Portable Drilling Machines for Creating Small Water Supplies in Bedrock

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WaTER Conference
University of Oklahoma
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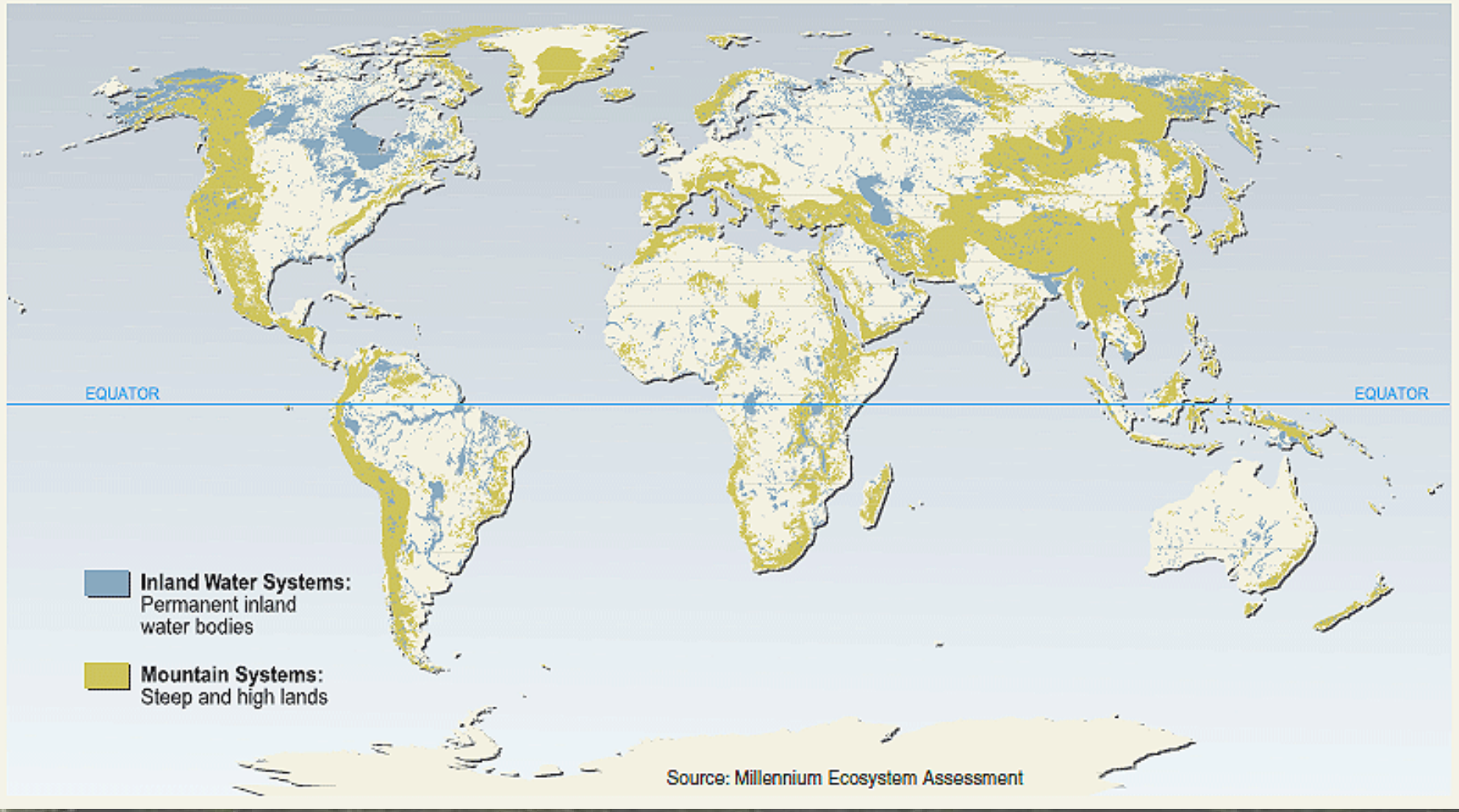
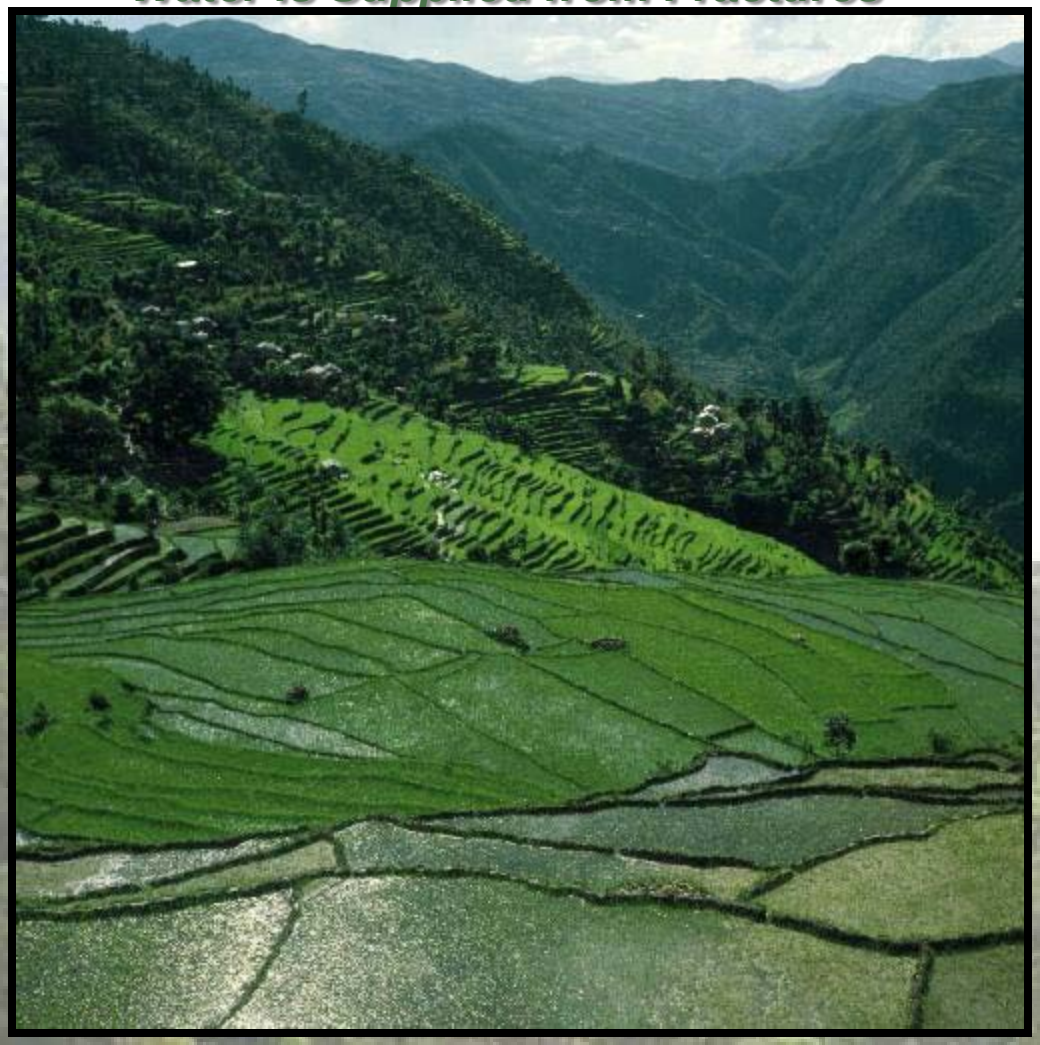
UNIVERSITY of GUELPH
CHANGING LIVES IMPROVING LIFE

Global Distribution of Mountains



Mountains Are Formed of Rock

Water is Supplied from Fractures

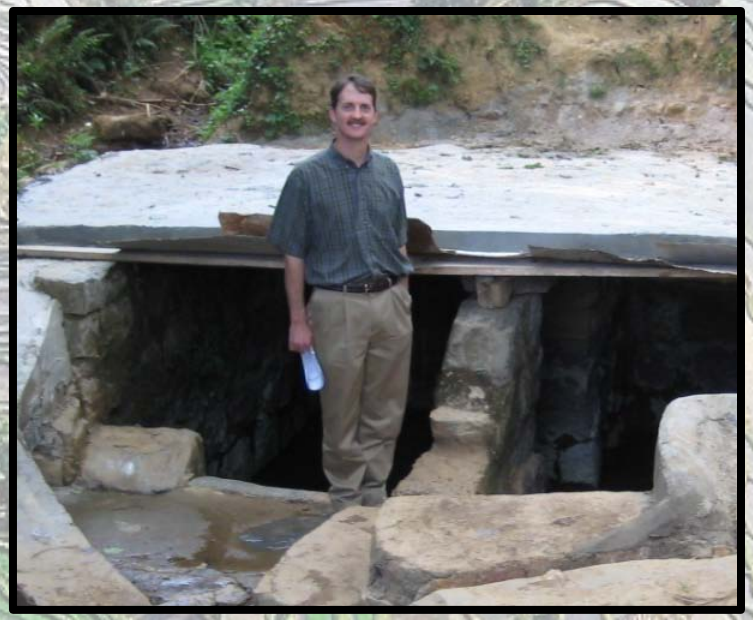


Problem Statement

- Hundreds of millions of mountain dwelling people worldwide live without access to safe drinking water
- Areas are often remote and not accessed by roads
- Drinking water is commonly unsafe due to bacteria from human and animal waste.

