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ESTIMATION OF VEHICULAR POLLUTION GROWTH AND THEIR IMPACTS ON AIR QUALITY: A MODEL STUDY

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ABSTRACT

The city of Hyderabad is expanding at a tremendous pace and the urban growth is reflected in the traffic intensities on the roads. At present, there are around 13 lakh vehicles moving on the roads of the city and the growth rate observed in the traffic in the recent past is around 16 percent per annum on an average. With the potential increase in tourism industry, Andhra Pradesh State Youth Advancement Tourism and Cultural Department has proposed to develop Buddha Purnima Project Area at Hussain Sagar lake front by various developmental activities like Tourist center, Promenade & food courts, people's plaza, amusement park, IMAX theater, rail cum bus transportation etc., mainly located on the vacant land on NTR Marg and Necklace road. In this paper, existing vehicular traffic flow on the Necklace Road and NTR Marg, and the projected increase in traffic loads due to these activities were estimated for different scenarios. From these data, the projected values on any eventful day representing peak load are found not to exceed more than 2-3 units in log scale, and as such they do not significantly alter the resultant ambient air quality. Further even for the eventful day peak load scenario, considering the air pollutants released by the increased traffic volumes by these four activities in Buddha Purnima Project area, the ambient air quality with respect to SPM, SO_X, and NO_X is estimated to be well within the CPCB residential area standards while for CO and HC in residential areas there are no standards prescribed by CPCB. There will be marginal increase in CO and HC

content in air which will however not be harmful from health point of view. Pre project maximum predicted GLC values for CO, NO_X, HC are 0.8 mg/ m^3, 17.5 mg/ m^3 and 0.9 ppm and post project maximum predicted GLC values are for CO 1.2 mg/ m^3, NO_X 25.5 mg/ m^3 and HC 8.3 ppm respectively. A better option for controlling the air pollution loads from increased traffic volume is switching from petrol to CNG for entire Hyderabad city as it showed good results in Delhi. As two wheelers are the maximum contributors for HC, Necklace road and NTR marg may be considered, further for introduction of public transit system with alternate fuels for improving the air quality.

Keywords: Vehicular Emissions, Air Quality, SO_x, NO_x, CO and SPM

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1. INTRODUCTION

The possible changes that occur during any developmental activity, either on physical or biological environment are need to be evaluated before commission of the proposed activity for sustainable development and an ecological balance. Therefore, Environmental Impact Assessment was carried out for the proposed activities at Buddha Purnima project area and land- water parcel of Hussain sagar environs. Considering the growing influence of the tourism industry throughout the developing world, Andhra Pradesh State Youth Advancement Tourism and Cultural Department is aimed at developing Buddha Purnima Lake front area into tourist attraction site by various entertainment and recreational projects in and around water- land parcel of Hussian Sagar Lake. Land use land cover of Hussian sagar area is presented in Figure 1. The proposed Buddha Purnima Project activities and their locations are given in Table 1.

Table 1 Proposed activity's at Buddha Purnima project area

S.No.	Existing Site	Total Area (in acres)	Proposed activity	Expected people and Vehicles
1	NTR Park The existing park should be converted into an amusement park	20	Amusement Park (4 acres) to encourage the tourism for the entire family along the lakes edge IMAX Theater (2 acres)	Every Day 6000 Normal day 1850 people Cars :400 Two wheelers :600 Buses:25
2	Exhibition Grounds The site is widest piece of land between edge of the lake and the road	5	People's Plaza (3.75 acres) A light weight, temporary tensile structure could cover part of the site for public functions	At any time 14,840 people Cars: 1610 Two wheelers :3750 Auto rickshaws :300
3	Land between Necklace Road and Lake Narrow strip of land on either side of the people's plaza	10	Promenade and Food Courts (2000 sq.yds) Site on either side of people's plaza into promenade and food court	

