels and windcharger on grey, windless days.

How Much Electricity Will a Small 12 VDC System Provide?

If you are careful to turn off lights and other appliances when they are not being used, you should be able to operate 4 or 5 LED or CFL lights, a 12-volt RV water pump, a small fan and a laptop computer. When the sun is shining brightly, you can use your system for a variety of other tasks: pumping water for the garden, powering electric tools, etc.

What Kind of Batteries Should I Use?

For the sake of simplicity, I suggest a sealed, gel, deep-cell battery. DEKA brand batteries have an excellent reputation for durability. If you buy cheap batteries, you will have to replace them more often. Never use auto batteries. They are not designed for this purpose and will be a waste of money.

Sealed batteries are maintenance-free and leak proof. The most important feature is that these batteries do not have to be vented. Unlike sealed gel batteries, lead acid batteries must be refilled from time to time with distilled water and must be vented to the outside because they create explosive hydrogen gas when being charged or discharged. While sealed gel

batteries cost 40% more than comparable lead acid batteries, I believe they make sense for the beginning solar electric user or the person who does not want to worry about their batteries.

Note: Your charge controller must have a setting for gel batteries to prevent battery damage.

Note: Batteries are heavy! Make sure you will be able to move them and that your structure will support them. I purchase batteries that weight about 70 pounds. Most people can handle 70 pounds. You may want heavier batteries to make theft difficult.

Note: Batteries operate best at temperatures between 50°- 90°F. For this reason and to discourage theft, I put my batteries inside my living space.

For this small system, I am going to start with one 85 watt 12-volt Kyocera photovoltaic panel ($500) and one 12-volt, DEKA, gel cell battery, model #8G31 ($200).

What About a Refrigerator?

A very small system (200 watts of panels and one or two batteries) will not produce enough power for even the most efficient (and expensive, $900-$1500) refrigerators and freezers. With 400 watts of panels and four batteries, you may sometimes run a bit short of power. You may want to look at small Sun Danzer freezer. You can make ice and place it in an ice chest. You will get maximum performance for minimum dollars in this way. Others options for refrigeration are propane and kerosene refrigerators and freezers. I have a Danby propane refrigerator/freezer ($1000) that has given me excellent service. Still, if I had the money, I would invest in the extra solar for a STECA refrigerator/freezer. Propane is expensive and still going up!

The Charge Controller

The charge controller is the brain of your system. It protects your batteries from over-charging and over-discharging. I recommend the Morningstar PS series because of their price, features and dependability. Two features

are particularly helpful. A built-in battery disconnect allows you to isolate the battery bank for safety or maintenance. The other great feature is the metering. I always put the charge controller where I can easily see the meters. With a digital LCD display, the Morningstar tells me the voltage of my batteries, the amount of amps coming from my panels and the amount of amps that I am using. The controller has LED lights that warn me of any problems. It also has a switch for sealed batteries.

Wire Sizing for a 12-VDC System

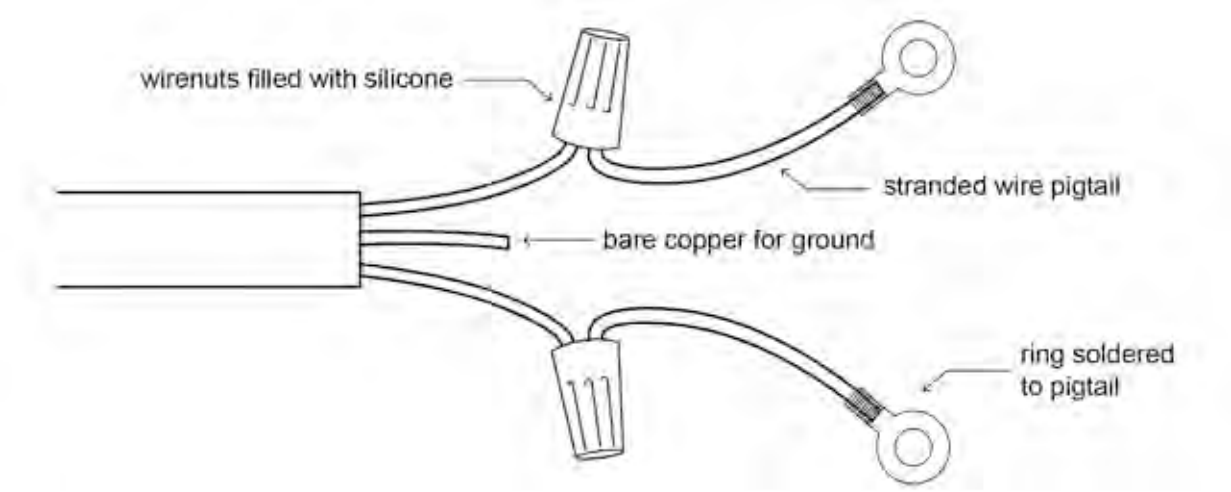
12 VDC needs heavier wiring than 120 VAC. Using copper wiring (no aluminum) at lengths of 50 feet or less, use the following chart:

LOAD	AC Sizing	DC Sizing
10 amps	#14	#14
15 amps	#14	#12
20 amps	#12	#10
30 amps	#10	#8
60 amps	#6	#4
100 amps	#2	#1

If your wire run is longer than 50 feet, go to the next larger size of wire. Keep all wire runs as short as possible. Put panels and battery banks as close together as possible.

Wire Connections

To attach heavy wire to switches, receptacles and fuse boxes, ring terminals and blade-type connectors, available at good automotive parts stores, should be soldered to wire ends. Do not just clamp on connectors. Often I add a pigtail of stranded wire to the end of my solid wire because it is more flexible and easier to manipulate.



Note: Solder – there are two types of solder typically available, one for electrical use and one for plumbing. Use electrical, rosin-core solder.

Corrosion

After wires are attached, all bare connections should be treated with a corrosion preventative, available at an auto parts store. A product called NO-CO NCP_2 works well. Vaseline or bearing grease or silicone will also work. Silicone is permanent. Do not put it on any screws or bolts that may need to be tightened or removed at some future time.

Receptacles

Do not use standard AC receptacles for a 12-volt system. If you plug a 120-volt AC appliance into a standard receptacle wired for 12 VDC, you will ruin your appliance. You can use a 20-amp, 250-volt receptacle. The receptacle pattern design should be different from a standard 120-volt AC receptacle so that it is physically impossible to ruin AC appliances.

I use 12-volt cigarette lighter receptacles because it is simple. Most 12 VDC appliances have a cigarette lighter-type plug.

Switches

You can use 12 VDC switches that you can buy at any auto parts store. You will often read that standard AC switches will not work in a 12 VDC system. My friend, Les Eldeen, who has installed more than 8000 solar systems, informs me that he uses standard switches in his systems with no problems. You can avoid the switch issue and simplify your wiring by purchasing 12 VDC light fixtures with built-in switches, available at RV dealers.

Breakers and Fuses

If you like breakers, the Square D "QO" line of AC breakers will work for 12 VDC. This only applies to the "QO" line by Square D.

I use ATC blade-type automobile fuses because of cost and availability.

Every circuit should be fused. This helps prevent fires and protects appliances. Include a fuse in the positive wire between the solar panels and charge controller, and between the charge controller and the battery.

System Grounding

Proper grounding will help prevent lightning damage. Every solar module has a predrilled and labeled hole in the frame for a ground wire. Use #10 bare-copper wire to connect to each module. Then run the wire to a copper clad ½ -inch steel ground rod driven next to your home's foundation. Wherever a connection is made, use a corrosion preventative.

Each receptacle or switch need not be grounded using the bare copper wire in standard romex cable. **This applies only to 12 VDC systems.** Romex cable is the type of highly insulated wire that is typically seen in house wiring.

Installing Photovoltaic Panels

Note: When installing panels, cover them with a tarp to avoid sparks and electric surges during installation.

Panels must face the sun directly (usually south) and must not be shaded in any way. Even just a little shading will dramatically decrease panel output. The panels can be mounted on your roof or on a pole. In areas where theft is a problem, panels can be welded on a 15-foot metal pole placed in lots of concrete.

Solar panels produce the best year-round performance with a tilt angle equal to your latitude. For most of the United States, this is from 37-42 degrees. A lesser angle will improve summer output, and a steeper angle will be better in winter.

Make sure the panels are securely mounted so that they cannot be blown away by the wind. Wind-lift is a problem. Use stainless steel screws or lag bolts that are anchored into studs, not just plywood sheeting. Always allow for air movement behind the panel. Just a few inches will suffice. As heat builds, the panel's performance will diminish slightly.

Wiring Your System

Safety Note: You must avoid "crossing your wires", that is attaching positive wires to negative posts or vice versa. Use black for positive and white for negative. For this small 12 VDC system, the bare copper ground in romex wire need not be used at each appliance. Ground the system as shown on the diagram. Plus and minus are clearly marked on the panels, the charge controller and the batteries. PAY ATTENTION!

Safety Note: Do not connect batteries until all other connections are made and tested.

The 12-volt panels should be wired in parallel, that is plus to plus and minus to minus.

If you have more than one panel, you should use a combiner box located close to the panels. Notice that each panel runs directly to the combiner box. Use copper wire, type "use 2" or equivalent. This wire is high temp,

sunlight and waterproof. Because the ultraviolet rays can be so damaging, I run any wire exposed to the sun in an old piece of garden hose.

Follow the diagram carefully, noting wire types and sizes.

Connect the wires from the panels to the charge controller. Be sure to include a 30 amp fuse on the plus (+) side between panels and the charge controller. Run wires from the charge controller to your batteries but do not connect them yet. Be sure to include a 30 amp fuse on the plus (+) side between the charge controller and the battery. Run wires from the charge controller to the fuse box or breaker box. Run wires to individual lights and receptacles.

Double check every connection for shorts (i.e., plus being connected to minus.)

Carefully connect your batteries. Carefully touch the wires coming off of the batteries. They may become slightly warm, but not hot. If they are hot, disconnect them immediately. If your fuses blow, disconnect the batteries immediately. Check again for shorts. Black wires to positive, white wires to negative. Reconnect your batteries and check them again.

After you have the batteries connected and working without overheating, check each circuit for proper fuse size as follows:

Turn on every light or appliance typically used in the circuit. Start with small amp fuses. If they are too small, they will blow quickly. Try the next size higher amp fuse. A fuse that is too heavy for the circuit can cause fire or damage to appliances before it blows. A fuse that is too small will blow often. You are Goldilocks looking for the fuse that is “just right’.

Finally, make a chart that shows what appliances are on each circuit and what size fuse is required. Keep the chart close to your fuse box. Example:

Fuse #1 .... water pump ..... 9 amps
Fuse #2 .... bedroom lights ..... 30 amps
Fuse #3 .... receptacle by kitchen sink... 20 amps

ENJOY YOUR ELECTRICITY!

SUCCESS WITH SOLAR

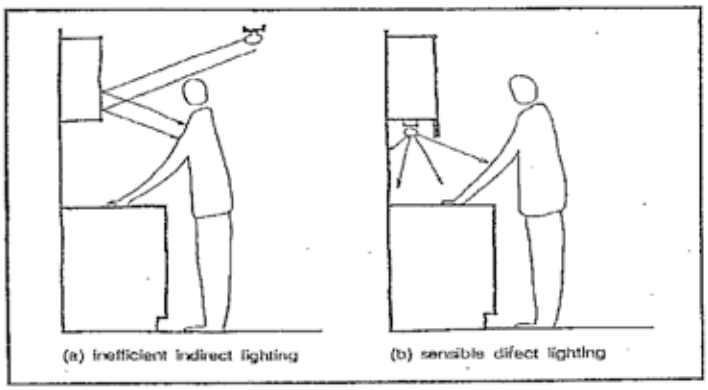
Here are some tips to maximize your solar system:

1. Avoid phantom loads (clocks, remote controls, transformers, etc.) These appliancesare always drawing power, 24 hours a day!

2. Use another source of power (propane or kerosene) for refrigeration. Sundanzer DC refrigerators and freezers (www.sundanzer.com) that operate on solar electricity are excellent, but expensive. You may want to consider a root cellar or other forms of preserving foods.

3. Use LED or florescent lighting.

4. Put lights close to work areas. Where a fixture is placed will determine how effective the lighting is.



(Illustration from: More Other Homes and Garbage, Sierra Club 1981)

5. Use smaller fans, placed close to your body or 12-volt ceiling fans, (120-volt ceiling fans don't work well with inverters.)

6. Use the smallest pump that will do the job.

7. Use direct current whenever possible.

8. Take good care of your batteries. Check them every day. Use only the top 20% of the batteries' power.

9. Adjust your panels at least twice a year to maximize power output. Panels should be perpendicular to the noonday sun.

10. Portable radios and clocks work well with AAA, AA, C and D batteries. Powering these appliances with small batteries helps keep your electric system simpler and smaller.
    (2014) New rechargeable batteries work well and can be recharged a thousand times! For more information, see “Build Your Own Battery Charging Station” by Jeffrey Yago, Backwoods Home Magazine, July/August 2013.

11. Compact florescent (CFLs) provide the most light per watt. (LEDs are a close second.) CFLs are most suitable to illuminate larger spaces.

12. Use stick-on push lights with LEDs. These are battery powered and easy to use. They cost about $4 each and are great where you need light for short periods of time—by the toilet, by the front door so you can see the lock, etc.

13. Consider <u>when</u> you use energy. If you use power in the morning, the batteries have time to recharge.

Power Requirements for Common Appliances

Use the manufacturer's specs if possible, but be careful of nameplate ratings that are the highest possible electrical draw for that appliance. Beware of appliances that have a "standby" mode and are really "on" 24 hours a day. (chart updated 2009)

DESCRIPTIONS	WATTS
Kitchen Appliances	
Refrigeration:	
4-yr. old 22 cu. ft. auto defrost (approx. run time 7-9 hours per day)	500
New 22 cu. ft. auto defrost (approx. run time 7-8 hours per day)	200
12 cu. ft. Sun Frost refrigerator (approx. run time 6-9 hours per day)	58
4-yr.-old standard freezer (approx. run time 7-8 hours per day)	350
NOTE: Refrigerators are improving. Check new products for new ratings.	
Blender	350
Can opener (electric)	100
Coffee grinder	100
Coffeemaker	850-1200
Deep fat fryer	1380
Dishwasher: cool dry	700
Dishwasher: hot dry	1450
Egg cooker	500
Exhaust Hood	144
Food Dehydrator	600
Food processor	400
Food waste disposer	420
Fruit Juicer	100
Frying pan	1170
Grill, sandwich	1050
Hot plate	1250
Microwave (.5 cu. ft.)	900
Microwave (.8 to 1.5 cu. ft.)	1500
Mixer	120
Range, large burner	2100
Range, small burner	1250
Range, Amana (propane) with glow bar	380
Roaster	1345
Slow cooker (crockpot)	180-240
Toaster (2-slice)	750-1200
Trash compactor	1500
Waffle iron	1080
Water Pumping	
AC Jet Pump (1/2 hp) 300 gal. per hour, 20-foot well depth, 30 psi	750
AC Submersible Pump (1/2 hp), 40-foot well depth, 30 psi	1000
DC pump for house pressure system (typical use is 1-2 hours per day)	60
DC submersible pump (typical use is 6 hours per day)	50
Shop	
AC grinder, 1/2 hp	1080
AC table saw, 10 inch	1800
Hand drill, ½ inch	600
Hand drill, 3/8"	400
Lathe (12 inch)	660
Router	720
Sander (orbital)	300
Saw, band	660
Saw, circular	1080
Saw, saber	288
Saw, table	950
Worm drive 7 1/4 -inch saw	1800

DESCRIPTIONS	WATTS
General Household	
Air conditioner, 1 ton or 10,000 BT/hr.	1500
Air conditioner, window	1300-1500
Alarm/security system	6
Clock radio	5
Clock, electric	4
Clothes dryer, electric	4800-5750
Clothes dryer, gas	300-500
Clothes washer, horizontal axis	145-250
Clothes washer, vertical axis	900
Dehumidifier	240
Electric blanket	170-400
Electrostatic cleaner	60
Fan, attic	375
Fan, circulating	85
Fan, furnace 1/4 hp	600
Fan, furnace 1/3 hp	700
Fan, furnace 1/2 hp	875
Fan, roll about	205
Fan, window	190
Floor polisher	315
Fountain, tabletop	5
Garage door opener, 1/4 hp	550
Germicidal lamp	20
Heat lamp (infrared)	250
Heat pump	9600
Heater, radiant	1300
Heating pad	60
Humidifier	70
Iron (electric)	1200
Light bulb, incandescent	(on bulb)
Light bulb, typical fluorescent light (60W equivalent)	15
Oil burner or stoker	260
Serger (Pfaff)	140
Sewing machine	75
Vacuum cleaner, average	900
Vacuum, central	1500
Vacuum, Oreck	410
Vacuum, Dirt Devil upright	980
Water heater, quick recovery	4500
Water heater, standard	3000
Waterbed heater	300

DESCRIPTIONS	WATTS
Hygiene	
Hair curler	750
Hairdryer	400-1500
Shaver, electric	15
Sunlamp	290
Toothbrush, electric, charging stand	6
Waterpik	90
Whirlpool bath	750
Entertainment/Telephone	
CB (receiving)	10
Guitar amp (Jimi Hendrix volume)	8500
Guitar amplifier (avg. volume)	40
Laser disk/CD player	30
Piano, electric	30
Radio	80
Satellite system, 12-ft dish/VCR	30
Stereo home theater, AC	500
Stereo, AC (avg. volume)	25-55
Stereo, DC (avg. volume)	10-15
Telephone, cellular (on standby)	5
Telephone, cordless (on standby)	5
TV, 12-inch black & white	16
TV, 19-inch color	50-80
TV, 27-inch color	120-170
LCD TVs use less power than older models: LCD 50-inch TV	175
Video games (excluding TV)	20
Office/Den	
Adding machine	8
Computer, desktop	90
Computer, laptop	25
Fax machine, plain paper printing	50
standby	5
Monitor, 15-inch LCD display	35
Monitor, 17-inch flat screen	50
Monitor, 17-inch color	100
Pencil sharpener, electric	60
Printer, ink jet	15
Printer, laser	600-900
Typewriter, electric	200

Power Requirements for Common 12 VDC Appliances

DESCRIPTIONS	AMPS
Lighting	
15-watt fluorescent light	1.0
16-watt slimline fluorescent light	1.2
Dual 8-watt fluorescent tubes	1.2
20-watt standard fluorescent light	1.5
30 watt slimline fluorescent light	2.0
Kitchen	
Coffee percolator	11.5
Toaster	15.0
Slow cooker	20.0
Range hood, fan and light	5.0
Vent fan	2.5
Refrigerator	5.0
Sundanzer Refrig/Freezer	0.5-11.0
Household	
Travel iron	10.0
Electronic bug killer	2.5
Electric razor	1.3
Vacuum cleaner, hand portable	5.0
Electric toothbrush	1.0
Tools	
Winches (for light use)	10.0-100.0
Air compressor	3.5-9.0
Chain saw, 14" blade	100.0
Drill	12.0-15.0
Communications	
TV, B&W, 12"	1.4
TV, Color, 9"	4.0
CB radio	0.5
Digital clock	0.1
Tape recorder	0.5
Amplifier (30 watt)	2.0
DC turntable	0.5

FORMULA TO COMPUTE AMP-HOURS

Light.....1.5 amps x 6 hours = 9.0 amp-hrs
Coffee maker.....
.....11.5 amps x 1 hour = 11.5 amp-hrs
TV.....1.4 amps x 3 hours – 4.2 amp-hrs

Total (of this example) .....24.7 amp-hrs.

TYPICAL WATTAGE REQUIREMENTS FOR 12 VDC APPLIANCES

Shurflo 12 VDC pump.....5-7 amps

O_2 Cool fan .....low .3 amps
..... hi .6 amps

From *RV Repair and Maintenance Manual*, p. 24. Edited by Bob Livingston ©1989

Recommended Reading and Resources

Earthships I, II, III

The Evolution of an Independent Home, Paul Jeffrey Fowler, Fowler Enterprises, 264 Bashan Hill Road, P.O. Box 253, Worthington, MA 01098-0253. This book shows how you can start small and build over time. The advice is real and practical.

Backwoods Home Magazine I BackHome Magazine I Countryside Magazine These three publications will provide many examples of working energy systems. Most of the systems are owner-built.

HomePower Magazine, www.homepower.com Excellent examples of both small and large homemade power systems.

On the net: Rex Ewing, author of several fine books. Mr. Ewing covers both simple and complex solar electric systems. (2010)

On the net: New Tribes Solar catalogue.
go to: tribaltech@NTM.org
You must indicate that you are a missionary and tell them what agency you serve.
Tell them that Jack Dody sent you.

Tech Tips for Living in Remote Locations by Tim See. This is one of the most detailed, authoritatively-written guides available. Purchase from New Tribes Solar catalogue.

LEARN MORE ABOUT SOLAR POWER

(This is a resource list from Mother Earth News, *A Guide to Homes*, Summer 2003, p. 26.) updated 2009

SOLAR PRODUCTS MANUFACTURERS
These sites provide useful information about solar energy in general, about specific products and, in some cases, distributors and installers.

Bekaert ECD Solar Systems (Uni-Solar thin film roofing) www.uni-solar.com

Affordable Solar www.affordable-solar.com

Evergreen www.evergreensolar.com

Astropower www.astropower.com

Siemens Solar www.siemenssolar.com

Kyocera Solar www.kyocerasolar.com

Atlantis Energy Systems www.atlantisenergy.com

PowerLight www.powerlight.com

ON MOTHER'S BOOKSHELF, PAGE 103
The New Independent Home, by Michael Potts, $30

The Natural House, by Dan Chiras, $35

GENERAL INFORMATION
National Renewable Energy Laboratories www.nel.gov

Energy Efficiency and Renable Energy Network www.eren.doe.gov (800)363-3732

A Consumer's Guide to Buying a Solar Electric System
www.nrel.gov/docs/fy99osti/26591.pdf

American Solar Energy Society www.solartoday.org (303)443-3130

California Energy Commission www.energy.ca.gov

Center for Renewable Energy and Sustainable Technology (CREST)
www.crest.org

Real Goods Institute for Solar Living
www.realgoods.com/renew/intertie/index.cfm

Florida Solar Energy Center www.fsec.ucf.edu

The Solar Electric Power Association www.solarelectricpower.org

DEPENDABLE SOLAR PRODUCT DEALERS (as of 2009)

Note: These dealers have been in business for several years and have a solid track record. Because there are so many fly-by-night solar businesses, I suggest that you find a reputable dealer. You will probably need service after the sale.

Help Designing Solar Electric – Les Eldeen
www.sunbeamsolutions.com
Note: Mr. Eldeen has designed more than 8000 systems for missionaries around the world.

Kansas Wind Power – www.kansaswindpower.net

Backwoods Solar Electric – www.backwoodssolar.com

Affordable Solar – www.affordable-solar.com

Alternative Choices – acsolar@earthlink.net / www.acsolar.com

Sunbeam Solutions – www.sunbeamsolutions.com

New Tribes – As of 2013, this is my favorite solar dealer. They work only with missionaries. tribaltech@ntm.org phone (573)317-8610

STEPS ON THE PATHWAY TO ABUNDANCE

HOUSING

Note: We call the home we have designed a Solar Ark. It has special features listed below that make it an essential component of abundant living.

Psalm 127:1 *Unless the Lord builds the house, its builders labor in vain.*

- Build without a mortgage

Luke 14:28 *[Jesus speaking] Suppose one of you wants to build a tower. Will he not first sit down and estimate the cost to see if he has enough money to complete it?*

Proverbs 22:26-27 *Do not be a man who strikes hands in pledge or put up security for debts; If you lack the means to pay, your very bed will be snatched from under you.*

- Use passive solar design principles.
- Use local materials whenever possible.
- Recycle and reuse building materials.
-] Consider alternative building methods: tires, bags, straw, cob, etc.
- Plant trees for firewood, energy and building materials.
- Heat your home with solar and wood.
- Heat water for your home with solar and wood. Use rocket stoves (see internet).
- Use refrigeration devices designed for photovoltaics.
- Include water catchment in your home design.
- Include composting toilets in your design.
- Always include a greenhouse or a place to start plants for your garden.

Designing Your Solar Ark

Review: Four Traits of the Solar Ark

1. On-site energy production.
2. On-site water collection and water conservation.
3. On-site food production.
4. On-site waste recycling and disposal.

A Solar Ark can be built in any location, in any climate.

How you build your Ark depends upon:

1. Available materials
2. Climate considerations
3. Budget considerations
4. Cultural considerations

Designing Your Solar Ark

from Malcolm Wells – the father of Earth-Sheltered Design

A list of 15 properties of an excellent building.

1. Create pure air.
2. Create pure water.
3. Store rainwater.
4. Produce its own food.
5. Create rich soil.
6. Use solar energy.
7. Store solar energy.
8. Create silence.
9. Consume its own wastes.
10. Maintain itself.
11. Match nature's pace.*
12. Provide wildlife habitat.
13. Provide human habitat.
14. Moderate climate and weather.
15. Be beautiful.

* A good house should provide a refuge from the frenetic pace of modern society.

Designing Your Solar Ark

from “The New Ecological Home”
by Daniel D. Chiras

Keys to Successful Passive Solar Design

1. Choose a site with unobstructed solar access.
2. For optimal solar gain, orient your house so that its long axis lies on an east-west axis.
3. Concentrate windows on the south side of the house.
4. Include overhangs, especially on the south side of the house.
5. For maximum comfort, include an adequate amount of thermal mass in your design.
6. All solar design relies on energy efficiency.
7. Protect insulation from moisture.
8. Design your house so that most, if not all, of the rooms are heated directly by incoming sunlight.
9. Create sun-free zones in your home.
10. Install an efficient, properly sized, environmentally responsible back-up heating system.

Summary of Principles of Sustainable Design and Construction
(by Daniel D. Chiras)

- Build small.
- Make homes efficient.
- Use recycled or recyclable materials.
- Recycle and compost all waste.
- Build recycling centers in homes
- Use renewable resources, especially energy.
- Promote environmental restoration.
- Create safe, healthy living spaces
- Make homes easy to operate, service, and maintain.
- Design homes to be accessible.
- Make homes affordable.
- Make homes durable.
- Build community.

BASIC COMPONENTS OF SUCCESSFUL PASSIVE SOLAR CONSTRUCTION

EASY AS 1, 2, 3!

1. **WINDOWS**
2. **INSULATION**
3. **THERMAL MASS**

Note: A well-designed passive solar home will be comfortable all year long in any climate.

WINDOWS

Sizing - Windows should cover an area equal to 17-22% of the square footage of the home.

Placement - Most windows should be on the sunny side. Minimize windows on the cold side. Placing bathrooms, bedrooms, closets, storage areas and garages on the cold side helps minimize windows and acts as a thermal block.

Construction - Use double-paned windows. Frames should be constructed of wood or vinyl to prevent convection. Insulated, moveable window coverings can be effective in cold climates. Use clear glass on south side. Use "low E" glass on other sides.

Eaves - Sunny side windows should be shaded by eaves to prevent summer sun from overheating living spaces. On the sundown side of the structure, shades, shutters and curtains can prevent overheating.

Window Allocations in Direct-Gain Systems
(from "The New Ecological Home" by Daniel D. Chiras)

South-facing glass – 7 to 12%*

North-facing glass – no more than 4%

East-facing glass – no more than 4%

West-facing glass – no more than 2%

* percentages are based on total square footage of a home. Window space is glass area (total window space minus frame).

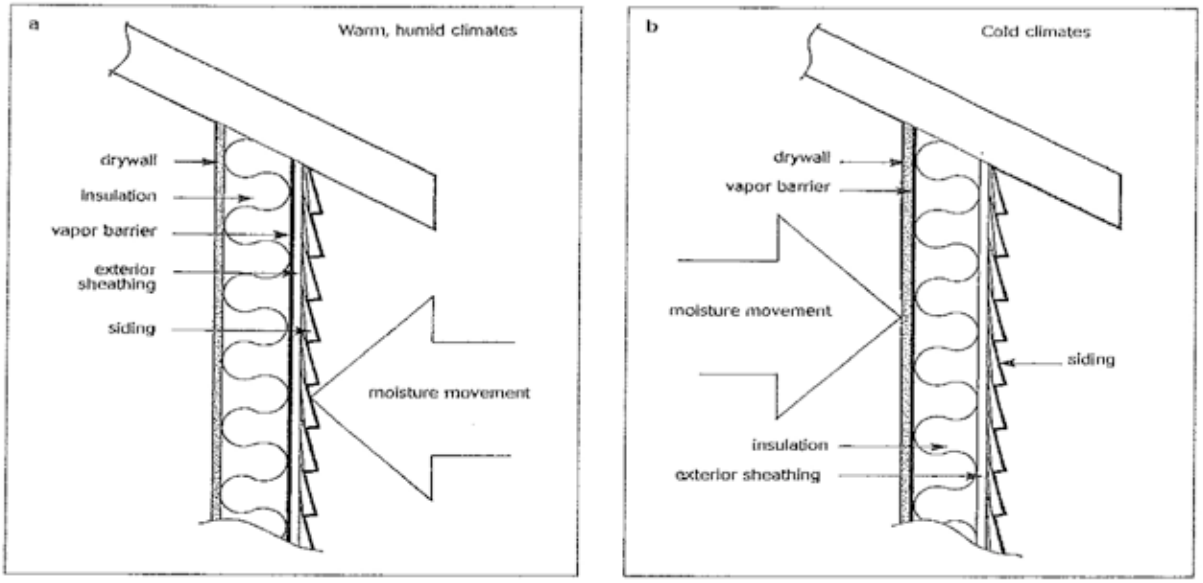
INSULATION...THE KEY TO COMFORT

WHAT IS INSULATION?

Insulation is any material that resists the transfer of heat or cold. This resistance is represented by the letter "R". The R-value provides information about the effectiveness of insulating materials. The higher the R-value, the greater the resistance and insulating capability. Usually, insulation traps air in cells. It is the dead air that slows the movement of heat and cold. The smaller the air cells are, the better. Because insulation is mostly air it is often very light-weight.

HOW TO HAVE SUCCESS WITH INSULATION

1. Use enough insulation to be effective in winter and in summer. <u>If you are using non-standard types of insulation, use more</u>. You may have to increase the thickness of walls to provide enough space for adequate insulation. Example: Walls could be 12 inches thick instead of 4 or 6. Find out how much insulation is being used in your area. Increase that amount by a few inches, if possible.
2. Insulation must be used in a fire-safe way. Keep insulation behind low-combustion materials like drywall or plaster. Be careful when running wire near combustible materials. Consider wire encased in metal conduit. Always be ready for fire with extinguishers and alarms.
3. Keep insulation dry. Learn when and how to use moisture barriers.



Vapor barriers are neıpтuı ın nearly any home. They prevent moisture from penetrating the wall and thus help keep insulation dry. Even a tiny amount of moisture in insulation dramatically reduces its R-value. In warm climates, moisture barriers are typically installed just beneath the exterior sheathing (a). In cold climates, moisture barriers are usually installed beneath the drywall (b). [source: David Smith in “The New Ecological Home” by Daniel D. Chiras] The new vapor barrier materials breathe”, allowing moisture out of wall cavities.

4. Insulate carefully. Fill every void. Use caulking where needed. Eliminate leaks and cracks. Plan for settling. If you use a loose-fill type of insulation in walls it will probably settle. Let it. Push it down, then fill the void created with a springy type of insulation like fiberglass or plastic bags. Fill the void as tightly as possible to allow for future settling. If settling occurs, use an expanding foam like “Great Stuff.” It may take a few years for settling to occur.

5. Provide adequate ventilation in your living space. This will help eliminate condensation problems.

6. Use the cleanest, driest materials available. Use organic pest deterrents like borax, diatomaceous earth, salt, etc.

7. Take steps to deal with conductivity. Conductivity is the transfer of heat or cold through solid materials like studs and window frames. Styrofoam sheathing is one way to deal with conductivity and provides a moisture barrier.

8. Combine proper amounts of insulation with proper amounts of mass to create a comfortable living space.

9. Consider solar radiation. Use a reflective materials like aluminum foil on walls and roof surfaces that are exposed to direct sun. White roofing reflects a great deal of heat.

10. Insulating floors over an unheated basement beyond the thickness of the joists is usually not worth the extra effort.

11. Insulating heated crawl spaces beyond R-19 is not cost effective.

Sources: Superinsulated Design and Construction by Lenchek-Mattock-Raabe, © 1987 Van Nostrand Reinhold Co., Inc.

Solar Living Meredith Corp., © 1983 Better Homes and Gardens Books

TRADITIONAL TYPES OF INSULATION

NOTE: R-values notated per inch

FIBERGLASS...R-value 2.9 - 3.7... Positive features: Good availability. Inexpensive. New types do not irritate skin. Fire resistant. Negative features: Old type irritates skin and lungs during installation.

STYROFOAM...R-value 3.7 -4.0... Positive features: Lightweight. Rigid. The blue stuff can be buried. Excellent for outside perimeter insulation. Can be used under roofing. Negative features: Creates poisonous gas if burned.

ROCK WOOL... R-value 2.9 - 3.7... Positive features: Inexpensive. Fire resistant. Negative features: irritates skin and lungs during installation.

CELLULOSE(SHREDDED PAPER)... R-value 3.1 - 3.7... Positive features: Easy to blow in. Non-irritating. Non-flammable. Uses recycled paper. Negative features: Flame retardant (borax) can corrode metal. Absorbs moisture. May settle.

VERMICULITE AND PERLITE... R-value 2.1 -2.7... Positive features: Fire resistant. Negative features: Low R-value. May settle. Expensive in some areas.

POLYURETHANE AND ICYNENE... R-value 5.8-6.2... Positive features: Expands to fill voids. Moisture resistant, High R-value. Negative features: Expensive. Requires professional installation. Gives off toxic fumes when burning.

POLYISOCYANURATE BOARD... R-value 5.9 - 7.0... Positive features: High R-value. Rigid board, can be foil-faced. Negative features: Expensive. Gives off toxic fumes when burning.

REFLECTIVE INSULATION... R-Value N/A…usually made with shiny aluminum foil. Positive features: Keeps the sun's heat from entering the living space. Helps keep a living space cool in very sunny areas. Negative features: Expensive. Must be installed very carefully.

NON-TRADITIONAL TYPES OF INSULATION

NOTE: Non-traditional insulation is often flammable. Care must be taken to lessen fire danger. Pests and vermin could also pose problems unless materials are very clean and very dry. Organic pest controls may be necessary.

COTTON...R-value 2.9 - 3.7... Positive features: Non-irritating. More dense than fiberglass, i.e. better sound proofing. Treated for fire resistance. Negative features: New product. Not readily available. Expensive.

STRAW… R-value approximately 35 for a standard bale... Positive features: Available. Easy to use. Negative features: Must be very dry. Must be covered with adobe or plaster to protect it from fire and animals. Loose straw is sometimes mixed with salt and placed in walls and ceilings. The salt discourages insects and vermin.

WOOL… R-value 5.5...Positive features: High R-value. Fire resistant. Will not settle. Negative features: Not available in all areas.

LEAVES... R-value N/A... Positive features: Available. Inexpensive. Negative features: Must be protected from vermin and fire. Must be very dry.

SAWDUST... R-value N/A... Positive features: Good sound proofing. Negative features: Must be very dry. Must be protected from vermin, termites and fire. May settle.

CARDBOARD...R-value N/A...Positive features: Available. Inexpensive. Can be used as sheathing to cut down on conduction. Negative features: Flammable. Must be protected from fire, vermin and moisture.

RAGS...R-value N/A... Positive features: Inexpensive. Available. Negative features: Rags must be clean and dry. Must be protected from fire and vermin. Synthetic rags less likely to rot or attract vermin.

DIRT...R-value low... Positive features: Universally available. Will not burn. Negative features: Must be very dry. Because of its poor R-value, must have thick walls to be effective. Heavy.

WOOD...R-value low...Positive features: Available in many areas. Wood buildings are attractive. Negative features: Expensive. Because of poor R-value, walls must be thicker. (Consider cordwood building.) Must be protected from fire, insects (termites) and moisture.

PLASTIC BAGS AND WRAPPINGS...R-value 3 - 4... Positive features. Inexpensive. Available. Will not settle. Not effected by moisture. Negative features: Must be protected from fire. Creates toxic fumes while burning. Must be clean.

ASHES…R-value N/A…Positive features: Will not burn. Can be used to insulate heat sources such as fireplaces, woodstoves, cookstoves and chimneys. Negative features: Must be carefully screened to remove any burnable charcoal. Must be kept dry.

THERMAL MASS

What It Is

Thermal mass is any material that can be used to moderate temperatures in a passive solar structure.

Types of Thermal Mass

Water provides excellent thermal mass. Use two to four gallons of water per square foot of glass.

Types of Thermal Mass

Dense materials such as concrete, stone, brick and block will moderate temperatures. Use two cubic feet of these materials for each square foot of glass.

Note: Without thermal mass, a passive solar home can become uncomfortably hot during the day and uncomfortably cold at night.

Note: Thermal mass must be combined with insulation to be effective.

Concrete, stone, brick and block are popular materials in many countries. Without insulation, these materials often create living structures that are too hot in the summer (particularly at night) and too cold in the winter. Once these high mass materials are cold all the way through, they stay cold. When they are hot to the core, they will radiate heat all night long.

Note: Earth-Coupling is another technique for moderating temperatures. An example of earth-coupling is a basement wall. The earth against the wall moderates temperatures in the basement.

Calculations for Passive Solar Dwellings

NOTE: These calculations are rough guidelines. As you live in your home you will be able to fine-tune your passive solar dwelling by adding or subtracting glass or mass.

1. Calculate the square footage (L x W) of the home.

2. To calculate how much glass you should have multiply the square footage of the home times 17-22%. In colder climates use the higher percentages.

3. Calculate the square footage of all your glass. Measure just the glass, not the window frames.

4. If you use water for thermal mass, use 2 to 4 gallons per square foot of glass.

5. If you use concrete, stone, brick, etc. for mass, use 2 cubic feet for each square foot of glass.

Reference Note:
Some of the best examples of passive solar dwellings can be found in *The Passive Solar House* by James Kachedorian.

Design Considerations

Answer the following questions:

1. What is the average rainfall on the building site?
   Does the rain fall in just one month? ...two? ...year round?
2. How many days will the sun shine on your site?
3. Will trees block the sunshine from your Ark?
4. What are the wind conditions?
5. What type of vegetation is on your site?
   trees...grass...cacti, etc.
6. What materials are available?
7. What materials are used in the construction of local houses?
8. How are local houses designed?
9. What type of soil is on your building site?
   rocky...sandy…heavy clay...loam...sandy loam
10. What is your elevation above sea level?
11. Is your land flat? ...steeply sloped? ...both?
12. How much money do you have for your Solar Ark?
13. How much does local labor cost?
14. Is there anyone in the neighborhood who has a good reputation building houses?
15. How far will you have to go for materials?
16. Do you have a vehicle that can carry your materials?
17. Do you have the tools needed to build your Ark? Are any tools available in your community?
18. Do you own or rent your property?
19. Should your Ark be moveable?

