

**E432**  
Volume 17

# Tree Plantation Strategy

## Grand Trunk Road Improvement Project



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# PLANTATION STRATEGY FOR GTRIP

## BACKGROUND

The Grand Trunk Road between Wagha border (Amritsar) and Kolkata traverses across the six Indian states of Punjab, Haryana, Delhi, Uttar Pradesh (UP), Bihar and West Bengal and it mainly falls in the fertile Indo-Gangetic plains. This highway has been the conduit of development for the past several centuries, and seven of the 28 metropolitan cities of the country are located along the highway. It has over 10% of the urbanisation within 10km influence area on either side. As a result of the intense developmental activities along the highway, this area (10km on either side) supports a population of over 40 million. The highway between Agra and Dhanbad passes through two of the most populous and the least developed states in India.

The Delhi to Agra section at the western end and Dhanbad to Calcutta section at the Eastern End of the Corridor are either already 4-laned or are in the process of being 4-laned. The remaining about 1000 km long corridor falling between Agra and Dhanbad is still two laned and is being considered of four laning under the proposed World Bank NH Project. The Grand Trunk Road Improvement Project (GTRIP) aims at strengthening and four laning of 422.78 km of selected stretches between Agra to Dhanbad as per details given under Table 1.

**Table 1 GTRIP Contract Packages**

PACKAGES	CONTRACT PACKAGES FOR ICB	LENGTH KM
I [Agra - Bhognipur]	I-A [Agra-Shikohabad] [km 199.66-250.5]	50.84
	I-B [Shikohabad-Etawah Bypass (start)] [km. 250.5-307.5]	59.02
	I-C [Etawah bypass(end)- Bhognipur] [km. 321.100 – 393.0]	72.825
II [Khaga – Varanasi]	II-B [Khaga-Kokhraj] [km.115-158]	43.00
IV [Varanasi-Aurangabad]	IV-A[Mohania-Sasram Bypass] [km 65-110]	78.00
	IV-C [Sone River –Aurangabad] [km 140-180]	40.00
V [Aurangabad-Dhanbad]	V-B [Aurangabad-Barachetti] [km 180-240]	60.00

The stretch of NH-2, in GTRIP, (Packages- I-A, I-B, I-C, II-B, IV-A, IV-C and V-B) is proposed to be strengthened and reinforced using various techniques of soft landscapes, principally through plantation of various types. A Road landscape Plan has been developed to enhance the visual

quality of the road. The landscape treatments are not only to mitigate the visual impacts of the construction, but also to glorify the historic context of the road.

## Impact on flora

A total of 48,119 trees existing within the ROW is expected to be felled due to the project. The package-wise details of the trees to be cleared are as presented in Table 2.

The stretch of NH-2 in Package I has multiple rows of Seesham, Arjun, Neem, Eucalyptus trees. Similarly, package II has multiple rows of various species on either sides such as Eucalyptus, Seesham, Jamun, Neem, Mango etc. Package IV & V have similar kind of trees as mentioned in package II. However in parts of the Package V teak, Sal, Kher are also found. The various impacts on flora due to the felling of roadside plantation are as follows:-

- loss of trees
- loss of canopies
- loss of green tunnel
- compaction of vegetation
- pollution and dust accumulation on vegetation.

To address the negative impacts likely due to the felling of these roadside plantations, compensatory plantation have been planned along the proposed alignment and on the median. As per the proposed plantation programme, a total of more than 200,000 trees are to be planted along the highway, which amounts to compensating at the rate of 4 trees for every tree cut. A comparative estimate of the extent of tree felling along each of the packages and the number of trees that have been proposed are presented in the table below.

**Table 2: Comparative Statement of tree felling and proposed plantation**

Package	Number of trees to be felled	Proposed number of trees
I A	7900	24070
I B	6455	28044
I C	7622	34324
II B	6972	23645
IV A	15200	33972
IV C	887	20688
V B	3083	38226
Total	48119	202969

Apart from the compensation for the trees lost, measures have been worked out to enhance the visual and landscape quality along this ancient highway. These enhancements to the highway landscape have been planned through apart from the detailed landscaping that has been proposed along the highway, proposing improvements to the various significant community resources / water bodies etc, development of the existing cultural sites. Along the 18 km stretch of the corridor in

Package V B that passes through the Gautama Buddha Wildlife Sanctuary, an additional 12,000 trees will be planted along the animal routes within the sanctuary area.

The tree plantation strategy along the GT road has been conceptualized keeping in mind a set of objectives, including road safety, to improve the overall visual and environmental quality of the project corridor.

## **Objectives of Tree Plantation Strategy**

The broader objectives of tree plantation / landscaping are:

- Climatic amelioration,
- Check in air & noise pollution,
- Check in soil erosion and reduce water logging,
- Moderating the effect of wind and incoming radiation, and
- Aesthetics, shade and ornamentation.

In addition to the specific aim of tree plantation / landscaping along the GT Road is -

- To enhance the visual experience of traveling along the GT Road;
- To define the RoW especially highlights sharp horizontal curves during night;
- To screen unsightly view from the road as well as the roadside communities from air & noise pollution;
- To compensate for the trees proposed to be cut;
- Selective plantation at bus stops/rest areas/truck lay byes etc, and
- To enhance sites of natural and cultural importance.
- To prevent the glare from the incoming vehicles

## **Selection of Tree Species for Landscaping**

Plantation is one of the most important constituents of soft landscaping. Trees, shrubs and climbers have been used to enhance the soft natural ambience against harsh elements in most of the enhancement schemes. The planting species are decided based on the physical growth characteristics of trees, like form and shape, foliage pattern, growth rate, branching pattern, soil characteristics and conditions of the strip like water logged areas etc. While selecting the species of trees for landscaping a great care has been taken to choose from the already existing indigenous species along the project corridor. The selection of plant types and planting arrangement has been based on the following considerations:

### **Screening**

Plantation of pollution hardy shrub dwarf species in the median to prevent glare from the vehicles moving in opposite direction during night.

A mix of medium and large trees along roadside to screen the evening glare for the traffic moving towards west-northwest.

Screen plantation as a visual barrier in schools, hospitals, residential colonies, etc.

#### **Aesthetics**

Provision of flowering trees in the urban sections and major crossings

Provision of flowering shrubs in the median

Softening of vertical surfaces of the retaining walls of grade separators and raised sections of the carriageway by climbers.

#### **Shade**

Large and spreading shade trees, with thick foliage are proposed in the innermost edge. This is meant for the slow moving traffic that shall ply along the paved shoulders of the proposed corridor.

Medium evergreen shade trees on footpaths in the urban sections have been provided. Evergreen trees do not have substantial leaf fall, which avoids the nuisance of clogging of lined drains.

#### **Fruit, Fodder and Fuel**

Provision of trees that have economic importance where space is available between the shade trees and the edge of the RoW for the local village people.

#### **Natural Reserves and asset**

The economic trees may be harvested on maturity and generate revenue for the body responsible for tree plantation and maintenance. These stretches shall also house valuable soil micro flora and micro fauna.

#### **Other benefits**

Trees along the highway and ground cover along the embankment slopes and near major water bodies play a major role in the control of erosion. Similarly, plantation and green covering in the form of turfing stabilizes steep slopes and high embankments. Along water logged areas, plantation of tree species such as Eucalyptus shall aid in the maintenance of water balance.

