

# APPLICATION OF GIS IN NATIONAL GREEN HIGHWAYS MISSION

Engr. Aman Kumar<sup>1</sup>, Prof. A.B. Shelar<sup>2</sup>

<sup>1</sup>Student ME, Dept. of civil-Environment Engineering, Anantrao Pawar College of Engineering & Research, Pune

<sup>2</sup>Head of Dept., Civil Engineering, Anantrao Pawar College of Engineering & Research, Pune

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**Abstract** - Ministry of Road, transport and Highways (MoRTH), Government of India formulated National Green Highways Policy, 2015 (Plantation, Transplantation, Beautification and Maintenance Activities along Green Highway) with the vision to develop eco-friendly National Highways with participation of the community, farmers, NGOs, private sector, institutions, government agencies and the Forest Department for economic growth and development in a sustainable manner. The application GIS implementation and maintenance of these plantations will reduce the manpower used in such projects. It will also try to use GIS to minimize use of irrigation water in such projects.

**Key Words:** Avenue Plantation, NGHM, GIS, Manpower, database, green cover, sustainability

## 1. INTRODUCTION

National Highways is an arterial road network of the country for interstate movement of goods and passengers. The total length of national highways in the country at present is 1, 32,499 kms. National Highways constitute about 1.7% of the total length of roads in the country and carries 40% of the road traffic. In the end of financial year 2016-17, 55,886 km of national highways were planned to be developed. Various upcoming major national highways and expressways projects are like the Eastern Peripheral Expressway, Western Peripheral Expressway, Delhi-Meerut Expressway, Purvanchal Expressway, Ganga Expressway, Delhi-Mumbai Expressway, Bharatmala Project etc. Loss of ecosystem, changes in land use, noise pollution and air pollution caused during construction and operation of highways are the major negative impacts of highway construction.

The Ministry of Road Transport & Highways (MoRTH) has promulgated Green Highways (Plantation, Transplantation, beautification & Maintenance) Policy-2015, under which plantations have been initiated in collaboration with Forest Departments and other agencies. No separate funds are earmarked for plantations along National Highways. Plantations are part of all new National Highway projects and are undertaken as per the relevant contract provisions within the Right of Way of a national highway. Under this mission, 1% of the total project cost of all highway projects will be kept aside for the highway plantation and its maintenance. This policy will also generate employment opportunities for about 5 lakh people in rural areas.

## 2. OBJECTIVES

The green cover of the country is around 25% which is very less than the proposed 33% of the geographical area. Ministry of Road, transport and Highways (MoRTH), Government of India formulated National Green Highways Policy, 2015 (Plantation, Transplantation, Beautification and Maintenance Activities along Green Highway) with the vision to develop eco-friendly National Highways with participation of the community, farmers, NGOs, private sector, institutions, government agencies and the Forest Department for economic growth and development in a sustainable manner. Subsequently, National Highway Authority of India (NHAI) through National Green Highway Mission (NGHM) has developed guidelines for execution of green highway projects under National Green Highway Policy, 2015 for complete planning, implementation and best outcome. The main objective of NGHM is to build a resilient ecosystem and an aesthetically appealing green corridors along the highway. NGHM emphasizes on three tier plantations on both sides of road with native and Rare, Endangered and Threatened (RET) species of appropriate plantation matrix. NGHM provides guidelines for provision of funding for planning, implementation, monitoring and management of these green corridors from 1% of the total project cost of highway project.

The objective of this study is to find application of GIS in National Green Highways Mission and increase the survivability of the plantation proposed and share real time data with user and policy makers. As the objective of National Green Highways Mission is plantation along National Highways, maintaining these plantations will be a tedious task. The objective of this study will be using GIS data in implementation and maintenance of these plantations. This study will discover opportunities for reducing manpower by using GIS in such projects. It will also try to use GIS to minimize use of irrigation water in such projects.

The national highways pass through varying terrain and hence use of GIS can ease the regular updating of physical status of the plantation and thorough monitoring by user

1. To understand what asset management system is and the terms in it.
2. To examine the current practices followed in the study area for capital maintenance.