KEEPING COOL!

Comfort in Hot Climates

(A cool missionary is a happy missionary!)

BUILDING DESIGNS FOR HOT CLIMATES

1. Buildings on stilts to maximize air movement. (Particularly suitable for wet climates.)

2. Superinsulated buildings such as strawbale structures. Consider aluminum foil or mylar when insulating.

3. Earth-coupled buildings such as Earthships and bermed structures.

4. High-mass buildings such rammed-earth structures, concrete construction and cob construction.

5. Combinations of the above options.

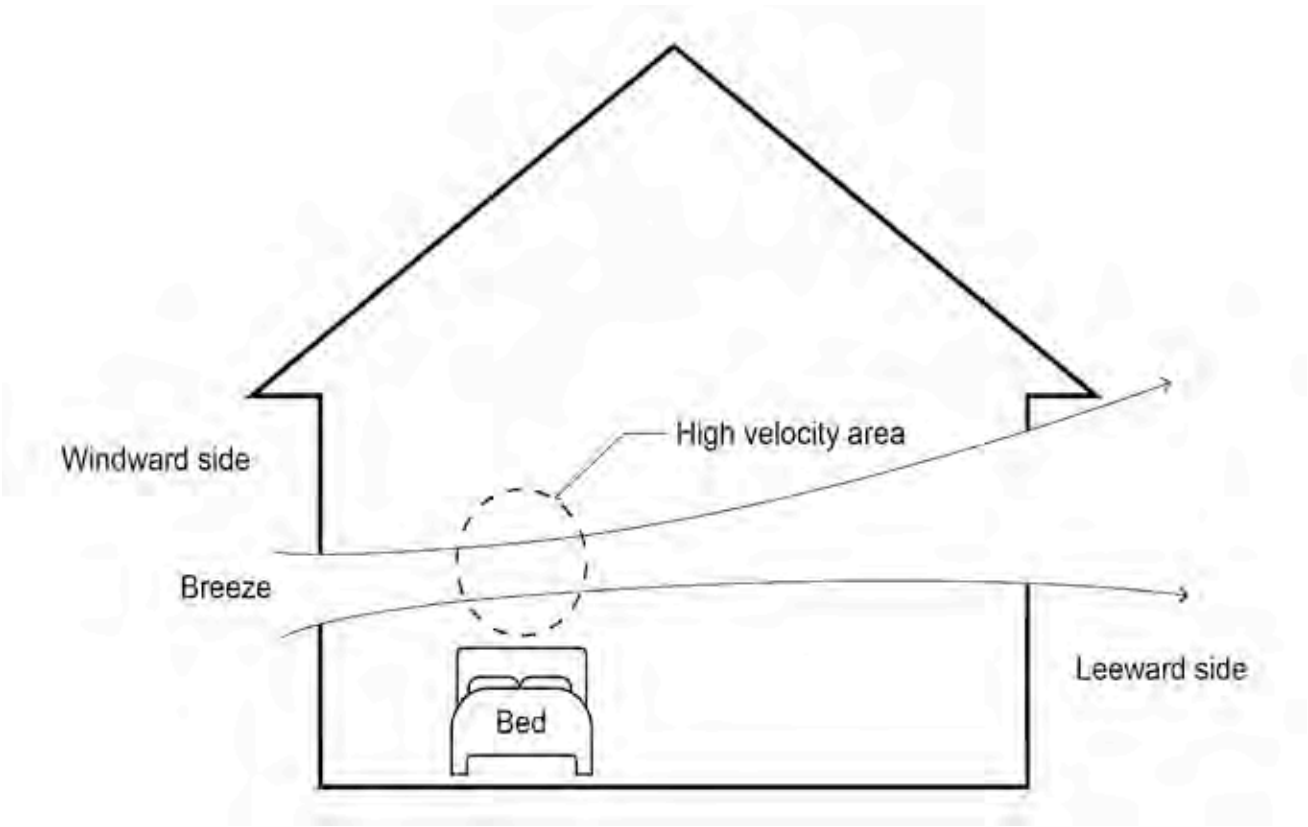
MAXIMIZING AIR MOVEMENT

Maximum air movement = maximum cooling.

Place fans as close as is safe to your body. The closer you place the fan to your body, the greater will be its cooling effect. Place the fan so that it will not dry out your eyes, nose and throat, making you susceptible to sinus infections. By placing the fan close to your body you may be comfortable with a small fan that will use less electricity. If you must sleep under a mosquito net, put your fan inside the net.

Design your living space so that the air will be moving at maximum velocity over your bed.

To maximize air flow through windows reduce the size of the inlet to half of the outlet area. Also, place the exhaust window high on the leeward side of the building and the intake window low on the windward side. See illustration below.



SOLAR COLLECTOR - BIOMASS HEATER WITH ROCK STORAGE

Origins:

The Solar Collector - Biomass Heater w/ Rock Storage (SCBH) is a refinement of several ideas including the Trombe Wall and James Kachadorian's Solar Slab. The addition of a wood stove makes the SCBH an excellent choice for areas with heavy winter cloud cover.

Operation:

The SCBH operates much like a Trombe Wall. When the rays of the sun pass through the glazing and strike the absorption plate, hot air is created. As the hot air rises, cool air is drawn into the hot air chamber. Using a fan to increase air movement in the SCBH may or may not be a good idea. Fans can move air too quickly to allow heat exchange. Using a fan in the living space may be useful to distribute heat. The concrete blocks in the bottom of the SCBH are spaced an inch apart so that warm air can rise through the bin of rocks. If more heat is needed the wood stove can be fired. The stove operates more efficiently because its heat is stored in the rocks. The stove operates more cleanly because it is allowed to burn "hot" with lots of air, which creates more complete combustion. The stove should seldom be dampened. Because the stove access is outside, the mess of wood burning is eliminated. On very cold nights the insulated covers must be placed over the glazing to prevent loss of heat and cold drafts. The covers should be in place on warm days to prevent heating. If the insulated access door to the wood stove is opened and the door of the stove is opened, cool, night air can lower the temperatures in the rock bin to provide cooling.

Vents:

When the vents are open the natural convection in the living space will allow the rock storage to be heated. Cool air will be taken from the floor of the living space. Warm air will enter the living space through the top vents. Like the Solar Slab the temperatures of the rock storage will be just a few degrees above the comfort zone.

Modifications:

If there are not enough sunny days where the SCBH is to be built, the solar collector can be eliminated.
A hot water tank can be placed in the rock storage bin for winter operation. Care must be taken to prevent freezing.

Calculations:

NOTE: These are rough calculations. Using passive solar is an art. Some adjustments may be necessary.

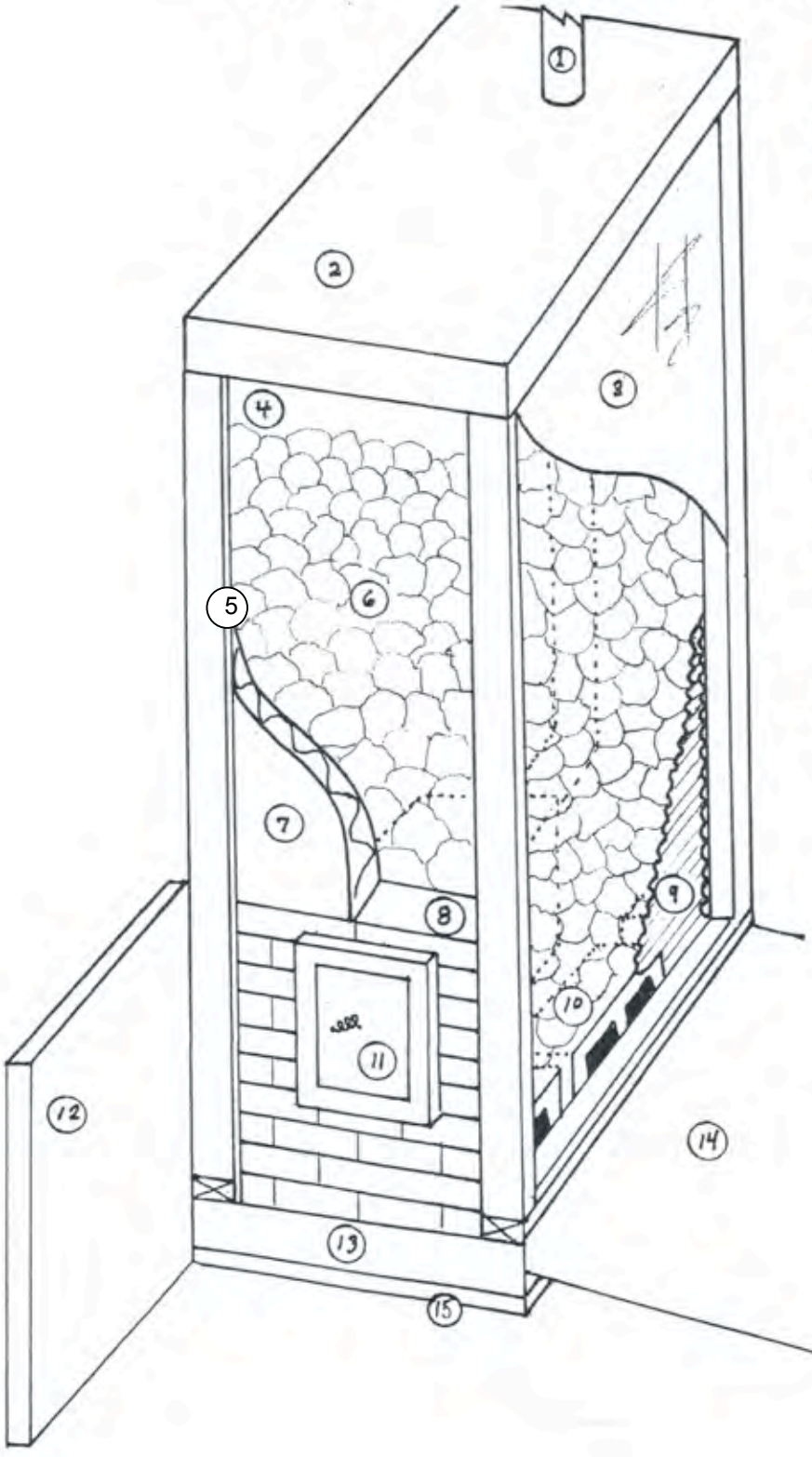
The size of the SCBH is calculated in the following way:

1. Calculate the square footage of the structure to be heated.
2. Multiply the square footage of the home by 17% to 22%. This is the square footage of the glazing required. [In warmer climates use 17% to 18%. In cooler climates use 20% or 22%.]
3. To find the amount of rock required, multiply the number of square feet of glazing by 2.25. The resulting figure is the number of cubic feet of rock required.
4. CALCULATING VENT SIZE: Multiply the square footage of the glazing by 3%. The resulting figure is the total square footage of the vents on the wall of the SCBH that adjoins the living space. The vent area should be distributed evenly between upper and lower vents. There will also be the same number and size of vents in the absorption plate. The vents should not be directly in line with one another, either horizontally or vertically. More effective airflow is created by the uneven spacing of the vents.

Notes:

1. Glazing should be of tempered glass or fiberglass, which will withstand higher temperatures than standard glass. The frame which holds the glass should be wood or metal. Vinyl is not a good choice.

SOLAR COLLECTOR - BIOMASS HEATER W / ROCK STORAGE



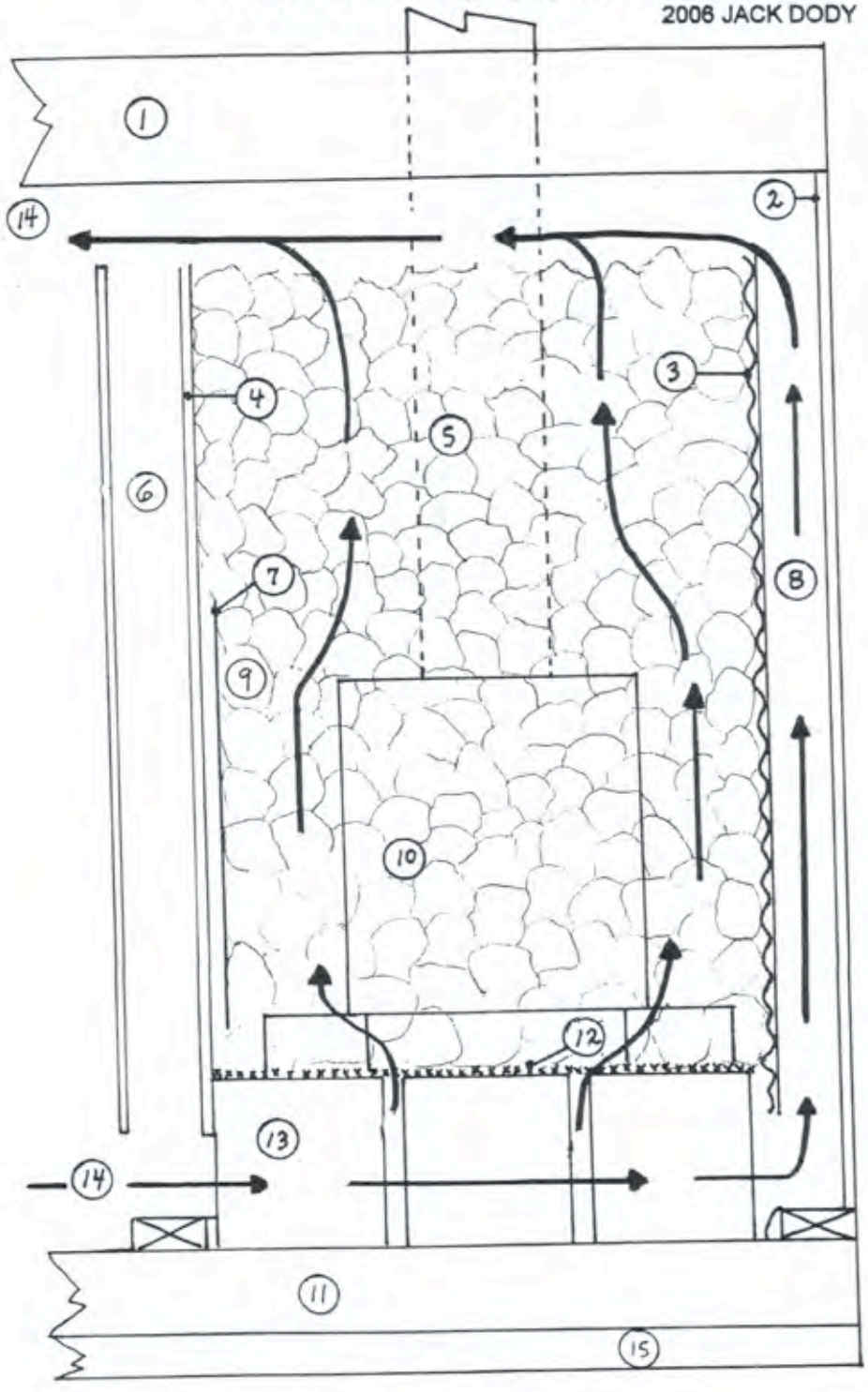
CALL LIST:

1. Chimney and stovepipe made of heavy steel pipe so that it will not have to be replaced.
2. Insulated roof.
3. Tempered glass or fiberglass.
4. Open space for air flow.
5. Wall of living space.
6. Fist-sized rock. Clean and uniform in size.
7. Insulated wall. Box is super-insulated.
8. Brick or block hip wall.
9. Solar absorption plate. Corrugated steel, painted black.
10. Concrete block, on its side to create a vent.
11. Box woodstove.
12. Insulated, fireproof door.
13. Concrete slab.
14. Insulated cover for solar collector.
15. Two-inch rigid insulation.

SOLAR COLLECTOR – BIOMASS HEATER W / ROCK STORAGE

Detail of Construction and Air Flow

2006 JACK DODY



CALL LIST:

1. Insulated roof.
2. Tempered glass or fiberglass
3. Solar heat absorption plate. Corrugated metal painted black.
4. Sheathing
5. Stove pipe
6. Wall to living space
7. Metal heat shield
8. Hot air chamber
9. Rock storage
10. Wood stove
11. Slab
12. Heavy hardware cloth allows warm air to filter through rocks
13. Concrete blocks on their sides to create air passages. Blocks are spaced one inch apart to allow airflow upward.
14. Openable vents to living space
15. Rigid insulation

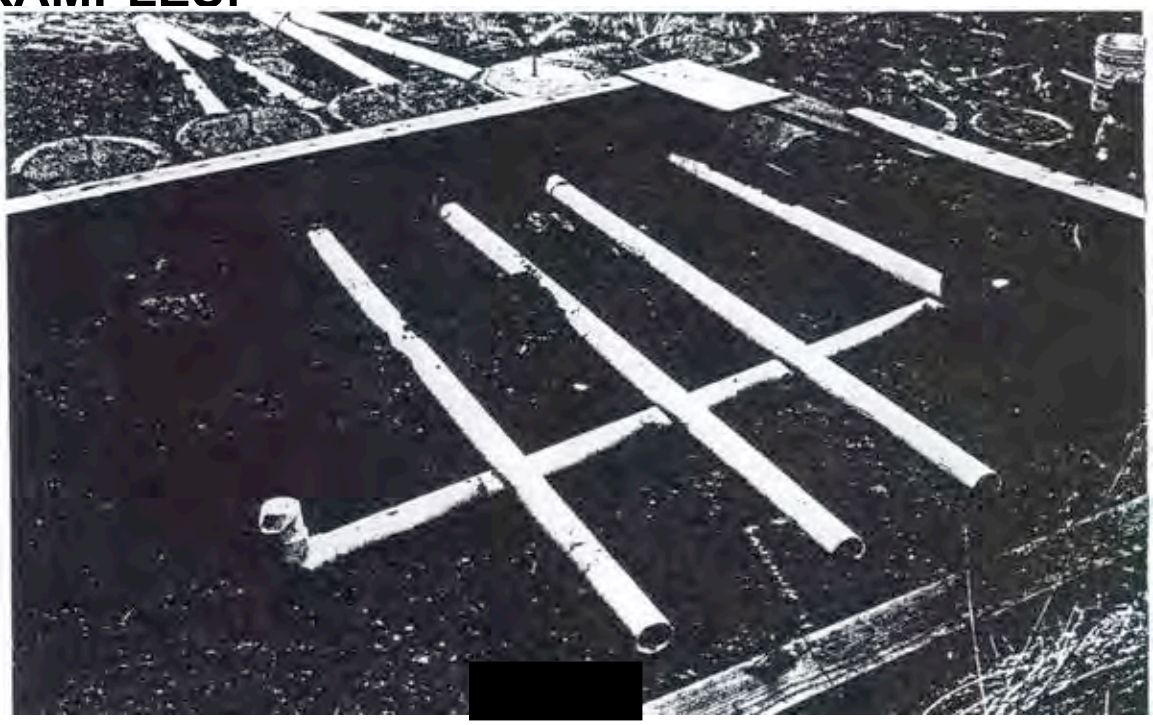
VENT PIPES

- Use clay or PVC pipe.
- Pipe must be smooth, not corrugated.
- Pipe must drain to inside or outside. **It must hold no standing water that would encourage the growth of mold.**
- Pipe must be screened on both ends to prevent vermin from making their homes in the pipe.
- Pipe is buried at depths which remain constant in temperature. Depth will vary with locale, usually 3 to 7 feet. If it is not practical to bury the pipe deeply, the pipe will still function when buried less deeply. Some efficiency will be lost.
- One square foot opening of pipe for every 100 square feet of living space is minimal. Twice that amount is optimum.
- Vent pipes must be coupled with fans, windows or solar chimneys to create air flow. It is important that the air moves slowly through the pipe. If the air moves too quickly through the vent pipe, the efficiency of temperature transfer will be reduced.

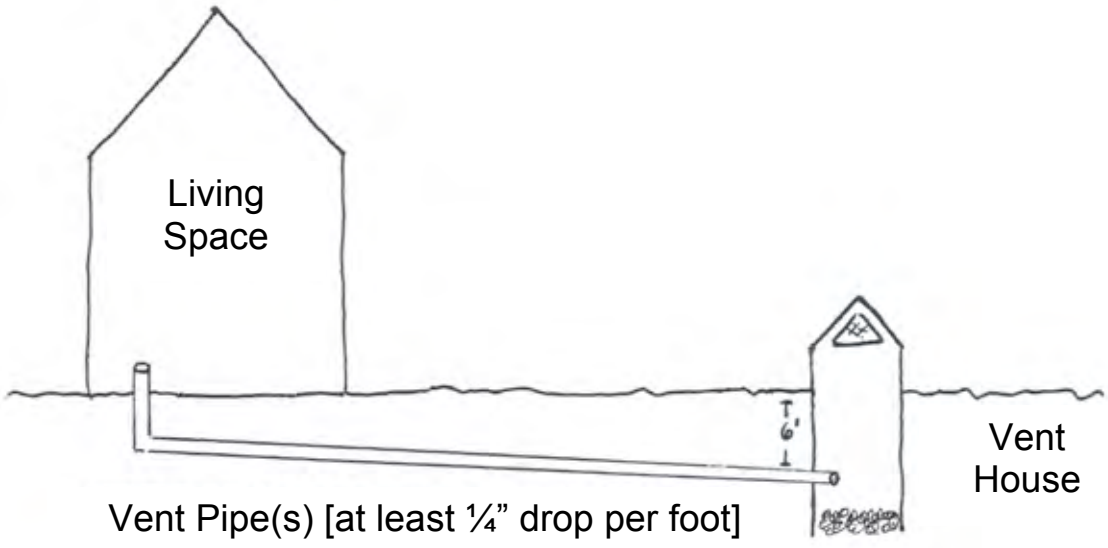
HOW IT WORKS

in warm weather, air from outside is cooled as it passes through the pipe, helping cool the living space. In cold weather, air is warmed as it passes through the pipe, providing preheated fresh air.

EXAMPLES:



VENT PIPES FOR A LEVEL BUILDING SITE



Notes:

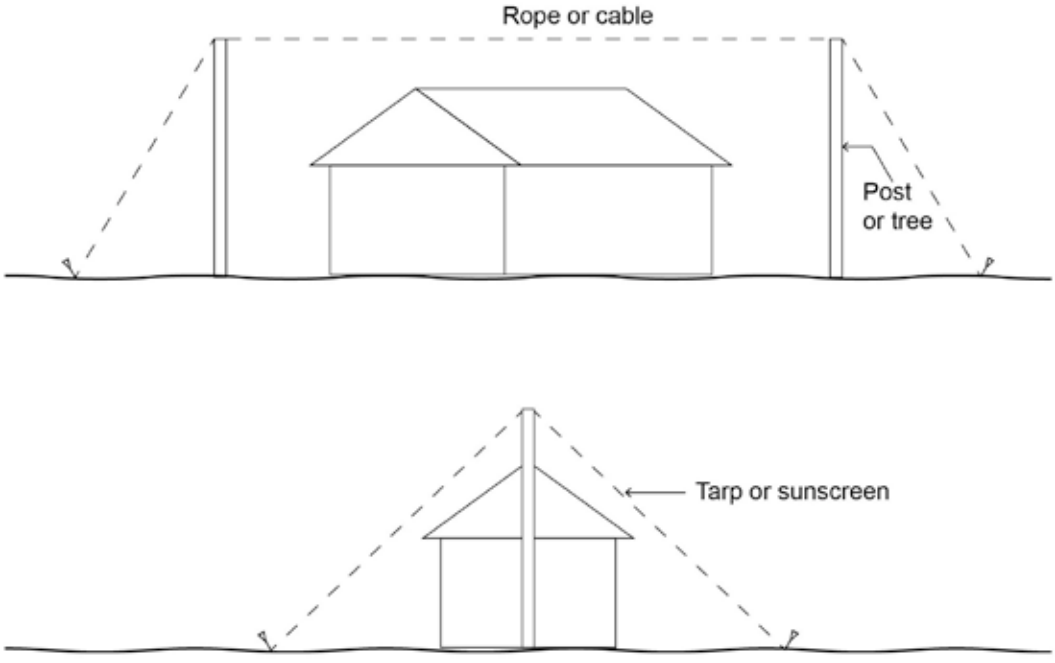
- Vent house has an open bottom lined with six inches of gravel.
- Vent house is screened to provide maximum air movement and to prevent the invasion of insects or vermin.
- Vent house should be seven to ten meters from the living space.

SHADE

It is hard to overestimate the positive effect of shade in keeping your dwelling cool. Unfortunately, it may be a scarce commodity where you live. It may also interfere with your photovoltaic panels if you are making your own electricity.

Here are some solutions:

1. Plant some trees - today.
2. Spend time laying out your homestead. Watch the path of the sun. Watch shadows. Consider using trees for a windbreak if applicable. If you are collecting rainwater from your roof, make sure your dwelling is far enough from trees so that the roof is not contaminated with leaves or bird droppings.
3. If you have PV panels, consider mounting them on a pole away from your dwelling. (Not too far, resistance in wire will cause voltage to drop.) PV panels may be more secure from theft when mounted on your roof.
4. Consider using a tarp like a tent fly to create shade over your dwelling. Be sure fly is large enough to shade all sides of the living structure. An inexpensive silver, poly tarp will reflect lots of heat. A more expensive sun screen cloth will allow air to pass through and will allow some view. The fly should not cover PV panels or solar heaters.



TWELVE-VOLT FANS

NOTE: Inverters do not like AC ceiling fans. They will be noisy and inefficient. Use DC ceiling fans.

Our Most-Efficient DC Ceiling Fan

For keeping comfortable with a 12- or 24-volt power system, you can't beat the efficiency and quiet operation of our 42" diameter DC ceiling fan. It comes with both a close flush-mount for flat ceilings, or a down rod ball-mount for sloped ceilings. The fan can be assembled with either four or five blades, showing either walnut or oak finish (five blades included). The fan body is a charcoal-gray ABS injection casting that can be painted to match or left stock. Reversible and speed-adjustable using the solid-state controls sold below. Close mount hangs down 9.5"; down rod needs 13".

Performance specs; at 12 volts: 60 rpm, 4.8 watts, 1,800 cfm; at 24 volts: 120 rpm, 19.2 watts, 4,000 cfm. Note that performance is ... um ... modest at 12 volts. 12-volters may be interested in the 12 to 24 voltage doubler speed control sold on the next page. Fan weight 11 lb. USA.

64-495 RCH DC Ceiling Fan **$199**

Noisy, poorly made 12-volt fans will not last. On the following pages are high-quality fans that will last. The first page is from Real Goods. (Realgoods.com)

Vari-Cyclone DC Ceiling Fan

The Vari-Cyclone utilizes revolutionary "Gossamer Wind" blade design technology that delivers 40% more air flow without any increase in power use. Intended for 12- or 24-volt off-grid DC power systems, this 60" diameter fan can be assembled with either three or four blades. Finish of blades and body is white. Can be mounted as either a close flush mount for flat ceilings, or with a down rod ball mount for sloped ceilings. Hardware is included for both. Close mount hangs down 9.5", down rod takes 13". Fan becomes variable speed and reversing with addition of 12- or 24-volt solid state control listed below.

Performance specs (with 3-blade configuration): At 12 volt: 60 rpm, 7 watts, 2,500 cfm. At 24 volt: 120 rpm, 27 watts, 3,400 cfm. We recommend the voltage doubler adjustable fan speed control below for 12-volt use. Fan weight approximately 14 lbs. USA.

53-0100 Vari-Cyclone DC Fan **$279**

12V Fans

These 12VDC axial fans are ideal for moving woodstove heat throughout the house. The brushless motor design minimizes electromagnetic interference and radio frequency (rf) interference. The fans have PBT plastic housings with permanently lubricated ball bearings. All motors are polarity protected. The voltage range for the nominal 12VDC fan is 6 to 16 VDC. The two smaller fans are 1 inch in depth and the larger fan is 1½ inches deep. Size shown is square.

64-211	4C909 15cfm 0.24amps 2-3/8"	$42
64-212	4C911 32cfm 0.25amps 3-1/8"	$42
64-213	4C918 105cfm 0.55amps 4-11/16"	$45

Endless Breeze

"Endless Breeze" a powerful portable 12 volt fan. Endless Breeze is a high volume 12 volt fan with a twelve inch blade that operates at three speeds. Air movement of up to 900 CMF (cubic feet per minute) introduces a major breakthrough in 12 volt portable fans. Portable it is! Standing only fourteen inches tall on retractable legs and less than four inches deep it travels and stores easily and weights under five pounds. Endless Breeze can be powered by any 12 volt power source such as automotive lighter outlets or connecting jumpers to any 12 volt battery. Maximum current draw is three amps. Equipped with a 12 volt plug and cord. The uses for Endless Breeze are literally endless! Boats, tents, campers, sleeper cabs, horse trailers, power failures and the family car, van or SUV are a few of many applications. "We've had customers tell us they have used them to blow the bugs away on hot muggy nights or even help thaw out the RV refrigerators," said Dave Struck, Fan-Tastic's Vice President of Sales and Marketing. Endless Breeze 12 volt fans will be available through mass marketers, specialty stores and specialty catalogs.

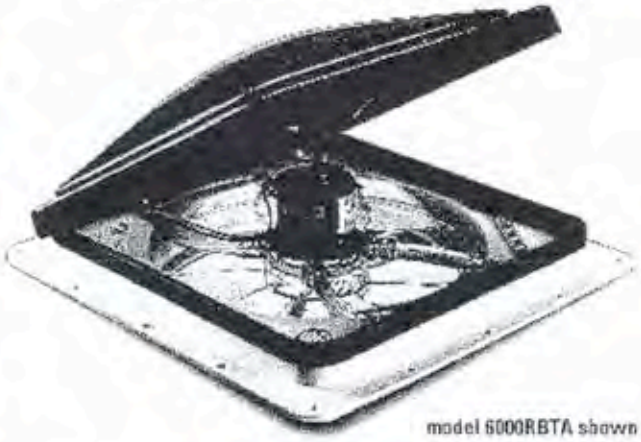
For a larger view please download the PDF version

Web address: Fantasticvent.com

Model 6000 RBTA

Web address: Fantasticvent.com

Select speed (1-low, 2-medium or 3-high). Placing the IN/OUT switch in the center (neutral) position can turn off fan blade. Automatic Dome Opener with Built-In Rain Sensor. This model is activated when the three-speed switch is turned to any of the three speed selections. The dome cover is opened when the dome up switch is activated and closed when the down feature of the switch is selected. To activate the fan blade, the built-in thermostat must be turned to a temperature selection, which is lower (cooler) than the current interior temperature. Once the selected temperature is attained, the fan blade will shut off, but the dome will remain open until the down feature is selected or the built-in rain sensor becomes wet. Once the sensor dries, the dome will re-open. A built-in manual knob can be used to close the dome in an emergency, to adjust the dome to a desired partially open level or to override the rain sensor. For storage, the dome switch must be in the down position and the three-speed switch in the off ("O") position.

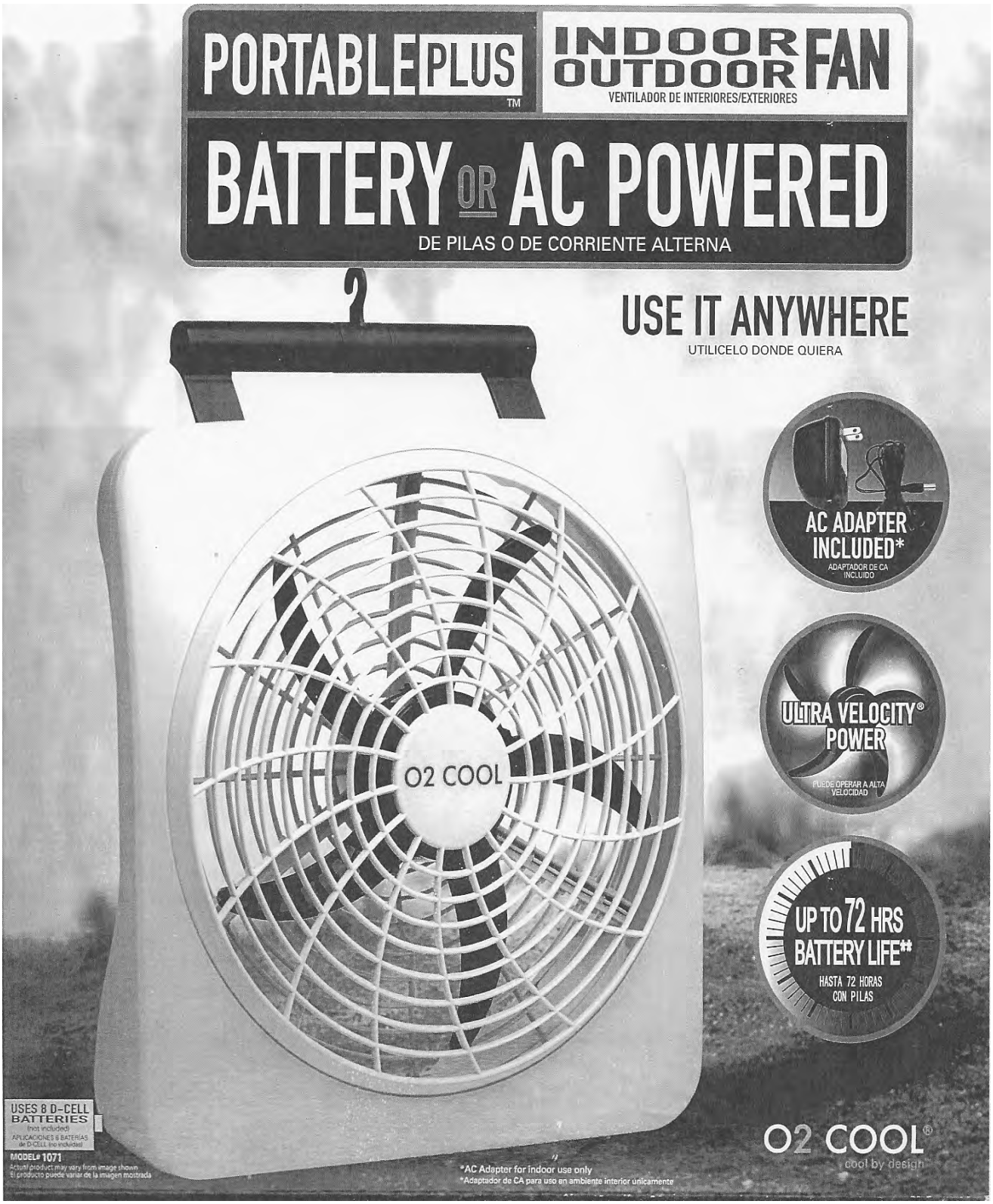


model 6000RBTA shown

model 6000RBTA bottom shown

Technical Information:

- Durable, proven longevity
- Quiet, 12 –volt ceiling fan with 3-speeds
- Lexan dome/Lifetime guarantee
- Removable screen for easy cleaning
- Reversible fan blade motor (in or out)
- Low AMP draw insures full-time use
- Optional insulated dome. Please call for informaion.



This fan is available at Walmart for $12-$15, plus $10 for a 12VDC cord. It can be wired to your 12VDC system (2009). Fan uses .3 amps on low and .6 amps on high.
O_2 Cool fans with 12VDC plugs are available at New Tribes.

AC Solar
Alternative Choices Solar, Inc.
solar and wind power specialists
1-800-784-3603

Note: This is a bid from 2002 showing options for powering fans.

Jack Dody
PO Box 26
Rush, CO 80833
719-471-4231

ITEM	DESCRIPTION	#	PRICE	TOTAL
OTB	12 volt Oscillating Table Fan	1	$ 38.00	$ 38.00
PW80	Photowatt 80 Watt Modules	1	$ 346.00	$ 346.00
SW5	Solsum 5 Amp Charge Controller	1	$ 39.00	$ 39.00
T220	Trojan Golf Cart Batteries - 6V 220Amp	2	$ 75.00	$ 150.00
BC#2/0	Battery Cables	1	$ 9.50	$ 9.50
			SUBTOTAL	$ 582.50
			DISCOUNT 5%	$ (29.13)
			TOTAL	$ 553.38

March 11, 2002
Prices do not include tax, freight, or installation.

PV SPECS: 80Watts @ 17.75V, 4.8 Amps, 25 Year Warranty.
BATTERY STORAGE: 220 Amphours @ 12 Volts.

ITEM	DESCRIPTION	#	PRICE	TOTAL
CF12	12 Volt Ceiling Fan	1	$ 165.00	$ 165.00
SW20	Sunwize 20 Watt Module	1	$ 145.00	$ 145.00
SW5	Solsum 5 Amp Charge Controller	1	$ 39.00	$ 39.00
T220	Trojan Golf Cart Batteries - 6V 220Amp	2	$ 75.00	$ 150.00
BC#2/0	Battery Cables	1	$ 9.50	$ 9.50
			SUBTOTAL	$ 508.50
			DISCOUNT 5%	$ (25.43)
			TOTAL	$ 483.08

March 11, 2002
Prices do not include tax, freight, or installation.

PV SPECS: 20Watts @ 16.5V, 1.22 Amps, 20 Year Warranty.
BATTERY STORAGE: 220 Amphours @ 12 Volts.

P.O. Box 128
Florence, CO 81226

acsolar@earthlink.net
www.acsolar.com

SMALL IS BEAUTIFUL !

MAXIMIZING THE SPACE THAT YOU HAVE...

Simplify, simplify, simplify...before you go any further, figure out what you really need in your space. Get rid of everything else. No matter what tricks you use to maximize space, if you pack it with too much junk, it will be cramped and cluttered. Consider building a shed for your seldom used stuff that you just can't part with. Think priorities. How do you want to use your space? Do you work at home? Do you entertain? Are you an avid reader with a need for a big, soft chair? Think necessities. Decide which things are essential, which would be great to have, which you can live without if necessary.

Colors can add space...use light colors, cool colors (light blues and greens, buttery yellows). Use tone-on-tone color techniques. Paint furniture and recover with cloth that matches the room's colors. Avoid wallpaper borders and darkly painted moldings in small rooms; they tend to outline the room's dimensions and can make your space seem smaller. Painting moldings and trim a slightly lighter color than the walls can make the room loftier and more spacious.

Eliminate obstructions...the farther you can see into and through a space, the larger it will seem. Arrange furnishings to open up areas of floor. Avoid blocking views to windows and doors. Consider open plans with fewer walls. Low benches, ottomans and armless chairs are good choices.

Bring in more light...banish room darkening shadows by uncovering windows and adding more light fixtures. (L.E.D. lighting will not use very much homemade electricity). Consider cove lighting, up-lights, rope lights, bookshelf lights, etc. Consider skylight, light tubes, clerestory windows and glass blocks.

Use mirrors...mirrors can add sparkle and dimension to any room. Use mirrors for table tops. When you hang mirrors on a wall, make sure they will reflect something you want to see.

Use glass and Lucite...furniture made of these materials will add

see-through style.
Use sheer fabrics...for window treatments and tablecloths. Let light shine through while adding softness. Avoid heavy, fancy window treatments that cut out light and make the room feel fussy.

Use larger pieces and accessories...reduce visual clutter by using fewer pieces. Lots of small pieces can make a room look cluttered. Clutter takes up space, lots of space.

