SSWM
sustainable sanitation and water management

Well Development & Rehabilitation

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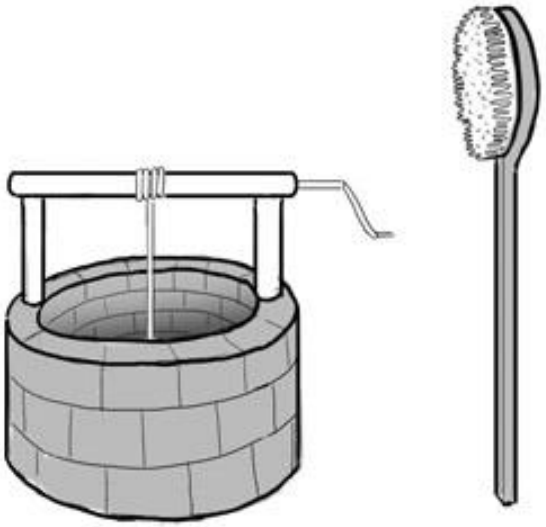
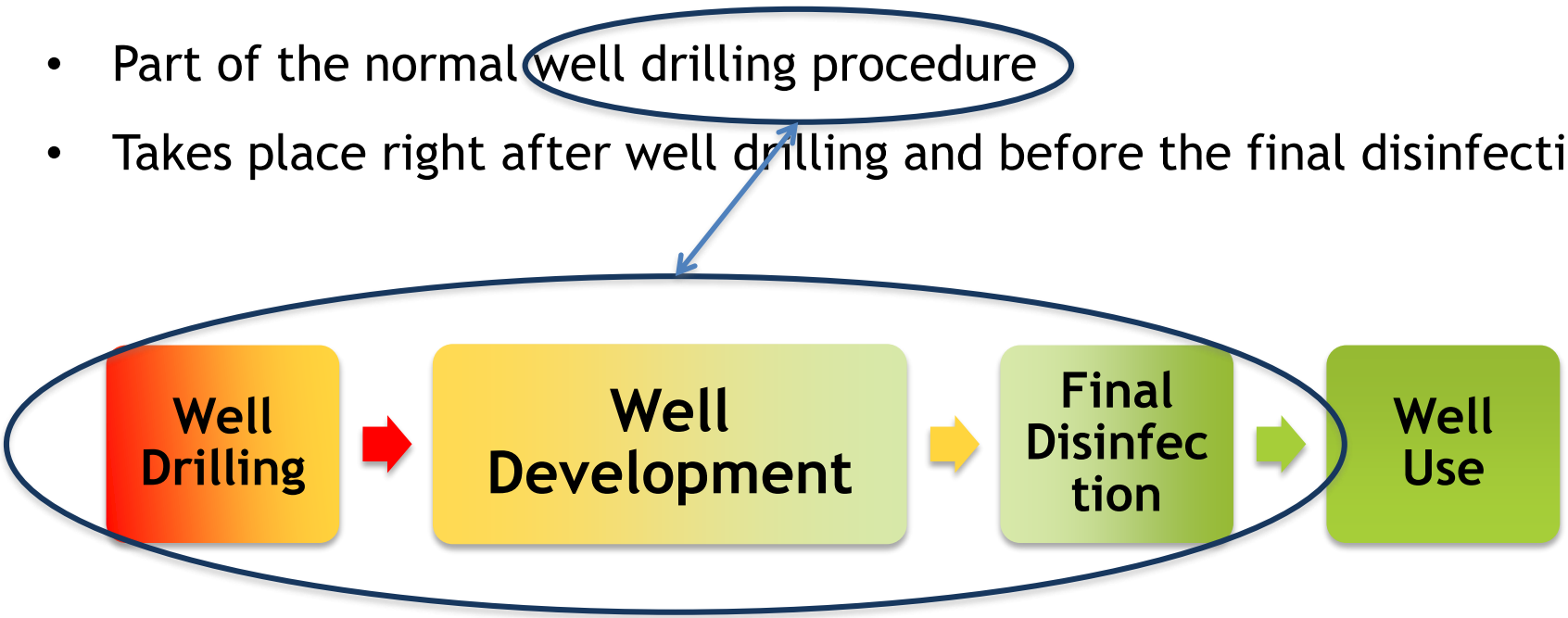


