Ecological and Energy Efficient Practices for Storm Water Management

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Problem Faced in Urban Water Sector

Problem of more water

Flooding due to high water yield from the surrounding catchments because of conversion of forest land to urban area

Problem of inadequate drainage

Reduction in drainage capacity due to high sediment yield from the upper catchments and their deposition in the drains and river.

Problem of less water

Water scarcity due to rapid depletion of ground water for reduced recharge and extensive pumping

Energy Involved in Management

Energy in pumping flood water

Energy for clearing water way

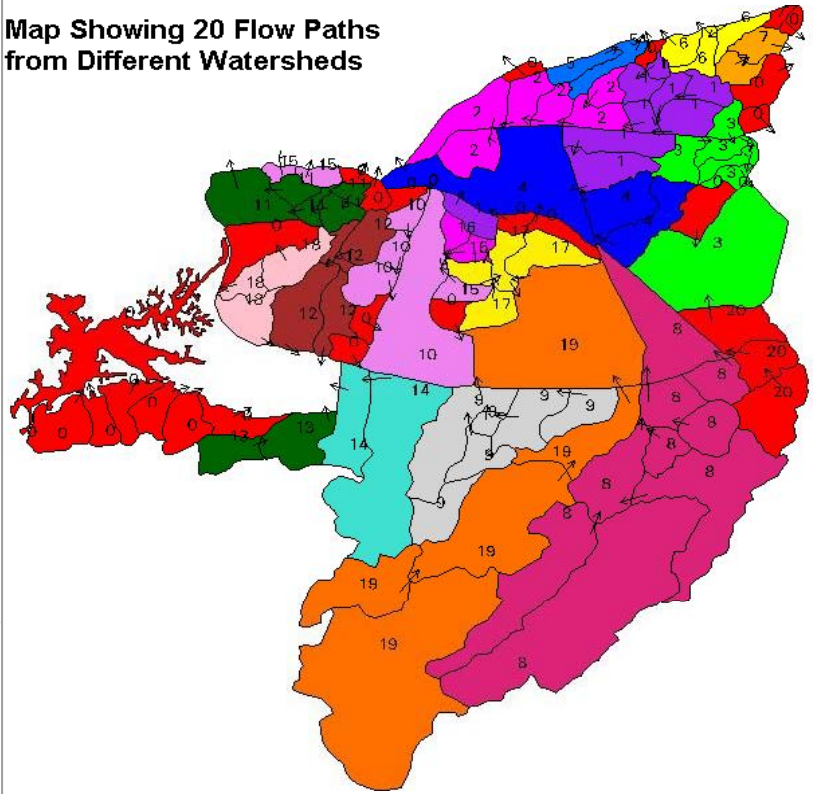
Lower the GWT more is the energy

More energy to drive

3D View of Guwahati using DEM

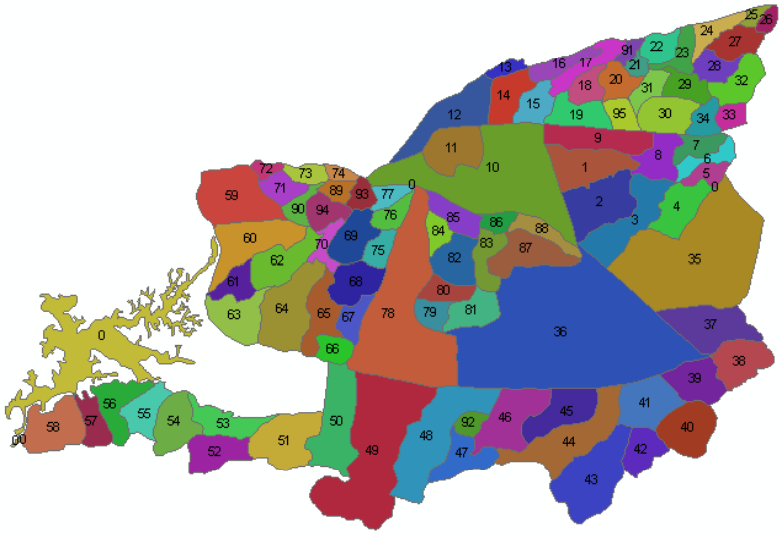
Effects of Vegetative Cover on Water Yield

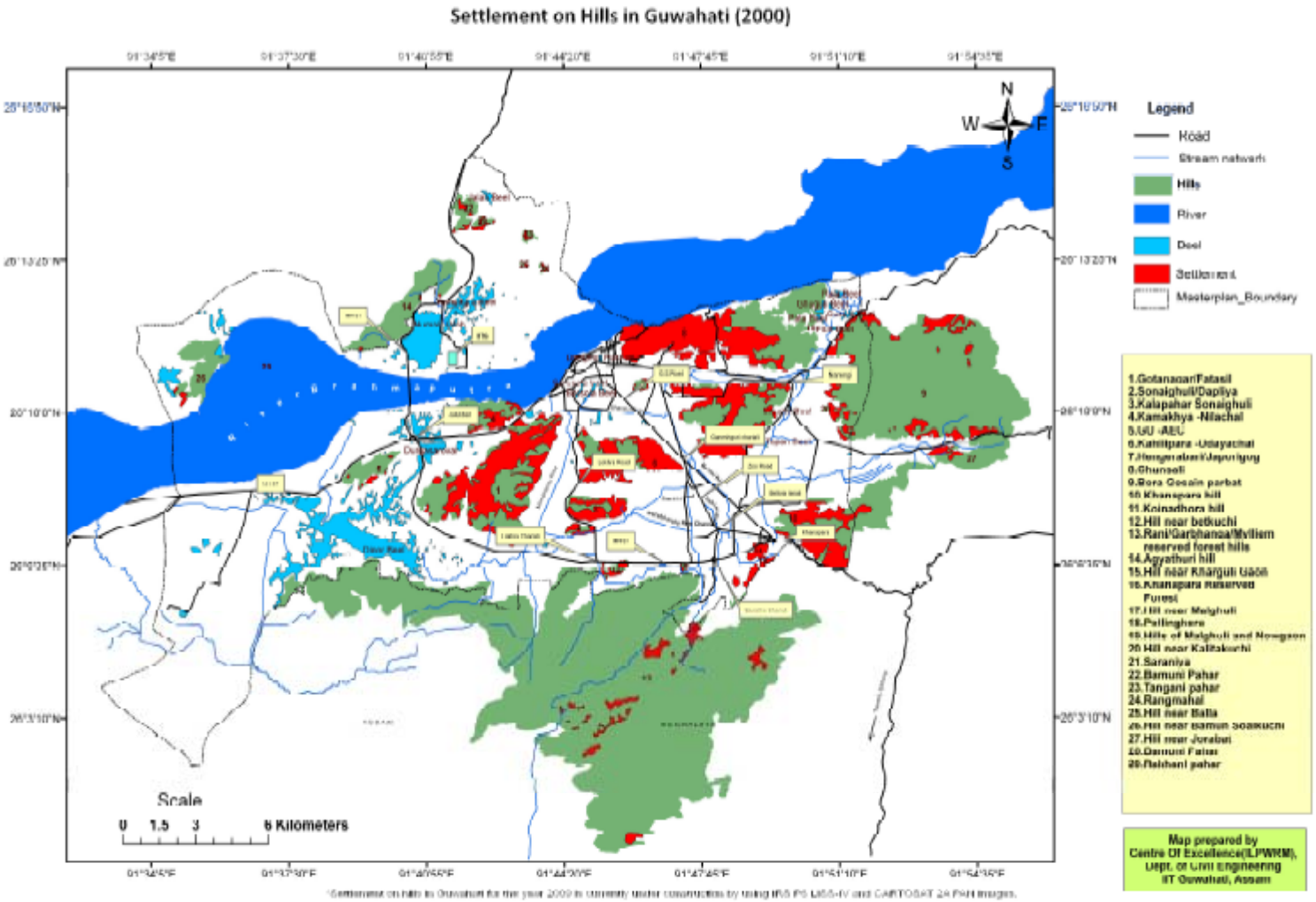
Present Maximum outflow at pilot watershed (cumec)	Outflow if bareland and open mix forest area are covered by vegetation (cumec)	Outflow if all the vegetation cover is removed from the watershed (cumec)
6.031	5.27	7.25



Effect of Deforestation (RUSLE)

Present annual sediment yield in tons/yr	Annual sediment yield in tons/yr if bare land and open mix forest area are completely covered by vegetation	Annual sediment yield in tons/yr if vegetation cover is removed completely from the watershed
20943.88	7903.27	289412.6




Settlement on Hills in Guwahati (2000)
N
W
E
S
Legend
Road
Stream network
Hills
River
Deel
Settlement
Masterplan_Boundary
1.Gotanagar/Fatasil
2.Sonaighuli/Dapliya
3.Kalapahar Sonaighuli
4.Kamakhya -Nilachal
5.UU -AEC
6.Kamlapara -Udayachal
7.Hengrabari/Jayantigyg
8.Ghunsali
9.Bora Gosain parbat
10.Khanapara hill
11.Koinadhora hill
12.Hill near betkuchi
13.Rani/Garbhanga/Mylliem reserved forest hills
14.Agyathuri hill
15.Hill near Khanguli Gaon
16.Khanapara reserved Forest
17.Hill near Meghuli
18.Pelinghera
19.Hills of Meghuli and Nowgaon
20.Hill near Kalitakuchi
21.Saraniya
22.Bamuni Pahar
23.Tangani pahar
24.Rangmahal
25.Hill near Balla
26.Hill near Bamun Boakuchi
27.Hill near Jorabat
28.Bamuni Fatar
29.Pelchari pahar
Scale
0 1.5 3 6 Kilometers
Map prepared by
Centre Of Excellence(LPWRM),
Dept. of Civil Engineering
IIT Guwahati, Assam


"EXPERIMENTAL WATERSHED"
MoUD SPONSORED CENTRE OF EXCELLENCE
"INTEGRATED LANDUSE PLANNING &
WATER RESOURCE MANAGEMENT (ILPWRM)"
CIVIL ENGINEERING DEPARTMENT, IIT GUWAHATI