How can these people gain access to safe drinking water?

Fecal Contamination of Springs in Mountainous Southwest China



Derek E Chitwood, PhD
International Health Resources

Paper Presented: AWRA meeting Albuquerque NM, 2007

Poorly Protected Springs

Results of Water Survey

Example of Springs contaminated by leachate from rice patties

- **July 2006 (Patty Flooded)**
  [E. coli] = 65/100 ml
- **Nov 2006 (Patty Dry)**
  [E. coli] = 19/100 ml
- **Feb 2007 (Patty Dry)**
  [E. coli] = 5/100 ml
- **May 2006 (Patty Dry)**
  [E. coli] = 22/100 ml

Village Hand Dug Well

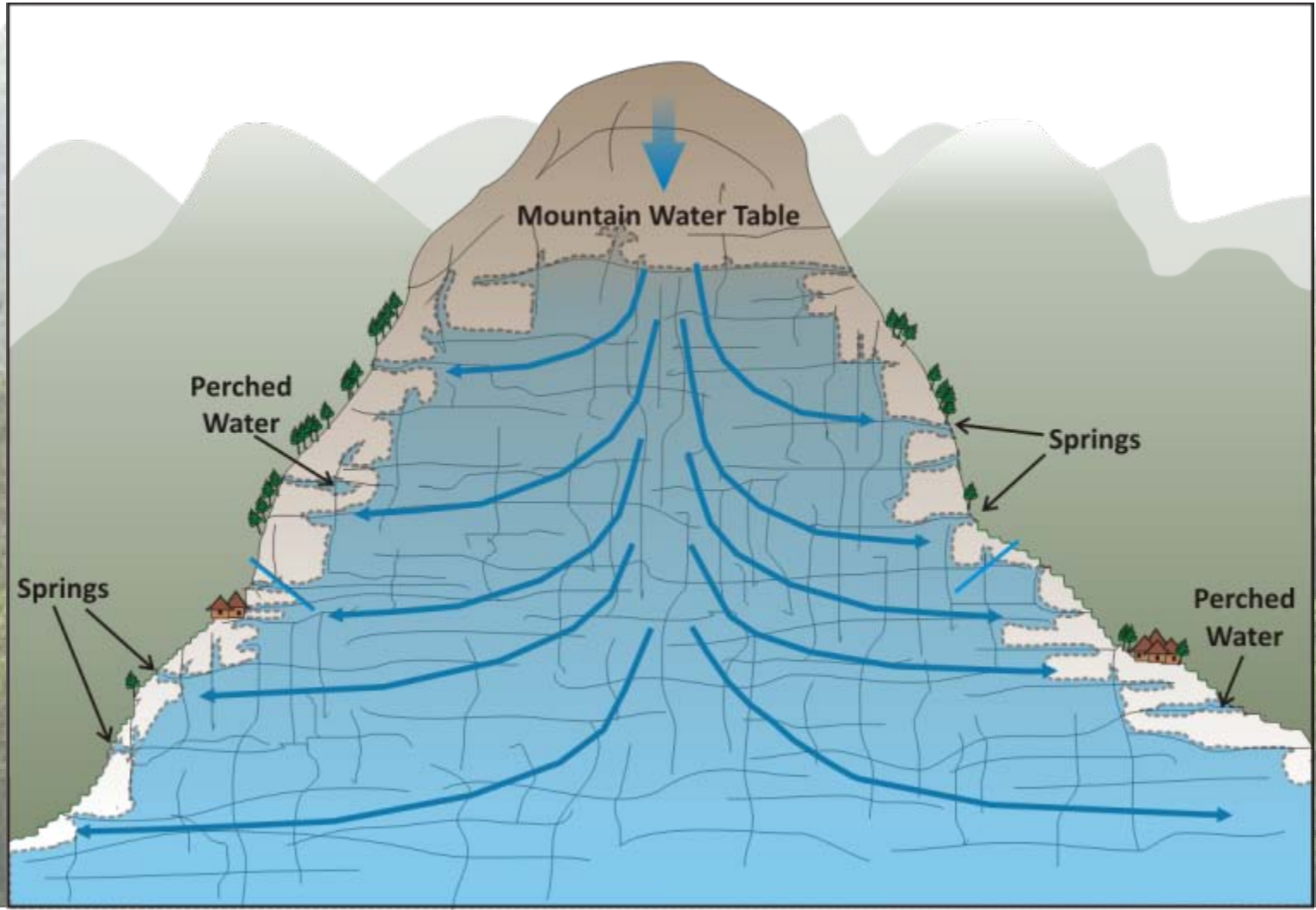
One low yield well may support multiple families

U of G Research Program Relevant to 'Wells in Mountains'

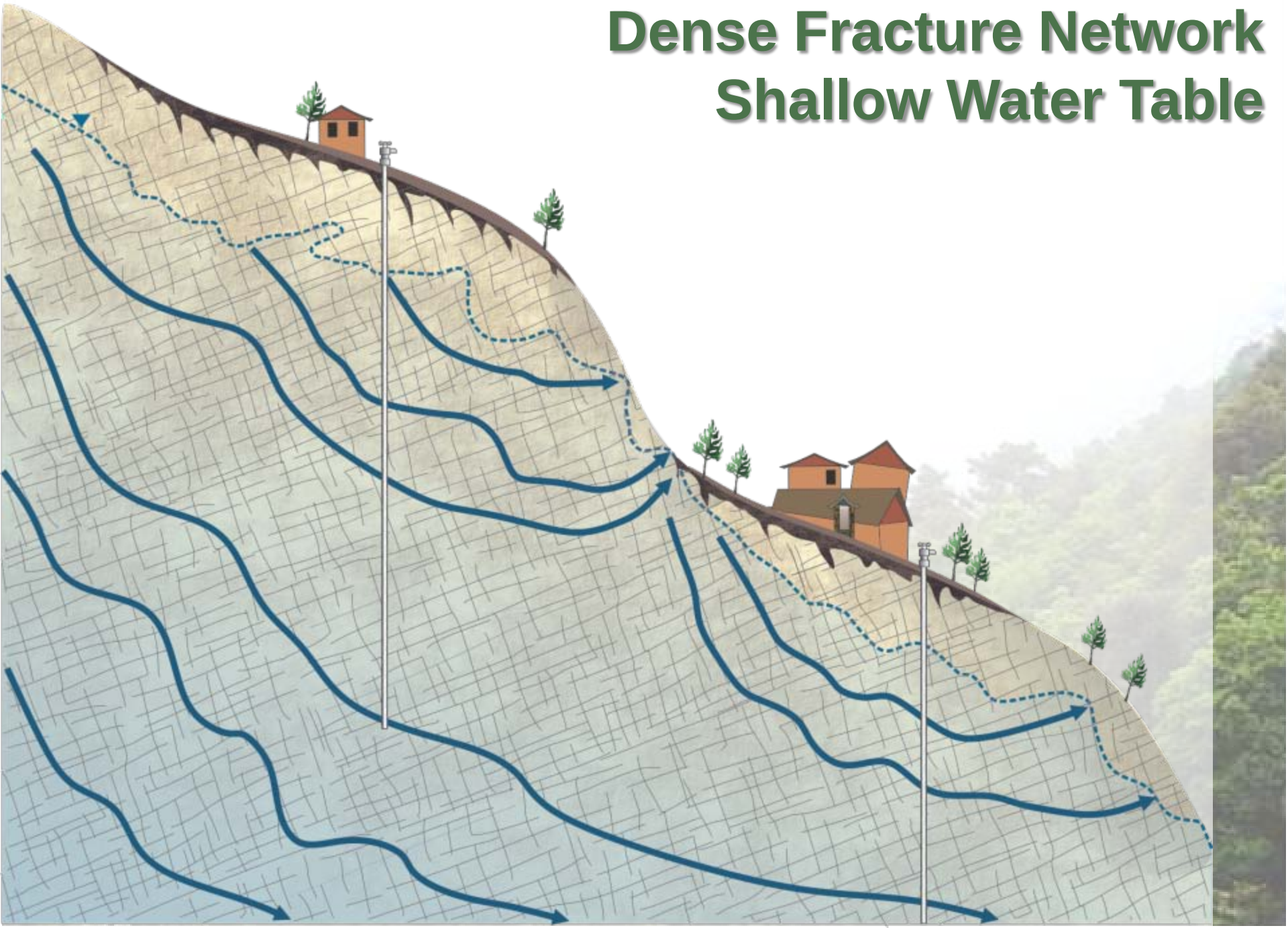
- Nature of fracture networks and groundwater flow in bedrock
- Mountain hydrogeology
- Creation of water wells using portable drills