## **Plantation Pattern**

The road landscape has been developed envisaging a holistic approach to the entire stretch. A concept has been evolved so as to maintain visual characteristics and uniformity in terms of landscape along the stretch. In the absence of uniform land availability for the plantations, different schemes have been worked out in tune with the local variations in the design. To achieve this, the entire stretch of the project corridor has been divided into homogenous landscape sections based on similarity in terms of soil conditions, climate (temperature and rainfall) and topography. A study on the local flora and vegetative cover native to these sections has been carried out as part of the field surveys to enable a choice of the suitable species for that particular section.

In order to identify sections with similar natural factors the entire project corridor was divided into 13 homogeneous stretches with similar climatic (rainfall and temperature), soil and topographic characteristics, as shown in the following table.

**Table 3 Criteria for Road Landscape Sections Along the Project Corridor**

S. No.	Package	Chainage	Distance	Rainfall	Elevation	Local soil type
1	IA	199.6-250	51	600-700mm	80-120m	Alluvial; Fertile
2	IB	250-307.5	57	700-800mm	80-120m	Alluvial; Fertile
3	IC	321 - 393	72	800-900mm	80-120m	Alluvial; Fertile
4	IIB1	471-17(A)	35	900-1000mm	80-120m	Alluvial; Fertile
5	IIB2	17-39	22	900-1000mm	80-120m	Alluvial; Fertile
6	IV A	0-65	65	1000-1050mm	80-120m	Thin Alluvial; rocky; barren stretches; silty clay
7	IV C1	111.2-132	21	1000-1050mm	80-120m	Clayey; Fertile
8	IV C2	132-140	8	1000-1050mm	80-120m	Deep alluvial; Fertile
9	V B1	240-252	12	1200-1400mm	150-300m	Thin alluvium
10	V B2	252-260	8	1200-1400mm	300-400m	Thin alluvium
11	V B3	260-270	10	1200-1400mm	300-400m	Thin alluvium
12	V B4	270-286	16	1200-1400mm	200-300m	Thin alluvium
13	V B5	286-320.5	36	1200-1400mm	300-450m	Thin topsoil

These stretches were further divided into 40 sections based on the adjacent landuse of rural or urban stretches. In each of these sections different types of typical road design sections are applied in all the packages, for which, according to the ROW available, the plantation is proposed on either side at the particular Chainages.

**Table 4 Existing Cross Section details in GTRIP**

Package	Carriageway Width (m)	Paved Shoulder Width (m)	Earthen Shoulder Width (m)	Embankment Height (m) Typical and maximum values
I-A	7	0 to 1.5	1 to 2.5	6-2.5
I-B	7	0	2 to 2.5	6-2.5
I-C	7	0	2.5	6-2.5
II-B	7	Unpaved 2.5	1	10, 12
IV-A	7	1.5	0.5	15.1
IV-C	7	1.5	0.5	1.5 9.5
V-B	7	1.5 (partly)	1.0-2.5	2.0, 8.0

The planting type has been decided based on their requirement and feasibility at various sites along the project sub packages. Physical growth characteristics of trees, like form and shape, foliage and

rooting characteristics, growth rate, canopy type and branching pattern were the major criteria in the selection of plantation type and density.

The space available in the RoW is one major guiding factor for different themes of landscaping applied in the entire corridor. The analysis of RoW along GT Road reveals a highly varied picture. Over 50% of the total length has an average RoW width of 40-45m (nearly 203km) followed by 22% with 30-35m RoW. A substantial portion of the length, i.e., about 17.5% has a liberal RoW of about 60m or more. Accordingly, a plantation pattern has been worked out as follows:

The first row along the Highways will be of shade plants.

Subsequent rows depending on the availability of width will comprise of ornamental and other species.

Planting of shrubs in the median .

### **Shade Plants**

One of the main objectives of Roadside Avenue is to provide shade. The first row of trees primarily consists of shade trees, at a spacing of 12m C/C. These tree species are the locally significant and are mostly evergreen in nature, which ensures no substantial leaf fall in winters preventing the problem of blockage of roadside drains. Trees with the following characteristics will be planted as shade trees:-

1. Trees with high crown forms secure better visibility and are therefore ideal.
2. Trees that retain their foliage longest are preferred to deciduous trees.
3. Trees with long gestation period and having rapid growth and a capacity to resist fungal and insects attack form ideal avenues.
4. Long slender trees unable to support their own weight and trees with low crown density decreasing visibility have been avoided.
5. Fruit trees are generally avoided with exception to Mango, Imli, Jamun as these form excellent avenues.
6. Brittle trees, like Millingtonia hortensis are not recommended.
7. Those trees have been preferred which have thick shade and are also valuable from economic point of view.

A major length of the GTRIP corridor falls within the Gangetic Plains with rich alluvial, loamy soils, which can support the tree plantations. However, there are certain stretches where usar (alkaline) lands exist, and some other stretches with sandy soils. These usar [alkaline] lands and heavy clays do not support any significant vegetation beyond grass, or dhak, babul, none of which afford satisfactory shade. The only species that can survive are Neem and Kanji, and have been recommended. Similarly, along stretches with sandy soils, Shesham is the species

recommended. The tree species recommended as shade plants for roadside avenues are given in Table 5.

**Table 5 Shade trees recommended for roadside avenues**

Soil	Species	
	Local name	Botanical name
Loamy	Peepal	Ficus religiosa
	Paker	Ficus infectoria
	Mahua	Madhuca indica
	Mango	Mangifera indica
	Neem	Azadirachta indica
	Imli	Tamarindus indica
	Jamun	Syzynium cuminii
	Shisam	Dalbergia sissoo
	Shisam	Dalbergia sissoo
Sandy	Shisam	Dalbergia sissoo
	Neem	Azadirachta indica [ at p up to 8.5]
	Kanji	Pongamia pinnata [ upto 9.0 p h]
Alkaline soils[usar]	Arjun	Terminalia arjuna
	Jamun	Syzynium cuminii
	Arjun	Terminalia arjuna
Water logged area	Jamun	Syzynium cuminii
	Arjun	Terminalia arjuna

**Ornamental and Other Species**

The second and subsequent rows of plantations along the highway have been worked out based on the land availability within the RoW along the various sections. A combination of ornamental, shade and screening trees have been recommended. The number of outer rows and the repetition of the trees and their type varies with the landscape section, the TCS and the space available in the RoW for tree plantation. In many of the urban areas there is no space available for Outer rows, even the inner rows are planted at the footpaths of the service roads. The species proposed for the second and subsequent rows of plantation are presented below:

**Table 6: Species Recommended for 2<sup>nd</sup> Row of Avenue Plantations**

S.NO.	SOIL	BOTANICAL NAME	LOCAL NAME	FLOWERING MONTH/ COLOUR
1.	Loamy	Delonix regia	Gulmohar	May/ Yellow
2.		Cassia fistula	Amaltas	May /Yellow
3.		Bauhinia sps.	Kachnar	Feb-Mar./ Pink
4.		Cassia nodosa		May June/ Pink
5.		Jacaranda mimosaeolia		April /Blue
6.		Gravillea robusta		April /Yellow
7.		Peltophorum ferrugineum		Oct. /Yellow
8.	Water logged	Terminalia arjuna	Arjun	

	condition			
9.		Syzynium cuminii	Jamun	
10.		Cordia dicotma	Lasoda	
11.	Alkaline soils [Usar]	Terminalia arjuna	Arjun	
12.		Pongamia pinnata	Kanji	
13.		Albizzia lebbek	Kala Siris	