Comparison of the watersheds

Lush green vegetation cover

Construction of house exposing subsoil strata to erosion

Runoff from the two watersheds

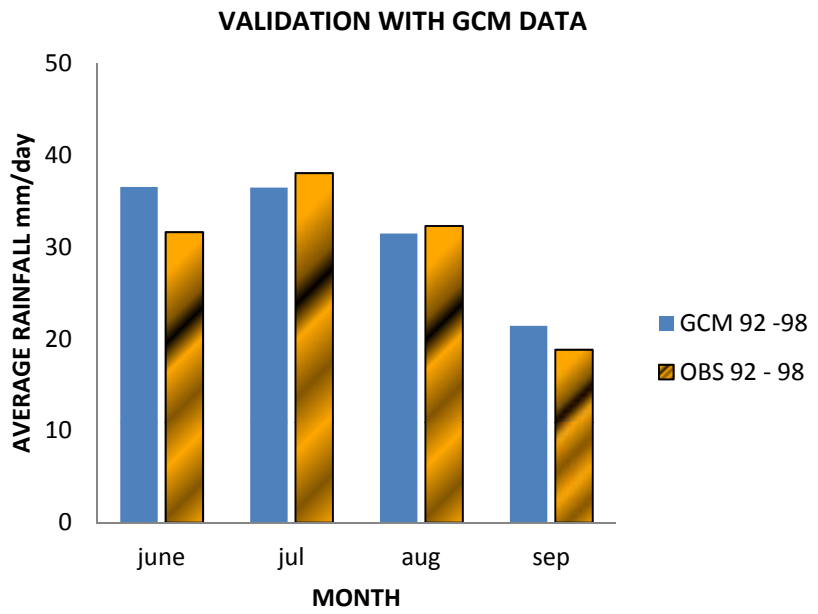
Clearer runoff from the undisturbed watershed

Sediment laden runoff from the disturbed watershed

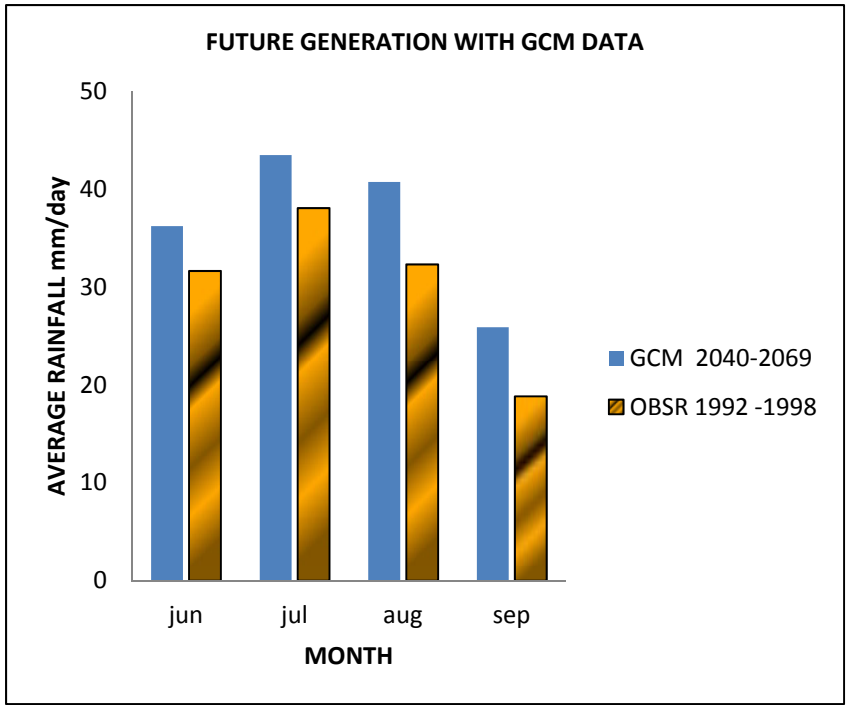
Water samples from the watersheds

undisturbed watershed **disturbed watershed**

Validation and Generation using GCM



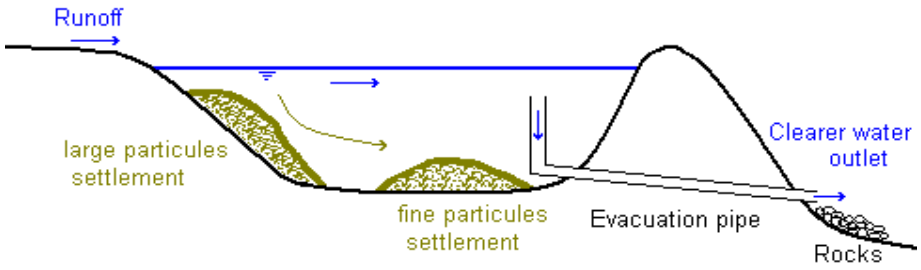
An increase in the precipitation up to 20 % in the monsoon period could be seen by 2050's.



Such high intensity rainfall will cause

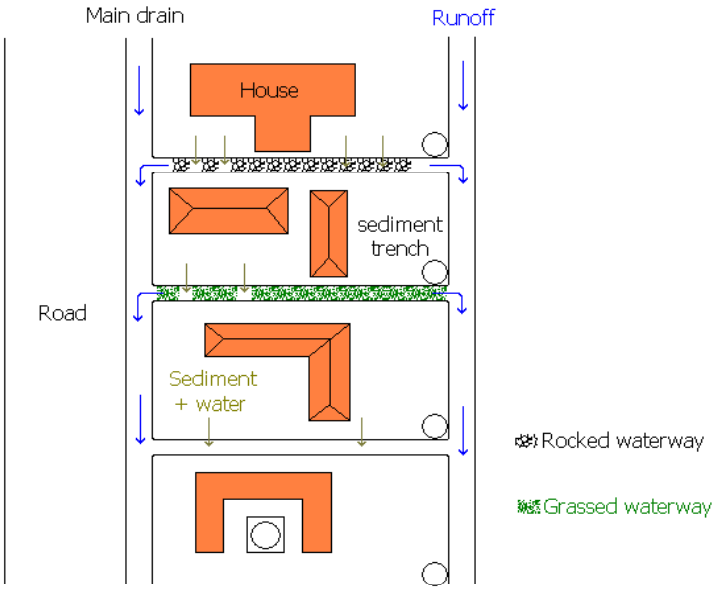
- High erosion in the hilly catchment
- High Peak flow
- Longer dry spell

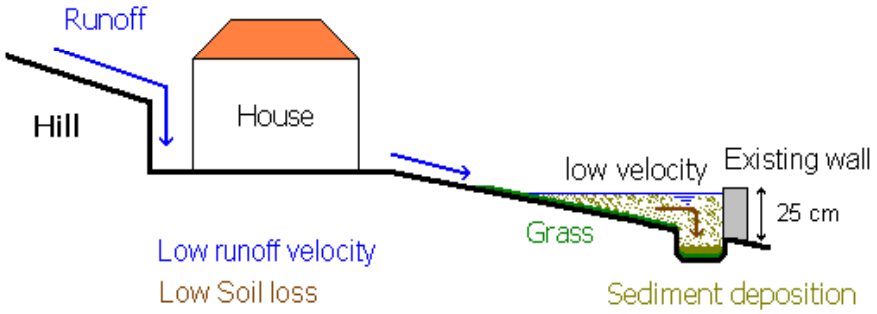
Watershed Management with Energy Efficient Optimal Ecological Management Practices



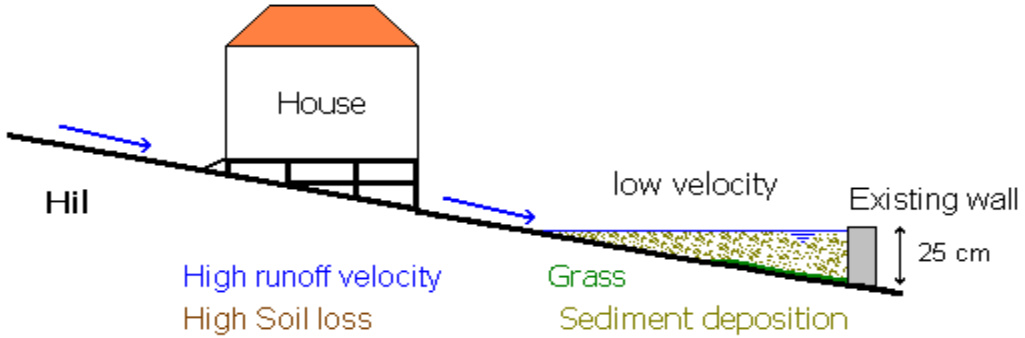
Sedimentation basin

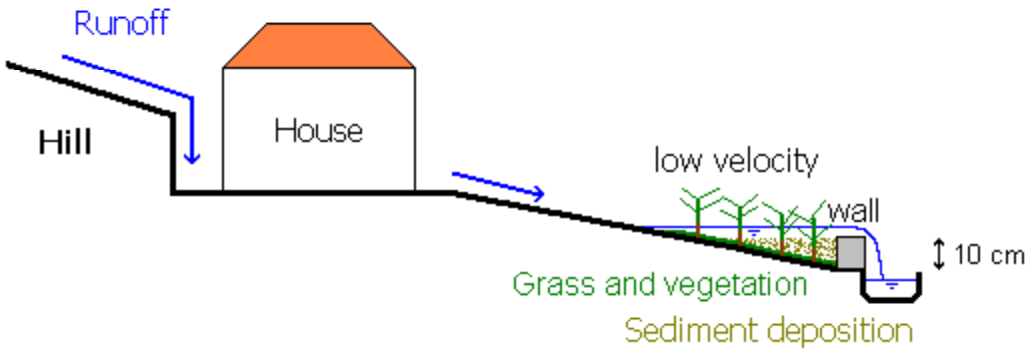
Measures for runoff and sediment control





