Report of the Study Team on Continuous Contour Trenches

1. Background:

WASSAN initiated the process of creating resource groups of experts and experienced persons on various themes, which help in the process of strengthening the on going watershed program in AP. As part of this process, Technology Resource Group (TRG) already met once in June 2000 and discussed on issues related to watershed technologies. One such topic was "Large Scale Implementation of Continuous Contour Trenches (CCT)" in watersheds under Neeru Meeru Program. WASSAN organized a Field Study to understand the process of implementing the CCTs in watershed program with the following objectives.

2. Objectives:

1. To understand the technical norms adopted for designing, estimating CCTs.
2. To understand the process of implementing CCTs in watershed program.
3. To assess the short-term impacts of CCTs.
4. To understand the perception of community on the implementation process and utility of CCTs as part of watershed program.

3. Members of Study Team:

The following members from various organizations were invited to join the study team.

1. Dr. G. Sastry, CRIDA.
2. Mr. Narendra, AFPRO.
3. Mr. Sridhar, PROGRESS
4. Mr. MV Rama Chnadrudu, WASSAN.

4.Details of the Villages/ Organizations supported:

1. Villages: Malchelma, Chinna Cheruvu watershed (in Sekhapur village)
Persons/ PIA supported: Mr. Hameed, Chotumia, Mr. Bakka reddy, Venkatesh, Suresh Reddy, Ms.Salomi of KVK - DDS, Zaheerabad, Medak District.

2. Villages: Mirzaguda
Persons/ PIA supported: Ramesh Babu, Nagaraju and their collegues, PROGRESS, Chevella, RR Dist.P

5.Structure of the report:

The study team made some observations on 4 themes namely Technology, Implementation Process, Impact and Community Participation. For each theme, the team's observations were described, with a note on "Emerging Issues and Tentative Action Points (if any)" related to that particular theme.

A1. Technical Norms Practiced:

1. Contours are identified using eye judgment, as a result of which trenches are not exactly on contours.
2. WDTs/ Committee members tried to use U tube for identifying contours. But they did not continue, as it is a tedious process.
3. A frame is used in one case, which lead to determination of contours in a fairly accurate way.
4. Trenches are dug in the following combinations.
    i) Only CCTs at the foot hills of small hills with Proclainers.

ii) Only CCTs along the slopes of small hills with manual labour.
iii) CCTs at the foot hills (with Proclainer) with Contour Staggered Trenches above CCTs (using manual labour).

5. Equalizers were not seen in CCTs – both man and machine made trenches.

FOR FURTHER DETIALS SEE THE TABLE ENCLOSED ON TECHNICAL NORMS.

A2. Emerging Issues on Technical Norms:

1. Rational for Standard Specifications across district is not explained to WDTs.
2. Based on field situations and design parameters like slope, rain-fall, soil type, tree canopy planned – Specification of Trenches need to be **DESIGNED**. But this practice is not followed.
3. High cross sectional area of Trenches (1M X 1M) is possible only with machines. With manual labor, it is very difficult to dig these pits as per SSRs.
4. When the depth of the trench is high, (more than 0.5Mt) the vertical sides are collapsing. Ideally Trapezoidal section needs to be adopted for such depths. But the availability of land and high unit cost per RM would be constraints.
5. Nearly Rs.100000 per watershed is going to contractors/ owners of MACHINES. This budget should ideally go for **WAGE PAYMENTS**. The main reason for using machinery seems to be **HIGH SECTION** of the trench.
6. Purpose of the CCTs:
    a. It is primarily seen as a mechanism to harvest rainwater. Which is the reason for high section of the trench.
    b. In normal technical theories, CCTs are mainly used for regenerating natural vegetation/ tree canopy by conserving soil and moisture in the pits. Even smaller sections can achieve this objective.