**Table 7: Species Recommended for 3rd row of Avenue Plantations**

1.	Loamy	Malia azadiracta	Bakain	
2.		Pongamia pinnata	Kanji	
3.		Acaccia auriculiformis		
4.		Albizzia lebbek	Kala siris	
5.		Dalbergia sissoo	Shisham	
6.		Terminalia arjuna	Arjuna	

### **Species for Median**

The shrubs planted in the median are of low or medium height for prevention of the headlight glare. One to two rows of flowering shrubs have been provided according to the varying width of the median in different sections. In sections where the median width is less than 1.5m only grasses turf is proposed. The species proposed for the purpose for turfing are Cynodon dactylon, Cythocline perpurea, Solanum nigrum, and Xanthium strumerium. The species proposed in the median are mainly bougainvillea and Thavetia nerifolia (Kaner). The species recommended for median are given in Table

**Table 8 Recommended species on the median**

S.NO	SHRUBS/ LOCAL NAME	BOTANICAL NAME
1.	Kaner	Thavetia nerifolia
2.	Chandini	Ervatamia divericala
3.	Bougainvillea	Bougainvillea sps.
4.	Gurhal	Hibiscus sinensis
5.	Cassia glauca	Cassia glauca
6.	Chameli	Jouminum grandiflorum

## CONCEPT OF PLANTATION FOR DIFFERENT AREAS

### Rural areas

Common plants generally recommended for national and state highways passing through rural areas, are Amaltas (*Cassia fistula*) alternating with shade trees like, *Azadirachta indica*, *Tamarindus indica*. Tall trees like *Eucalyptus* are not suitable as they interfere with electric and telephone lines and moreover are safety hazards on the road. Medium trees like, *Acacia auriculiformis*, *Gravillea robusta*, are ideal for screening. In a tropical country like India, where the temperature during summer months may rise up to a maximum of 46°C or more, the 'shade' is of greatest value to the travelers. Thorny trees like *Acacia Arabica* and *Ber (Zizyphus jujuba)* are avoided, as these create a nuisance for the pneumatic tyre of motor vehicles.

### Urban Areas

Near market places and congested areas, the trees known for behaving as 'pollution sink' are proposed. Though, trees in general absorb the pollutants, filter the air from pollutants, and act as noise barrier, but some trees like *Neem (Azadirachta Indica)*, *Mango (Mangifera Indica)*, *Paker (Ficus Infectoria)*, *Shisham (Dalbergia Sisso)*, *Imli (Tamarindus Indica)* can do it in a better way.

Near sensitive areas like schools and hospitals, tall trees with thick canopies can create a wind screen through which the air can be filtered and the noise levels be considerably reduced. Some such trees are *Acacia auriculiformis* and *Gravillea robusta*. Tall shrubs like *Casia biflora*, *hamelia patens* etc are provided at the sensitive noise receptors for maximum possible screening.

### Edges Along Clear Zone

The clear zone along the Grand Trunk Road is of varied nature depending upon the different embankment heights. Some areas have steep gradients that need intensive stone pitching treatment. In order to increase the structural stability of this type of treatments, plant materials such as shrubs and ground covers, can be introduced in the interstices. They can be used with emphasis on their rooting characteristics, so that they help in binding the stone pitching treatments. In areas of high water table or water logging, special emphasis has been given on the selection of plant materials that can survive in moist conditions.

### Water Logged Areas

Waterlogged areas along the road are generally a result of Inadequate drainage conditions, the road acting as a bund and contributing to water logging, high water table of the region or the Low lying nature of the terrain itself.

Water logged areas are generally associated with larger water bodies, serving as waterfowl habitat and often, scenic spots with religious and recreational setting. One of the common situations met for roadside plantation is the water logging since roadsides have been dug for excavating the earth for

putting on road edge. This type of situation is common throughout the plains in the country. Planting of such sites after proper drainage is now a common practice. Eucalyptus sp, Terminalia arjuna, Scyzinium cuminii are recommended species for waterlogged areas.

#### **Protected Forest / Reserved Forest Areas**

The design has been worked out to minimise the impacts on the forest stretches along the proposed alignment. The acquisition of 0.5 ha of forest land in Package I A and 1.28 ha of forest land in Package IV C has been unavoidable and the clearance of these forests are being taken up in accordance to the Gol requirements.

For stretches of the corridor through the reserved / protected areas, the contractor shall ensure that the construction activities shall be limited to the proposed RoW, so as to avoid any impacts on the vegetation within the forest areas.

Along the sections passing through protected / reserved forests, dense plantation has been proposed within the RoW. Apart from these, if the forest department wishes to establish a buffer<sup>1</sup>, NHAI as part of the project shall contribute a portion of the estimated budget for the establishing a vegetative buffer between the forest and the highway. All species proposed in the reserved forest areas shall be native of the forest area. In package V-B, where the corridor passes through the Gautam Buddha Wildlife Sanctuary, Sal trees have been planted along the five flowing water sources, for a distance of 100m on each side of the water channel on both sides of the NH.

#### **Taj Trapezium Zone**

Package I stretch of the of the project road traverses through the Taj Trapezium. To minimize any likely impact due to air pollution on the Taj Mahal an additional belt of 10m widths has been acquired on either sides of the project road to plant pollution resistant trees. The additional width shall facilitate additional 2- 3 rows of pollution resistant trees, which shall form a green belt all along the corridor. Starting from Agra in Package I, species to be planted in the section of Taj Trapezium Zone in Package I have been considered as per the recommendations of the two studies carried out in the region. These recommendations have been adopted for all of Package I depending up on the availability of space on the roadsides. The pollution resistant species included in the Landscape plan

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<sup>1</sup> Along the Gautama Buddha Wildlife Sanctuary, a strip of 400m on either side of the highway has been demarcated by the Bihar Sate Forest Department as a buffer zone. Such buffer zones can be worked out at other forest locations along the corridor. This buffer shall effectively minimize any wildlife vehicle conflicts.

are trees like *Azadirachta indica*, *Tamarandas indica*, *Madhuca indica*, *Magnifera indica*, etc which are also locally significant species in this area.

## Proposed Plantation Scheme

The following table shows the species proposed for plantation in the inner row, outer rows, and the median according to the typical cross section available at particular chainage and the landscape zone, in each of the packages:

**Table 9 Proposed Landscape Sections Along the Project Corridor**

PKG	Chainage	Length (km)	Urban / Rural	Section type	Plantation		
					Inner row	Outer rows	Median
IA	199.6-205.51	6	U	TCS 1	<i>Azadirachta indica</i>	–	Turfing
			U	TCS 2	–	–	<i>Thavetia nerifolia</i>
			R	TCS 3	<i>Azadirachta indica</i>	<i>Cassia fistula</i>	<i>Bougainvillea</i>
			R	TCS 4	–	–	<i>Bougainvillea</i>
IA	205.51-231.66	25	R	TCS 5	<i>Azadirachta indica</i>	<i>Cassia fistula</i>	<i>Bougainvillea</i>
			U	TCS 6	<i>Azadirachta indica</i>		<i>Bougainvillea</i>
			R	TCS 7	<i>Azadirachta indica</i>	<i>Delonix regia</i>	<i>Bougainvillea</i>
			U	TCS 8	–		–
			U	TCS 9	–		Turfing
			R	TCS 10	<i>Azadirachta indica</i>	<i>Delonix regia</i>	<i>Bougainvillea</i>
			R	TCS 11	<i>Azadirachta indica</i>	<i>Delonix regia</i>	<i>Bougainvillea</i>
IA	231.66-234.96	3	R	TCS 12	<i>Ficus infectoria</i>	<i>Cassia fistula</i>	<i>Bougainvillea</i>
IA	234.96-245	10.04	U	TCS 13, 14, 15	–	–	–
IA (IB)	245-257	12		TCS 10	<i>Azadirachta indica</i>	<i>Cassia fistula</i>	<i>Bougainvillea</i>
			R	TCS 1 (IA)	<i>Azadirachta indica</i>	–	Turf
IB	257-	5	U	TCS 2	<i>Anthocephalu</i>	<i>Bauhinia sp.</i>	Turf