Measures for Controlling Water and Sediment Yield

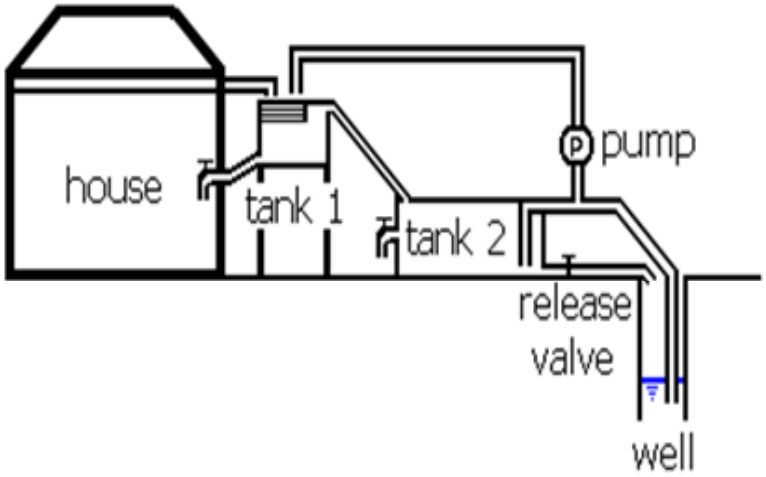




GRASS LAND

SLOPE STABILIZATION STRUCTURE

Perforated Concrete Block



ROFTOP RAINWATER HARVESTING

HADGE FOR ROAD SIDE PROTECTION

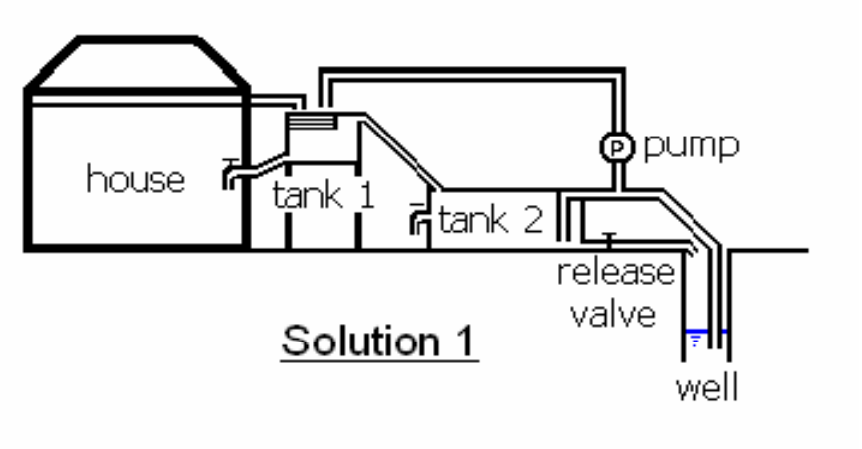
PAVED GROUND WITH SPACE FOR RAINWATER PERCOLATION

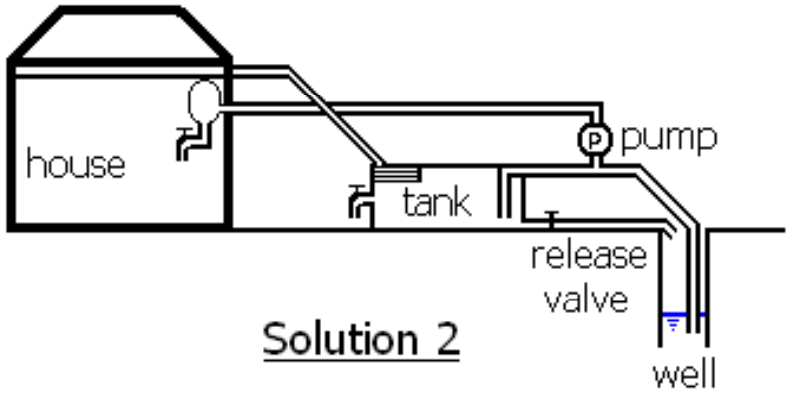
FOREST LAND

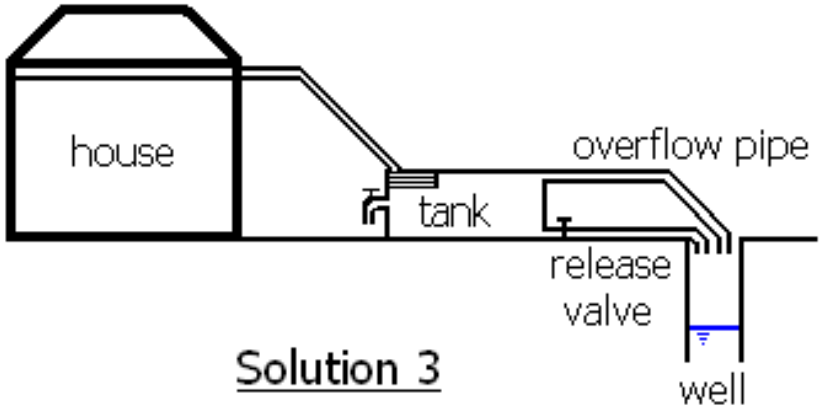
RAIN WATER HARVESTING FOR URBAN FLOOD PEAK REDUCTION

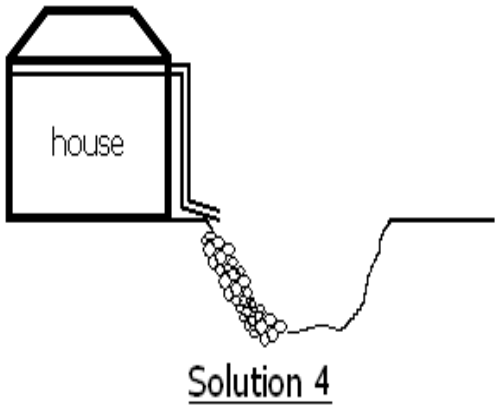
Buildings and Drains in Hatigarh Watershed

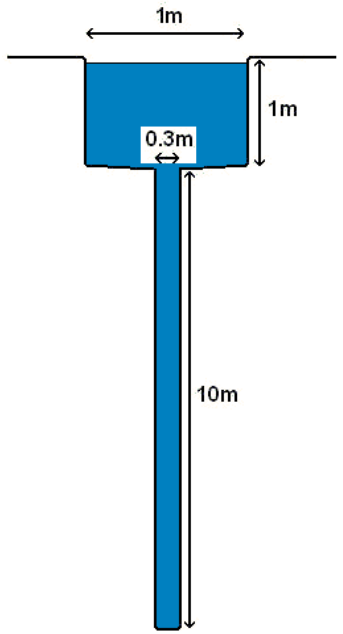
Rain Water Harvesting Options











Summary of RWH Analysis (Contd.)

Parameters	Before Solution	After solution		
		Only RTRWH	RTRWH +10 FW/ha	RTRWH +20 FW/ha
Water level in drains (m)	**1.78**	**1.62**	**1.44**	**1.29**
Sediment in drain (m)	0.5	0.5	0.18	0.18
Depth of outlet drain (m)	1.5	1.5	1.5	1.5
Flood with sediment control(m)	**0.78**	**0.62**	**0.11**	**0.00**
% Reduction in Maximum Runoff Volume	**-**	**12.2**	**21.54**	**30.87**
% Peak Discharge Reduction	**-**	**12.20**	**12.70**	**22.9**
% Flood Reduction in Drains (without Sediment Control)	**-**	**20.5**	**43.6**	**62.8**
% Flood Reduction in drains (With Sediment Control, Studyed by Bracht and Sarma)	**-**	**20.5**	**85**	**100**



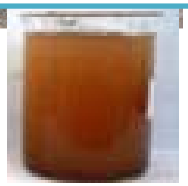

We need to go for Optimal Ecological Management (EMP)Practices






Experimental Watershed

Sediments in runoff



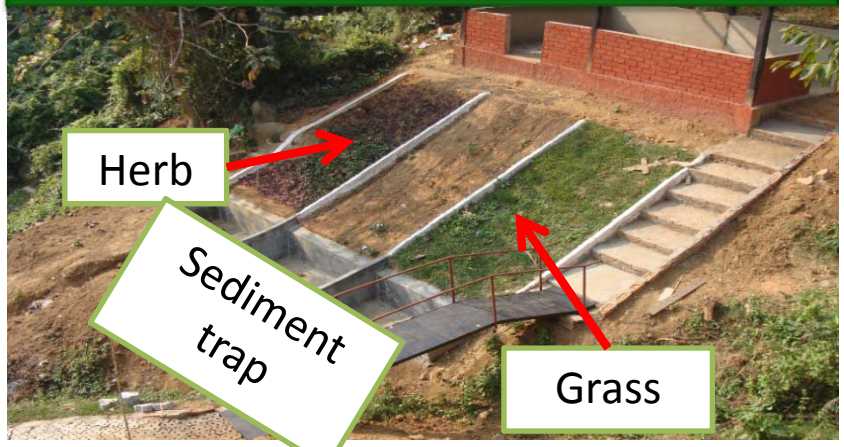
Denudation leads to

✓Increase in total runoff volume : as high as 54 times

Denudation leads to

✓Increase in total sediment yield: as high as 21 times

Efficiency in Sediment control :
Grass = 65%-100%
Herb= 38% -97%
(compared to barren land)

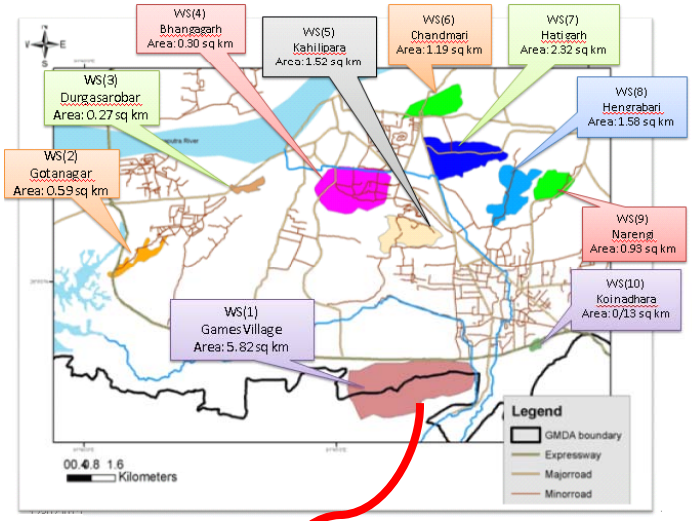


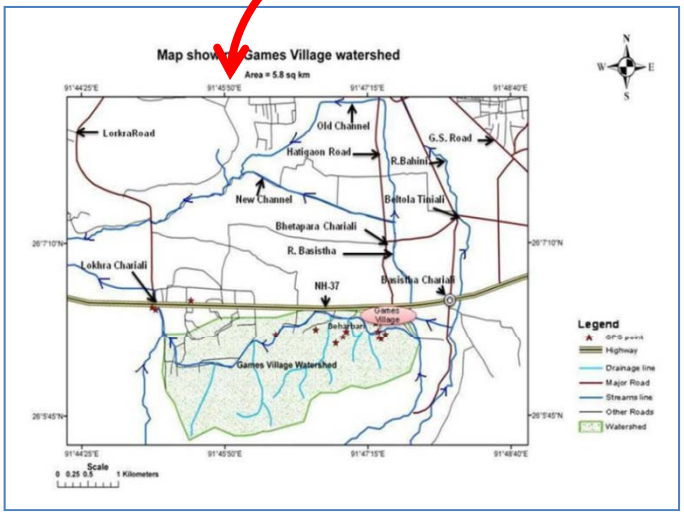
Denudation leads to

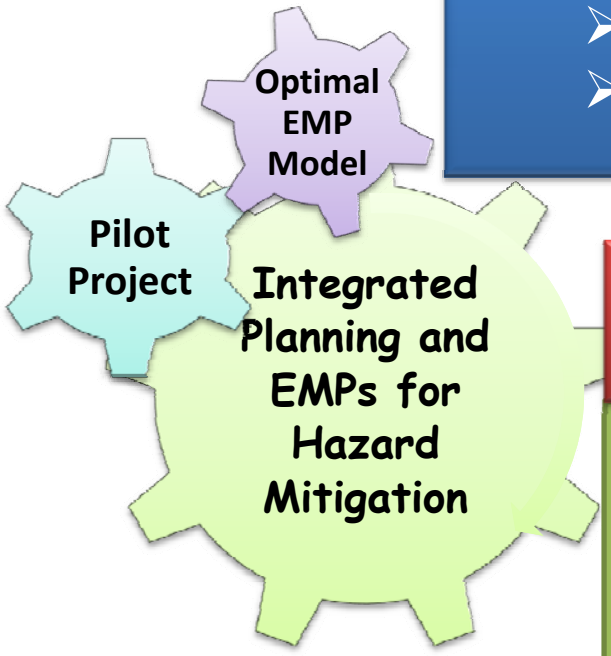
✓Changes in Chemical Composition s of Water

Integrated Planning and EMPs for Hazard Mitigation

Technical Core Committee (TCC) with 11 govt. departments was constituted in June 2010







✓Plots under single ownership
- ➢OPTEMP-LS model

✓Plots under multiple ownership
- ➢OPTEMP-LM model
- ➢OPTEMP-LDM model

✓**October 2012:** Completed the Conceptual DPR

✓**May 2013:** Govt agreed to implement the EMP concept

Work accomplished under pilot project planning

✓**August 2010**: Initial concurrence from state govt.