Leaky Mountain Conceptual Model for Seeps and Springs

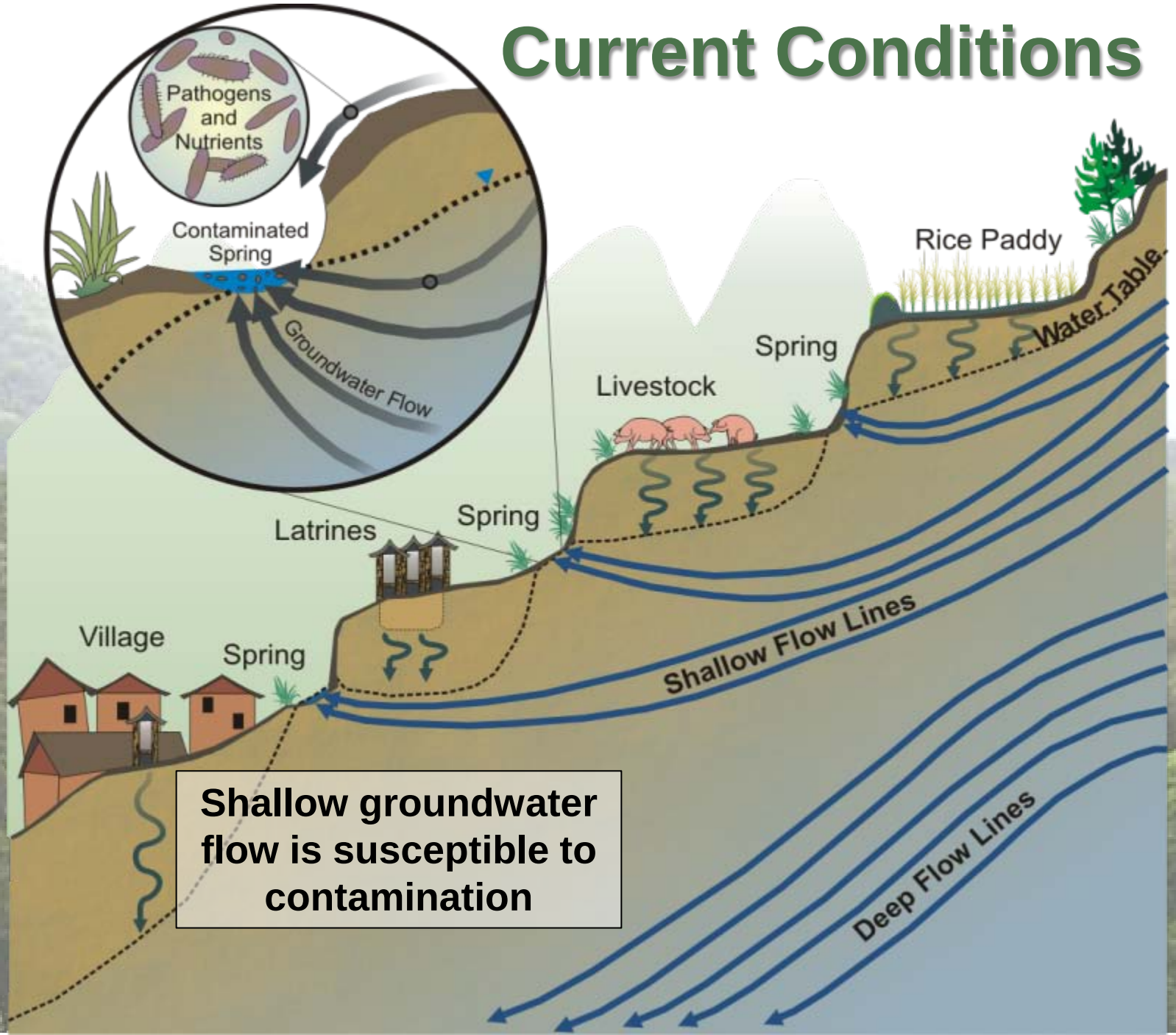
People Live as High up in the Mountains as there are Springs to Provide Water



Dense Fracture Network
Shallow Water Table



Current Conditions



Organizations Involved in Mountain Development Research

- International Mountain Society
- International Centre for Integrated Mountain Development, Kathmandu, Nepal
- Consortium for the Sustainable Development of the Andean Ecoregion, Lima, Peru
- Mountain Research Initiative, Bern, Switzerland
- Interacademic Commission for Alpine Studies, Bern, Switzerland
- Centre for Mountain Studies, Perth College, University of the Highlands and Islands, Perth, Scotland
- Food and Agriculture Organization of the United Nations, Rome, Italy
- University of Central Asia, Bishkek, Kyrgyz Republic
- Centre for Development and Environment, University of Bern, Switzerland

What do Canada and China Have in Common?

Both have been unable to provide water wells in remote areas inhabited by aboriginal people

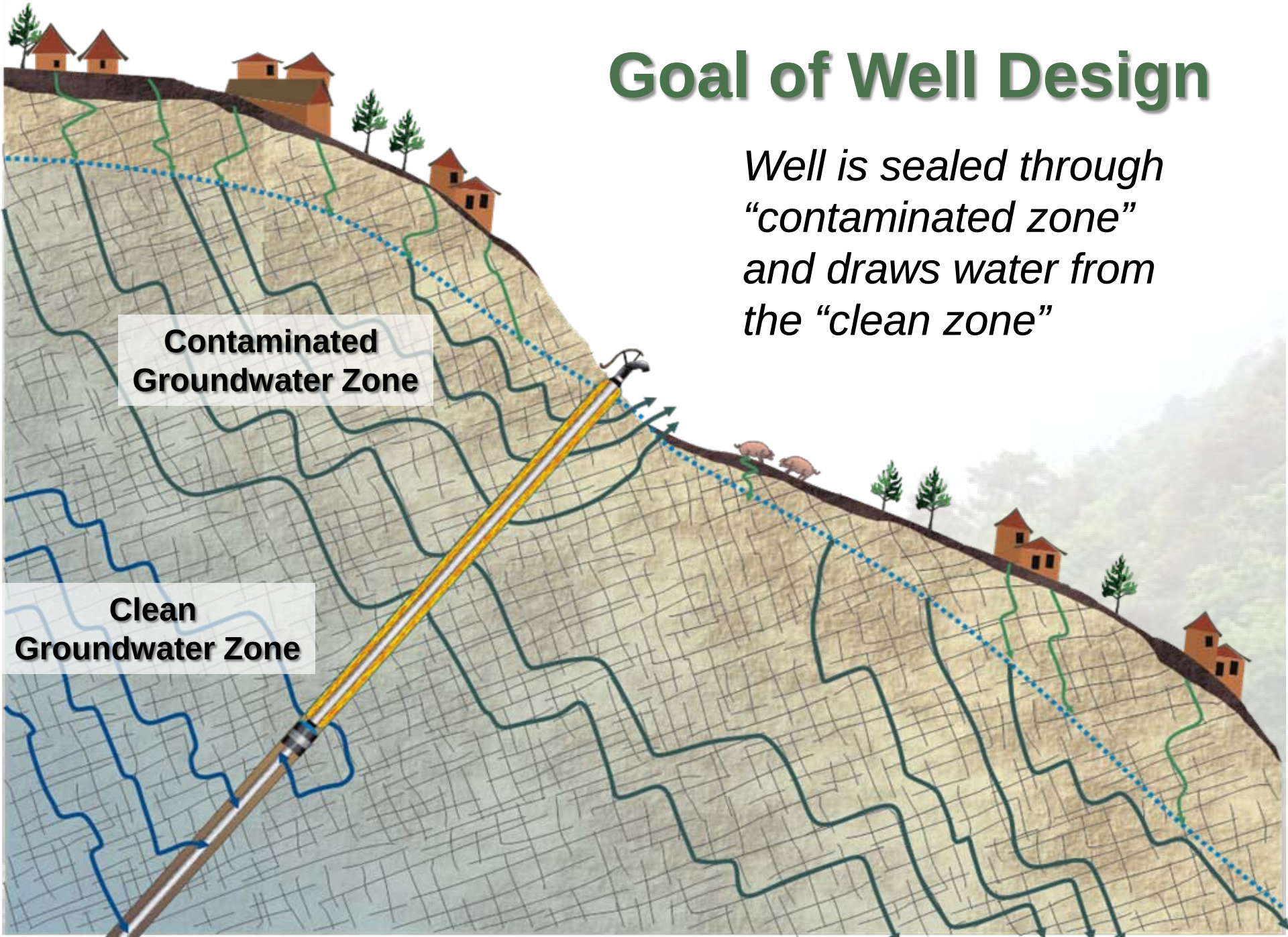
Wealthy Countries Are Unable to Provide Safe Drinking Water to Remote Communities on Bedrock

Why?

This particular type of safe drinking water problem requires technologically soft, low-cost but sophisticated solutions not easily delivered/managed by government bureaucracies

Goal of Well Design

Well is sealed through "contaminated zone" and draws water from the "clean zone"



Problem Solution: Portable Drills For Bedrock

Why are these drills available?

- Small percussion drills have been developed for drilling in developing countries
- Gasoline-driven core drills developed for mineral exploration industry

Portable Drills for Wells in Bedrock

Size
Cost
Complexity

Manual

- Auger-jetting with percussion
- Percussion: Water4 Inc.