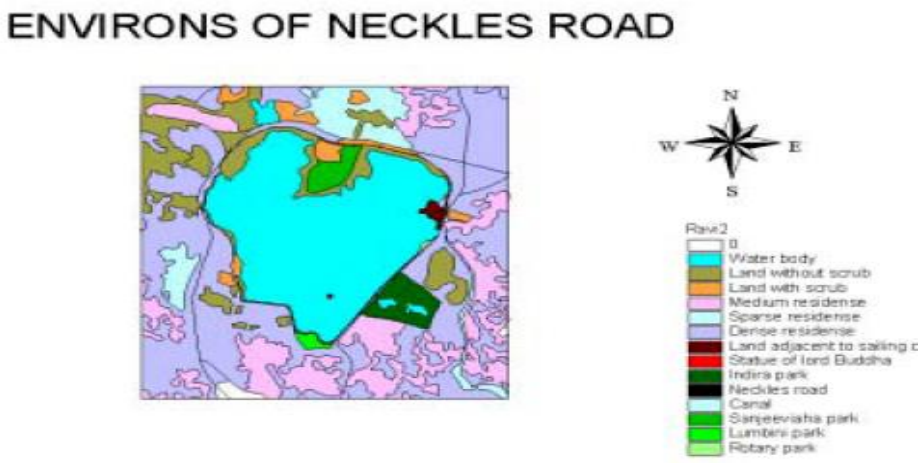


Figure 1 Land use land cover map of Hussein Sagar, Hyderabad

2. METHODOLOGY

Hyderabad is facing 16% annual growth in vehicular traffic and Tank bund being one of the major traffic corridors, the growth on Tank bund may be much more than average annual growth, even in the absence of BPP (Buddha Purnima Project) activities. As most of the developmental activities are located on NTR Marg and Necklace road, a detailed traffic survey was carried out for different scenarios like present normal day, present Sunday and present eventful day. Projected traffic loads are also estimated due to the proposed project activities at BPP (Buddha Purnima Project) area, for different scenarios, to identify the impacts of proposed developmental activities at Buddha Purnima Project activities on air quality. Based on the traffic surveys, total vehicular emission loads on NTR Marg and Necklace road have been estimated for different scenarios. The present baseline air quality in and around the Buddha Purnima Project area is examined according to the National Ambient Air Quality standards Procedure, given in Table 2, by carrying out ambient air quality monitoring for SPM, CO, SO_X and NO_X at four stations namely 1) Necklace Road – Khairtabad Junction, 2) Sanjeeviah Park, 3) Tank bund, 4) NTR Marg–New Mint road junction covering all the four directions of lake Hussein Sagar. And the analysis results of the ambient air quality at BPP (Buddha Purnima Project) Area are presented in Table 3, Figure 2 and Figure 3. By considering the annual growth rate in vehicular increase and also increase in vehicular traffic due to proposed Buddha Purnima Project activities, Temporal Vehicular emission levels for Necklace road and NTR marg for different scenarios were estimated by taking the Indian Institute of Petroleum Emission standards, according to the following methodology. The ambient air quality in the four monitoring stations was carried out using High Volume Sampler according to CPCB procedure and analyzed for SO_2, NO_2, CO & SPM. Estimation of vehicular emission factors due to increased traffic growth: The methodology followed here is compiled from different sources to establish source emission rate along the roads where automobiles are continuously emitting pollutants.

Emission factors for different category of vehicles are estimated by Indian Institute of Petroleum and are given in Table 4, the driving cycle adopted by Indian Institute of Petroleum for measuring the emission factors is termed as four mode cycle and consists of four modes of operations–idling, acceleration, cruising, and deceleration. Temporal Vehicular emission levels for Necklace road and NTR marg for different scenarios were estimated. Table 5 gives estimated temporal vehicular emission on NTR Marg and Necklace Road

Table 2 National ambient air quality standards notification Delhi the 11th April, 2014 Central

