Staggered and Continuous Contour Trenches

MCLLMP Virtual Training
By Spring Initiative Partners

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- What are the benefits of trenching?
- What are the different types of trenching?
- Where should trenches be dug?
- What are the sites suitability of different types of trenches?
- How to design different trenches?
- How effective are trenches?
- How trenches are maintained?
- What are the limitations of trenches?

Trenching: Objective and Benefits

The main objectives of trenching is to obstruct the flow of water and store it.

This results in

- In situ conservation of soil and reduced soil erosion
- More percolation of surface water into the ground resulting in recharge of ground water.
- Improvement of soil moisture locally
- Reducing flash floods
- Reducing siltation of structures downstream
- Increasing discharge and duration of springs flows

Types of Trenches

In general there are four types of trenching:

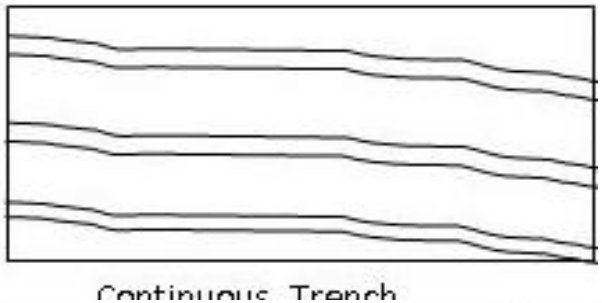
1. Continuous Contour Trenching

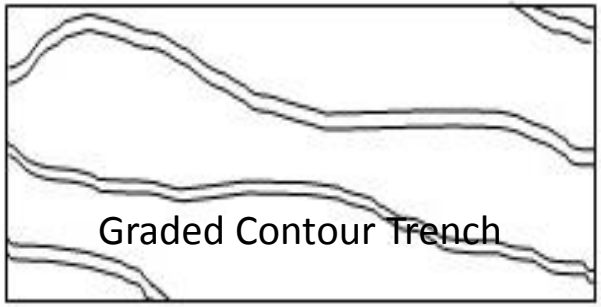
2. **Graded Contour Trenching**

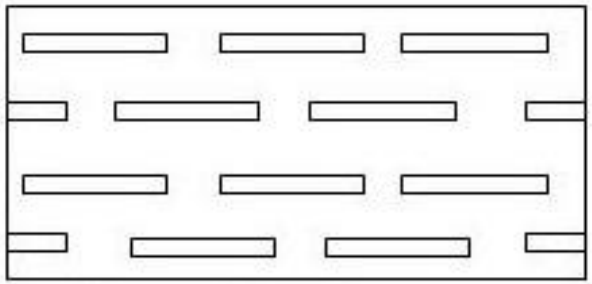
3. In Line Trenching

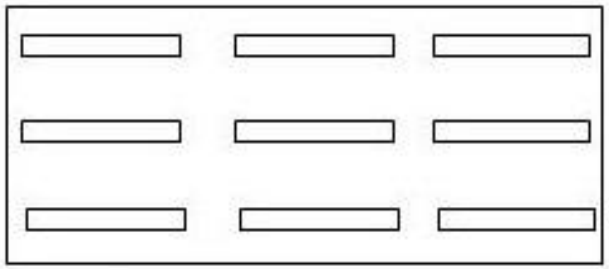
4. Staggered Contour Trenching

- All these trenches are dug on a contour.
- The selection of trenches depends on the site characteristics and rainfall intensity.





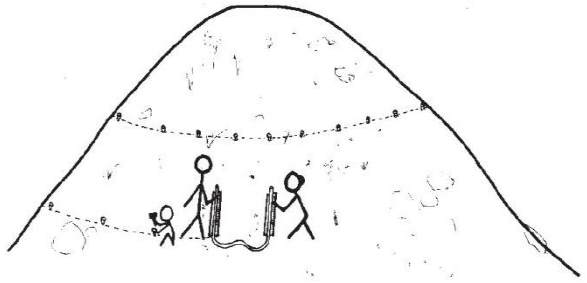




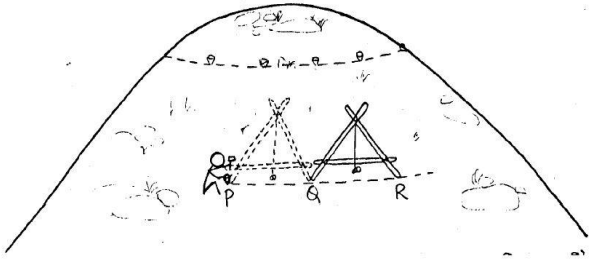
Location of Trenches

1. All the above mentioned types of trenches are usually dug on the upper reaches of the catchment or the recharge area where surface flow is like a sheet.