} Very soft rock only

Gasoline Engines

- Percussion: Consallen Forager — Soft Rock
- Rotary Coring:
  - Shaw
  - Winkie
  - Hydradrill

} All types of rock

Portable Drills for Wells in Bedrock

Manual

- Auger-jetting and percussion
- Percussion: Water4

Gasoline Engines

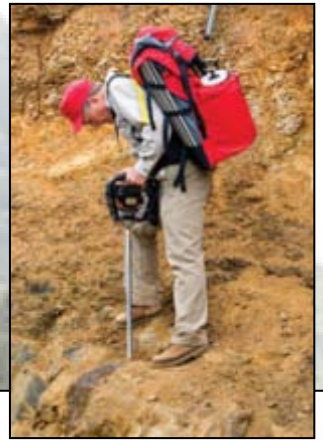
- Percussion: Consallen Forager
- Rotary Coring:
  - Shaw
  - Winkie
  - Hydradrill

Criteria for Mountain Drilling Equipment

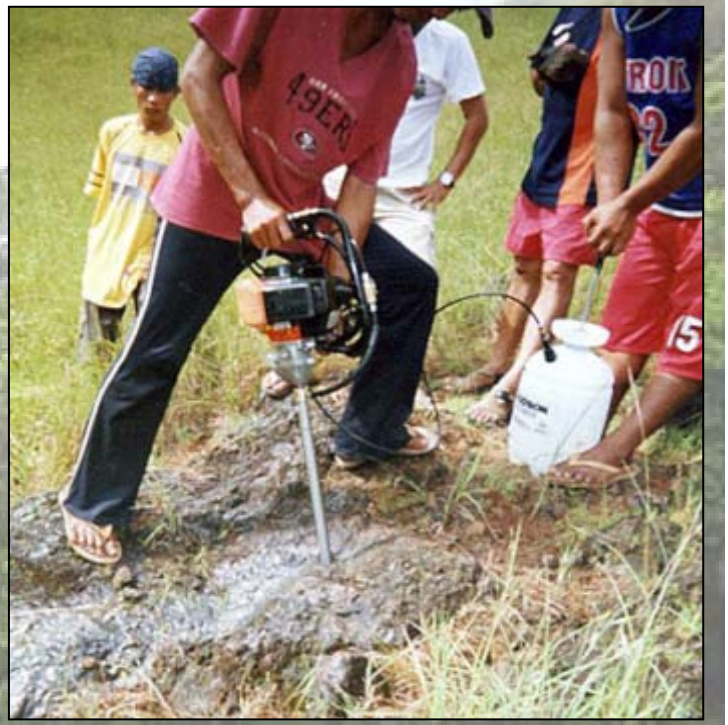
- Capable of rock drilling to grater than 50ft
- Diameter of hole 3” down to 1”
- Capable of angled drilling
- Transportable by people
- Lowest possible cost
- Easily maintained

Shaw Portable Core Drill *(lowest cost)*

www.backpackdrill.com



Core Diameter: 0.81”
Bore Diameter: 1.04”or 1.52”
New: 1-5/8” and 2”
Depths: 20 to 35’



Winkie Drill *(intermediate cost)*

www.minex-intl.com (sole manufacturer)

Core Diameter: 1”
Hole Diameter: ~2”
Depths: up to 100’

Fred Wink (1914-2007) Inventor of the Winkie Drill

Larger Portable Drill Used for Mineral Exploration

- Drilling capabilities of 400ft of more
- Modifications possible to suite different needs
- Vancouver Company ***Hydracore*** and a Chinese affiliate are potential suppliers of equipment

U of G Program for testing portable drills

Two locations:

Sandstone: Santa Suzanna Field Laboratory near Simi, California

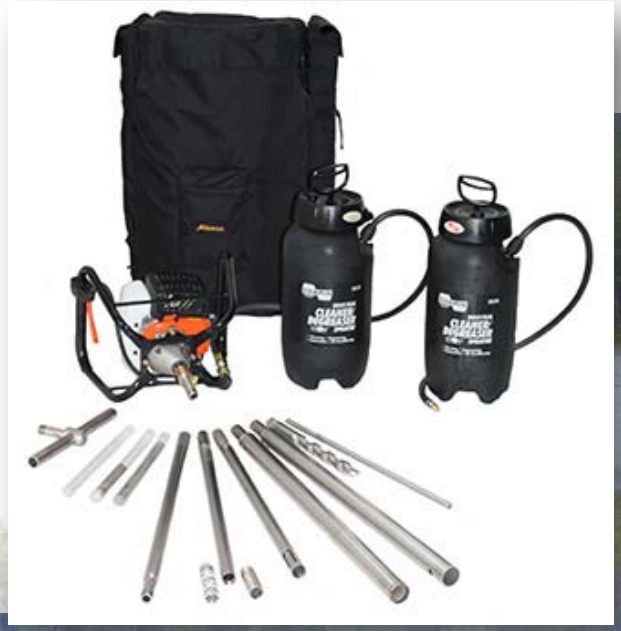
Dolostone: Rockwood conservation area near U of G

Questions about the drills

- How deep can they drill?
- How fast?
- What is maximum diameter of hole?
- How portable?
- How reliable?

Shaw Backback Drill

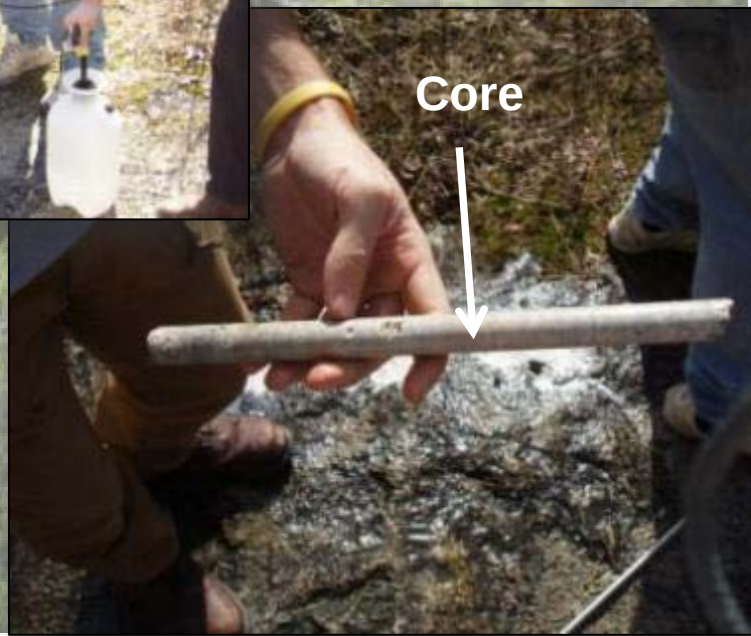
Approximate cost of complete system ~ 5000$



Shaw Portable Core Drill
Shaw Tool Ltd.
10160 Oak Ridge Road
Yamhill, Oregon 97148

Shaw Field Trial

Rockwood Dolostone



Shaw Field Trial: Sandstone May 2010

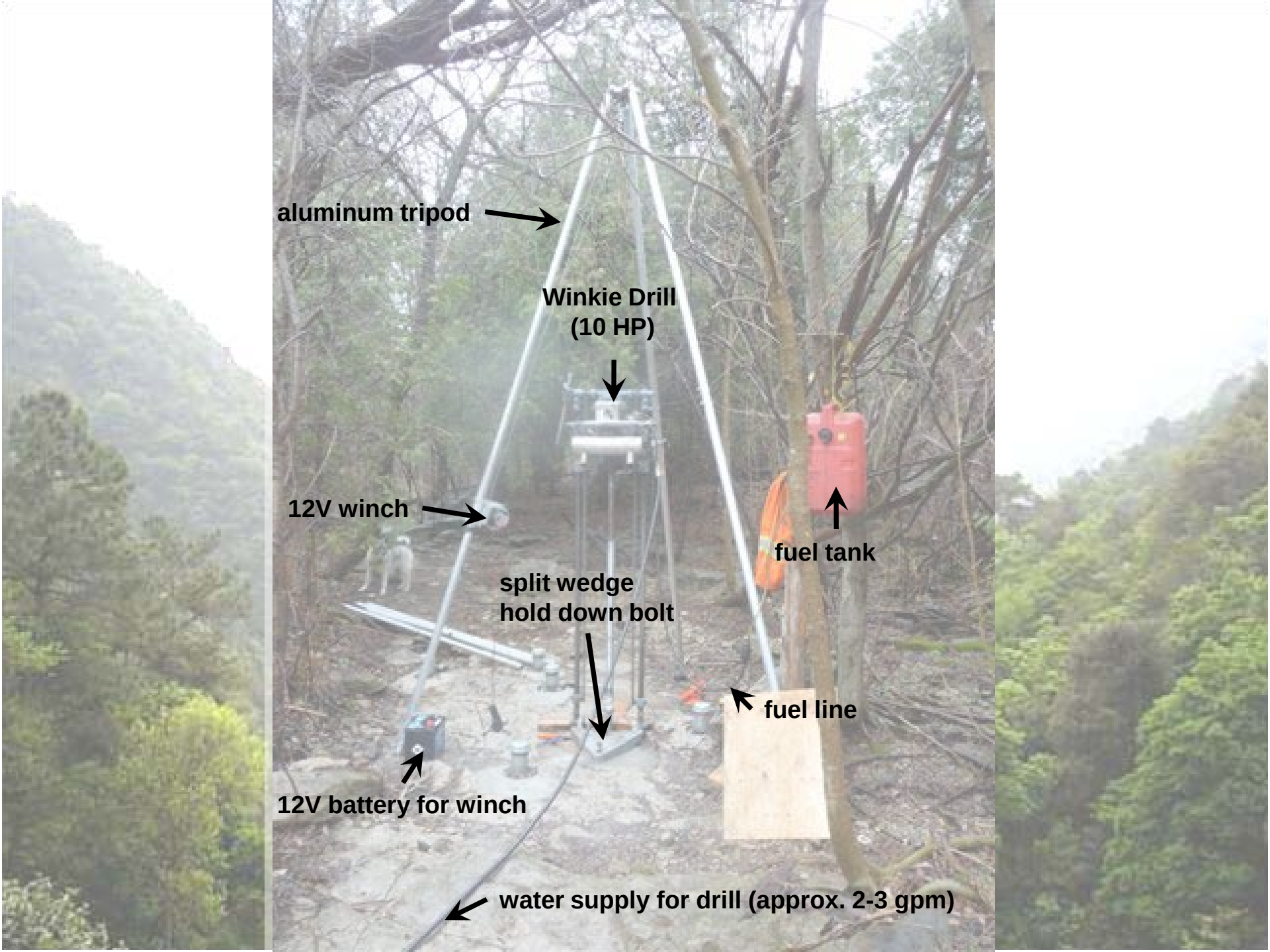
Drilled to 11’bgs using LMB
Rate: 20 min/ft