Use plain upholstery...cover sofas and chairs with plain cloth rather than vibrant prints. Neutral tones in lighter colors will make the room feel larger.

Use closed storage...to cut down on clutter.

Use smooth surfaces...avoid sharp corners. Round edges of walls and furniture. Use sleek handles, or no handles at all, on furniture and cabinet doors. Avoid gross, bold textures.

Create visual lines...use floor patterns that extend the path of the eye. Let windows take the eye outside. Create a smooth inside to outside transition with plants and ground coverings.

Use one type of wood...for trim and furnishings. Use just a few design materials and colors.

Use simple floor coverings...with monochromatic tones. Wall-to-wall coverings are better than area rugs that break up a room's space. Low pile carpets provide less obtrusive textures. Tile laid on the diagonal fools the eye and makes space appear larger.

Think multi-function...a cedar chest (or other chest) which can be used as storage can also be a coffee table. A kitchen table can also be a desk. A chest of drawers can hold office supplies, linens, CDs or even stereo components.

Use built-in storage...built-ins can be squeezed into any nook or cranny. They often take less floor space than regular furniture.

Think vertical...the most underused space in any room is the two or

three feet below the ceiling. Instead of a three or four foot tall bookcase, think about a seven foot one. Mount shelves high up on walls, over windows and doors, or above kitchen cabinets.

Think about scale…every piece of furniture, every fence, every door and window should be of an appropriate size for your living space.

Be creative with sleeping space...consider lofts, futons, pull-out couches and day beds. Go visit some newer college dorm rooms where beds are often placed above study/eating spaces.

Pare down on clothing...pick two coordinating colors of basics (for instance, navy and tan). Try to have no more than two each of these: pants; jackets; sweaters; skirts; dresses; and two pairs of shoes.

Make outside part of your living space…let your eye be led outside by windows and floor coverings. Let dominant outside colors and designs be used inside to create a transitions. Use decks and balconies.

Use various ceiling heights…to “open” a room.

Use folding doors…or sliding doors and panels and pocket doors.

All of the ideas above were taken from numerous sources. Below is a reading list:

Big Ideas for Small Spaces by Christine Brun-Abdeinour

Compact Living by Jane Graining

Designing for Small Homes by Dylan Landis and Donna Warner

House Beautiful by the editors of “House Beautiful”

Living in Small Spaces by Lorrie Mack

One Space Living by Cynthia Inions

Spaces for Living by Liz Bauwens and Alexandria Campbell

Studio Apartments: Big Ideas for Small Spaces by James Grayson Trulove and Il Kim

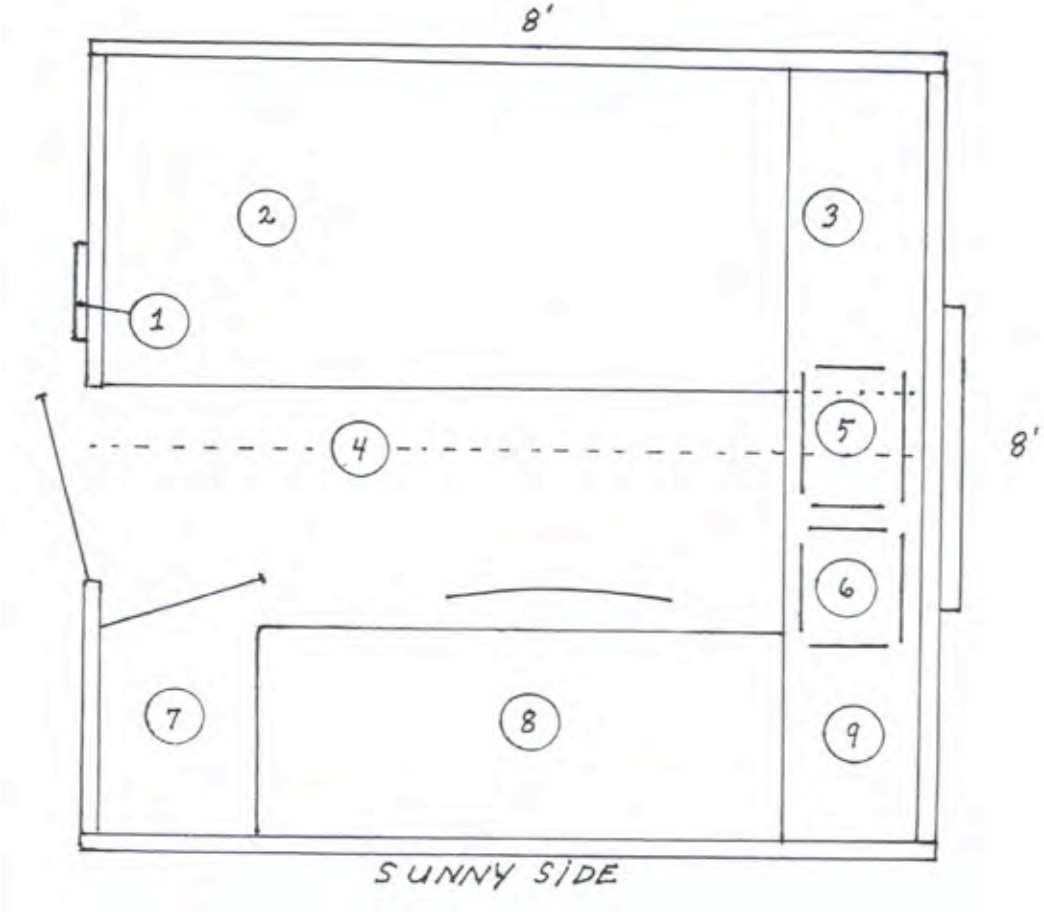
Blueprint Small – Creative Ways to Live with Less by Michelle Kodis, Gibbs Smith Publisher, © 2003.

Check out “tiny Houses” on the net. Lots of great ideas.

For some wild ideas:
www.fastcompany.com/magazine/160/environmental-prep-school?...

A-House ~ Floor Plan

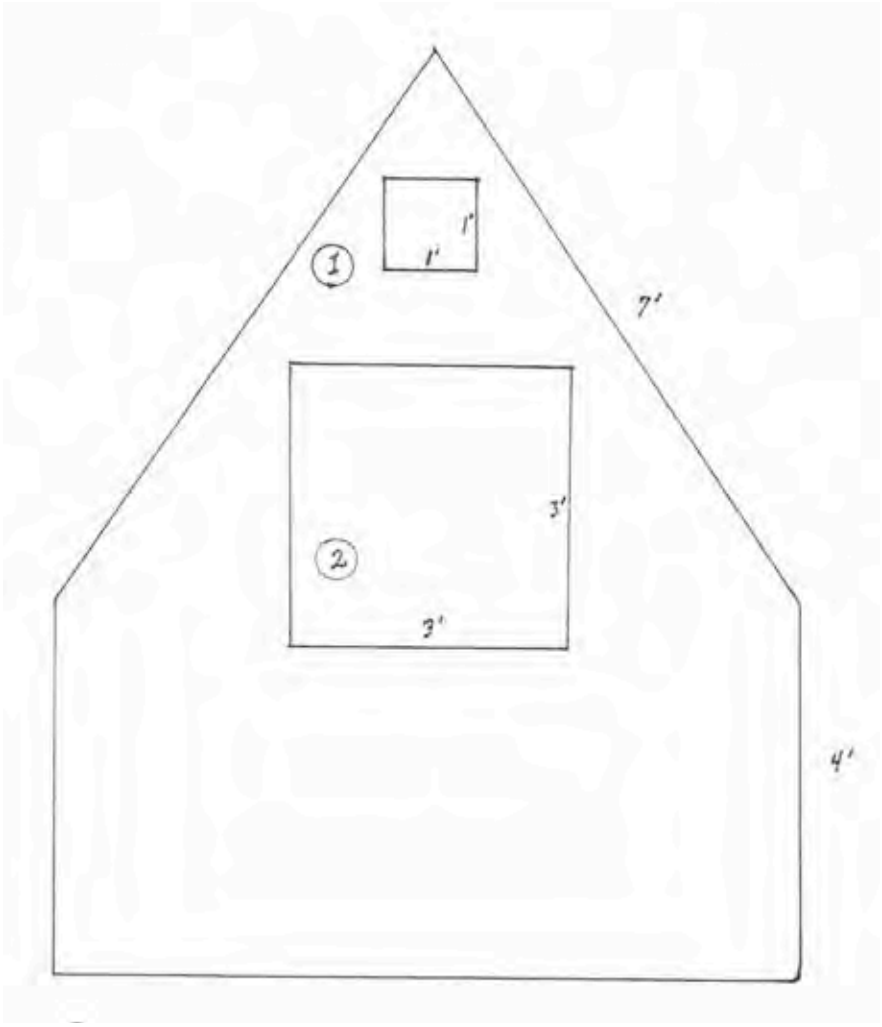
Scale ½" = 1'



1. Fantastic vent/fan
2. Bed (39" wide) storage below
3. 36" counter (above bed ~ space allowed for feet)
4. Ridgeline
5. Stovetop with cover
6. Sink with cover
7. Closet
8. 30" table/desk ~ storage below
9. Battery storage ~ on floor under desk

A-House ~ E. Elevation

Scale ½" = 1'



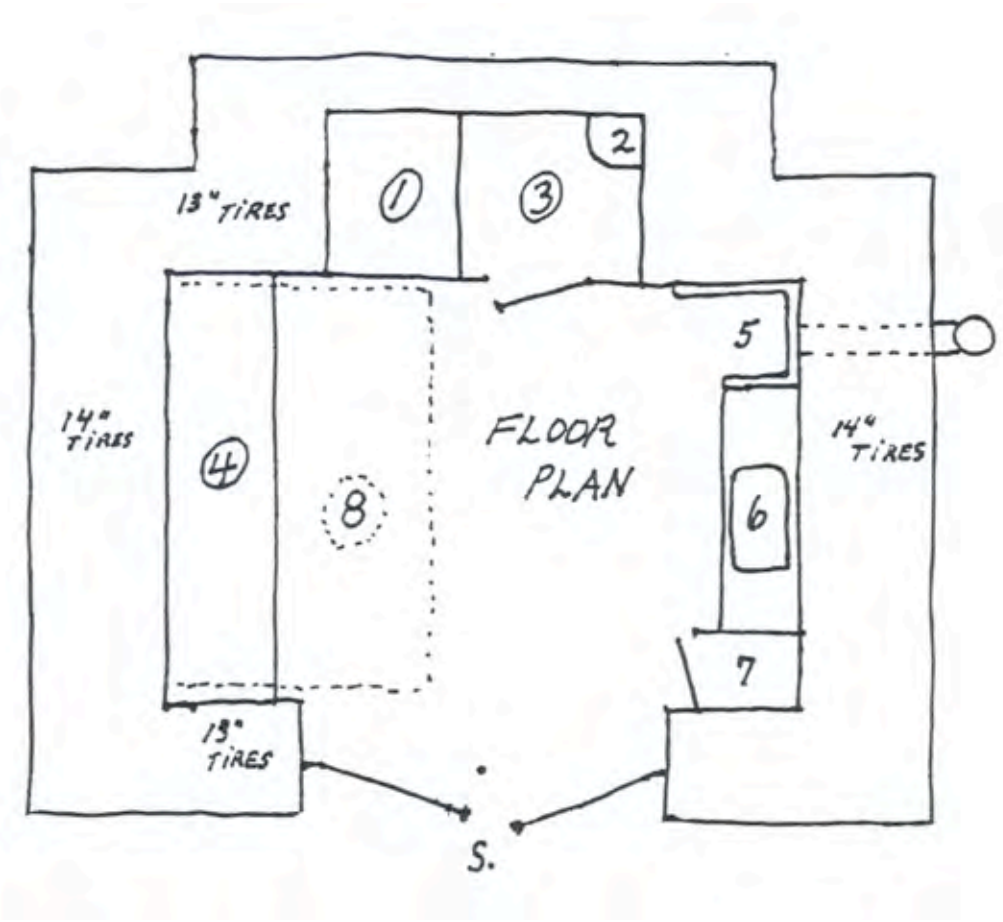
1. Vent / Fan
2. Window

Notes:

- Uses standard 4' x 8' sheathing
- Shape gives sense of openness
- Can be combined with Life Support Module for shower/toilet and woodstove

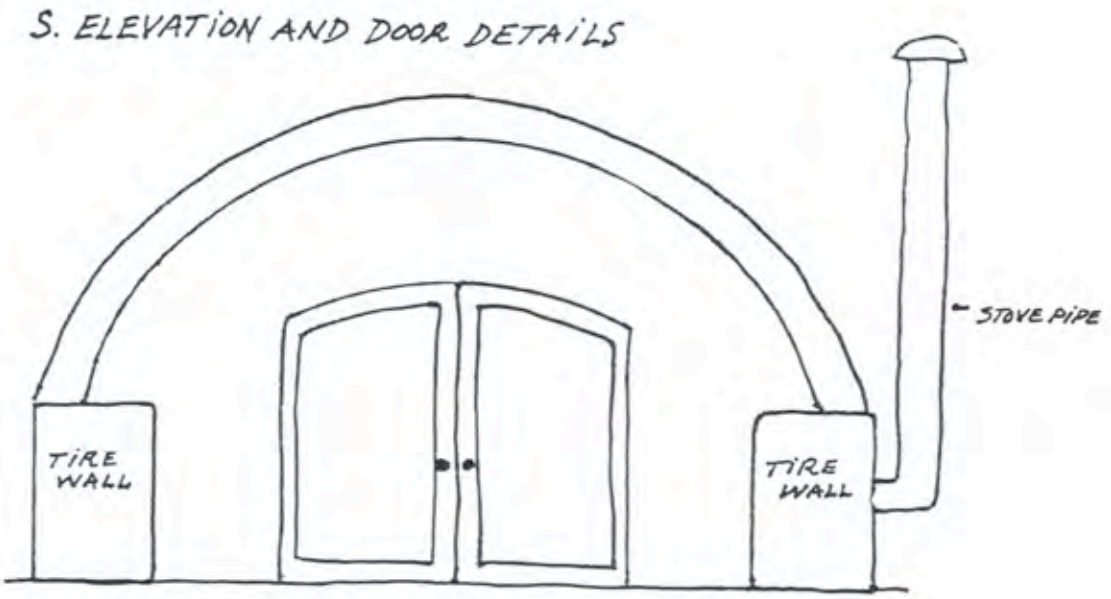
Arch House

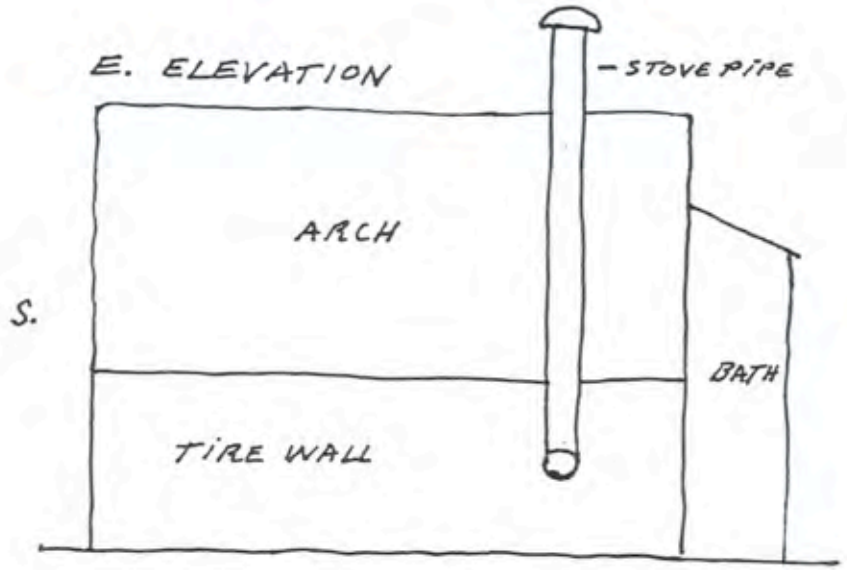
Scale ¼" = 1'



1. Composting Toilet
2. Bath Sink
3. Shower Area
4. Table – Desk – Drawers
5. Fireplace
6. Kitchen Sink
7. Closet
8. Area used when bed is down

The Arch House

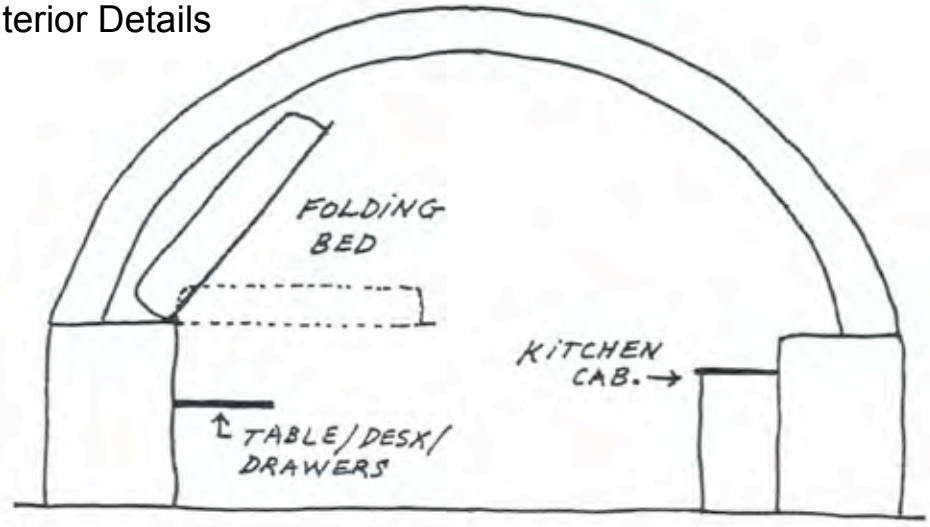




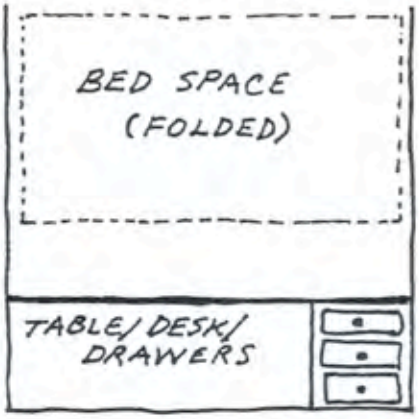
© 2002 Jack Dody

The Arch House

Interior Details



West Wall Interior

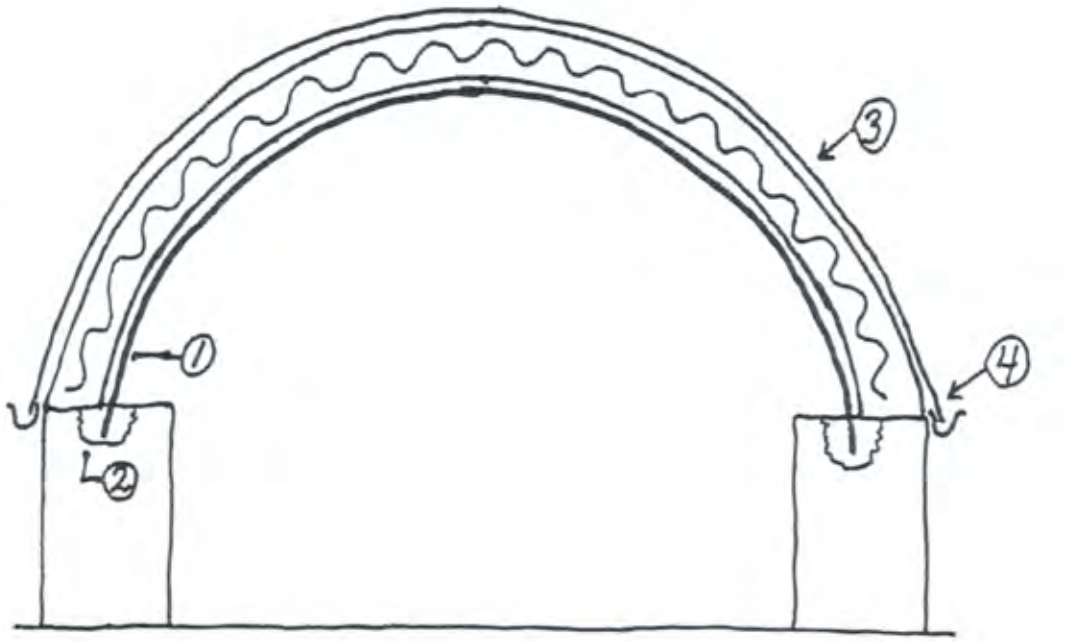


East Wall Interior

1. Wood burning Stove
2. Sink
3. Closet

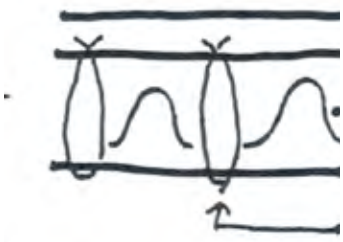
The Arch House

Roof Construction Details



1. Build the arch. Use re-bar, PVC, bamboo, etc. The arch components are 20' long.
2. Set arch in concrete.
3. Create roof quilt. Use three silver, poly tarts. Silver tarps will last longer in the sun's ultraviolet light than other colors. It also reflects heat. Infill the roof quilt with at least 12" of insulative material.

Detail of Roof Quilt -

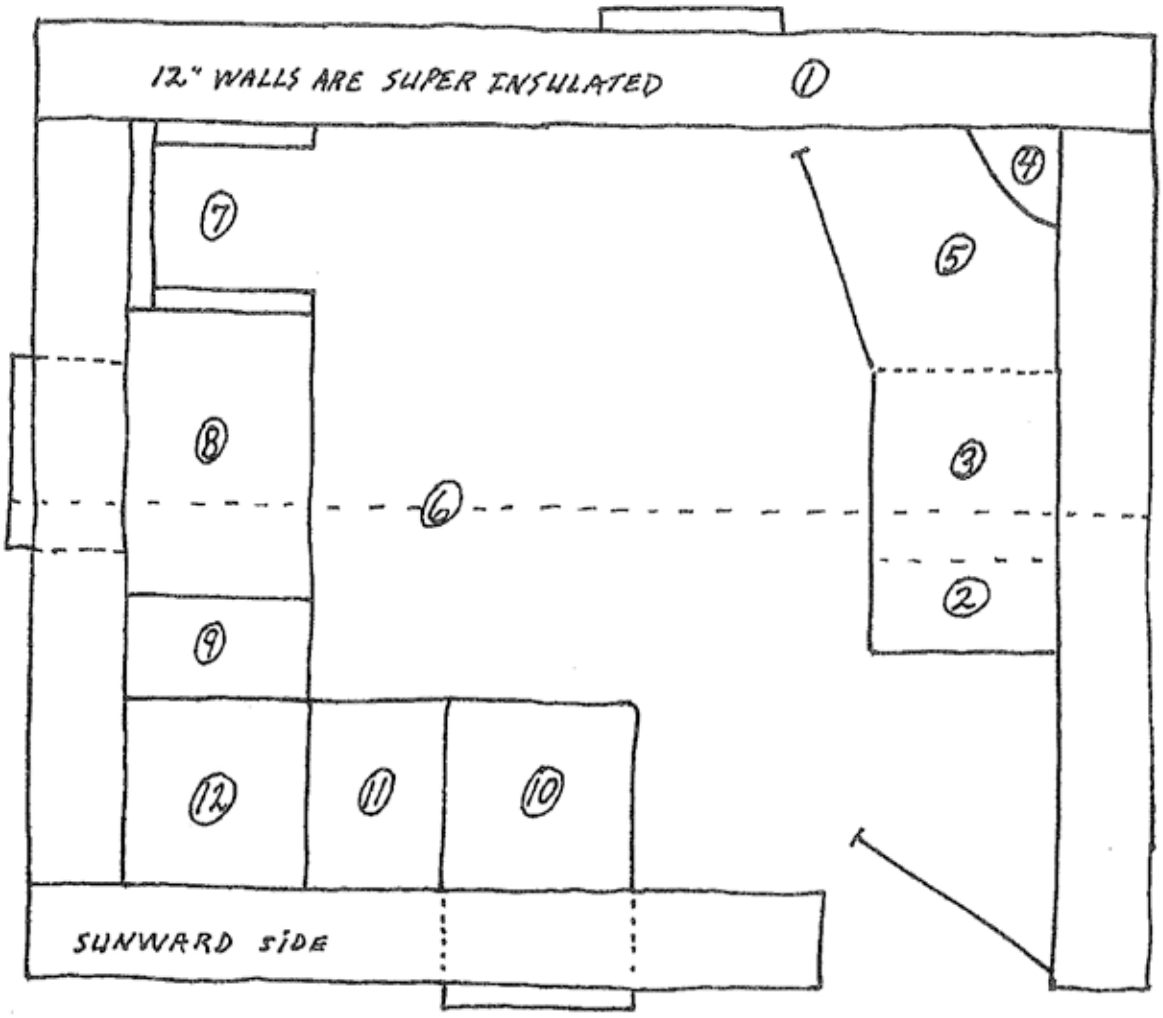


Tarp #1 – seamless, without holes
Tarp #2
Insulative Material
Tarp #3
Poly ties to bind tarp #2 & 3

Note: You will need a very large needle to tie tarps together.

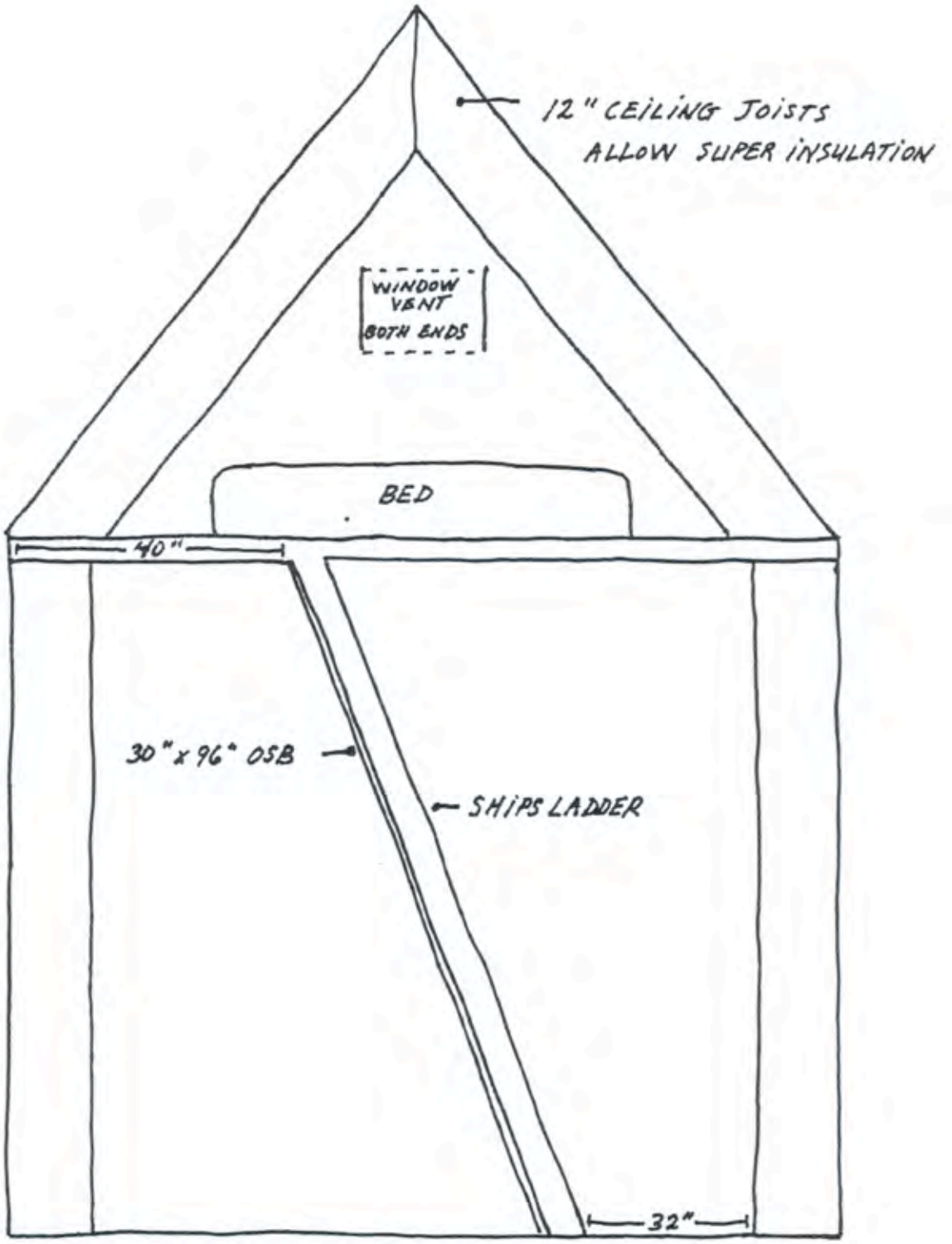
4. Tarp #1 is the last to be installed. It must overlap the rain gutters so that all rain is captured.

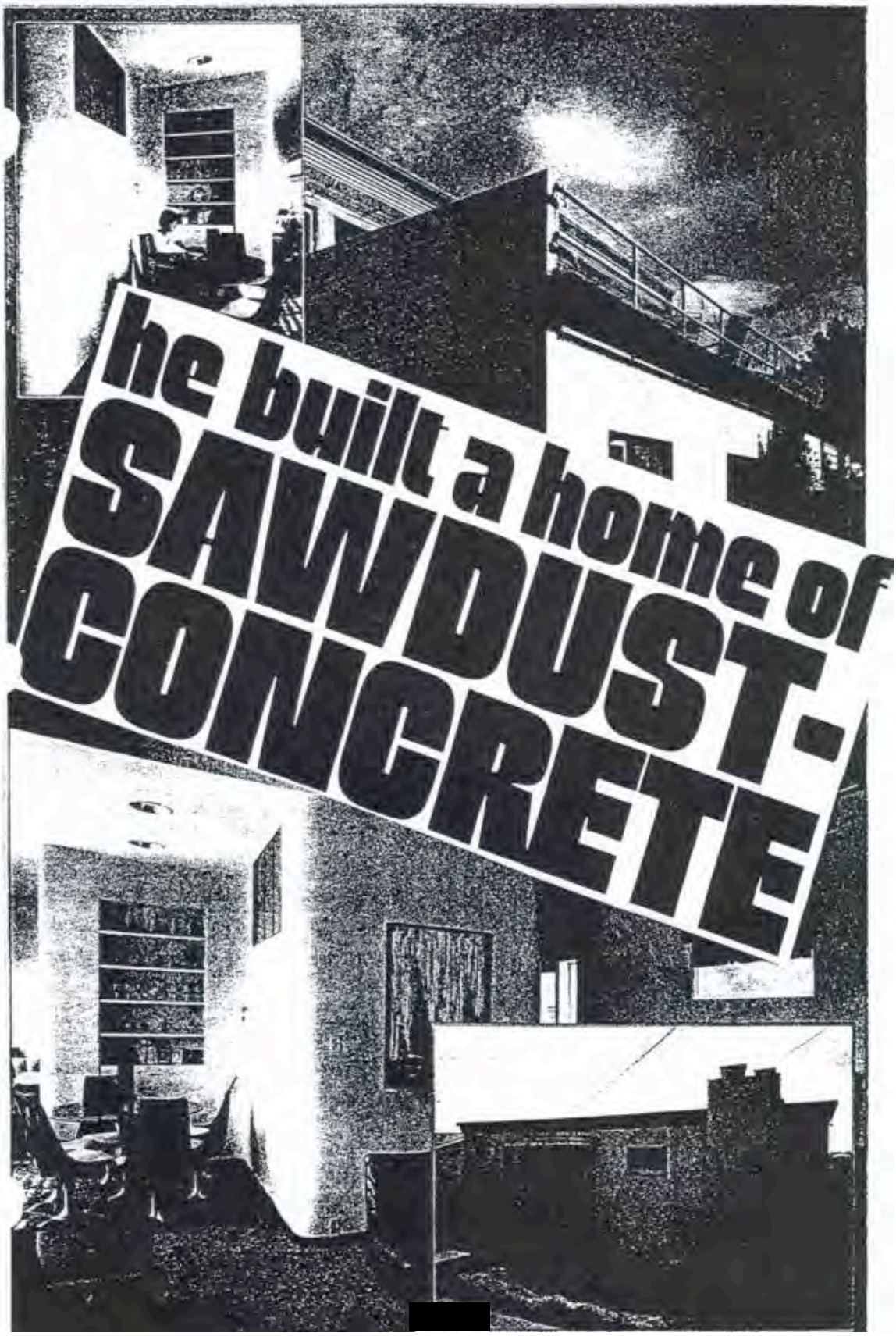
The Loft House ~ Floor Plan

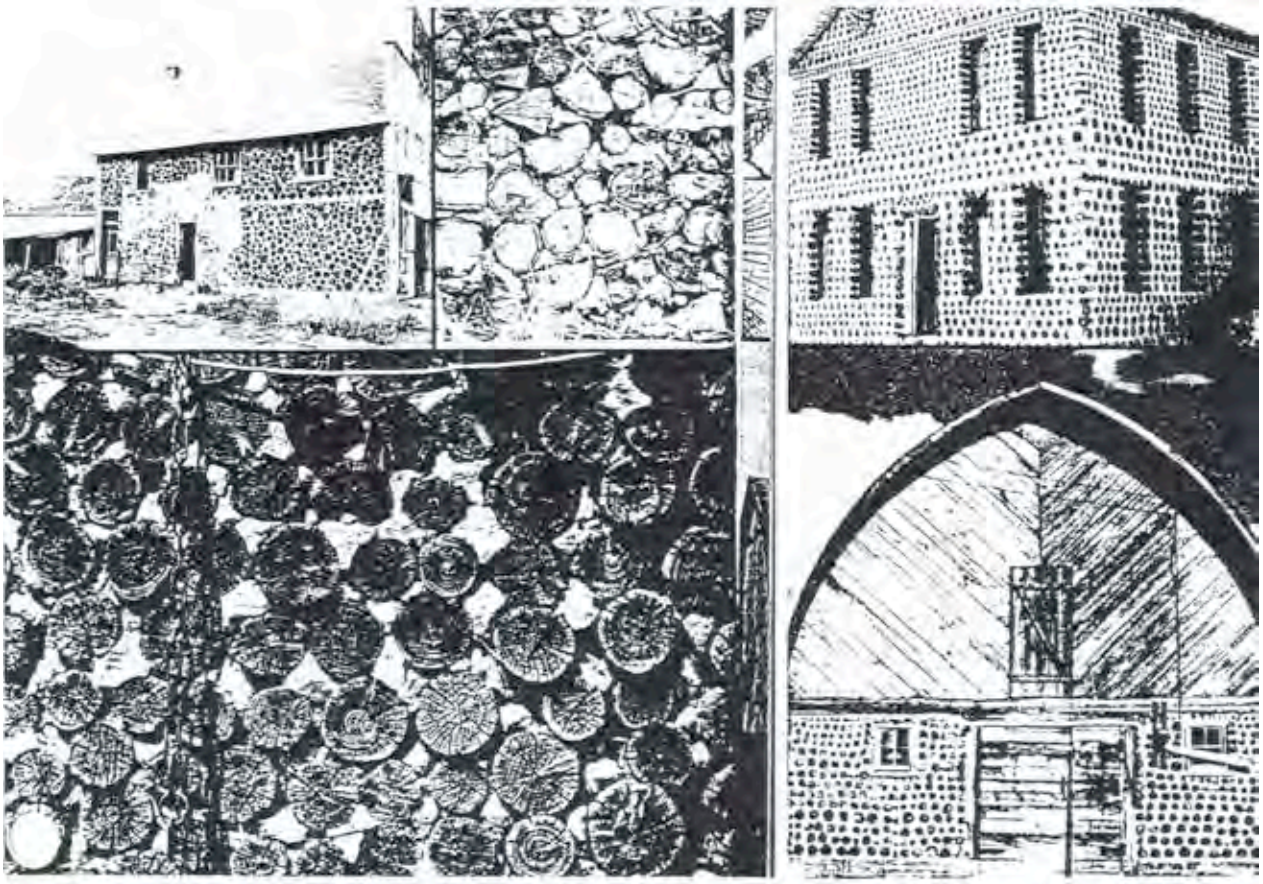


1. 12” Walls
2. Ladder to Loft
3. Composting Toilet
4. Bath Sink
5. Shower Area
6. Roof Ridge Line
7. Wood Stove with metal cover to extend cabinet space
8. Double Sink
9. Shelf Area
10. Table Area
11. Closet – floor to ceiling
12. Storage – floor to ceiling

