A MAJOR PROJECT REPORT ON

APPLICATION OF CALINE 4 MODEL TO PREDICT $PM_{2.5}$ CONCENTRATION IN MEGACITY DELHI

Submitted in partial fulfillment of the requirements

For the award of the degree of

MASTER OF TECHNOLOGY

IN

ENVIRONMENTAL ENGINEERING

Submitted by

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CERTIFICATE

This is hereby certify that the major project (II) report entitled **"APPLICATION OF CALINE 4 MODEL TO PREDICT $PM_{2.5}$ CONCENTRATION IN MEGACITY DELHI"** submitted by **PRADEEP KUMAR** (ROLL NO: 2K13/ENE/08) as a record of the work carried by him, is accepted as major project (II) work submission in fulfillment of the requirement for the award of degree of **Masters of Technology in Environmental Engineering** in the **Department of Environmental Engineering, Delhi Technological University, Delhi-110042**

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CANDIDATES'S DECLARATION

I hereby declare that the work being presented in the dissertation title "**APPLICATION OF CALINE 4 MODEL TO PREDICT $PM_{2.5}$ CONCENTRATION IN MEGACITY DELHI"** in partial fulfillment of the requirements for the award of degree of **Master of Technology in Environmental Engineering,** submitted in the department of Environmental Engineering, Delhi Technological University (formerly Delhi College of Engineering), Delhi, is an authentic record of my own work and carried out by me under the supervision of Dr. Rajeev k. Mishra, Assistant Professor, Department of Environmental Engineering, Delhi Technological University (formerly Delhi College of Engineering), Delhi.

The matter embodied in this dissertation has not been submitted by me for the award of any other degree or diploma.

Delhi

Dated: May 2017 Pradeep Kumar

This is to certify that the above statement made by the candidate is correct to the best of our knowledge.

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ABSTRACT

The current trends in urban development, including growth of road transport, increasing energy demand and rising house hold consumption causes severe damage to urban environment, health and quality of life in cities. Rapid increase of the vehicle population in mega cities has results in the poor environmental quality and human health. Ambient concentrations of air pollutants at major traffic intersections are exceeding the National Ambient Air Quality Standards (NAAQS) in Delhi. The people are exposed to higher pollution levels which causes health problems i.e. respiratory diseases. Hence, an attempt was made using CALINE 4 model to estimate fine particulate matter ($PM_{2.5}$) concentrations at roadways of Madhuban chowk, Janpat, Punjabi Bagh, Karol Bagh, Uttam nagar, Laxmi nagar in Delhi. Traffic analysis of roadways was conducted on hourly basis and traffic volume is found in units of vol./hr. Peak flows of traffic were recorded between 10:00AM to 12.00 Noon at Madhuban Chowk, 11:00 AM to 13.00 Noon at Janpat, 11:00 AM to 13.00 Noon and 17:00 eve to 19.00 eve at Punjabi Bagh, 16:00 noon to 17.00 Eve at Karol Bagh 15:00 noon to 17.00 eve at Uttam Nagar, 17:00 eve to 19.00 eve at Laxmi nagar. Concentraton of $PM_{2.5}$ is measured for every minute time interval. Measured $PM_{2.5}$ with EPAM HAZ-5000 was ranged from 889 $\mu g/m^3$ to 399 $\mu g/m^3$ at Madhuban Chowk, 842 $\mu g/m^3$ to 102 $\mu g/m^3$ at Janpat, 267 $\mu g/m^3$ to 7 $\mu g/m^3$ at Punjabi Bagh, 410 $\mu g/m^3$ to 21 $\mu g/m^3$ at Karol Bagh, 520 $\mu g/m^3$ to 11 $\mu g/m^3$ at Uttam Nagar, 514 $\mu g/m^3$ to 25 $\mu g/m^3$ at Laxmi Nagar. Hourly average measured $PM_{2.5}$ ranged between 680 $\mu g/m^3$ to 432 $\mu g/m^3$ at Madhuban Chowk, 372 $\mu g/m^3$ to 150 $\mu g/m^3$ at Janpat, 142 $\mu g/m^3$ to 26 $\mu g/m^3$ at Punjabi Bagh, 111 $\mu g/m^3$ to 57 $\mu g/m^3$ at Karol Bagh, 217 $\mu g/m^3$ to 38 $\mu g/m^3$ at Uttam Nagar, 173 $\mu g/m^3$ to 81 $\mu g/m^3$ at Laxmi Nagar. Estimated $PM_{2.5}$ concentrations using CALINE 4 hourly average ranged from from 680.8 $\mu g/m^3$ to 432.7 $\mu g/m^3$ at Madhuban Chowk, 379.4 $\mu g/m^3$ to 155.4 $\mu g/m^3$ at Janpat, 170.8 $\mu g/m^3$ to 41.3 $\mu g/m^3$ at Punjabi Bagh, 120.7 $\mu g/m^3$ to 61.4 $\mu g/m^3$ at Karol Bagh, 226.6 $\mu g/m^3$ to 42.7 $\mu g/m^3$ at Uttam Nagar, 192.1 $\mu g/m^3$ to 82.2 $\mu g/m^3$ at Laxmi Nagar. Maximum concentrations were observed in evening time than in morning or afternoon time. The estimated concentrations of $PM_{2.5}$were compared with measured concentrations of $PM_{2.5}$.The eight hourly average of observed and predicted values are 625 $\mu g/m^3$ and 625.8 $\mu g/m^3$ at Madhuban Chowk, 254.44 $\mu g/m^3$ and 264.48 $\mu g/m^3$ at Janpat, 90.11 $\mu g/m^3$ and 114.56 $\mu g/m^3$ at Punjabi Bagh, 91.37 $\mu g/m^3$ and 98.63 $\mu g/m^3$ at Karol bagh, 86.67 $\mu g/m^3$ and 92.72 $\mu g/m^3$ at Uttam Nagar, 124.44 $\mu g/m^3$ and 131.37 $\mu g/m^3$ at Laxmi

Nagar. The comparison is done using Normalized Mean Square Error (NMSE), Fractional Bias (FB), and Geometric Mean Bias (GMB) and the results of NMSE, FB and GMB were found to be within prescribed limits as NMSE value is less than 0.50, FB value is from -0.5 to +0.5, and GMB varies between 0.75 to 1.25. Hence, CALINE 4 model is a useful tool to estimate the particulate matter concentrations near roadways in the city like Delhi.

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