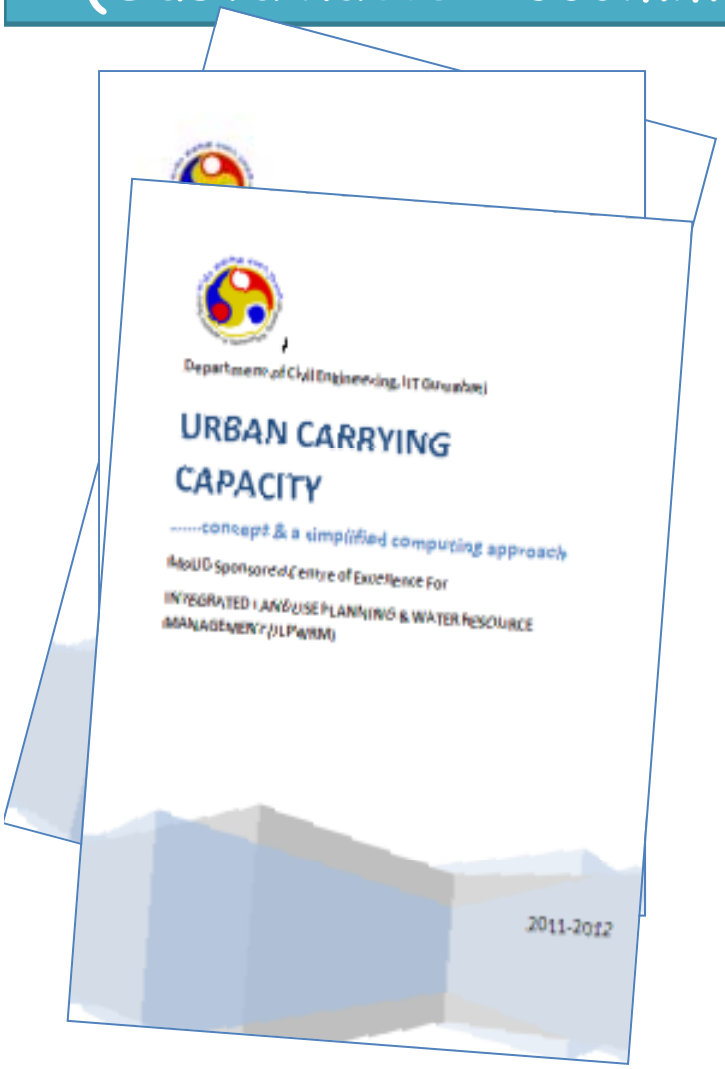
✓Had to defer due to socio-political disturbance

✓**June 2011:** Final concurrence from state govt.

✓**January 2012:** Work order issued for land survey

✓**March 2012:** Survey work completed

Urban Carrying Capacity (SAFE)
(Sustainable Accommodation through Feedback Evaluation)



Step 1: Delineation of hilly urban area for which carrying capacity need to be calculated.

Step 2: Demarcation of non developable areas

Step 3: Computation of area required for different infrastructure and facilities

Step 4: Assessment of net area available for residential development

Step 5: Estimation of Floor Area Requirement per person

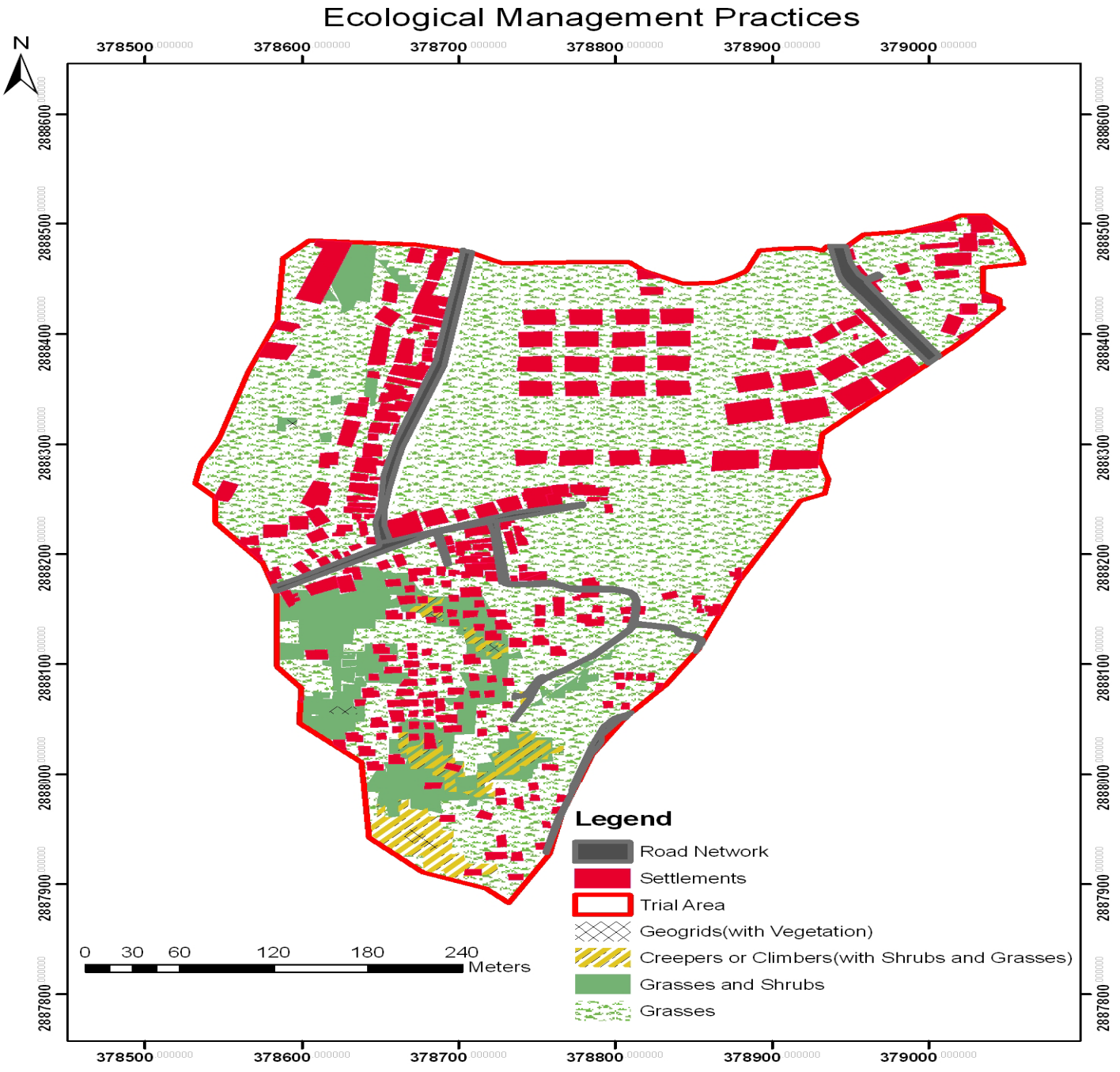
Based on socio-economic status of the prospective residents of the developable hilly area, an average floor area required for each person is determined.

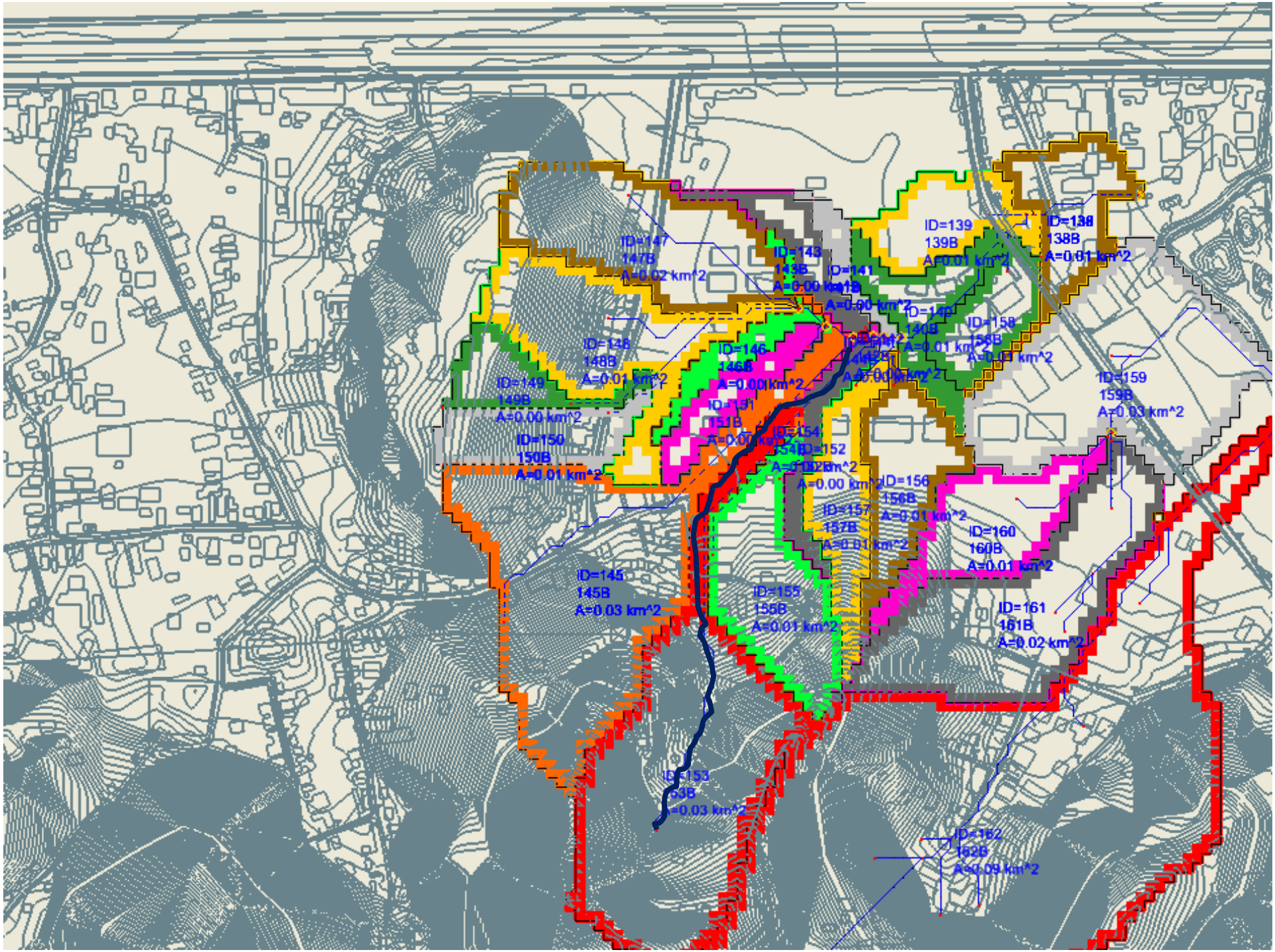
Step 6: Carrying Capacity Calculation through iterative procedure