7. Site Selection:
    a. On CPRs: CCTs are dug mainly to harvest rainwater, not for tree plantation.
    b. Near Private Lands: CCTs are dug to protect agriculture lands from excess run off from ridge area.
    c. Catchment Area: Some cases, the catchment of a CCT is too small for the section adopted.
8. Spacing between two trenches:
   Can the spacing be designed to suit the amount of water that needs to be harvested and canopy proposed?
   Example: In stead of one trench of 1 Sq.M cross section, say @ 20 M spacing, can there be trenches of lesser cross section, say 0.3 Sq.M, at closer intervals @ 6 M spacing, without reducing the equivalent cross section area? or any small sections to catch the rain and allow tree growth ?`
9. Supplementing CCTs with other components:
   CCTs in isolation seem to be not very effective. CCTs program needs to be integral part of watershed program. For this the following components should supplement the program.
    a. Combination of CCT with SCTs, tree plantation, gully checks.
    b. Supply of plant material for at least three or four years after the CCTs are completed.
    c. Social fencing to regenerate natural vegetation.
10. When any gullies/ streams are intersecting the CCTs, they need to be separately treated by appropriate gully control measures (depending on the stability of the gully). CCTs should not go across the streams/ gullies.

A3. Tentative Action Points:

1. Developing site specific and flexible ***Design Practices*** & ***SPECIFICATIONS*** for CCTs for MDTs.
2. Capacity Building of WDTs/ Committee members to understand and modify specifications, based on experience and site situations.
3. Developing user-friendly manuals on CCTs and SCT, providing details on specifications, cost norms implementation process and community participation.

B1. Implementation Process:

Please refer the table for understanding the process of implementing the CCTs.

B2. Emerging Issues in Implementation of CCTs.

1. CCTs were not part of watershed Action Plan. They are introduced in the 2nd or 3rd year.
2. Depending on the PD's understanding of the situation/ PIAs ability to mobilize manual labour, manual labor is encouraged. (In very limited cases).
3. Machines operate day and night, which leads to poor quality CCTs, wrong site selection and poor monitoring of the program.
4. When the program is to be completed in short span of time (in 30 days), artificial demand for machines was created which increased the unit rate also.
5. Some PIAs made advance payments to suppliers of machines. But the payment made to suppliers/ PIAs so far is only up to 30%.
6. In some cases, the source of budget for this program (CCTs under Neeru Meeru Program) is Agriculture Marketing Committee. But in most of the cases, it is watershed program of the village.
7. Most importantly sufficient time for MDTs/ WDTs to operationalize the plan and program. Combination of Technologies:

B3. Tentative Action Points:

1. Making Combination of technologies as an accepted and administratively feasible practice.
2. Facilitate availability of sufficient time frame for planning and developing locally suitable technical norms/ designs.
3. Priority to be given to local labor to participate in implementing CCTs.

C1. IMPACT:

On the whole, the CCTs seem to have good impact as observed by community leaders and farmers. The impacts are more effective, when they are implemented as part of watershed program. The following observations of the community are briefly mentioned below.

1. CCTs harvested rain water significantly.

2. Farms below CCTs were protected by excessive runoff. This helped to prevent soil erosion and nutrient/ fertilizer loss.

3. Lateral seepage from the CCTs reached root zone of the crops which helped to resist the dry spell resulting in comparatively a better crop growth.

4. Regeneration of natural vegetation is initiated in some places.

5. When technologies (along with SCT/ tree plantation/ gully checks/ earthen bunds) were integrated, the streams below started flowing.

6. When CCTs were in isolation, they are not very effective. They could harvest rain water effectively, but other impacts could not be observed.

7. Employment generation potential by CCTs under Neeru Meeru program is not realized as machinery is used. Since the section is also high, community and PIAs thought use of machinery is inevitable.

8. This led to conversion of wasteland into agriculture land.

C2. Tentative Action Points:

Indicators of impact / success can be developed and made part of process of awareness generation among community, while planning & monitoring.

D. Community Participation:

1. Since it is not part of over all action plan of watershed program, there is not significant participation of the community. Only limited number of community representatives (leaders) participated.

2. Community did not contribute to CCT in any way when they are dug with machines. For SCT, community contributed as per norms of PIA (mainly in labor).