Pollution Control Board, Schedule – I

Pollutant	Time weighted average	Industrial Area	Residential Rural & Other Areas	Sensitive Area	Method of Measure
1	2	3	4	5	6
Sulpher Dioxide (SO_2)	Annual average*	80 µg/m^3	60µg/m^3	1µ5g/m^3	Improved west and GACK method
	24 hours**	120µg/m^3	80µ g/m^3	30µg/m^3	Ultra Fluorescence
Oxides of Nitrogen as NO_2	Annual average*	80µg/m^3	60µg/m^3	30µg/m^3	Jacob & Hochhesier modified (Na-Ar) method
	24 hours**	120 µg/m^3	80 µg/m^3	30µg/m^3	Gas Phase Chemiluminesence
Suspended Particulate Matter (SPM)	Annual average*	360µg/m^3	140µg/m^3	70µg/m^3	High Volume Sampling average flow rate no less than 1.1 m3/minute
	24 hours**	500µg/m^3	200µg/m^3	100µg/m^3	
Respirable Particulate	Annual average*	120 µg/m^3	60µg/m^3	50µg/m^3	Respirable particulate matter (Size less than 10µm) RPM sampler
	24 hours**	150µg/m^3	100µg/m^3	75µg/m^3	
Lead (Pb)	Annual average*	1.0µg/m^3	0.75µg/m^3	0.50µg/m^3	AAS method after sampling
	24 hours**	1.5µg/m^3	1.00µg/m^3	0.75µg/m^3	Using EPM 2000 or Equivalent filter paper
Carbon Monoxide(CO)	8 hours**	5.0mg/m^3	2.0mg/m^3	1.0µg/m^3	Non Dispersive Infrared
	1 hour	10.0mg/m^3	4.0mg/m^3	2.0µg/m^3	Spectroscopy

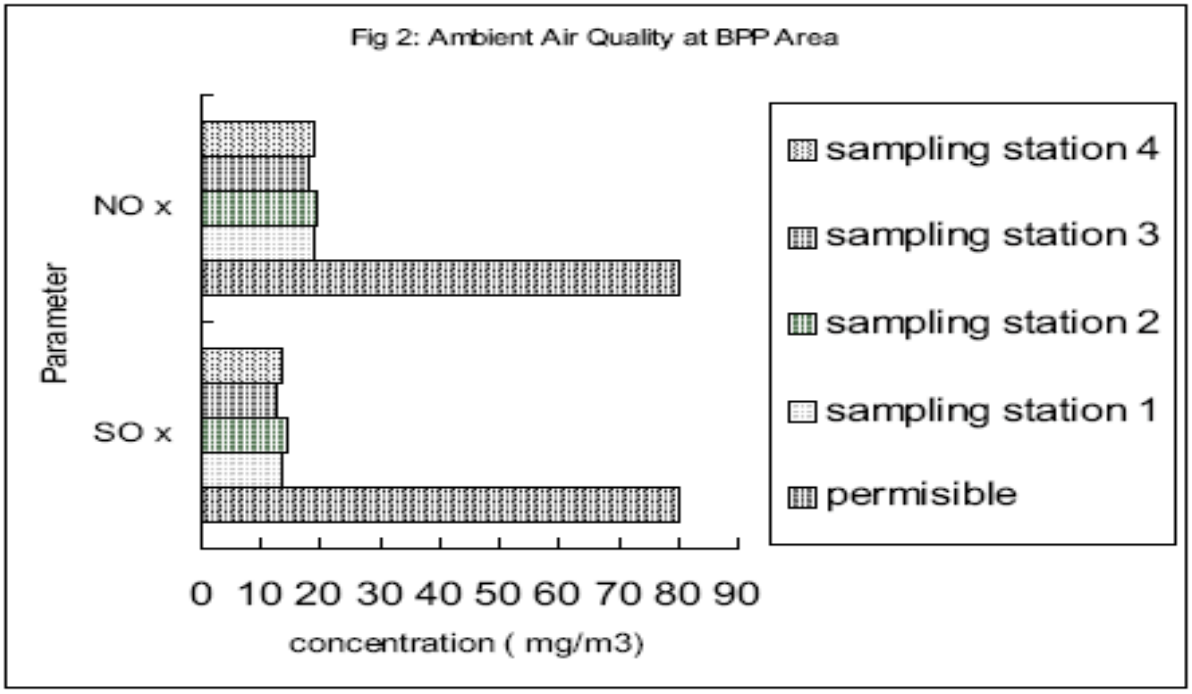
Table 3 Air quality analysis report in BPP AREA (All values are expressed in µg/m^3)