$$CC = (A_U - (A_{NDA} + A_{IF}[CC])) \times FAR/S$$

Step 7: Feedback Evaluation: Recheck for Drainage, Sediment yield etc.: If insufficient- Apply EMP(Technical Intervention), or adjust FAR


Bongaon Lakhimandir Path
Dr Bhabandra Nath Saikia Rd
Hatigaon Bhatdara Rd
NH 37
Beltola Basistha Road
Pillingkata Rd
Image © 2013 DigitalGlobe
Image © 2013 GeoEye
© 2013 Google


Ecological Management Practices
N
378500
378600
378700
378800
378900
379000
2888600
2888500
2888400
2888300
2888200
2888100
2888000
2887900
2887800
Legend
Road Network
Settlements
Trial Area
Geogrids(with Vegetation)
Creepers or Climbers(with Shrubs and Grasses)
Grasses and Shrubs
Grasses
0 30 60 120 180 240
Meters


ID=147
147B
A=0.02 km^2
ID=143
143B
A=0.00 km^2
ID=141
A=0.00 km^2
ID=139
139B
A=0.01 km^2
ID=138
138B
A=0.01 km^2
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140B
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158B
A=0.01 km^2
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148B
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A=0.03 km^2
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160B
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155B
A=0.01 km^2
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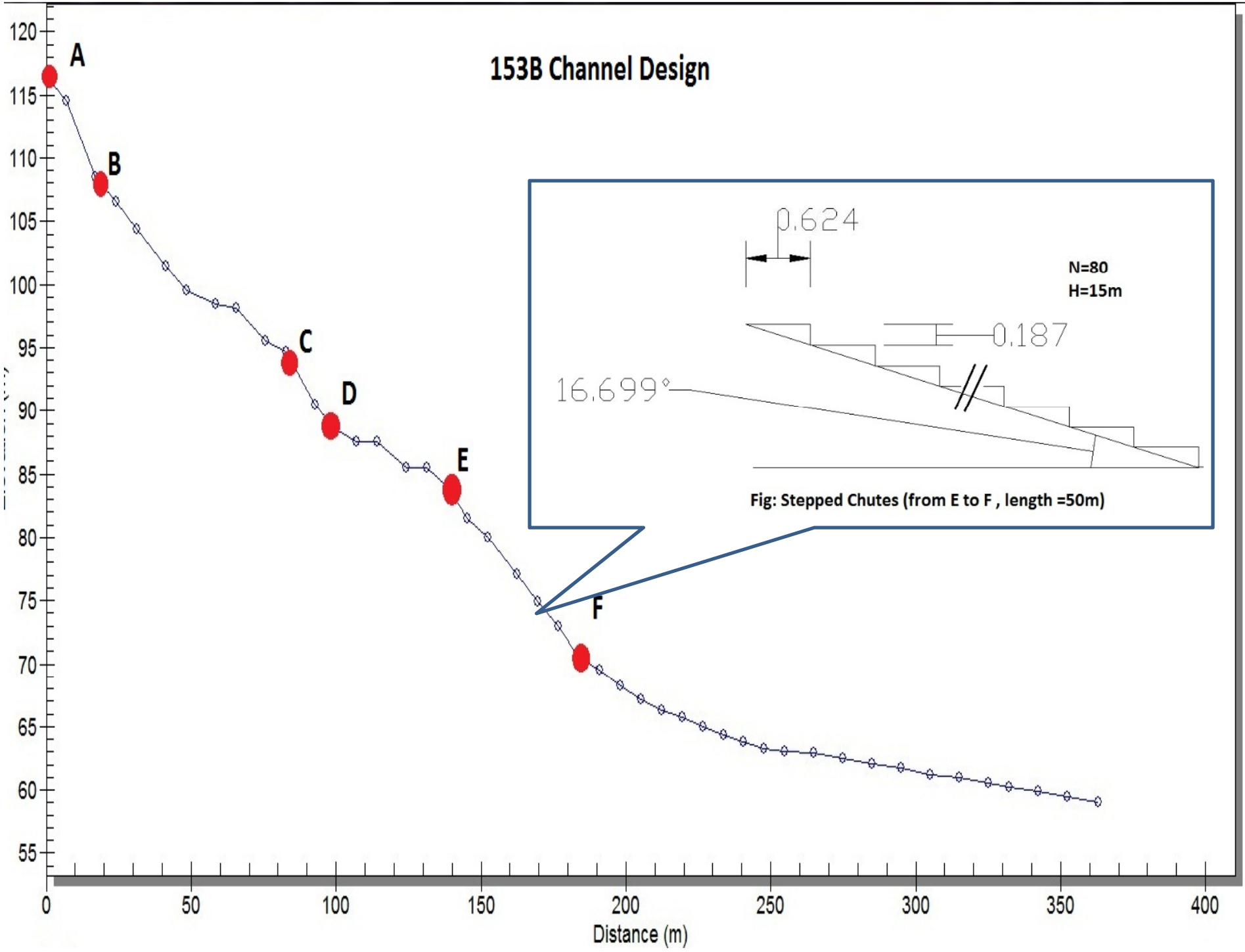
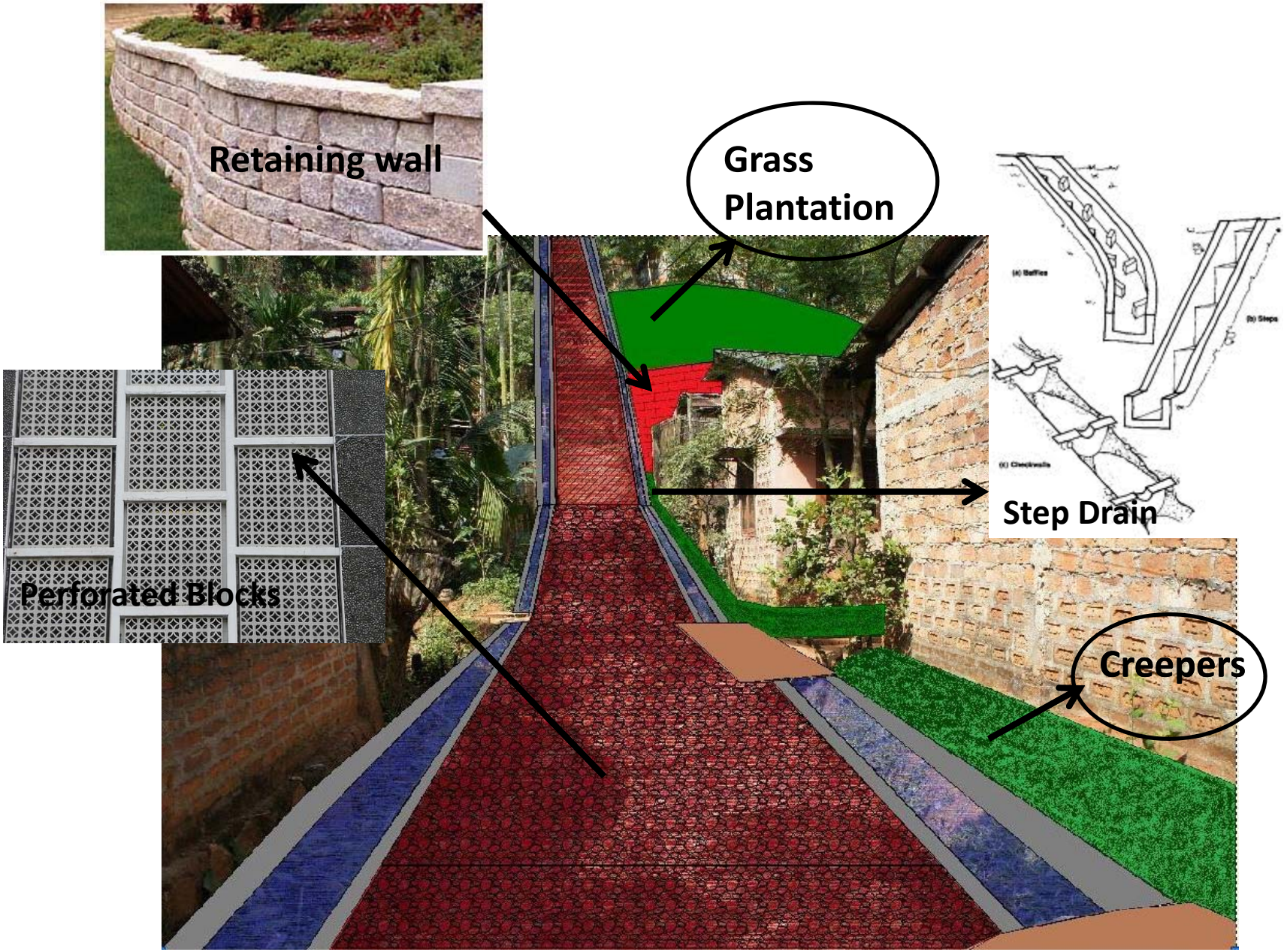
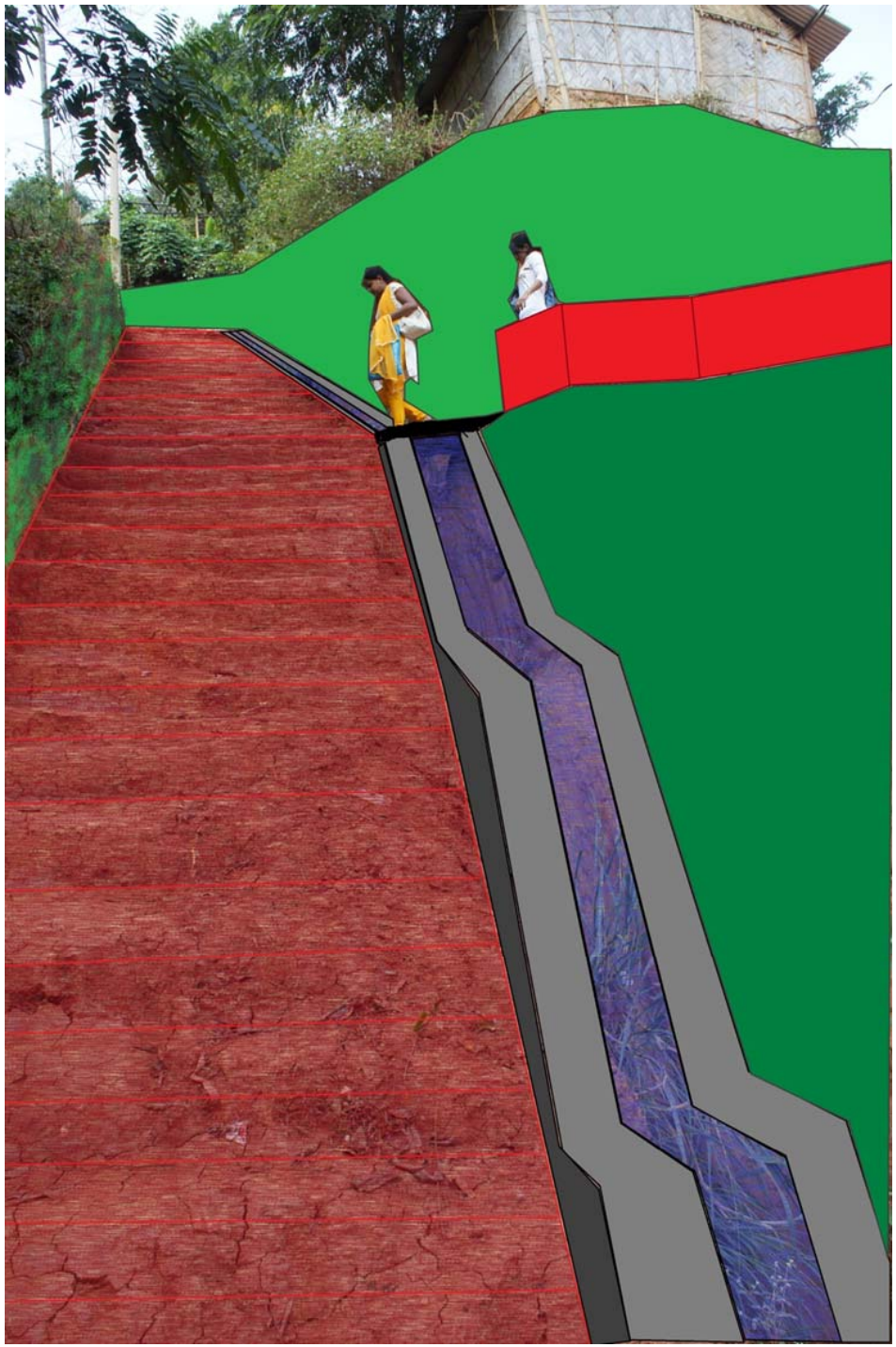
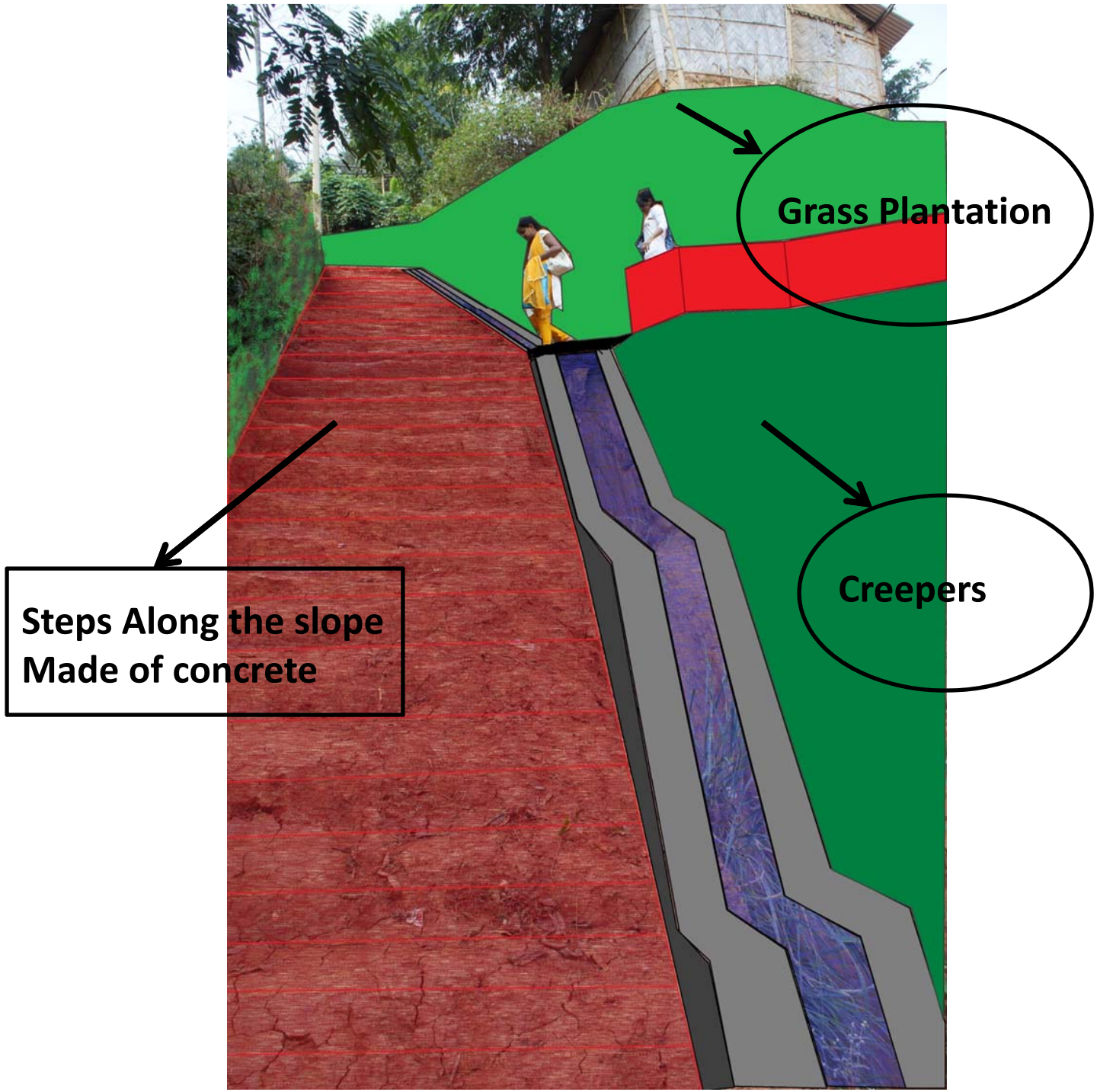
161B
A=0.02 km^2
ID=153
153B
A=0.03 km^2
ID=162
162B
A=0.09 km^2

