

Greenbelt development Plan

The NALCO as a public sector corporate body has taken all measures for prevention and control of pollution and conservation of wildlife. Though mining is its main activity, it is committed for sustainable mining and restoration of the mined areas. It has full-fledged environment monitoring and management cells.

Greenbelt is often recommended as a part of the EMP. Except in those areas where there thick forests, it is proposed to develop greenbelt on all sides of the MLA. The main objectives of a greenbelt are:

1. Greenbelts are mainly meant to isolate and protect the surroundings and neighboring areas of industries from air, dust and noise pollution. Greenbelts in and around urban areas may not have saved any lives, but they are important nonetheless to the ecological health of any given region. Greenbelts are also important to help urban dwellers feel more connected to nature.
2. To check the unrestricted sprawl of large built up areas and to safeguard the surrounding areas from further encroachment. City and Town planners suggest that all cities should “ earmark certain areas for the development of greenbelts to bring life and color to the concrete jungle and a healthy environment to the urbanities.
3. To minimize, confine and restrict the adverse impacts in case of any accident or natural calamity. For instance, the natural greenbelts along areas of Southeast Asia’s coastlines, including the region’s mangrove forests, served as buffers and helped to prevent even greater loss of life from the December 2004 Tsunami.
4. To act as a sink for carbon dioxide, a source for oxygen. The various plants and trees in greenbelts serve as organic sponges for various forms of pollution, and as storehouses of carbon dioxide to help offset global warming.
5. Dust suppression, wind break, noise attenuation, prevention of soil erosion and desertification – Tall and thick plant communities are proved to be highly effective even in restricting the velocity of cyclonic winds. Shelter belts are used widely to halt desert expansion.
6. To act a bio-drain for draining the waste water used for land application and wasteland reclamation. Some plants which are capable of growing in water logged soils such as rain tree (*Samanea saman*) are found to be highly suitable in draining the stagnant water.
7. To provide the natural medium for treatment, filtration and recharge of ground water i.e., waste water treatment and ground water recharge. Several plant species like sweet alyssum plants (*Lobularia maritime*, *Alyssum maritimum*) have been identified for phytoremediation by means of hyper accumulation or rhizofiltration, phytovolatalization or chelation of heavy metals.

8. To act as a stabilizer of climate. In case of large industrial units where trees are grown in hundreds of acres, they are found to have brought about the qualitative change in the local microclimate. They can bring down the temperature by feeding the dry atmosphere with moisture from soil through transpiration and shading the soil surface.
9. To provide shade, shelter, food and nesting space for wildlife. Salim Ali, the famous Ornithologist states that birds can't exist without trees and the world would perish without birds.
10. For conservation of local biodiversity, a large stretch of undeveloped and unused land is left undisturbed, it can transform into a wildlife reserve within study area.
11. To give green and pleasant look and a relaxing place for workers. An industry without greenbelt is like a naked human being.
12. To prevent neighboring towns from merging into one another in case of city and town planning.
13. To provide tangible economic benefits of fruit, fodder, firewood and other minor produce to the workers and nearby communities and others.
14. Above all, a strong and thick greenbelt can make the environment acceptable and sustainable.

Characteristics of a greenbelt

The major consideration in greenbelt design and development is the density (number per Ha) and width of the greenbelt. Just a row of scattered and isolated trees will not form a greenbelt. Similarly, lawns and few ornamental herbs and shrubs are not going to make a greenbelt. Ideally, a green belt is a thick plantation of at least 15 m width on all sides of industrial units. The density of trees should be at least 1500 to 2000 trees per hectare in 3m x 3m or 2m x 2m spacing. In certain case such as high-density plantations it can be as high as 10,000 plants per Ha. As per the norms of CPCB and MoEF&CC, at least about 33% of the area should be under the greenbelt. The general criteria for selection of plants for greenbelt are:

1. It is preferable to go for tall and evergreen plants which are locally adapted. Exotic species except those which got naturalized should not be introduced.
2. Trees with multiple uses are more desirable than the useless fast-growing species. They should be able to provide at least non-timber products such as minor fruit, flower, fodder etc.
3. The plants chosen for greenbelt should be structurally and functionally similar to the local trees.
4. Another criterion for selection is their tolerance to pollution which is measured as Air Pollution Tolerance Index (APTI) for many of the trees grown in green belts and avenue plantations.
5. Species with invasive potentials should not be planted.