3. In case of SCTs, there is some kind of experimentation with specifications, which resulted in stabilized specifications.

4. Community members felt that the CCTs are effective compared to SCTs , as more amount of water is harvested.

5. Local laborers did not benefit and participate in CCTs, as the specifications were too high/ difficult for them to follow.

A1. Technical Norms followed for Contour Trenches

S.N	Parameter	For CCTs with Proclainers (Under Neeru Meeru Program)	CCTs under watershed program	Staggered Contour Trenc
1	Shape of Section	Rectangular	Trapezoidal Section	Rectangular
2	Specifications: (TwXBw X Ht)	1M X 1M X 1M	2.25M X 0.75M X 0.75M	1M X 1M X O.3M
3	Who Decided ?	Commissionerate of Rural Development	MDT	MDTs
4	On What Basis ?	Not clear to WDTs at local level. Some administrative convenience for measurement and payments. Minimum section that a Proclainer can do is 1M X 1M	Not clear to WDTs at local level.	Not clear to WDTs at loc
5	Spacing between Trenches	30 Mt along slope.	30 Mt along slope.	6 to 8 Mt along slope.
6	Rates	19 to 23 Rs/Cub.M	21 Rs/ Cub.M	17 to 21 Rs / Cub.M
7	Machinery/ Labor	Machinery	Labor	Labor
8	Permeability	High (50 Cm in 8 Hours – as reported by community)	Not observed	High
9	Observations	Sides of bunds are collapsing, as the soil is becoming wet.	Not implemented as they require more area. Wage rates are not agreeable to laborers.	Good quality trenches. C runoff effectively even in rains.

Experiments with Specifications:

In some cases, WDTs and WCs tried to experiment with specifications of SCTs and arrived at locally suitable specificati

S.No	Stage	Specification	Result	Revised S
1	Stage 1	0.3 M X 0.3 M	Trenches got silted up. No survival of plants.	0.3 M X 0.
2	Stage 2	0.3 M X 0.6 M	Some improvement, but not significant enough.	0.3 M X 1
3	Stage 3	0.3 M X 1 M	Plant survival increased. (Now it is up to 50 to 70%)	Continued specificati

B1. Implementation Process of CCTs :

Step	For CCTs with Proclainers (Under Neeru Meeru Program)
1	Targets for each district were set at state level
2	PD set targets to each MDT
3	MDTs set targets to PIAs
4	PIAs set targets to villages
5	Limited number of persons from village (Chairman of committee) and WDT identify sites and INFORM nearby farmers
6	Machines/ Proclainers were engaged to complete the work.
7	Machines work day and night to complete CCTs. Each watershed has an average target of 5000 RM
8	Rates are finalized at district level either --- By Market Rates OR --- By Collective experience of PIAs

Step	CCTs under Neeru Meeru with Manual Labor
1	Targets for each district were set at state level
2	PD set targets to each MDT
3	MDTs take PIA's support in identifying village and sites.
4	WDT supports, consults Sarpanch to identify site
5	WDT consults laborers to finalize wage rates.
6	Since local laborers did not agree, laborers from Mahaboobnager were hired.
7	WDT withdraws and MDTs take up complete responsibility to supervise
8	Payments were made after completing the work as per SSR (Rs.6.90 Rs/ RM)

Step	Staggered Co under watersh
1	Introduced in in 1998. Till th of program.
2	Based on buc S&M) as deci was set in the
3	Local laborers complete the
4	Specifications a period of tim experience.
5	Committee m supervised w payments.
6	Farmers cont Guidelines, m

Manual On Continuous Contour Trenches (CCTs):

WASSAN organized a study on the implementation of Continuous Contour Trenches (CCTs). Representatives from CRIDA, AFPRO, PROGRESS and WASSAN participated in this study. The findings of the study team were presented to Technology Resource Group. TRG is an initiative of WASSAN, in which eminent persons from various technology focused institutes/ organizations are members. With their feedback, a "Manual for Implementing CCTs" is prepared. It is expected that this manual and recommendations would be useful for improving the participation of communities & quality and impact of the CCTs.

