4. SUBSOIL CONDITION, STRATIFICATION AND PROPERTIES

4.1. SUB-SOIL CONDITION:

The boring records showing the various soils met with are enclosed in the Appendix. These are prepared from field logs after proper modifications in the light of the laboratory test results and observation of disturbed and penetrometer soil samples. The results of the Standard Penetration Tests are given as 'N' values in these boring records. The sub-soil profiles (as obtained from field and Laboratory test results) across the bore holes are shown under Figs. 2.01 to 2.28 giving description, consistency and colour of each strata. The "N" values are shown in the profiles as well as presented in the borelogs. The laboratory test results and the back up sheets are also presented there.

4.2. SUB-SOIL STRATIFICATION:

The subsoil is characterised by a layer of filled up soil at top followed by loose to medium dense, clayey silty sand. Below these, very dense, silty sand / sandy silt layer was found. After that weathered rock layer is struck and that continues upto the terminating depth of all the boreholes. However, stiff and very stiff to hard, silty clay layers have also been observed at few borehole locations. The description of each layer is presented below.

4.2.1. Fill:

The filled up soil found at top consists of reddish brown to blackish grey / brownish grey, silty sand / sandy silt to silty clay with coal dust, brick bats, kankar, gravel, roots of vegetation etc.

Bulk Density, gms/cc	1.39	Natural Water Content %	32
Dry Density, gms/cc	1.50	Specific gravity	2.41
TRSH-UU:		Void Ratio	0.388
Cohesion kg/sqcm	0.07		
Friction angle °	24°	**GRAIN SIZE**	
DRSH-CU:		Sand %	29
Cohesion kg/sqcm	0.04	Silt %	68
Friction angle °	29°	Clay %	03

4.2.2. STRATUM - I:

The soil in this layer is characterized by loose to medium dense, yellowish brown / reddish brown to brownish grey / whitish grey, silty sand. Clay binder, kankar & decomposed rock fragments have been observed in this layer. Routine laboratory tests conducted on the "UDS" and “SPT” samples that could be collected from this layer show the following average properties.

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 16/03/2020	Sheet No:

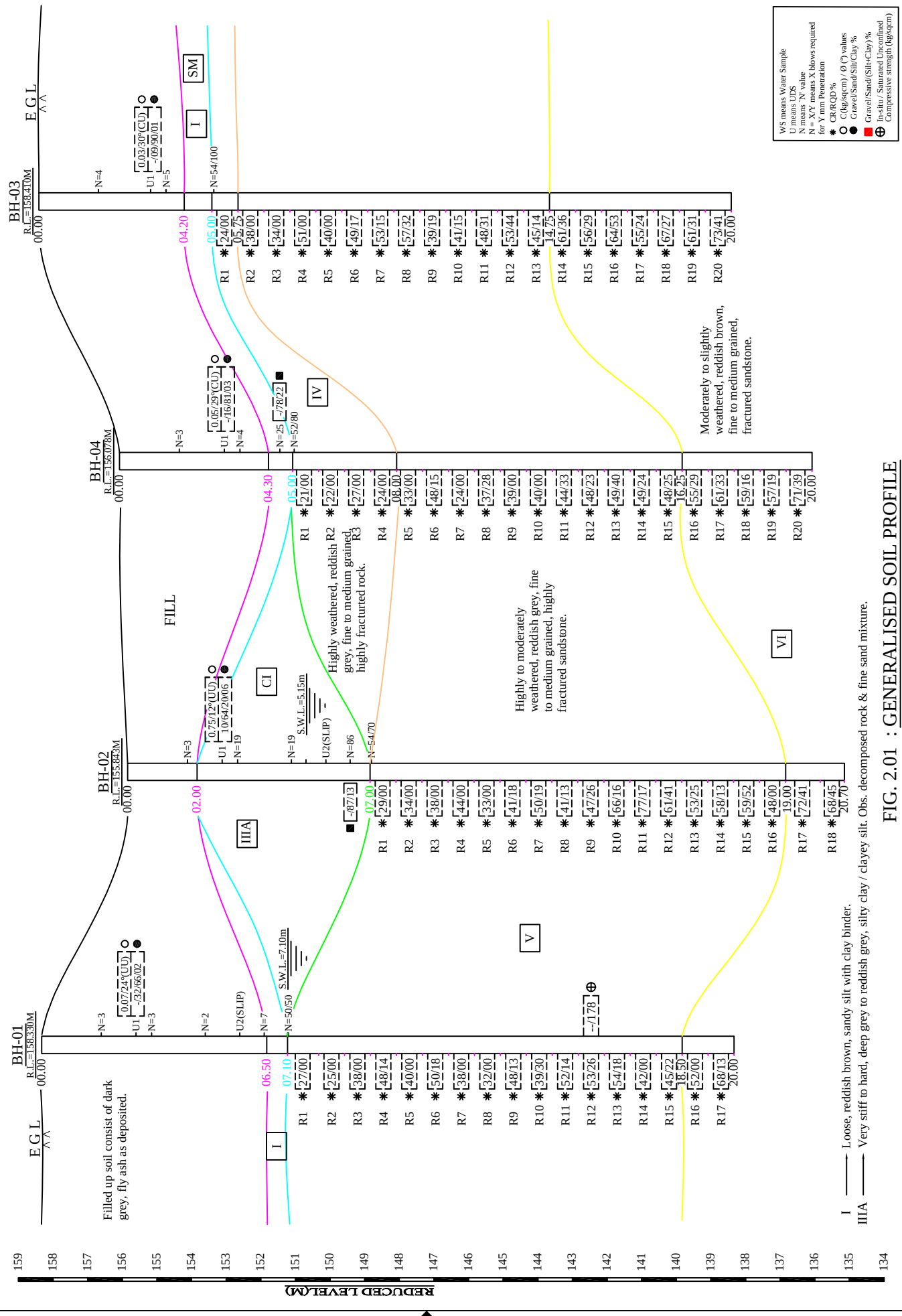


FIG. 2.01 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 17/03/2020	Sheet No:

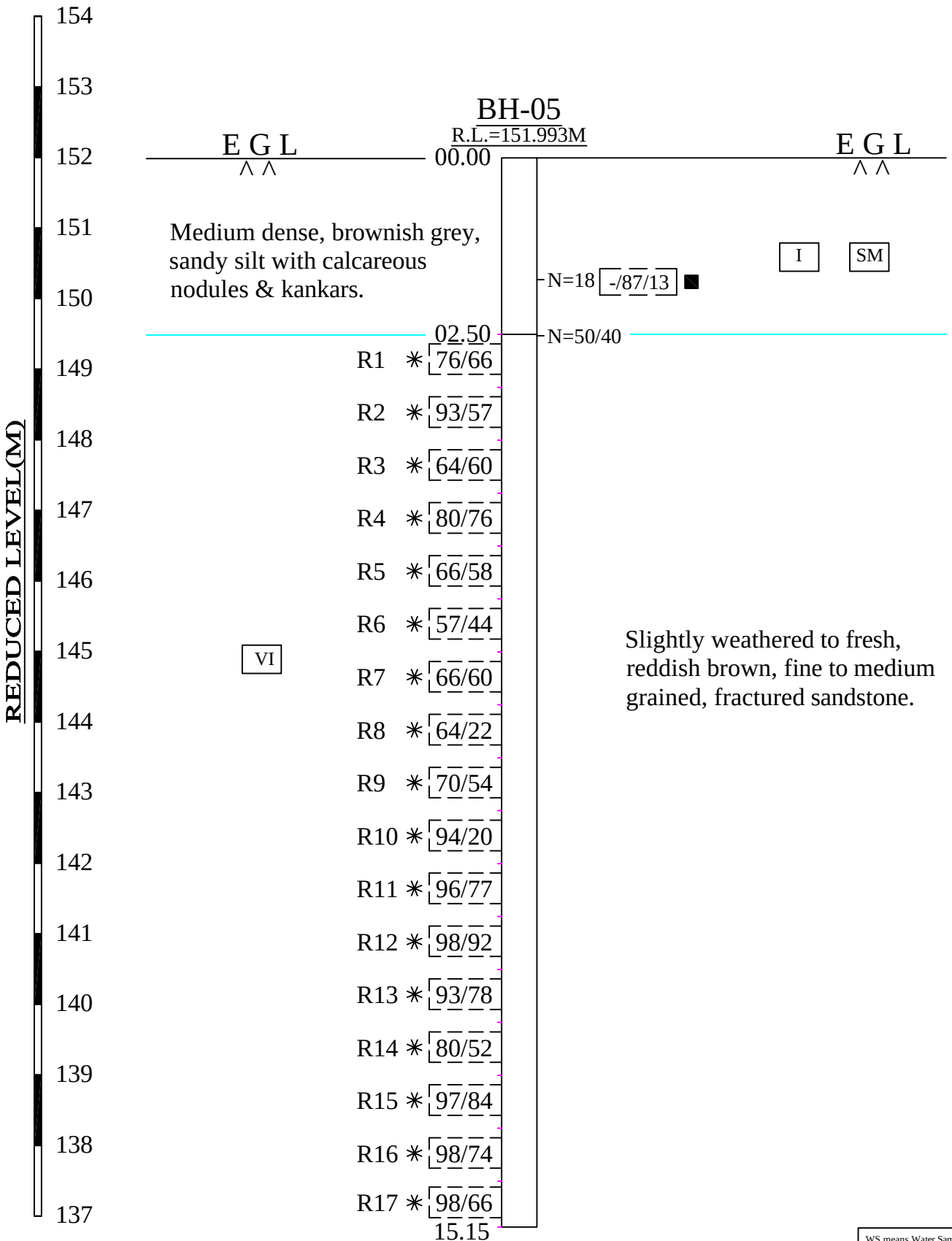


FIG. 2.02 : SUB - SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 17/03/2020	Sheet No:

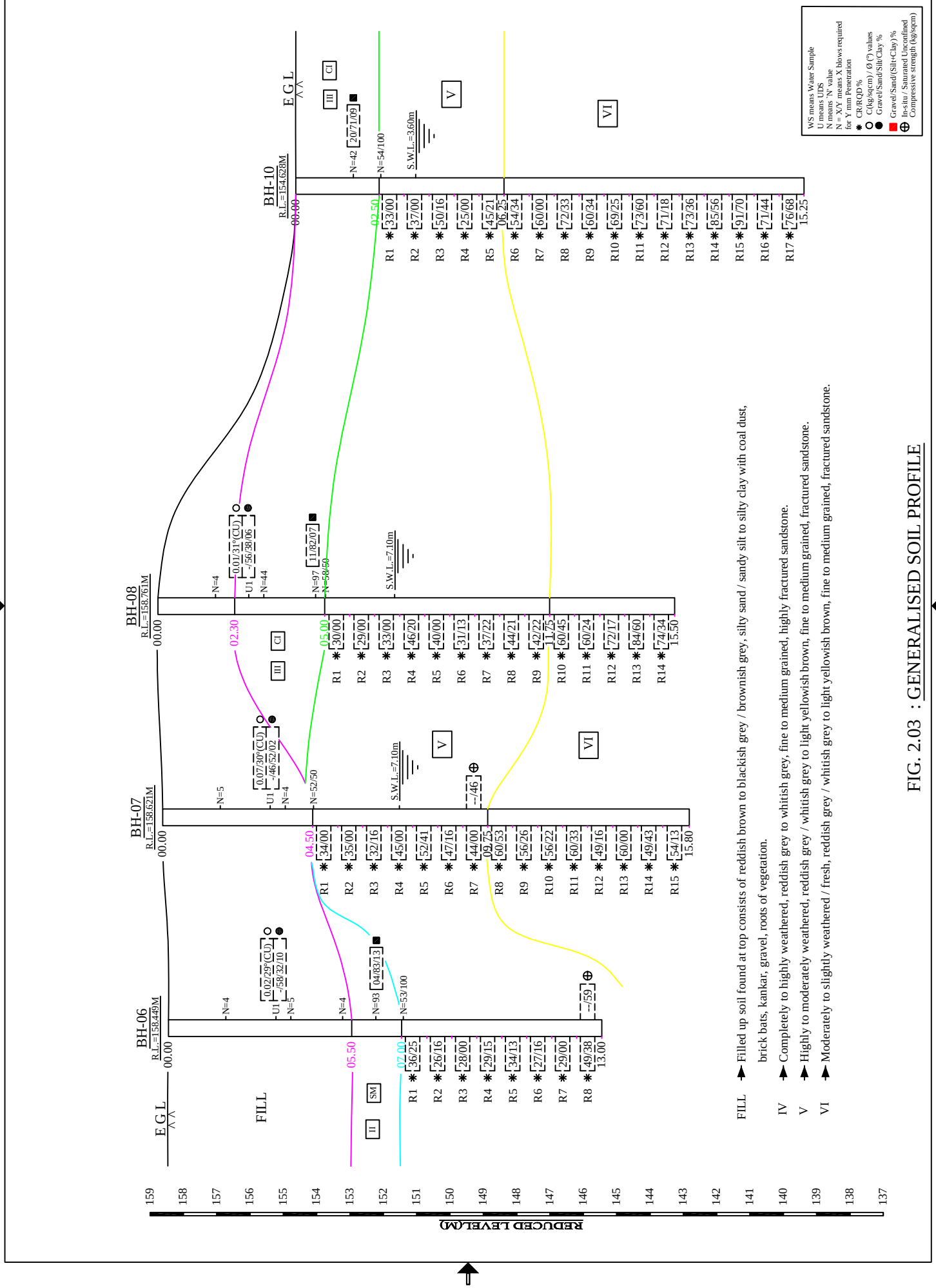


FIG. 2.03 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 17/03/2020	Sheet No:

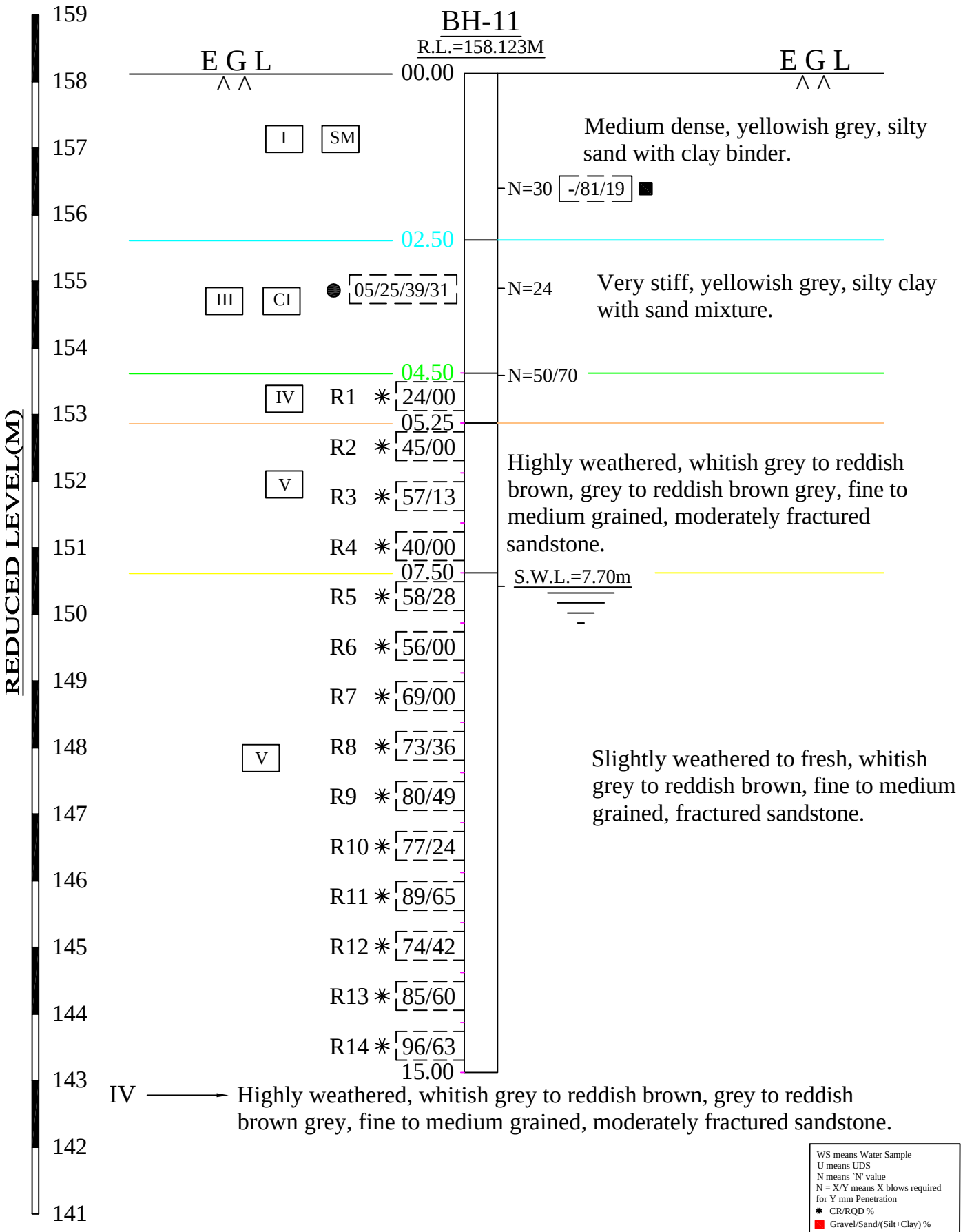


FIG. 2.04 : SUB - SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 17/03/2020	Sheet No:

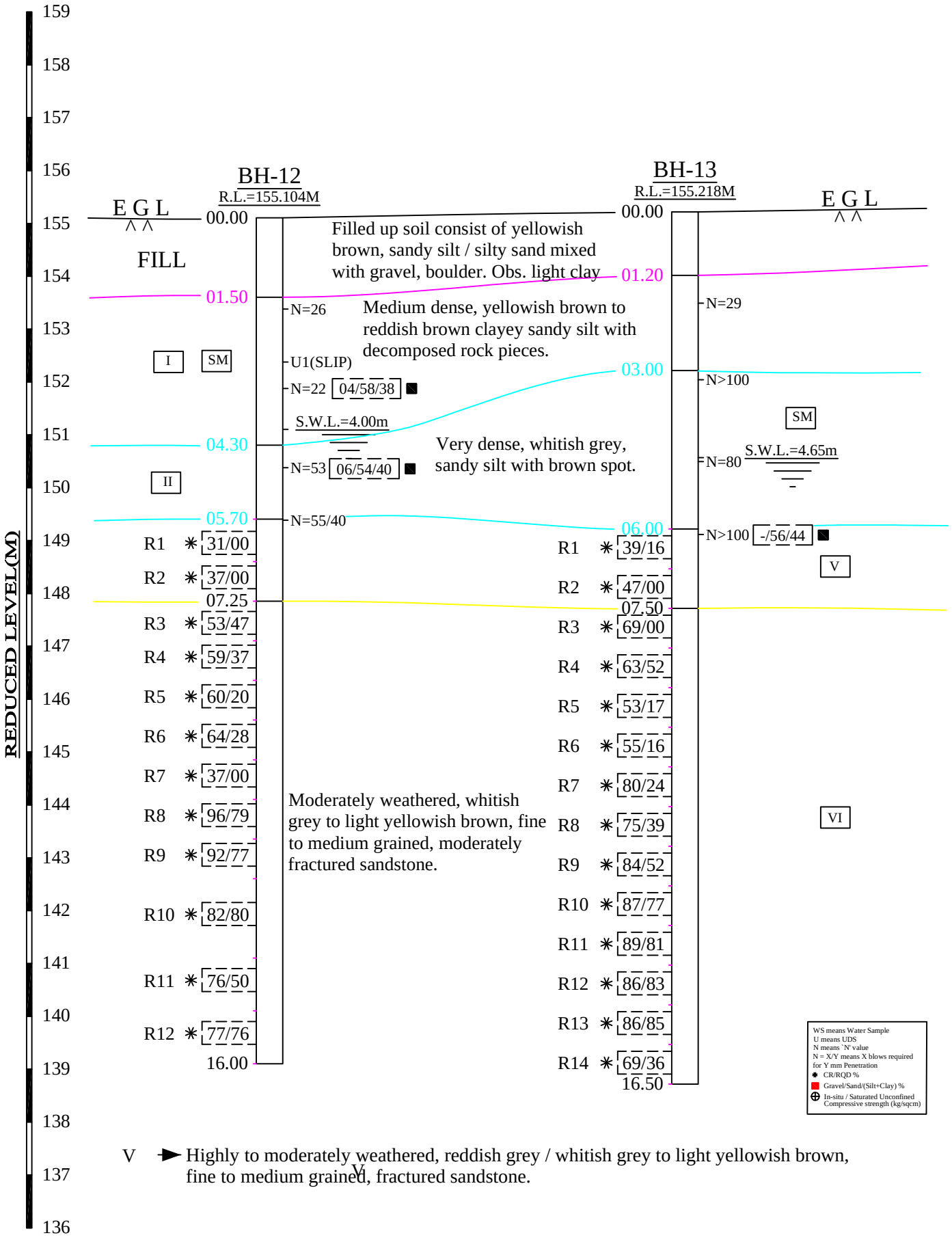


FIG. 2.05 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 17/03/2020	Sheet No:

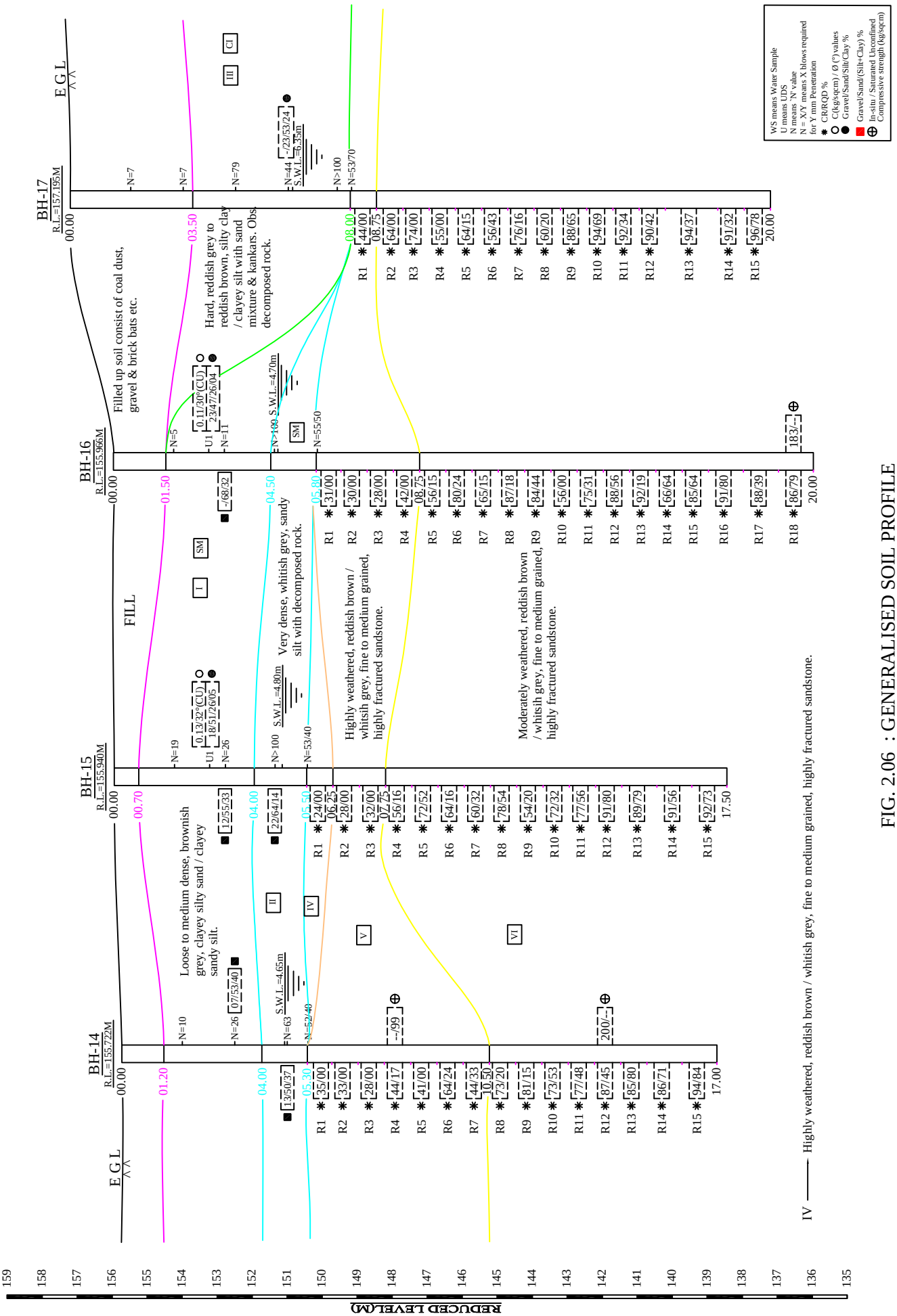


FIG. 2.06 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 18/03/2020	Sheet No:

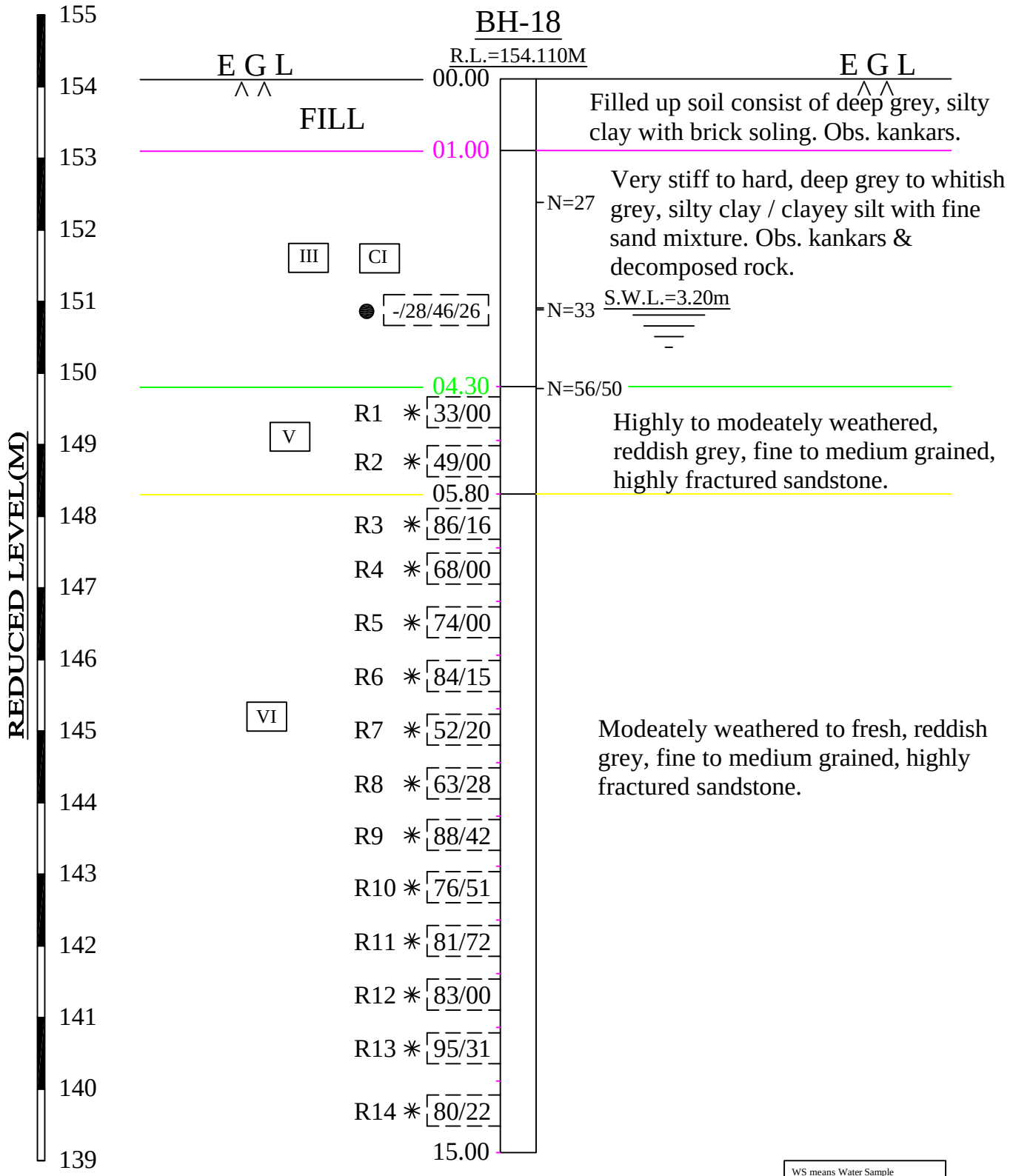
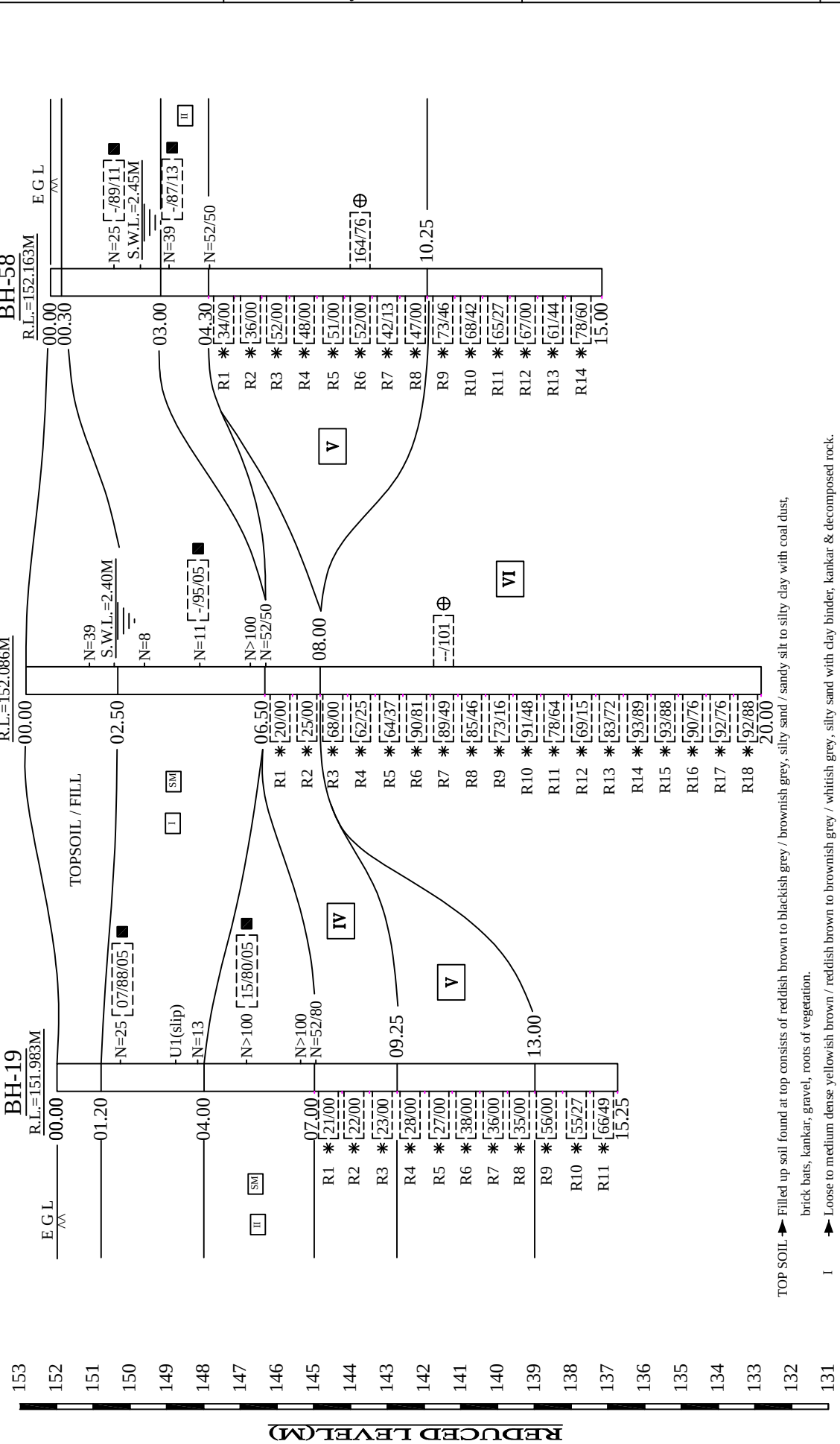