1. Introduction

Well Development for Drilled Wells

- Part of the normal well drilling procedure
- Takes place right after well drilling and before the final disinfection

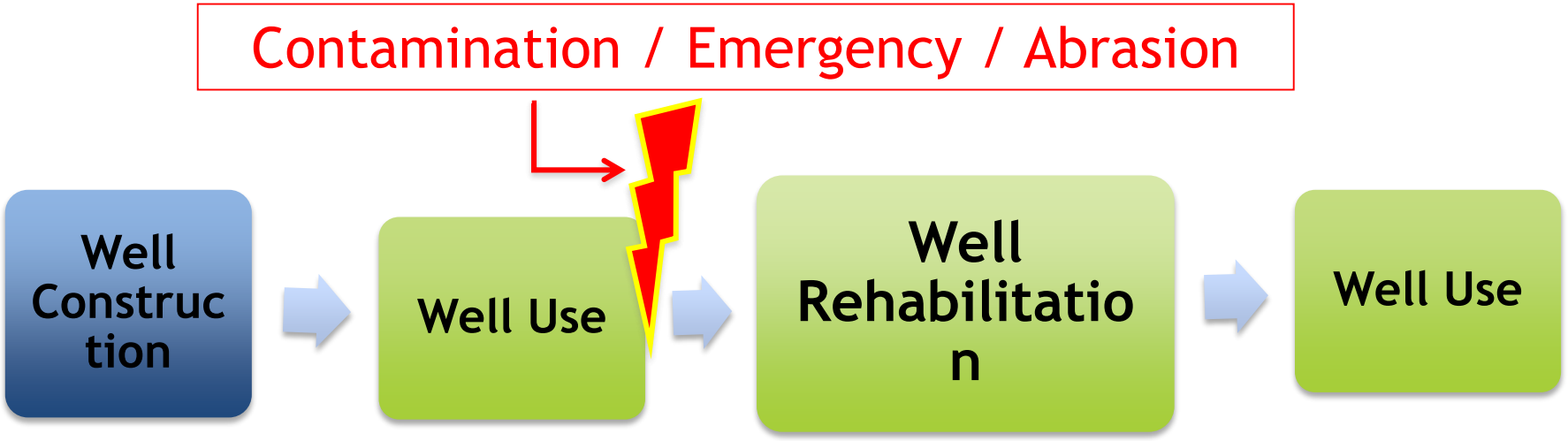


- **Purpose of well development procedures:**
  - Maximising the **well yield** after construction
  - Optimising the filter capacity of the gravel pack

1. Introduction

Well Rehabilitation for Drilled and Dug Wells

- Well rehabilitation of dug or drilled wells becomes necessary if operating wells lack in providing adequate water quality or quantity as the well becomes contaminated or clogged through natural processes or in consequence of emergencies (e.g. floods, seawater intrusion, etc.).
- It involves the **cleaning** and **disinfection** of the well and sometimes the application of **well development procedures**.