Keeping in view the needs of promoting organizations (DPAP Office) and field practitioners (PIAs/ WDTs/ Village Functionaries), the recommendations are classified into 3 (A, B, C) categories. While this classification helps the easy understanding of the readers, it is to be noted here that "C " category recommendations are particularly targeted for technical staff involved with the program.

A. Purpose of CCTs.
B. Planning and Implementation and Role of Local Communities
C. Technical Specifications.

A. Purpose of CCTs

It is very important to understand the primary and secondary purpose(s)/ objectives of CCTs. With clarity of purpose, one can design the program in such a way that the primary purpose/ objective(s) are realized first. In this process, one can see that the secondary purpose(s) can also be realized eventually.

Primary Purpose(s):

Primary purpose of a CCT is to prevent the soil erosion in upper reaches of watersheds. CCTs can achieve this purpose by

- Breaking the slope.
- Reducing the velocity of runoff

Secondary Purpose(s):

- In the above process, CCT can also conserve soil and harvest rainwater (in the trenches).
- As a result of the above process, regeneration of lands (facilitating growth of natural vegetation) takes place.
- When all lands in the upper reaches are treated with CCTs and other technical interventions, ground water recharge takes place.

- Further, CCT can also act as a barrier that prevents stray cattle to enter into treated area.

B. Planning and Implementation for CCTs & Role of Local Communities:

It is very essential to realize that CCTs are only one of the interventions for regenerating natural vegetation in upper regions of watershed. CCTs should not be seen as an independent intervention for harvesting rainwater or flood control measure. The clarity of purpose of CCTs is very essential, while planning for the same.

i) Guiding Principles for the program:

1. The CCTs **SHOULD** be integral part of watershed program.
2. CCTs **SHOULD NOT** be constructed ALONE, WITHOUT combining with other technical interventions like staggered trenches, tree plantation/ fodder development, gully checks etc.
3. Involvement of local community (Watershed/ JFM Committees) in planning, designing, implementing and maintaining the CCTs and other interventions is very essential. Incidentally the choice of trees should be according to the choice of local community.
4. Employment generation opportunities for local community (eg: SHG members/ Labour Groups) should be one of the important and integral components of the program.
5. Facilitate availability of sufficient time frame for planning and developing locally suitable technical norms/ designs.
6. Machines and contractor system should not be employed for construction of CCTs.

ii) Planning & Implementing Process:

The following planning process is recommended for planning for CCTs.

A. **For Watershed Villages**:

It is observed that in a number of ongoing watershed projects, CCTs are not necessarily part of the watershed development plan. Since this planning process in on going watersheds is ad-hoc, the same process should not be adopted for CCTs. The following table presents a series of steps for planning and implementing the CCTs (along with other interventions) in the context of watershed program.

It may be noted that the role of DPAP (PD and MDTs) is to support this process and allow sufficient time for building the groups first. The monitoring and facilitating convergence of other programs (tree plantation, fodder, etc) to these groups is an

important responsibility of DPAP functionaries, along with releases of funds when needed.

Table No.1 -- Planning and Implementation Process – Watershed Villages:

S.No	Description of Process	Who does this	Support/ Methodology/ Documents Required	Suggested Time Frame (Be flexible as per local conditions)
1	Identification of potential sites with in watershed villages	Watershed Committee (WC)	Meeting/ PRA with WC & others.	1 Week
2	Identification of Users Group or SHG or Labour Groups that can take the responsibility of planning, implementing CCTs and maintaining the assets	WDT and WC	PRA with SHGs and labour groups Group Building Process of the selected group	2 Weeks to 12 Weeks
3.	Survey and design specifications	WDT with the help of Volunteer	Use of Ready Reckners, U - Tube or A - Frame	1 Week
4	Preparing Plans for all interventions along with CCTs – Plantation/ SCT and other soil moisture conservation in the selected site	Group responsible for the site along with WDT	Local Estimates (Praja Estimates)	1 Week
5	Deciding on cost sharing and contribution by Users Deciding on rules for benefit sharing Deciding on Social Fencing Practices	Group and WC	Cost benefit Analysis and group discussions. Resolution by Group and WC	2 Weeks
6	Implementation of program	Groups with the support from Volunteer.	Local Labour, with the supervision by volunteer and WDT Use of A Frame	Depending on area to be covered. (4 to 8 Weeks)
7	Measurements and payments	Volunteer/ WC / Secretary with WDT	Check payment to Group.	As the work progresses.

