



# **A Study on the Proposed Green Deck at Cross Harbour Tunnel**

## **Assessment of Pedestrian Circulation and Vehicular Traffic Emissions**

(Final Report)

By Dr W. T. Hung

Department of Civil and Environmental Engineering

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**A study on the proposed Green Deck at Cross Harbour Tunnel (CHT) –  
Assessment of pedestrian circulation and vehicular traffic emissions, by Dr WT Hung, CEE**

**Pedestrian Circulation**

The potential impacts of the proposed Green Deck on the pedestrian circulation system were critically assessed both in the “Base” (without the GD) and “Project” (with the GD) conditions at the model year of 2013. A large scale pedestrian flow survey was conducted to quantify the existing pedestrian flow patterns. Analysis indicated that the **most problematic section of the pedestrian circulation is the footbridge near the library**. It is anticipated that, upon completion of the proposed GD, 10-30% (AM) and 30-50% (PM) of current pedestrians would be diverted away from the problematic section to the GD.

Two pedestrian simulation models were developed for the Base Case (without the Green Deck) and the Project Case (with the Green Deck). Using the two models, the potential impacts of the proposed Green Deck on the pedestrian circulation system was critically assessed at the model year of 2013 taken into account of different enhancements to the existing pedestrian system. Assessment results indicated that the differences in level of services (LOS) between the Base and Project Case Models were significant. The LOS standard of the problematic footbridge was improved from LOS E to LOS B. **It is reasonable to conclude that the introduction of the Green Deck would positively affect the future pedestrian circulation system in terms of improved level of services and reduction of pedestrian flows. The pedestrians’ walking environment would be significantly improved.**

**Traffic Emissions**

The potential impact of the proposed GD on the air quality was also critically assessed in the “Base” and “Project” conditions at the model years of 2013, 2015 and 2020 for four scenarios reflecting the changes in the ambient temperature in the Study Area. **Assessment results using the EPD’s EMFAC-HK model indicated that, in the base case (i.e. year 2013), there would be about 0.329 ton of VOC, 1.612 tonnes of CO, 1.294 tonnes of NO<sub>x</sub>, 0.276 ton of CO<sub>2</sub> and 0.058 ton of PM<sub>10</sub> emissions per day in the Study Area.**

Comparison across different hypothetical future scenarios showed that VOC, CO and CO<sub>2</sub> emission levels per day would be reduced by about 1% to 5% while NO<sub>x</sub> would be slightly increased by similar magnitude. **Though the changes in the total emission levels per day is not very significant, the proposed Green Deck provides a potential to capture the tonnes of pollutants emitted as effective ventilation and exhaust emission treatment systems can be incorporated within the enclosed areas underneath the Green Deck.**

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## **1 INTRODUCTION**

### **1.1 Background**

Commissioned by the Task Force on the Proposed “Green Deck” of The Hong Kong Polytechnic University, this Study is initiated (the Study) to conduct an analysis on the potential impacts of the proposed Green Deck at the toll plaza area of the Cross Harbour Tunnel (CHT) on the pedestrian circulations and traffic emissions in the study area.

### **1.2 Study Tasks**

The tasks of the Study can be summarised as follows:

- To conduct a pedestrian count survey to understand the existing pedestrian flow pattern within the study area;
- To conduct a traffic count survey to identify the composition of vehicular traffic using the CHT;
- To develop a pedestrian flow model, based on the existing pedestrian flow pattern, for the existing situation and for the situation after installing the proposed Green Deck;
- To conduct a before and after study, on the basis of the estimates from the developed pedestrian models, so as to identify any potential effects the proposed Green Deck may have on the pedestrian circulations within the study area;
- To develop a traffic emission model using the EMFAC-HK model from HKEPD, based on the vehicle classification information obtained from the traffic count survey and the traffic flow statistics from the updated Annual Traffic Census (ATC) from TD;

### **1.3 Structure of Report**

Following this introductory chapter, Chapter 2 describes details of the project proposal and defines the Study Area for pedestrian circulation and traffic emissions. Evaluation of the potential impacts of the proposed Green Deck on the pedestrian circulations and traffic emissions in the study area are presented in Chapters 3 and 4 respectively. Chapter 5 summarises the findings of the study.