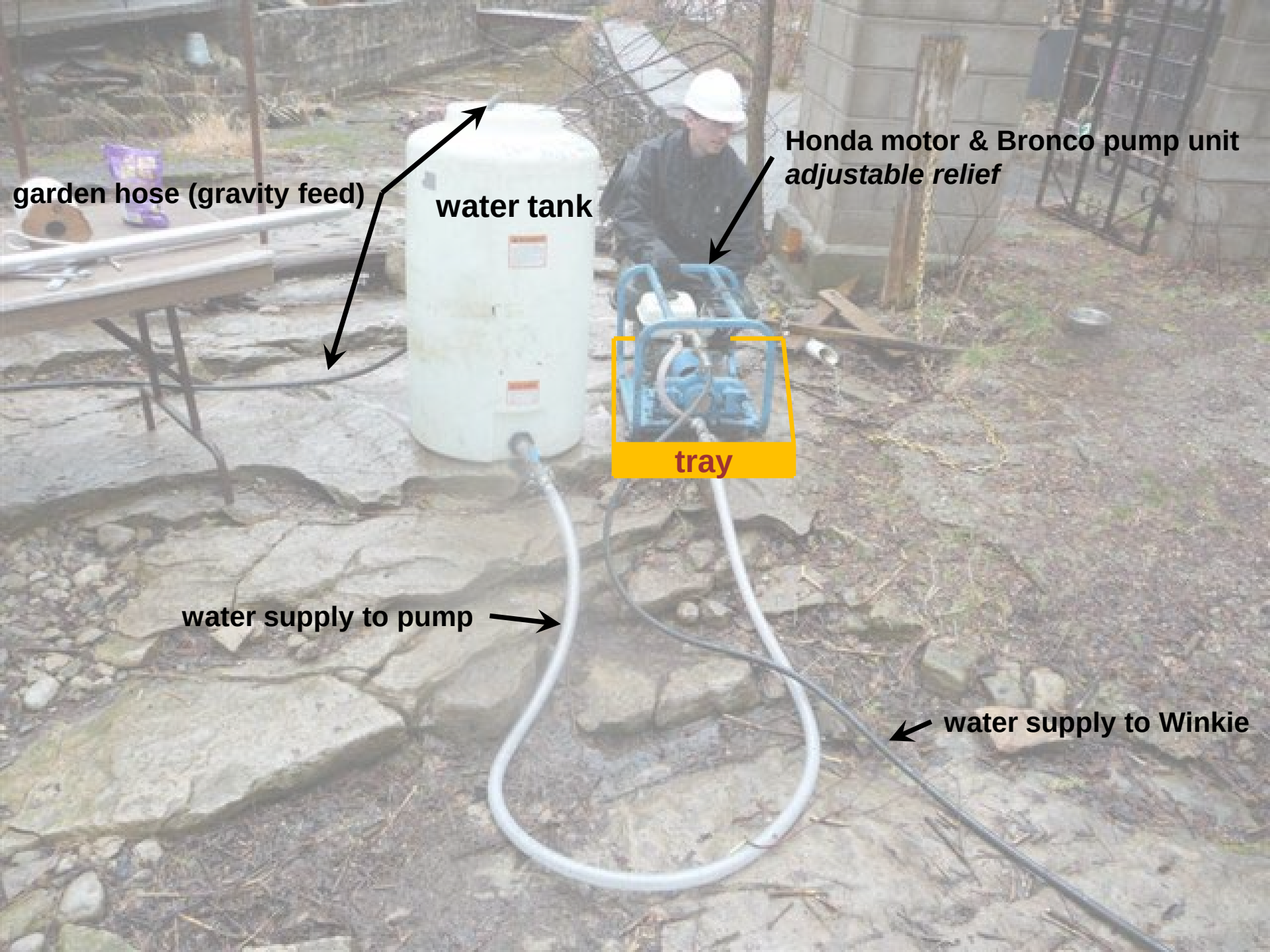
Cored to 18’ bgs using 1.5” drill bit
Rate: 3 min/2 ft

SSFL sandstone requires reinforced core barrel

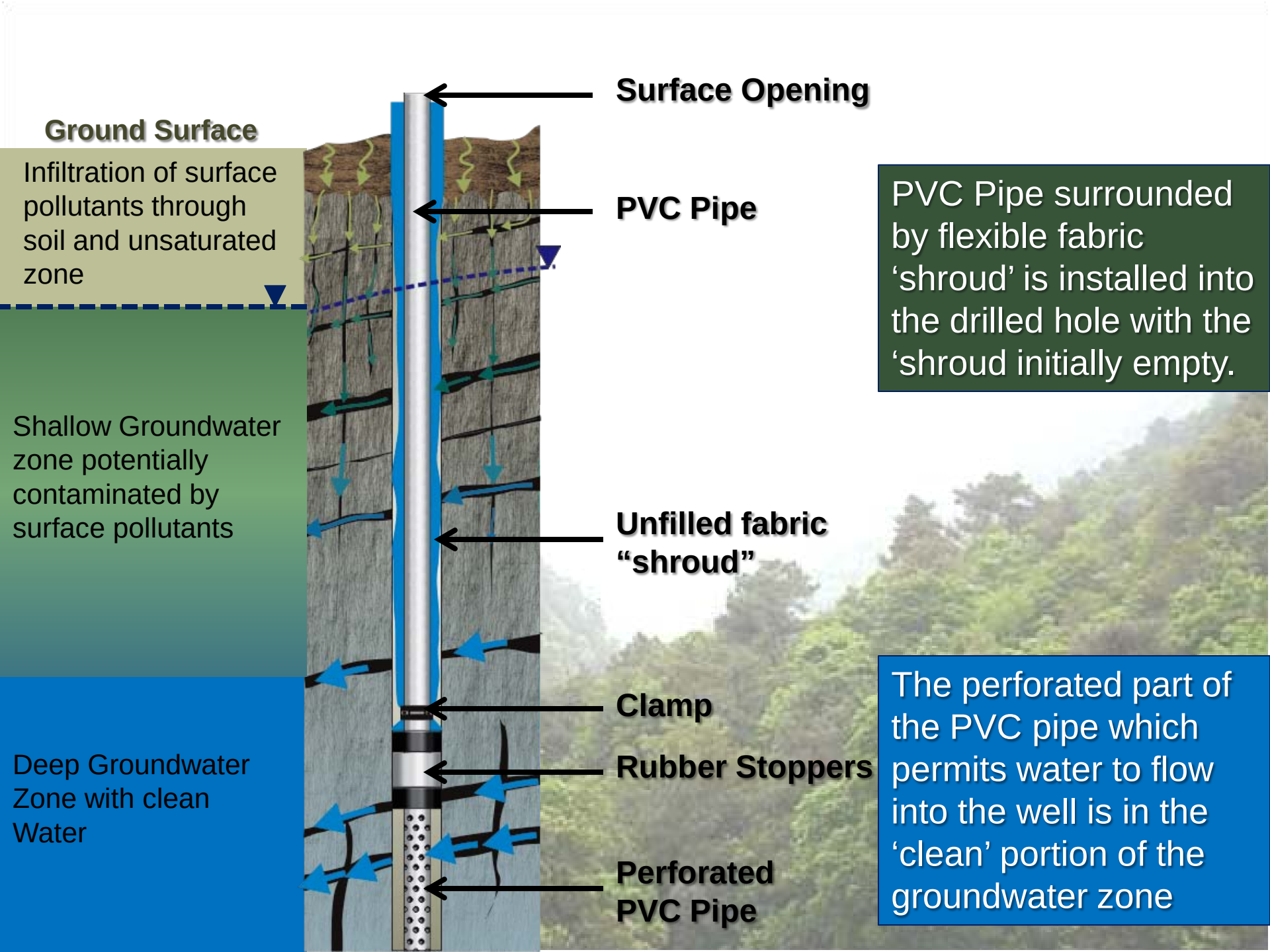
General Winkie Drill Set-Up

Eden Mills, Ontario


aluminum tripod
Winkie Drill
(10 HP)
12V winch
fuel tank
split wedge
hold down bolt
fuel line
12V battery for winch
water supply for drill (approx. 2-3 gpm)


garden hose (gravity feed)
water tank
Honda motor & Bronco pump unit
adjustable relief
tray
water supply to pump
water supply to Winkie