8	Maintenance and other interventions	Groups / WC Panchayat.	Social Fencing and practices as agreed by the groups.	Continuous on going affair.

B. For Non Watershed Villages:

It is observed that CCTs are constructed under NEERU MEERU program in many non-watershed villages also. The process of planning and implementation can be significantly improved in this program also, by adopting the following process (keeping in mind the broad Guiding Principles).

Even though, there are no watershed programs in these villages, CCTs can initiate the process of regenerating common property resources (particularly land in the upper regions of the selected villages). For this process, the local government office responsible (either DPAP/ Irrigation Dept/ Forest Dept/ Any Other) has to work with Panchayats and local groups like JFM Committees, water user associations, DWACRA/ SHGs, etc. In this case, the program interventions may be limited to the selected patch of land (unlike watershed villages, where majority of land gets treated).

Apart from this, district administration is expected to support this process and allow sufficient time for building the groups first. Apart from this, monitoring, facilitating convergence of other programs (tree plantation, fodder, gully checks etc) and release of funds to these groups are some of their important responsibilities.

Table No.2 -- Planning and Implementation Process -– Non-Watershed Villages:

S.No	Description of Process	Who does this	Support/ Methodology/ Documents Required	Suggested Time Frame @
1	Selection of villages	District Administration	Priority to villages with waste lands	1 Week
2	Identification of potential sites with in selected villages	Panchayat/ Local Groups	PRA with Panchayat/ Groups	1 Week
3	Identification of Users Group or SHG or Labour Groups that can take the responsibility of planning, implementing & maintaining the program	Panchayat / Other Groups with the support of District/ Mandal Officers	PRA with SHGs and labour groups Group Building Process of the selected group	2 Weeks to 12 Weeks
4.	Survey and design specifications	Technical Staff with Mandal level Office	Use of Ready Reckners, U Tube or A Frame	1 Week
5	Preparing Plans for all interventions along with CCTs – Plantation/ SCT and other soil moisture conservation in selected site.	Group responsible for the site along with Mandal Level Officers	Local Estimates (Praja Estimates)	1 Week
6	Deciding on cost sharing and contribution by Users. Deciding on rules for benefit sharing. Deciding on Social Fencing Practices	Group and Panchayat	Cost benefit Analysis and group discussions. Resolution by Group and Panchayat	2 Weeks
7	Implementation of program	Groups with the support from Panchayat	Local Labour, with the supervision by Mandal Level Officers/ Panchyat Use of A-Frame	Depending on area covered. (4 to 8 Weeks)
8	Measurements and payments	Panchayat with Mandal Level Officers	Check payment to Group	As the work progresses
9	Maintenance and other interventions	Group with the support from Panchayat.	Social Fencing and practices as agreed by the groups.	Continuous affair

@ Be flexible depending on site situation.

ii) Capacity Building & Support Needs:

For operationalizing the above plan, there is strong need for building capacities of various actors involved in the process. Some suggested topics/ themes, on which the training programs need to be organized, are mentioned below.

Table No.3.

S.No	Topic/ Theme	Target Group
1	Technical Aspects of land treatment – CCTs, SCTs, Bunds, etc. Developing CPRs and related issues (Institutions, Technology and Conflicts) PRA – Planning and Group Identification	WDT and PIA Other Government Officers at District and mandal levels
2	Local Estimate Preparation Experimentation with specifications Planning and Community Mobilization Conflict resolution Giving lay outs, measurements and accounts	WDT, Volunteers, Committees and Panchayats.
3	Group Formation – Importance, Decision making process and leadership, etc.	Selected Groups

iii) Use of Machinery:

It is STRONGLY RECOMMENDED that MACHINCES SHOULD NOT be sued for digging CCTs, as the following disadvantages are observed with use of machinery.