2. Basic Design Principles – Well Development

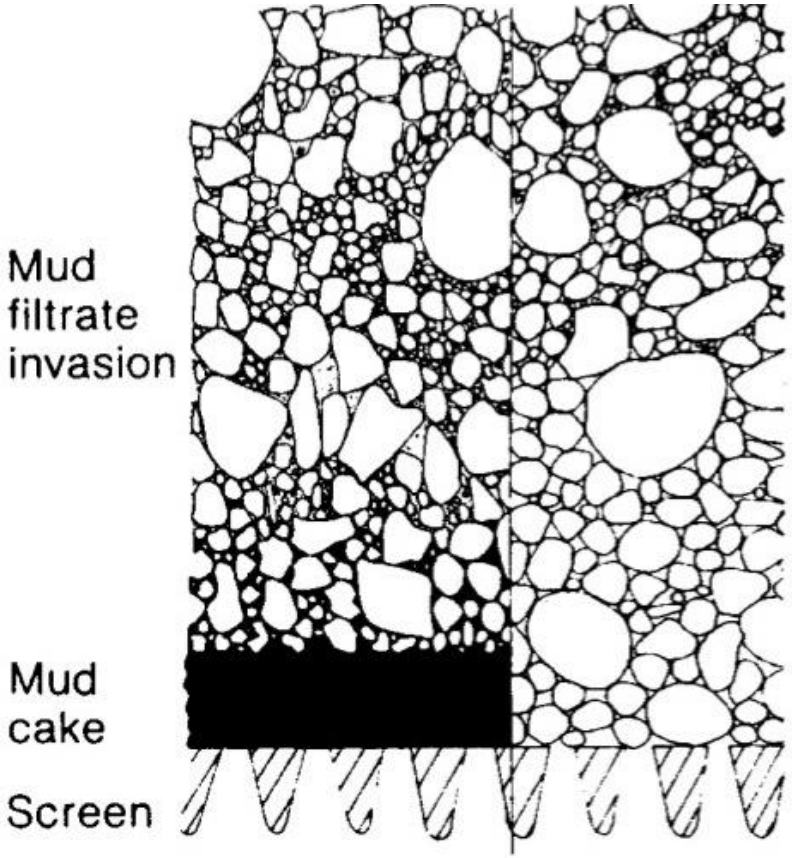
Improving the Well Yield right after Construction

- **Well drilling procedures** alter the hydraulic in the vicinity of the well

  → Fines and drilling fluid additives originating from the drilling process remain in the borehole and blxock the pores of the surrounding aquifer.

- **Well Development techniques** aim to remove these fines (mud cake) and to let consolidate the gravel pack.

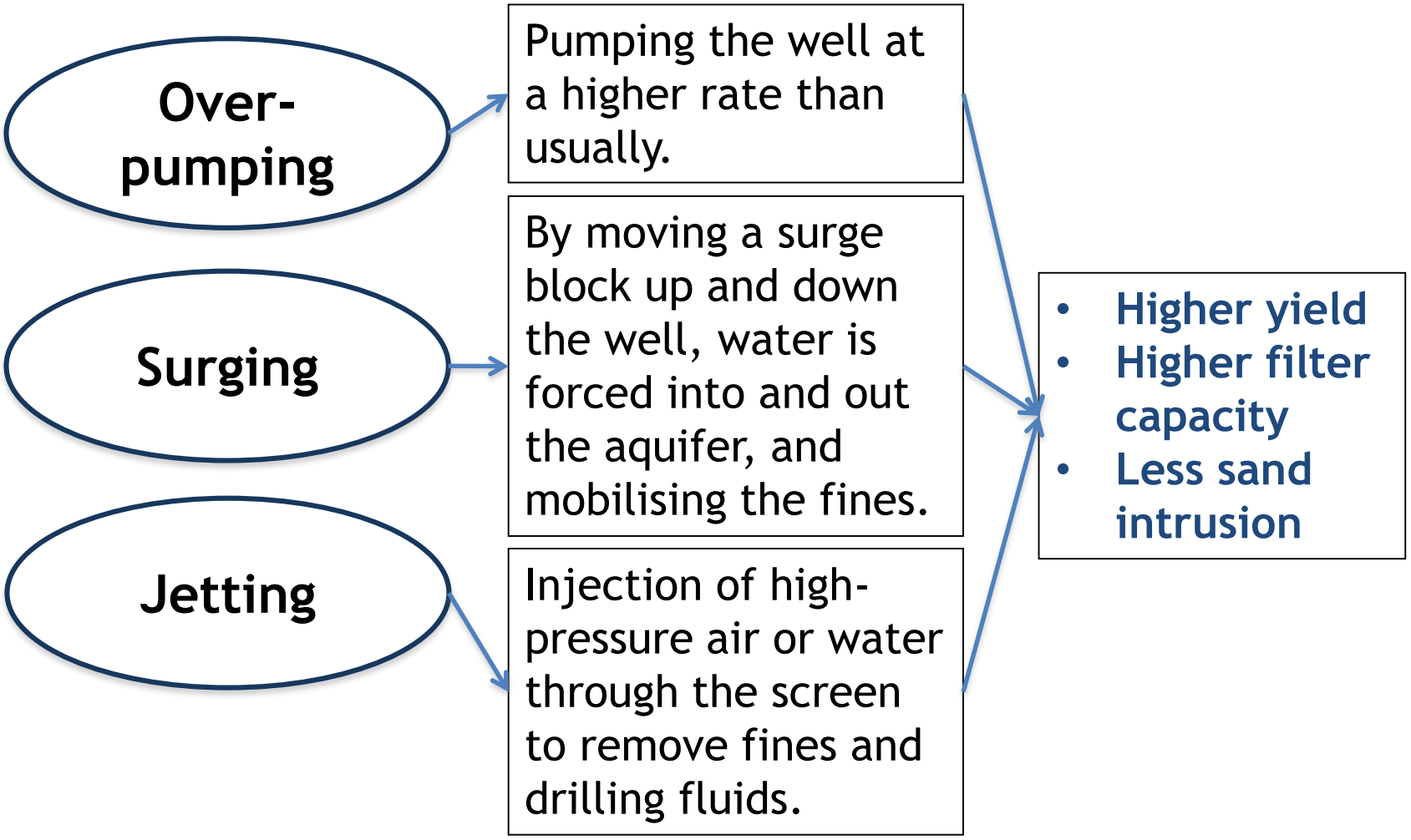
Results: - Higher yield
- Less sand intrusion