3. Study the probable environmental effect of the asset over its life cycle.
4. Formulate and execute long and medium-term plans for improvement in asset performance

Study and relate any analytical and optimisation models to support decision making in the capital maintenance.

To provide a platform for a given area to manage, operate, maintain a particular asset so that it can meet the desired end user's requirement throughout its life cycle.

### 3. LITERATURE REVIEW

The Manual on Landscaping of Roads was published by Indian Road Congress as IRC SP-21 in December 1979 revised in 2009. The manual provides a comprehensive guideline on both hardscaping and softscaping of roads with respect to physiographical, environmental, climatic and operational factors. Road Projects especially rural road projects have few adverse consequences on environment. There is always a conflict between development and environment and therefore the idea of sustainable development has been incorporated in roads and highway projects. An approach of "Corridor Development & Management" rather than "Highway Development" would help incorporate sustainable development in highway projects. Under Corridor Development and Management, the road agencies are required to mitigate the environmental losses from various factors like felling of trees along the highway etc. and also enhance the aesthetics of corridor.

National Green Highway Mission (NGHM) was a policy initiated by National Highway Authority of India (NHAI), under which they issued some specific guidelines for complete planning, implementation and best outcomes for any Green Highway Project

Chief guiding principles specified under **NGHM Policy 2015**, related to all the Plantation Programmes in the Country are deliberated and stated below:

1. For all developing and upcoming highways and road widening projects, the space for Plantation scheme should be included within the Right of Way (RoW), during the planning stage itself.
2. Project reports for development of integrated Green Corridor will be a part of the Detailed Project Report. The provisions for the same shall be made in RFP-RFQ.
3. Priority shall be given to native trees/shrubs and grasses.
4. Also 1% of Total Project Cost should be reserved for the plantation programme and maintenance of plantations.
5. For all new highways, trees of age 2 years and above shall be considered for transplantation.
6. Sites of cultural and historical importance are identified and landscaping activities around it shall be undertaken to highlight the site aesthetics.

7. Such project shall have five-year maintenance schedule with year-wise expected outcomes. Maintenance schedule of each plant/tree/shrub shall be reported.
8. Promoting Non-governmental organizations (NGO's)/Self Help Groups (SHG's)/Private organizations to get involved in Plantation Programmes' and take individual initiatives by offering them certain tax benefits and similar motivational schemes.
9. Real time monitoring of plantation and allied activities is to be undertaken using Geographic Information System (GIS) enabled data imagery tool. Periodic progress reports will also be submitted time to time.
10. Under these guidelines, plantation agencies are required to be empanelled to the NGHM before undertaking any such plantation works.
11. Apart from empanelled plantation contractors, plantation can also be undertaken through institutional tie-ups, individual citizens/farmers and corporates/institutions.
12. PPP based captive plantation along the highway stretch can be undertaken by Agro-forestry industries on profit sharing basis or other contractual agreement.
13. A comprehensive Quality Assurance Mechanism is employed based on GIS mapping, field verification etc.

### 4. METHODOLOGY

The project involved identifying a project location at the study area, sample design and sample analysis. The first step of the project is to conduct a reconnaissance survey in the study area to identify suitable locations.

- Identifying the study area
- Site Visit and Reconnaissance Survey
- Collection of project data
- Review of drawings and details
- Preparation of details to be updated on the GIS tool
- Defining of Unique Code
- Development of tool using ArcGIS and Google Earth tool

### 5. NEED OF STUDY

The green cover of the country is around 25% which is very less than the proposed 33% of the geographical area. Ministry of Road, transport and Highways (MoRTH), Government of India formulated National Green Highways Policy, 2015 (Plantation, Transplantation, Beautification and Maintenance Activities along Green Highway) with the vision to develop eco-friendly National Highways with participation of the community, farmers, NGOs, private sector, institutions, government agencies and the Forest Department for economic growth and development in a sustainable manner. Subsequently, National Highway Authority of India (NHAI) through National Green Highway Mission (NGHM) has developed guidelines for execution of green highway projects under National Green Highway

Policy, 2015 for complete planning, implementation and best outcome. The main objective of NGHM is to build a resilient ecosystem and an aesthetically appealing green corridors along the highway. NGHM emphasizes on three tier plantations on both sides of road with native and Rare, Endangered and Threatened (RET) species of appropriate plantation matrix. NGHM provides guidelines for provision of funding for planning, implementation, monitoring and management of these green corridors from 1% of the total project cost of highway project.