Site	Date of Sampling	SOX			NOX			CO (8Hours)	SPM (24Hours)
		6 PM to 2 PM	2 PM to 10 PM	10 PM to 6 AM	6 PM to 2 PM	2 PM to 10 PM	10 PM to 6 AM		
Necklace Road to Khairatabad fly over junction		14.2	13.5	7.6	22.9	18.8	10.6	7850	460
		15.2	14.2	8.1	23.6	20.5	15.9	6950	455
		14.8	12.9	6.5	22.1	21.4	16.5	8009	435
		16.9	13.5	6.8	23.1	20.5	14.9	7800	501
		12.1	10.3	5.2	11.5	9.5	7	8112	285
Sanjeevaiah Park		16.2	14.3	7.9	21.5	19.5	10.7	9850	503
		17.1	13.5	8.6	24.3	20.1	14.5	7560	481
		15.8	12.6	8.1	22.8	20.3	14.5	8015	482
		17.9	13.6	7.3	20.5	22.1	13.5	9006	465
		10.9	9.8	4.7	9.3	11.3	7.2	8350	235

Tank Bund		15.8	12.6	7.3	22.5	17.8	11.5	6970	493
		16.2	14.8	7.9	23.8	21.3	14.5	7460	433
		15.2	12.3	7.1	22.5	20	17.3	7002	445
		16.7	12.8	6.9	25.3	19.8	13.5	8230	550
		10.9	9.6	3.4	11.3	9.7	6.8	8200	261
Near NTR Marg to New Mint road junction		14.2	13.5	7.6	22.9	18.8	10.6	7850	460
		17.3	15.2	6.8	23.1	18.3	9.8	7850	493
		18.2	12.5	8.3	23.2	21.1	15.4	7605	4118
		15.9	12.3	9.5	22.6	23.4	13.4	8500	485

Table 4 Emission factors for different vehicles, in g/km

Vehicle Type	CO	HC	NO_X	SO_X	Pb	TSP
Two Wheelers	8.3	5.18	0	0.013	0.028	0
Cars	24.03	3.57	1.57	1.053	0.0116	0
Three Wheelers	12.25	7.65	0	1.029	0.0063	0
Buses	5.87	2.27	11.1	1.93	0	0.37
Sub-Urban Urban	4.51	1.75	8.52	1.48	0	0.28
Trucks	3.52	1.36	6.66	1.16	0	0.22
Light Commercial vehicles	1.3	0.5	2.5	0.4	0	0.1