Source: CLARK (1988)

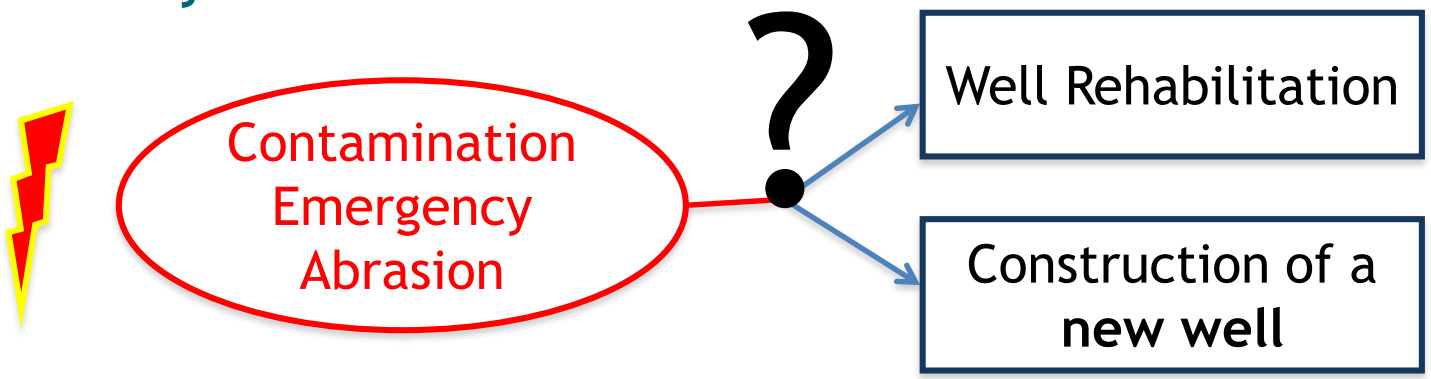
2. Basic Design Principles – Well Development

Most Common Well Development Techniques



3. Basic Design Principles – Well Rehabilitation

Does it Pay Off?