## 6. STUDY AREA

The Hindu Hrudaysamrat Balasaheb Thackeray Maharashtra Samruddhi Mahamarg (HHBTMSM) is a six-lane expressway connecting Nagpur and Mumbai passing through 10 districts, 26 talukas and 392 villages. The expressway project is entirely Greenfield in nature. Various agro-industrial nodes, Krushi Kendras have been proposed at different locations along the expressway to facilitate socio-economic development of the region.



The entire project stretch having been divided into 16 EPC (Engineering Procurement Contracts) packages and ten districts has been studied in detail. This study is based on review of secondary data and observations from site visits. The project area has been studied on various parameters like climate, soil, water availability, crops, industries, indigenous flora species, historical and cultural importance and important tourist places. Various of these parameters like climate, water availability, soil, crops and local industries would be considered while selecting plantation species in that region while details like historical and cultural importance and tourism spots will be reflected in the landscaping design of various areas along the expressway stretch.

## 7. FIELD STUDY

The study was commenced visit from Nagpur (000+000 Chainage) and ended at Thane (701+355) by travelling along the project stretch.

Following salient points were identified during the reconnaissance survey:

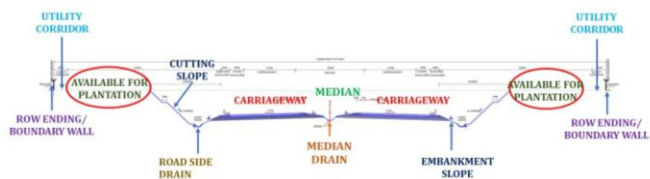
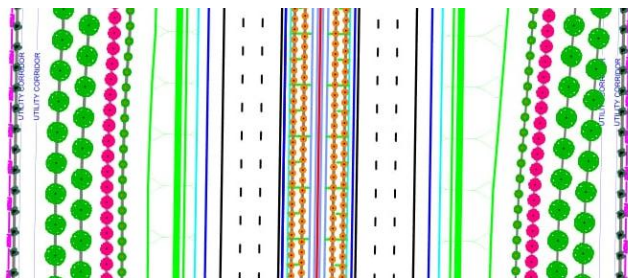
- Right of Way boundary has been marked by pillars on both sides at each 50m interval throughout the stretch.
- Construction activity was progressing at good pace in most construction packages.

- Barring starting 6.4km of the alignment which has 80m Right of Way the remaining stretch has 120m Right of Way.
- Plantation width on both ends of Carriageway are varying due to varying embankment height along the alignment.
- Plantation area on both sides is being used by construction contractors for transport of materials and labourers. Due to this movement the soil in the area has become compacted.
- Most stretch of the alignment is motorable excluding some hilly terrain in forest areas.
- Several Structures such as VUP, Utility Crossing, Major Bridge, Minor Bridge, Culverts, Viaducts are proposed frequently along the alignment.
- There is least possible vertical curve in the alignment.
- Existing plantation in the Right of Way has been either cleared or were being cleared.
- Interchanges area has been cleared but the construction activity was yet to be commenced at these areas.
- At certain locations in cutting portions natural pond were observed in RoW; showing groundwater sources at those locations.
- Several existing borewells in the right of way were filled during construction activity; still several borewells were live and being used by farmers from adjoining agricultural fields.
- Many surface water sources were having abundant water available; as informed by locals it is due to ample rainfall in the preceding monsoon season.
- During discussion with construction labourers it was noted that the construction activity is affecting the movement of wild animals in the project vicinity.
- Excavation for construction activity gave preliminary idea of major Soil type in the region which is Black Cotton Soil at top with murum after 1-2 feet depth, Weathered and Hard rock are present in hilly terrain of Washim, Buldhana Nashik and Thane.
- Agriculture is the major land use in the project area. Major crops grown are Pulses, Soya bean and Cotton. At some location bulk plantation of Eucalyptus, Sagwan and several fruit farms were seen.
- HT/LT lines are crossing or running parallel to the alignment at certain locations.
- Irrigation method is mostly traditional but at many locations drip irrigation and sprinkler was seen in fields. Solar powered irrigation system was also visible at few sites.
- Construction of boundary wall at both ends hadn't been commenced at any location.