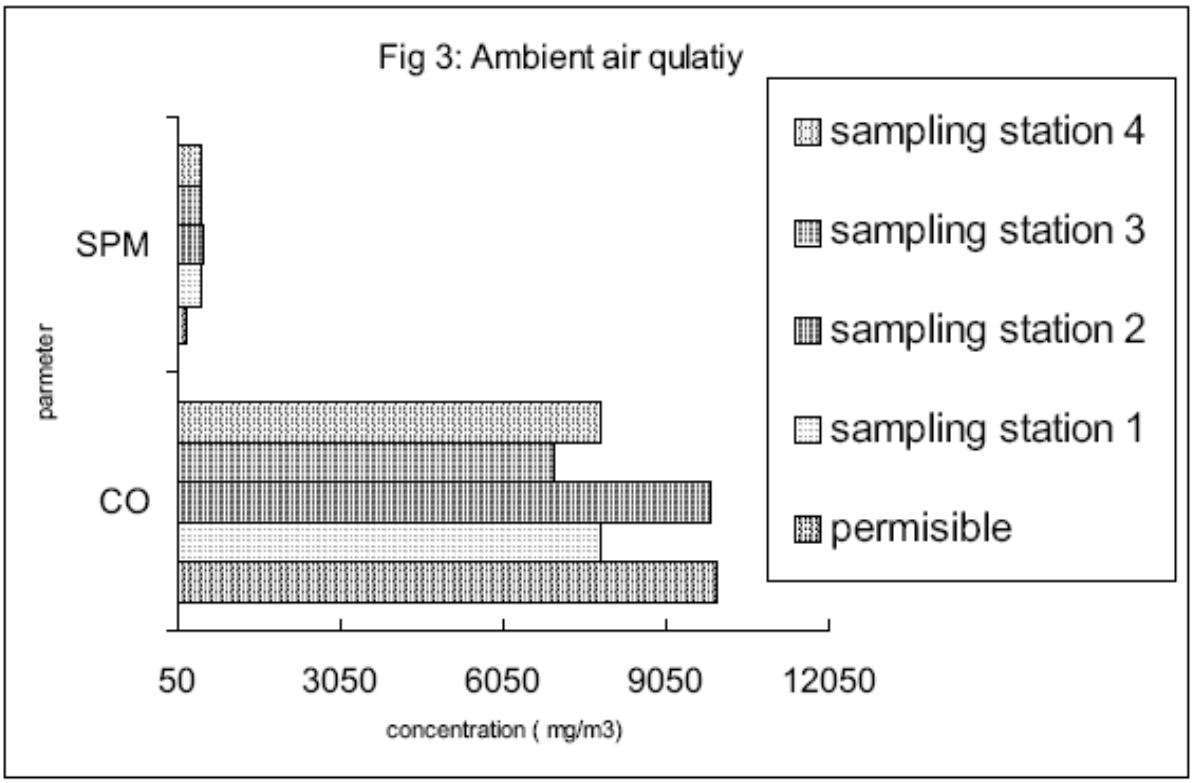


Table 5 Peak hour temporal vehicular emission levels for Necklace road and NTR marg for different scenarios

Parameter	Type of Vehicle	Scenario	Necklace Road (gm/km, peak hour traffic: log scale)	NTR Marg (gm/km, peak hour traffic: log scale)
CO	Two Wheeler	Present normal day	10.86 (5-6 PM)	10.44 (5-6 PM)
		Sunday	10.47 (7-8 PM)	10.46 (6-8 PM)
		Present event day	11.19 (5-6 PM)	11.54 (5-6 PM)
		Present normal day	11.06 (5-6 PM)	11.84 (5-6 PM)
		Projected Sunday	11.47 (5-6 PM)	11.24 (5-6 PM)
		Projected event day	12.16 (5-6 PM)	11.93 (5-6 PM)
	CAR	Present normal day	10.23 (6-7 PM)	10.74 (5-6 PM)
		Sunday	10.68 (7-8 PM)	10.84 (7-8 PM)
		Present event day	11.33 (6-7 PM)	11.84 (5-6 PM)
		Present normal day	11.26 (6-7 PM)	11.11 (5-6 PM)
		Projected Sunday	11.66 (6-7 PM)	11.51 (5-6 PM)
		Projected event day	12.36 (6-7 PM)	12.20 (5-6 PM)
	Auto Rickshaw	Present normal day	8.01 (5-6 PM)	9.01 (5-6 PM)
		Sunday	8.59 (6-7 PM)	8.93 (5-6 PM)
		Present event day	9.11 (5-6 PM)	10.11 (5-6 PM)
		Present normal day	8.95 (5-6 PM)	9.22(5-6PM)
		Projected Sunday	9.36 (5-6 PM)	9.63 (5-6 PM)
		Projected event day	10.05(5-6PM)	10.32 (5-6 PM)