PKG	Chainage	Length (km)	Urban / Rural	Section type	Plantation		
					Inner row	Outer rows	Median
	262				s sp. (Bengali kadam)		
IB	262-269.9	8	R	TCS 1	Azadirachta indica	Bauhinia sp.	Bouganvillae
IB	269.9-278.7	9	R	TCS 3	Ficus infectoria	Albizzia lebbek	Bouganvillae
IB	278.7-282.75	4	R	TCS 1	Azadirachta indica		Bouganvillae
IB	282.75-284.05	1.2	R	TCS 3	Mangifera indica	Albizzia lebbek	Bouganvillae
IB	284.05-307.5	23.5	R	TCS 1	Azadirachta indica	Cassia fistula	Bouganvillae
			U	TCS 4	-		Turf
IC	321-326.1	5	U	TCS 1	-		Turf
			R	TCS 2	Madhuca indica	Cassia nodosa	Bouganvillae
IC	326.1-327.25	1	R	TCS 3	Scyphinium cuminii	Terminalia arjuna	Bouganvillae
IC	327.25-336.3	9	U	TCS 1	-	-	Turf
			R	TCS 2	Madhuca indica	Cassia nodosa	Bouganvillae
			R	TCS 3	Azadirachta indica	Terminalia arjuna	Bouganvillae
IC	336.3-341.6	5	U	TCS 1	-	-	Bouganvillae Alternate turf
			R	TCS 2	Madhuca indica	Cassia nodosa	Bouganvillae
			R	TCS 3	Mangifera indica	Terminalia arjuna	Bouganvillae
IC	341.6-342.5	0.7	R	TCS 2	Madhuca indica	Cassia nodosa	Bouganvillae
IC	342.3-350.75	8	R	TCS 3	Azadirachta indica	Terminalia arjuna	Bouganvillae

PKG	Chainage	Length (km)	Urban / Rural	Section type	Plantation		
					Inner row	Outer rows	Median
IC	350.75-353.0	2.2	R	TCS 2	Madhuca indica	Cassia nodosa	Bouganvillae
			R	TCS 3	Mangifera indica	Terminalia arjuna	Bouganvillae
IC	353-359.1	6	U	TCS 3	Syzynium cuminii	Delonix regia	Bouganvillae
IC	359.1-360	1	R	TCS 2	Madhuca indica	Cassia nodosa	Bouganvillae
			R	TCS 3	Azadirachta indica	Terminalia arjuna	Bouganvillae
IC	360.0-366.9	7	R	TCS 3	Syzynium cuminii	Bauhinia sp.	Bouganvillae
IC	366.9-377.5	10.5	U	TCS 1			Turf
			R	TCS 2	Madhuca indica	Cassia nodosa	Bouganvillae
			R	TCS 3	Azadirachta indica	Terminalia arjuna	Bouganvillae
			R	TCS 4	Syzynium cuminii	Terminalia arjuna	Bouganvillae
IC	377.5-383.65	6.5	U	TCS 1			Turf
IC	383.65-393	9.4	R	TCS 2	Madhuca indica	Cassia nodosa	Bouganvillae
			R	TCS 4	Syzynium cuminii	Lagerstromia flosreginea	Bouganvillae
IIB	470.0-473.6	33.8	U	III-D	Syzynium cuminii	Gravillea robusta	Turf
			R	V	Syzynium cuminii	Peltoforum ferrugineum	Turf
			R	IV-A	Syzynium cuminii	Peltoforum ferrugineum	Turf
IIB	13.8-17.15	3.35	R	I	Tamarindus indica	Cassia fistula	Bouganvillae
			R	VI	Tamarindus indica	Peltoforum ferrugineum	Bouganvillae
			R	I	Tamarindus indica	Peltoforum ferrugineum	Bouganvillae

PKG	Chainage	Length (km)	Urban / Rural	Section type	Plantation		
					Inner row	Outer rows	Median
IIB	17.15-36.0	18.85	R	III-D	Syzynium cuminii	Peltoforum ferrugineum	Turf
			R	I	Tamarindus indica	Cassia nodosa	Bougainvillae
			R	II	Dalbergia sisso	Delonix regia	Bougainvillae
			R	III-C	Syzynium cuminii	Peltoforum ferrugineum	Bougainvillae
IV A	0-32	39.4	R	BP120	Syzynium cuminii	Cassia nodosa	Turf
			R	1RA	Azadirachta Indica	Bahunia perpuria	Bougainvillae
			U	1UA	Tamarindas Indica	Bahunia perpuria	Bougainvillae
			U	BP500	Syzynium cuminii	Cassia nodosa	Bougainvillae
IV A	32-42	10	R	1RA	Azadirachta Indica	Cassia fistula	Bougainvillae
IV A	42-49	8	R	1RA	Syzynium cuminii	Cassia nodosa	Bougainvillae
			R	1RB	Syzynium cuminii	Cassia nodosa	Turf
			R	1RC	Syzynium cuminii	Cassia nodosa	Turf
			U	1UC	Syzynium cuminii	Cassia nodosa	Bougainvillae
IV A	49-65	13	R	1RA	Azadirachta Indica	Delonix regia	Bougainvillae
IV C	110-131	20	R	1RA	Tamarindas Indica	Acacia auriculiformis	Bougainvillae
			U	1UD	Tamarindas indica	-	Turf
			U	1UA	Tamarindas indica	Gravillea robusta	Turf
IV C	131-140	9	R	1RA	Azadirachta indica	-	Bougainvillae
			R	1RC	Tamarindas indica	Lagerstroemia Flosreginea Terminalia arjuna	Turf
			U	1UA	Tamarindas indica	-	Bougainvillae
V-B	240-242	2	R	TCS II	Dalbergia sisso	Terminalia Arjuna	Bougainvillae
V-B	242-260	18	R	TCS II	Dalbergia sisso	Albizzia lebbek	Bougainvillae
V-B	260-280	20	R	TCS II	Dalbergia sisso	-	Bougainvillae
			SU	TCS IV	Dalbergia sisso	-	Bougainvillae
V-B	280-	6.3	R	TCS II	Dalbergia sisso	Albizzia lebbek	Bougainvillae

PKG	Chainage	Length (km)	Urban / Rural	Section type	Plantation		
					Inner row	Outer rows	Median
	286.3						
V-B	286.3-310	31.7	R	TCS-II	Dalbergia sisso	-	Bougainvillae
			SU	TCS-IV	Dalbergia sisso	-	Bougainvillae
V-B	318-320.5	2.5	R	TCS-II	Dalbergia sisso	Terminalia arjuna	Bougainvillae

## PLANTATION SPECIFICATIONS

The specifications for carrying out the proposed plantation scheme has been presented for the following 3 categories :-

- (i) Tree planting along the Highway
- (ii) Turfing with grasses and shrub planting on median
- (iii) Plantation on cultural and historical sites which are of community interest.