FIG. 2.07 : SUB - SOIL PROFILE



TOP SOIL → Filled up soil found at top consists of reddish brown to blackish grey / brownish grey, silty sand / sandy silt to silty clay with coal dust, brick bats, kankar, gravel, roots of vegetation.

I → Loose to medium dense yellowish brown / reddish brown to brownish grey / whitish grey, silty sand with clay binder, kankar & decomposed rock.

II → Dense to very dense yellowish brown / reddish brown to whitish grey, silty sand / sandy silt with kankar & decomposed rock fragments.

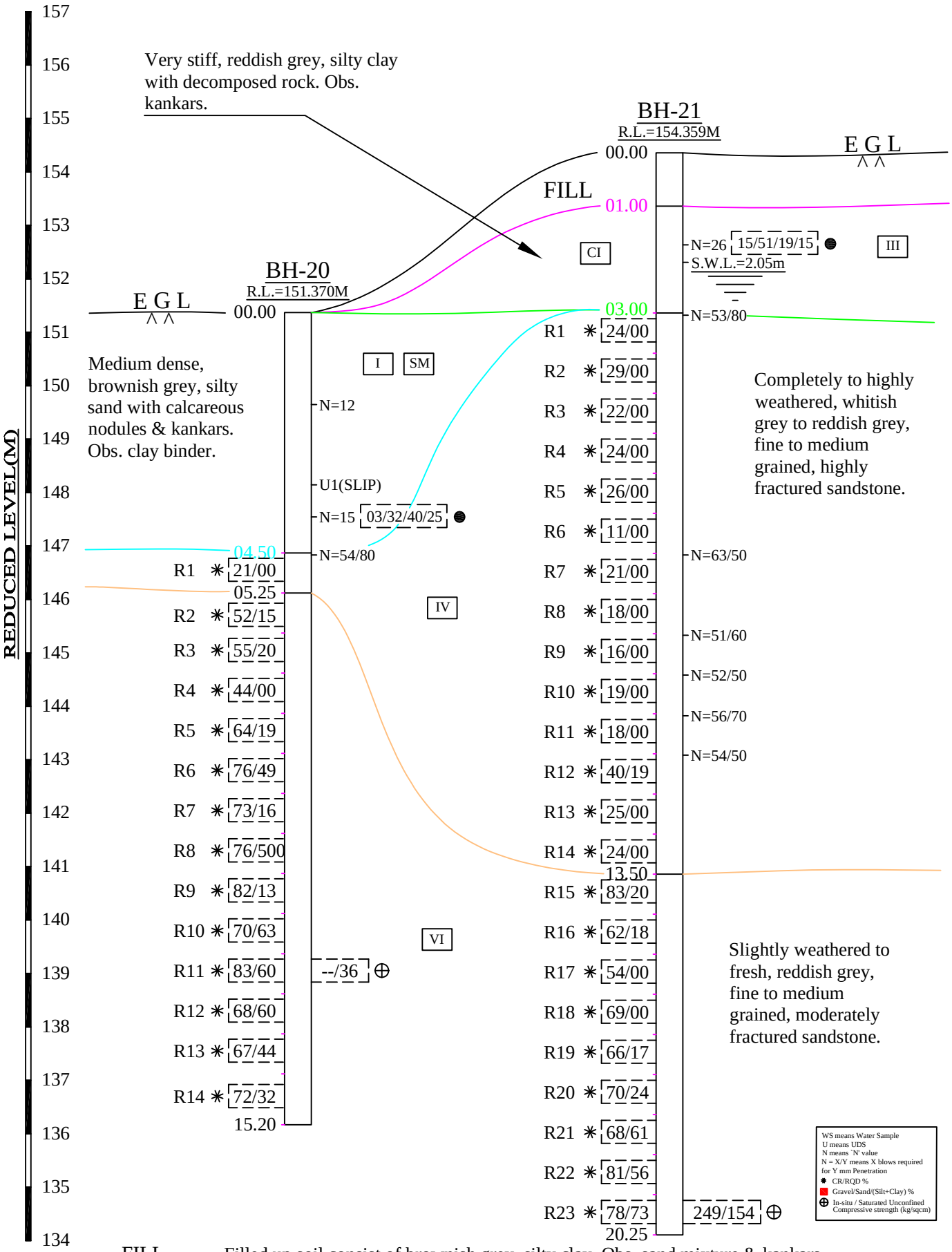
IV → Completely to highly weathered, reddish grey to whitish grey, fine to medium grained, highly fractured sandstone.

V → Highly to moderately weathered, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.

VI → Moderately to slightly weathered / fresh, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.

FIG. 2.08 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 18/03/2020	Sheet No:



FILL ⟶ Filled up soil consist of brownish grey, silty clay. Obs. sand mixture & kankars.

FIG. 2.09 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 18/03/2020	Sheet No:

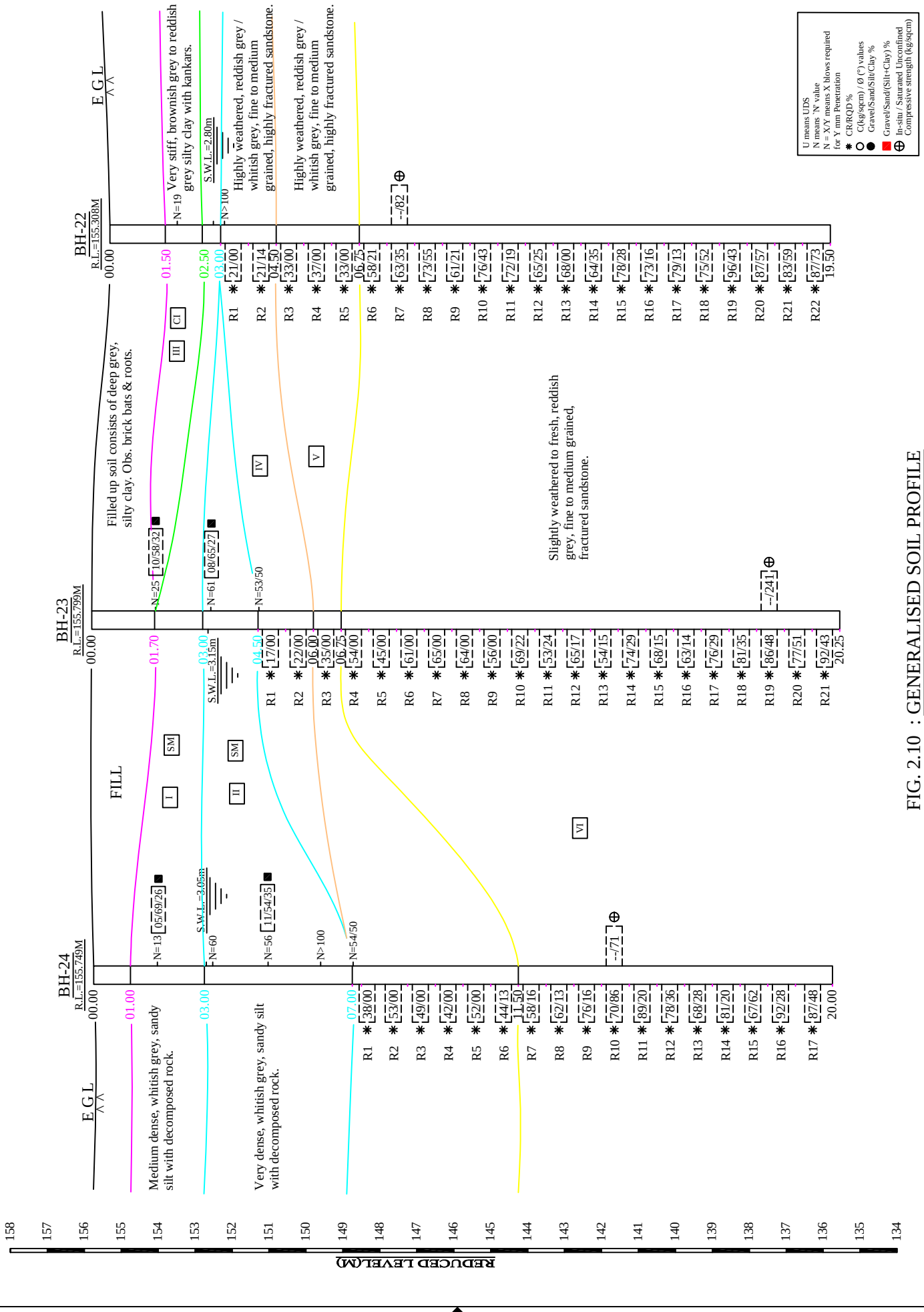


FIG. 2.10 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 18/03/2020	Sheet No:

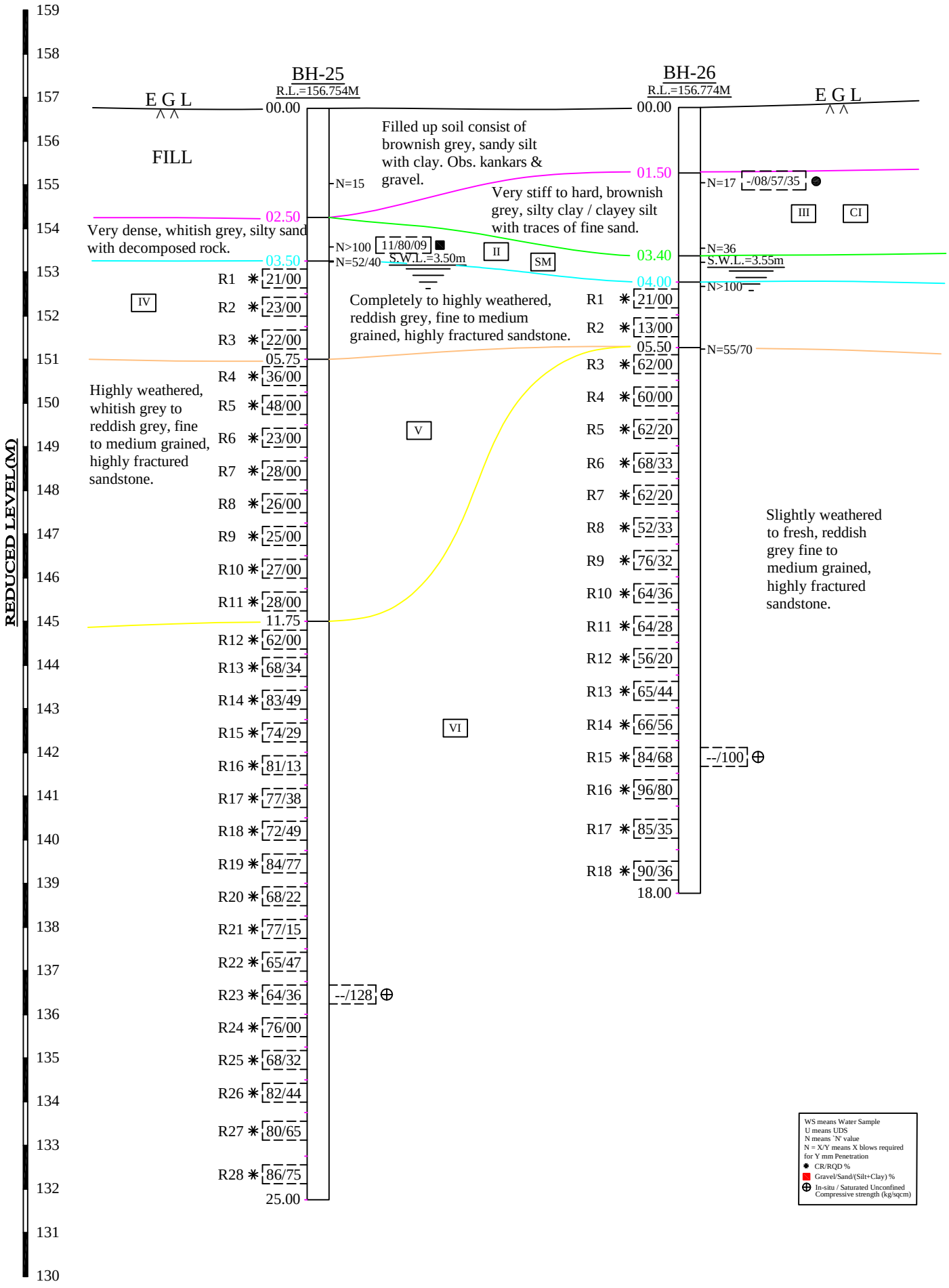


FIG. 2.11 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 18/03/2020	Sheet No:

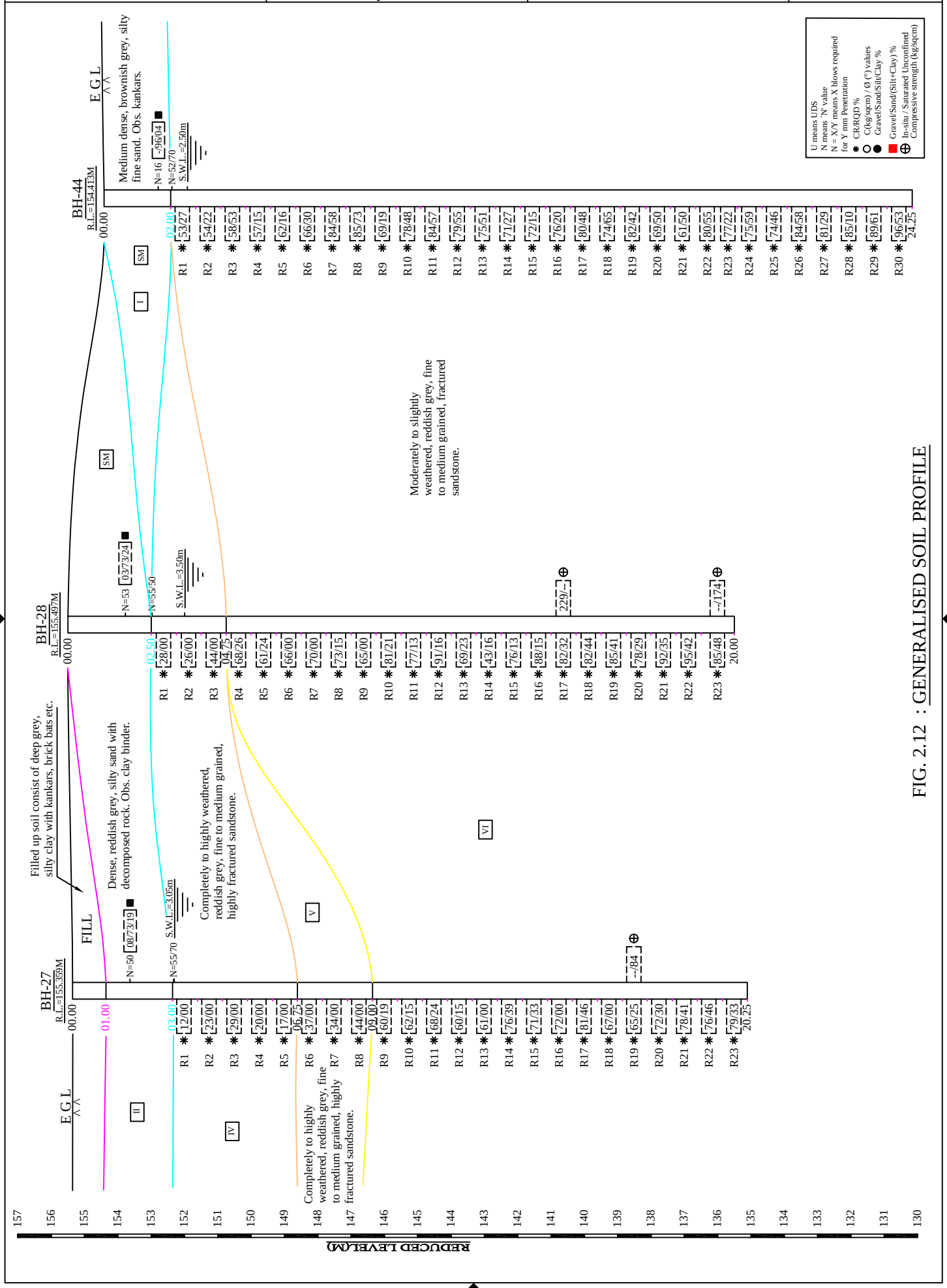
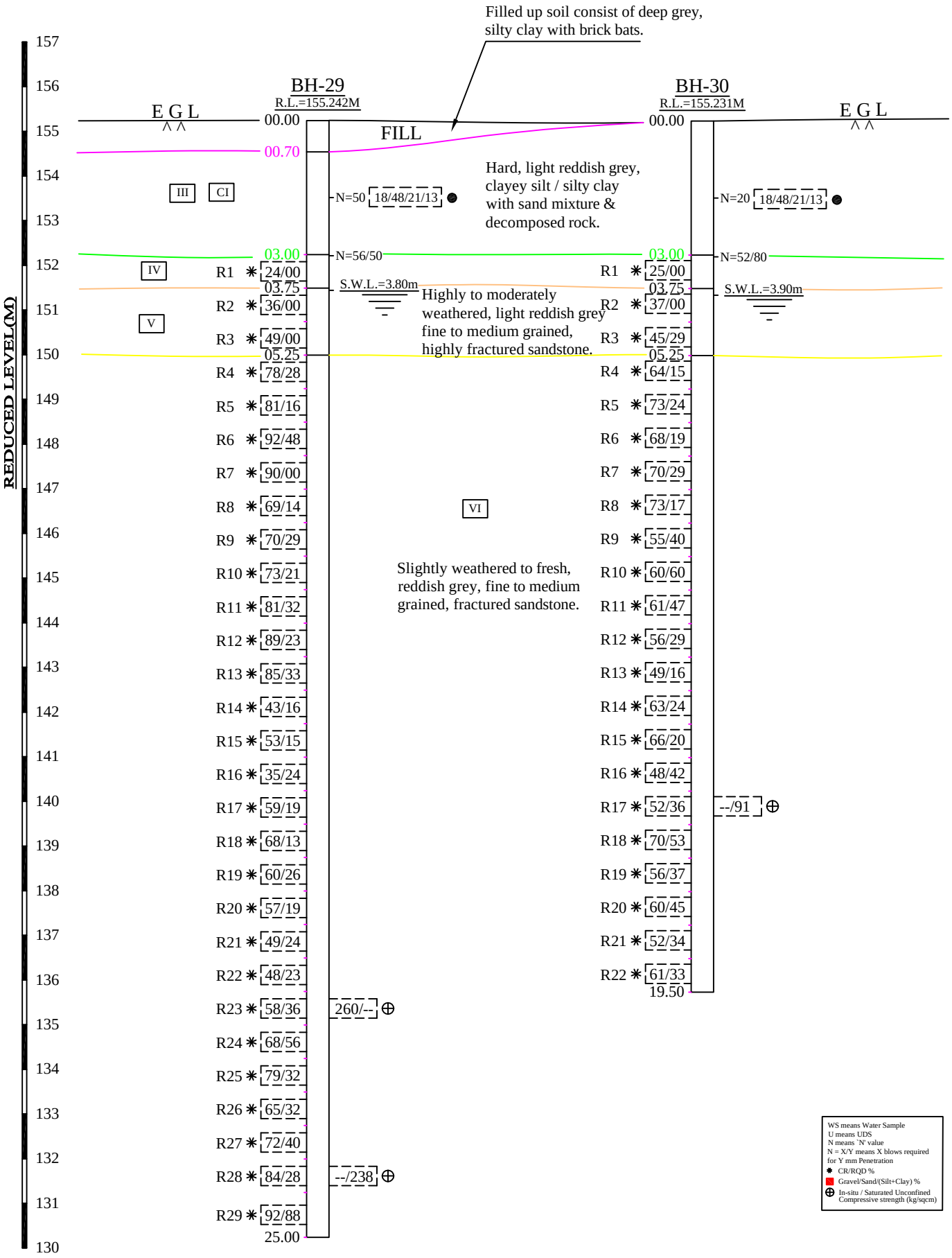


FIG. 2.12 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 19/03/2020	Sheet No:



IV ——→ Highly weathered, light reddish grey fine to medium grained, highly fractured sandstone.

FIG. 2.13 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 19/03/2020	Sheet No:

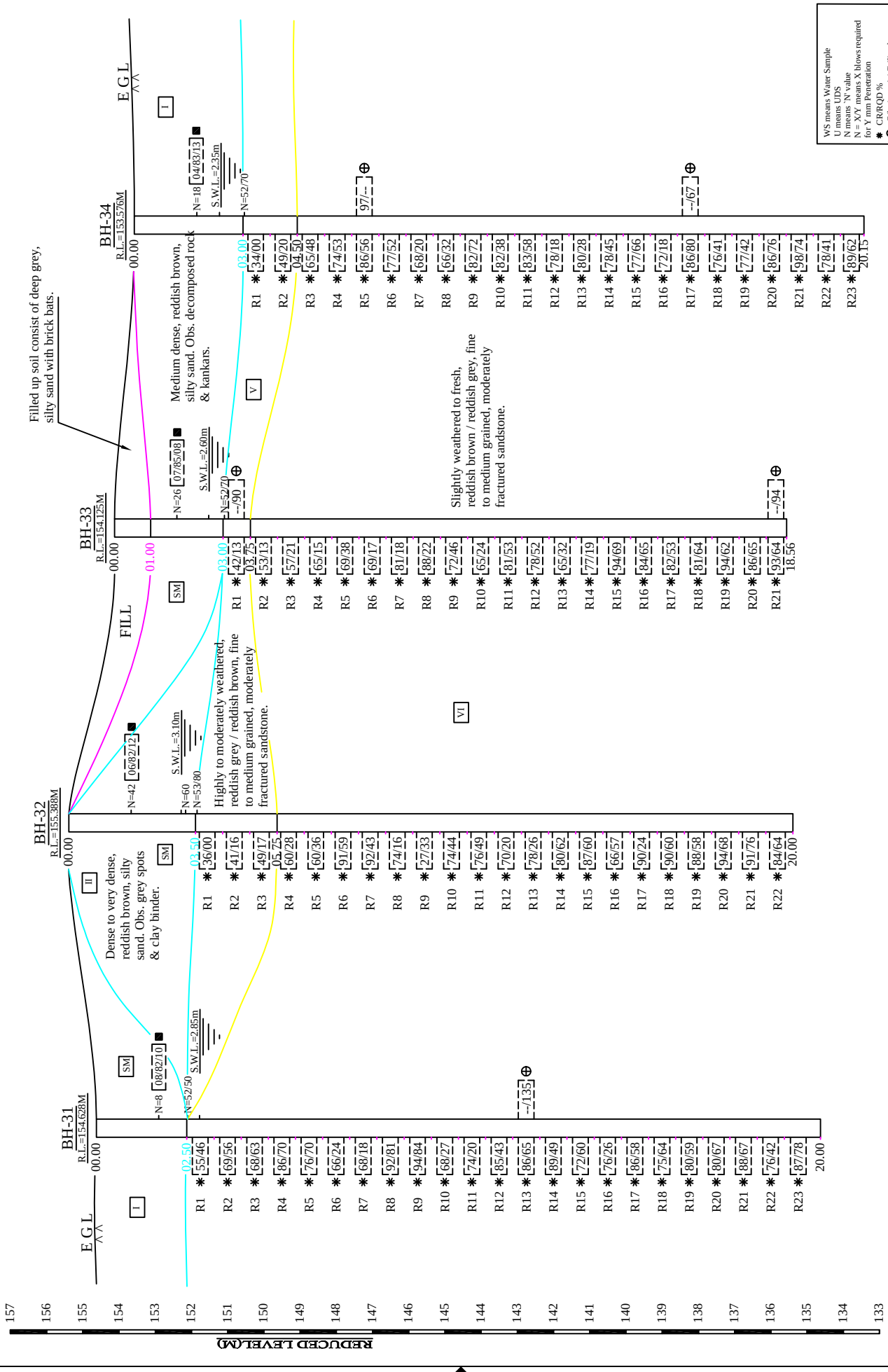


FIG. 2.14 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 19/03/2020	Sheet No:

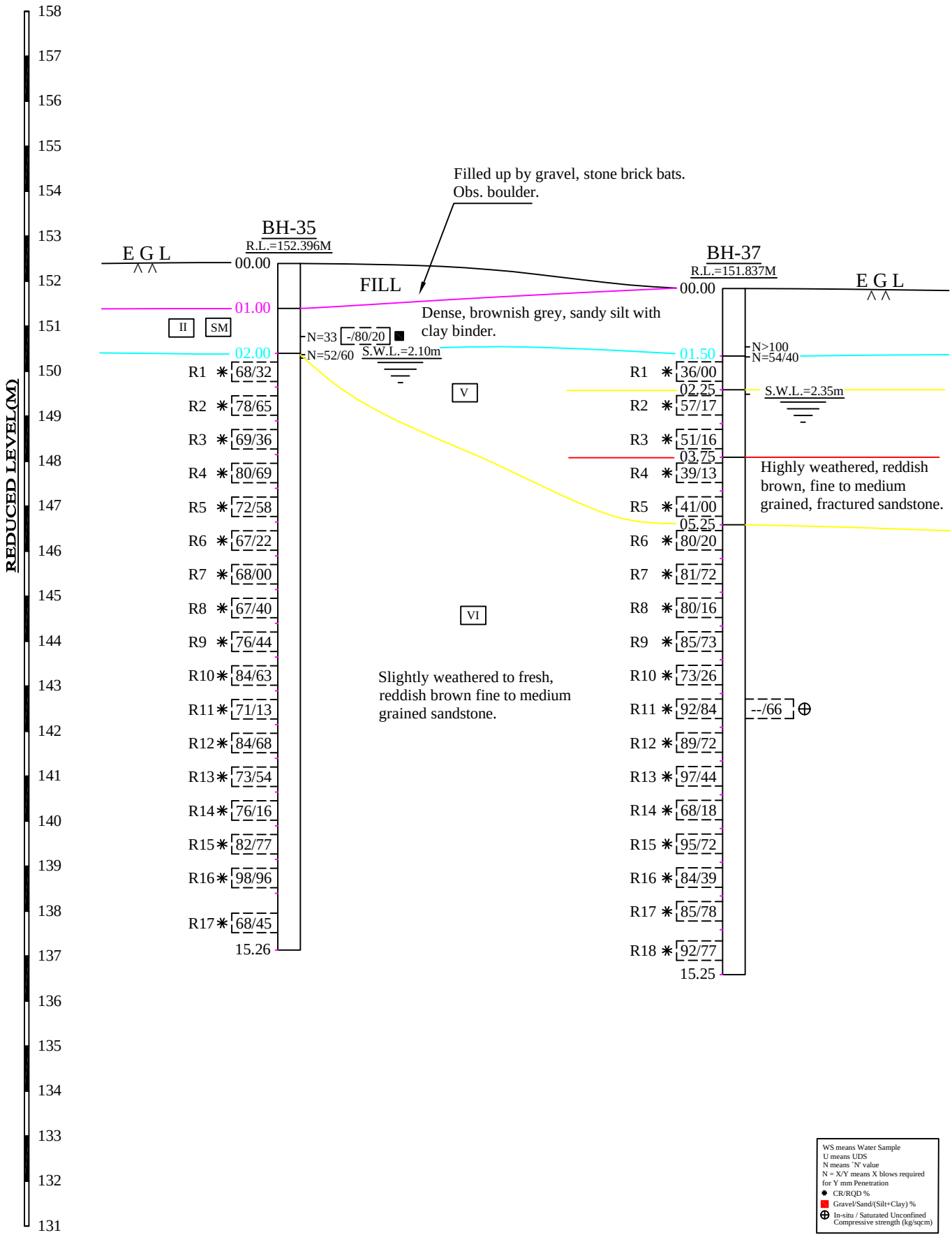


FIG. 2.15 : GENERALISED SOIL PROFILE

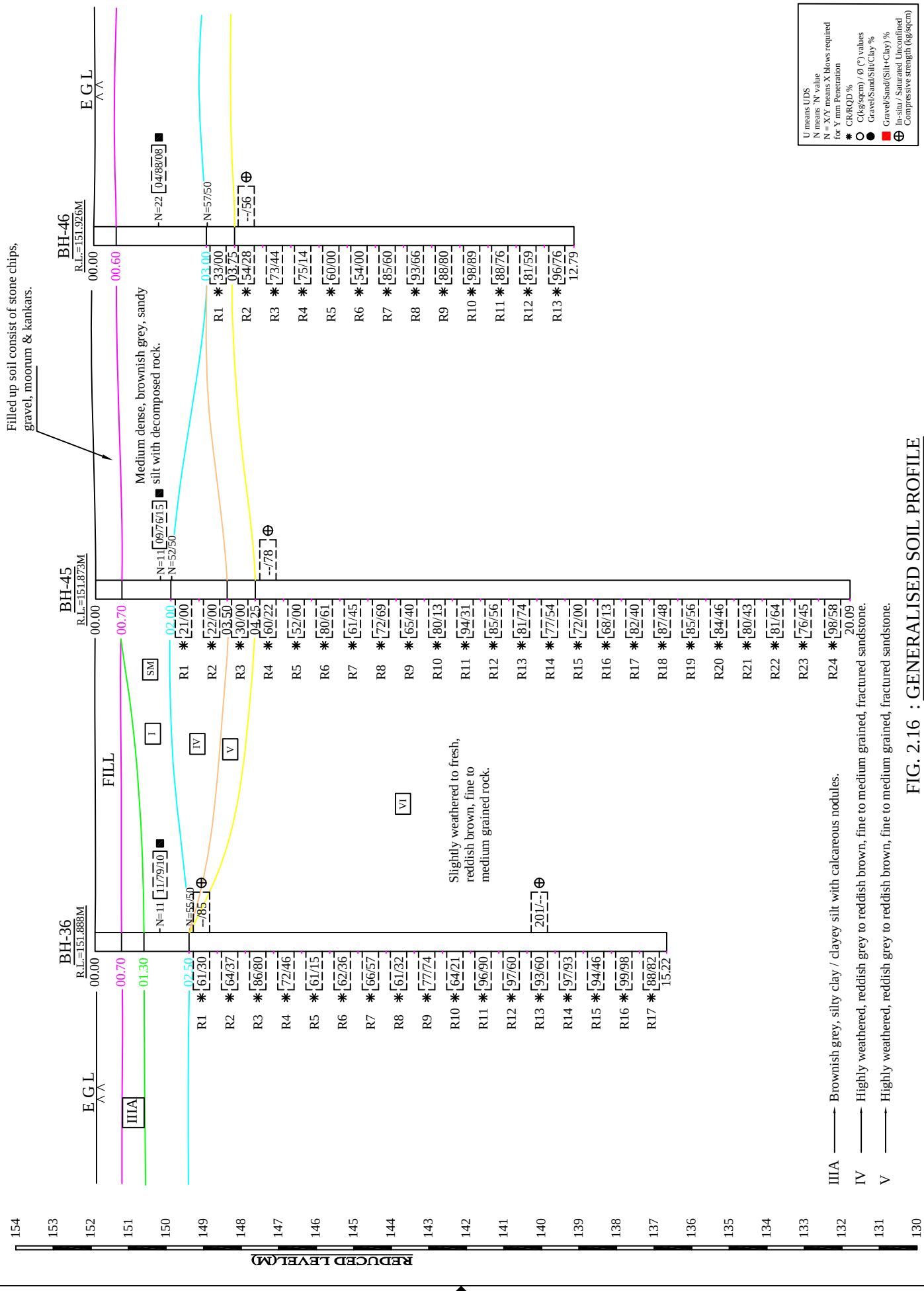


FIG. 2.16 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 20/03/2020	Sheet No:

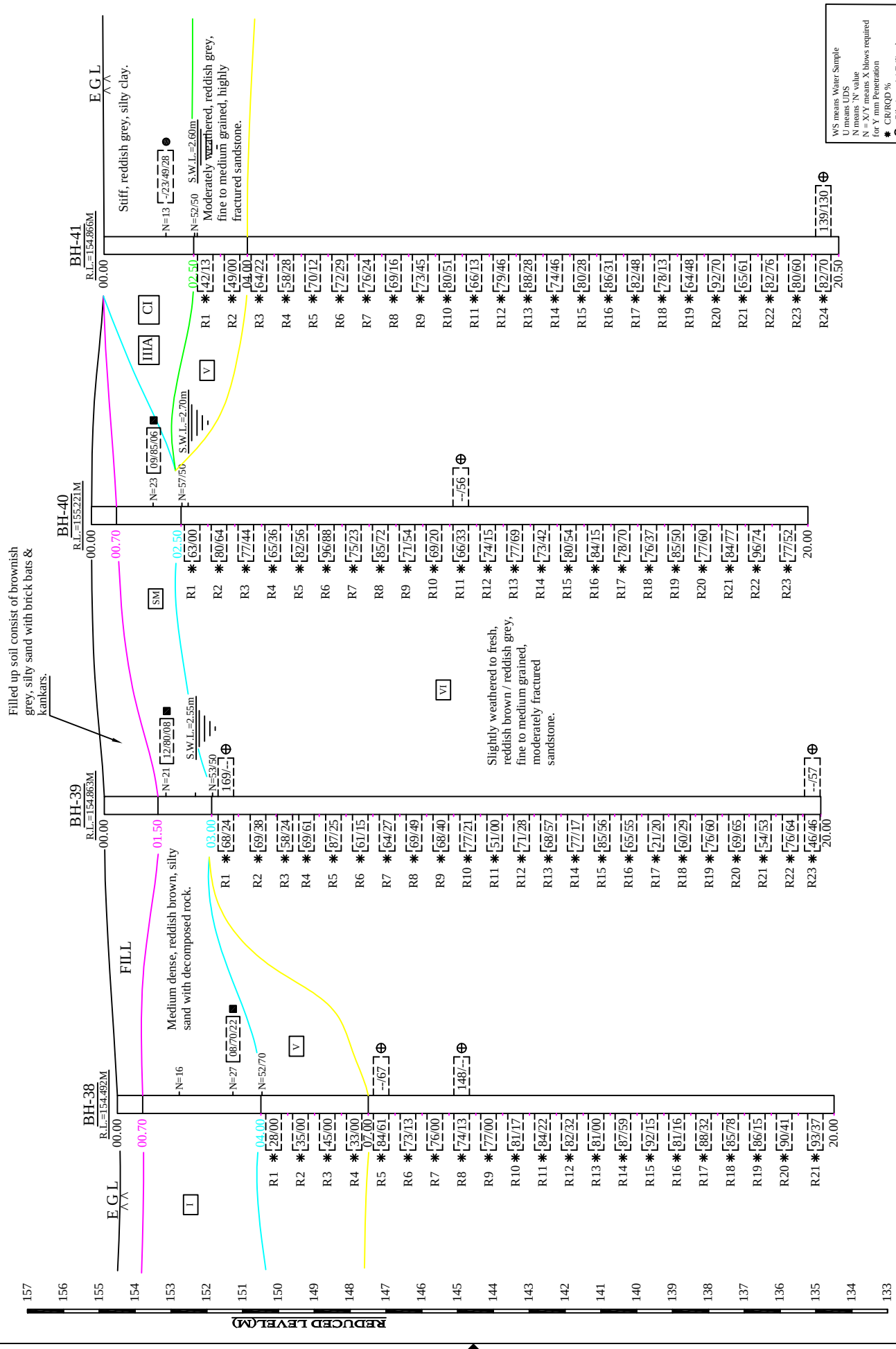


FIG. 2.17 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 20/03/2020	Sheet No:

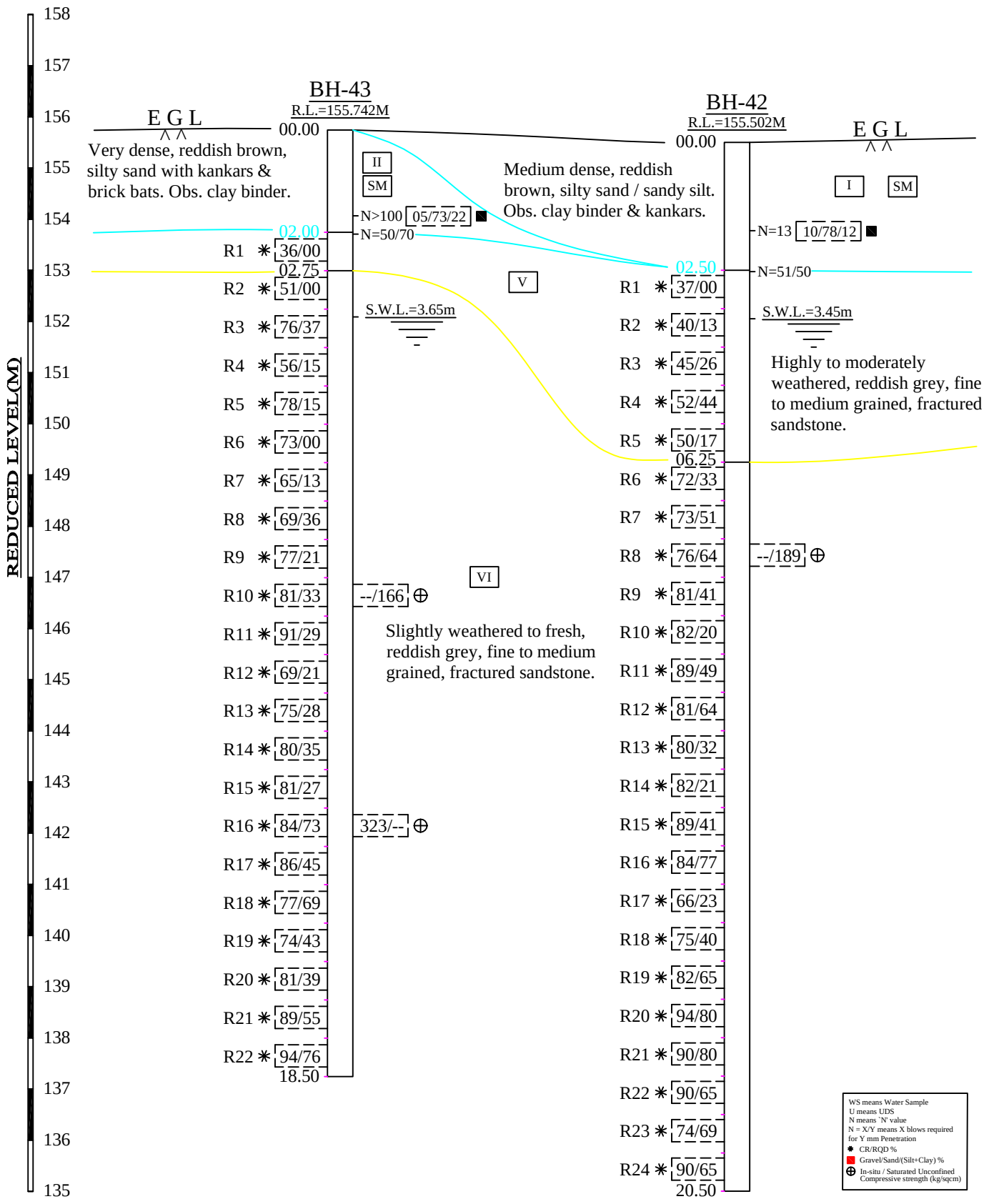


FIG. 2.18 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 20/03/2020	Sheet No:

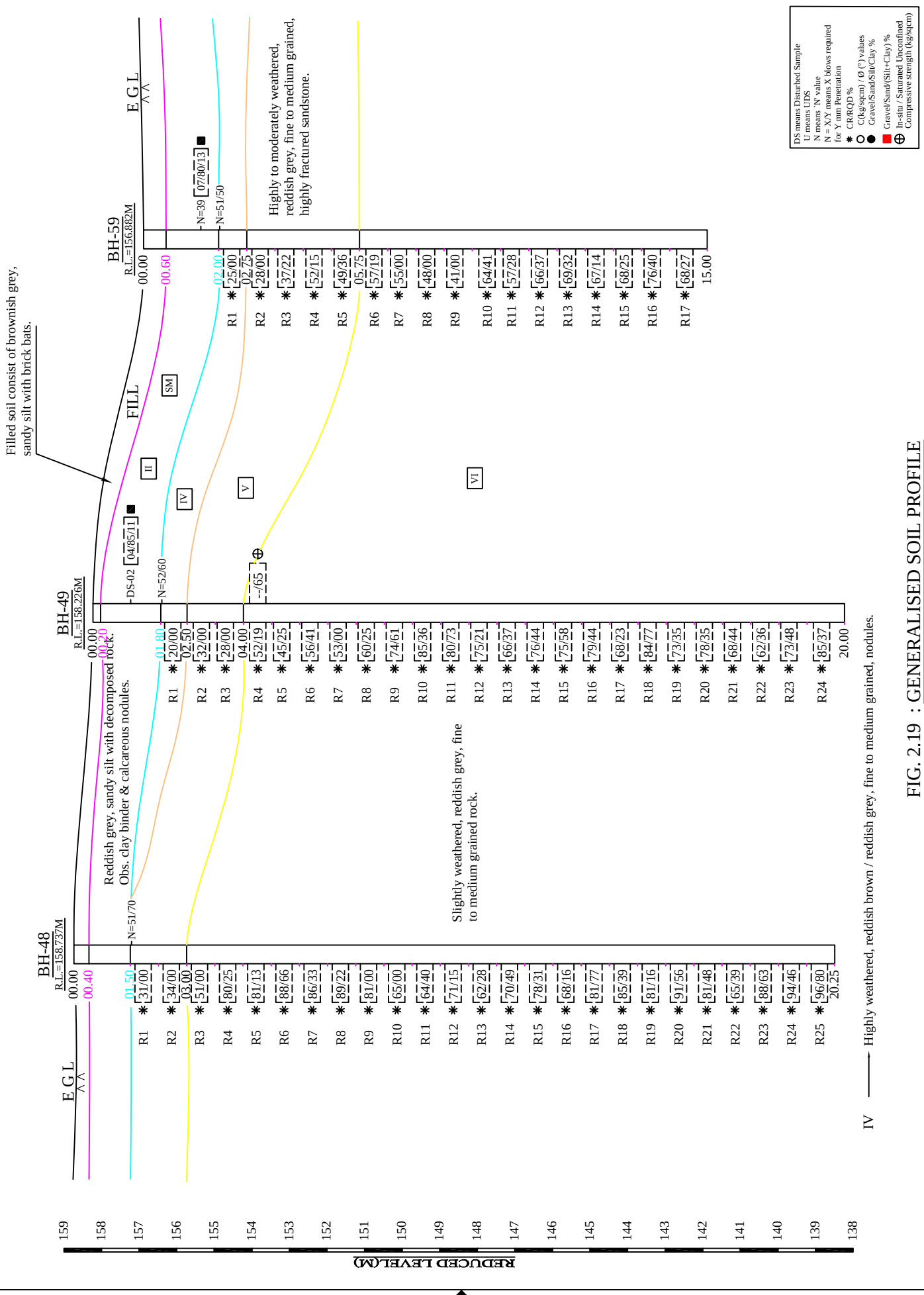
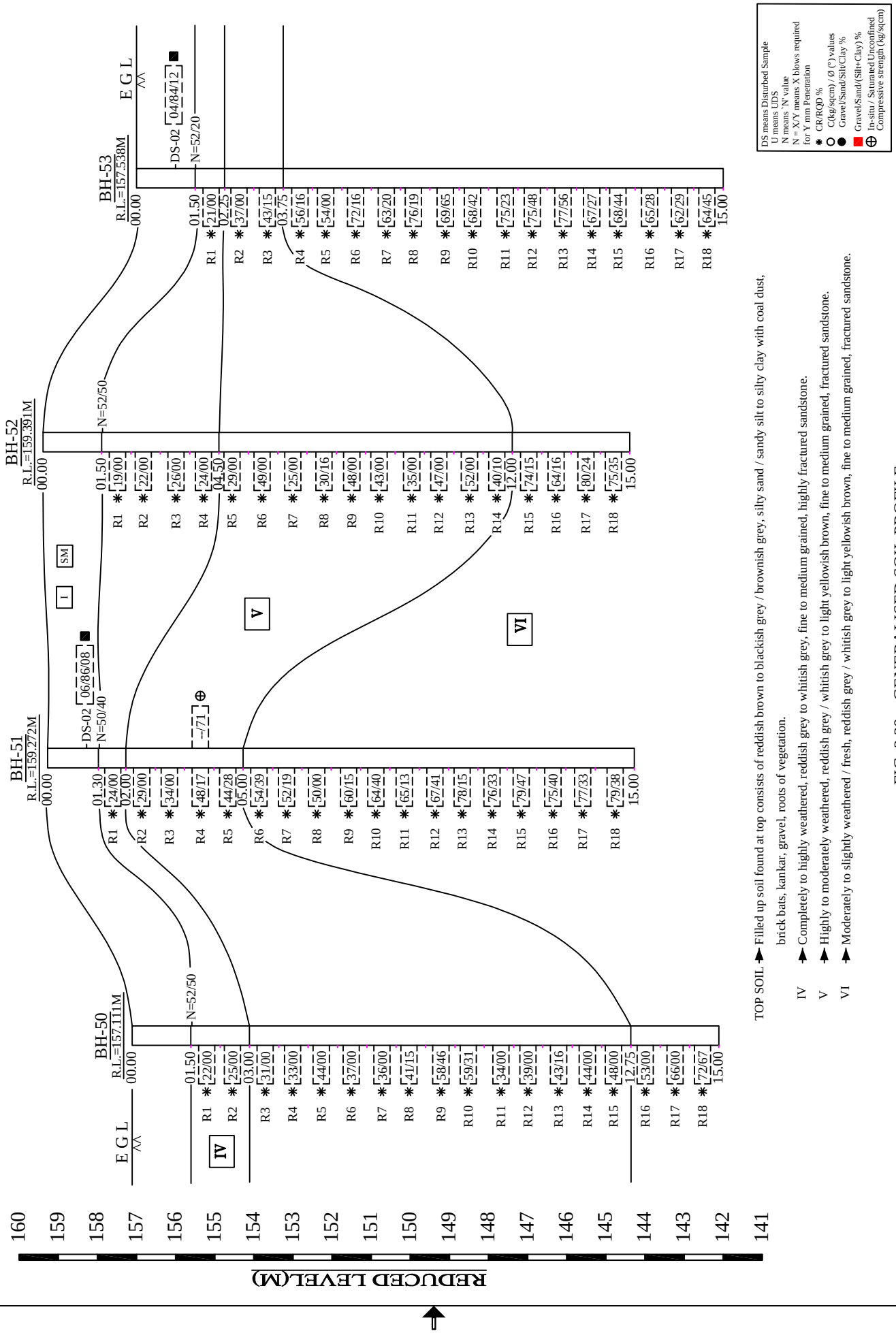


FIG. 2.19 : GENERALISED SOIL PROFILE



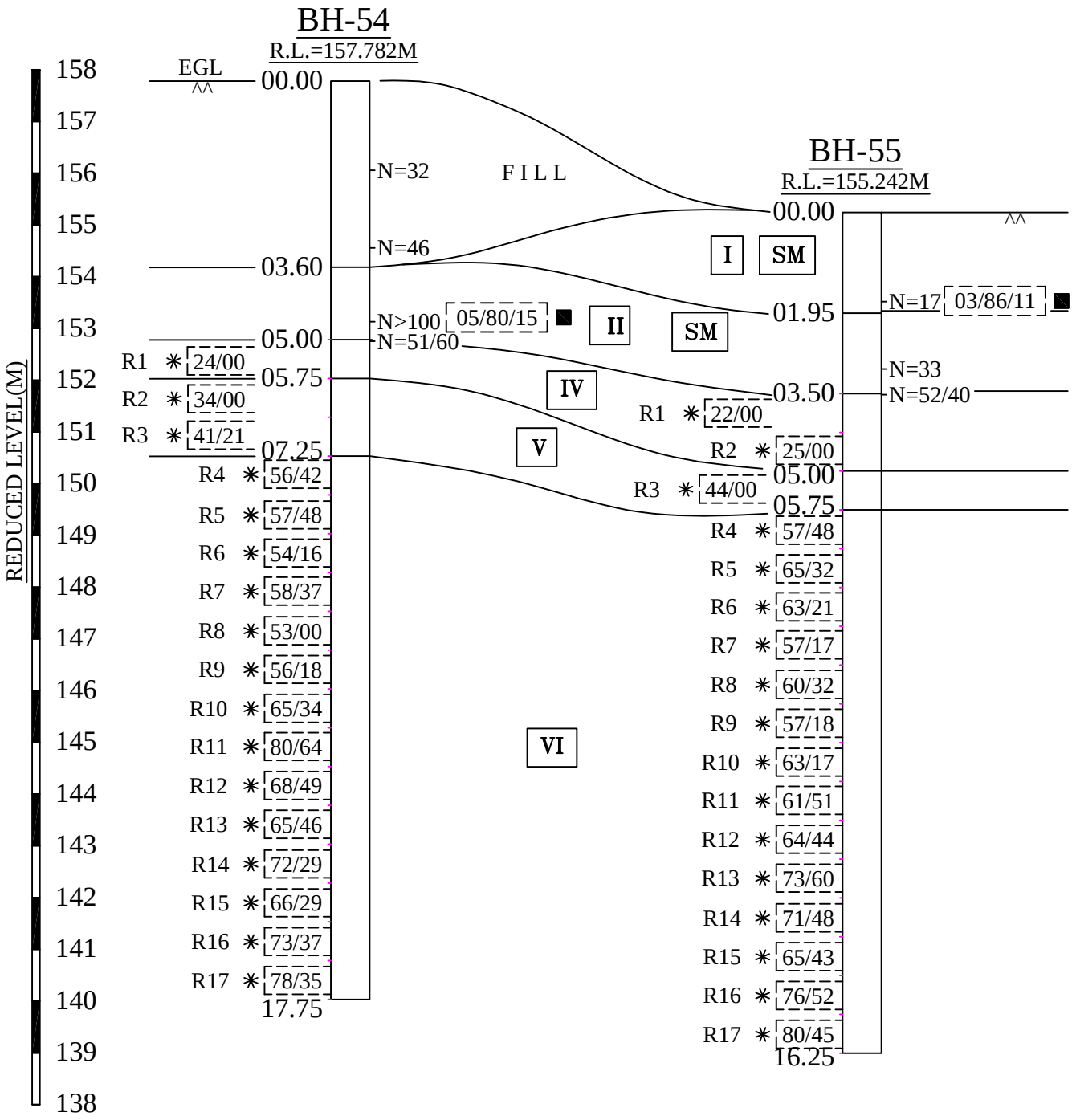
IV → Filled up soil found at top consists of reddish brown to blackish grey / brownish grey, silty sand / sandy silt to silty clay with coal dust, brick bats, kankar, gravel, roots of vegetation.

V → Completely to highly weathered, reddish grey to whitish grey, fine to medium grained, highly fractured sandstone.

VI → Highly to moderately weathered, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.

→ Moderately to slightly weathered / fresh, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.

FIG. 2.20 : GENERALISED SOIL PROFILE



FILL / TOP SOIL ➔ Filled up soil found at top consists of reddish brown to blackish grey / brownish grey, silty sand / sandy silt to silty clay with coal dust, brick bats, kankar, gravel, roots of vegetation.

I ➔ **Loose to medium dense yellowish brown / reddish brown to brownish grey / whitish grey, silty sand with clay binder, kankar & decomposed rock.**

II ➔ **Dense to very dense yellowish brown / reddish brown to whitish grey, silty sand / sandy silt with kankar & decomposed rock fragments.**

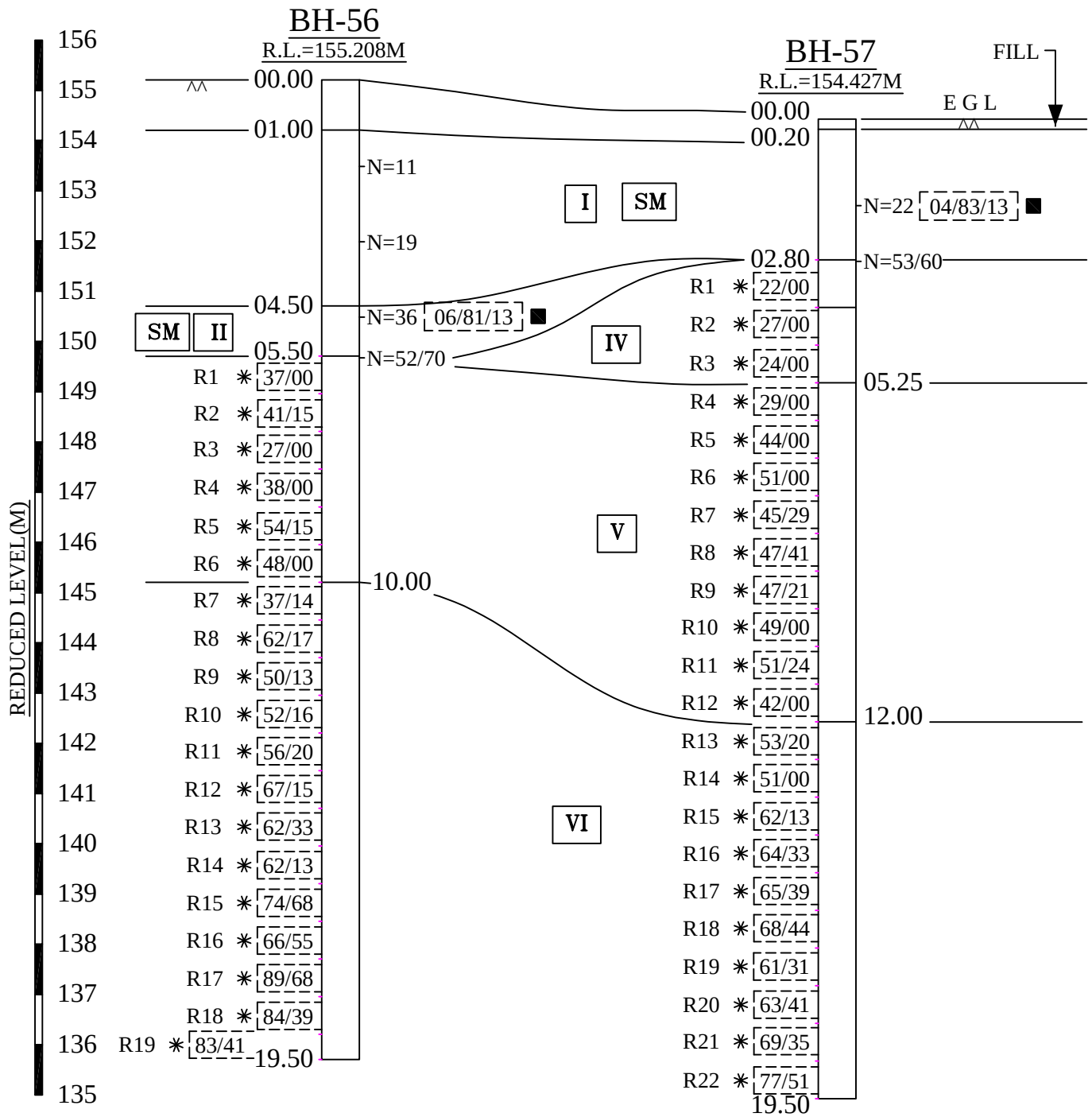
IV ➔ Completely to highly weathered, reddish grey to whitish grey, fine to medium grained, highly fractured sandstone.

V ➔ Highly to moderately weathered, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.

VI ➔ **Moderately to slightly weathered / fresh, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.**

FIG. 2.21 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 19/03/2020	Sheet No:



FILL / TOP SOIL → Filled up soil found at top consists of reddish brown to blackish grey / brownish grey, silty sand / sandy silt to silty clay with coal dust, brick bats, kankar, gravel, roots of vegetation.