SO_X	Two Wheeler	Present normal day	3.63 (5-6 PM)	3.98 (5-6 PM)
		Sunday	4.01 (7-8 PM)	4 (6-8 PM)
		Present event day	4.73 (5-6 PM)	5.08 (5-6 PM)
		Present normal day	4.6 (5-6 PM)	4.38 (5-6 PM)
		Projected Sunday	5.03 (6-7 PM)	4.78 (5-6 PM)
		Projected event day	5.7 (5-6 PM)	5.48 (5-6 PM)
	CAR	Present normal day	4.11 (6-7 PM)	4.62 (5-6 PM)
		Sunday	4.56 (7-8 PM)	4.72 (7-8 PM)
		Present event day	5.21 (6-7 PM)	5.72 (5-6 PM)
		Present normal day	5.14 (6-7 PM)	4.99 (5-6 PM)
		Projected Sunday	5.55(6-7 PM)	5.39 (5-6 PM)
		Projected event day	6.23 (6-7 PM)	6.08 (5-6 PM)
	Auto Rickshaw	Present normal day	1.96 (5-6 PM)	2.96 (5-6 PM)
		Sunday	2.54 (6-7 PM)	2.87 (5-6 PM)
		Present event day	3.05 (5-6 PM)	4.06 (5-6 PM)
		Present normal day	2.91 (5-6 PM)	3.18 (5-6 PM)
		Projected Sunday	3.31 (6-7 PM)	3.58 (5-6 PM)
		Projected event day	4 (5-6 PM)	4.28 (5-6 PM)
NO_X	CAR	Present normal day	7.49 (6-7 PM)	8.01 (5-6 PM)
		Sunday	7.95 (7-8 PM)	8.12 (7-8 PM)
		Present event day	8.59 (6-7 PM)	9.12 (5-6 PM)
		Present normal day	8.53 (6-7 PM)	8.38 (5-6 PM)
		Projected Sunday	8.93 (6-7 PM)	8.78 (5-6 PM)
		Projected event day	9.63 (6-7 PM)	9.48 (5-6 PM)
HC	Two Wheeler	Present normal day	9.62 (5-6 PM)	9.97 (5-6 PM)
		Sunday	9.9 (7-8PM)	9.99 (6-8 PM)
		Present event day	10.72 (5-6 PM)	10.07 (5-6 PM)
		Present normal day	10.59 (5-6 PM)	10.36 (5-6 PM)
		Projected Sunday	10.59 (5-6 PM)	10.76 (5-6 PM)
		Projected event day	11.69 (5-6 PM)	11.46 (5-6 PM)
	CAR	Present normal day	8.32 (6-7 PM)	8.83 (5-6 PM)
		Sunday	8.77 (7-8 PM)	8.93 (7-8 PM)
		Present event day	9.42 (6-7 PM)	9.93 (5-6 PM)
		Present normal day	9.35 (6-7 PM)	9.19 (5-6 PM)
		Projected Sunday	9.95 (6-7 PM)	9.6 (5-6 PM)
		Projected event day	10.45 (5-6 PM)	9.85 (5-6 PM)
	Auto Rickshaw	Present normal day	7.54 (5-6 PM)	8.54 (5-6 PM)
		Sunday	8.12 (6-7 PM)	8.45 (5-6 PM)
		Present event day	8.64 (5-6 PM)	9.64 (5-6 PM)
		Present normal day	8.48 (5-6 PM)	8.75 (5-6 PM)
		Projected Sunday	8.89 (5-6 PM)	9.16 (5-6 PM)
		Projected event day	9.58 (5-6 PM)	9.85 (5-6 PM)