- Since the machines are used, the cross sections of the CCTs are higher (more than necessary).
- The sides of the vertical sections dug by machines are collapsing in most of the cases, leading to considrable waste of investment made. Ideally Trapezoidal section needs to be adopted for such depths. But the availability of land and high unit cost per running meter would be constraints. It is not feasible for machines to dig trapezoidal sections with in stipulated rates.
- Machines operate day and night, which leads to poor quality CCTs, wrong site selection and poor monitoring of the program.
- When the program is to be completed in short span of time (say in 30 days), artificial demand for machines may be created which increases the unit rate also.
- Most importantly, the budget is spent on machines, which should ideally go to local labourer towards wage payments. By giving preference to local labourer, the main objective of watershed program could be easily achieved. But unfortunately, this opportunity is completely missed in the on going programs.

vi) Propagation / Media Material

It is very important to develop appropriate communication material on various aspects of the CCTs. This material should be distributed to appropriate target groups, in right time. In the absence of such material, there is very poor understanding of the program among various actors.

C. Technical Principles:

This section covers all details related to design process of CCTs. The technical staff involved with this program can use this as reference material and develop site-specific designs.

C1. Site Location:

- Mainly in the upper reaches of watershed.
- Where there is sloppy land/ hill slopes.
- Degraded/ Waste lands
- At the foothills of small hills with other interventions above.
- Without treating the upper regions of watershed with other treatment options (Staggered Trenches, Tree Plantation, etc), CCTs alone SHOULD NOT be constructed.

C2. Design Components:

Design process of CCTs involves finding of the following specifications.

- Horizontal and vertical interval between two CCTs. (spacing between two CCTs)
- Cross Section of CCTs (Top Width, Bottom Width and Depth)
- Choice of Plant Species.

C3. Design Principles:

Main principles for designing CCTs are

- To make specifications site specific.
- Flexibility in practice.
- Smaller sections
- "NO STANDARDIZATION OF SPECIFICATIONS" for all types of sites.

C4. Design Parameters:

The designing of CCT is a function of/ dependent on the following design parameters.

- Rainfall in that given area (High, Medium or Low).
- Soil Type (Soil Infiltration Levels – Low/ Average and above / Medium)
- Slope of the land.
- Tree canopy planned/ exists in that region.

C5. Technical Data Collection:

The following data on technical aspects of the given site need to be collected before designing CCTs. (The methodology of collecting this data is separately discussed in the later part of this note.)

- Average rainfall and highest rain fall intensity at the selected site.
- Slope of the selected site (S - in percentage)
- Soil Type and its infiltration capacity.
- Local species of trees/ plants that grow there and required spacing.

C6. Design Steps / Formulae:

The following Steps need to be followed for designing/ arriving at the specifications of the CCTs in a given site.

iv) Step 1: Finding Out Vertical Intervals (VI):

The following formula is used for finding out VI: 0.305 (X S + Y) where

S = Slope of the land in %.

X = Rain Fall Factor (Refer Table No.1)

Y = Factor due to Soil and type and canopy (Refer Table No.2)

Table No.4 – Rainfall Factor --- X

Rainfall (In mm)	Value of X
Below 625	0.8
625 – 875	0.6
More than 875	0.4

Table No.5 – Value for Y

Soil Infiltration	Crop Canopy cover during erosive rain	Value of Y
Low (Heavy Soils)	Low	1.0
Average and above	Good	2.0
Medium	Medium	1.5

v) Finding out Horizontal Interval (HI):

After determining the Vertical Interval (VI) from Step No.1, use the following formula for deriving HI.

HI = (100 * VI) / S

vi) Determining Dimensions of Trench: (Cross Section of Trench)

During this stage, the Cross Section of the Trench is to be determined keeping in view the runoff from the catchments of each trench and required storage capacity.