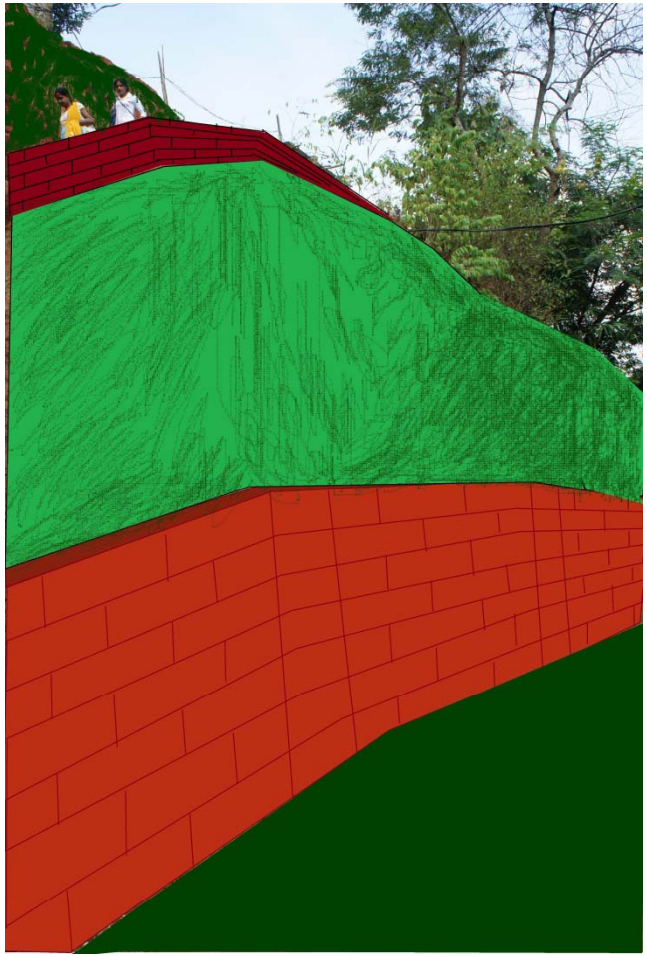

153B Channel Design
A
B
C
D
E
F
120
115
110
105
100
95
90
85
80
75
70
65
60
55
0
50
100
150
200
250
300
350
400
Distance (m)
0.624
N=80
H=15m
0.187
16.699°
Fig: Stepped Chutes (from E to F , length =50m)