2. All these trenches are dug on a contour. For laying a contour, pipe levels or ‘A’ frame can be used. Pipe level is more accurate and requires semi skilled person whereas ‘A’ frame can be done by a lay person. Both of these need some field training.



3. Small diversion bunds can be constructed in upper reaches to guide the surface run off to these trenches especially in case of recharge areas.



Site Suitability of Different Trenches

Contour Trenches also called as Continuous Contour Trenches (CCT). These trenches are made where

- Rainfall is low to medium (up to about 1000 mm annually)
- Slopes are less (<6%). Practically it can be dug at slopes upto 10%.

Graded Contour Trenches are made where

- Rainfall ranges from 1000-1200 mm annually. A slight gradient of 0.1-0.5% is given to contour bunds so that water retained behind the bund escapes safely.
- In CCT effort is to capture almost all the surface run off.
- In both the above cases, small **spillways** are made for safe disposal of surface run-off.

Site Suitability of Different Trenches (Contd.)

Staggered Contour Trenches (SCT) are dug where

1. Rainfall is high (more than 1200mm annually)
2. Slopes are higher (10 -50%). They can, however, be dug up to a slope of about 60% only where the slope is stable.

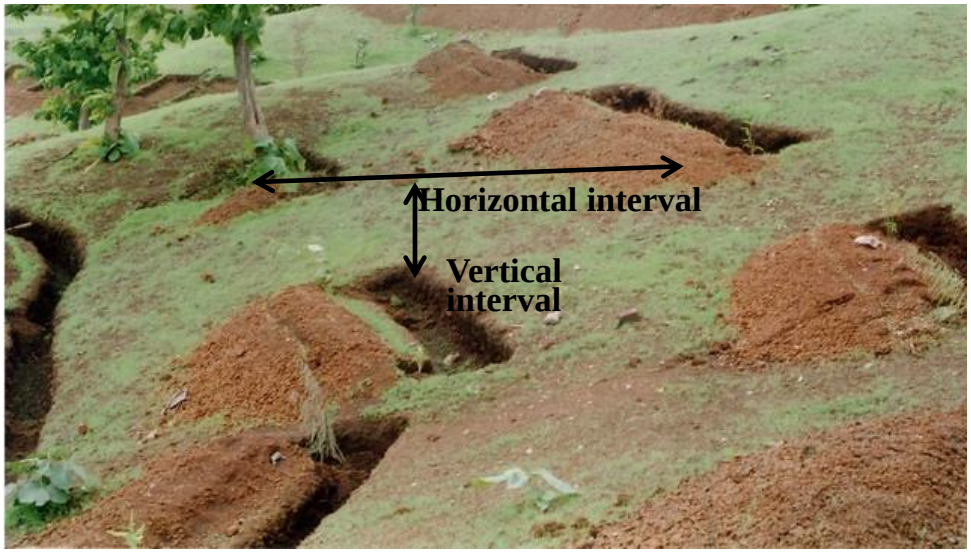
- **SCTs should not be dug where the slopes are higher as they could trigger landslides.**
- The effort here is not to capture 100% surface run off and allow some portion of the run off escape. Because of more rainfall it is not possible to capture 100% run off and it might not be safe either.
- **SCTs are preferred in the whole of North Eastern States except for some plain areas of Nagaland, Arunachal Pradesh and Assam.**