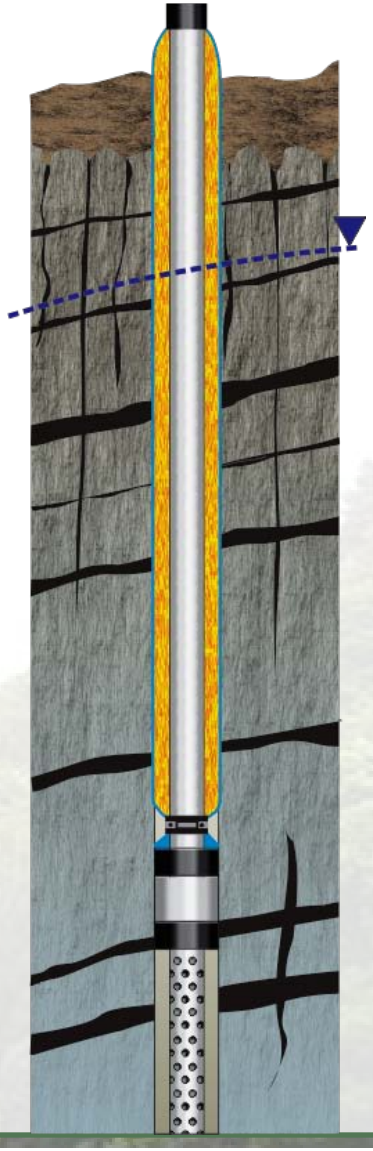
Core Retrieved


Ground Surface
Infiltration of surface pollutants through soil and unsaturated zone
Shallow Groundwater zone potentially contaminated by surface pollutants
Deep Groundwater Zone with clean Water
Surface Opening
PVC Pipe
Unfilled fabric "shroud"
Clamp
Rubber Stoppers
Perforated PVC Pipe
PVC Pipe surrounded by flexible fabric 'shroud' is installed into the drilled hole with the 'shroud initially empty.
The perforated part of the PVC pipe which permits water to flow into the well is in the 'clean' portion of the groundwater zone

Need for the ‘Shroud’

No Shroud

Injected grout pushes outward into formation along fractures potentially disrupting local flow system