Detail Planning in Already Developed Area

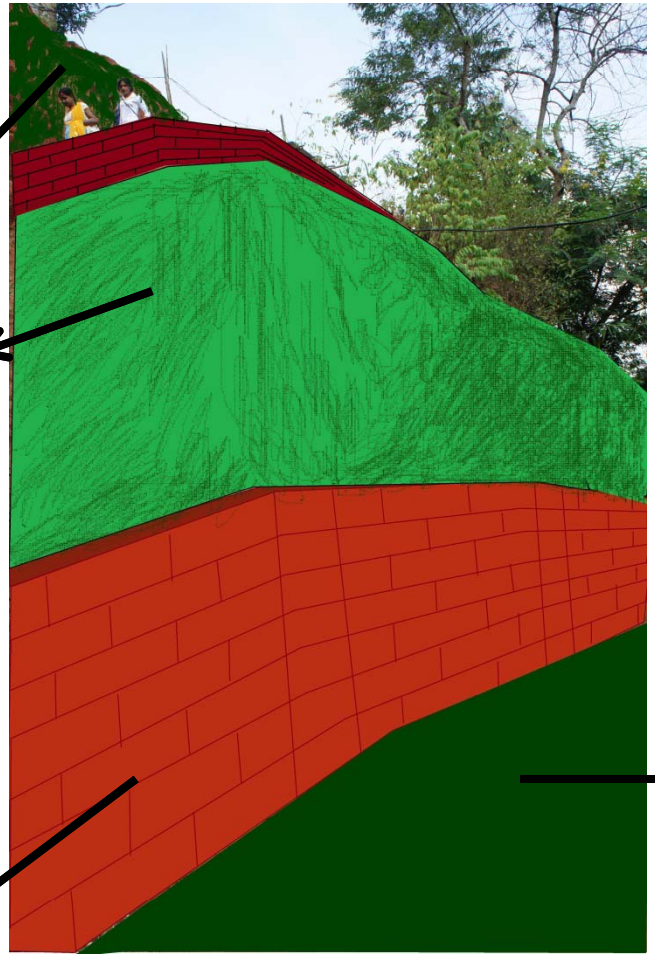

Retaining wall
Grass Plantation
Step Drain
Perforated Blocks
Creepers




Grass Plantation
Creepers
Steps Along the slope
Made of concrete

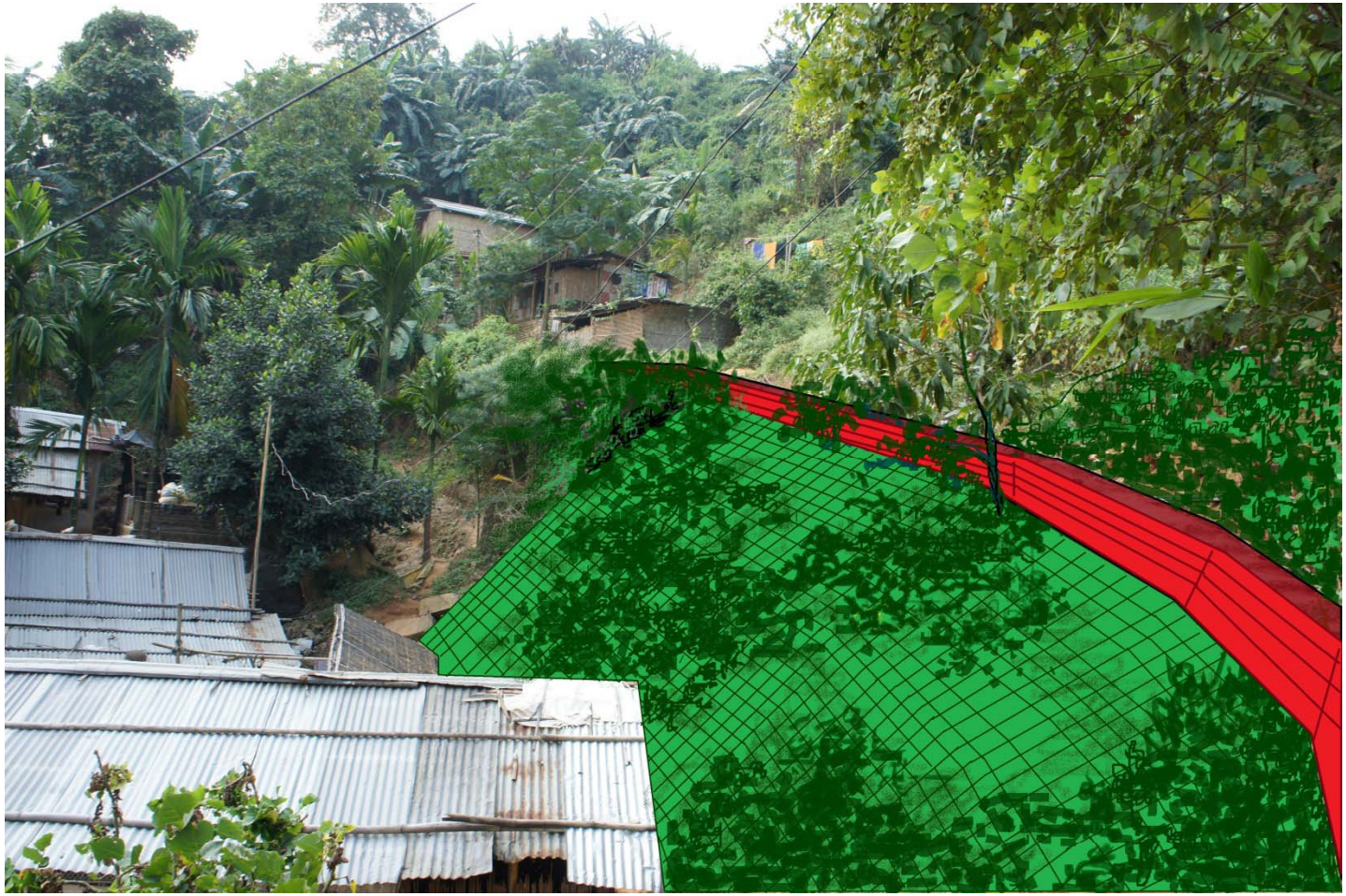


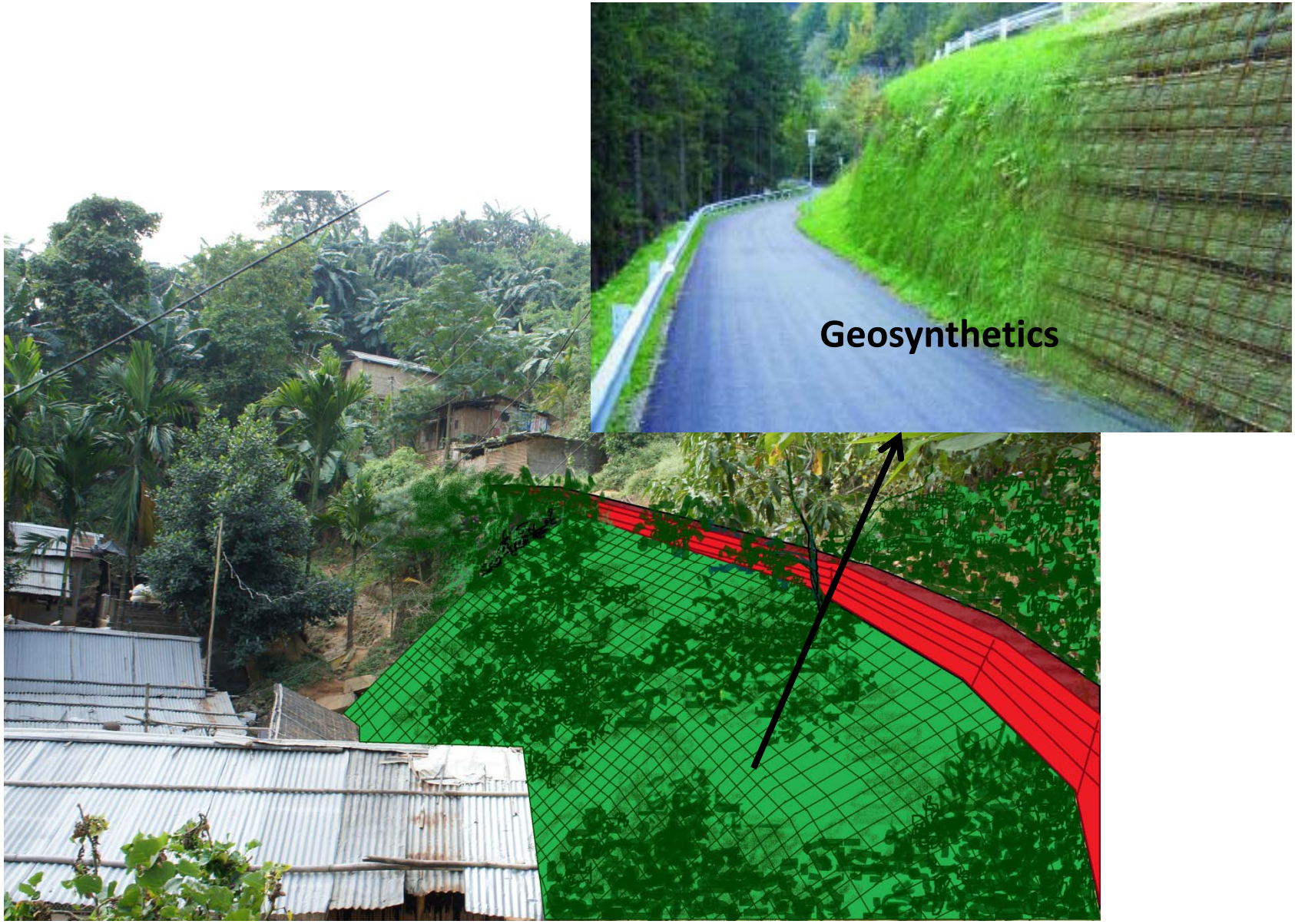
Creepers / Vegetation