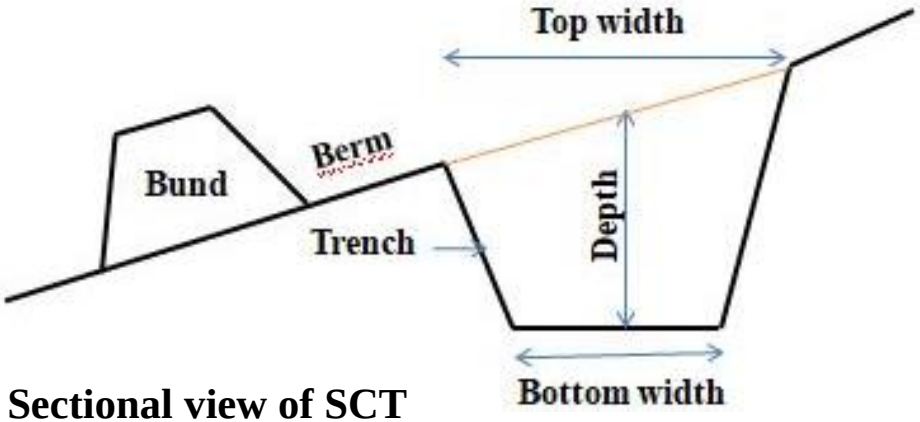
Design of Staggered Contour Trench (SCT)

The figure shows the distribution of trenches on the field.

The right bottom figure shows the sectional view of the trenches.

Dug out soil is placed on the downstream side slope in the form of a bund after leaving a **berm** of about 0.3-0.5m. This protects the edges from caving in and silting the trench.





Sectional view of SCT

Design of SCT (Contd.)

The size of the SCT varies with

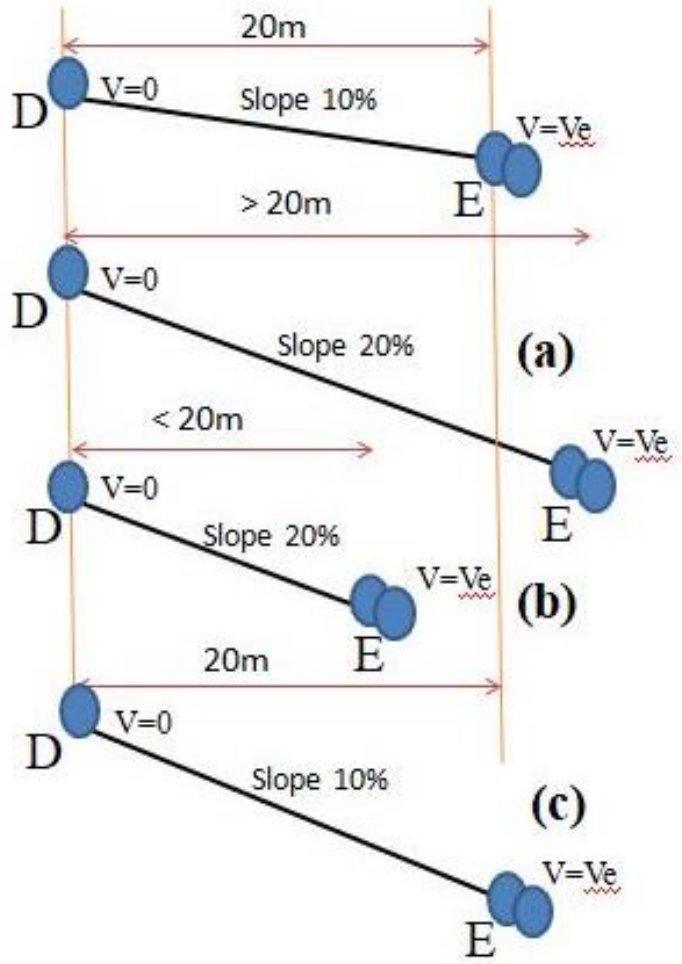
1. Slope
2. Soil texture and
3. Vegetation

This can be understood with the figure

For a slope of say 10%, surface water travels 20m horizontally before it starts eroding the slope.

Then how much will the water travel on 20% slope to erode the slope?

i) 20m ii) >20m or iii) <20m



Design of SCT (Contd.)

The tables below shows the measurement of trenches, their distribution, storage volume and approximate number per ha for different types of soils and slope.