6. Plants with thick canopy and high leaf area index are more preferable than others.
7. They should be capable of growing under the given set of environmental conditions.
8. Trees with known allergens should be avoided in human environment.
9. Resistance to wind, cyclones, dust, heat, water logging or drought etc. are among the other considerations.
10. Even if it is the most suitable species, it is desirable to avoid monocultures (single species). Poly-culture or mixed culture of different species is always better than a single species.

Nearly about 200 species of perennial plants, trees and shrubs have been identified and grown in greenbelts in different countries. What is desirable and suitable for one agro-climatic region may be unsuitable for another region. Hence, due attention should be paid for selection of plants.

Design and development of a greenbelt

This is the most important task in developing a structurally strong and functionally sound greenbelt. But very little attention is paid to this aspect. It is the job of a specialist such as a botanist or horticulturist or silviculturist or an experienced farmer and a committed gardener. The primary consideration in the design and development of the greenbelt is the choice of plant species. It depends on suitability of soil, climate, and availability of water, extent of land available and its atmospheric emissions and other local circumstances such as the availability of planting stock etc. But the best and simple point is to find ecological equivalents of the species that were growing originally in the area under consideration.

Plantation techniques include selection of seed or sapling, preparation of land, alignment in the form of rows and columns, digging of pits, size of pits, filling of pits with mixtures of garden soil and organic manure, pretreatment of pits with insecticides for control of termites, filling the pit after transplantation, watering and weeding schedules, gap filling or replacement of dead saplings and many other practices involved in the establishment and maintenance of plantations.

Site specific greenbelt development plan

In the mine lease area, dwarf date palm (*Phoenix acaulis*) is widely scattered and easily the most abundant and dominant species. The plant is endemic to northern India but it is now widely grown as an ornamental. It has an extensive fibrous root system and highly resistant to drought. It is a soil binder and prevents soil erosion. Further it promotes ground water recharge by intercepting rain drops and retarding the runoff. It is easy to translocate and transplant them with a very high rate of survival provided due care is taken for a month after transplantation.

Dwarf date palms from the mining areas shall be uprooted and transplanted all along the boundary in five rows at a distance of 1.5 m. The width of the greenbelt shall be 7.5 m and the total length shall be 31256m. Mathematically, it is possible to grow 1,01,935 plants along the

boundary. During the rainy season, seeds of Hamata (*Stylosanthes hamata*) and pelletized seeds of Subabul (*Leucaena leucocephala*) shall be sown liberally in order to have a two tier greenbelt with perennial fodder. Additionally, avenue trees shall be grown on both the sides of roads at a distance of 5 m (total 400 trees per Km of road with 200 on each side at a distance of 5 m). About 32,000 avenue trees can be grown along the road sides. A list of avenue trees is given in **Table 1**.

Plants suitable for greenbelt

The plants choose for greenbelt must be process the characters listed below:

1. High Air Pollution Tolerance Index (APTI).
2. Adaptation to local climatic conditions.
3. Tall and evergreen with high leaf area index (LAI) and chlorophyll content.
4. Resistance to diseases and pests.
5. Resistance to wind, cyclones and tolerance to flooding or drought
6. Multipurpose trees such as Mango, Neem, Tamarind, Pongamia etc.
7. Capacity to survive after an initial maintenance of three years and many more

For development of greenbelt the native species are recommended as per the “Guidelines for developing greenbelts” compiled by the CPCB [Ref. Probes/75/1999-2000]. Based on nature of soil, performance of species and purpose of plantation, following species have been suggested for greenbelt plantation is given in **Table 1**.