### 8. DATA ANALYSIS

In order to identify width available for plantation, the approved GFC drawings of individual Construction Packages were gathered. Plan, profile and Typical Cross Section were studied in detailed. Firstly, TCS were reviewed to identify the project features. Various Project features identified have been listed below and elaborated.



Sr. No.	Rows	Set Distance	Back	Plant to Plant Spacing
	Plantation		previous row	

All of the trees, shrubs and plants which will be planted under the Landscaping & Plantation Scheme will be given certain code-names with the help of some specific coding progression. Under this process the coding will be such established that will help to identify the plant with its specie name, location along the corridor & the specific Row or Median category.

Monitoring the plantation status on continuous basis will be carried out by site visit for field verification to check survival, growth and size of plantation and maintenance of the same. Plantation agencies will use mobile app to submit the status of plantation and project activities performed by them. Data generated through this app will help in monitoring of the project.

The below table, shows the fields that will be collected:

ID	Condition
Street (Package)	Cond Notes
Species	Mulch
Location	Unit
Prop. Num	Stakes
Date	Plant Depth
Notes	Time
Latitude	Moisture
Longitude	Irrigation
Caliper	More Attribute fields will be added as per requirement

The plantation width available on avenue area and median has been calculated based on the plan and profile of the area and the site condition. The plantation width availability has been summarised below:

Sr. No.	Rows	Set Distance	Back	Plant to Plant Spacing
1	First Row	1m from edge of drain		3 m
2	Second Row	3m from previous row		3 m
3	Subsequent Rows	5m from previous row		6 m
4	Bamboo Plantation	1m from the boundary wall		4 m
5	Median	2m distance from		2 m

Con s. Pkg s.	Left Side (Km)			Median (km)			Right Side (Km)		
	< 12 m	12-18 m	> 18 m	5 m	12.5 m	15 m	< 12 m	12-18 m	> 18 m
CP 01	6.2	12.26	12.52	8.50		22.50	6.04	11.69	13.2

Con s. Pkg s.	Left Side (Km)			Median (km)			Right Side (Km)		
	< 12 m	12-18 m	> 18 m	5 m	12.5 m	15 m	< 12 m	12-18 m	> 18 m
CP 02	6.09	17.05	35.27			58.41	6.43	16.87	35.1
CP 03	4.57	16.56	52.12			73.25	4.96	17.77	50.5
CP 04	2.41	8.75	43.20			54.36	4.29	10.07	40.0
CP 05	1.29	2.71	38.88			42.88	1.43	2.69	38.7
CP 06	0.81	7.72	28.17			36.70	0.82	8.81	27.0
CP 07	1.82	5.06	43.71			50.59	1.98	4.66	43.9
CP 08	2.05	6.95	34.26			43.26	1.98	7.26	34.0
CP 09	9.82	12.28	31.94			54.04	8.85	10.94	34.2
CP 10	3.94	14.01	40.29			58.24	4.24	13.40	40.6
CP 11	2.78	10.30	16.26			29.34	2.80	10.42	16.1
CP 12	5.40	11.74	28.51			45.65	7.67	14.25	23.7
CP 13	7.00	6.46	32.28			45.74	6.84	8.47	30.4
CP 14	10.40	1.00	1.60		13.00		10.58	0.90	1.52
CP 15	6.49	1.58	19.93		28		7.04	1.73	19.2
CP 16	12.45	3.02	21.43		36.9		12.40	3.41	21.0
<b>Total</b>	<b>83.54</b>	<b>137.45</b>	<b>480.4</b>	<b>8.50</b>	<b>77.9</b>	<b>614.9</b>	<b>88.35</b>	<b>143.3</b>	<b>469.6</b>

### 9. FUTURE SCOPE

The individual codes provided to each plant will help in monitoring it throughout its life. Using this code, the given monitoring agency will update the condition of tree at any given time and the user can access this from around the world using GIS. Also, the given code will work only when the monitoring agency will update the plant standing in its nearby area within given geographical coordinate which will remove chances of fake results.