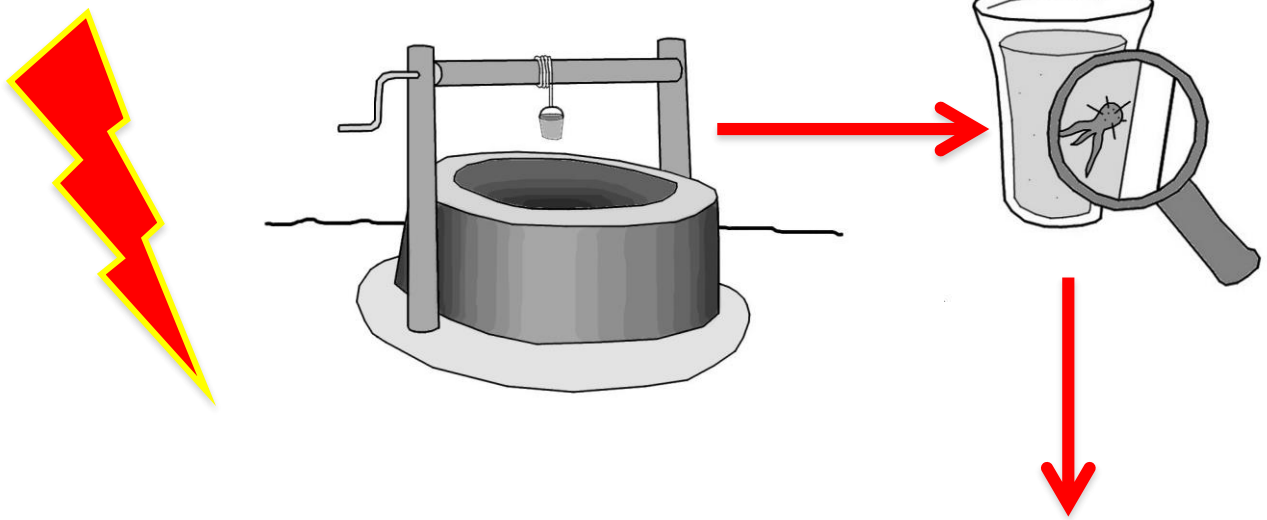


- Before rehabilitating any well, it has to be checked whether rehabilitation is more economic than the construction of a new well. This includes determination of the necessary equipment and related costs.
- Factors determining the costs:
  - The ground formation where the well is drilled;
  - The construction or drilling method used; and
  - The causes for reduced flow. *THE WORLD BANK (2012)*

3. Basic Design Principles – Well Rehabilitation

Well Rehabilitation in Emergency Situations

- Tsunamis
- Storms
- **Floods**
- Earthquakes



Contamination of wells due to emergencies require immediate **well rehabilitation** measures including **well disinfection.**

3. Basic Design Principles – Well Rehabilitation

Typical Causes for Reduced Well Yield

- **Mechanical Blockage** (e.g. fine-grained soil materials, corrosion by-products):
  Fine-grained soil particles or corrosion by-products originating from metallic well parts can enter the well through the screen and reduce the water flow from the aquifer into the well.
- **Chemical Encrustation** (e.g. iron/manganese oxides, calcium/magnesium carbonates, sulphates):
  Chemical encrustation is the deposition of minerals on the well screen or gravel pack, which act to restrict the movement of water into a well.
- **Bacteriological Plugging** (e.g. iron bacteria):
  Microorganisms, such as bacteria, can cause clogging problems in wells, pipelines, and treatment facilities.

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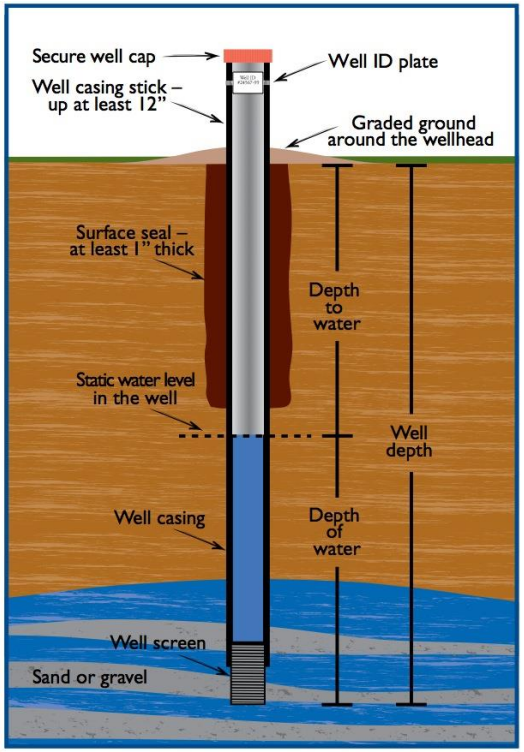
3. Basic Design Principles – Well Rehabilitation