(A) Staggered Contour Trenches for Clayey Soils

Description	Unit	Clayey Soil			
Slope of land	%	40-50	30-40	20-30	10-20
Number of trenches per ha	per ha	420	360	300	250
Size of one Trench	lxbxd m	2.0x0.5x0.3	2.0x0.6x0.4	2.5x0.6x0.6	2.5x0.75x0.6
Volume of one trench	cum	0.21	0.35	0.6	0.80
Total Volume of trenches/ha	cum	86	126	180	200
Horizontal distance (approx)	m	6	7	8	10

Design of SCT (Contd.)

(B) Staggered Contour Trenches for Loamy Soils

Description	Unit	Loamy Soil			
Treatment area	ha	1.00	1.00	1.00	1.00
Slope of land	%	40-50	30-40	20-30	10-20
Number of trenches per ha	per ha	330	280	225	210
Size of one Trench	lxbxd m	2.0x0.5x0.3	2.0x0.6x0.4	2.5x0.6x0.6	2.5x0.75x0.6
Volume of one trench	cum	0.20	0.35	0.6	0.80
Total Volume of trenches/ha	cum	66	98	135	168
Horizontal distance (approx)	m	7.5	9	10.5	12

Design of SCT (Contd.)

(C) Staggered Contour Trenches for Sandy Soils

Description	Unit	Sandy Soil			
Treatment area	ha	1.00	1.00	1.00	1.00
Slope of land	%	40-50	30-40	20-30	10-20
Number of trenches per ha	per ha	280	240	200	185
Size of one Trench	lxbxd m	2.0x0.5x0.3	2.0x0.6x0.4	2.5x0.6x0.6	2.5x0.75x0.6
Volume of one trench	cum	0.20	0.35	0.6	0.80
Total Volume of trenches/ha	cum	56	84	120	148
Horizontal distance (approx)	m	9	10.5	12	13.5

Design of SCT: Summary

Comparing the tables for different soil texture and slopes it is seen:

1. The number of trenches per ha is more in clayey soil than in sandy or loamy soil for a particular slope.

2. As the slope increases the number of trenches also increase. But at the same time the storage volume decreases. This is because as the slope increases, the soil stability decreases. The trenches are designed so that they do not trigger landslides.

Design of SCT: Summary

3. The horizontal distance between the two rows is more for sandy soil as compared to clayey. This is primarily because a lot of surface run off gets infiltrated in sandy soil and the surface run off is less.
4. The size of the trenches is more in mild slope as compared to steeper slope. It is safer to store more water in gentle slopes than in steeper slopes.

Effectiveness of SCT

The effectiveness of the SCTs can be understood better with the following example:

How to increase discharge of a spring with a recharge area of **1ha** having **clayey soil** and having a **slope of 25%** with **sparse vegetation** with a maximum discharge of **5 lpm** which disappears during the lean period. Av rainfall is 30mm/day and area receives 100 rainy days.

First of all find Coefficient of run off C. From table **C = 0.6**

Surface Run off = A x C x rainfall = $\frac{10000 \times 0.6 \times 30}{1000}$ = 180cum

This is the surface run off from the outlet.

Now question is how much water goes to the aquifer to feed the spring? How to calculate this?

Effectiveness of SCT (Contd.)

C = 0.6. This means that 60% is surface runoff and the rest 40% either evaporates or goes into the ground. During monsoons, evaporation is minimal so we assume that 40% goes inside the soil.

Therefore volume that goes to aquifer $= \frac{10000 \times 0.4 \times 30}{1000} = 120$cum

This means that 120 cum of water reaching the aquifer causes a spring discharge of 5 lpm.

This means that if we want more discharge more water should go to the aquifer. For this staggered contour trenches are made.

For the given terrain, and from the table provided for clayey soil

We get the following information

Effectiveness of SCT (Contd.)

Description	Unit	Clayey Soil			
Slope of land	%	40-50	30-40	20-30	10-20
Number of trenches per ha	per ha	420	360	300	250
Size of one Trench	lxbxd m	2.0x0.5x0.3	2.0x0.6x0.4	2.5x0.6x0.6	2.5x0.75x0.6
Volume of one trench	cum	0.21	0.35	0.6	0.80
Total Volume of trenches/ha	cum	86	126	180	200
Horizontal distance (approx)	m	6	7	8	10

From the table we see that 300 trenches can be dug in 1ha area with a maximum volume of 180cum.