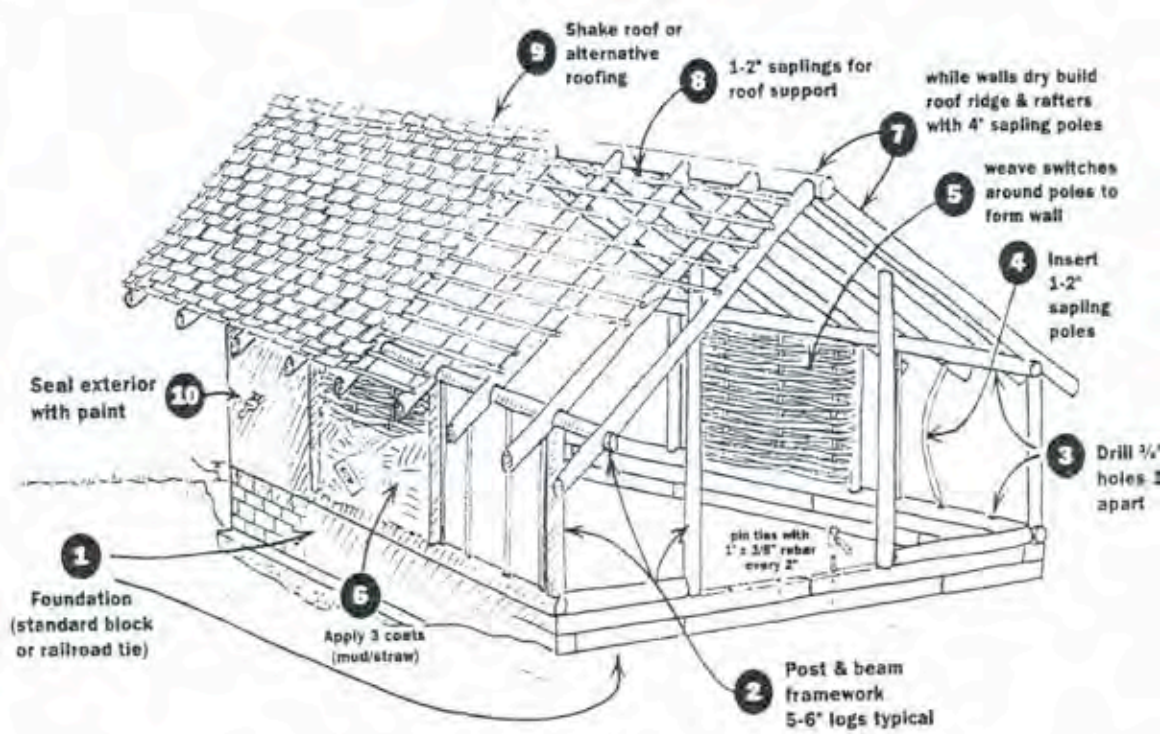
The Loft House ~ Elevation




he built a home of
SAWDUST-
CONCRETE

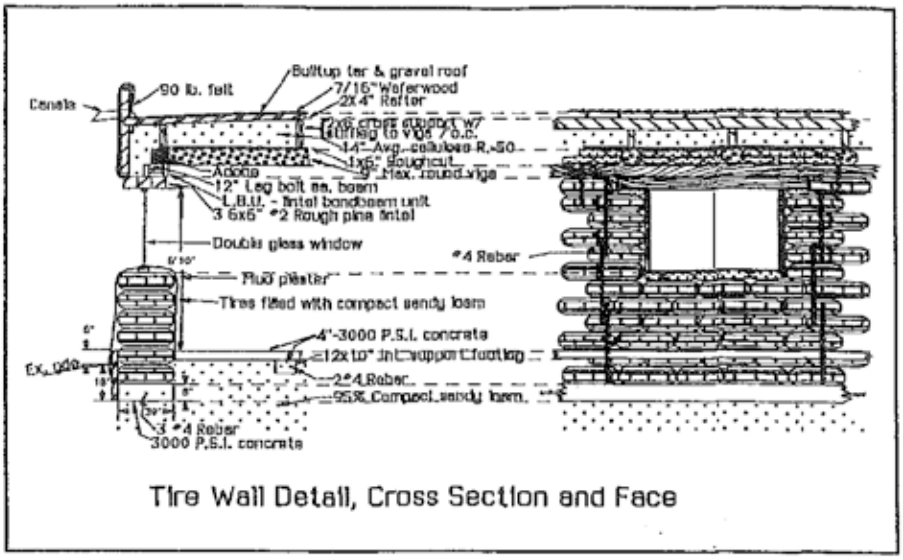


A CENTURY (OR MORE) OF STACKWOOD HOMES



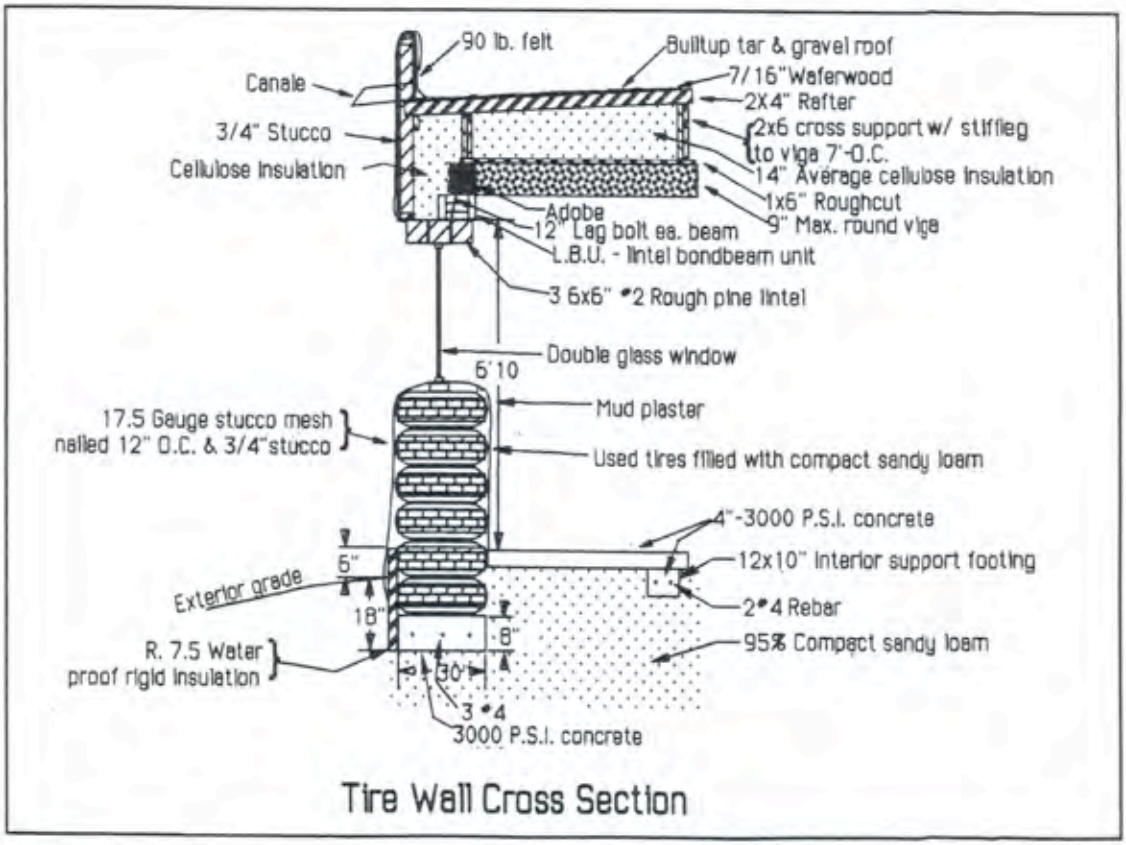
Use "wattle & daub" methods for low-cost construction

BUILD WITH OLD TIRES



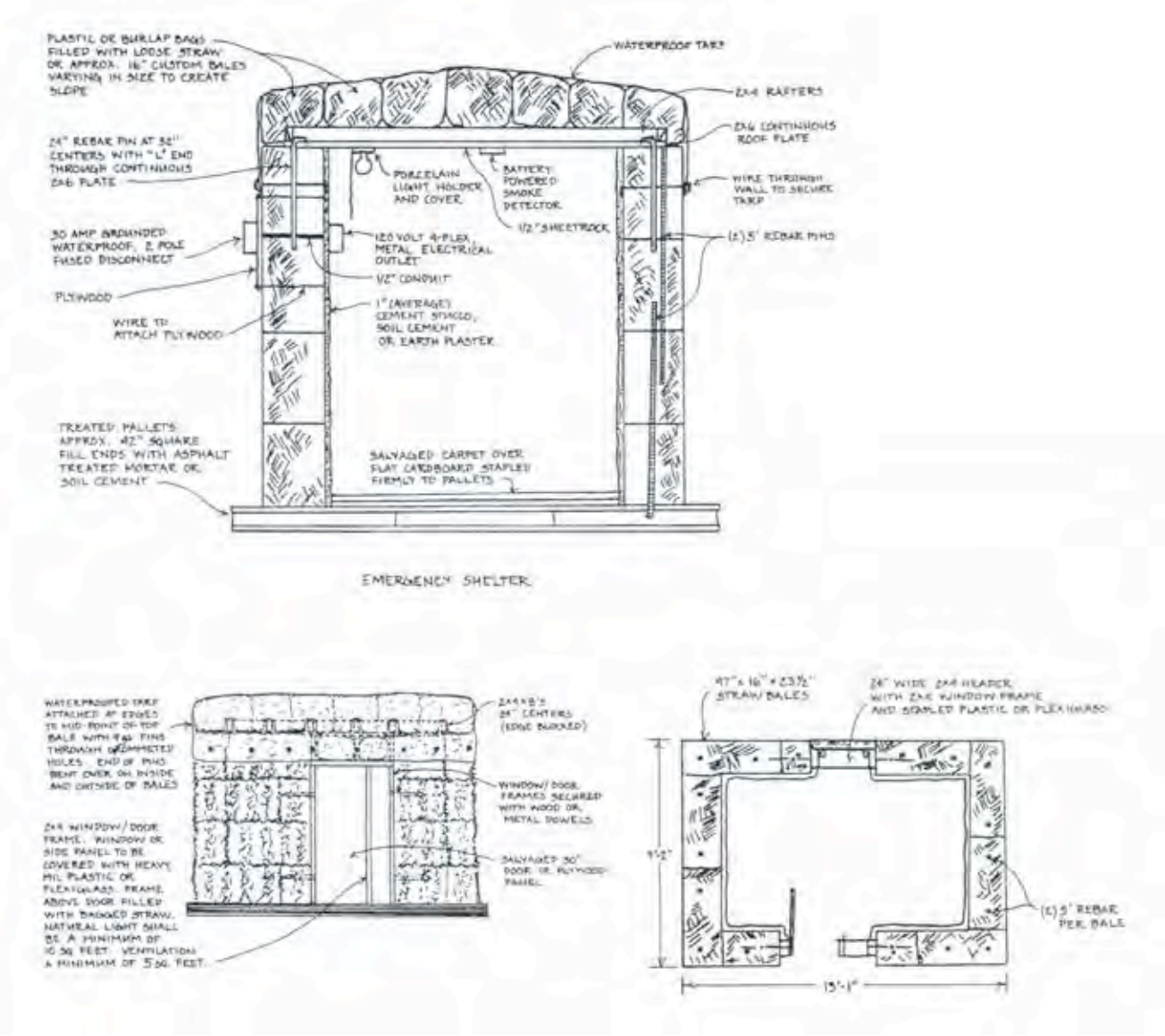
Tire Wall Detail, Cross Section and Face

These illustrations come from ***The Tire House Book*** by Ed Paschich and Paula Hendricks. This book is an excellent, simplified overview of building with tires. It includes information on the time-saving technique of cutting out the top rim of each tire for easier compacting. ***The Tire House Book***, Sunstone Press, Box 2321, Santa Fe, NM 87504-2321 © 1995, 505-988-4418



Tire Wall Cross Section

BUILDING THE STRAW BALES



A cooperative project of the Development Center for Appropriate Technology and Out on Bale, with help from Tucson architect Bill Ford, has created a design for a temporary emergency shelter for victims of homelessness or disasters. The city of Tucson will issue permits to construct this straw-bale shelter, which can be inexpensively built, especially when using salvaged and donated materials. For further information, contact David Eisenberg of the Development Center for Appropriate Technology.

This illustration is from an excellent book, The Straw Bale House, from Chelsea Green Publishing, © 1994, p. 236.

Earthbag Building

Poly bags, often used for feed, are filled with earth and tamped.

Barbed wire prevents bags from slipping.

These illustrations come from *Earthbag Building* by Kaki Hunter and Donald Kiffmeyer. This book provides clear, step-by-step instructions.

New Society Publishers
P. O. Box 189 Gabriola Island
BC VOR 1XO, Canada
copyright 2004

Another excellent resource is found on the Internet:
calearth.org/emergshelter.htm

A bond beam ties walls together and provides a point of attachment for the roof.

RECOMMENDED READING

The Passive Solar Energy Book, Edward Mazria. Rodale Press, 1979. This is a must for anyone designing a passive solar structure. It is a compilation of hundreds of basic passive solar design ideas, with photographs.

Earthships I, II, III, Michael Reynolds. Solar Survival Press, Taos, NM, 1990. Another must. Michael lived out in the desert of New Mexico and put in 25 years of practical research. His work has provided a cornerstone for sustainable living design.

Solar Spaces, Darryl J. Strickier. Van Nostrand Reinhold Co., Inc., 1983. This book gives good examples of working solar greenhouse-type structures. Lots of good ideas for retrofitting an existing conventional house.

The Owner-Built Home, Ken Kern. Charles Scribner's Sons, 1975. This is a must for any serious builder. Kern has interesting layout ideas and simplified charts that will help any builder create a safe, sturdy dwelling.

The Have-More Plan, Ed and Carolyn Robinson. Great book about the rationale of homesteading. Fascinating because it was written in the '40's.

Solar Houses for a Cold Climate, Dean Carriere and Fraser Day. Charles Scribner's Sons, 1980. Good photos of solar installations.

Introduction to Permaculture, Bill Mollison and Reny Mia Slay. Tagari Publications, P.O. Box 1, Tyalgum NSW2484 Australia, 1991. Thought-provoking presentation on how all natural systems are intertwined. Good practical ideas on design and building. Reader must take into consideration that the authors are socialists, leaning toward pantheism.

The Passive Solar House, James Kachadorian. Chelsea Green Publishing. Box 428, White River Junction, Vermont 05001.

1997. Good primer for passive solar basics. Of particular interest is the author's Solar Slab concept for heat storage.

The New Ecological Home, Daniel D. Chiras, 2004, Chelsea Green Publishing Co., White River Junction, Vermont.

From Eco-Cities to Living Machines, by Nancy Jack Todd and John Todd, 1994. Lots of interesting ideas using biology, primarily composting and solar power, to solve living problems. Authors are committed socialists/communists.

MAGAZINES

For excellent examples of unique buildings, There are three periodicals that I read cover-to-cover. They present practical, often inexpensive solutions for the homesteader. For the most part, all three publications are written by people living the homestead life.

"Countryside" P.O. Box 6017, Duluth, MN 55806-6017 .1-800-551-5691, 8-4 Central time

"Back Home" P.O. Box 70, Hendersonville, NC 28793 1-800-992-2546

"Backwoods Home" P.O. Box 712, Gold Beach, OR 97444 1-800-835-2418

The Solar Ark...

On-site water collection and water conservation...

(water catchment and gray water systems)

The World Health Organization says 1.1 billion people do not have access to an improved water supply (2000).
2.4 billion do not have access to “improved sanitation.”

International Forum on Globalization (1999) Blue Gold Report.
Consumption of water is doubling every 20 years, at twice the rate of population growth.

STEPS ON THE PATHWAY TO ABUNDANCE

WATER

Matthew 5:45c *… He [God] sends rain on the righteous and the unrighteous.*

Zechariah 10:1 *Ask the Lord for rain in the springtime; it is the Lord who makes the storm clouds. He gives showers of rain to men, and plants of the field to everyone.*

Leviticus 26:3-4 *[3]If you follow My decrees and are careful to obey My commands, [4]I [God] will send you rain in its season, and the ground will yield its crops and the trees of the field their fruit.*

Isaiah 24:4-5 *[4]The earth dries up and withers, the world languishes and withers, the exalted of the earth languish. [5]The earth is defiled by its people; they have disobeyed the laws, violated the statutes and broken the everlasting covenant.*

Improve and increase water resources by utilizing all rainwater that falls on your property.

Psalm 65:9 *You [God] care for the land and water it; You enrich it abundantly. The streams of God are filled with water to provide the people with rain, for so You have ordained it.*

Isaiah 41:17-18 *[17][God speaking] The poor and needy search for water, but there is none; their tongues are parched with thirst. But I, the God of Israel, will not forsake them. [18]I will make rivers flow in barren heights, and springs within the valleys. I will turn the desert into pools of water, and the parched ground into springs.*

- ☐ Reduce erosion and increase rainwater infiltration.
  Slow wind and water flow with vegetation, mulch, contouring, dams, swales, etc.

- ☐ Use roof catchment and cisterns or ponds to prepare for drought.

In Roman times six large towns, Auja, Esbeita, Khalasa, Ruheiba, Abda, and Kurnub (5k to 10k each) relied on cisterns. Every house had a cistern in the basement, as they have now (1939) in Jerusalem. In every town also there were enormous cement reservoirs in which the whole of the rain was collected, and dotted all over the mountainside were these underground cisterns or harabas carved out of living rock. from Palestine Land of Promise, Lowdermilk, p. 185

- Create a wooded area to increase rain through evapotranspiration. A large tree can put 300 gallons of water into the air daily.

Isaiah 41:17-20 (Notice how God speaks of increasing water and planting trees in the same chapter.) *[God speaking] The poor and needy search for water, but there is none; their tongues are parched with thirst. But I the Lord, will answer them; I the God of Israel, will not forsake them. I will make rivers flow in barren heights, and springs within the valleys. I will turn the desert into pools of water, and the parched ground into springs. I will put in the desert the cedar and the acacia, the myrtle and the olive. I will set pines in the wasteland, the fir and the cypress together, so that the people may see and know, may consider and understand, that the hand of the Lord has done this, that the Holy One of Israel has created it.*

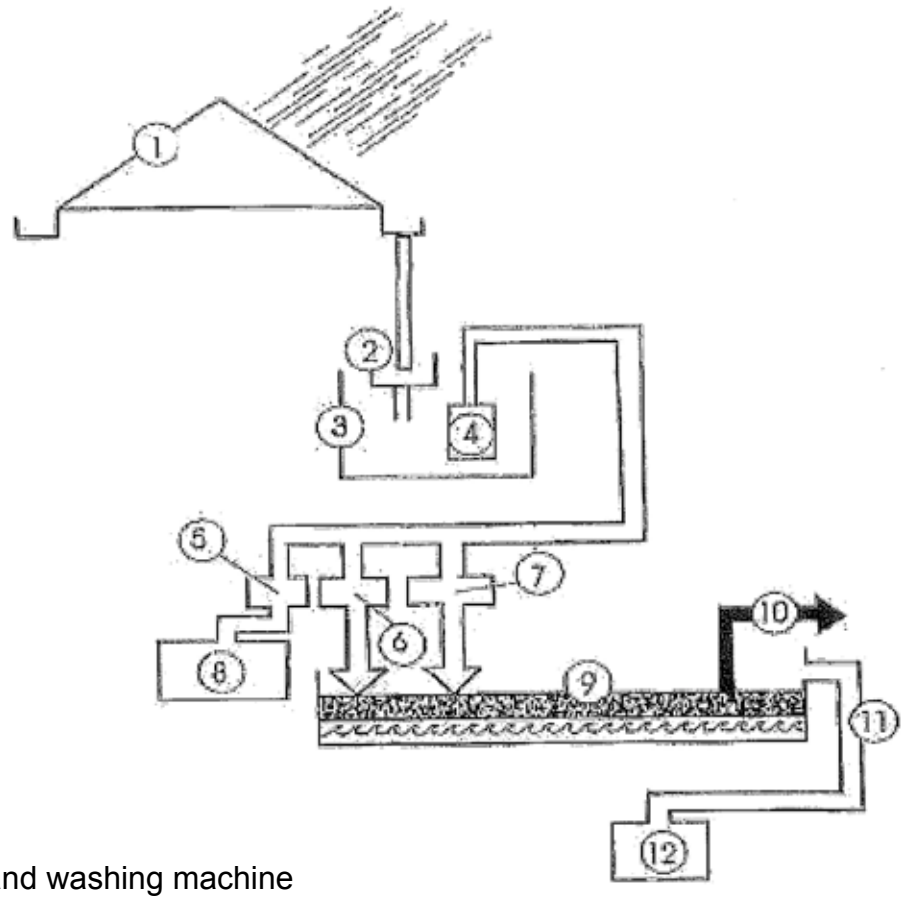
- Avoid polluting any water source.

Ezekiel 34:18-19 *…Is it not enough for you to drink clear water? Must you muddy the rest with your feet? Must my flock feed on what you have trampled and drink what you have muddied with your feet?*

- Manage solid waste with composting.
- Send blackwater to septic systems.
- Reuse graywater for vegetation.
- Use irrigation methods that conserve water: drip systems, measured watering, sub-irrigation planters, etc.

Water System Diagram

(Dody residence)



1. Roof
2. Filter
3. Cistern
4. Pump
5. Kitchen sink and washing machine
6. Bathroom sinks
7. Tub or shower
8. Kitchen drywell
9. Planter
10. Gray water for plants
11. Planter overflow
12. Planter drywell

SYNERGY

If you need less water, you need to store less water. If you need to store less water, your holding tank can be much smaller, simpler and less expensive.

WATER SAVING IDEAS...

... Use handiwipes for hand cleaning and work surface cleaning. (You can make your own handiwipes.)

... Use the SIP method (Subterranean Irrigation Planters) for gardening.

... Use waterless hand sanitizer.

... Measure water for gardening

... Take "Marine" showers.

... Build a graywater system.

... Use polymers in the garden.

... Use mulch in the garden.

... Use containers for gardening.

... Use drip systems for irrigation.

... Use a tippy-tap.

... Use paper plates.

…Use water rings around plants.

BACK HOME JAN/FEB 2C

Water Conservation: The Secret to Successful Storage

By Doug Pushard

The most economical approach to water storage is water conservation. Being mindful of our most precious resource is neither difficult nor expensive, and simple lifestyle changes can have a major impact on how much water we actually consume.

1. The Bathroom

According to the U.S. Environmental Protection Agency, the bathroom typically uses almost 75 percent of the water used inside a house. If you can focus only on one room inside the house, focus on the bathroom.

• Toilets are the major consumer of fresh, clean drinking water in a typical house. Go low-flow at 1.6 gallons per flush, less than half of older toilets.

• Go with a dual-flush or composting toilet to save even more water. The new composting toilets are quick, odorless, and provide fertilizer for your yard.

• Check your faucets and toilets for leaks at least annually. One drop per second can waste up to 2,700 gallons of pure drinking water a year.

• On average, a regular faucet uses about 4 gallons a minute. New low-flow models use half the water without noticeably affecting the pressure.

• Older showerheads (pre-1992) supplied water at up to 5.5 gallons per minute (gpm), while newer high-efficiency ones use no more than 2.5 gpm. By replacing your showerhead you could save 20 to 25 gallons per shower. Keep your showers to less than 5 minutes.

• Turn the water off while brushing your teeth.

2. The Laundry Room

• New Energy Star clothes washing machines can save up to 20 gallons or more per wash over older models.

• When doing laundry, always match the water level to the size of the load. Only wash full loads of laundry when possible.

3. The Kitchen

• Replace your current kitchen fau cet with a new low-flow model.

• Wash your produce in a pan an reuse the water in your garden.

• Avoid defrosting frozen food under running water.

• Use your dishwater a second time by putting it in the garden instead c down the drain.

• Sink disposals use a lot of wate Start a compost bin and avoid using th kitchen disposal altogether.

• When buying a new dishwashe look for an Energy Star model.

4. The Outdoors

Summer will be here sooner tha you think. Outdoor watering in the hc season can use more than 40 percer of the water consumed, dependin on how arid it is where you live. It i the biggest consumer of summertim water.

• Install a drip irrigation system. delivers water only to the plants an not to bare soil. Heads can be correctl sized for each plant.

• Water only during the mornin hours, to reduce evaporation. Invest i a multifunction zoned irrigation time These timers allow you to set differer watering times for your trees, shrub flower beds, vegetables and othe plants. Water only the amount yo need to water for each type of plan Overwatering your plants is bad fc them and bad for the pocketbook.

• If you have a sprinkler or drip irr gation system, install a rain gauge. N need to water if it is already raining

• Rip up that lawn and go with na tive plants that are less water-intensiv This does not mean a rock garden; i almost all areas of the country ther are colorful native plants and grasse that use much less water and add colc spring through the fall.

• Never just let the hose run. Insta good quality, nonleaking nozzles c all hoses.

• Lay two to four inches of mulc around plants to retain moisture.

• Install porous materials for wall ways and driveways to keep the wat in your yard.

• Use a broom, not water, to clea outside areas.

A WATER CATCHMENT SYSTEM

Unless you have a good spring or a year-round creek flowing across your property, catching rainwater is often the simplest and least expensive way to secure the water that you need.

My friend, Glen Eitemiller, is dedicating his life to the poor, helping them have clean water. Here are his words: “I am increasingly a believer in rain water harvesting! It is such a no brainer! It’s free, easy to collect, and in most cases it’s the best water available.”

Rainwater Harvesting Principles:
from Colorado Gardener April 2010 (adapted from Brad Lancaster’s book *Rainwater Harvesting for Drylands and Beyond*, volume 1)

1. Observe. Go out in the rain and study how it travels on and off of your property.

2. Begin changing your topography from the highpoint of your watershed and work your way down.

3. Start small and simple by creating:
   - Planting holes—rounded, bowl-like depressions and flat bottoms. Plant, then mulch with organic matter.
   - Swales—shallow, trough-like depressions to carry water, mainly during rainstorms or snow melts. Fill these with mulch.
   - Berms—mounds or ledges of earth, or rocks, to slow water.

4. Use the three S’s in your design—Slow, Spread, and Sink (make it infiltrate).

5. Plan for overflow routes and manage these as resources.

6. Maximize living plants and organic groundcover (mulch).

7. Maximize beneficial relationships and efficiency by “stacking functions,” i.e., changes that perform multiple beneficial functions. Your rain-catching planting depressions will not only ease erosion but can also support wildlife and provide windbreaks, sunscreens, or even food. Raised contour berms can also be used as footpaths or property dividers.

8. Continually reassess your system. Don’t be discouraged by inevitable mistakes. Work through them, learn from them, and improve your system.

Advantages

- Rain is often the cleanest water source available if harvested before touching the ground.
- Rain is naturally distilled through evaporation.
- Rain is soft due to lack of calcium carbonate or magnesium in solution, and is excellent for cooking and washing.
- Rain is natural fertilizer. It contains sulfur, microorganisms and mineral nutrients collected from dust in the air.
- Rain has the lowest salt content of natural fresh water sources, making it excellent for plants.
- Rain is a free gift from God.

Source

Rainwater Harvesting for Drylands and Beyond, vol. 1, by Brad Lancaster, 2006, p. 6&7.

Disadvantages

- Your water supply is affected by drought.
- You must ingest minerals to replace those typically found in well water.

Synergy

- A deep well requires a large electric pump, which requires a large solar array with lots of batteries.
- A catchwater system requires a small pump (or no pump at all), which works well with a very small solar array and a few batteries (or no batteries at all).

Roofing Materials for Water Catchment Systems

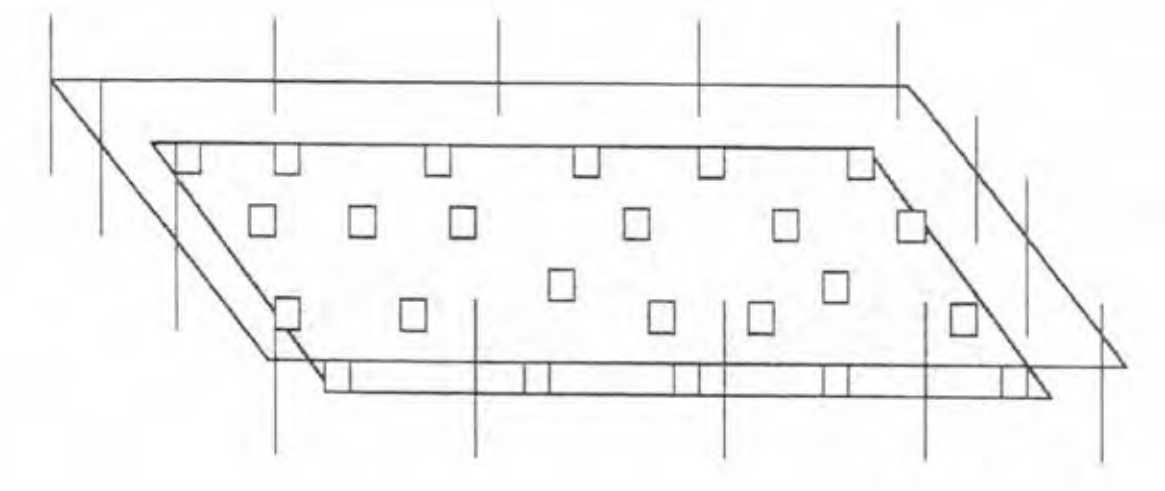
1. Unpainted galvanized metal
2. Painted metal roofing with lead-free baked enamel
3. EPDM (rubber) roofing
4. Slate, tile, or concrete
5. **Untreated** wood

Note: If your roof is covered by tree limbs, leaves and bird droppings can contaminate your water.

Safety Alert: Make sure no lead is used in paint or solder that is used to make gutters.

Safety Alert: Make sure any containers used for rainwater were not used previously for toxic materials.

Using Sheathing as Part of Your Catchment System



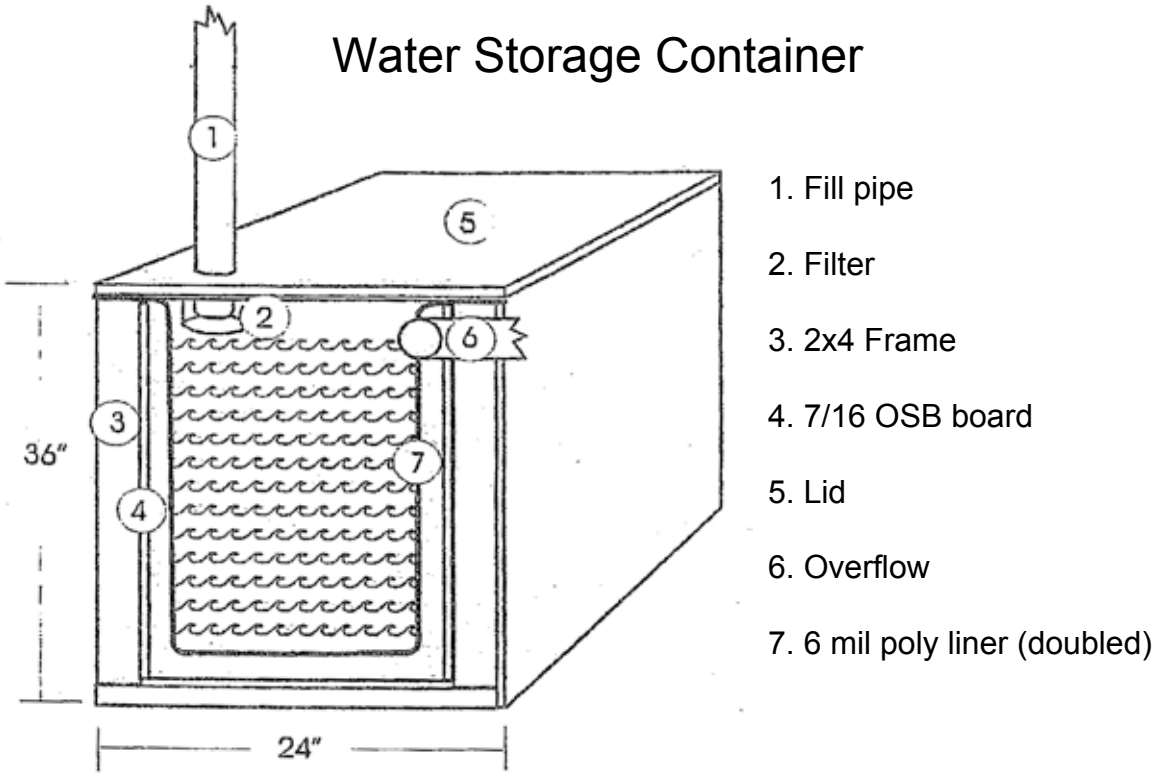
1. Use black 6 mil. or heavier polyethylene sheathing.
2. Put the catchment area away from trees.
3 Hold the sheathing in place with stones, bricks, concrete blocks, etc. (Don't use old tires; they make breeding places for mosquitoes).
4. Fence off the catchment area.

(Not shown: A tank to store the water that falls on the sheathing.

Building a Holding Tank for Water Catchment

Note: Water weighs about 8 pounds per gallon. Your floor must be able to support the weight of your holding tank.

1. Build a box frame with 2 x 4's on 12 inch centers. The box shall be 24" wide and 36" high and as long as is needed and/or practical. The box shall have a removable lid.



2. Cover the 2x4 frame with 1/2 inch to 3/4 inch O.S.B. board or plywood.

3. Glue and screw the OSB or plywood to the 2 x 4 frame,

4. Check the box for any sharp objects or rough areas that could puncture or tear the poly liner.

5. Line the box with one continuous piece of black 6 mil. polyethylene sheathing. Black is less affected by ultraviolet light and lasts longer than clear. Use two thicknesses for safety. This sheathing is often called Visqueen and is sold in hardware stores and garden shops.

**Consider FDA approved, food quality sheathing.

Note: 6 mil. polyethylene is usually available in 10 foot widths. A 10 foot section will fit nicely into the 2' x 3' box you have built.

Note: During manufacture, 6 mil. sheathing can develop small holes. Lay out the sheathing for the holding tank and check it carefully before lining the holding tank.

6. Fill the holding tank very slowly the first time and check it for leaks.

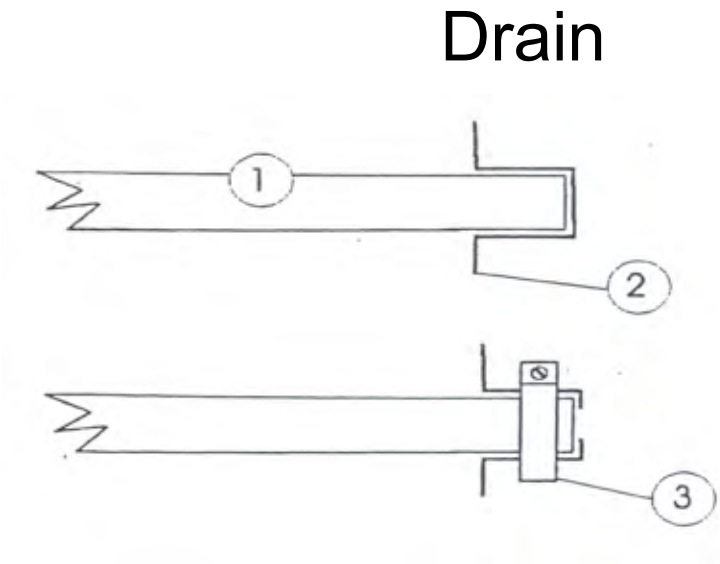
7. Build an overflow for the holding tank. **If you have a 3-inch pipe filling the tank, you need two 3-inch pipes for the overflow.**

   A. Place the pipe through the wall of the tank at the highest point possible.

   B. Stretch the sheathing around the overflow pipe.

   C. Use a stainless steel clamp to secure the sheathing.

   D. Cut out the sheathing that is stretched over the overflow pipe.



1. Pipe.
2. Poly liner.
3. Stainless steel clamp.

Note: The top of the holding tank is the standard height of a kitchen cabinet. It makes an excellent work surface or plant shelf.

Note: Having the holding tank in your living space is a great way to moderate air temperatures. Make sure that air can move easily around the box. Do not set it directly against a wall; leave a gap of one or two inches to encourage air movement.

Maintaining the Holding Tank

1. The water coming directly from your roof should be clean enough for bathing and washing dishes. **It must be purified for drinking.**

2. Over time, sediment will develop on the bottom of the holding tank. Unless it is very deep, this sediment layer can be ignored. If too much sediment collects in the tank, it can be cleaned out carefully to avoid tearing the liner. (Jack's Note: After 12 years in a very dusty area, less than an inch of sediment has collected.)

3. Occasionally, the water in the holding tank will develop a musty odor. This occurs because of the bacteria in the tank. A small amount of chlorine bleach will eliminate the problem. An inexpensive swimming pool test kit will allow you to test for bacteria.

4. Always keep the holding tank covered and not exposed to sunlight. Sunlight will encourage algae growth.

More Information About Holding Tanks

As more people in the United States are harvesting rain water, there are many websites that offer education on many different types of holding tanks. Use keywords “rainwater harvesting” to find information.

ANOTHER TYPE OF HOLDING TANK – THE BURIED HOLDING TANK

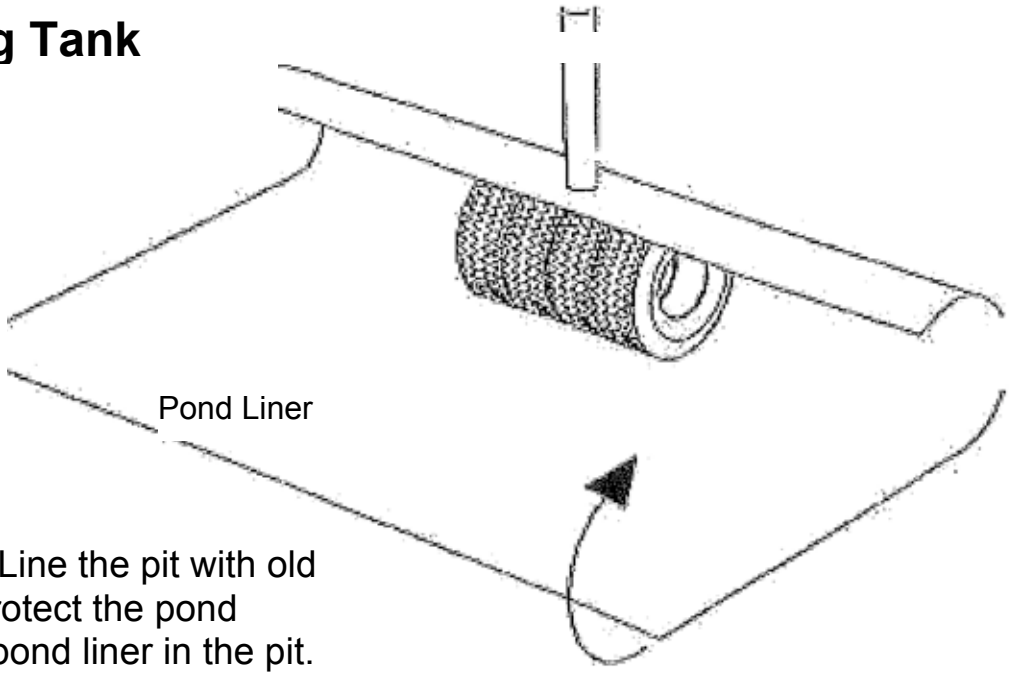
Advantage
Since it is buried, it does not take up space in a building.

Disadvantages
Since it is buried, it is difficult to maintain.

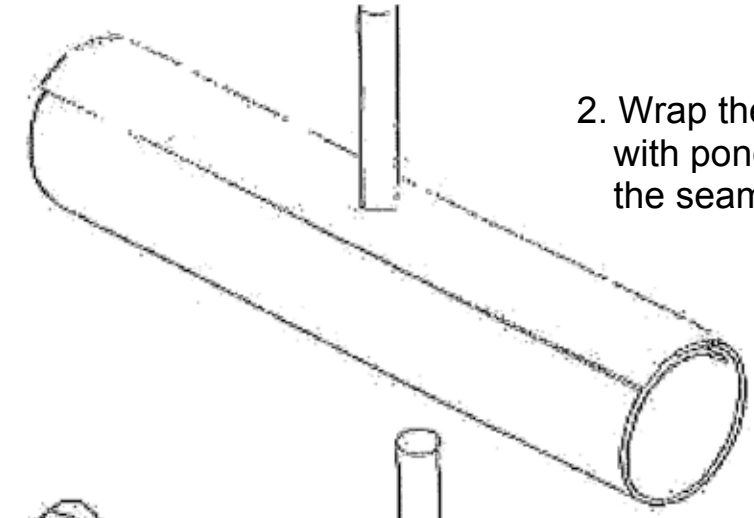
Since it is not in the living space, it will not help moderate living space temperatures.

Note: In non-freezing climates or where digging is too difficult, the tank may be placed on the surface and then covered with soil. It must be covered to prevent solar disintegration of the pond liner.