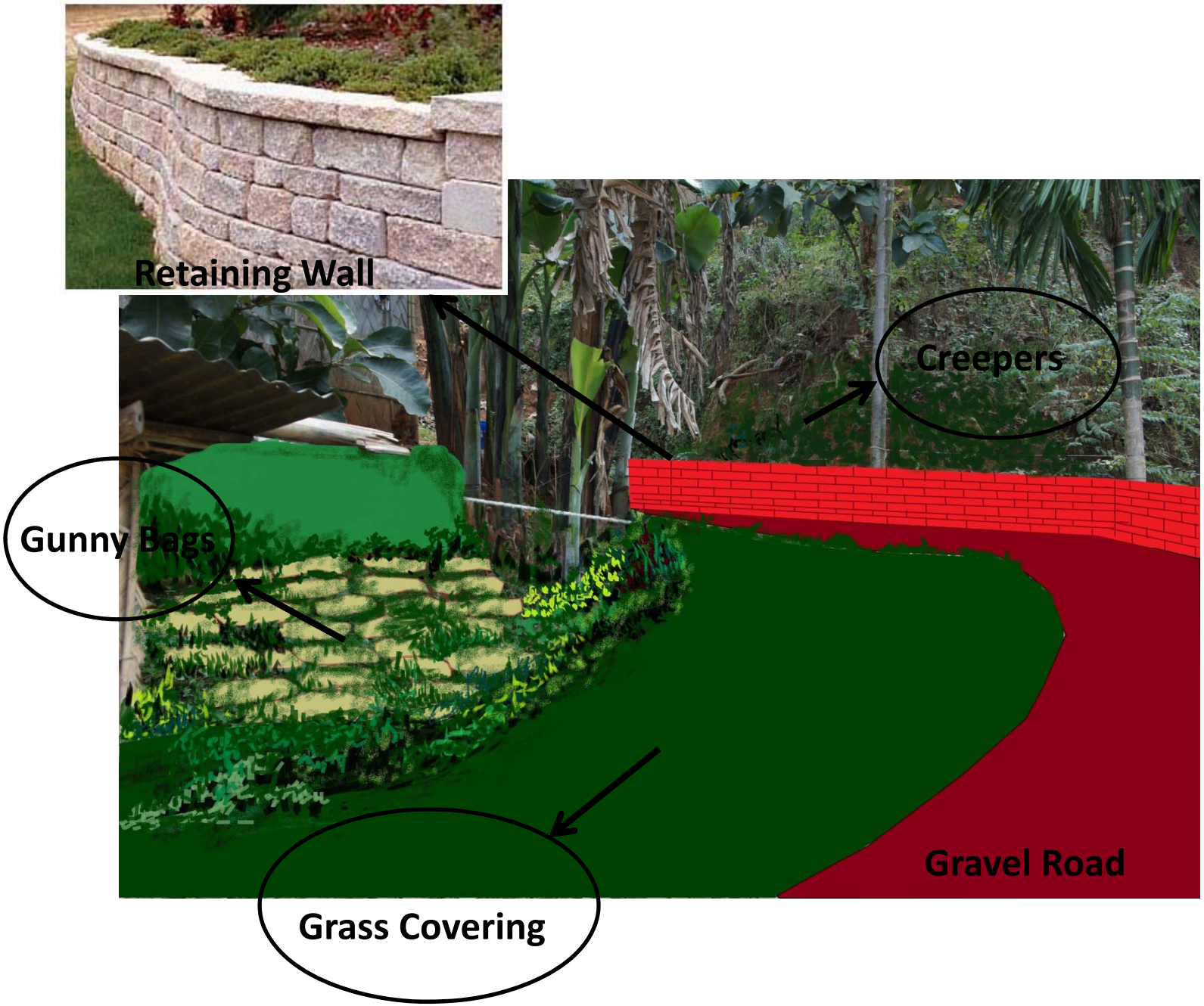


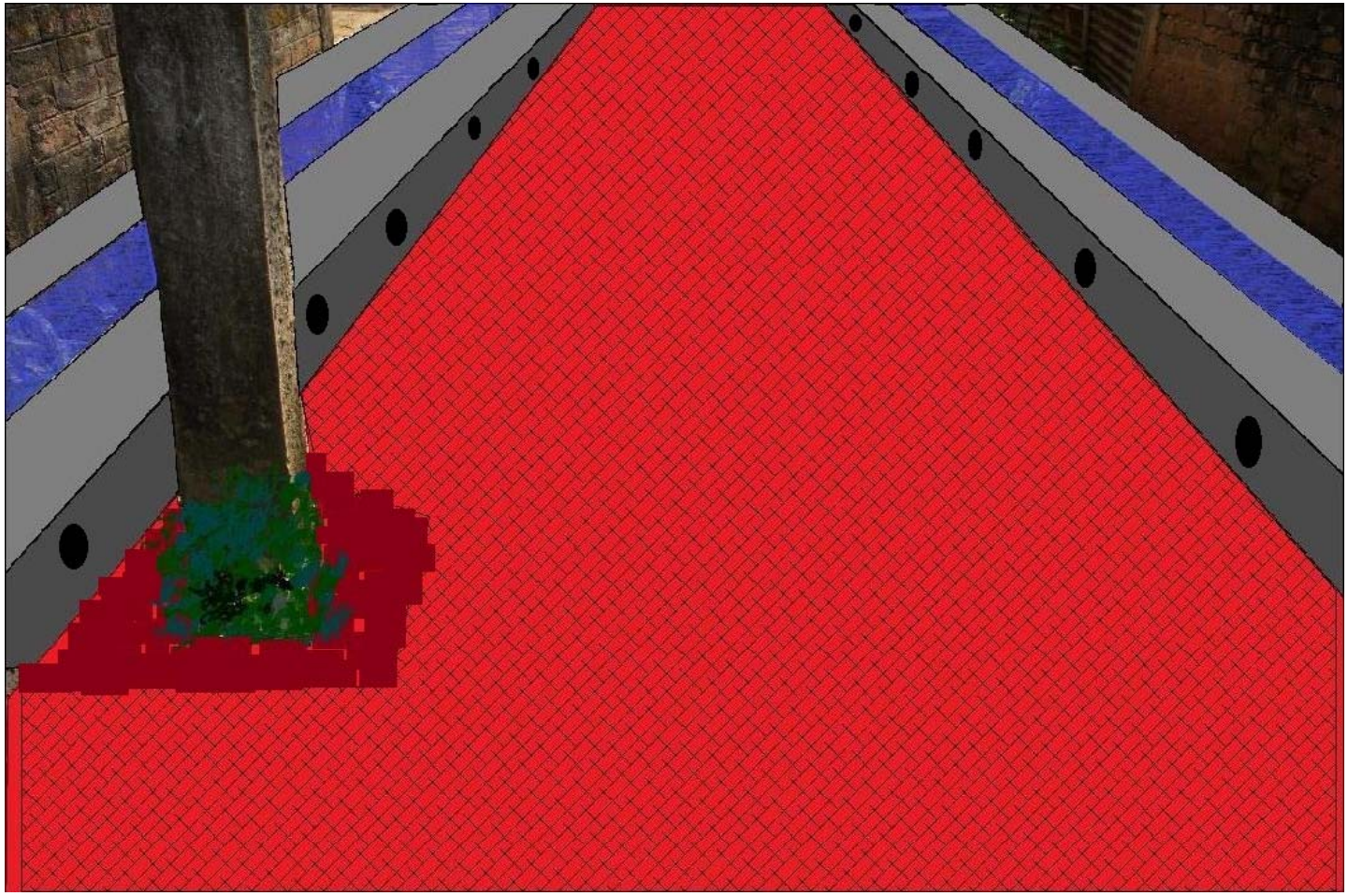
Retaining wall

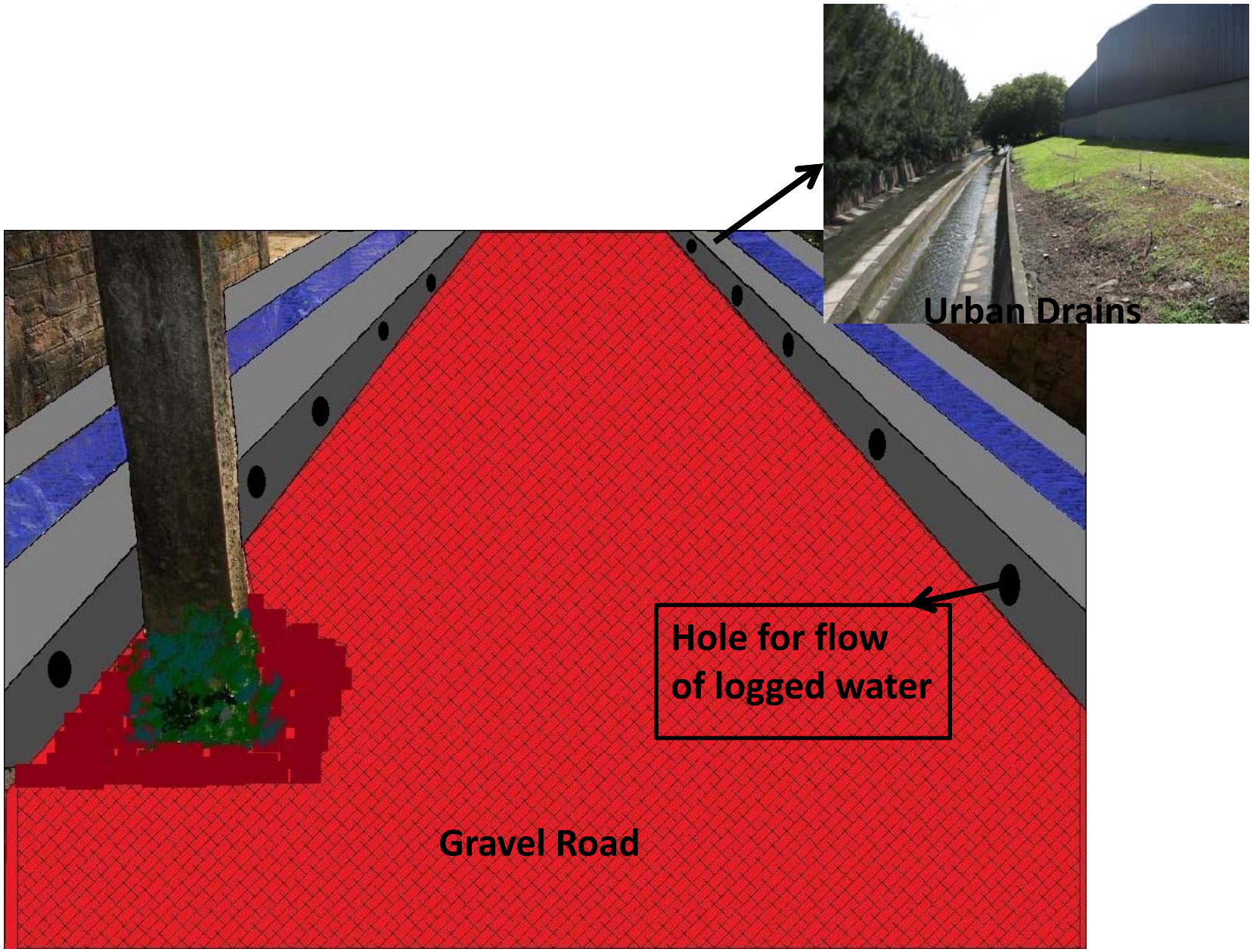
Grass Covering on
Flat ground




Geosynthetics


Retaining Wall
Creepers
Gunny Bags
Gravel Road
Grass Covering




Urban Drains
Hole for flow
of logged water
Gravel Road


Thanks