### TREE PLANTING ALONG THE HIGHWAYS

The execution of the plantation activities will be entrusted to the State Forest Department of Uttar Pradesh for Packages I-A, I-B, I-C, II-B and part of IV-A. For the remaining stretches of the Package IV-A(Bihar portion), IV-C and V-B the responsibilities of executing the proposed plantation activities proposed will be with the State Forest Departments of Bihar and Jharkhand. The technical specification for planting along the Highways are as follows:-

#### Shade plant [first row]

Distance from edge of shoulder	-	6 mts. or 1mt. away from toe or embankment whichever is higher
spacing between plant to plant	-	12 mts.
Size of the pits		
Normal site	-	60 x 60 x 60 cms.
For Alkaline soil [Usar]	-	Pit digging by Augar
Water logged areas	-	mounds with height varying depending on the water level.
Species recommended	-	as per above table for shade plant
No. of plants per km	-	84
Height of the plant	-	Not less than 2 mts

## **2<sup>nd</sup> and subsequent rows**

Distance from edge of shoulder of 2 <sup>nd</sup> row-	9 mts
Subsequent rows from 2 <sup>nd</sup> row	- at a distance of 3 mts.
Spacing between plant to plant	- 3 mts.
Size of the pits:	
Normal site	- 45 x 45 x 45 cms
Alkaline soil	- Pit digging by auger
Water logged areas	- mounds with heights varying according to the water level
Species recommended	- As per table 6 and table 7
No. of plants per km	- 333 [ for each row]
Height of the plants	- more than 1 m

In localities where a really bad patch of usar occurs, there is a need to dug deep pits by auger [mechanical device] to break the kankar pan down below and replacing the soil by good quality soil. The soil amender Gypsum 1 to3 kg. depending on the pH along with 2 kg. composite and sand are filled in the pits. The treatment helps in lowering down the pH and thus enabling better survival of plants.

- Haphazard mixture of various species just because they happen to be available complicates subsequent management. Owing to variation both in the rate and form of
- growth of trees mixed, the avenues present a patchy appearance. It is therefore best and most convenient to use the same species on either side of a road for at least 5 km or so and secure regularly grown avenues of the same form and type. Such avenues will mature at about the same time and can be replaced with minimum sacrifice.
- An average spacing of 12 mts. requiring 84 plants per km. and will provide ample growing space for most species. Too many trees apart from involving higher planting costs, very often unnecessarily reduce visibility for fast traffic. Excessive dense avenues serve no useful purpose and apart from affecting the tree growth adversely. It also reduces visibility and proves to be dangerous to fast moving traffic. Close spacing on curves and crossing can be dangerous so best plan is to miss a tree or two at such locations.

### **Protection Measures**

Where the availability of the width is only sufficient for single row plantation, the protection will be done by tree guards of iron/ pre-cast concrete/brick.

For multiple row plantations, protection will be done by barbed wire fencing. Angle iron will be fixed at a spacing of 5 mts. and 3 strand barbed wire will be stretched.

## Requirement of Plants

The total stretch under GTRIP is around 422.78 kms. and considering 10% area under urban limits and 20% areas where width is sufficient only for single row plantation then following is the requirement of the plants for entire GTRIP:-

**Table 10 : Plant Requirements for Roadside Plantations - GTRIP**

Package No.	length [km.]	Stretches not sufficient for plantation (app.20%) in Km	Urban areas sufficient for single row [10%] in Km	Other areas where only 1 row is possible [20%] in Km	Stretches sufficient for multiple rows (app.50%) in Km	No. of shade plants (on both sides)	No. of other plants (on both sides)	No. of Total plants
IA	50.84	10	5	10	25.84	6861	17209	24070
IB	59.02	12	6	12	30.00	8064	19980	28044
IC	72.825	14.5	7	14.5	36.825	9799	24525	34324
IIB	51.33	10	5	10	25.33	6775	16870	23645
IVA	76.10	15	8	15	36.10	9929	24043	33972
IVC	31.10	2.5	1	2.5	24.10	4637	16051	20688
VB	81.57	16	8	16	41.00	10920	27306	38226
<b>TOTAL</b>	<b>422.78</b>	<b>80.002</b>	<b>40.1</b>	<b>81.2</b>	<b>219.2</b>	<b>56985</b>	<b>145984</b>	<b>202969</b>

### PLANTING ON THE MEDIAN

The Civil Contractors of the various project packages will carry out the turfing by grasses and planting on the median.

The surface on the median is to be prepared adequately for shrubs planting or grass sowing. The grasses and shrubs planting is done to provide a strong surface cover but needs a well-prepared surface. All masses of loose debris on the median will be removed. Any convexities will be removed and similarly any concavities are to be filled by good soil. The surface will have sufficient layer of good quality soil [ upto 45 cms] so as to have better growth and survival of grasses and shrubs.

Grass lines will be used to provide a strong surface cover and will be planted over a well-prepared surface. Slope treatments using grasses will be allowed to establish properly such that the slopes

### PLANTING OF GRASSES

are not subject to undue stress from erosion and mass movement in its initial stages. The sowing of grasses will create a strengthened surface that will reduce the vulnerability to erosion. Median with a width of 1 mts. will have only grasses to strengthen the surface. The contractor will

Ensure that the condition of the site is good enough for the successful establishment of grasses.

supervise all field operations like preparation of surface, sowing of grasses and quality of grasses seeds used.

Carry out grassing such that a cover of 25 grams of grass seed per square mt. of surface is achieved.

Carry out seed sowing before the onset of monsoon [May & June] so as to achieve the desired results. The watering of the surface will be by tankers till the onset of the monsoon.

Ensure that a mulch of prepared and dried out herbs is laid over the whole seeded area after sowing, in a thin layer, so that the grass is not affected by direct sunlight and transpiration loss.

The grasses recommended for median are Cynodon dactylon, Cythocline purpurea, Solanum nigrum, Xanthium strumerium etc.

### PLANTING OF MEDIAN SHRUBS

The plantation on the median will be the responsibility of the contractor. The plants will be procured from the private nurseries. As the plantation activity will commence in July, 2003 so the contractor can tie up with the private nurseries for obtaining the necessary plants.

The contractor will plant shrubs [low height plants] as specified in Table 8 at a spacing of 3m c/c.

Only two rows of shrubs will be planted on median of width of 5 m. The plants will be at a spacing of 1.5 m from the inner edge of the median.

The contractor will be responsible for the quality of shrubs planted and survival of the plants.

The contractor will ensure the regular watering of the plants as per the activity schedule given in Table 1.4

The height of the plants will not be less than 1 ft. and need to be in polythene bags until the planting.

All plants supplied must be planted within three days of removal from the nursery.

The contractor will be required to water the area in case of insufficient rains after planting.

Size of the pits for planting shrubs:	-	45 x 45 x 45 cm.
No. of plants per km	-	666
Use of compost and manure	-	2 kg. per pit.

### REQUIREMENTS OF MEDIAN PLANTS

Considering around 20% of the median having a width of 1 m (along the urban sections), median plantations have been proposed along the remaining sections of the corridor. Accordingly, the number of plants required will be as follows:-

**Table 11 : Plants required in the median - GTRIP**

Package No.	Package length	20% urban + others [having width of 1.2/1.5mts.]	Balance stretch	No. of plants required

IA	50.84	10	40.84	27200
IB	59.02	12	47.02	62630
IC	72.825	15	57.825	77022
IIB	51.33	10	41.33	55052
IVA	76.10	15	61.10	81386
IVC	31.10	6	25.1	33434
VB	81.57	16	65.57	87340
TOTAL	422.78	84	338.785	424064

#### PLANTING MATERIAL:

Roadside avenues can be planted up by following:-

- (a) Entire transplant
- (b) Seedlings in polybags
- (c) Cuttings

#### Entire Transplant

- ◆ The plants are retained in the seed beds.
- ◆ At the time of planting, plants are carefully dug out with a ball of earth.
- ◆ As far as possible, injury to the root system is avoided
- ◆ The ball of earth around each plant can be kept in place by a piece of gunning bag or straw tied round by a piece of string. The transplants are to be kept moist during transit.
- ◆ To avoid transpiration loss, except for the leaves on leading shoot all other leaves may be snipped off with a sharp pair of scissors.