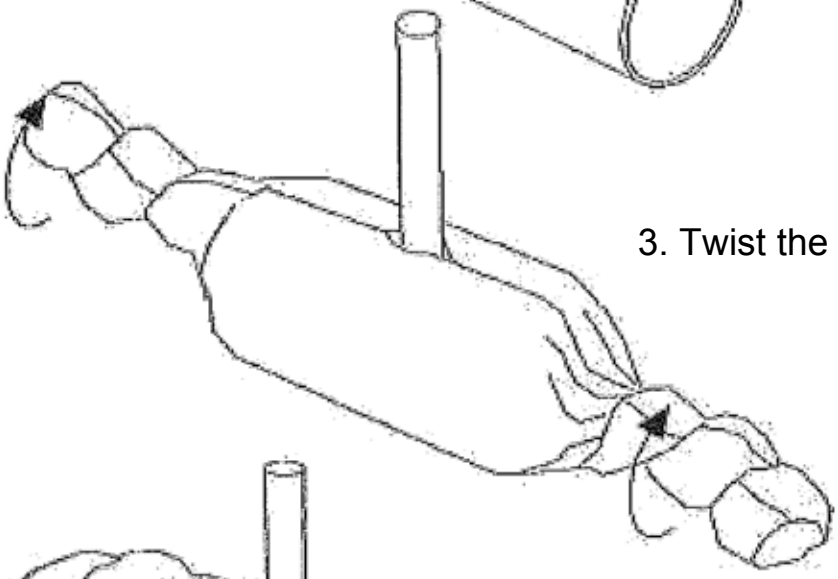
Buried Holding Tank



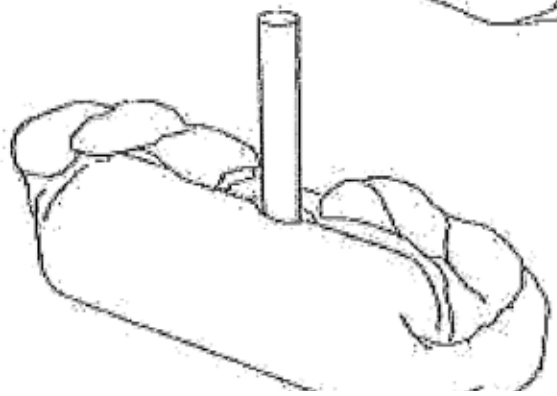
1. Dig a pit a bit wider than the diameter of the tiresto be used. Line the pit with old carpet, etc. to protect the pond liner. Place the pond liner in the pit. Place tires in the pit. Tires will be wrapped like a Tootsie Roll.



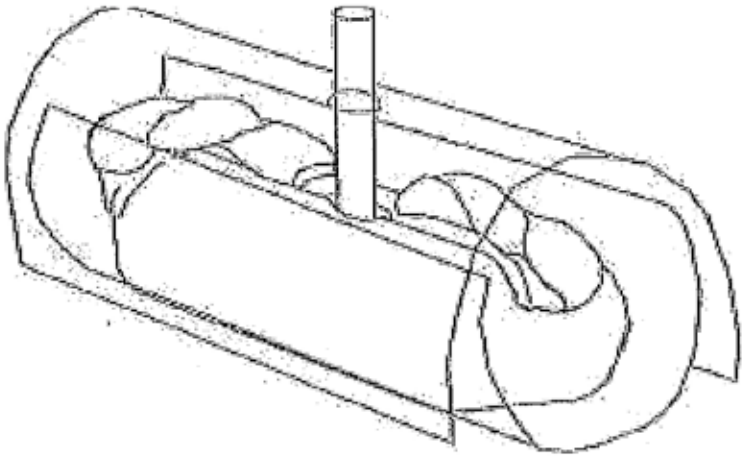
2. Wrap the tires completely with pond liner, Make sure the seam is at the top



3. Twist the ends of the pond liner



4. Pull the twisted ends up and over the top of the tires. Carefully install vent/fill/access/overflow.



5. Cover the top of the wrapped tires with carpet to protect the liner.

6. Fill the tank with water and test for leaks.

7. Carefully bury the tank.

8. Keep cars and trucks from driving over the tank.

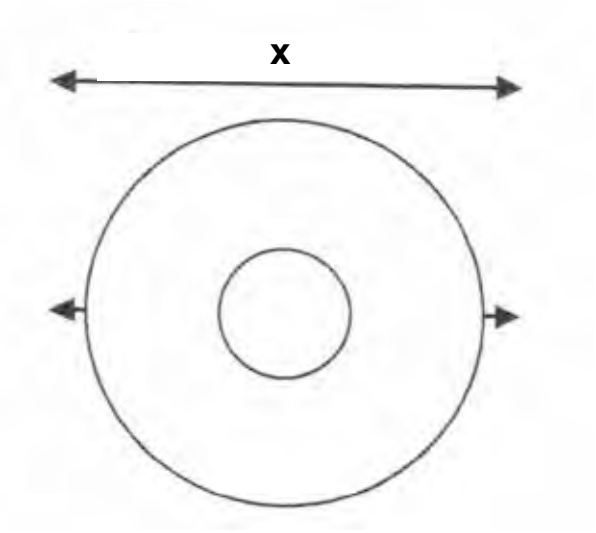
CONSTRUCTING THE BURIED HOLDING TANK

Materials Needed:

- Old tires
- Old cardboard, plastic sheathing, tarps, carpet, etc.
- PVC pipe and fittings
- Pond liner

How to Construct a Buried Holding Tank

1. Dig a trench just a bit wider than the diameter of the tires being used.



Locate the tank a safe distance from the living structure. Think ahead. What will happen if it leaks?

Note: In cold climates, the tank may need to be six feet deep to prevent freezing.

Note: In areas that are difficult to dig, the tank can set on the surface. It must be completely covered with soil to protect the poly liner from ultraviolet rays.

2. Once the trench is dug, it shall be lined with a pond liner. Be careful not to tear or puncture the liner.

3. The tires shall be placed into the lined trench carefully, so as not to puncture the pond liner.

4. The tires placed on each end of the trench shall have sheet metal placed over the wheel hole. This will keep dirt from filling in the tires. Another method uses tires placed horizontally at each end of the trench. The horizontal tires must be filled with compacted soil.

5. The pond liner shall be carefully wrapped about the tires to create a tank that will hold water. (see diagrams)

6. The vent/fill/access/overflow pipe shall be put in place from the top of the tires through a carefully made slit.

7. Fill the tank and test for leaks before burying.

8. The pond liner shall be covered from the top with old cardboard or sheathing or carpet or an old tarp, etc. This will protect the sheathing when the tires are carefully buried.

9. Bury the tank. Compact the soil gently. Leave a mound over the tank - it will settle over time.

10. Place markers or a fence around your buried tank so that it will not be driven over. You can walk over it with no problems.

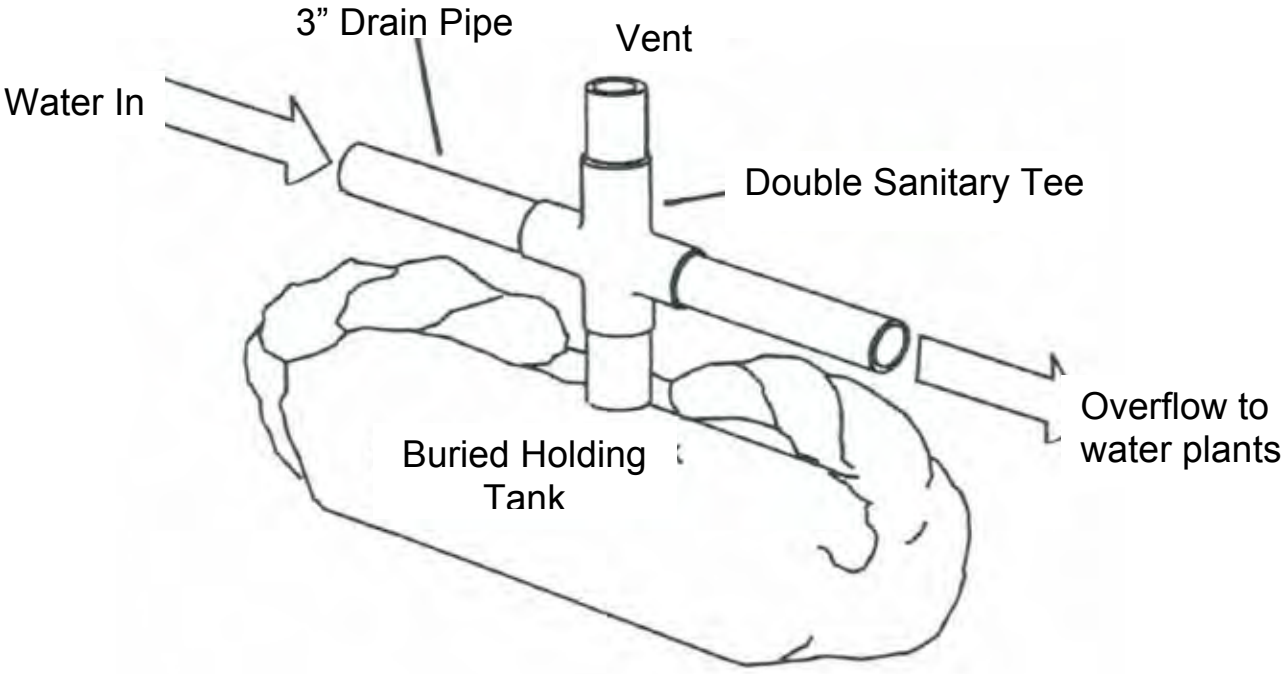
Note: One of the most inert objects on the planet is an old tire. Tests have not yet been done to see how the water would be tainted in a buried holding tank constructed with old tires. The water will certainly be acceptable for watering plants. What type of purification is necessary to make the water potable is a question that needs to be answered.

Money Saver: It may make financial sense to build two separate holding tanks, a smaller tank for drinking water only and a larger tank for other purposes. The larger tank would not need to be built of expensive materials that meet potable water standards.

Extracting Water from the Buried Holding Tank

A hand pump, a submersible electric pump powered by a solar panel, a gas-powered trash pump, or a dirty water pump will remove water from the buried holding tank. Tank access is through the vent/fill/access/overflow. **Choose your method of extraction and make sure it will work before you bury the holding tank.**

Constructing the Vent / Fill / Access / Overflow



Calculating Water Needs and Availability

One inch of rain on one square foot of catchment surface will yield .623 gallons.

Note: Allows for 1/3 of water being wasted due to leakage, roof washing, and evaporation. Based on recommendation of Harry L. Garver, *Safe Water for the Farm,* F.B. 1978, 1948.

Important Questions to Consider About Water Catchment

1. What is the average rainfall in your area?

2. Does the rain come in a very short period of time, or does it rain throughout the year?

3. What is the size of your catchment area?

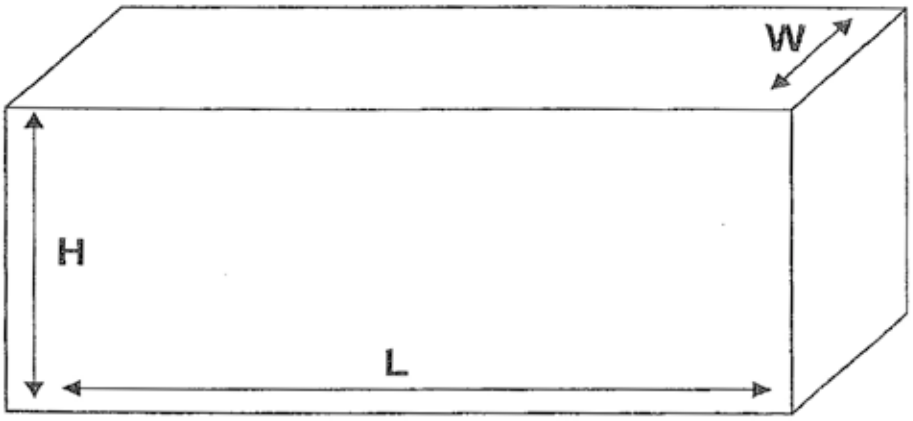
4. How much water do you use daily?

5. How large a holding tank is needed?

Calculating the Size of the Holding Tank

One cubic foot of water is approximately 7.5 gallons.

To calculate the volume of a square or rectangular box:
multiply width x height x length = cubic feet.



Cubic feet x 7.5 equals the number of gallons that can be contained in a square or rectangular box.

It is often necessary to measure the holding tank in inches. One cubic foot contains 1728 cubic inches.

A Practice Problem

You have a home that is 16' x 20'. You also have an area in a field beside your home that is covered with black 6 mil. sheathing. It is 20' x 50'. It rains 12 inches annually in your area, usually in just two consecutive months. The rest of the year is very dry.

Discover the following:
How many gallons of water will fall on your roof and sheathing in an average year?

How large a holding tank will you need?

PURIFYING YOUR WATER

If you use a catchment system and maintain it properly, your water should be clean enough for bathing, cooking, cleaning, and watering plants.

Drinking water must be purified.

Techniques for Water Purification

1. Chemicals - chlorine

2. Filtration

3. SODIS

(This list excludes many purification strategies that are too complicated and/or expensive. The techniques listed are simple, inexpensive and reliable.)

Basic Bleach Method

For emergency treating of water of unknown quality, use any household bleach containing sodium hypochlorite (5.25% solution) *without* soap additives or phosphates. By using common household bleach as a chemical treatment method, large amounts of safe drinking water can be provided quite inexpensively. **Clorox has a 12-month shelf life.**

Caution:
Be sure sodium hypochlorite is the only active ingredient in bleach when used for water treatment.

Follow these simple instructions:
- Add bleach to water in container
- Thoroughly mix bleach in water by stirring briskly
- Let mixture stand for at least 30 minutes

Note: Conditions requiring longer exposure to the chlorine are cold water and heavy turbidity. The colder the water and the airier the water, the longer the time required for the chlorine to kill contaminants. Chemicals do not purify water; they merely render the water potable by neutralizing some of the toxic animal and plant life in the water.

Basic Bleach Water Treatment Method

Water Quantity	Water Condition	5.25% Sodium Hypochlorite
1 quart	clear	2 drops
	cloudy	4 drops
½ gallon	clear	4 drops
	cloudy	8 drops
1 gallon	clear	8 drops
	cloudy	16 drops
5 gallons	clear	½ teaspoon
	cloudy	1 teaspoon
120 gallons	clear	2 ounces
	cloudy	4 ounces

Mixture should still have a distinct chlorine taste or smell after waiting period. If chlorine smell is not detected, add same dose of the solution to the water and let mixture stand for an additional 15-20 minutes.

From *Making the Best of Basics* by James Talmage Stevens, Gold Leaf Press, ©1997.

Safety Note:
2014—For the past three or four years, the manufacturers of bleach have changed the percentage of the active ingredient, sodium hypochlorite, in their products. You must make sure that the sodium hypochlorite is at least 5.25%.

CERAMIC FILTERS

The Katadyn Drip Filter

With no moving parts to break down, superior filtration, and a phenomenal filter life, there is simply no safer choice for potentially pathogen-contaminated water. There are no better filters than Katadyn for removing bacteria, parasites, and cysts. Three 0.2-micron ceramic filters process one gallon per hour. Clean filters by brushing the surface. Ideal for remote homes, RV, camp site, and home emergency use. Food-grade plastic canisters stack to 11" Dia.x 25" H. Weighs 10 lb. One-year manufacturer's warranty, Switzerland.

42-842 Katadyn Drip Filter $289
42-843 Replacement Filter (needs 3) $75 ea

Ceramic filters are simple to use and they require no electricity. Always have extra ceramic candles (the filter part) on hand. Ceramic filters are pricey, but will work for years if properly maintained. If the water to be filtered is muddy, it should be sent through a sand filter before it is sent through the ceramic filter. Muddy water will clog the ceramic candles very quickly. The illustration is from Real Goods. Other brand names you may want to consider are Berkey and Doulghton.

In the past, ceramic filters did little to filter chemical pollutants. A new ceramic filter from Berkey does remove some chemicals. This will be particularly important in areas that are or once were heavy industry or farming areas. Here is information from the Berkey Company about the Black Berkey filter. Cost is $50 each (2009).

The revolutionary Black Berkey, self-sterilizing and cleanable purification elements purify water by removing pathogenic bacteria, cysts and parasites entirely and by extracting harmful chemical such as herbicides, pesticides, VOCs, organic solvents, radon 222 and trihalomethanes. They also reduce nitrates, nitrites and unhealthy metals such as lead and mercury without removing the healthful and nutritional minerals that your body needs. Black Berkey purification elements are so powerful that they are able to remove microscopic food coloring particles from water without removing the beneficial minerals your body needs. Virtually no other filtration system can duplicate this performance.

Moreover, Berkey systems are ideal for the self-sufficient, because they have the capability of purifying both treated water and untreated raw water from such sources as remote lakes, streams, stagnant ponds and water supplies in foreign countries, where regulations may be substandard at best. Perfect for everyday use and a must in hostile or emergency environments where electricity, water pressure or treated water may not be available. What's more, the Black Berkey elements are cleanable and can be used over and over again. Black Berkey elements will also fit most other major brand gravity filtration systems. www.berkeywater.com

The Sawyer SP1803 Point One Filter

Note from Jack: This filter is an excellent choice for those who want the safety and ease of operation of ceramic or catadyne filters without the high costs. The Sawyer filter starts at $60 for the basic filter. For $120 you can get a unit that will even filter out viruses. (2010)

(source: www.sawyersafetravel2.com)

This Filter Removes:

Bacteria, Which Cause:

I.E.: Cholera, Botulism (Clostridum botulinum), Typhoid (Salmonella typhi), Amoebic Dysentery, E. Coli, Coliform Bacteria, Streptococcus, Salmonella

Protozoan (Cyst):

I.E.: Giardia, Cryptosporidium, Cyclospora

Using technology taken from kidney dialysis, Sawyer® water filters use Hollow Fiber Membranes. Our filters are comprised of tiny "U" shaped micro tubes that allow water through tiny micro pores. The PointOne Filter pores are so small (0.1 micron absolute) that no bacteria, protozoa, or cysts like E.Coli, Cholera and Typhoid can get through. At 7 log (99.99999%) the filter attains the highest level of filtration available today and yet it has a very high flow rate due to the large amount of tubes. Each filter is certified for ABSOLUTE microns. That means there will be no pore size larger than 0.1 microns in the biological filter Simply put, it is impossible for bacteria to pass through the 0.1 micron filter.

Assembly Kit Includes:

1 - Hole Cutter
1 - Water Filter, adapter & 3 Foot Hose
1 - Backwash Syringe
1 - Filter Hanger
1 - Filter Cap

Detailed Instruction Sheet

Sawyer made it as simple as it gets. No more digging wells if there is a water source, no constructing sand filters and no more purification chemicals. Families are able to construct and adapt their filter in literally minutes to locally found containers. The kit includes everything you need to attach the filter to any plastic bucket or container. (Bucket not included)

1. Obtain a clean bucket or plastic container
2. Use a hole cutter to drill a hole 1.5 inches from the bottom of the bucket (you can do this hand).
3. Screw the connector, hole and filter onto the bucket.
4. Fill the bucket with water from any source, lower the filter head below the water line, and let gravity do the rest.

CAWST BioSand Filter

Construction: Concrete

Cost: A bag of cement and 3 feet of PVC pipe - $10 -20.

Effectiveness: Removes 98% of contaminants

Capacity: 1 liter per minute

Producer: Center for Affordable Water and Sanitation Technology

Web address: www.CAWST.org

Advantages: Low costs. No power required. Low maintenance.

Note: You must have training and concrete forms to build this filter. Contact EQUIP for more information.

EQUIP, Inc., P.O. Box 11267, Marion, NC 28752
www.equipinternational.com / 828-738-3891

Plans for another excellent sand filter are available at www.aquaclara.org
Go to the *Purifier Construction Manual* for step by step instructions.

I like this filter because it can be constructed using inexpensive materials that can be found almost anywhere.

Solar Disinfection - SODIS

Materials needed: Clear plastic pop bottles, 1 or 1½ liters
Polyethylene Terephthalate (PET) bottles are preferred.
PVC can have harmful additions.

Solar cooker (optional)
Sand Filter (optional)
Oven thermometer (optional)
WAPI – An excellent addition to the SODIS system is a Water Pasteurization Indicator (WAPI). The reusable, durable WAPI is a simple device containing a special soy wax that helps users determine when water has reached pasteurization temperatures. In 2005 the WAPI could be purchased for $6 from *solarcookers.org.*

Procedure:

1. Fill bottle half way with clear water. Use a sand filter to pre-treat muddy water.
2. Shake vigorously.
3. Fill to the top.
4. Expose to direct sunlight for at least 6 hours (2 days in cloudy weather), or until the water reaches 55° C (135° F).

How it works: Sunlight helps kill micro-organisms as UV-A radiation is directly absorbed by organic material. Sunlight radiation also produces highly reactive forms of oxygen which kill micro-organisms. Heat kills some micro-organisms.

To improve efficiency:

1. Fill bottles completely.
2. Put black paint with no lead from top to bottom on half of the outer surface of the bottle. Lay the bottle horizontally with the blackened side downward.
3. Place bottles on a reflective surface such as aluminum foil.
4. Replace scratched bottles.

Sources: First presented by Professor Aftim Acra, UNICEF,1984. Tested by the Swiss Federal Institute of Environmental Science and Technology (EAWAG) and the Department of Water and Sanitation in Developing Countries (SANDEC).

In my tests, just placing the Sodis bottle in the sun did not generate enough heat for adequate purification. This system will work best when combined with a solar oven.

The Sodis system is an example of very simple technology that is heartily embraced by Third World people, particularly in Africa. While the water is not perfectly safe, it is a great improvement over doing nothing. In community development, perfection is often the enemy of practical, affordable improvement.

Recommended Reading and Resources

Cottage Water Systems, Max Burns. Cottage Life Books, 1993

The Home Water Supply, Stu Campbell. Garden Way Publications, 1983

Making the Best of Basics, James Talmage Stevens. Gold Leaf Press, 1997.

Handmade Hot Water Systems, Art Sussman and Richard Frazier. Garcia River Press, P.O. Box 527, Point Arena, CA 95468, 1998

Mother Earth News, "The Secrets of Low Tech Plumbing," John Vivian. June/July, 1995, p. 34.

"Rainwater Harvesting" Texas Water Development Board, P. O. Box 13231, 1700 N. Congress Avenue, Austin, TX 78711-3231. (512) 463-7847, Fax (512) 478-2053.

Rainwater Harvesting For Drylands and Beyond, vol. 1 and 2. By Brad Lancaster, 2002. This is a must-read, ground-breaking work.

Build Your Own Solar Water Heater, Stu Campbell. Garden Way Publishing, 1978.

Rain Catcher, Stephen Derynck, Mother Earth News, Feb,/March 2004.

Harvest the Rain, Environmental Building News, Mother Earth News, Aug./Sept. 2003.

Important articles on water purification from *Backwoods Home Magazine Emergency and Backwoods Water Treatment*
Part 1 – *The Theory*, March/April 2010
Part 2 – *The Practice*, July/August 2010
Part 3 – *Taking It To the Field*, September/October 2010

The Texas Manual on Rainwater harvesting, 3rd Ed. 2005
https://www.twdb.state.tx.us/RWPG/rpgm_rpts/200:

Google Roofwater Harvesting Resources

A Solar Ark Conserves All Water Used...

A Gray Water System

Words to Know:

Gray Water — Water that has been used that is **not** contaminated with urine, feces, body fluids or harsh chemicals.

Black Water — Water that has been used that **is** contaminated with urine, feces, body fluids or harsh chemicals.

Gray Water System — A system that facilitates using gray water for trees and plants.

Drywell — A covered pit that allows gray or black water to drain into the soil where it is filtered and purified.

SYNERGY AND GRAY WATER

If you use water more than once you will need less water. If you need less water you will need a smaller holding tank. If you use less water you will need a smaller dry well, surface mound or septic system. Less water requires a smaller pump. A smaller pump requires a smaller and less expensive electrical system.

Guidelines for an Effective Gray Water System

(Much of the following information comes from an article by Claire Anderson in Mother Earth News, August/September 2004, pp. 100-106.)

1. Do not save gray water in a tank. It will become black water as bacteria multiplies.

2. Do not use kitchen sink water that is contaminated with food particles which attract insects and animals. This water should go to a black water disposal system.

3. Do not use water that has been used to wash diapers; it is contaminated with feces. It should go directly to a black water disposal system.

4. Do not over-water plants and trees. Make sure you have adequate space and drainage for the amount of gray water you are sending to plants and trees.

5. Use fresh water about 50% of the time to help wash away salts that can build up and damage plants.

6. Acid-loving plants do not like gray water.

7. Do not let gray water stand in pools. Catchment basins must be large enough to absorb all the water sent to them.

   How to size catchment basins
   kitchen sink.....5 to 15 gallons per person per day
   bathroom sink.....1 to 5 gallons per person per day
   top-loading washer .....30-50 gallons per load
   front-loading washer.....10 gallons per load
   bathtub.....25-40 gallons per bath
   (from *Create an Oasis with Gray Water)*

8. Do not plant edible root crops in gray water.

9. Be careful not to splash gray water on edible plants.

10. Wash all edible plants with soap or iodine or vinegar.

11. Do **not** use **perforated** pipe - it clogs. Use 1-inch polyethylene pipe to deliver gray water to plants.

Comments on Guidelines for an Effective Gray Water System

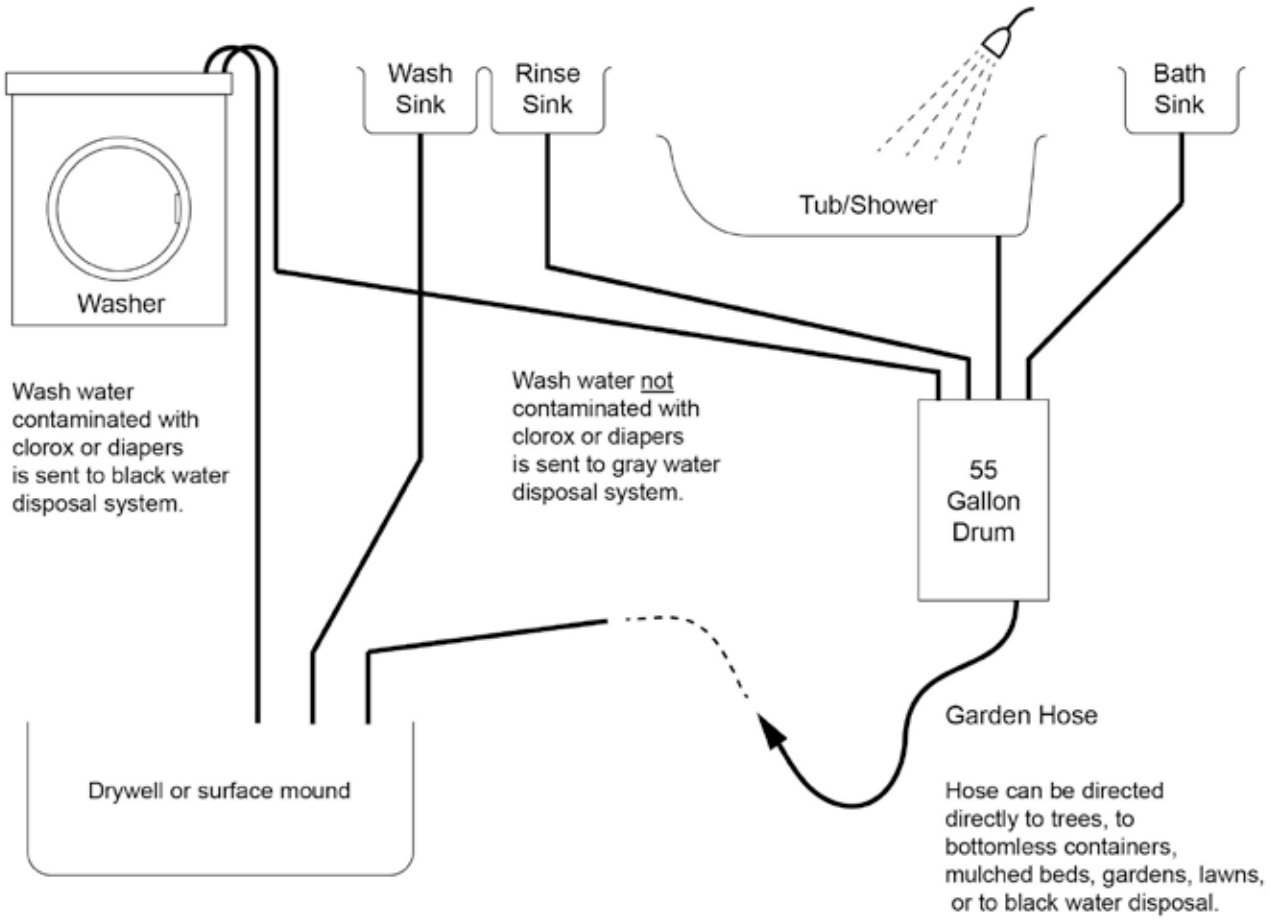
The Outlines for an Effective Gray Water System are generally accepted guidelines for Gray Water Systems in populated areas of the United States. Typically these areas also have clean water on demand from local utilities. On my remote site, with no well to back up my rainwater catchment system, and in the midst of a severe drought that has lasted 15 years at the time of this writing, I have challenged the basic concepts of the Outlines for an Effective Gray Water System. Consider the following ideas and use at your own risk.

Concerning point number 1: I have a planter inside my home that captures and holds 250 gallons of water. The water remains in the tank for months at a time. I use the water to irrigate trees and bushes. It does have a strong odor, which lingers for only a few moments. I am careful to wash my hands after I use this water. In many situations, if gray water is to be useful, it needs to be saved until it is needed.

Concerning point number 2: I do use water from my kitchen sink. Yes, it is smelly and it does contain food particles. In my arid climate, I have not had an increase in insect activity on plants watered with water from the kitchen sink. This water also works well in my sub-irrigated planters. I do not use gray water on root crops.

Concerning point number 6: I use gray water on my pine trees, which are acid-loving plans. This water may not be the best choice for my pine trees, but it has kept them from dying during a lengthy drought.

GRAY WATER SYSTEM



Notes:

1. 55 gallon drum is NOT a holding tank. The drum contains large volumes of water from washers and bath tubs only long enough to drain. If gray water is not needed for vegetation, water is diverted to a drywell or surface mound.
2. Wash water can be directed to black water or gray water disposal by moving drain hose.
3. A very simple system is the “Laundry-to-Landscape” system.

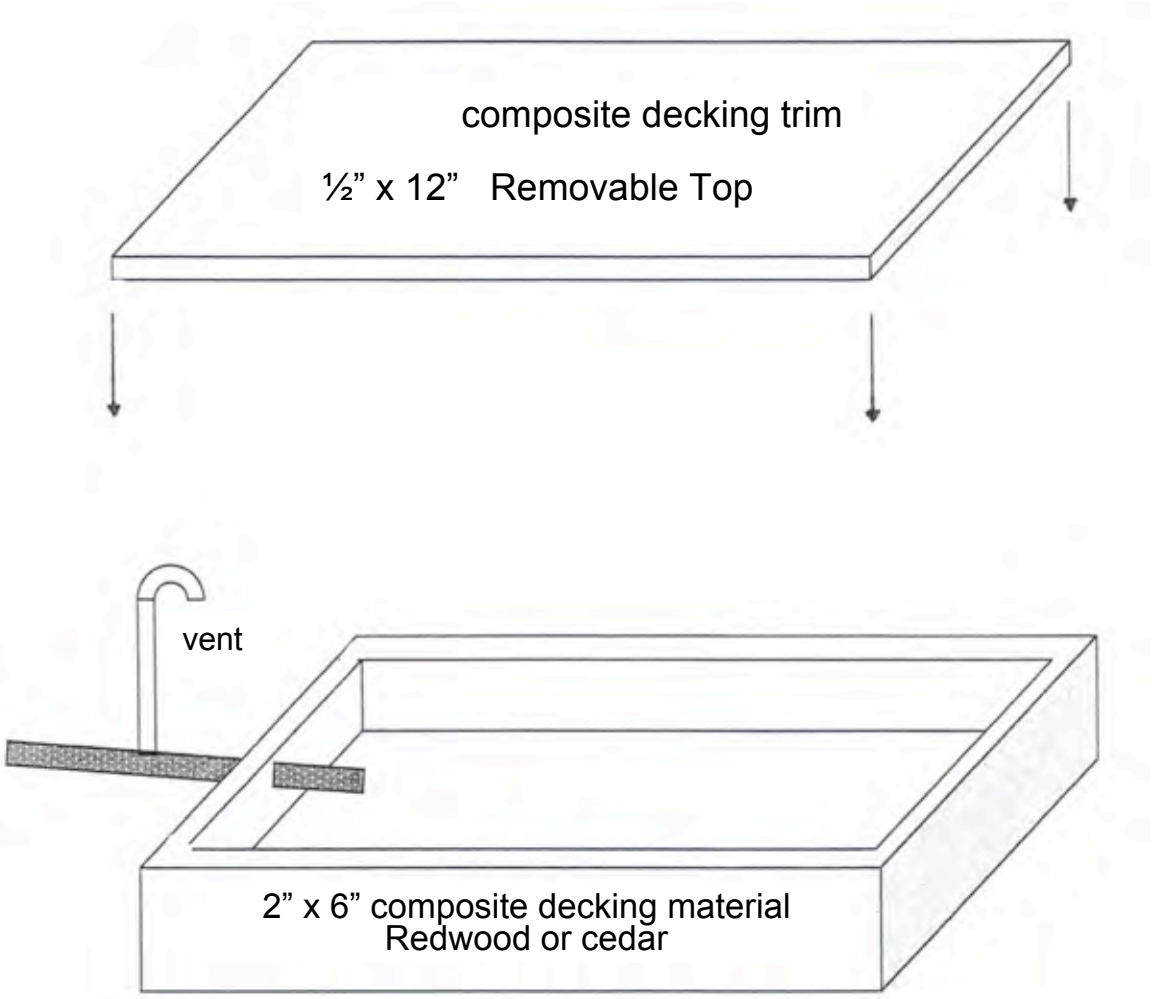
How to Build a Laundry-to-Landscape System.

A Laundry-to-Landscape system directs gray water from the washing machine to specific areas where the gray water is needed. The system consist of several drainpipes that are installed next to the washing machine. Each drainpipe is clearly marked as to destination.

Example: Pipe number 1 is marked: Oak Tree
Pipe number 2 is marked: Septic Tank for black water
Pipe number 3 is marked: South Meadow

When using the washing machine, the drain hose is placed in the drainpipe that goes to the vegetation that most needs to be watered. If diapers are being washed, the water is directed to a septic tank.

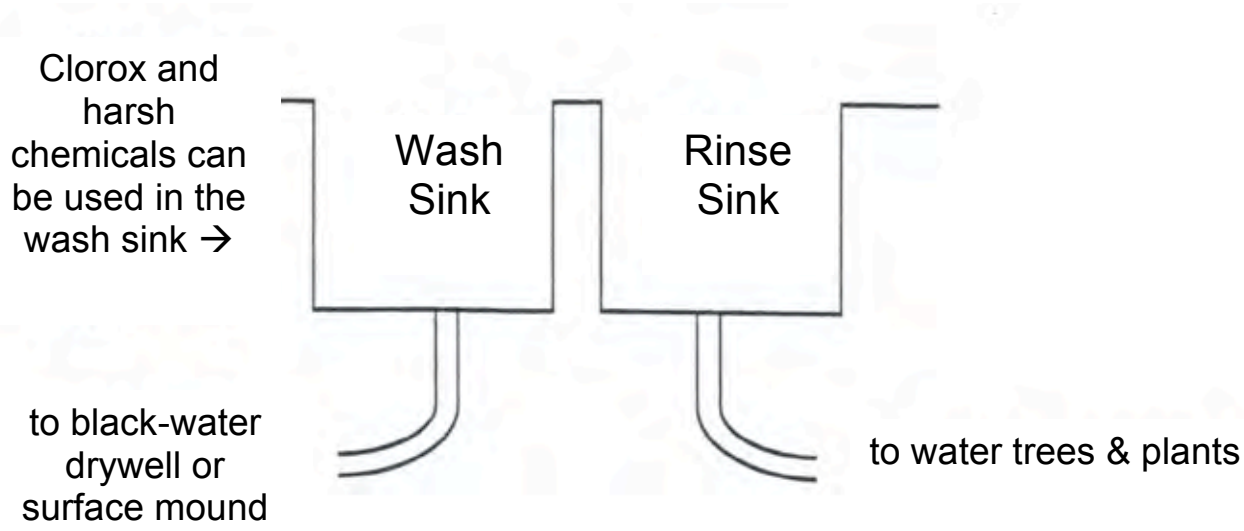
Ideas for Bottomless Box Container for Gray Water Disposal



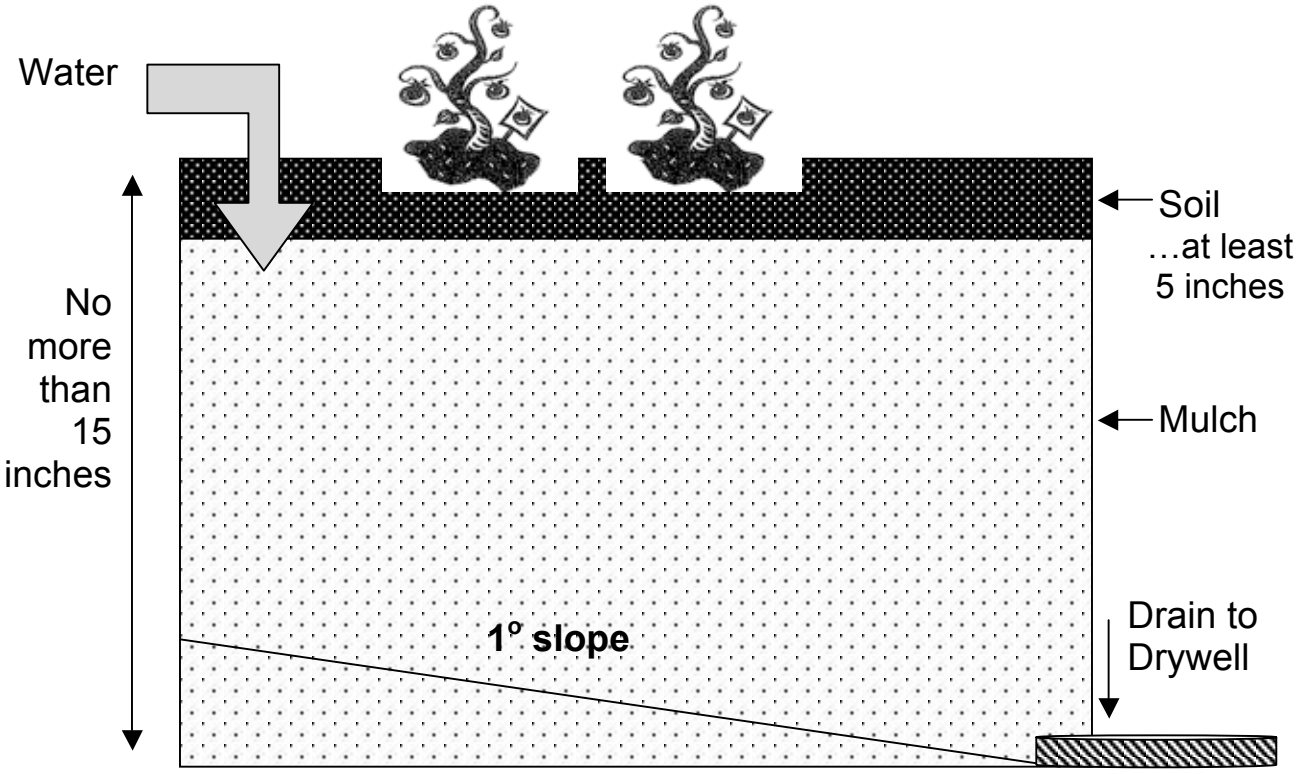
Box can be buried or sit on the surface of the ground.