Practically, even if can make 250 trenches , a potential of 150cum storage is created. Assuming a conservative figure of only 60% of this actually gets tapped then

Effectiveness of SCT (Contd.)

90 cum of additional water goes into the ground resulting in increase of discharge. This is from one rain. For 100 rainy days, the trenches would help in infiltration of **9000 cum additionally in a year.**

This means 65% additional water is going to the aquifer to increase the discharge.

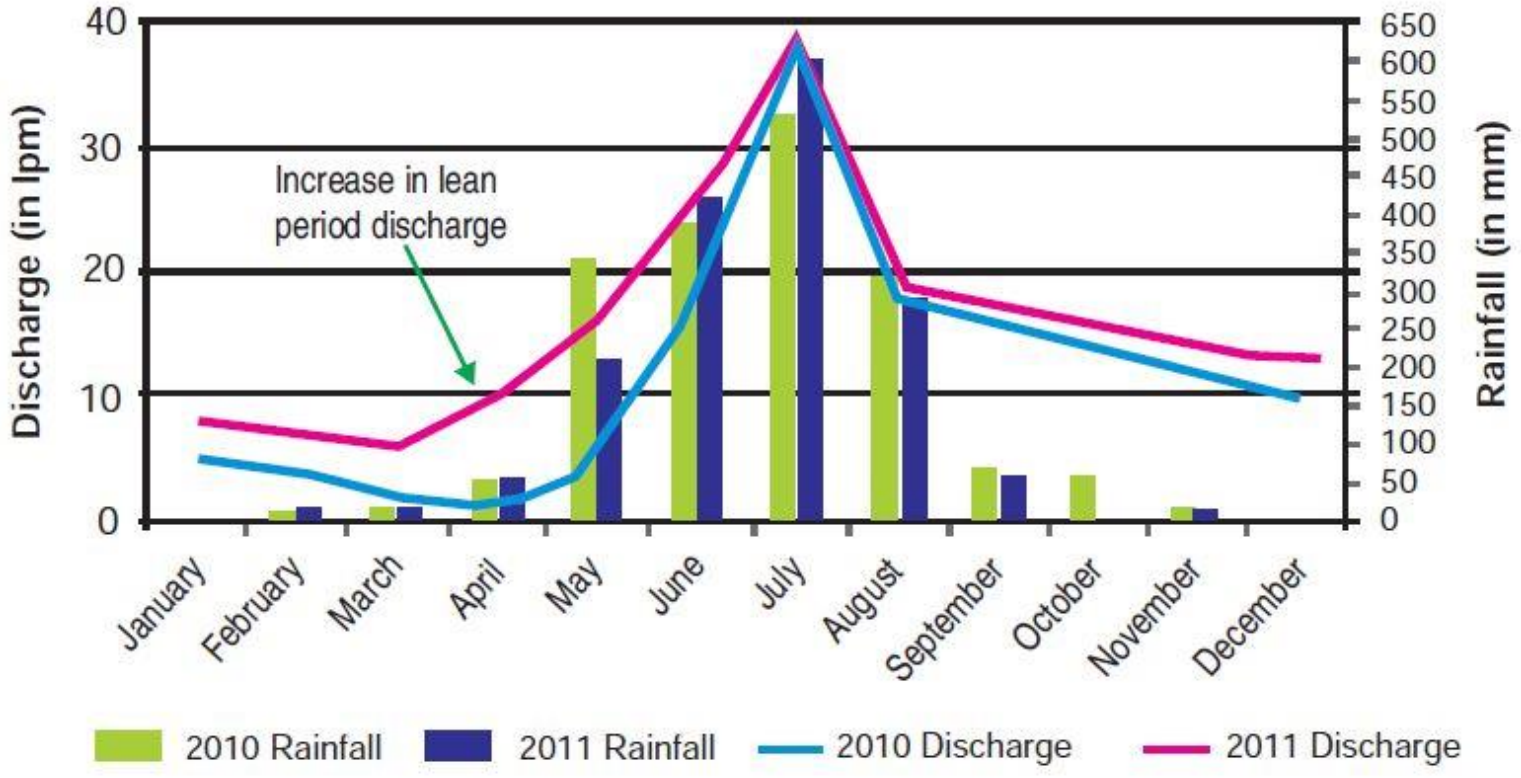
This is the effectiveness of these trenches and the result is very quick. If trenches are made before the monsoons, one can get positive results just after the monsoons.