Well Rehabilitation Procedures - Steps

Step 1: Notify all users

- Notify all users of the well **not to drink the water** while the strong solution of chlorine is present in the system and **to store sufficient amount of water** for use during the period of rehabilitation.



Source: AAFC (n.y.)

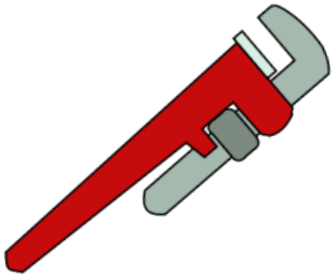
Step 2: Determine the characteristics of the well (depth, diameter) (also question the users):

- How deep was the well originally? What was the former yield of the well in comparison to the current one?
- For drilled wells, determine the pH level. Ideally, the **pH should be 7 or less**. If it is above 7, add one litre of vinegar or citric acid to the well and re-test the pH in the well water before proceeding.

3. Basic Design Principles – Well Rehabilitation

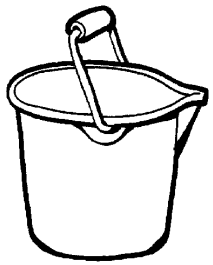
Well Rehabilitation Procedures - Steps

Step 3: Remove the pumping mechanism or lifting device and undertake any repairs to the headwalls, drainage curtain, sanitary seal, cover and lifting device.



Step 4: Remove all polluted water, sediments and debris from the well.

- For dug wells, you can use either buckets or pumps for removal.
- For drilled wells, there are a number of ways for removal (e.g. over-pumping, surging, jetting).



3. Basic Design Principles – Well Rehabilitation

Well Rehabilitation Procedures - Steps

Step 5: Repair the damage in the inside of the well.

- For dug wells; deepen the well, undertake localised repairs to the well lining, or consider re-lining to reduce sub-surface contamination.

Step 6: Clean the well physically.

- For dug wells, clean the well lining manually using a brush and chlorinated water.
- For drilled wells, clean the well casing and screen by using a brush or by using jetting or surging techniques also applied for well development.

Source: VERDAD (n.y.)

3. Basic Design Principles – Well Rehabilitation

Well Rehabilitation Procedures – Steps

Step 7: Clean the well chemically (if necessary).

- **The types of chemicals are selected according to the type of contamination.** The selected chemicals are placed in the well and agitated frequently for 24 to 72 hours. The well is then dewatered to remove the chemicals.
- For iron bacteria and slime, a liquid bacteria acid is effective.
- If the bacteria problem is persistent, some of the more aggressive chemicals are muriatic acid and hydroxyacetic acid
- For clogs with carbonate scale, sulphamic acids are used with inhibitors and modifiers.

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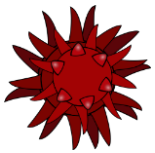
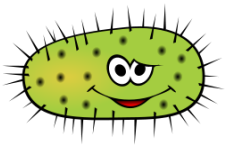
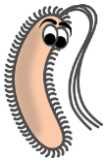
3. Basic Design Principles – Well Rehabilitation

Well Rehabilitation Procedures - Steps



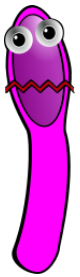


Step 8: Disinfect the well.



- The most common method of disinfection is chlorination. The chlorine compound most commonly used is high strength calcium hypochlorite (HSCH) in powder or granular form (contains 60 – 80% chlorine). Also used is sodium hypochlorite in liquid bleach or bleaching powder form.