3. RESULTS AND CONCLUSIONS

From these data, the projected values on any eventful day representing peak loads are found not to exceed more than 2-3 units in log scale, and as such they do not significantly alter the resultant ambient air quality. Further even for the eventful day peak load scenario, considering the air pollutants released by the increased traffic volumes by these four activities in BPP (Buddha Purnima Project) area, the ambient air quality with respect to SPM, SO_X, and NO_X is estimated to be well within the CPCB residential area standards while for CO and HC in residential areas there are no standards prescribed by CPCB. There will be marginal increase in CO and HC content in air which will however not be harmful from health point of view. Pre-project maximum predicted GLC values for CO, NO_X, and HC are 0.8 mg/ m3, 17.5 mg/ m^3 and 0.9 ppm and post project maximum predicted GLC values are for CO 1.2 mg/ m^3, NO_X 25.5 mg/ m^3 and HC 8.3 ppm respectively. As we do not have emission factor for two wheelers and auto rickshaws for NO_X, it is not possible to compare. However, the present and projected levels NO_X and SO_X are well below the CPCB standards for residential areas. There will be marginal increase in the ambient air quality with reference to CO and HC. As the health effects of CO are temporary, more concern should be given for hydrocarbons which constitute polycyclic hydrocarbons, since two wheelers are the maximum contributors for hydrocarbon emission, restricting the entrance of two wheelers on Necklace road and NTR marg may be considered for improving the air quality. A better option for controlling the air pollution loads from increased traffic volume is switching from petrol to CNG for entire Hyderabad city as it showed good results in Delhi. As two wheelers are the maximum contributors for HC, Necklace road and NTR marg may be considered, further for introduction of public transit system with alternate fuels for improving the air quality. Different options for better traffic management are also suggested.

3.1. POSSIBLE SCENARIOS OF TRAFFIC MANAGEMENT

Option-I: Permitting traffic on Necklace road

If traffic is permitted on Necklace Road, then the additional traffic entering the Necklace Road will be 644 Cars, 1500 Two Wheelers and 120 Auto Rickshaws in the peak hour. The number of buses covered not is computed as there is no basis for such calculation because presently there are no buses moving on this road. There is sufficient packing space on the other side of Necklace Road facing people plaza and food courts, which can take care of parking demand. In this case, the total peak hour traffic on Necklace Road (both directions) including incremental traffic is expected to be 1634 Cars, 4800 Two Wheelers and around 1000 Auto Rickshaws.

Option II: Banning through traffic on Necklace road and permitting only alternate-fuel buses.

Another option suggested in the report is to go for park and ride facility where in the individual vehicles are not permitted on the Necklace Road. The people are expected to park their vehicles beyond Sanjeevaiah Park on one side and beyond Necklace Road Junction on the other side and they are expected to travel to facilities on Necklace Road by alternate fuel buses. From the point of pollution, there will be substantial reduction of pollution on Necklace Road due to this measure and there is no need to develop parking places for personal vehicles. But this policy makes Necklace Road to lose its role as an alternate route between Hyderabad and Secunderabad and makes it purely a recreational area. It is understood that Necklace Road is planned to act as an alternative to the Tank Bund and with this view only other infrastructural facilities like Patigadda flyover are being planned. In such

a scenario, the option of not permitting traffic on Necklace Road needs serious thought and not recommended.

Option III: Making NTR Marg–Mint road one way

One of the options suggested is to make the road connecting NTR Marg fly-over to the rear of the Secretariat us one way The scheme implies that vehicular entry into Necklace Road Junction will not be there from NTR Marg and all the vehicles presently entering Necklace Road Junction through NTR Marg and the additional traffic generated has to turn into the road opposite Lumbini Park, abutting NTR Garden and to take a right turn near Mint to the Mint road connecting Necklace Road Junction. There by this road has to cater to the additional traffic. These roads are under development and they can very well take the expected traffic. But much of the NTR Marg remains underutilized in this case. The road is a divided one, the factor which is a psychological hindrance for the one way concept. However, from the geometrical requirements point of view, the one way can be implemented without any problem, but whether the road infrastructure is put to optimum use or not has to be examined for taking such a policy. Further there will not be any reduction in total air pollution loads as the traffic diverted from NTR Marg (nearly 83 cars, 1475 two wheelers and 375 auto rickshaw) in one direction has to travel 0.5km more distance to reach activities located on necklace road

Option IV: Railway stations coming up near Necklace road

It is understood that two local railway stations are coming up near Necklace Road as a part of MRTS project for Hyderabad city. One station is near Sanjeevaiah Park and the other is nearer for the Necklace Road Junction. These railway stations may attract some traffic diverting them from road based modes. The shift of trips to railway mode are expected only form two wheeler and auto rickshaw traffic. The car traffic may remain unchanged even in the event of these railway stations coming up. The shift of traffic expected is also not very high as it may be in the range of 10% - 15%

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