These will be qualitative data from the community who are actually using the sources. Regular monitoring of discharges will show quantitative results.

Impact of Trenches: The Sikkim Experience

Hydrograph of a spring

Hydrograph of a spring, showing the impact of artificial recharge on spring discharge along with rainfall pattern.



Dhara Vikas Program: The Sikkim Experience

Name of Spring	Discharge during March 2010	Discharge in March 2011	Increase in Discharge
Malagiri Dhara, Lungchok Kamarey GPU, Sumbuk	7.5 liters per minute	15 liters per minute	2 times
Aitbarey Dhara, Deythang GPU, Kaluk	2 liters per minute	6 liters per minute	3 times
Dokung Dhara, Takuthang GPU, Kaluk	8 liters per minute	30 liters per minute	3.5 times
Nunthaley Dhara, Deythang GPU, Kaluk	2 liters per minute	10 liters per minute	5 times
Kharkharey Dhara, Deythang GPU, Kaluk	1 liters per minute	5 liters per minute	5times
Chukudum Dhara, Kewzing Bakhim GPU, Ravangla	45 liters per minute	60 liters per minute	1.3 times

Tree and Grass Plantation on SCT

- Trees species and grasses should be planted along with SCTs to make the structure more sustainable. In the figure, a pit of 1.5x1.5x1.5ft has been dug between the trenches for plantation of a tree species.
- On the bunds made downstream side of the trenches, grasses should be planted to prevent soil erosion and provide fodder for the livestock also. The life of the trenches will increase.

Maintenance of SCT

- In spite of all precautions, there is a tendency for these trenches to get silted. The rate of siltation is more in the first monsoon since the soil is loose. **Desiltation** needs to be done.
- **Planting grasses** like napier on bunds would decrease the siltation rate.
- Providing **berm** of approx. 0.5m would also reduce siltation.

Limitations of SCT

Apart from having enormous benefits from the SCTs, there are some limitation to this technique:

- Staggered contour trenches are not very effective in areas having a slope of less than 10% and where rainfall is less than 1000 mm annually. It is designed in a way to let some portion of water to escape.
- On slopes higher than 50% (in exceptional cases 60%) SCTs are not dug, especially in Indian condition where the slopes are very fragile. SCTs on higher slopes may trigger land slides. Afforestation, grassland or agro forestry should be promoted in higher slopes.

Continuous Contour Trenches (CCTs)

As mentioned earlier the primary objective is to check velocity of flow and thereby increasing soil moisture. CCTs are **suited to low rainfall areas** where the effort is to collect maximum surface run off. The main problem associated with this is **chances of overtopping**.

Continuous Contour Trenches (CCTs)

To minimize this, the continuity is broken at some places. Thus the length of trenches would be 10-20m as shown in the figure.

The CCTs can be dug at the foot hills of the high rainfall areas with the support of SCTs at the upper reaches.

Questions

1. What are different types of trenches?
2. Staggered Contour trenches are best suited for
   a. Mountain regions with high rainfall
   b. Mountain regions with low rainfall
   c. Plain regions with high rainfall
   d. Plain regions with low rainfall.
3. Contours for SCT can be drawn with the use of
   a. Pipe level
   b. ‘A’ frame
   c. Both of them
   d. None of them
4. The most effective measure for increasing discharge of a spring is
   a. By making Continuous Contour Trenches
   b. By making LBCD
   c. By making Staggered Contour Trenches

Questions

5. Mild slopes attain erosive velocity faster than higher slopes
   a) True
   b) False
   c) Can't say
6. Trenches on mild slope has more volume than those on higher slopes
   a. True
   b. False
7. Areas having clayey soil should have less trenches than areas having sandy soil.
   a. True
   b. False
8. The number of trenches in high slopes is more than in lower slopes.
   a. True
   b. False

Link for the Video

- https://www.youtube.com/watch?v=2M6d1BntE6w

Thank You

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