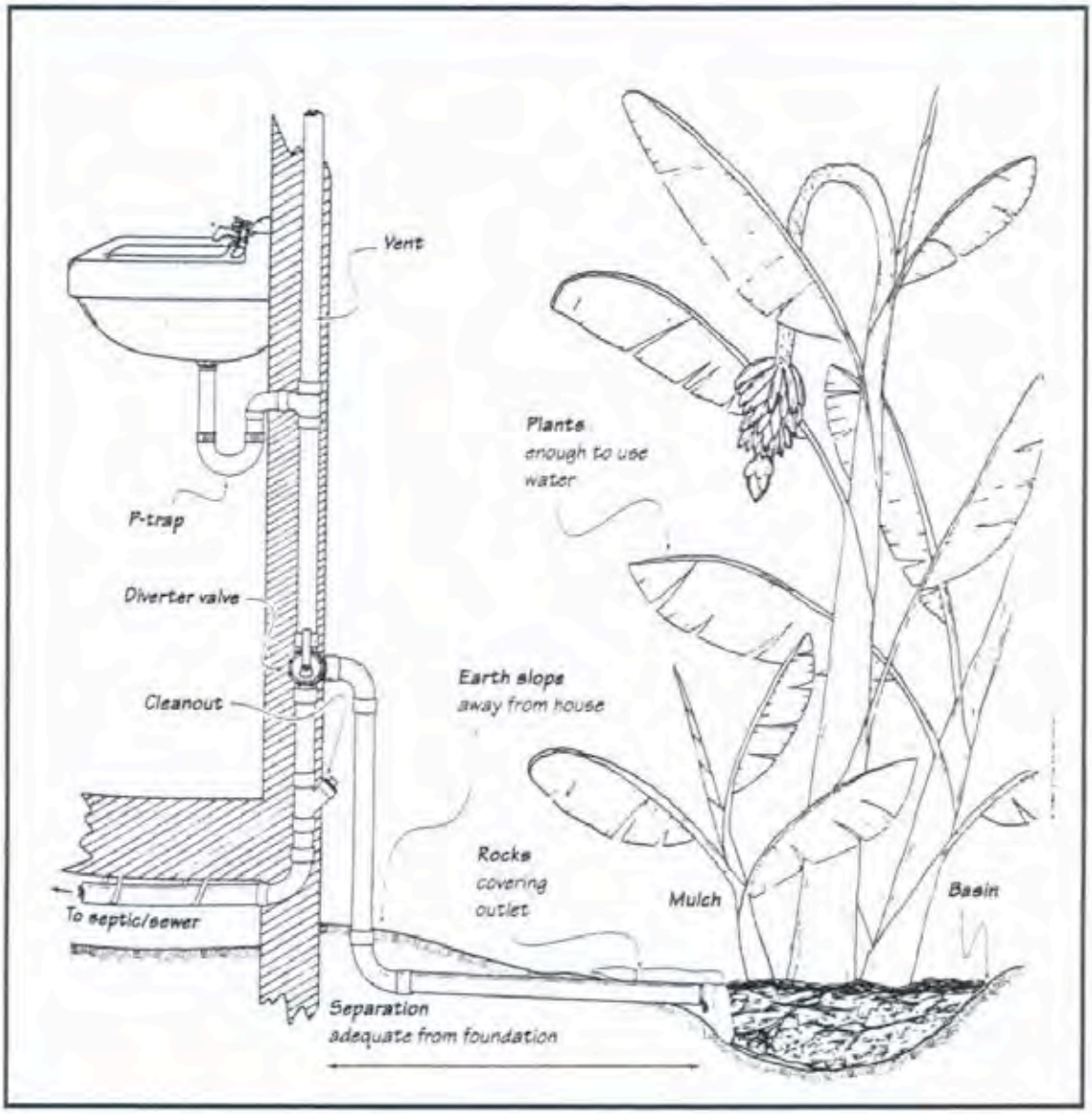
Note: Plants can be placed around the perimeter of the box.

Double Kitchen Sink Arrangement



Ideas for a Mulched Bed System





BACKHOME MAGAZINE MAR/APRIL 2007

The Drain-to-Mulch Basin option is a simple system that's built off existing plumbing and ensures a high level of treatment.

Listed here are products that work for the garden.

Soaps, Detergents, and Gray Water

From *Rainwater Harvesting for Drylands and Beyond*, vol. 2, ©2009

Cleaning products labeled “biodegradable” or “natural” or even “eco-friendly” may not be gray water compatible—meaning suitable for the plants and soils of your gray water-irrigated landscape.

Gray Water Compatible Products

I prefer to use Oasis brand or Bio-Pac concentrated liquid laundry detergent and dishwashing soap; both are gray water compatible (see www.bio-pac.com). I dilute 1 part Oasis brand dishwashing soap with 8 parts water to use as a hand and body soap. For shampoo, I use Aubrey Organics brand shampoos after scanning labels to be sure there are no sodium products in the ingredients.

Traditional liquid soaps made from potassium-based ingredients such a Dr. Bonner’s liquid soaps and handcrafted liquid soaps are gray water compatible as long as they don’t contain harmful additives such as sodium salts. You can contact soap makers and ask about their ingredients.

Products and Ingredients to Avoid

- harsh chemicals such as chlorine and drain cleaners
- bleaches and fabric softeners
- detergents with whiteners, softeners, and enzymes
- bar soaps and powdered laundry detergents that typically use sodium-based products as filler materials. Sodium salts can harm plants and soils. Accumulation of salts is of special concern in drylands where soils tend to be alkaline and naturally high in salts. It is wise to occasionally flush dryland soils with rainwater or other non-salty water.
- borax and other cleansers and products made with boron. Boron is needed by plants, but only in extremely small amounts
- soaps and detergents with the following ingredients: peroxygen, sodium perborate, sodium trypochlorite, petroleum distillate, alkylbenzene, salt
- disinfectants

The above list of products and ingredients was compiled from State of California, Department of Water Resources (www.owue,water.ca.gov) publication *Graywater Guide: Using Graywater in Your Landscape*.

My website includes a page on gray water harvesting with more information on soaps and detergents, recommended brands, and laundry cleaning tips (www.HarvestingRainwater.com).

Recommended Reading and Resources

Know Your Graywater, David Del Porto and Carol Steinfeld. Center for Ecological Pollution Prevention, P.O. Box 1330, Concord, MA 01742, 1999.

Running Dry, Addkison and Sellick. Stein and Day Publishing, 1983.

The Composting Toilet System Book, "What About Graywater?", pp. 182,223.

Saving Water in the Home and Garden, Jonathan Erickson. Tab Books, McGray-Hill, 1993.

Earthship III, p. 58-66.

Mother Earth News, "Tap Into Water Savings", Claire Anderson. August/September 2004, pp. 100-106.

Art Ludwig, *www.oasisdesign.net*

Water Storage, Art Ludwig

Harvest H20.com (founded by Doug Pushard)

Rainwater Harvesting for Drylands and Beyond, vol. 1 and 2. Water-Harvesting earthworks by Brad Lancaster, 2009. Rainsource Press, Tucson, AZ www.HarvestingRainwater.com

The Solar Ark

On-site food production... (Life-support/greenhouse module)

SYNERGY

The more food you grow,
the less food you buy.

The more food you grow,
the less food that needs refrigeration.

The less refrigeration needed,
the less power needed.

The less power needed,
the smaller the energy system.

Home grown food needs no
transportation –
no transportation, less expense.

STEPS ON THE PATHWAY TO ABUNDANCE

FOOD PRODUCTION

- Consider the importance of good soil.
  Mark 4:3-8 [Jesus speaking] *Listen! A farmer went out to sow his seed. As he was scattering the seed, some fell along the path, and the birds came and ate it up. Some fell on rocky places, where it did not have much soil. It sprang up quickly, because the soil was shallow. But when the sun came up, the plants were scorched, and they withered because they had no root. Other seed fell among thorns, which grew up and choked the plants, so that they did not bear grain. Still other weed fell on good soil. It came up, grew and produced a crop, multiplying thirty, sixty, or even a hundred times.*

  [Author's note: Jesus was obviously taking about spiritual matters in the above passage. However, there is a great deal of soil science contained in the parable.]

- Allow fields to lie fallow every seventh year.
  Leviticus 25:3-4 *For six years sow your fields, and for six years prune your vineyards and gather their crops. But in the seventh year the land is to have a Sabbath rest, a Sabbath to the Lord.*

- Rotate crops.

- Calculate the reasonable, sustainable production capacity of your land. Do not exceed that capacity..
  Leviticus 19:9-10 *When you reap the harvest of your land, do not reap to the very edges of your field or gather the gleanings of your harvest. Do not go over your vineyard a second time or pick up the grapes that have fallen. Leave them for the poor and the alien. I am the Lord your God.*

- Create and use compost to make soil more productive. Always compost manure. Use a composting toilet or moveable arbor loo.

- Weeds can be a resource. Use for compost. Composting kills weed seeds.

  [Weeds and grasses that are not too aggressive can be composted. Try to pull weeds before they have gone to seed. See: *Composting*]

- Use urine for fertilizer.

- Blanket the soil with mulch to avoid sun-scald.
- Blanket the soil with mulch to increase water infiltration and retain moisture. *Farming God's Way* calls this mulch, "God's blanket."
- Blanket the soil with mulch to discourage weeds.
- Blanket the soil with mulch to prevent wind and water erosion.
- Create biodiversity to reduce insect and disease problems.
- Create a wooded area for animal and insect habitat, increasing biodiversity.
  Genesis 2:9 *And the LORD God made all kinds of trees grow out of the ground—trees that were pleasing to the eye and good for food.*
- Contain and control animals with fencing, etc.
  Genesis 1:18 *Rule over…every living creature that moves on the ground.*
- Guard against two-legged animals. Provide security.
  Mark 12:1 *…a man planted a vineyard. He put a wall around it…and built a watchtower.*
- Use a greenhouse or cold frames to start plants early and extend the growing season.
- Use low-till methods. Disturb planting areas as little as possible.
  Isaiah 28:24-26 *When a farmer plows for planting, does he plow continually? Does he keep on breaking up and harrowing the soil? …His God instructs him and teaches him the right way.*
- Avoid soil compaction. Plant in planting areas, walk on walkways, drive on roads.
- Your food production operation should be diversified so that the success of your entire operation does not depend on any single crop or venture.
  Ecclesiastes 11:6 *Sow your seed in the morning, and at evening let not your hands be idle, for you do not know which will succeed, whether this or that, or whether both will do equally well.*

Notes from Walter Lowdermilk

The following quotes are from Palestine—Land of Promise, Harper © 1944. These words aren't the Gospel, but they are extremely prescient and relevant.

"…in the last reckoning all things are purchased with food." p. 19

"Men will sell all—their liberty and more—for food, if driven to this tragic choice." p. 19

"It was not until the tillers of the soil produced more food than they themselves had need of that their fellow villagers were released for other tasks." p. 19

"There is no substitute for food in the complex division of labor in modern civilization." p. 19

A Manifesto from Walter Lowdermilk (language modified by me):

"You shall inherit the Holy Earth as a faithful steward, conserving its resources and productivity from generation to generation. You shall safeguard your fields from soil erosion, your living waters from drying up, your forests from desolation, and protect your hills from overgrazing by the herds, that your descendants may have abundance forever. If any shall fail in this stewardship of the land, your fruitful fields shall become sterile stony ground or wasting gullies, and your descendants shall decrease and live in poverty or perish from the face of the earth." p. 22

FOOD PRODUCTION

Our goal is to have more food with less work.

If we are to produce enough food for our families and to share with others, we must cooperate with God's plans for food production. It's great to be able to go to the store and purchase food, but that source can diminish at any time due to circumstances beyond our control, or it may become too expensive. No matter where you live—in the country or in a bustling city—"tend the garden" and grow as much food as you can.

Let's divide the process of food production into key areas: SOIL, WATER, and GARDENING TECHNIQUES.

SOIL

If you build good soil, plants grow strong enough to protect themselves from many insects and diseases. Yields will greatly increase when plants are rooted in good soil.

What is Good Soil?

(The following information comes from "Build Better Garden Soil" by Harvey Ussery, Mother Earth News, April/May 2007, pp. 147-151.)

1. Good soil contains organic matter (humus).

2. Good soil is workable (friable), easily crumbled or pulverized.

3. Good soil allows oxygen to plant roots because it is friable and full of living organisms that create tunnels to the roots.

4. Good soil absorbs and holds water.

5. Good soil provides a home for a living community.
   LIVING THINGS FOUND IN GOOD SOIL:
   - Algae
   - Bacteria, microbes
   - Mycorrhizal fungi
   - Protozoa (single-celled animals)
   - nematodes (tiny, non-segmented worms)
   - Arthropods (pseudo scorpions, mites, spiders, centipedes)
   - Earthworms
   - Mammals (moles, voles, gophers, prairie dogs, etc.)

Note: Most of the action for healthy plants takes place in the first 10-12 inches of soil around the root hairs of plants.

What Damages Good Soil?

1. Monoculture

2. Harsh chemicals (fertilizers, chicken manure, blood meal)

3. Too much plowing exposes soil to sun scald. The living things in the soil are exposed to the sun and die.

4. Uncovered soil (The rain pounds on the soil and makes it hard or washes it away. The sun scalds the soil and kills the living community. The wind blows the soil away.)

5. Compacting (walking or driving on planting areas)

How Can Soil Be Improved and Protected?

1. Plow and till as little as possible (Use raised beds, containers, low-till methods, a broad fork.)

2. Compost, compost, compost! (This adds organic matter to the soil. The living community thrives on compost.)

3. Mulch (Use organic material to keep soil covered at all times.)

4. Use cover crops (Peas, hairy vetch, alfalfa, rye, oats, beans, crimson clover, oil seed radishes in cold climates, buckwheat, sorghum, etc.)

Composting

Composting is a great gift from God. It allows us to rebuild and replenish soil while managing waste that could cause poor sanitation and sickness. When waste is carefully composted and placed on or mixed with existing soil, the same piece of land can be used year after year and actually become more productive with the passing of time. (see Composting)

Consider using liquid fertilizers to supplement compost. (see Homemade Liquid Fertilizers)

WATER

Where I live, water is scarce. I have spent years learning ways to get the greatest amount of food with as little water as possible. In many countries, there is plentiful rain, but water systems are not available to bring water where it is needed, when it is needed. Often water is carried by hand to homes and gardens, sometimes miles from the water source. Here are some ideas that will maximize the water that you have.

- Use containers for gardening. Containers allow great control of water.
- Use sub-irrigated planters, SIPs.
- Control evaporation by using a greenhouse, row covers or mulches (or all three).
- Use polymers. Polymers for gardening are mixed with garden soil. They expand with moisture and hold water in the root zone.
- Use drip systems.
- Choose drought-resistant plants that produce more food with less water.
- Use fast-growing plant varieties.
- Apply water in measured amounts by hand. This has proven to be the most efficient way to get the most food with the least amount of water.
- Use biochar (charcoal) to hold moisture in the root zone.
- Use plenty of compost. Compost holds more water than poor soils.
- Use gray water for gardening. This must be done with great care. (see Gray Water)
- Develop rainwater catchment to secure water and contain it until it is needed in the garden. (see *Rainwater Catchment for Drylands and Beyond* by Brad Lancaster.)

NOTE: The basic organic methods suggested in ABUNDACULTURE will reduce water needs by 67-88% according to research done by John Jeavons. (see the internet for a complete listing of John Jevons' work.)

GARDENING TECHNIQUES

NOTE: Every gardener will develop his own methods for success. The following are some of my favorite techniques.

- Start small and grow as needed. A well-maintained, small garden can produce more food than a larger, poorly maintained space. A huge garden can be overwhelming and discouraging. It is not uncommon to produce 300-500 pounds of food in a 10’ x 10’ space.

- Use vertical space for plants. Pole beans, peas and tomatoes are good candidates for vertical growth.

- Eat as much food as possible fresh from the garden. Preserve foods as needed by drying, canning or pickling.

- Extend the growing season. Use strategies to plant earlier and harvest later.
  A. Use double-covering methods in cold climates. This means to provide at least two coverings to protect plants from cold. Example: Plants covered by a greenhouse are also covered by cloth.
  B. Store water in the greenhouse to moderate temperature.
  C. Use a heat source in the greenhouse if absolutely necessary.

- Diversify your garden biosphere. Plant many types of vegetation. Raise bees.

- Allow for failure of certain crops. Diversify plantings so that the failure of one crop is covered by a crop that succeeds.

- Avoid using harsh chemicals for pest control. Allow for some losses and go to the internet for easy-to-make organic pest control solutions.

- Use fencing to control predators and wind.

- Choose garden crops carefully. Plant only what you can eat or trade. Take care of your family’s needs first.

- Hybrids can greatly increase yields. Use open-pollinated and heritage seeds to facilitate seed saving.

- Rotate crops to prevent disease and make the most of soil nutrients.

- Rest your garden every seventh year.

- Weeds are easy to control if you are diligent. Pick weeds when they are small, before seeds are present. Non-invasive, immature weeds can be composted.

- Make gardening a community project. The relationships that grow are even more important than food. Gardening with friends is fun!

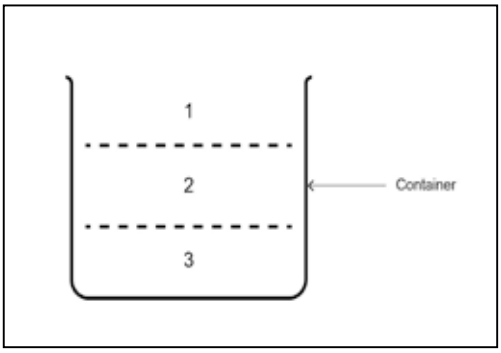
- THIS IS IMPORTANT! Plan on spending at least 10 minutes every morning and evening carefully inspecting your garden. Many problems can be avoided this way. If you are going to spend most of the growing season away from your garden, save yourself the aggravation and forget the garden.

- Use containers for gardening. Containers allow great control of water, space and soil amendments. Containers are great for urban gardens.

I plant all my food in SIPs (Sub-Irrigated Planters) in 100% compost. Once I prepare a SIP, my work is greatly simplified. I spend just a few minutes a day watering and weeding.

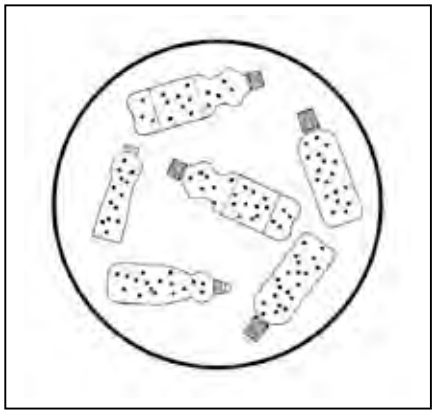
SUB-IRRIGATED PLANTERS (SIPs)

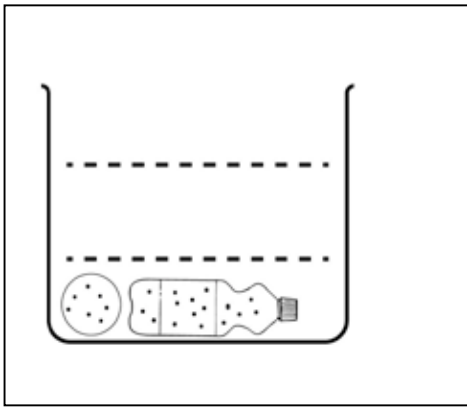
How to Build an SIP



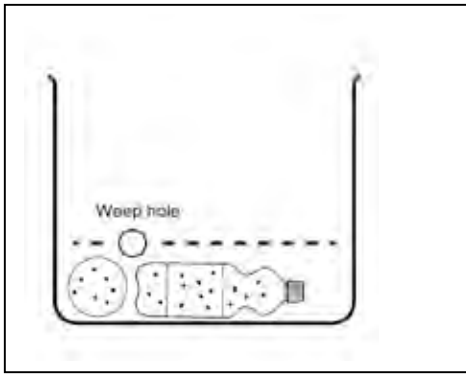
1) Choose a container that does not leak. If the container leaks, it can be lined with a sturdy plastic bag or a piece of plastic sheathing. You can use just about any container that is large enough for your plant(s): five-gallon buckets, plastic barrels, etc. Translucent 30 or 55 gallon plastic barrels are my favorite containers. They let in light and they are very sturdy. I buy used barrels for $10-25. They are typically used for soaps or food products. I avoid containers that held harsh chemicals.

2) Place into the bottom of the container, discarded plastic containers such as pop bottles and food jars. Plastic containers can be drilled with holes to allow water to fill the void. Even wide-mouth glass jars placed on their sides will work as reservoirs. These reservoirs will hold water for plants. After you've drilled holes in the reservoirs, they need to be placed in an old nylon stocking or a piece of cloth. This allows water into the reservoir, but not soil. The reservoirs are placed in the bottom of the SIPs. They will create a void that will be 4-6 inches deep.

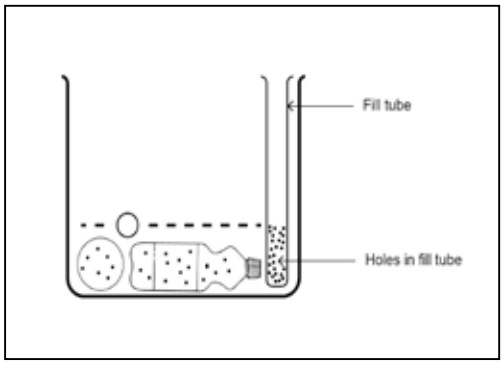




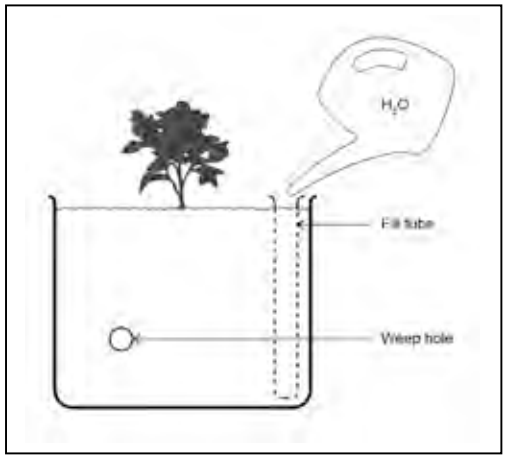
3) Drive two ¾-inch holes in the SIP just above the depth of the reservoir created by containers wrapped to prevent filling with soil. These holes are called weep holes. They allow excess water to leave the container so that plants cannot drown. Make sure that you will be able to see the weep holes when the SIP is in place.



4) Place a fill-tube in the planter. Put it well away from the weep holes. You can use a tall plastic container or a piece of plastic pipe for the fill-tube. Drill holes in the bottom 6 inches of the fill tube. Cover the holes with a nylon stocking or a piece of cloth so that the fill-tube won't become filled with soil. Hold the cloth or stocking in place with duct tape. Large pipe (2-4 inches) is easy to fill.



5) Fill the planter carefully with lightweight, fluffy potting soil or compost. I often use horse, cow, chicken or sheep manure mixed about 50/50 with sawdust or fine woodchips and composted for at least one year. For another option, see Mel Bartholomew's Square Foot Gardening. Put the SIP where you want it. Once it is filled with soil and water, it will be very heavy and difficult to move.



6) Add water slowly through the fill tube. Fill only until water starts to come out of the weep hole. Do not overfill. Because you are using a SIP, you will need much less water, perhaps 50-70% less water. Less water will be lost to evaporation. After your plants are established, you may choose to cover the exposed soil with mulch to further discourage evaporation. You may need to keep the topsoil moist while your seeds are germinating or if the weather is particularly hot and windy.

Advantages of the SIP Planter

1) It uses less water.
2) Soil nutrients are not washed away.
3) Soil amendments and plant supplements can be customized to each SIP.
4) If you use a translucent barrel with a lid for your SIP, you can protect young plants from wind, hail and frost.

Authors Note

Through the years, I have encouraged many people to try SIP planters. I have spent four years experimenting with the best way to construct and

use the SIPs. Often I find that my instructions are ignored and the planter performance is poor. Here are some pointers: You cannot use soil in the SIP planters or any container because it becomes hard as concrete. You must use a potting mix that remains fluffy and friable. You must follow the reservoir instructions carefully; no more than 4-6 inches deep. You must have at least three ¾-inch weep holes. If you do not follow instructions carefully, your SIPs will be disappointing.

HOMEMADE LIQUID FERTILIZERS

A great way to have more food with less work!

Source: Developed by Will Brinton, Dr. of environmental science, Woods End laboratories, Mt. Vernon, ME. From *Mother Earth News*, Feb/Mar 2011.

WHY LIQUID FERTILIZERS?

- Faster acting.
- Will work on young plants.
- Works well for container plants with possible frequent feedings.
- Good for cold-tolerant crops like spinach, strawberries, lettuce, broccoli, cabbage, etc.

HOW TO APPLY

- Apply no more than every two weeks with a thorough soaking.
- Use with longer-lasting solid organic fertilizers, such as composted manures.
- Apply to sweet corn in full silk.
- Apply to pepper plants loaded with fruit.
- Apply to young leafy plants.
- Apply to cold-weather plants.
- Apply to long-living plants such as chard and tomatoes. They will produce for a longer time.
- Don't apply to drought-stressed plants. Water the plants first with pure water.

NOTE: If you apply liquid fertilizers to young plants, you will encourage leaf growth. For example, you will have tomatoes with giant leaves and little fruit. Wait until fruit sets before applying liquid fertilizers to non-leaf crops.

FOUR DIFFERENT TYPES OF HOMEMADE LIQUID FERTILIZERS

1) chicken manure with wood shavings
2) seaweed
3) fresh grass clippings
4) urine

HOW TO MAKE LIQUID FERTILIZER WITH CHICKEN MANURE AND WOOD CHIPS

- In a 20-liter (5 gallon) bucket.
- Mix 750 ml. of dry chicken manure with 2 ½ liters of wood shavings.
- Fill the bucket the rest of the way with water.
- Let sit for 3 days, stirring each day.
- After 3 days, filter the mixture through a piece of cloth.
- Dilute the mixture with an equal amount of water.
- Use within a day or two.

NOTE: With all of the liquid fertilizers listed in these pages, use within a few days. Changes occur in the fertilizer over time that make it unfit for use. Put old fertilizer on the compost pile.

HOW TO MAKE LIQUID FERTILIZER WITH SEAWEED

- In a 20-liter (5 gallon) bucket.
- Place 4 liters of seaweed.
- Fill the bucket the rest of the way with water.
- Let sit for 3 days, stirring each day.
- After 3 days, filter the mixture through a piece of cloth.
- Use within a day or two.

HOW TO MAKE LIQUID FERTILIZER WITH GRASS CLIPPINGS

- In a 20-liter (5 gallon) bucket.
- Place 13 liters of fresh grass clippings. Make sure no weed killers have been used on the grass.
- Fill the bucket the rest of the way with water.
- Let sit for 3 days, stirring each day.
- After 3 days, filter the mixture through a piece of cloth.
- Dilute the mixture with an equal amount of water.
- Use within a day or two.

HOW TO MAKE LIQUID FERTILIZER WITH URINE

- In a 20-liter (5 gallon) bucket.
- Place one liter of urine in the bucket.
- Fill the bucket the rest of the way with water.
- Stir.
- Use immediately or within a day or two.

NOTE: Urine is my favorite fertilizer. I simply put one gallon of water in a bucket, and then pee in the bucket. I use the mixture immediately. My yields have increased by as much as 400%!

GENERAL INFORMATION

- Most garden plants use three major plant nutrients: 3 parts nitrogen, 1 part phosphorus and 2 parts potassium.
- NITROGEN encourages growth of new stems and leaves.
- PHOSPHORUS encourages vigorous rooting.
- POTASSIUM regulates water distribution within the plant.
- The most balanced fertilizers are grass clippings and urine.

EVERY HOMESTEAD NEEDS A LIFE SUPPORT MODULE (LSM)

Primary Functions of the LSM

1. Indoor space for growing food.

2. Space protected from bad weather, insects and animal such as goats and pigs.

Secondary Functions of the LSM

1. Save garden water.

2. Captures solar heat that can be transferred to your living space.

3. Provides space for water storage.

4. Can serve as a shower and toilet space.

Designs for the LSM

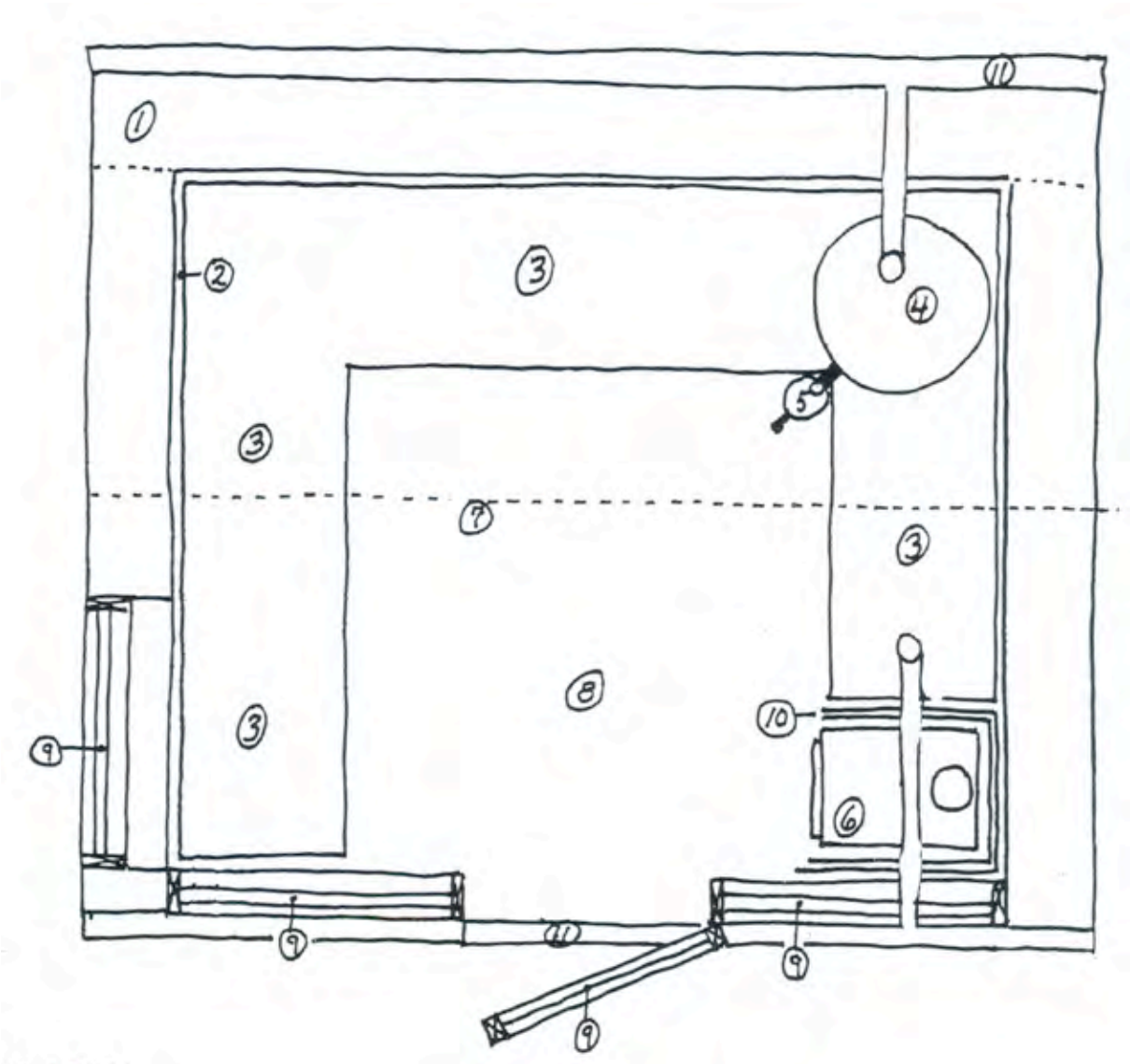
Design depends upon climate

In tropical climates, all functions of the LSM can be housed in a simple greenhouse.

In climates that experience freezing temperatures, a year-round greenhouse is required for the LSM.

A solar-powered electric fence can protect a greenhouse from large animals.

LIFE SUPPORT MODULE – FLOOR PLAN



scale 1/2 = 1

NOTES:

1. 12-inch super-insulated Walls
2. Air Space – 1 inch
3. Water Storage
4. Drinking Water Storage
5. Sand Filter
6. Wood Stove
7. Roof Ridge Line
8. Gravel Floor
9. Double Glazing
10. Heat Shield
11. Rain Gutters

LIFE SUPPORT MODULE - NOTES

1. 12-inch Super-Insulated Walls – possibly of OSB – using super-I studs and beams. Walls painted – possibly with epoxy paint to prevent moisture damage.

2. 1-inch air space to allow circulation of air.

*3. Rain Water Storage Cabinets – 3-feet high x 2-feet wide. Lined with 6 mil. plastic. Cabinets painted black for heat absorption.

4. Drinking Water Storage – Container made of a material that will not contaminate water. Container protected from sunlight to prevent algae growth.

5. Sand Filter – for drinking water purification.

6. Wood Stove – Provides frost protection for plants. Also used for cooking and heating water for bathing. Burnable refuse disposed of here.

7. Roof Ridge Line – If pitched roof is used. Roof of fiberglass or tempered glass.

8. Gravel Floor – Space can also be used for bathing.

9. Double Glazing – Used glass or corrugated fiberglass.

10. Sheet Metal Heat Shield.

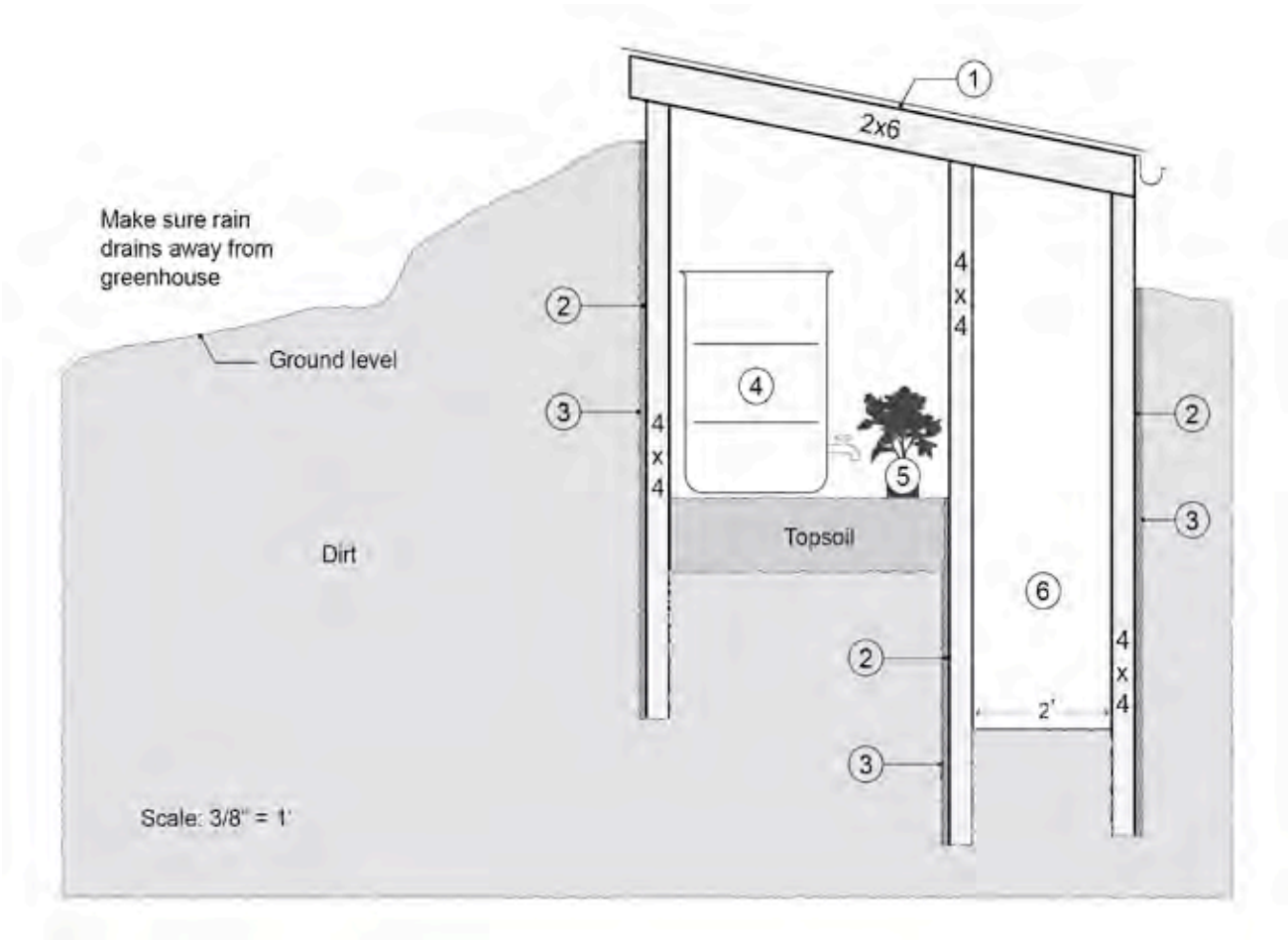
11. Rain gutters.

Caution: Floor must be built to withstand the weight of water (8 pounds per gallon).

* Top of water storage cabinets used for plants in containers.

An LSM for Cold Climates

(The basic idea for this LSM comes from Mike Oehler, the guru of inexpensive, earth-sheltered and underground housing. Check out his article called “Earth-sheltered Greenhouse” in *Mother Earth News*, Feb./March 2004, p. 82.)