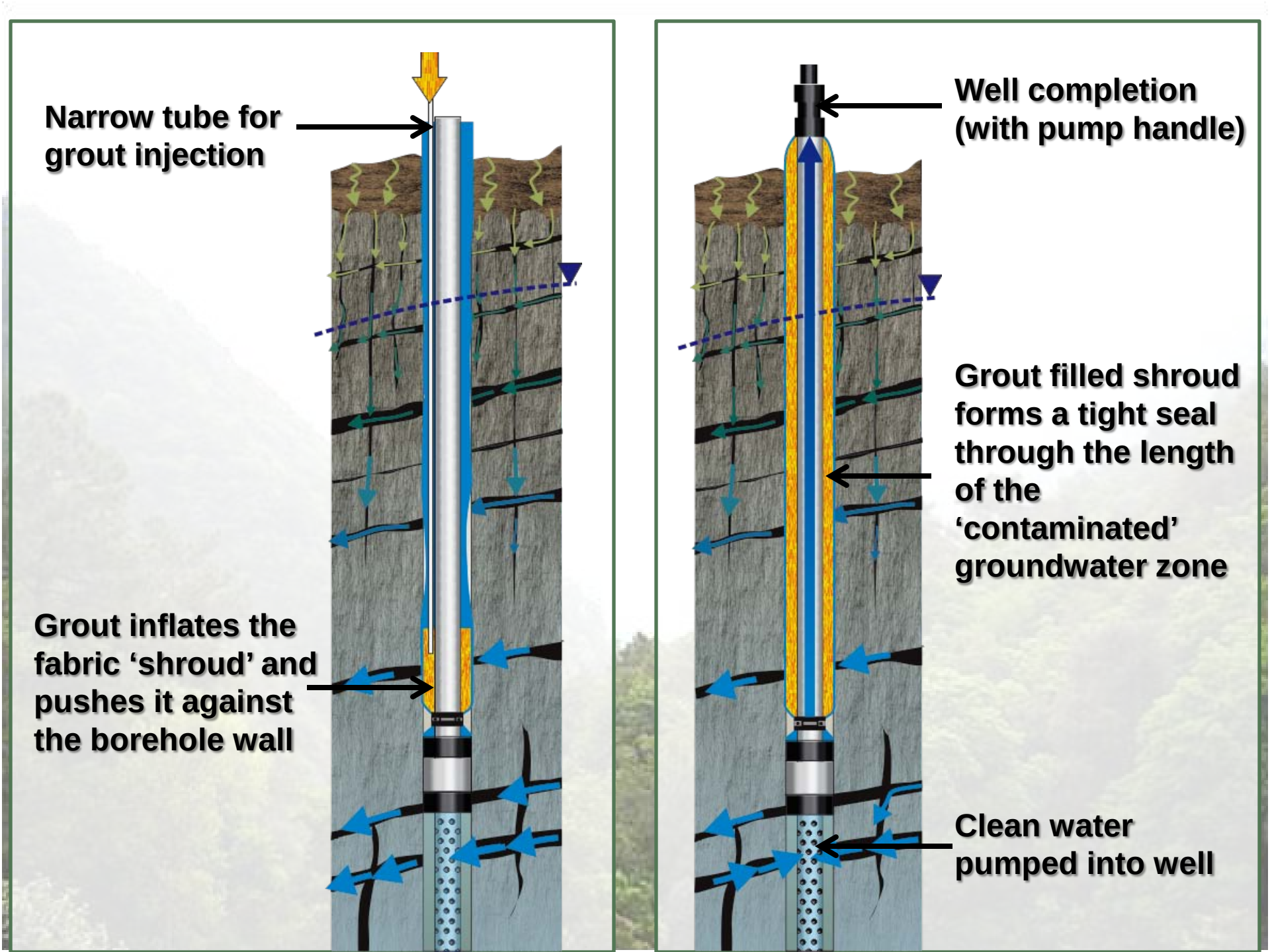


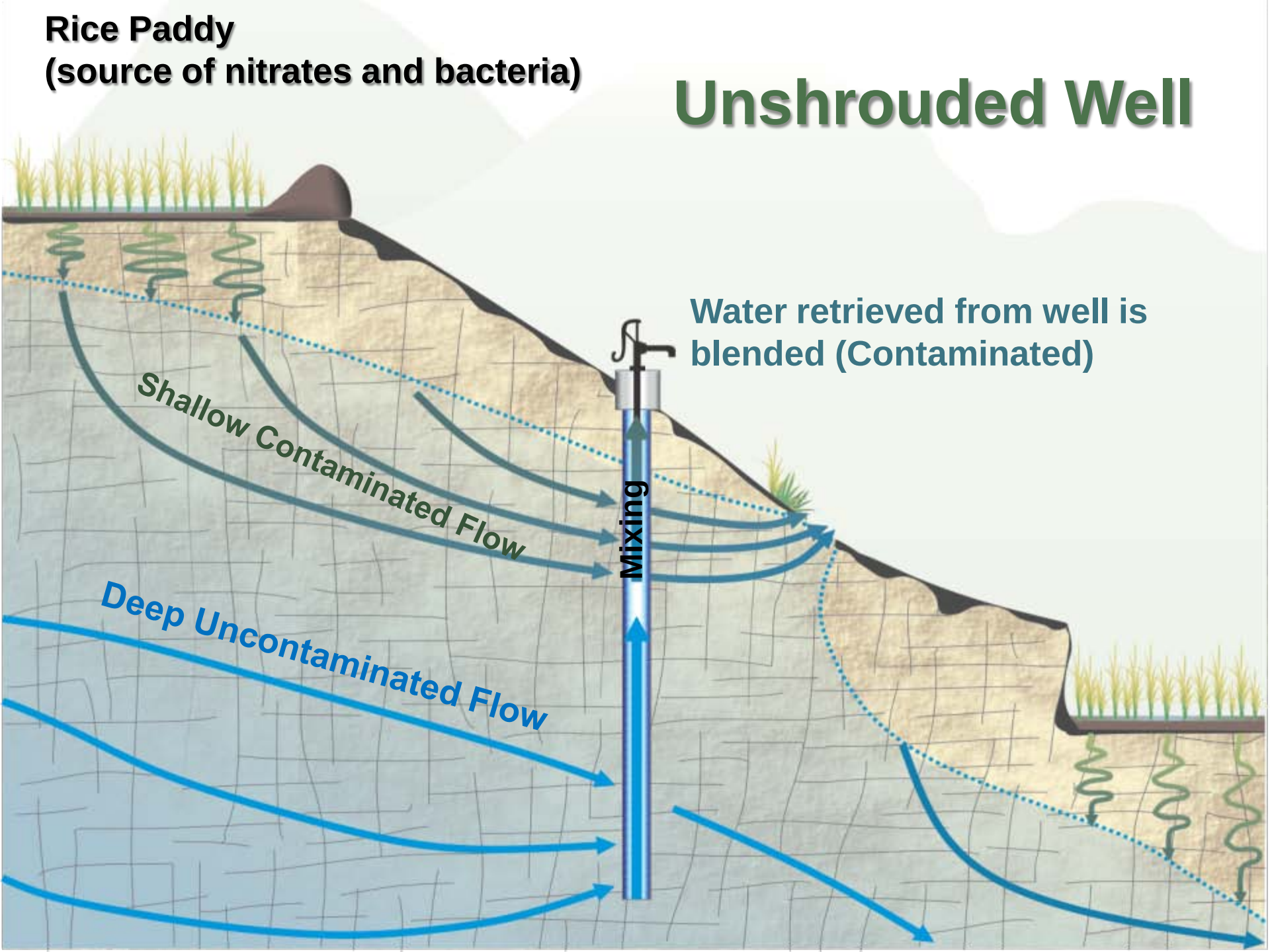
With Shroud

Grout is contained and more natural flow conditions maintained

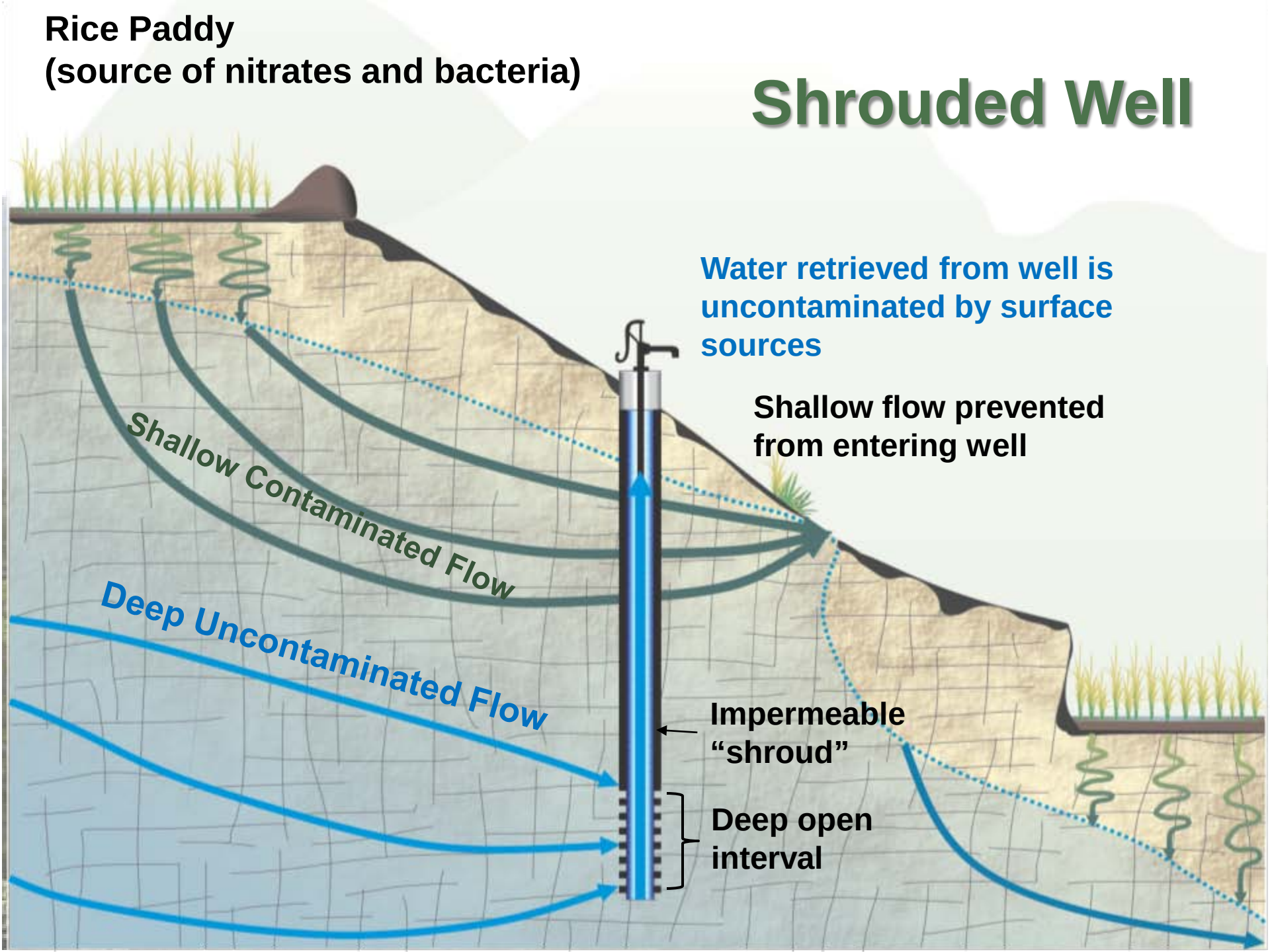
Close ups of the ‘shroud’

Installation of ‘shrouded’ well

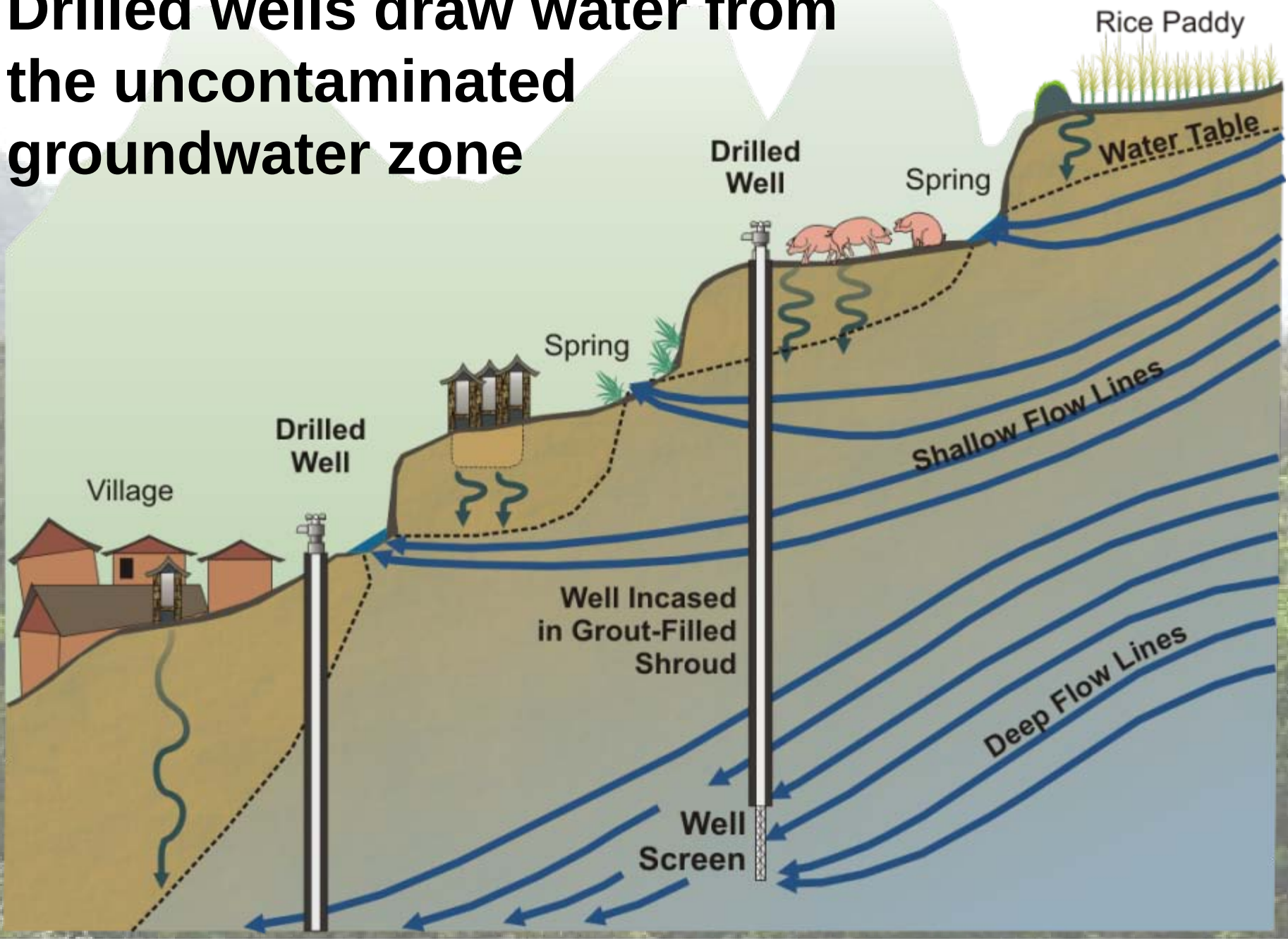

Narrow tube for grout injection
Grout inflates the fabric ‘shroud’ and pushes it against the borehole wall
Well completion (with pump handle)
Grout filled shroud forms a tight seal through the length of the ‘contaminated’ groundwater zone
Clean water pumped into well


Rice Paddy
(source of nitrates and bacteria)
Unshrouded Well
Water retrieved from well is blended (Contaminated)
Shallow Contaminated Flow
Mixing
Deep Uncontaminated Flow