The advantage of transplantation is that very tall sized plants [ upto 3 mts] can be directly planted on the roads and within a short period [ 2 – 3 years] a good avenue can be developed. Species recommended are *Azadirachta indica*, *Syzynium cuminii*, *Mangifera indica*, *Ficus religiosa*, *Ficus glomerata*, shisam, kanji etc.

#### Polythene bag plants

Plants are grown in polythene bags in nurseries and are transplanted to the site.

Polythene sheet is removed before planting the saplings.

#### Cuttings

Cuttings made from aerial roots and branches of species of ficus like Gular, Pakad and Bargad generally strike roots and rapidly establish themselves.

**Table 12 Activities Schedule For Plantation along the Highway / Median**

Executing Agency (roadside plantations): State Forest Departments, Govt of U.P., Bihar and Jharkhand				
Executing Agency (median): Civil Contractors of the respective packages				
		<b>Month</b>		<b>Activities to be done</b>
<b>1st Year</b>	<b>2002-2003</b>	<b>Jan-March</b>	1	Surveying & cleaning of the area
			2	Digging of Pits
			3	Procurement of Angles Iron and barbed wire
<b>2nd Year</b>	<b>2003-2004</b>	<b>April-June</b>	1	Purchase of Farm yard manure
			2	Brick guard for 1 <sup>st</sup> row
			3	Filling up of Pits with Farm Yard manure and Soil
		<b>July-August</b>	1	Transportation of Plants
			2	Planting of Saplings
			3	Watering
			4	Weeding and hoeing
		<b>Sep-Nov</b>	1	Weeding and hoeing
			2	Watering 4 times a month
		<b>Dec-Feb</b>	1	Weeding and hoeing
			2	maintenance
		<b>March</b>	1	Watering 4 times a month
<b>3rd Year</b>	<b>2004-2005</b>	<b>April-June</b>	1	Watering 6 times a month
		<b>July-August</b>	1	Casualty Replacement ( 20% of the total plants )
			2	Weeding
			3	maintenance by Mali
		<b>Sep-Nov</b>	1	Watering 2 times a month
			2	maintenance by Mali
		<b>Dec-Feb</b>	1	maintenance by Mali
		<b>March</b>	1	Watering 4 times a month
			2	maintenance by Mali
<b>4th Year</b>	<b>2005-2006</b>	<b>April-March</b>	1	Watering
			2	Casualty Replacement ( 10% of the total plants )
			3	maintenance by Mali



## LANDSCAPING AT SPECIFIC IDENTIFIED SITES

### Landscaping At Road Junction/Intersection And Traffic Islands

Road intersections are main nodal spaces and are of vital importance in terms of road aesthetics. Proper landscaping of the traffic islands and the surrounding areas shall integrate these features with the surrounding landscape. The lay out of traffic intersections shall be fixed by the traffic needs of the junction. The landscape design has considered the basic standards of height limitations, appropriate sight lines and other geometric design elements that are applicable to each type of traffic intersection.

Considering the high intensity of traffic volume in such areas, the proposed treatment has been designed in such a way that minimum attention is needed in the maintenance of the landscape features. Stability of the landscape items also forms a part of the design proposal.

The major road junctions identified for enhancement along the Grand Trunk road are as per following table:

**Table 13 Major Road Junctions identified for enhancement**

Pack age	Locatio n	Type of Junction	Remarks
1A	200.75	Cross Junction	Rambagh Crossing, Flyover proposed
1A	231.210	Y Junction, Major junction	Landscaping required
1A	232.10	Y junction, start of Raja Ka Tal Bypass	Landscaping required
1A	235.4	Y junction, end of Raja Ka Tal Bypass	Landscaping required
1B	270.277 5	Y Junction	Bypass Cross road, major junction.
1B	282.400	Y junction	Bypass Ukrend meets here, major junction.
1B	283.700	Cross road	Intersection of a major junction.
1C	326.125	Y Junction	Start of Ekdil Bypass
1C	327.0	Y Junction	End of Ekdil Bypass
1C	336.0	Y Junction	Start of Bakewar Bypass
1C	339.3	Y Junction	End of Bakewar Bypass
1C	342.5	Y Junction	Start of Ujhayani Bypass
1C	350.5	Y Junction	End of Ujhayani Bypass
1C	347.6	Y Junction	End of AnatRam Bypass
1C	353.05	Y Junction	Start of Ajitmal Bypass
1C	358.7	Y Junction	End of Ajitmal Bypass
1C	360.4	Y Junction	Start of Bhikepur Bypass
1C	363.45	Y Junction	End of Bhikepur Bypass
1C	366.45	Y Junction	End of Muradganj Bypass
1C	371.500	Cross roads, Major junction	
1C	378.300	Cross roads, Major junction	
II-B	484.100	Cross roads	Major junction near Police Station +

Package	Location	Type of Junction	Remarks
			Temple
II-B	12.400	T-Junction	Road leads to Railway Station chakori
II-B	22.700	T-Junction	Major Junction
II-B	33.400	Cross road	Junction near school, P.S
II-B	38.000	Cross road	Major Junction
IV-A	39.000	Syed Raza Bypass	Major Junction
IV-A	41-300	Syed Raza Intersection	Major Junction
IV-A	45.300	Nanbatpur Bypass	Major Junction
IV-A	46.800	Nanbatpur Bypass	Major Junction
IV-A	62.000	Didekhili Bypass	Major Junction
IV-C	111.5	Bypass Intersection	Major Junction
IV-C	130.5	Bypass Intersection	Major Junction
IV-C	133	Bypass	Major Junction
IV-C	139.5	Bypass Intersection	Major Junction
V-B	203.85	Cross Junction	Semi urban area
V-B	273.275	T- Junction	Rural Area
V-B	278.05	Y-Junction	Rural area
V-B	281.35	Y-Junction	Start of Barhi bypass
V-B	286.775	Y-Junction	End of Barhi bypass
V-B	381.20	T-Junction	Rural area

In addition typical enhancement designs have been prepared for minor junctions. The locations of the minor road junctions for which typical enhancement designs have been proposed are as per the following table:

**Table 14 Minor Road Junctions proposed for enhancement**

S. No.	Package	Location	Type of Junction	S. No.	Package	Location	Type of Junction
1	1A	202.66	T Junction	14	1B	299.8	T-Junction
2	1A	203.76	Y-Junction	15	1C	330.4	T-Junction
3	1A	208.56	Y-Junction	16	1C	357.5	T-Junction
4	1A	210.91	Cross-Junction	1	II-B	12.400	Mavaiya / Chakeri
5	1A	222.56	Cross-Junction	2	II-B	22.700	Igeha / Narwal village
6	1A	240.56	Y_Junction	3	II-B	25.960	Sarsaul
7	1A	250.19	Cross-Junction	4	II-B	33.400	Domanpur / Purvanvir
8	1B	254.5	T-Junction	5	II-B	484.100	Baradevi / Hamirpur
9	1B	257.3	Cross Junction	6	II-B	479.000	Gujaini colony
10	1B	259.6	Cross Junction	7	IV-A	317.150	N
11	1B	276.8	T-Junction				
12	1B	277.7	T-Junction				
13	1B	294.7	Cross Junction				