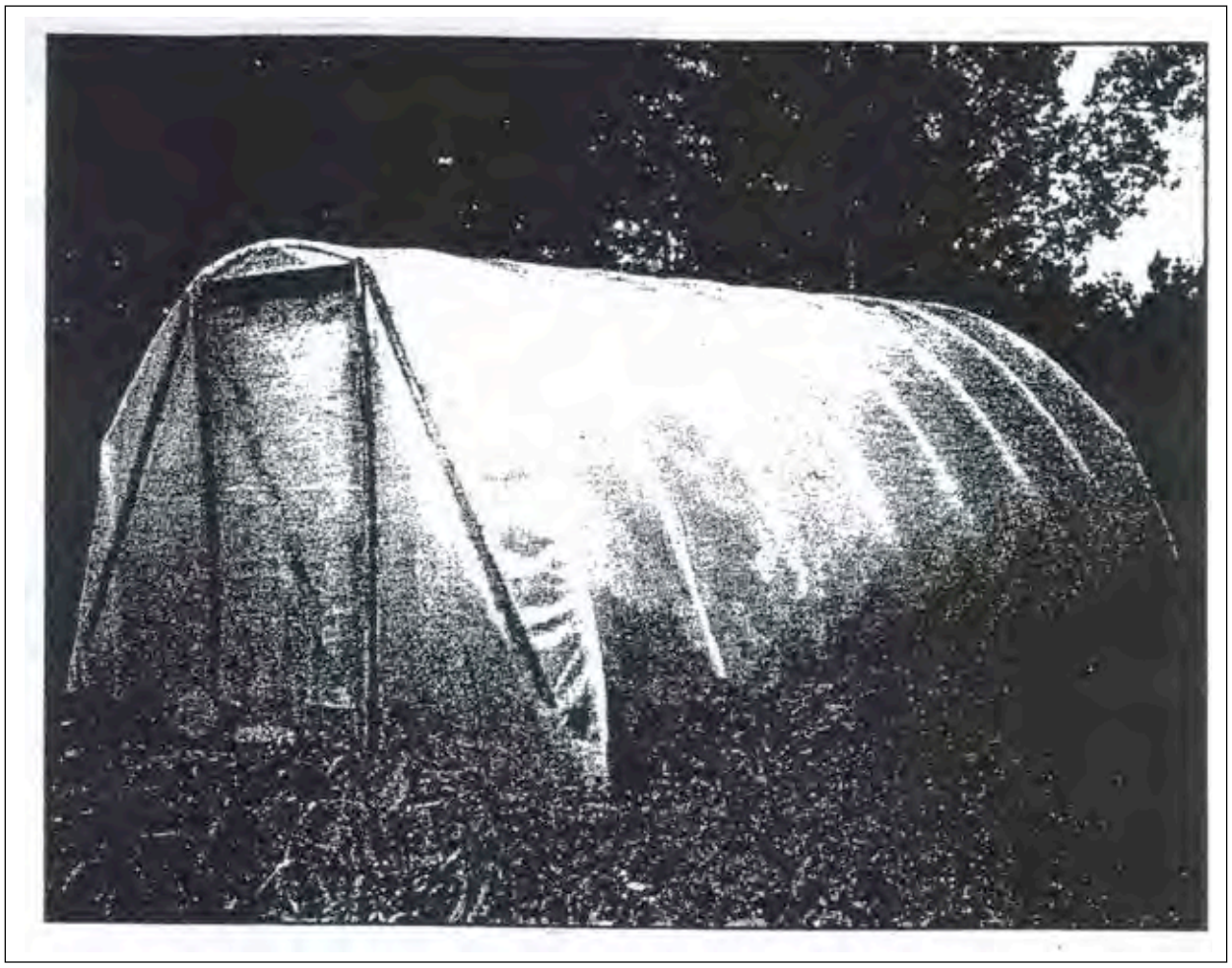


1. Translucent glazing
2. Shoring to hold back dirt
3. 6-mil polyethylene sheathing to keep out moisture
4. 55 gallon drums to hold water for plants and to moderate temperatures
5. Planting area—36-inch high and 24-inch wide for easy access
6. Cold sink-walkway. Coldest air naturally falls away from planting area.

LIFE SUPPORT MODULE

An LSM for Warmer Climates

(This plan comes from Countryside Magazine, vol. 85, no. 5, pp. 60-62. I recommend Countryside Magazine. If you can only afford one subscription, make it Countryside!)



The garden:

Build a Greenhouse for Under $100

All that's needed to complete this greenhouse is a door and the plastic covering.

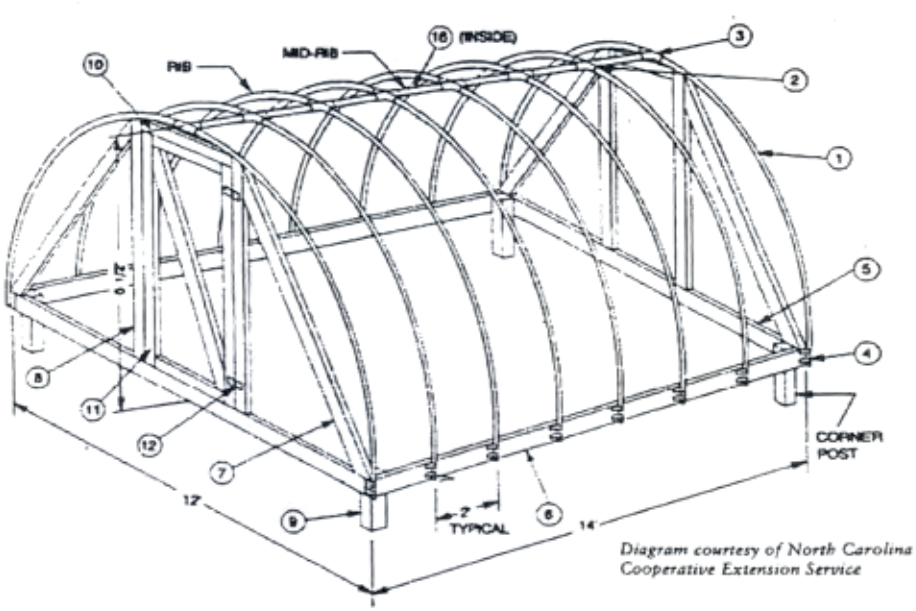
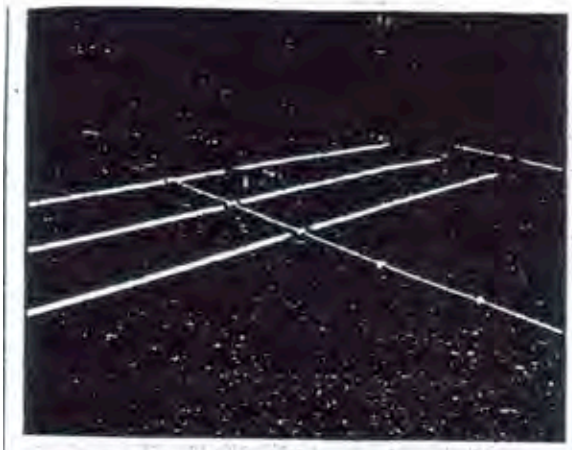


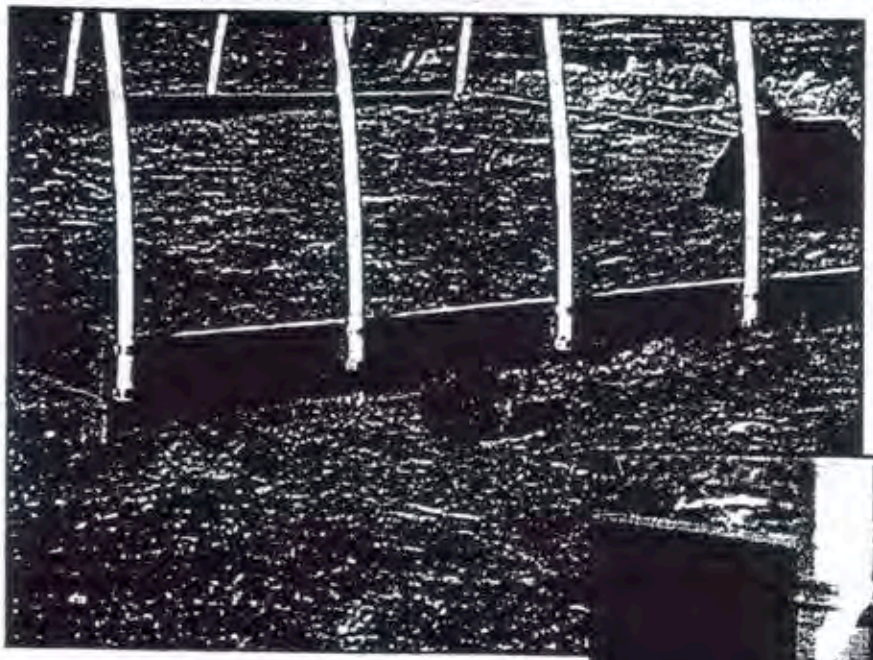
Diagram courtesy of North Carolina Cooperative Extension Service

Materials List:

Item	Quantity	Description
1	16	¾-inch PVC pipe, schedule 80, 10 feet long
2	6	¾-inch PVC crosses, schedule 80
3	2	¾-inch PVC tees, schedule 80
4	32	¾-inch galvanized electrical metallic tubing (EMT) straps
5	2	2" x 6" x14' treated #2 pine boards
6	2	2" x 6" x 12' treated # 2 pine boards
7	4	2" x 4" x 7' treated #2 pine board
8	4	2" x 6" x 6' treated #2 pine boards
9	4	4" x 4" x 2' treated #2 pine boards
10	2	2" x 4" x 3' treated #2 pine boards
11	2	1" x 4" x 12' treated #2 pine boards (to be cut for door parts)
12	1	Set of door hinges
13	1	Sheet of clear plastic, 24' x 20' , 4 mil.
14	1	Can of PVC cleaner
15	1	Can of PVC cement
16	1	½" x 10' galvanized electrical metallic tubing (EMT)
17		Miscellaneous nails, screws, and staples



PVC ribs laid out and ready to assemble



The PVC ribs are attached to the base boards

Note: Any lightweight structure, such as this greenhouse, may need to be protected from large animals with a solar-electric fence.

Recommended Reading and Resources

Bountiful Container, Rose Marie Nichols, McGee and Maggie Stuckey. Workman Publications, 2002.

Cubed Foot Gardening, Christopher O. Bird, The Lyons Press, 1993, 2001.

The Vegetable Gardener's Bible, Edward C. Smith, Storey Publishing, 2000.

How to Grow More Vegetables, John Jeavons. See the internet for Jeavons' body of work. This is one of the most complete references for modern gardeners. Make sure you get the latest edition.

How to Have a Green Thumb Without an Aching Back, Ruth Stout, Cornerstone library, 1968, 1973, 1955.

Square Foot Gardening, by Mel Bartholomew, 2006, Cool Springs Press.

On the net: Sub-irrigated plants, SIP, 2010

On the net: Aquaponics and other AT. fastonline.org (Faith and Sustainable Technologies) (2012)

The Solar Ark...

On-site waste recycling and disposal

(composting toilet, blackwater systems)

STEPS ON THE PATHWAY TO ABUNDANCE

WASTE MANAGEMENT

- Use composting toilets.
- Send all black water to septic systems.
  Note: All sewage must be managed or there will be no clean water.
- Refuse—Ask yourself, “Do I really need this?”
- Re-use—Don’t throw away something useful. If you don’t need it anymore, give it away.
- Reduce—Purchase only what you need.
- Create compost with any compostable waste. Use compost to build soil.
- Use burnable waste to heat living spaces and/or water.

KINDS OF WASTE

1. **Black Waste** - feces and urine, chemicals, or body fluids

   Disposal method - a sawdust composting toilet or arbor loo

2. **Black Water** - water contaminated with feces and/or urine

   Disposal methods - drywell or surface mound

3. **Gray Water** - Water that has been used but not contaminated with feces or urine, chemicals, or body fluids

   Disposal method: a drywell or surface mound or used for watering plants and trees.

4. **Trash** - paper, metal, plastic, etc.

   Disposal method: whatever is practical, socially acceptable, and environmentally intelligent

   A. Burning*

   B. Burial

   C. Sanitary landfill

   D. Recycling

   * While burning, use the heat for hot water or heating living spaces. Let nothing go to waste.

STRIVE TO CHANGE WASTE INTO A RESOURCE.

Why We Use a Composting Toilet

For 15 years we have used a composting toilet, and during all of that time many of our visitors have questioned our sanity. One of my friends told me he'd love to visit more often, but that he doesn't like to use the bathroom like a gerbil! Marilou calls the sawdust toilet a cat box for humans. People make jokes about our toilet system because it is different and it makes them culturally uncomfortable.

It is important for you to know that the sawdust toilet does not smell. Never, in 15 years, has any guest complained about odor. We have a vent fan located next to the toilet that is turned on when the toilet is being used. We let it run for a few minutes to ventilate the bathroom. The sawdust neutralizes odors.

The sawdust toilet is one of the most important features in the ABUNDACULTURE scheme. Here are the reasons it is important:

1. When used properly with a good compost pile, the sawdust toilet is sanitary. Composting is God's way of turning organic waste into an essential soil builder. Without the composting process, we would be buried by organic waste. If you would like to see the science behind the composting toilet, see The Composting Toilet System Book: A Practical Guide to Choosing, Planning, and Maintaining Composting Toilet Systems, by David Del Porto and Carol Steinfeld.

2. The sawdust toilet is inexpensive and easy to build. The poorest of the poor can usually afford a five-gallon bucket and a box to put it in. That's all that is needed for a sawdust toilet. There is nothing to break or leak. Maintenance is very simple. I paint our wooden box with an enamel paint every few years. We've used the same buckets for 15 years!

3. The sawdust toilet saves water every time it is used. Clean water is so precious that it seems foolish to foul it with human waste.

4. The sawdust toilet allows us to rebuild the poor soil on our homestead. Without the compost from our sawdust toilet, our garden yields would not be acceptable. We garden in containers and use 100% compost. Yes, you can safely use human waste if it is properly composted. It's simple: the key factor is TIME. We never use any compost that has not had at least one year to cure.

Laugh if you must, but the sawdust toilet can solve many problems facing the poor. It is sanitary, inexpensive to build and maintain, it saves water, and it helps to regenerate worn-out soils. AND it does not stink!

BUILDING A SAWDUST TOILET

Note: If sawdust is not available, dry leaves or forest ground cover will work. Peat moss is acceptable. Even newspaper cut into confetti will work. Rice hulls, corn husks, ground straw, any high carbon, confetti-like material will work.

Materials list

- 4 or 5 5-gallon plastic buckets of exactly the same height
- plywood or 1-inch dimensional lumber
- nails and/or glue
- knobs or handles
- hinges (optional)
- toilet seat (optional)
- vent fan (optional)

Tools

- hammer
- saw
- hole saw
- square
- pencil or pen
- tape measure

Sawdust Toilet Plans

Your situation will dictate how you design your sawdust toilet. Here are ideas to consider:

1. To make efficient use of the toilet, store clean sawdust very close to the toilet.

   Note: To load your sawdust bin, use a plastic bag; this won't make a dusty mess.

2. A smooth surface, painted with oil-base paint is easy to clean.
   Note: Paint will yellow in the presence of the ammonia in urine.

3. The only time odor will be a problem is during and immediately after defecation. A small vent fan can solve this problem.

4. Buckets can spring leaks. I suggest placing the bucket in a larger plastic container for safety. Both are easily washed.

5. A toilet seat is a wonderful luxury. Avoid seats made of pressed sawdust or wood. The moisture from the toilet will ruin anything but a plastic seat.

6. Design a fly-proof cover for the composting toilet. Black flies are not generally a problem, but fruit flies can be a nuisance.

Using the Sawdust Toilet

1. Toilet paper will compost quickly. Avoid colors. Dyes may affect plants.

2. When defecating, turn on your vent fan. It needs to run only a few moments. If you do not have a vent fan, a scented candle can be helpful.

3. Cover feces with about 3 or 4 cups of sawdust. Use the same amount for urine. Contents of bucket shall always be moist, but not wet. If the contents become wet, add more sawdust.

4. My wife and I empty our 5-gallon bucket about once a week. Clean buckets are kept outside, but in the shade, (The sun will ruin buckets in less than a year.) The dirty bucket is washed with laundry soap (no bleach) and water. It is left outside to dry and air out. A clean bucket is placed in the toilet enclosure and lined with about 2 or 3 inches of sawdust.

OUR COMPOSTING TOILET

When people visit our home, they are usually fascinated by the solar panels and the windcharger. They comment favorably about the indoor garden and they enjoy the sunlight. If anything causes our visitors to do a double-take, it is our composting toilet. I have learned that people in most parts of the world are very sensitive about bathroom habits. There can be great resistance to any change in the bathroom. Therefore, much time was spent designing our composting toilet. Here are the criteria we developed for our waste management system:

1. The system shall be safe to operate. It shall not present unreasonable health hazards.

2. The system shall not contaminate soil or water.

3. The system shall be aesthetically pleasing, visually attractive with no objectionable odors.

4. The system shall be easily constructed by anyone with basic carpentry skills.

5. The system shall be inexpensive.

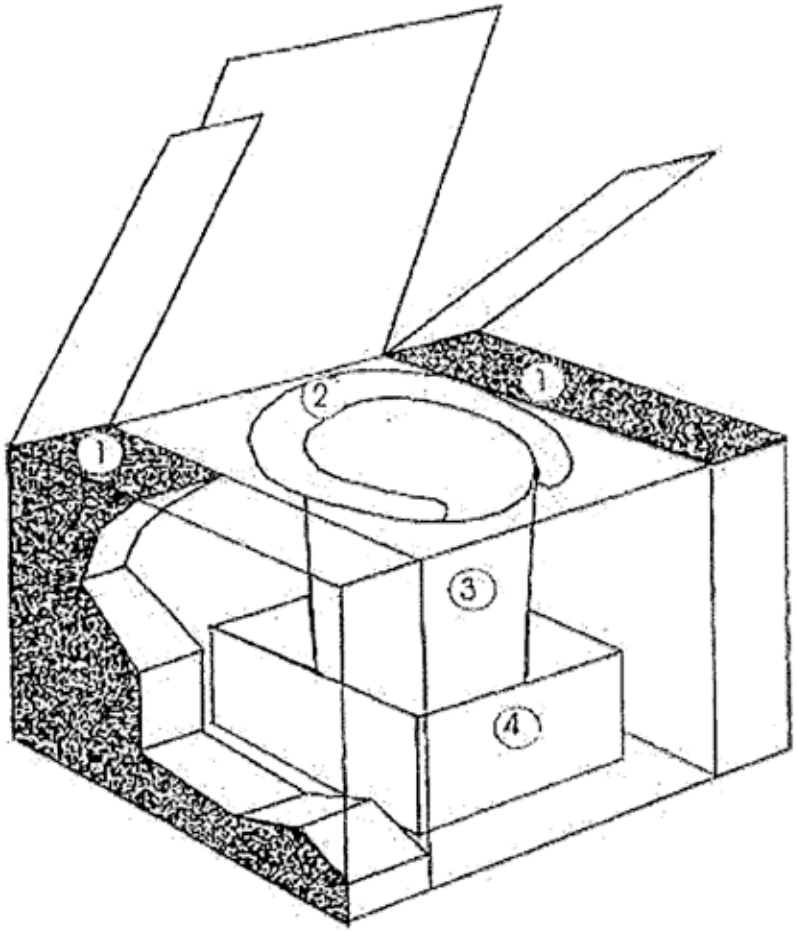
6. The system shall be easily maintained.

7. The system shall conserve water.

8. Excrement shall be rendered odorless and safe for use as fertilizer.

9. The system shall handle waste on-site. Waste shall not be transported to a distant area.

Composting Toilet



1. Covering material
2. Toilet seat.
3. Five gallon bucket
4. Plastic container

We built our toilet for less than $100. The components of the toilet were only about $35, but I paid a cabinet builder to help me. The toilet consists of a box with three compartments: a center compartment that holds a five-gallon plastic bucket and a storage compartment for sawdust and leaves on each side of the bucket. I put a plastic storage container under the bucket in case it springs a the leak.

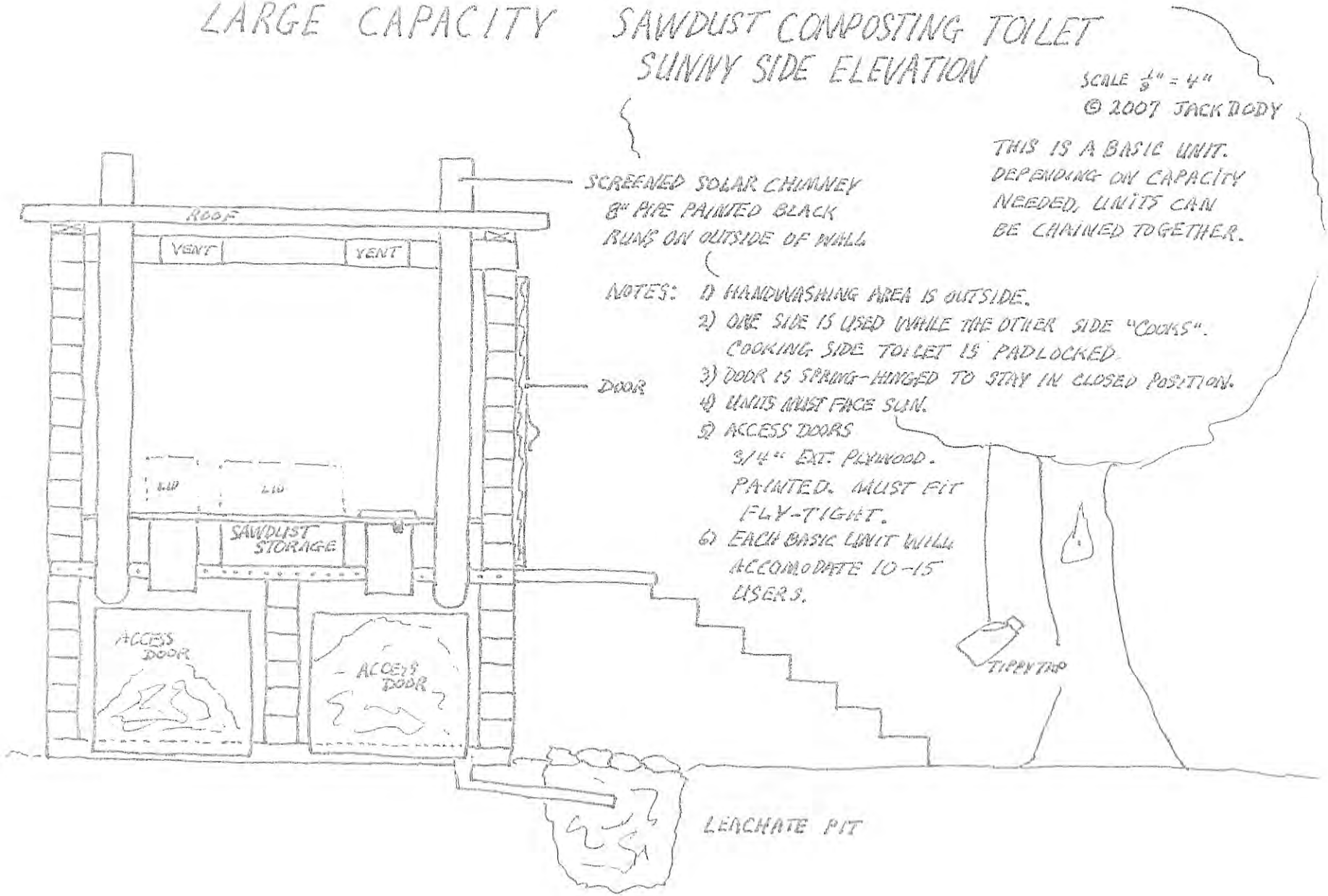
.

LARGE CAPACITY SAWDUST COMPOSTING TOILET
SUNNY SIDE ELEVATION

SCALE $\frac{1}{8}$" = 4"

© 2007 JACK DODY

THIS IS A BASIC UNIT. DEPENDING ON CAPACITY NEEDED, UNITS CAN BE CHAINED TOGETHER.



NOTES:
1) HANDWASHING AREA IS OUTSIDE.
2) ONE SIDE IS USED WHILE THE OTHER SIDE "COOKS". COOKING SIDE TOILET IS PADLOCKED.
3) DOOR IS SPRING-HINGED TO STAY IN CLOSED POSITION.
4) UNITS MUST FACE SUN.
5) ACCESS DOORS 3/4" EXT. PLYWOOD. PAINTED. MUST FIT FLY-TIGHT.
6) EACH BASIC UNIT WILL ACCOMODATE 10-15 USERS.

LARGE CAPACITY SAWDUST COMPOSTING TOILET C/S

SCALE ⅜" = 4"

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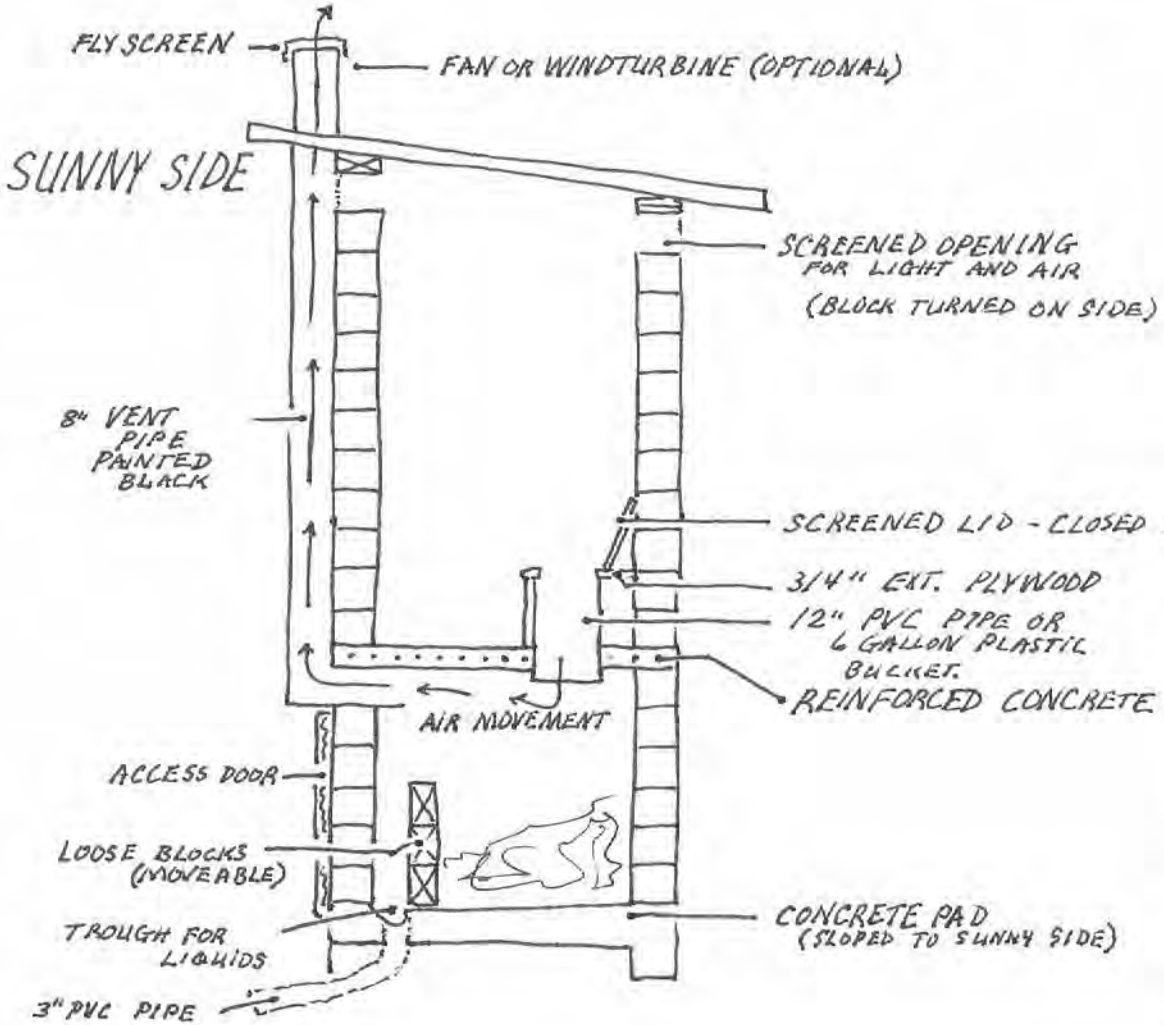
STRUCTURE IS CONCRETE BLOCK OR COMPARABLE



NOTES:

1) LEACHATE LIQUIDS DIVERTED TO A PIT - FIVE FEET DEEP, FILLED WITH WOOD CHIPS.
2) INTERIOR WALLS PAINTED W/EPOXY PAINT TO CREATE WASHABLE SURFACE.
3) ROOF MUST BE INSULATED.
4) VENT PIPE CREATES AIR MOVEMENT TO ELIMINATE ODORS.
5) WHITE TOILET PAPER IS USED.

SAWDUST COMPOSTING TOILET FOR HANDICAPPED AND SMALL CHILDREN

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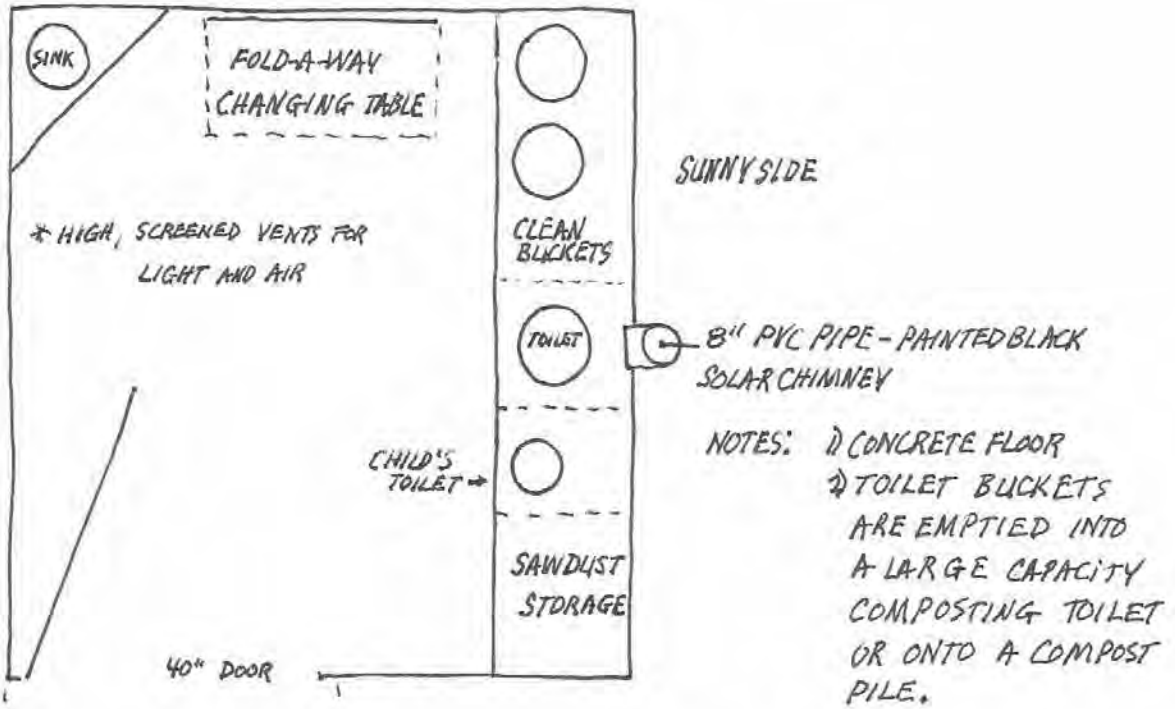
SCALE 1/2" = 1'

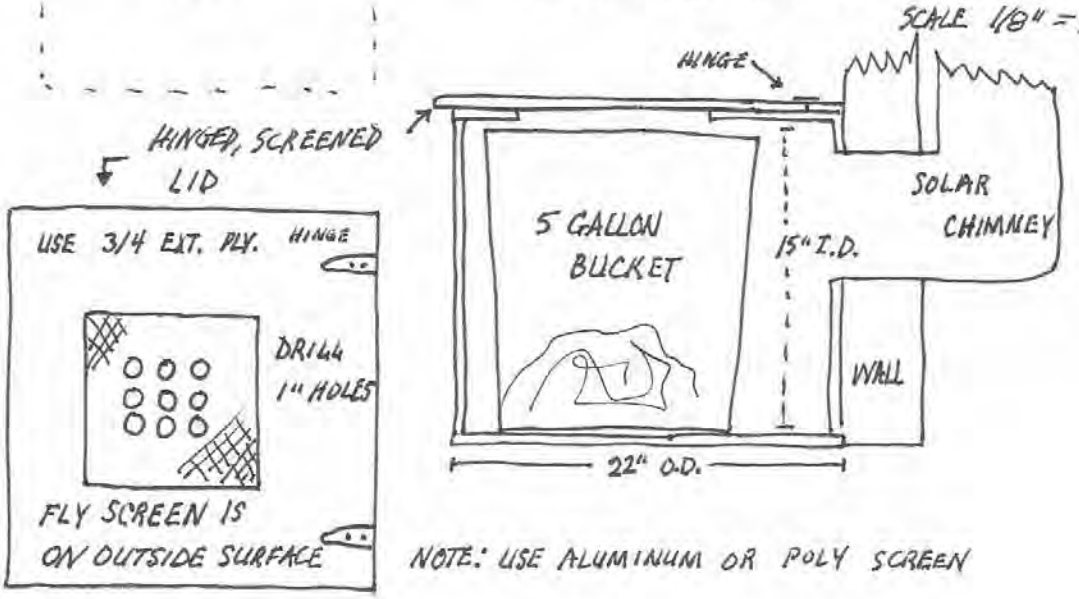


NOTES: 1) CONCRETE FLOOR
2) TOILET BUCKETS ARE EMPTIED INTO A LARGE CAPACITY COMPOSTING TOILET OR ONTO A COMPOST PILE.

DETAILS OF TOILET BOX

ADULT SIZE

SCALE 1/8" = 1"



NOTE: USE ALUMINUM OR POLY SCREEN

LARGE CAPACITY SAWDUST COMPOSTING TOILET ~ DETAILS

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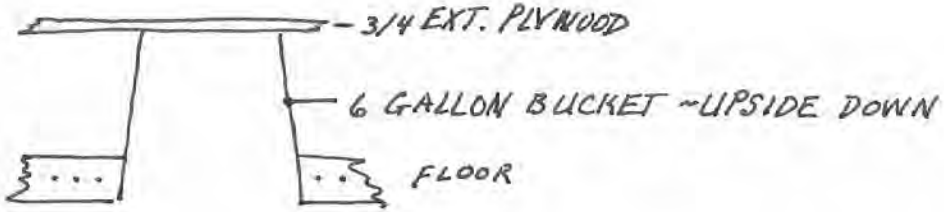


NOTES:
1) TOILET HOLE IS COVERED WITH A SCREENED, HINGED LID. LID IS PADLOCKED WHEN COMPOST BENEATH IS COOKING. OTHER TOILET IS USED AT THAT TIME.

BOTTOM OF BUCKET

CUT OUT THIS AREA

LEAVE 3/4 INCH LIP TO ATTACH TO PLYWOOD W/ SCREWS

NOTE: HOLE CUT IN PLYWOOD SEATING AREA IS SLIGHTLY SMALLER THAN THE HOLE IN THE BOTTOM OF THE BUCKET. BUCKET IS ATTACHED TO THE UNDERSIDE OF THE SEATING PLYWOOD.

A Solar Ark recycles wastes...

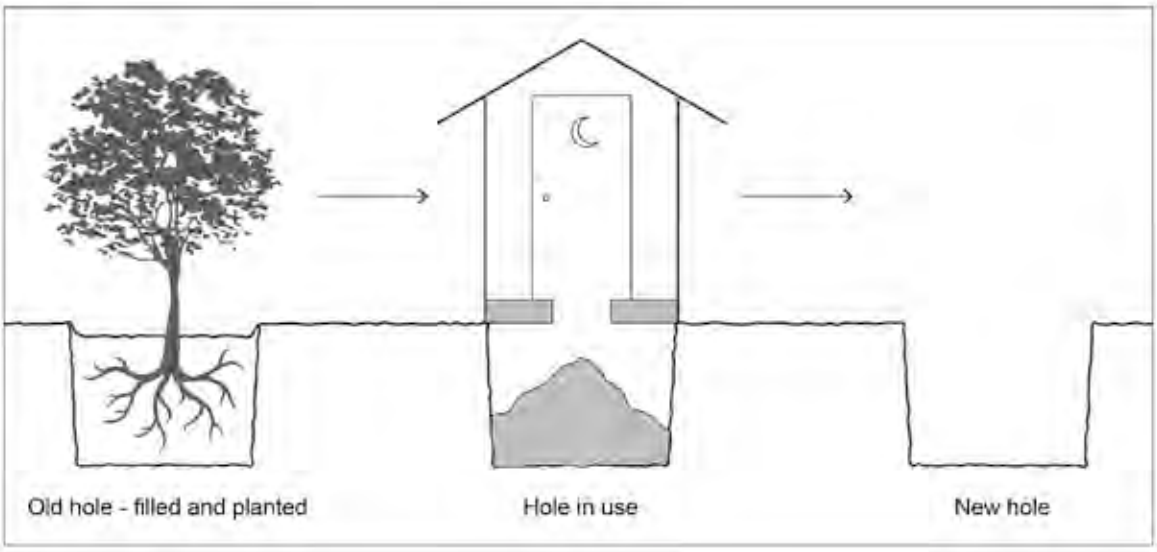
Composting: One of God's Recycling Systems

How to Compost

1. Build enclosure(s).
2. Monitor moisture, oxygen, nitrogen (heat) and carbon.
3. Let time and microbes do their work.
4. Use compost to improve soil.

The Arbor Loo

Friends in Kenya told me about the Arbor Loo. I love the idea for its simplicity and ease of use. It is a great companion to an indoor sawdust toilet. If you live far enough in the country so that it will not create problems for your neighbors, the Arbor Loo is worth considering.



NOTES:

1. Place the Arbor Loo in an area that will not be flooded, at least 15 meters from any water source.
2. Dig a hole 1 meter x 1 meter x 1 meter.
3. Build a shelter (the arbor) from available materials The base must be water and insect proof, i.e., concrete or treated lumber.
4. The shelter (arbor) is pulled over a new hole waiting for use.
5. When one hole is filled, simply move the shelter to the next hole. Immediately plant a tree in the compost of the old hole, or cover the waste with dirt. Keep animals and children away from the old hole.
6. If you use ashes or sawdust or some other high-carbon covering (see COMPOSTING), there will be minimal odors.
7. If there is a sawdust toilet inside the home, it can be dumped directly into the Arbor Loo hole.
8. The hole must always be covered—with the shelter, with dirt, or with another type of cover. Keep the contents of the arbor loo covered at all times to reduce odors and discourage insects and animals.

You can find excellent examples and illustrations of The Arbor Loo on the internet.

Building A Composting Enclosure

1. Choose a sunny site, out of the wind, that won't be flooded.

2. Build a three-sided enclosure that is about four feet wide, four feet deep and four feet high. Use old pallets, concrete blocks, scraps of lumber, woven-wire fencing, etc. Make sure that plenty of air can pass through the walls of the bins. It's good to have two or three bins so that one bin can be out of service and "cooking" at any time.

3. A three-sided bin is easy to fill and to turn. When the bin is full, the fourth side can be put in place to keep out animals and insects.