Shrouded Well

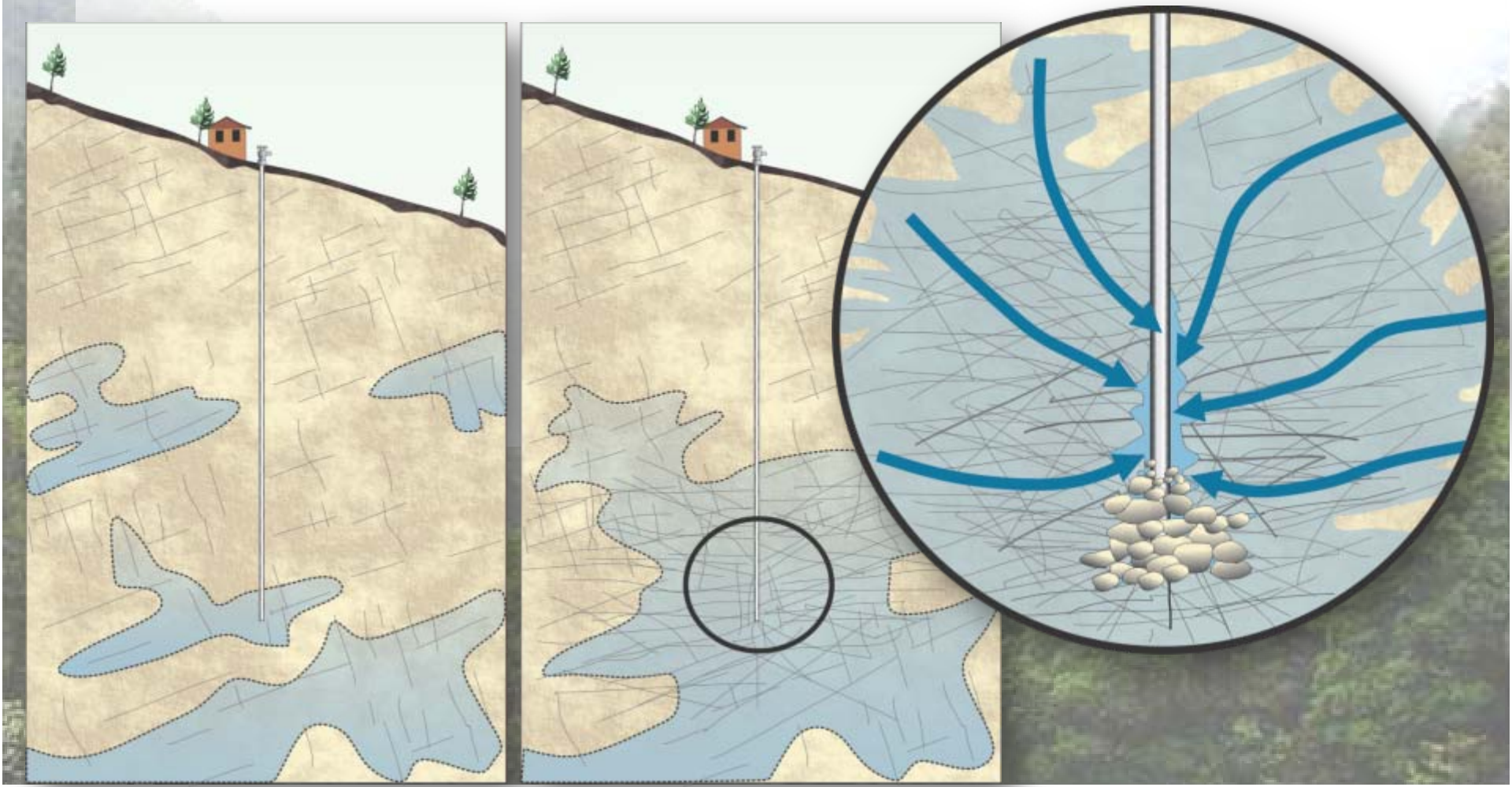


Drilled wells draw water from the uncontaminated groundwater zone

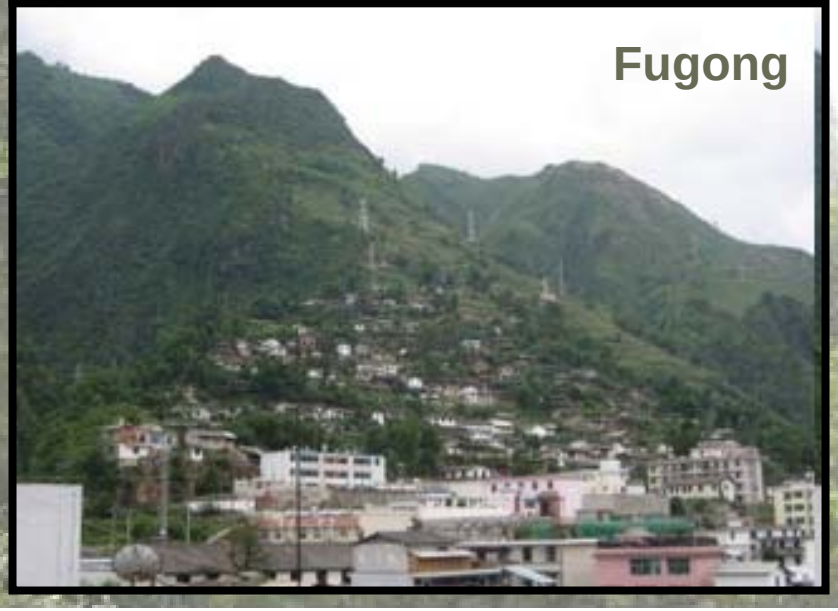


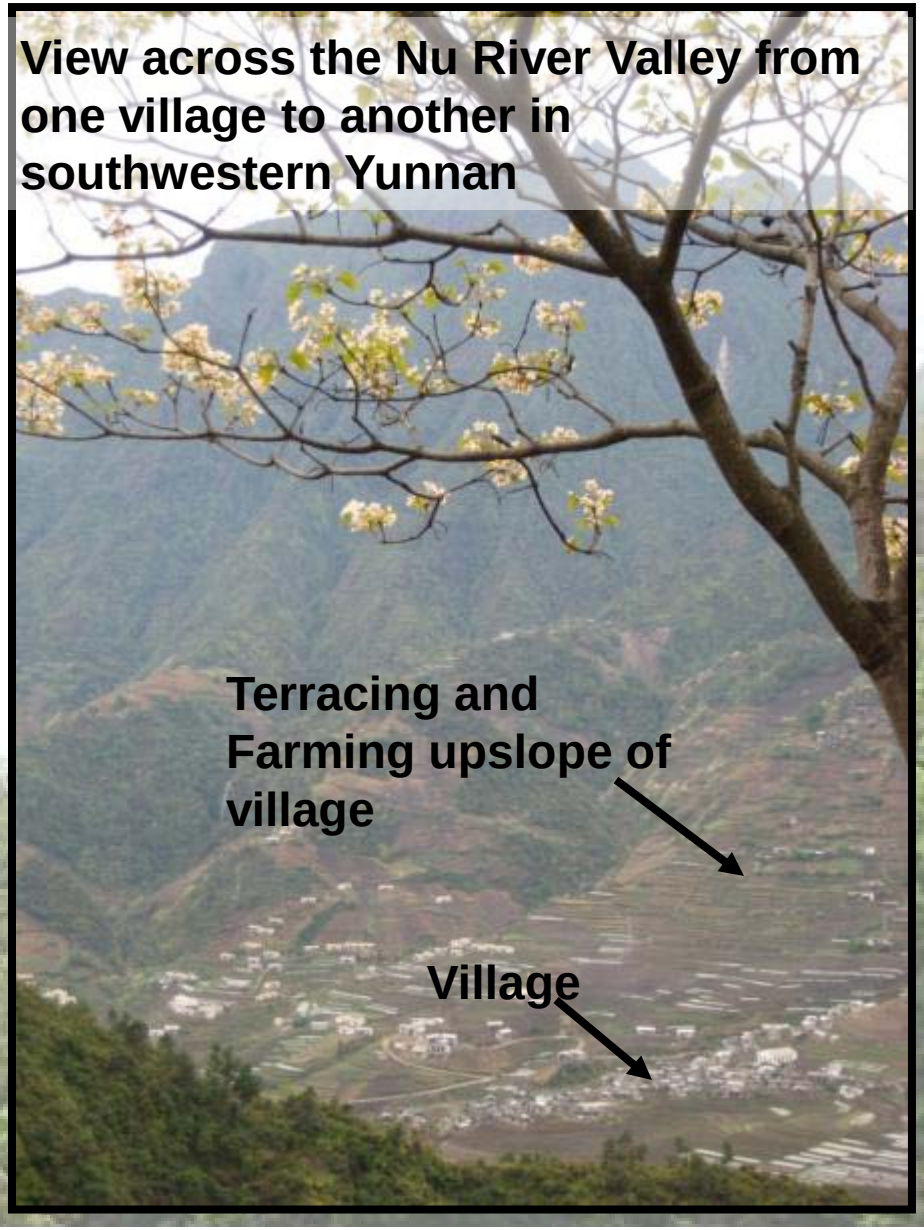
Blasting to Increase Well Yield

- Connection of hydraulically active fractures



Villages in Need of Clean Water Supply






Cell Phone Works Everywhere


The End
Thank you.