S. No.	Packag e	Location	Type of Junction	S. No.	Packag e	Location	Type of Junction
8	IV-A	317.350	N	46	IV-C	134.4	South
9	IV-A	317.550	S	47	IV-C	134.5	North
10	IV-A	317.950	S	48	IV-C	134.75	South
11	IV-A	318.150	N	49	IV-C	139	North
12	IV-A	318.450	N	50	IV-C	139.2	North
13	IV-A	318.480	S	51	IV-C	139.4	North
14	IV-A	318.850	S	52	V-B	240.3	T-Junction
15	IV-A	319.000		53	V-B	244.45	Y-Junction
16	IV-A	1.580	N	54	V-B	250.55	Cross Junction
17	IV-A	1.600	S	55	V-B	266.85	T-Junction
18	IV-A	4.400	N/S	56	V-B	272.20	T-Junction
19	IV-A	6.450	S	57	V-B	291.7	T-Junction
20	IV-A	6.550	N	58	V-B	292.0	Y-Junction
21	IV-A	8.270	S	59	V-B	295.20	T-Junction
22	IV-A	8.350	N	60	V-B	301.3	T-Junction
23	IV-A	10.840	N/S	61	V-B	311.6	Y-Junction
24	IV-A	12.050	S				
25	IV-A	14.900					
26	IV-A	16.600	N/S				
27	IV-A	17.500	N				
28	IV-A	18.090	N				
29	IV-A	18.150	S				
30	IV-A	19.450	S				
31	IV-A	19.610	N				
32	IV-A	22.600	N				
33	IV-A	27.200	N/S				
34	IV-A	28.750	N				
35	IV-A	29.2-21	N				
36	IV-C	110.8	N				
37	IV-C	111.6	S				
38	IV-C	304.6	S				
39	IV-C	321.4	S				
40	IV-C	131.2	N				
41	IV-C	131.8	N				
42	IV-C	131.9	N				
43	IV-C	132	N				
44	IV-C	132.4	Both Sides				
45	IV-C	133.4	North				

### Landscaping at Sensitive noise receptors

All along the project corridor certain sensitive receptors for noise have been identified which include Schools and Hospitals. Apart from the noise barriers designed for each location, there has been a special treatment given to all these sites in term of the plantation scheme. At these sites the innermost row planted is a tall shrub of 1.5-3m height for the purpose of maximum possible screening effect. Species like Cassia alata, Cassia biflora, Hemelia patens, etc are used for this purpose.

The locations where such plantation is proposed is given in the following table:

**Table 15 Proposed Plantation for Noise mitigation at identified sensitive locations**

Location of Sensitive receptor	Proposed Plantation			Side of the road	Total area available for Plantation (sq. m)
	From	To	Location		
<b>Package 1A</b>					
Km. 239.000	-	-	Inside the premises of the school	South	3012.7553
Km. 248.050	247.925	248.175	In the proposed RoW for a length of 100m on either side of the existing building	South	6250
<b>Package 1B</b>					
260.200	260.075	260.325	In the proposed RoW for a length of 100m on either side of the existing building as a future provision	North	10,000
284.800	284.675	284.925	In the proposed RoW for a length of 100m on either side of the existing building.	South	5250
290.200	290.075	290.325	In the proposed RoW for a length of 100m on either side of the existing building.	South	5250
292.400	292.275	292.525	In the proposed RoW for a length of 100m on either side of the existing building.	North	5250
297.600	297.475	297.725	In the proposed RoW for a length of 100m on either side of the existing building.	South	5250
302.200	302.075	302.325	In the proposed RoW for a length of 100m on either side of the existing building.	South	5250
<b>Package 1C</b>					
322.200	322.075	322.325	In the proposed RoW for a length of 100m on either side of the existing building.	North	NIL
334.400	334.275	334.525	In the proposed RoW for a length of 100m on either side of the existing building.	South	4350

Location of Sensitive receptor	Proposed Plantation				
	From	To	Location	Side of the road	Total area available for Plantation (sq. m)
336.100	335.975	336.225	In the proposed RoW for a length of 100m on either side of the existing building.	North	NIL
368.900	368.775	369.025	In the proposed RoW for a length of 100m on either side of the existing building as a future provision	South	2500
384.000	-	-	Inside the premises of the school	South	1551.0
<b>Package 2B</b>					
36.900	36.775	37.025	In the proposed RoW for a length of 100m on either side of the existing building	South	2125
<b>Package 4A</b>					
19.700	19.575	19.825	In the proposed RoW for a length of 100m on either side of the existing building	North	475
23.200	23.075	23.325	In the proposed RoW for a length of 100m on either side of the existing building	North	5000
27.400	27.275	27.525	In the proposed RoW for a length of 100m on either side of the existing building	North	5000
<b>Package 5B</b>					
274.800	274.675	274.925	In the proposed RoW for a length of 100m on either side of the existing building	North	NIL
276.500	276.475	276.625	In the proposed RoW for a length of 100m on either side of the existing building	North	NIL
290.900	290.775	291.025	In the proposed RoW for a length of 100m on either side of the existing building	North	NIL
Source: LASA Field Survey, October 2000.					

## Institutional Mechanism and Monitoring

For each consultancy package there will be an Environmental Manager who will be looking after the environmental activities before, during and after the construction.

The environmental cell of the Corporate Office will coordinate monitor and administer the activities relating to environmental issues.

The responsibility for the plantation and maintenance of the roadside plantation proposed will be entrusted to the respective state Forest Departments.

The plantation in the median, landscaping at junctions, landscaping at selected specific sites (around water bodies, cultural properties etc) will be the responsibility of contractors. The contractor will be accountable for the quality of the seedlings, Survival percentage and maintenance of the plantation.

The Forest Department will ensure the adequacy of plants before the beginning of plantation work. In the MoU submitted to the State Forest Departments, it has been indicated that the required saplings will be raised by the forest department in their existing nurseries. Interactions with the Forest Departments revealed that the existing nurseries will be sufficient to raise the required saplings for the project.

Forest Department will be raising the seedlings and the money pertaining to this will be borne from the (cost of plants) as mentioned in the scheduled rate.

The rates proposed in work plan are based on the schedule rates as per the quantum of work and the minimum wages. The Schedule rates of Forest Department will be applicable where plantation will be done by Forest Department. The Forest Department will follow the same technical specification as specified in the tree plantation scheme.

The plantation is a phased activity therefore the amount will not be released on lumpsum basis. The respective state forest departments will provide the certificate of utilization of funds along with number of trees/ survival to the PIUs after every six months. The concerned Environmental Manager along with Forest Department & Supervision Consultant will do the physical verification of the site. The contractor/forest Department will ensure 80% survival rates in the normal site and 70% in alkaline sites after the end of fourth year.