- Finding out Catchment of each CCT:
  - ✓ Area drained (between two trenches) = A
  - ✓ A = (Average width between two trenches * Length of Trench)

- Finding out Peak Runoff:
  - ✓ Using Rational Formula Q = (CIA/360)
  - ✓ Where
  - ✓ Q = Peak rate of runoff in Cum/ sec for the given frequency of rainfall.
  - ✓ C = Rational runoff coefficient having values ranging from zero to one depending upon watershed conditions.
  - ✓ I = Intensity of rain fall (in mm per hour for design frequency and for duration equal to time of concentration.
  - ✓ A = Catchment area for trench.

- Fixing up Dimensions for CCTs:

Dimensions of Trench can be either Rectangular or Trapezoidal, depending on the nature of soil. Most generally adopted practice is to keep these sections small, as the main objective is to retain sufficient moisture in the soil to regenerate natural vegetation.

The following formula is used for determining the dimensions of the Trench.

Q = (W * D) / (100 * HI)

Where
- ✓ Q = Depth of Runoff from catchment area of trench in Cm.
- ✓ W = Width of trench in cm
- ✓ D = Depth of trench in cm
- ✓ HI = Horizontal Interval in meters

Normal practice is use square cross sections ranging from 30 X 30 to 50 X 50 cm. In case of trapezoidal section, the side slopes are generally 1:1.

- Fixing up Dimensions for Staggered Trenches:

Dimension for Staggered Trench is fixed, using the following formulae.

Case 1:

- ✓ With Gap in between trenches equal to length of trench:
- ✓ Q = (W * D) / (100 * HI)

Case 2:

- ✓ With Gap in between trenches not l to length of trench:
- ✓ Q = (W * D) / [(100 * HI)*(1+X/L)]

Where,

- ✓ X = gap between trenches
- ✓ L = Length of the trench

iv) Equalizers:

While construction CCTs, at certain intervals (ranging from 5 mt to 8 mts), a small portion of land is left out, without excavating. This is called equalizer. When there is excessive runoff into trench, the entire trench may get breached causing formation of new gullies. When the length of these trenches is broken, with equalizers, only weak portion of trench gets breached, leaving the remaining portion of trench intact.

v) Ready Reckoner:

For easy reference, the following tables may be used for finding out the VI and HI, for a given Slope and Soil type. Based on this, the remaining design process can be easily completed.

REFERENCES:

1. WASSAN (Sep 2000) "Report of the Study Team on Continuous Contour Trenches" An unpublished document by WASSAN, Hyderabad
2. J. Venkateswarlu, "Technical Manual on Watershed management – II" (Published by National Institute of Agricultural Extenstion Management (MANAGE), Hyderabad.
3. E M Tideman (1996) Watershed Management Guidelines for Indian Conditions, Omega Scientific Publishers, New Delhi.
4. APARD, Field Hand Book on Watershed Treatment Works, An unpublished Document by Andhra Pradesh Academy of rural Development, Hyderabad.

Ready Reckoners for adapting in designing CCTs:

Horizontal Interval = HI = 0.305(S*X+Y)
Where S = Slope X = Rainfall Factor
Y + Factor Due to canopy and infiltration
Vertical Interval = VI = (100 * HI) / S

Condition 1:

Rain fall	Below 625 mm	Value for X	0.8
Soil Infiltration	Low	Value for Y	1
Canopy	Low		

Slope (%)	VI (In Mt)	HI (In Mt)
5	1.5	30.5
7	2.0	28.8
9	2.5	27.8
11	3.0	27.2
13	3.5	26.7
15	4.0	26.4
17	4.5	26.2
19	4.9	26.0
21	5.4	25.9
23	5.9	25.7
25	6.4	25.6
27	6.9	25.5
30	7.6	25.4

Condition 2:

Rain fall	Below 625 mm	Value for X	0.8
Soil Infiltration	Average	Value for Y	2
Canopy	Good		

Slope (%)	VI (In Mt)	HI (In Mt)
5	1.8	36.6
7	2.3	33.1
9	2.8	31.2
11	3.3	29.9
13	3.8	29.1
15	4.3	28.5
17	4.8	28.0
19	5.2	27.6
21	5.7	27.3
23	6.2	27.1
25	6.7	26.8
27	7.2	26.7
30	7.9	26.4