Table 1. List of plants identified for greenbelt, avenue and block plantations

Botanical name	Common name	Importance	Suitability
<i>Acacia auriculiformis</i>	Australian wattle/ Akasmoni	Avenue and agro- forests	An exotic species and widely grown all over India.
<i>Acacia nilotica</i>	Babool	Country timber and fodder for goats	Grows all over India but not preferred since it has spines.
<i>Achras sapota</i>	Sapota	Edible fruit	Widely cultivated fruit tree.
<i>Ailanthus excelsa</i>	Mahaneem	Tree borne oil	Widely grown as an avenue tree and also occurs in forests
<i>Albizia lebbeck</i>	Dirisana/Kala sirus	Shade, timber and scented flowers	Widely grown as an avenue tree
<i>Albizia procera</i>	Safed sirus	Shade and timber	Occasional avenue tree
<i>Alostonia scholaris</i>	Satwan	Shade & medicinal	Widely grown as an avenue tree and also occurs in forests
<i>Anacardium occidentale</i>	Cashew nut	Cashew nut	Cultivated mainly along the coastal areas.
<i>Annona squamosa</i>	Seetaphal	Fruit is delicious and edible	Small tree and hence it is not suitable except in mixed cultures.
<i>Artocarpus heterophyllus</i>	Jack fruit	Fruit is edible and timber is useful	Widely grown for fruit and also a forest species.
<i>Azadirachta indica</i>	Neem	Neem oil products	Widely grown as an avenue tree
<i>Bixa orellana</i>	Bixa	Grown for food colouring & dye.	Uncommon in green belts.
<i>Callistemon citrinus</i>	Indian Bottle brush tree	Ornamental	Widely grown as an ornamental tree
<i>Calophyllum inophyllum</i>	Alexandrian Laurel	Shade and medicinal	Widely grown forest species.
<i>Cassia fistula</i>	Rela / Amaltas	Ornamental & bark is	Widely grown as an avenue tree and

Proposed Pottangi Bauxite Mine by NALCO at Pottangi Village & Tehsil, Koraput District, Odisha

Botanical name	Common name	Importance	Suitability
		a source of tannin	also occurs in forests
<i>Cassia siaamea</i>	Cassia	Only firewood	One of the most widely grown tree in greenbelts
<i>Casuarina equisetifolia</i>	Sarvi	Pulp & construction material	Grown mainly in agro forests along the coast
<i>Ceiba pentandra</i>	Silk cotton	Seed fibers.	Widespread avenue tree
<i>Dalbergia sissoo</i>	Sissoo	Timber	Widely grown as an avenue tree and also occurs in forests
<i>Delonix regia</i>	Gulmohur	Ornamental & medicinal	Though beautiful, it is not suitable for greenbelts as it is a deciduous tree.
<i>Dendrocalamus strictus</i>	Bamboo	Bamboo products	Widely grown as an avenue tree and also occurs in forests
<i>Eucalyptus spp.</i>	Eucalyptus	Pulp & construction material	Different species are widely grown all over India.
<i>Ficus benghalensis</i>	Banyan tree	Shade and a source of food for birds	Rarely grown as an avenue tree as it highly spreading.
<i>Ficus racemosa</i>	Clustered fig	Edible fruits	Rarely grown as an avenue tree
<i>Ficus religiosa</i>	Raavi	Shade and a source of food for birds	Widely grown as an avenue tree
<i>Gmelina arborea</i>	Gummadi tekku	Timber	Widely grown as an agro forest tree and also occurs in forests
<i>Grevillea pteridifolia</i>	<i>Fern leaved Grevillea</i>	Timber & Ornamental	It is gradually becoming popular.
<i>Grewilia robusta</i>	Silver oak	Timber & Ornamental	A non-shedding exotic grown mainly as an ornamental tree
<i>Holoptelia integrifolia</i>	Nemali naara	Fibre and timber	A forest species but grown occasionally.
<i>Jacaranda acutifolia</i>	Jacaranda	Ornamental & timber	Capable of growing widely.
<i>Kigelia africana</i>	African Calabash Tree	Timber and shade	Occasional avenue tree
<i>Lagerstroemia indica</i>	Pride of India	Ornamental tree	Widely grown avenue tree
<i>Lagerstroemia parviflora</i>	Pride of India	Ornamental & medicinal	Widely grown avenue tree
<i>Leucaena leucocephala</i>	Subabul	Fodder & pulp wood	An exotic species and widely grown all over India.
<i>Leucaena leucocephala</i>	Subabool	Pulp wood & fodder tree	Widely grown in Agro forests for pulp wood and fodder.
<i>Madhuca longifolia</i>	Mahuva	Timber, flower & fruit	Widespread in forests and plains of central India
<i>Mangifera indica</i>	Mango	Edible fruit	Widely cultivated tropical fruit tree.
<i>Millingtonia hortensis</i>	Indian Cork Tree	Ornamental & shade	A plant capable spreading rapidly by root suckers.
<i>Mimosops elengi</i>	Pogada	Shade & edible fruit	Widely grown as an avenue tree
<i>Muntingia calabura</i>	Singapore Cherry	Shade & minor fruit	Umbrella shaped fast growing tree
<i>Neolamarckia cadamba (=Anthocephalus cadamba)</i>	Kadambam	Timber, medicinal and a sacred tree	It is becoming increasingly popular all over India
<i>Peltophorum pterocarpum</i>	Copper Pod	Shade	Except for shade no major use but very widely grown as an avenue tree and in greenbelts.
<i>Pithecellobium ulce</i>	Manila tamarind	Fruits with edible aril	Not popular in green belts but grows very widely