I → **Loose to medium dense yellowish brown / reddish brown to brownish grey / whitish grey, silty sand with clay binder, kankar & decomposed rock.**

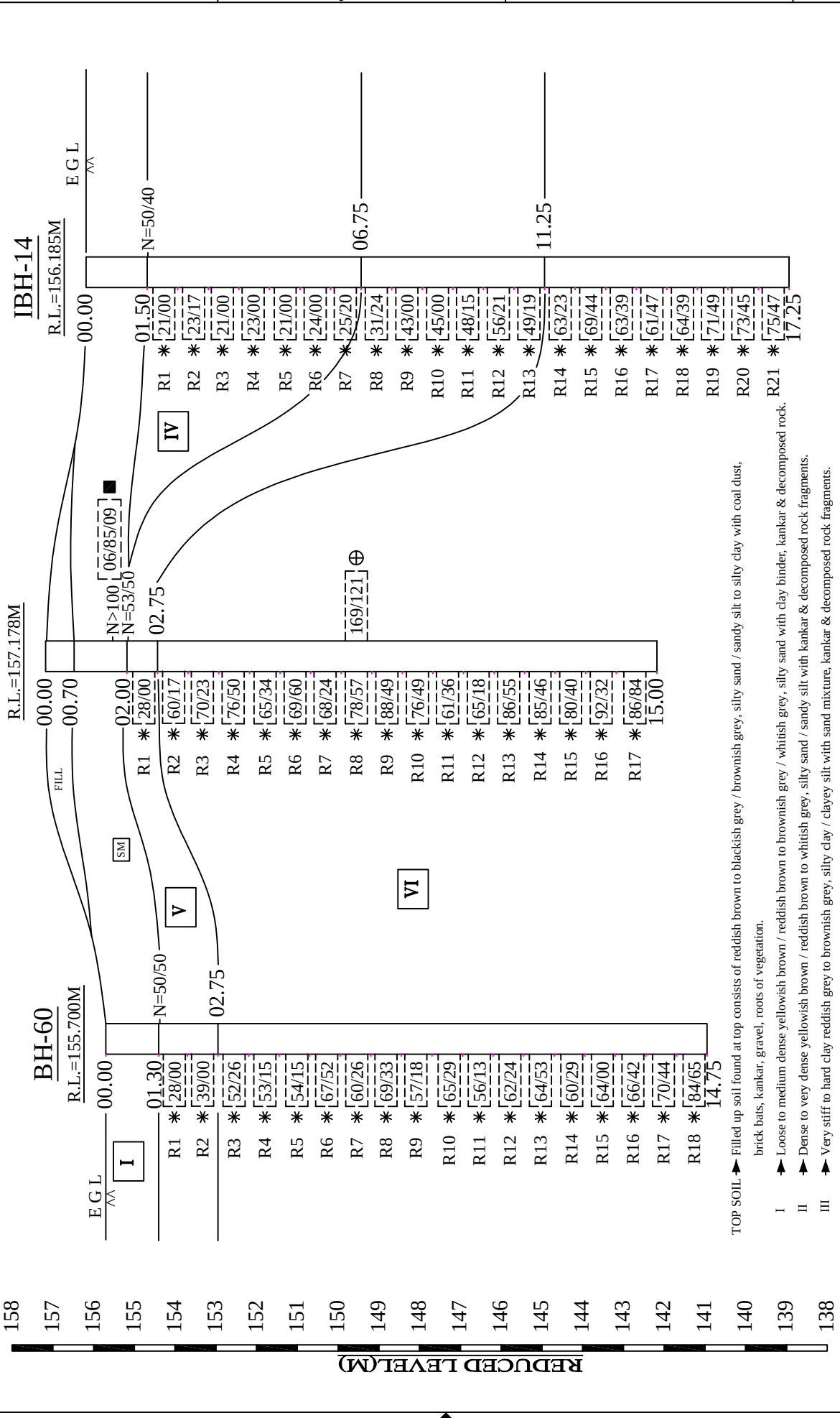
II → **Dense to very dense yellowish brown / reddish brown to whitish grey, silty sand / sandy silt with kankar & decomposed rock fragments.**

IV → Completely to highly weathered, reddish grey to whitish grey, fine to medium grained, highly fractured sandstone.

V → Highly to moderately weathered, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.

VI → **Moderately to slightly weathered / fresh, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.**

FIG. 2.22 : GENERALISED SOIL PROFILE



TOP SOIL → Filled up soil found at top consists of reddish brown to blackish grey / brownish grey, silty sand / sandy silt to silty clay with coal dust, brick bats, kankar, gravel, roots of vegetation.

I → Loose to medium dense yellowish brown / reddish brown to brownish grey / whitish grey, silty sand with clay binder, kankar & decomposed rock.

II → Dense to very dense yellowish brown / reddish brown to whitish grey, silty sand / sandy silt with kankar & decomposed rock fragments.

III → Very stiff to hard clay reddish grey to brownish grey, silty clay / clayey silt with sand mixture, kankar & decomposed rock fragments.

IV → Completely to highly weathered, reddish grey to whitish grey, fine to medium grained, highly fractured sandstone.

V → Highly to moderately weathered, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.

VI → Moderately to slightly weathered / fresh, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.

FIG. 2.23 : GENERALISED SOIL PROFILE

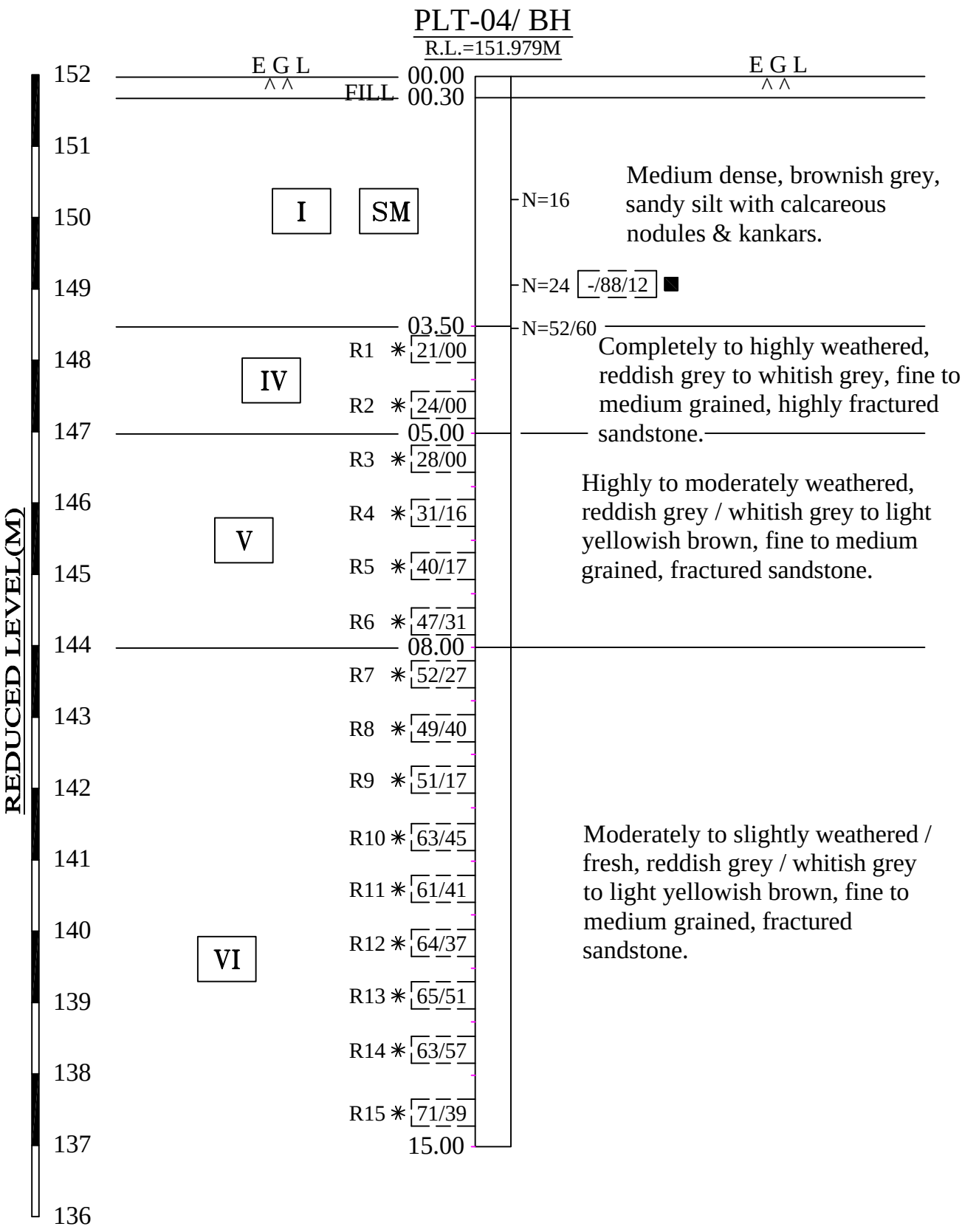
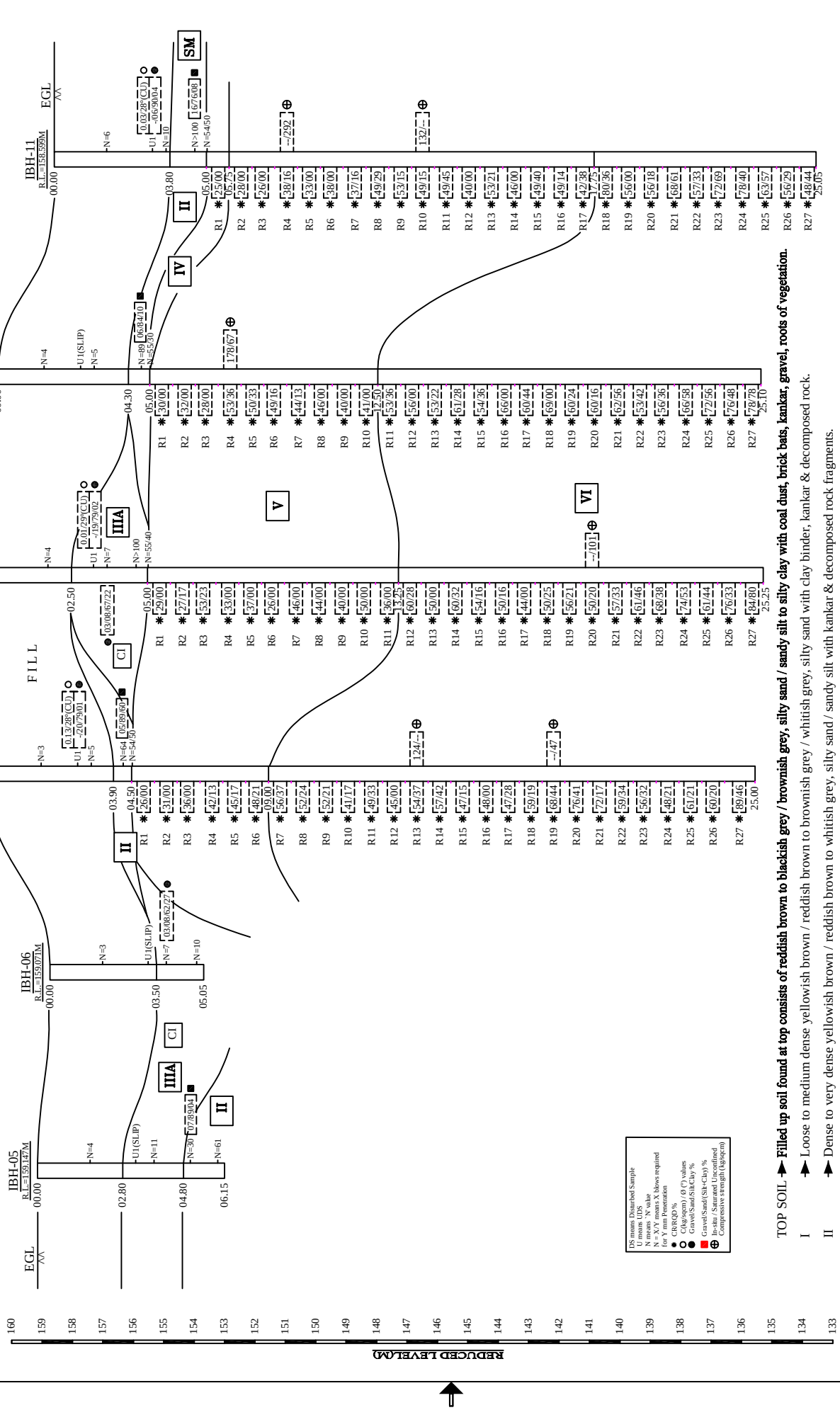


FIG. 2.24 : GENERALISED SOIL PROFILE



TOP SOIL → **Filled up soil found at top consists of reddish brown to blackish grey / brownish grey, silty sand / sandy silt to silty clay with coal dust, brick bats, kankar, gravel, roots of vegetation.**

I → Loose to medium dense yellowish brown / reddish brown to brownish grey / whitish grey, silty sand with clay binder, kankar & decomposed rock.

II → Dense to very dense yellowish brown / reddish brown to whitish grey, silty sand / sandy silt with kankar & decomposed rock fragments.

III → Very stiff to hard clay reddish grey to brownish grey, silty clay / clayey silt with sand mixture, kankar & decomposed rock fragments.

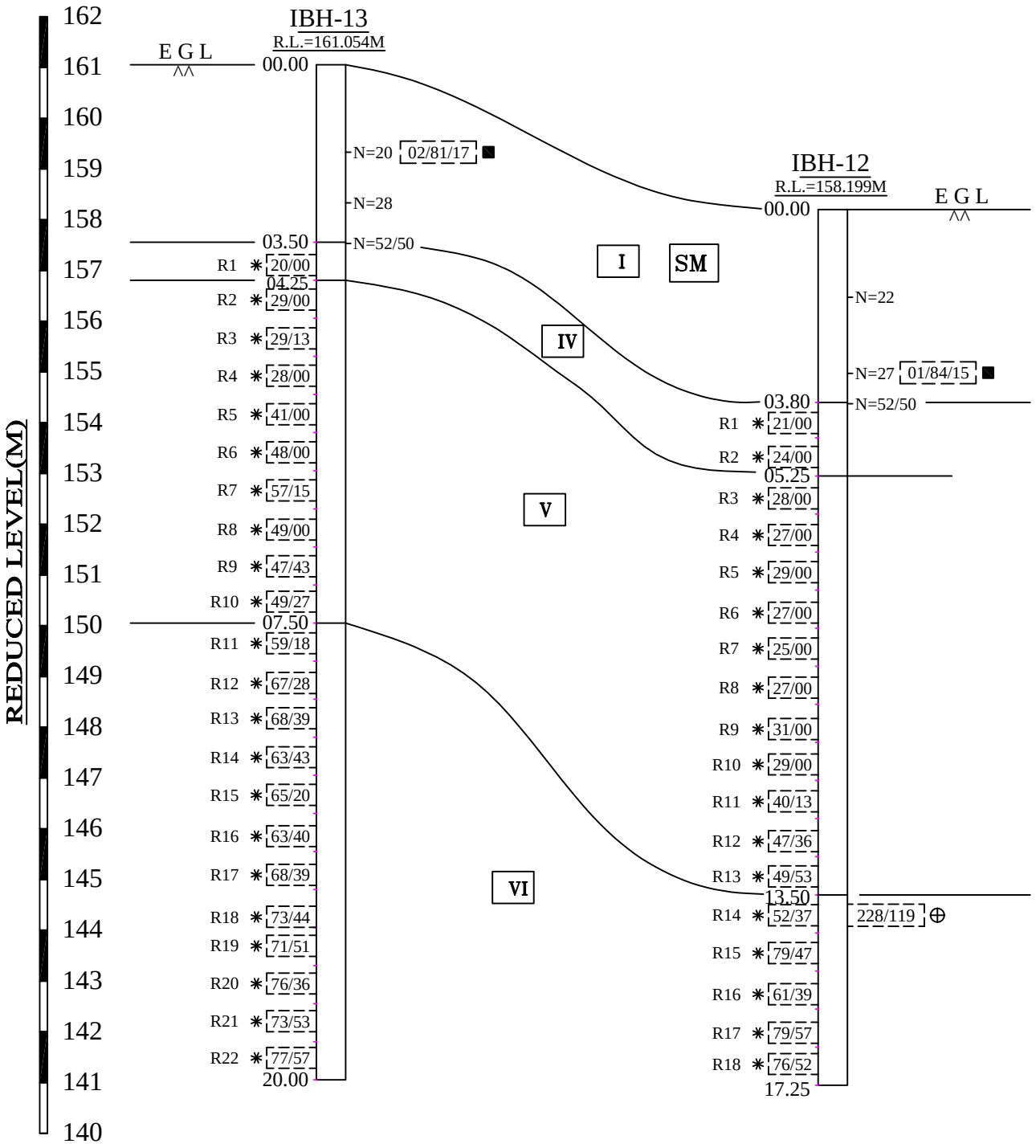
IIIA → Very stiff to hard, deep grey to reddish grey, silty clay / clayey silt. Obs. decomposed rock & fine sand mixture.