Condition 3:

Rain fall	Below 625 mm	Value for X	0.8
Soil Infiltration	Medium	Value for Y	1.5
Canopy	Medium		

Slope (%)	VI (In Mt)	HI (In Mt)
5	1.7	33.6
7	2.2	30.9
9	2.7	29.5
11	3.1	28.6
13	3.6	27.9
15	4.1	27.5
17	4.6	27.1
19	5.1	26.8
21	5.6	26.6
23	6.1	26.4
25	6.6	26.2
27	7.0	26.1
30	7.8	25.9

Condition 4:

Rain fall	625 to 875	Value for X	0.6
Soil Infiltration	Low	Value for Y	1
Canopy	Low		

Slope (%)	VI (In Mt)	HI (In Mt)
5	1.2	24.4
7	1.6	22.7
9	2.0	21.7
11	2.3	21.1
13	2.7	20.6
15	3.1	20.3
17	3.4	20.1
19	3.8	19.9
21	4.1	19.8
23	4.5	19.6
25	4.9	19.5
27	5.2	19.4
30	5.8	19.3

Condition 5:

Rain fall	625 to 875	Value for X	0.6
Soil Infiltration	High	Value for Y	2
Canopy	Good		

Slope (%)	VI (In Mt)	HI (In Mt)
5	1.5	30.5
7	1.9	27.0
9	2.3	25.1
11	2.6	23.8
13	3.0	23.0
15	3.4	22.4
17	3.7	21.9
19	4.1	21.5
21	4.5	21.2
23	4.8	21.0
25	5.2	20.7
27	5.6	20.6
30	6.1	20.3

Condition 6:

Rain fall	625 to 875	Value for X	0.6
Soil Infiltration	Medium	Value for Y	1.5
Canopy	Medium		

Slope (%)	VI (In Mt)	HI (In Mt)
5	1.4	27.5
7	1.7	24.8
9	2.1	23.4
11	2.5	22.5
13	2.8	21.8
15	3.2	21.4
17	3.6	21.0
19	3.9	20.7
21	4.3	20.5
23	4.7	20.3
25	5.0	20.1
27	5.4	20.0
30	5.9	19.8

Condition 7:

Rain fall	More than 875	Value for X	0.4
Soil Infiltration	Low	Value for Y	1
Canopy	Low		

Slope (%)	VI (In Mt)	HI (In Mt)
5	0.9	18.3
7	1.2	16.6
9	1.4	15.6
11	1.6	15.0
13	1.9	14.5
15	2.1	14.2
17	2.4	14.0
19	2.6	13.8
21	2.9	13.7
23	3.1	13.5
25	3.4	13.4
27	3.6	13.3
30	4.0	13.2

Condition 8:

Rain fall	More than 875	Value for X	0.4
Soil Infiltration	Medium	Value for Y	1.5
Canopy	Medium		

Slope (%)	VI (In Mt)	HI (In Mt)
5	1.1	21.4
7	1.3	18.7
9	1.6	17.3
11	1.8	16.4
13	2.0	15.7
15	2.3	15.3
17	2.5	14.9
19	2.8	14.6
21	3.0	14.4
23	3.3	14.2
25	3.5	14.0
27	3.8	13.9
30	4.1	13.7

Condition 9:

Rain fall	More than 875	Value for X	0.4
Soil Infiltration	High	Value for Y	2
Canopy	High		

Slope (%)	VI (In Mt)	HI (In Mt)
5	0.9	18.3
7	1.2	16.6
9	1.4	15.6
11	1.6	15.0
13	1.9	14.5

Condition 9 (contd)

Slope (%)	VI (In Mt)	HI (In Mt)
15	2.1	14.2
17	2.4	14.0
19	2.6	13.8
21	2.9	13.7
23	3.1	13.5
25	3.4	13.4
27	3.6	13.3
30	4.0	13.2