**Table 16 : Proposed Monitoring Arrangements**

Phase	Monitoring Parameter	Monitoring by	Release of Payment
1 <sup>st</sup> Year (Advance Soil Work)	No. of pits	Environmental Manager, Environmental Officer of Supervision Consultant & Representative of Forest Deptt.	December -50% of the total amount
2 <sup>nd</sup> Year (Plantation of Saplings)	Survival % of saplings	Environmental Manager, Environmental Officer of Supervision Consultant & Representative of Forest Deptt.	April-20% of the total amount
3 <sup>rd</sup> Year (Maintenance of Plantation)	Survival % before & after Causality replacement	Environmental Manager, Environmental Officer of Supervision Consultant & Representative of Forest Deptt.	April-20% of the total amount
4 <sup>th</sup> Year (Maintenance of Plantation)	Survival % before & after Causality replacement	Environmental Manager, Environmental Officer of Supervision Consultant & Representative of Forest Deptt.	April-10% of the total amount

A Memorandum of Understanding (MoU) has been prepared to link the release of payment with the survival rate of plantations and the same has been submitted to the State Forest Department.











Single row Plantation Activity Year wise starting from Jan 2001 along the Highway for all the Packages					
Year	Activity No	Description of Work for Single row Plantation	Unit Rate(Rs)	Quantity(per Km.)	Total Amount(in Rs.)
1st Year	1	Survey and alignment			500.00
	2	Cleaning of Area			1000.00
	3	Digging of Pits for			
		(a) Shade Plants (60cmX60cmX60cm)	8.00	84	672.00
	4	Purchase of tree Guard	500.00	84	42000.00
		Total			44172.00
		Contingency (5%)			2208.60
	Grand Total			46380.60	
2nd Year	1	Purchase of Farm Yard manure/chemicals	2.00	84	168.00
	2	Filling up Pits	1.00	84	84.00
	3	Fixing up tree guard	40.00	84	3360.00
	4	Cost of Plants(including 10% more due to mortality on transit and	15.00	94	1410.00
	5	Transportation of Plants	3.00	94	282.00
	6	Plantation	1.50	84	126.00
	7	Weeding	1.00	252	252.00
	8	Irrigation between Sep-March(16 times)	1.00	1344	1344.00
	9	Watch &Ward for nine Months	500.00	12	6000.00
		Total			13025.00
	Contingency (5%)			651.30	
	Grand Total			13677.30	
3rd Year	1	Casualty Replacemnt(20% of the total)			
		(a) Cost of the Plant	15.00	17	255.00
		(b) Transportation of Plants	3.00	17	51.00
	2	Weeding & hoeing	1.00	252	252.00
	3	Irrigation(16times)	1.00	1344	1344.00
	4	Watch &Ward(for 12months)	500.00	12	6000.00
	Total			7902.00	
	Contingency (5%)			395.10	
	Grand Total			8297.10	
4th Year	1	Casualty Replacemnt(10% of the total)			
		(a) Cost of the Plant	15.00	8	120.00
		(b) Transportation of Plants	3.00	8	24.00
	2	Weeding & hoeing	1.00	252	252.00
	3	Irrigation(16times)	1.00	1344	1344.00
	4	Watch &Ward(for 12months)	500.00	12	6000.00
	Total			7740.00	
	Contingency (5%)			387.00	
	Grand Total			8127.00	

**Multiple row Plantation Activity Year wise starting from Jan 2001 along the Highway for all the Packages**

Year	Activity No	Description of Work for Multiple row Plantation	Unit Rate(Rs)	Quantity( per Km.)	Total Amount( in Rs.)
1st Year	1	Survey and alignment			500.00
	2	Cleaning of Area	2000.00		2000.00
	3	Digging of Pits for			
		(a) Shade Plants (60cmX60cmX60cm)	8.00	84	672.00
		(b) Other Plants (45cmX45cmX45cm)	6.00	333	1998.00
	4	Angle Iron@ spacing of 4 metre	150.00	250	37500.00
	5	Barbed Wire	26000.00	0.5	13000.00
		Total			53170.00
	Contingency (5%)			2658.50	
	Grand Total			<b>55828.50</b>	
2nd Year	1	Purchase of Farm Yard manure/chemicals	2.00	417	834.00
	2	Filling up Pits	1.00	417	417.00
	3	Fixing up angle iron	20.00	250	5000.00
	4	Stretching of barbed wire			3000.00
	5	Cost of Plants(including 10% more due to mortality on transit and	15.00	460	6900.00
	6	Transportation of Plants	3.00	460	1380.00
	7	Plantation	1.50	417	625.50
	8	Weeding (3times)	1.00	1251	1251.00
	9	Irrigation between Sep-March(16 times)	1.00	6672	6672.00
	10	Watch &Ward for nine Months	500.00	9	4500.00
		Total			30579.50
	Contingency (5%)			1528.98	
	Grand Total			<b>32108.48</b>	
3rd Year	1	Casualty Replacement(20% of the total)			
		(a) Cost of the Plant	15.00	80	1200.00
		(b) Transportation of Plants	3.00	80	240.00
	2	Weeding & hoeing	1.00	1251	1251.00
	3	Irrigation(16times)	1.00	6672	6672.00
	4	Watch &Ward(for 12months)	500.00	12	6000.00
	Total			15363.00	
	Contingency (5%)			768.15	
	Grand Total			<b>16131.15</b>	
4th Year	1	Casualty Replacement(10% of the total)			
		(a) Cost of the Plant	15.00	40	600.00
		(b) Transportation of Plants	3.00	40	120.00
	2	Weeding & hoeing	1.00	1251	1251.00
		Irrigation(16times)	1.00	6672	6672.00
	4	Watch &Ward(for 12months)	500.00	12	6000.00
	Total			14643.00	
	Contingency (5%)			732.15	
	Grand Total			<b>15375.15</b>	

Plantation Activity in the Median Year wise starting from Jan 2001 along the Highway for all the Packages					
Year	Activity No	Description of Work for in the Median Plantation	Unit Rate(Rs)	Quantity( per Km.)	Total Amount( in Rs.)
1st Year	1	Survey and alignment			500.00
	2	Cleaning of Area			2000.00
	3	Digging of Pits for			
		(b) Other Plants (45cmX45cmX45cm)	6.00	666	3996.00
		Total			6496.00
		Contingency (5%)			324.80
		Grand Total			6820.80
2nd Year	1	Purchase of Farm Yard manure/chemicals	2.00	666	1332.00
	2	Filling up Pits	1.00	666	666.00
	5	Cost of Plants(including 10% more due to mortality on transit and	15.00	733	10989.00
	6	Transportation of Plants	3.00	733	2199.00
	7	Plantation	1.50	666	999.00
	8	Weeding (3times)	1.00	1998	1998.00
	9	Irrigation between Sep-March(16 times)	1.00	10656	10656.00
	10	Watch &Ward for nine Months	500.00	9	4500.00
		Total			33339.00
		Contingency (5%)			1666.95
		Grand Total		35005.95	
3rd Year	1	Casualty Replacemnt(20% of the total)			
		(a) Cost of the Plant	15.00	133	1998.00
		(b) Transportation of Plants	3.00	133	399.00
	2	Weeding & hoeing	1.00	1998	1998.00
	3	Irrigation(16times)	1.00	10656	10656.00
	4	Watch &Ward(for 12months)	500.00	12	6000.00
		Total			21051.00
	Contingency (5%)			1052.55	
		Grand Total		22103.55	
4th Year	1	Casualty Replacemnt(10% of the total)			
		(a) Cost of the Plant	15.00	66	990.00
		(b) Transportation of Plants	3.00	66	198.00
	2	Weeding & hoeing	1.00	1998	1998.00
	3	Irrigation(16times)	1.00	10656	10656.00
	4	Watch &Ward(for 12months)	500.00	12	6000.00
		Total			19842.00
	Contingency (5%)			992.10	
		Grand Total		20834.10	