4. If rain makes the pile too wet, it can be covered with a tarp or straw.

5. Keep children and animals away from the compost pile. If necessary, put a fence around the composting area.

...an Easier Way to Build A Compost Enclosure

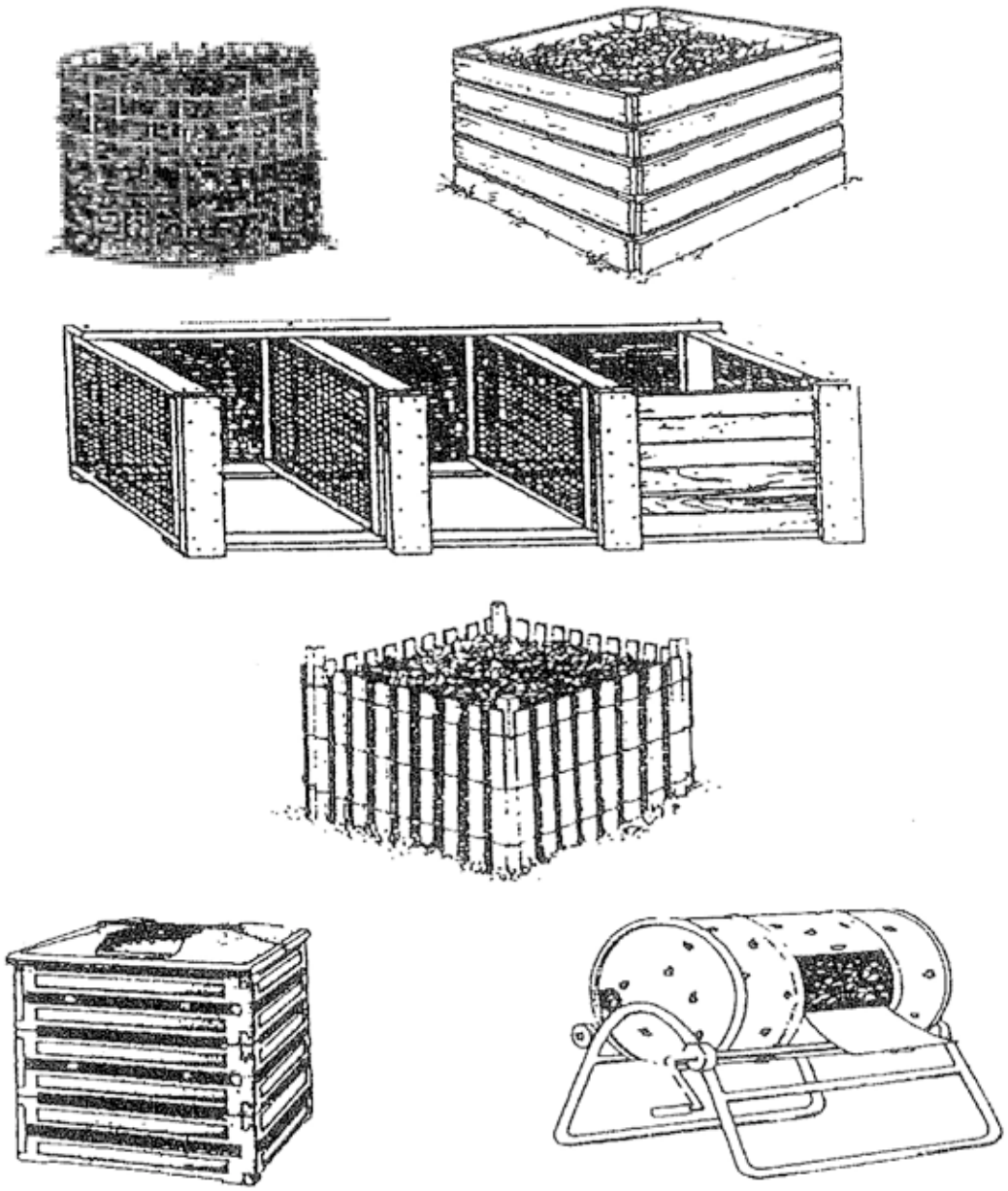
1. Turn the soil in a six foot by six foot piece of ground.

2. Place layers of material to be composted on the earth. If needed, moisten the material to be composted.

3. Cover the pile with a piece of black plastic sheathing held in place with bricks or rocks

EXAMPLES OF COMPOSTING ENCLOSURES

Below: Several types of yard waste composters in which end-product from composting toilet systems can be further composted. (Graphics: New Hampshire Governor's Recycling Program)



from Composting Toilet Systems, by David Del Porto and Carol Steinfeid, Chelsea Green Publishing, copyright 1999

Starting the Compost Pile

1. Place six to eight inches of dry, carbon material (hay, straw, sawdust, dry leaves, etc.) on the bottom of the compost pile. This material will absorb excess moisture.

2. Put materials to be composted on the pile in 2 to 4 inch layers.

3. Add water to each layer if necessary.

Maintaining the Compost Pile

1. Monitor moisture. The compost pile should be as moist as a damp sponge that has been squeezed as dry as possible. If the pile becomes too wet, add dry carbon material like sawdust, dry leaves, straw, hay, etc.

2. Monitor oxygen. If the pile becomes too wet or too compacted it will be starved for oxygen. If the compost pile has a foul odor, it is not properly oxygenated. Turn the pile with a fork or a shovel. If it is too wet, add carbon material. It is good to turn the pile about once a week. Turning also distributes microbes throughout the pile.

3. Monitor nitrogen (heat). **A properly functioning compost pile will reach temperatures of 130 -165 degrees Fahrenheit. This heat kills pathogens that are harmful to humans,** if the pile is not becoming warm, add nitrogen (cured manure, clover, pea plants, ammonium nitrate, ammonium sulfate, high-nitrogen fertilizer without
pesticide, or grass clippings. Follow instructions in "Things to Compost".) If the compost pile becomes smelly and it is not too wet, there is too much nitrogen. Add carbon material to balance the nitrogen. In very cold weather the pile will go dormant. It will function again when temperatures rise.

4. Monitor carbon. Carbon helps maintain the pile's balance. If the pile is too wet, too compacted or too smelly - add carbon,

5. Cover anything that will attract insects or animals with straw, hay or sawdust.

Things to Compost:

1. The contents of composting toilets
2. Autumn leaves from deciduous trees
3. Dead annuals and perennials
4. Pruned twigs cut short (less than a pencil in diameter or shredded)
5. Workshop sawdust or shavings (Because they are woody, add extra nitrogen.)
6. Lawn clippings (Must be carefully mixed into pile to avoid clumping. Use sparingly.)
7. Vacuum cleaner dust
8. Leguminous plants of the pea family that add nitrogen to the soil and compost: clover, pea vines, etc.
9. Vegetable leftovers from kitchen: coffee grounds, tea leaves, pasta and bread, eggshells
10. Finely-shredded brown paper bags, cardboard, and newspapers (No slick or colored papers)
11. Lake plants or seaweed
12. Hay or straw
13. Old manure from rabbits, goats, cows, poultry, pigs, sheep and horses (Use about a 2 inch layer as often as needed to raise nitrogen levels.)
14. Cornstalks and tomato vines
15. Ammonium nitrate, ammonium sulfate, or an inexpensive high-nitrogen lawn fertilizer without pesticide (Sprinkle the pile with 1/3 to 1/2 cup of fertilizer per 25 square feet of surface area.)
16. Hair—mix it thoroughly to avoid clumping.

Things Not to Compost

1. Oak, holly, or conifer leaves. (These are acidic and more resistant to decay.)

2. Toxic plants: eucalyptus, poison oak, poison sumac, black walnut, oleander, hemlock, castor beans, California bay laurel, juniper, cypress.

3. Plants with thorns.

4. Wood byproducts from lumber treated with wood preservative chemicals.

5. Aggressive weeds such as Bermuda which sprout runners and roots, ivy and succulents, wild morning glory, bind weed.

6. Bones, meat, grease, and other animal products.

7. Any manure from dogs, cats or other carnivorous animals. (Pathogens from carnivores can be difficult to kill and can cause illness in humans.)

8. Clorox, anti-bacterial soaps or toxic cleaning products, mouthwash.

9. Any plants, plant parts or soils that show signs of disease, pests, or any undesirable webby mycelia of soil fungi.

10. Ashes—save them to sprinkle directly on plants that need more alkalinity.

11. Plants that are slow to compost: magnolia leaves, pine needles.

Recommended Reading and Resources

(Note: All composting information came from the following sources. I rearranged and edited the information, often using the original authors' words. Jack)

The Budget Gardener, Maureen Gilmer, Penguin Books, 1996, p.34.

Compost the Quickie Way, Lynn Gordon Stetser, Jr., Backwoods Home Magazine, p. 16.

The Composting Toilet System Book: A Practical Guide to Choosing, Planning and Maintaining Composting Toilet Systems, by David Del Porto and Carol Steinfeld. This is my favorite book on composting toilets.

For Good Compost Every Time, Tom R. Kovach, Backwoods Home Magazine, Sept./Oct. 1998. p. 21.

Hints for the Vegetable Gardener-A to Z, R. Sanders, Garden Way Publishing, 1976.

The Rodale Book of Composting, Deborah L. Martin and Grace Gershung, editors, 1992 Rodale Press.

On the net: The Arbor Loo

On the net: The Sawdust Toilet

Using and Recycling Urine for Crops, John Valenzuela, Permaculture Activist, 78, Winter 2010-11, p.44.

Don't Flush the Fertilizer, Carol Steinfled, *Mother Earth News*, October/November 2002, p 57.

A Solar Ark Recycles Wastes...

BLACK WATER DISPOSAL (for Liquids Only)

(Black Water is water that is contaminated with urine, feces or harsh chemicals.)

Black water can be safely disposed of in a dry well, surface mound or septic system.

SOIL PERCOLATION TEST FOR BLACK WATER DISPOSAL

Note: Before you decide on an appropriate disposal system for black water, you must know how effectively your soil filters water. A percolation test provides this information.

1. There shall be one test hole for every 1200 square feet of absorption area. (Note: For most Solar Arks, one test hole will be adequate. A Solar Ark should generate little waste water.)

2. The test hole shall be at least 50 feet from any water source. Avoid flood plains.

3. The test hole shall be at least 6 feet deep.
   NOTE: For a surface mound, the test hole is only 14 inches deep.

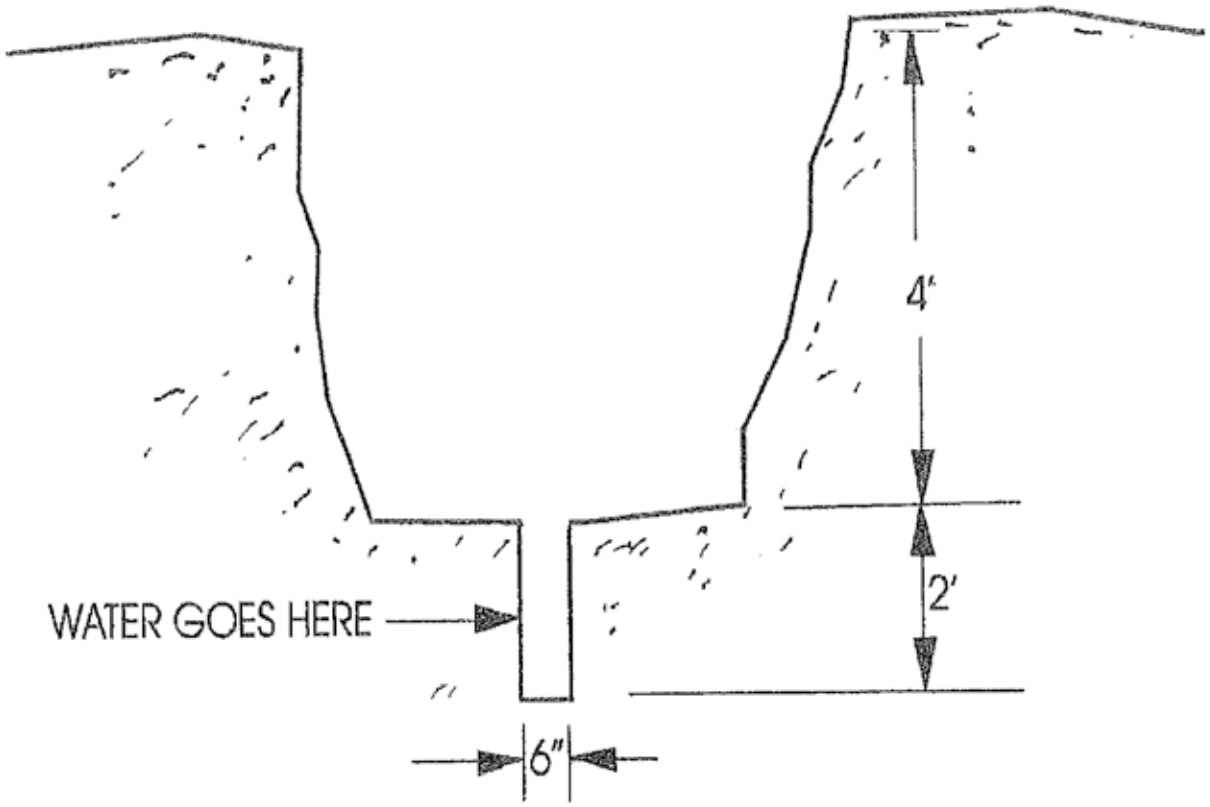
4. The test hole shall be 6 inches in diameter, or as close thereto as possible. (A standard post-hole digger will create a properly-sized hole.)

5. On the night before the percolation test, fill the test hole with 14 inches of water.

6. On the day of the test, the test hole shall be refilled with at least 14 inches of water. When the water drops to 6 inches, begin to measure the time it takes for those last 6 inches of water to be absorbed.

A percolation rate of between 5 and 60 minutes per inch is desired. It should take 30 minutes to 6 hours for the water to be absorbed.

Idea for the Soil Perc. Test Hole



1. Locate black water disposal at least 50 feet from any water source.
2. Dig a hole 4 feet deep and as small as is practical with pick and shovel.
3. Dig two feet more with a post hole digger.

(Note: If your perc. test is acceptable, consider building a drywell.)

Possible Perc. Test Problems

Problem #1 - The soil is too rocky to dig.

Problem #2 - The soil has too much clay and the water cannot percolate through it. (It takes more than 6 hours for the test hole to empty.)

Problem #3 - The test hole fills with ground water.

Problem #4 - The water empties out of the test hole too quickly. (It takes less than 30 minutes for the hole to empty.)

To solve these problems, build a surface mound.

Solutions for a Bad Perc. Test...

Principles for Building a Surface Mound

1. Locate the mound at least 50 feet from any water source. Avoid flood plains.

2. Locate the mound away from trees.

3. Level the ground

4. Create a void or open space that is capable of holding slightly more than the amount of water that typically will be sent to the mound.

   Example: You are building a mound for your washing machine. You want to be able to dispose of the waste water from two loads of laundry, about 70 gallons. The void under the mound must be able to hold at least 70 gallons.

5. Always create a vent so that water can enter the void.

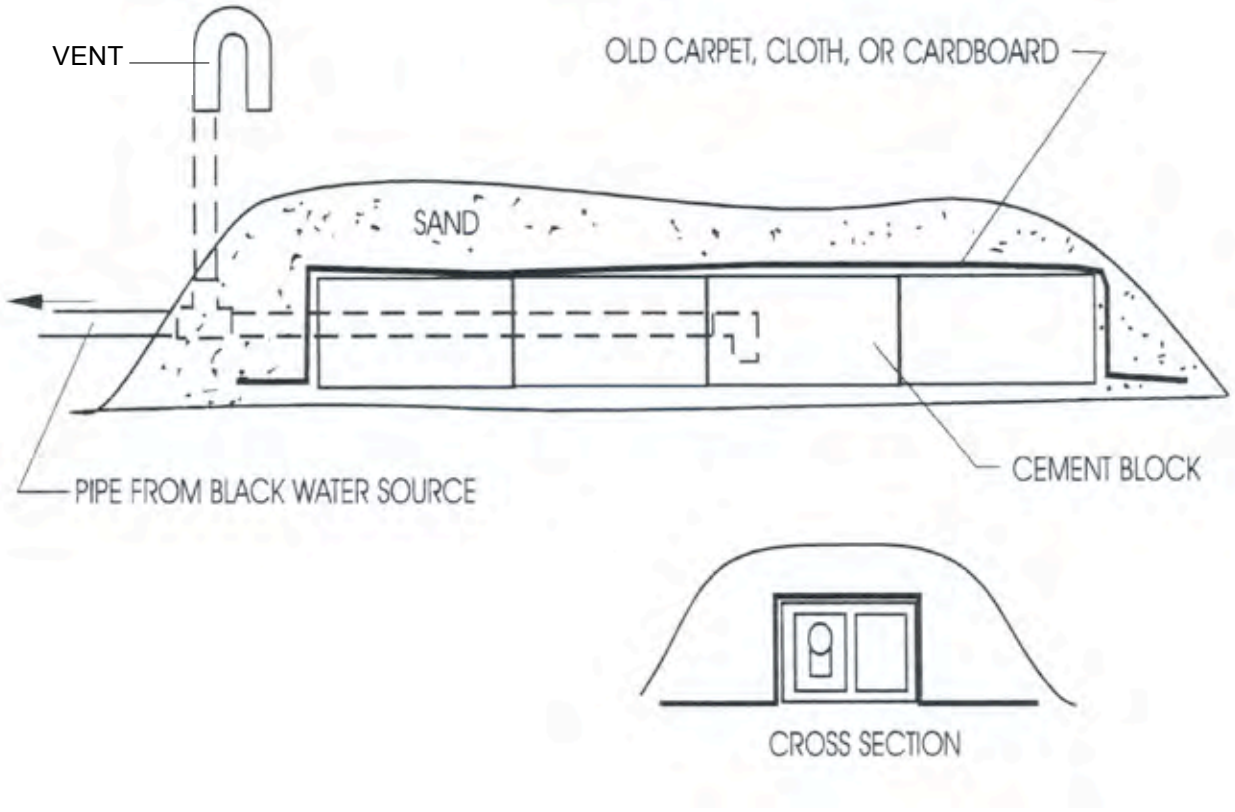
6. Cover the void so that it cannot be filled with soil. Use old carpet, corrugated galvanized sheet metal, cardboard, cloth, blankets, plastic sheathing, etc.

7. Use enough sandy soil on the mound to absorb all the moisture of of the mound. If the soil of the mound becomes wet, add more soil to the mound or send less water to the mound.

8. Build a fence around the mound to restrict children and/or animals.

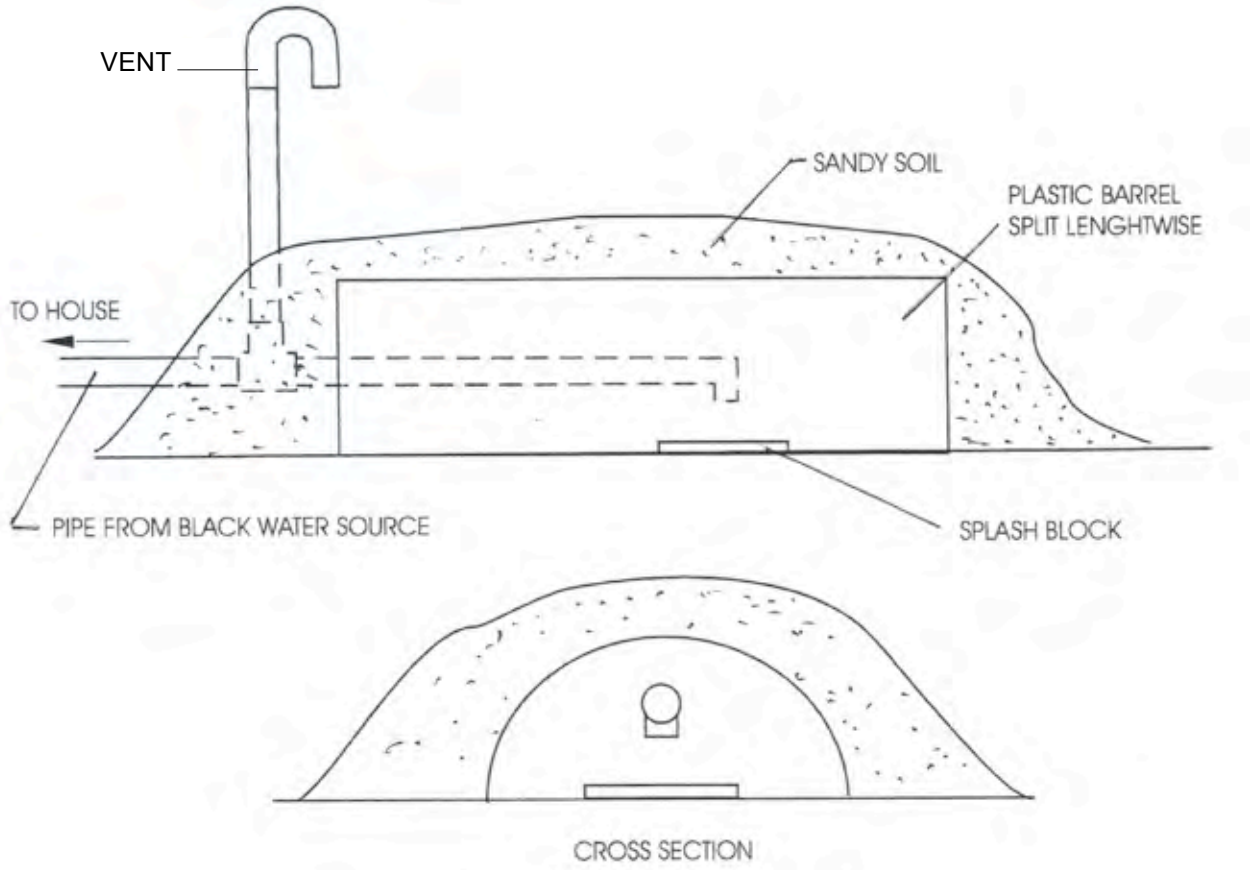
9. Plant flowers with non-invasive root systems on the mound.

Black Water Mound Idea #1



1. Place concrete blocks on the ground to create a void.
2. Extend the drain pipe to the center of the blocks.
3. Create a vent.
4. Cover the blocks with corrugated galvanized sheet metal, old carpet, cloth, cardboard, blankets, plastic sheathing, etc. so that soil cannot fill in voids.
5. Cover the blocks that are covered with old carpet, plastic sheathing, etc., with sandy soil..
6. Put a fence around the mound.
7. Plant flowers!

Black Water Mound Idea #2



1. Place a plastic 55 gallon drum, split lengthwise, on the ground to create a void. Substitute an old bathtub, stock tank, sink, etc.

2. Extend a drain pipe to the center of the void. Place a splash block at the end of the drain pipe.

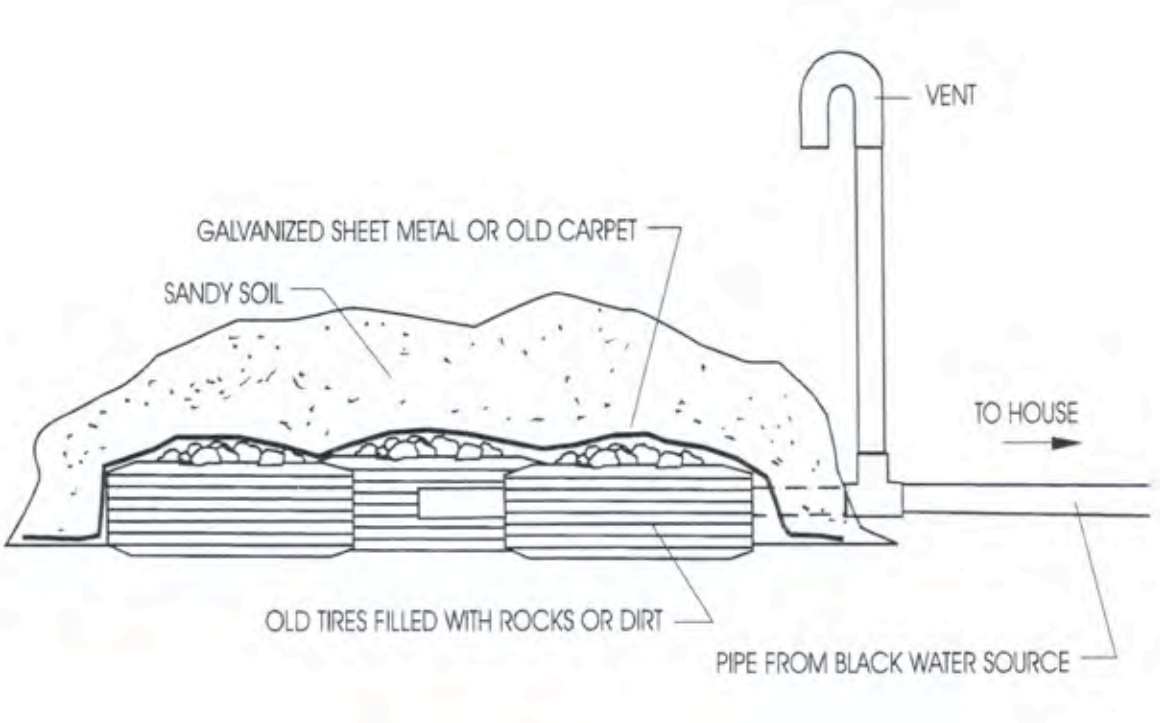
3. Create a vent.

4. Cover the 55 gallon drum, bath tub, stock tank, sink, etc. with sandy soil.

5. Put a fence around the mound.

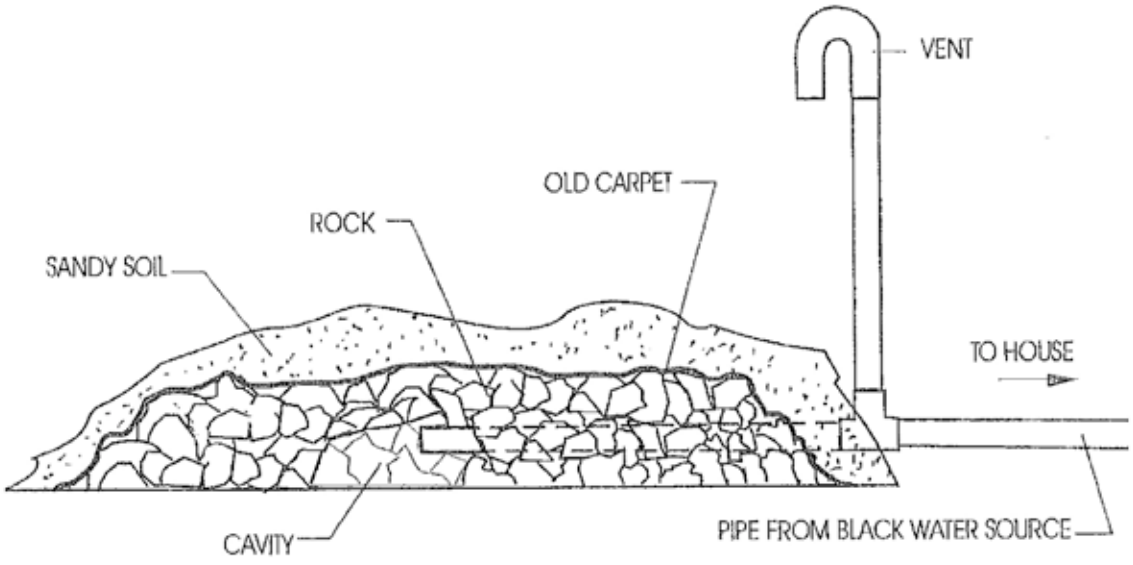
6. Plant flowers!

Black Water Mound Idea #3



1. Use old tire(s) to create a void.
2. Extend a drain pipe to the center of the void. Place a splash block at the end of the drain pipe.
3. Create a vent.
4. Use galvanized, corrugated sheet metal, old carpet, plastic sheathing, etc. to cover the tires and keep soil out of the void.
5. Cover the galvanized, corrugated sheet metal, old carpet, plastic sheathing, etc. and tires with sandy soil.
6. Put a fence around the mound.
7. Plant flowers!

Black Water Mound Idea #4



1. Use rocks of uniform size (at least fist size) to create a void.
2. Extend a drain pipe to the center of the pile of rocks.
3. Create a vent.
4. Cover the pile of rocks with old carpet, cloth, cardboard, blankets, plastic sheathing, etc. so that soil cannot fill the void.
5. Cover the pile with sandy soil.
6. Put a fence around the mound.
7. Plant flowers!

Constructing the Dry Well

(If your perc. test is acceptable, you may choose to build a dry well.)

This is for blackwater ONLY. No solid waste.

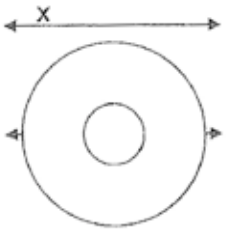
What it is: A covered pit that will allow water to seep into the earth, thus filtering and purifying it.

Materials needed:

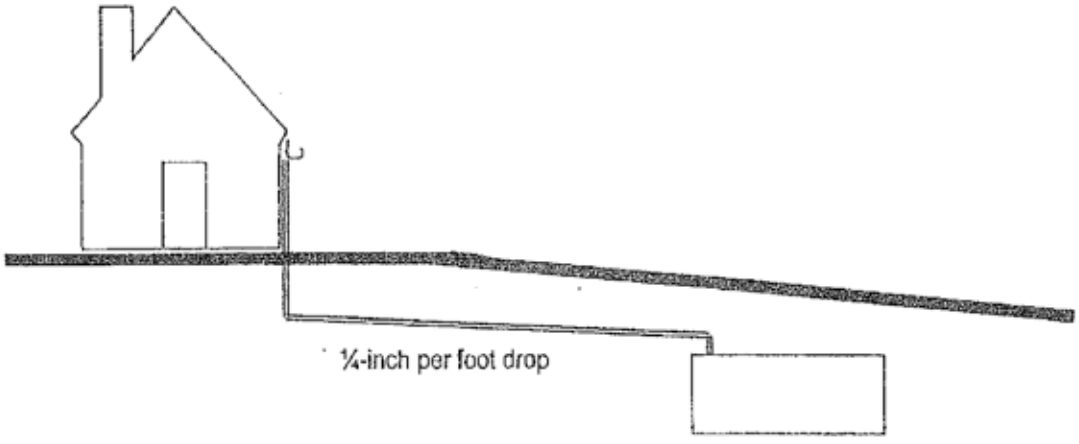
Old tires
Old cardboard, plastic sheathing, carpet, etc.
PVC pipe and fittings

How to construct a dry well:

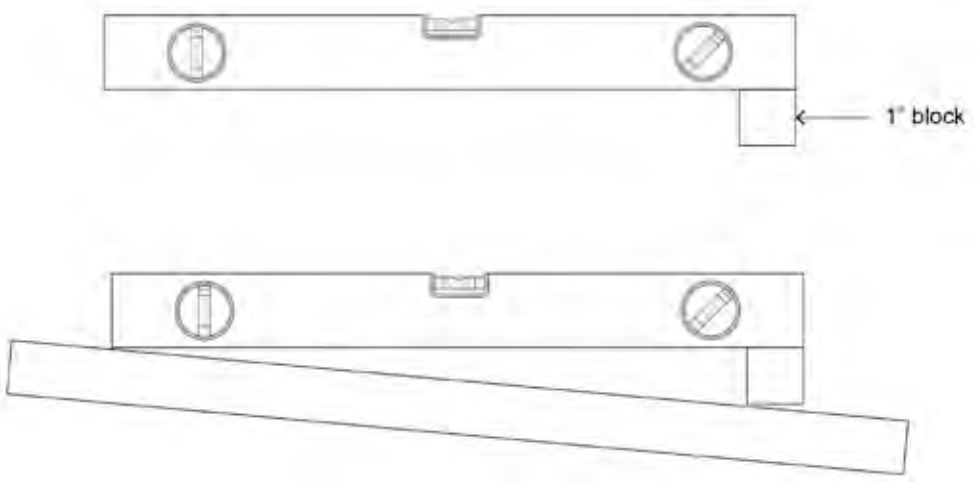
1. In an area away from trees, dig a pit just a bit wider than the diameter of the tires being used.



2. The pit should be deep enough to allow water to drain to the pit at the rate of 1/4 inch per foot.



Plumber's trick: To lay your pipe at 1/4-inch per foot fall, do the following. At one end of a 4-foot level, tape a 1-inch high block, like this:



When the level is laid on the pipe and the bubble indicates level, your pipe is falling at 1/4-inch per foot.

3. Size the pit to hold at least twice as much water as will be sent to the pit at any given time. Example: You are building a dry well for the water from your washing machine. You typically wash two loads at a time, creating about 70 gallons of waste water. Your dry well should be large enough to contain at least 140 gallons.

4. Place the tires in the pit. [See dry well illustration on the following page]

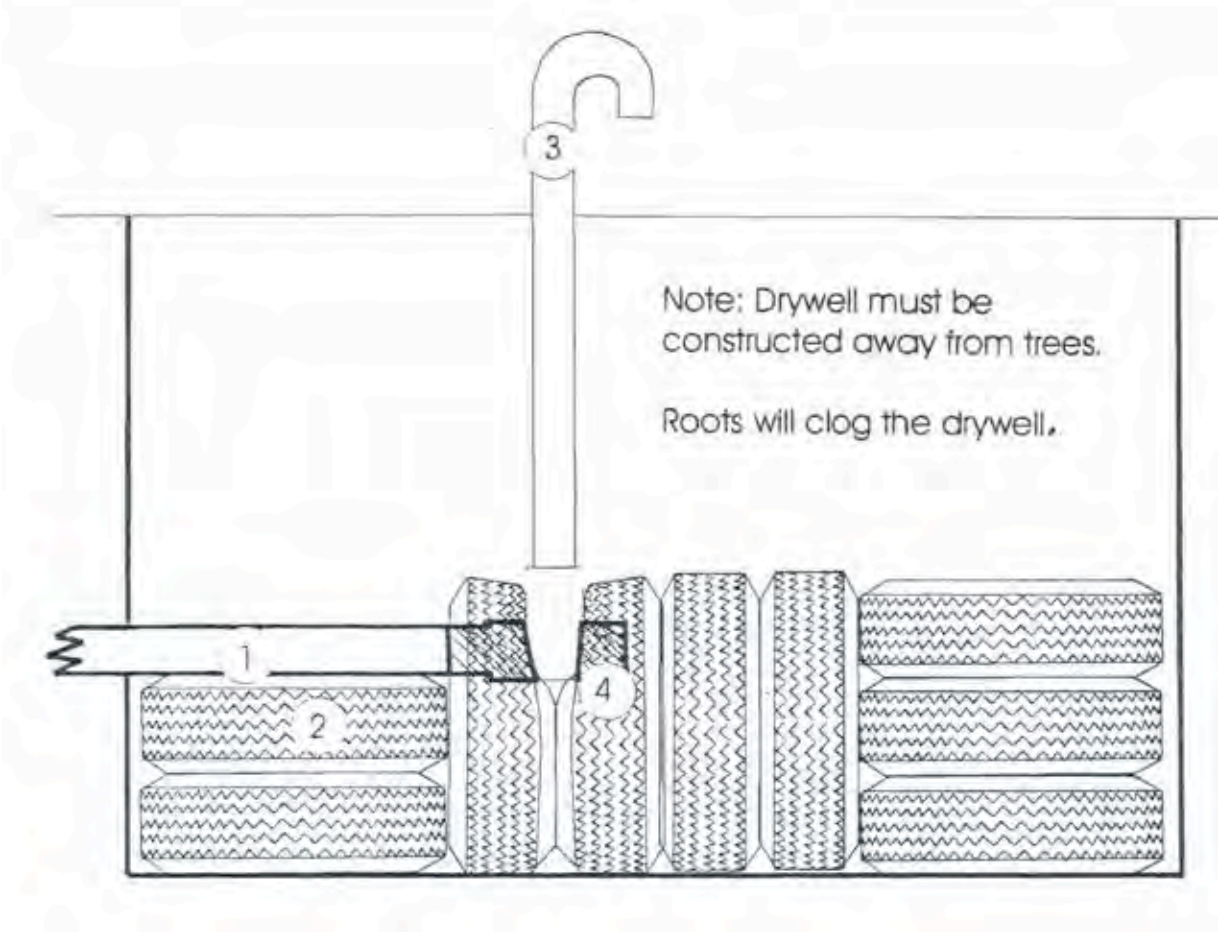
5. The horizontal tires on each end of the pit should be filled with compacted soil. Make sure the horizontal tires at the end of the pit where the pipe enters are well-compacted. If they settle, the pipe will be broken.

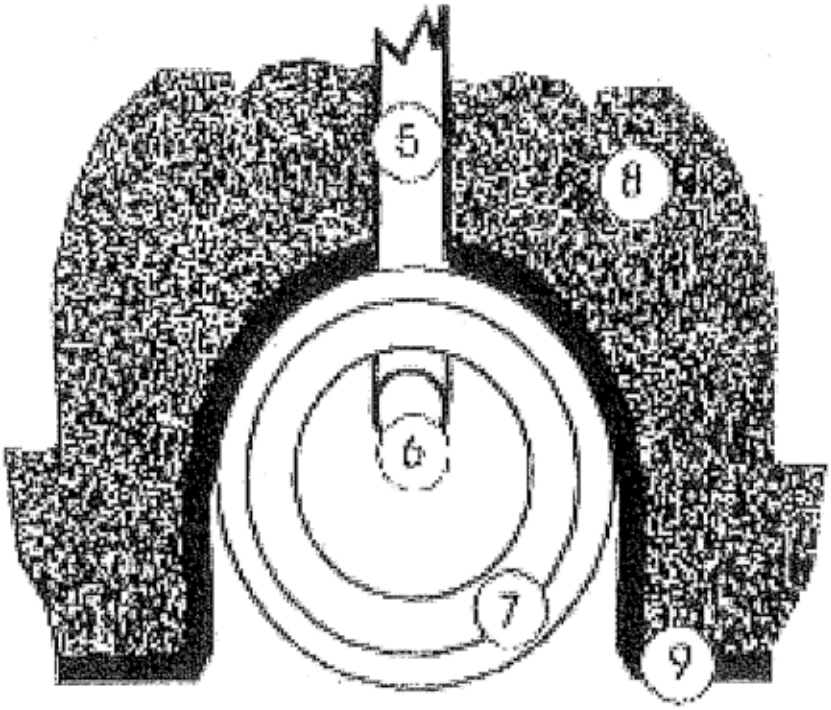
6. Create a vent.

7. Carefully cover all of the tires with sheathing, old cardboard, or an old piece of carpet. Make sure the covering goes all the way to the bottom of the pit on all sides of the tires. [Dry well illustration #9] This covering keeps the soil from filling the void created by the tires.

8. Cover the tires and sheathing in the pit with soil. Compact the soil gently. Leave a mound over the tank. It will settle over time.

9. Place markers or a fence around the dry well so that it will not be driven over. You can walk over it with no problems





1. Source of wastewater
2. Tires compacted with soil (vertical tires are not filled with soil)
3. Vent pipe
4. “T” section
5. Vent pipe
6. “T” section
7. Tire
8. Soil
9. Old carpet, etc.