When implemented all along the National Highways this system will reduce the manpower and time involved under management of such plantations. By using this system, the maintenance schedule of the plant can be updated by this the maintenance person can get the time at which manuring or fertilizer needs to be done.

Using GIS, the changes in tree cover in the area can be estimated. This will also help in gaining the carbon credits benefits under Clean Development Mechanism.

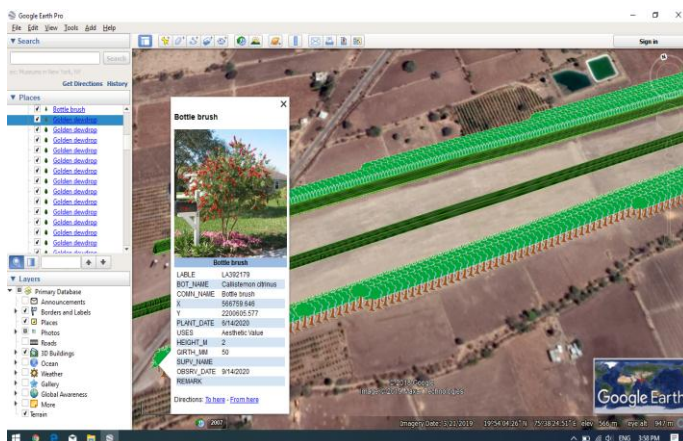
The data when compiled can give the details of flora in the region; when compared with the physical growth can help in understanding different species of flora in a given region. The geo tagged data act as profit generation option; the geotagged plants can be adopted by individuals online by paying a small amount of money and they can follow the growth of the tree.

### 10. CONCLUSION

Based on the plantation width available following number of avenue plants, bamboo and shrubs have been evaluated.

Package	Avenue	Bamboo	Shrubs	Total
EPC 01	43,090	13,178	42,654	1,23,747
EPC 02	1,03,573	26,073	1,11,688	3,07,361
EPC 03	1,18,348	31,501	1,40,555	3,31,454
EPC 04	95,290	23,037	1,02,283	2,76,488
EPC 05	77,133	17,901	77,237	1,97,984
EPC 06	63,642	17,226	68,870	1,89,671
EPC 07	87,099	21,857	92,356	2,91,020
EPC 08	72,940	19,008	79,446	2,00,781
EPC 09	88,377	25,165	1,00,604	2,72,890
EPC 10	96,806	26,208	1,11,806	2,62,289
EPC 11	46,067	13,109	54,466	1,26,751
EPC 12	69,097	20,742	86,927	2,00,555
EPC 13	70,158	18,980	78,877	2,37,482
EPC 14	1,173	275	2,746	8,956
EPC 15	45,772	11,695	46,754	1,58,798
EPC 16	54,348	13,715	57,698	1,79,083
<b>Total</b>	<b>11,32,913</b>	<b>2,99,670</b>	<b>12,54,967</b>	<b>33,65,310</b>

- In order to monitor plants all along its life individual and unique code has to be allotted. In this regard an eight-digit unique code system has been developed like RA008457.
- In this system first symbol is R/L representing Right or Left side of the alignment. The second symbol is row number of plants which can be A/B/C/D/E depending on row number. The rest six digits represent the chainage in meters at which plant is located.
- The six digits are considered based on the longest possible chainage in the alignment.
- The benefit of assigning the code with respect to chainage is to make it easier for site team to identify the trees. As the chainages will be marked on the nearby boundary wall.
- The code will be unique for each tree given to it at planning stage which will be georeferenced.
- Even if the tree dries after some time the unique code for each geographical location will be remain same.
- This will remove malpractice and the user will be informed about the status of each tree.
- All the physical details of each tree as well as its maintenance schedule will be linked with the code.



## ACKNOWLEDGMENT

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