- The amount of **chlorine solution** (i.e. water with chlorine) that must be poured into the dug or drilled well equals the amount of water that is currently present.



- Then resolve **50 – 100mg/l of HSCH** in a bucket of water. Putting more or less chlorine will make the disinfection process ineffective.
- Pour the chlorine liquid into the well and allow the water to stand in the well for 12 to 24 hours. For drilled wells, operate the pump until chlorine can be smelled in the outflow before letting it stand.

Source: GODFREY & REED (2011)

3. Basic Design Principles – Well Rehabilitation

Well Rehabilitation Procedures - Steps

Step 9: Dewater the well

- Operate the pump until all the chlorinated water is removed. If you have a chlorine test kit you can check the residual chlorine concentration in the water. It should be reduced to 0.5mg/l or below. Alternatively, pump the water until it no longer smells of chlorine.
- Make sure that:
  - No water with high concentration of chlorine flows into small streams or wetlands;
  - Salt water intrusion is avoided when dewatering in coastal areas;
  - No water runs into your septic system as the chemicals and the amount of water required to flush the system may overload or damage it.

MARC (my.)

3. Basic Design Principles – Well Rehabilitation

Well Rehabilitation Procedures - Steps

Step 10: Seal the top of the well using a sanitary seal (e.g. made of layers of clay). Construct a drainage apron and head wall around the well to prevent surface water, insects and rodents from entering the well. Provide a cover for the well.

Dug well

Source: NABUUR (n.y.)

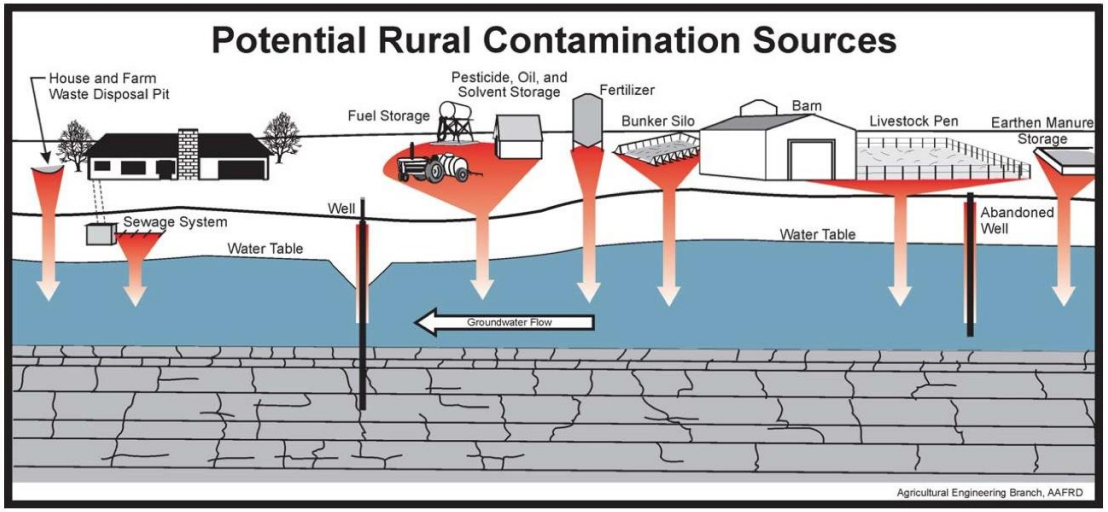
Drilled well

Source: APPROPRIATE PROJECTS (n.y.)

3. Basic Design Principles – Well Rehabilitation

Limitation of Chlorination

- **Chlorination only eliminates the bacteria present in the well**, on the pumping equipment or in the distribution system.



Source: BUCHANAN et al. (2010)

- **It will not kill bacteria in the aquifer beyond the immediate location of the well.** If there is some external source of contamination, the problem will only be solved temporarily. *AAFC (n.y.)*

4. Costs

Basic Measures – Low-cost Options

- The costs for basic well development techniques are usually very low and most often reasonable as the well's yield is clearly improved. However, a further analysis by an experienced contractor is recommended to determine an optimal output.