IV → Completely to highly weathered, reddish grey to whitish grey, fine to medium grained, highly fractured sandstone.

V → Highly to moderately weathered, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.

VI → Moderately to slightly weathered / fresh, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.

FIG. 2.25 : GENERALISED SOIL PROFILE



I ► Loose to medium dense yellowish brown / reddish brown to brownish grey / whitish grey, silty sand with clay binder, kankar & decomposed rock.

IV ► Completely to highly weathered, reddish grey to whitish grey, fine to medium grained, highly fractured sandstone.

V ► Highly to moderately weathered, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.

VI ► Moderately to slightly weathered / fresh, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.

FIG. 2.26 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work at NTPC Ramagundam TPS Stage-I & II FGD Package.			CETEST
Job No : 4371	Created by : T.SAHA	Created on : 16/03/2020	Sheet No:

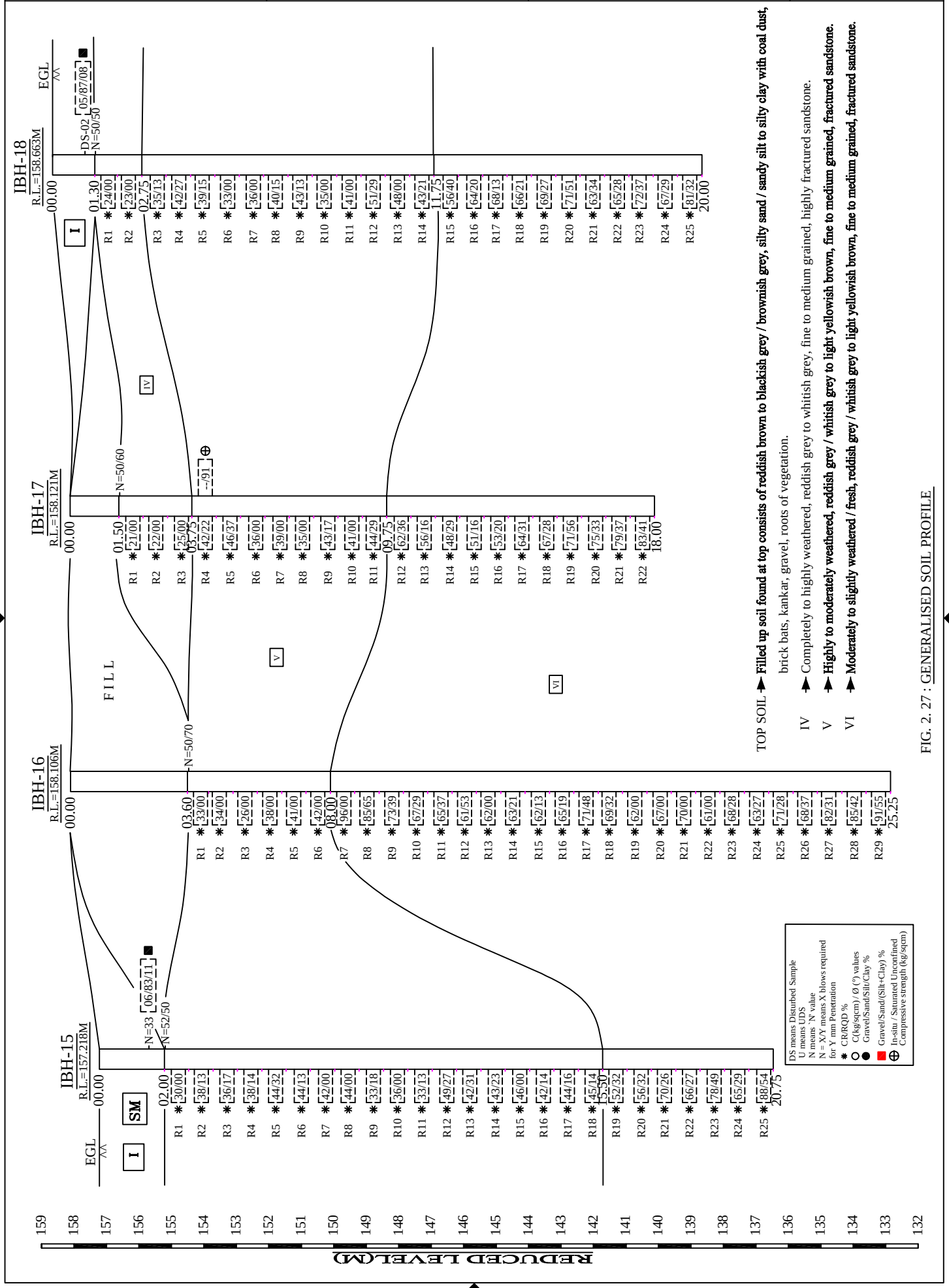


FIG. 2. 27 : GENERALISED SOIL PROFILE

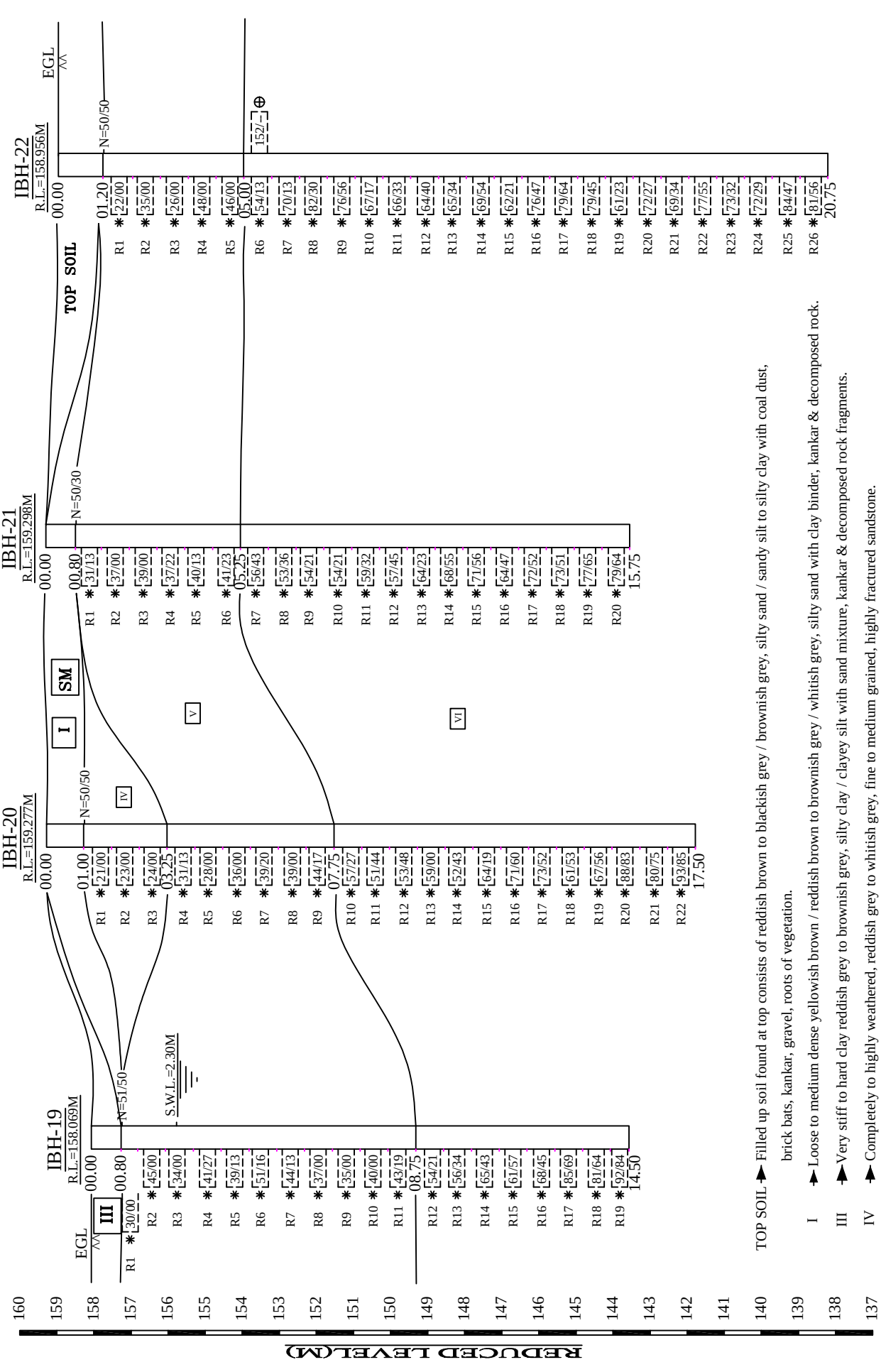


FIG. 2.28 : GENERALISED SOIL PROFILE

Bulk Density, gms/cc	1.80	Void Ratio	0.414
Dry Density, gms/cc	1.61	Liquid limit %	28
Natural Water Content %	12	Plastic Limit %	18
Specific gravity	2.67	Shrinkage Limit %	14
		GRAIN SIZE	
DRSH-CU:		Gravel %	06
Cohesion kg/sqcm	0.12	Sand %	77
Friction angle °	31°	(Silt +Clay)%	17

4.2.3. STRATUM - II:

This is also sand layer and it consists of dense to very dense, yellowish brown / reddish brown to whitish grey, silty sand / sandy silt. Kankar & decomposed rock fragments have been observed in this layer. No UDS could be collected from this layer. However, grain size analysis of some “SPT” samples shows the following average properties.

GRAIN SIZE	
Gravel %	08
Sand %	75
(Silt+Clay) %	17

4.2.4. STRATUM - III:

This is clay layer and found in very few boreholes. It consists of very stiff to hard, reddish grey to brownish grey, silty clay / clayey silt with sand mixture & kankar. Decomposed rock fragments have also been observed in this layer. Routine laboratory tests conducted on the "UDS" and “SPT” samples that could be collected from this layer show the following average properties.

Bulk Density, gms/cc	1.98	Liquid limit %	39
Dry Density, gms/cc	1.72	Plastic Limit %	19
Natural Water Content %	15	Shrinkage Limit %	15
Specific gravity	2.68	**GRAIN SIZE**	
Void Ratio	0.451	Gravel %	08
TRSH-UU:		Sand %	35
Cohesion kg/sqcm	0.75	Silt %	35
Friction angle °	12°	Clay %	22

4.2.5. STRATUM - IIIA:

The soil in this layer is characterized by stiff, reddish grey, silty clay. This layer is found at top around BH-41 only. The average properties of this layer obtained from routine laboratory tests on the few “SPT” and a disturbed samples collected from this layer are presented below.

Specific gravity	2.68
Liquid limit %	39

Plastic Limit %	19
Shrinkage Limit %	15
GRAIN SIZE	
Gravel %	02
Sand %	20
Silt %	53
Clay %	25

4.2.6. STRATUM - IV:

This is a rock layer and this layer consists of completely to highly weathered, reddish grey to whitish grey, fine to medium grained, highly fractured sandstone. The following test was carried out on the rock samples viz.

1. Determination of Point Load Strength Index.

The average properties of this layer as revealed from the routine laboratory test are as follows.

Point Load Strength Index, kg/sqcm	10.06

4.2.7. STRATUM - V:

This rock layer consists of highly to moderately weathered, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.

The following test was carried out on the rock samples viz.

1. Unconfined Compressive Strength determination of the rock samples as collected from the field (i.e. insitu condition).
2. Unconfined Compressive Strength determination of the rock samples after 24 hours full submergence and thereafter air drying before testing (i.e. saturated condition).
3. Determination of Point Load Strength Index.

The average properties of this layer as revealed from the routine laboratory test are as follows.

Bulk Density, gms/cc	2.222	UCS (in-situ), kg/sqcm	155
Dry Density, gms/cc	2.189	UCS (saturated), kg/sqcm	121
Water Content %	1.524	Co-efficient of softening	0.782
Specific Gravity	2.472	Point Load Strength Index, kg/sqcm	4.03
Porosity %	11.916	Slake Durability Index (%)	87.47

4.2.8. STRATUM - VI:

This is also a rock layer and it consists of moderately to slightly weathered / fresh, reddish grey / whitish grey to light yellowish brown, fine to medium grained, fractured sandstone.

The average properties of this layer as revealed from the routine laboratory test are as

follows.

Bulk Density, gms/cc	2.212	UCS (in-situ), kg/sqcm	193
Dry Density, gms/cc	2.179	UCS (saturated), kg/sqcm	107
Water Content %	1.513	Co-efficient of softening	0.553
Specific Gravity	2.476	Point Load Strength Index, kg/sqcm	5.419
Porosity %	12.110	Slake Durability Index (%)	89.308
		Soundness (% Loss)	18.123

4.3. GRAPHICAL PRESENTATION:

The detailed Laboratory Test Results in tabular form are given in the Appendix. The back up sheets are also presented there as given in below:

1. ***Strength envelopes from Triaxial Tests.***
2. ***Normal Stress vs. Shear Stress from Direct Shear Tests.***
3. ***Standard Proctor Compaction Curves.***
4. ***CBR Curves.***
5. ***e-log p curves from consolidation tests.***
6. ***Grain size distribution curves for sieve and hydrometer tests.***

The consolidation test results are analysed by numerical methods and only the final output in a tabular form is given. The m_{vc} indicates the time dependent component of m_v and c_v is the co-efficient of consolidation.