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Botanical name	Common name	Importance	Suitability
<i>Phyllanthus emblica</i>	Imli / Amla	Fruit and medicinal	Cultivated and also a wild tree but not suitable for green belt only in mixed plantations.
<i>Polyalthia longifolia</i>	Ashoka	Avenue tree	Widely grown as an avenue tree
<i>Polyalthia pendula</i>	Ashoka	Majestic tree with drooping branches	Widely grown as an avenue tree
<i>Pongamia pinnata</i>	Karanj	Source of biodiesel	Extensively grown for biodiesel production
<i>Populus deltaoides</i>	Populus	Pulpwood	Grows mainly in sub Himalayan region
<i>Samania saman</i>	Rain tree	Shade and timber	Widely grown as an avenue tree
<i>Sapindus emarginatus</i>	Kunkudu	Soap nut tree	Not highly suitable as the foliage is not thick.
<i>Shorea robusta</i>	Sal	Timber	Capable of growing only in the Sal growing States of Orissa, M.P., Chattisgarh and Jarkhand.
<i>Spathodea companulata</i>	Flame of the forest	Ornamental avenue tree	A dark green forest and it is tree widely grown
<i>Sterculia foetida</i>	Jungli baadam	Shade and medicinal	Widely grown as an avenue tree and also occurs in forests
<i>Sterculia urens</i>	Sterculia	Shade and medicinal	Widely grown as an avenue tree and also occurs in forests
<i>Swietenia mahogany</i>	Mahogany	Timber	Mainly in the Malabar region
<i>Syzygium cumini</i>	Indian black berry	Edible fruits	Very common avenue tree with valuable edible fruits.
<i>Tabebuia argentea</i>	<i>Tabebuia</i>	Ornamental	Occasional ornamental tree
<i>Tamarindus indica</i>	Chinta	Tamarind fruit and leaf	Though leafless during summer, it is one of the best candidates for green belt of mixed species..
<i>Tectona grandis</i>	Teak	Best quality Timber	Not suitable for greenbelt as it highly deciduous but its timber is highly valuable.
<i>Terminalia arjuna</i>	Nallamaddi	Timber and shade tree	A common tree suitable mainly for moist locations.
<i>Terminalia bellirica</i>	Taani	Timber and nut	Widespread all over India.
<i>Terminalia catappa</i>	Baadam	Edible nuts	Extensively grown all over India for Almond seed and shade.

Green belt is plantation of trees for reducing the pollution as they absorb both gaseous and particulate pollutant, thus removing them from atmosphere. Green plants form a surface capable of absorbing air pollutants and forming sinks for pollutants. It improves the aesthetic value of local environment. Under present project, green belts have been planned with emphasis on creating biodiversity; enhance natural surroundings and mitigating pollution. The greenbelt development plan aims to overall improvement in the environmental conditions of the region. The plan with a five-fold objective addresses issues such as providing sink for air pollutants likely to emitted from the project; enhancing the forest cover for increasing the biodiversity of the region; providing aesthetic value to the project area enhancing the ecological equilibrium of the area; and to a large proportion in combating soil erosion.

- Afforestation on degraded forest area, forest protection / conservation will be carried out every year by NALCO.

- This activity will promote the emergence of the primary succession species; hence it is extremely important for maintaining ecology and environmental condition of the area.
- This helps in regeneration & establishment of pioneer plant species saving expose land & land cutting.

Afforestation will be done along the boundary barrier and quarry roads. Considering a grid of 2m x 2m about 18.54 ha., area, Numbers of plants of different species, mainly fruit – bearing plants like Mango, Jackfruit, Cashew (as per availability) will be planted. About twice the area recommended for mining will be used for afforestation/greenbelt as per the “Forest (Conservation) Amendment Rule, 2004” and subsequently. Local species will be planted as per availability. A table showing year wise afforestation scheduled is given in **Table 2**.

Table 2. Afforestation schedule

S.No	Particulars	Lease periphery		Remarks
		No. of saplings	Area in ha	
1	1 st Year	14400	5.76	Greenbelt area will be developed
2	2 nd Year	22675	9.07	
3	3 rd Year	21425	8.57	Maintenance & Gap filling plantation
4	4 th Year	14050	5.62	Afforestation on backfilled area
5	5 th Year	32300	12.92	

The following characteristics would be taken into consideration while selecting plant species for green belt development and tree plantation.