- Rehabilitating an existing well is usually cheaper than drilling a new well given the same output. A professional contractor can do tests to determine if rehabilitation is possible and practical. *THE WORLD BANK (2012)*

6. Health Aspects

How Can Well D&R Improve my Local Water Management?

The benefit of well rehabilitation in terms of health is significantly improved water quality.

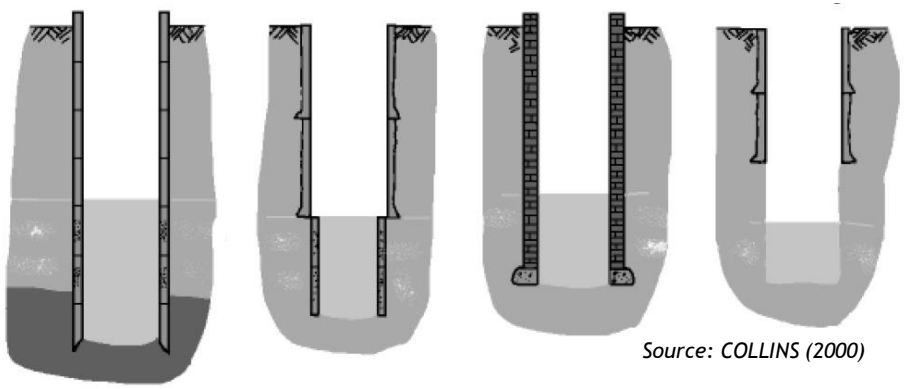
ATTENTION: The water in the well experience **high concentrations of chlorine** during the rehabilitation process and poses a health risk if consumed.

→ Make sure the water users are fully informed of the rehabilitation process and the well is dewatered adequately.

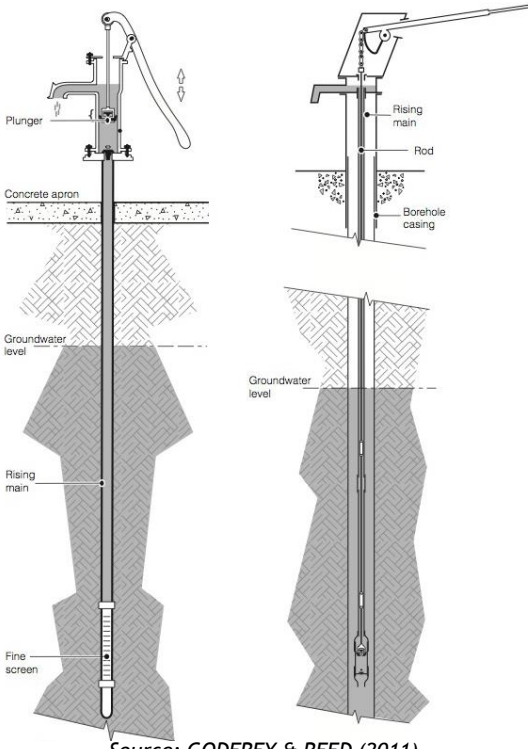
7. Application

No One-fit-to-all Solution

- The variety of different well types and constructions requires **tailor-made** well development and rehabilitation procedures for every single well.



Source: COLLINS (2000)



Source: GODFREY & REED (2011)

- Many such procedures are basic and easy to apply, yet, a certain level of care is important as ignoring basic rules can compromise the water quality and long-term functioning of the well.

8. Advantages and Disadvantages

Well Development & Rehabilitation Put in a Nutshell

Advantages:

- Increased performance of the well water yield and safe water quality
- Simple measures can be highly effective (particularly chlorination)
- Basic procedures for both well development and rehabilitation are rather easy to apply and very economic.
- Even for heavily damaged wells, rehabilitation is often more economic than the construction of new wells.

Disadvantages:

- Skilled workers and high-tech equipment may be required depending on the type and condition of the well
- Risk of damaging well installations if not conducted professionally (e.g. acids and chlorine can cause mechanical damages)
- No one-fit-to-all solution: tailor-made measures required for every particular situation

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