- They should be fast growing and tall trees.
- They should be perennial and evergreen.
- They should have thick canopy cover.

Plantation would be done in appropriate alternate rows around the proposed mine area to prevent lateral pollution dispersion. The trees would maintain regional ecological balance and confirm to soil and hydrological conditions.

Estimated cost of conservation of biodiversity

The NALCO will explore the possibility of involving the state forest department represented by the Divisional Forest Officer, for greenbelt development, afforestation, block plantations and avenue plantations. A list of plants suggested for afforestation, greenbelt development and avenue plantations are given in **Table 1**. It is proposed to add 40,000 plants every year for five years besides the soil binding forage crops like hamata grass. In about five years, all unused and vacant areas within the mine lease area will be fully covered with shrubs and trees. Integrated soil, water, nutrient and biodiversity conservation mechanisms shall be chosen to sustain the green initiative. If the State Social Forest Division is prepared to enter in to a Memorandum of Understanding (MoU) for greenbelt development, avenue and block plantations; soil, water and nutrient conservation systems, the NALCO is prepared to spend Rs. 1.0 crores/year for five years. If it is not feasible, the NALCO wants to rope in a private agency which has the potential and

competence to do the job. There shall be a third party midterm performance evaluation after 3 years and a final evaluation after five years. Cost estimates and targets for greenbelt development, afforestation and biodiversity conservation are given in **Table 3**.

Table 3 Action plan for Greenbelt development, avenue and block plantations

Year	Plantation type	No of trees / plants proposed	Amount in Lakhs
First year	Greenbelt	25,000	100
	Block plantations	2.5 Ha (37,000)	
Second year	Greenbelt	25,000	100
	Avenue plantations	16,000	
Third year	Greenbelt	25,000 including gap filling	100
	Avenue plantations	16,000	
Fourth year	Avenue plantations / gap filling	1000	100
	Block plantations	3 Ha (45,000)	
Fifth year	Back filling and block plantation	21 Ha	100
	Maintenance of plantations		
Total allocation			500.00 i.e. 5 Cr.

Greenbelt development in buffer areas

Since 1981 NALCO has undertaken several programmes for the development of thick forest in Koraput district as a part of compensatory afforestation, forestry in the reclaimed land (72 Lakhs trees) in the existing two Bauxite mines and refinery including social forestry.

NALCO will undertake 1800 Ha of degraded forest for extensive plantation under compensatory afforestation (CA) scheme 2016 (with an expenditure of 30 crores) of Pottangi bauxite mines in undivided Koraput District.

EMP Budget

It is necessary to include the environmental cost as a part of the budgetary cost component. The project authorities propose to undertake the following environmental works to achieve the environmental quality as desired. The budget for environmental management plans has been formulated and given in **Table 4**.

Table 4. Budget for Environmental Management Plan

S.No	Particulars	Details	Cost (Rs. in Cr.)	
			Capital	Recurring
1	Air pollution control	Water sprayer (Stationary)	2	0.2
		Water sprayer (Mobile), etc.	8	0.8
		Subtotal	10	1
2	Water pollution control	Sewerage Treatment Plant (STP)	5	0.5
		Garland drains, Retaining wall, check dams, etc.	10	1
		Storm water drains, Rain water harvesting	15	1.5
		Subtotal	30	3
3	Noise pollution control	Acoustics enclosure etc.	5	0.5
		Subtotal	5	0.5
4	Pollution monitoring	Laboratory testing equipment	5	0.5
		High volume air sampler	5	0.5
		Respirable dust sampler	5	0.5
		Micro-meteorological station etc.	5	0.5
		Subtotal	20	2
5	Safety & health	Firefighting equipment (Portable)	5	0.5
		Firefighting equipment (Fixed)	5	0.5
		Personal protective equipment, etc.	5	0.5
		Subtotal	15	1.5
6	Greenbelt development & Soil conservation measures etc...	Afforestation & reclamation, lawns	30	3
		Subtotal	30	3
7	Miscellaneous & Contingency expenses	Street lighting etc.	10	1
		Subtotal	10	1
		Grand Total	120	12

EMP budget considered as 8.3% of the Total Project Cost and recurring cost considered 10% of EMP capital cost.