## 2 PROPOSED GREEN DECK

### 2.1 The Proposed Green Deck

The proposed Green Deck consists of a two level structure covering the toll plaza area of the Cross Harbour Tunnel (CHT). According to the most updated version of the proposal, the Green Deck includes a landscaped pedestrian circulation system on the upper deck and an improved system with adequate width for pedestrian circulation in the lower deck replacing the existing problematic footbridge.

### 2.2 The Study Area

While the whole Green Deck may extend outside the toll plaza area of CHT, the study area for pedestrian circulations and traffic emissions is defined as shown in Figure 2.1, which is extracted from the MTR proposed footprint of a proposed Green Deck. It covers the Toll Plaza Area of CHT, the section of Hong Chong Road and Salisbury Road just next to the Toll Plaza, and a Green Deck covering the above mentioned areas.

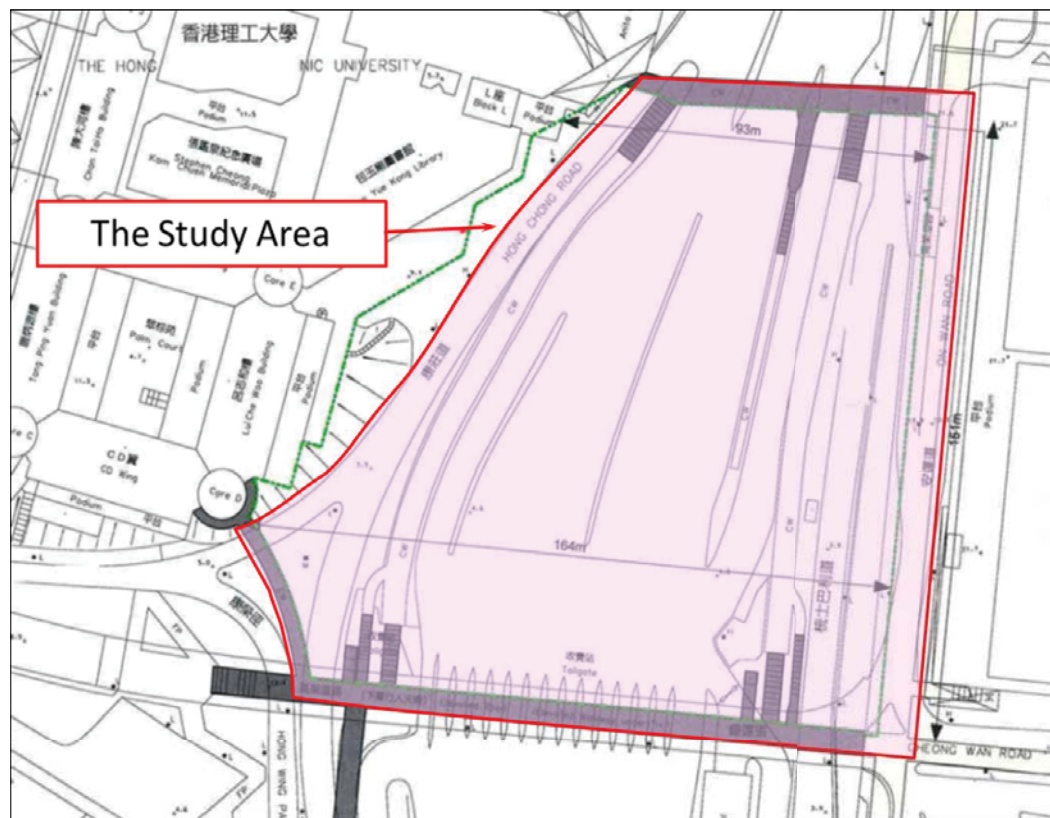


Figure 2.1 The Study Area

### 3 PEDESTRIAN CIRCULATIONS ASSESSMENT

#### 3.1 Existing Pedestrian Circulation Network

The existing pedestrian circulation system primarily includes the two footbridges connecting the PolyU campus and Hung Hom MTR station. The Study Area is divided into 14 major origin and destination zones as shown in Table 3.1 and Figure 3.1 which generate and attract pedestrian walking trips. The locations of these zones and the existing pedestrian circulation system are also shown in Figure 3.1. Based on the pedestrian flow information collected from the survey, the pedestrian flow origin/destination (OD) matrix between the zones can be generated.

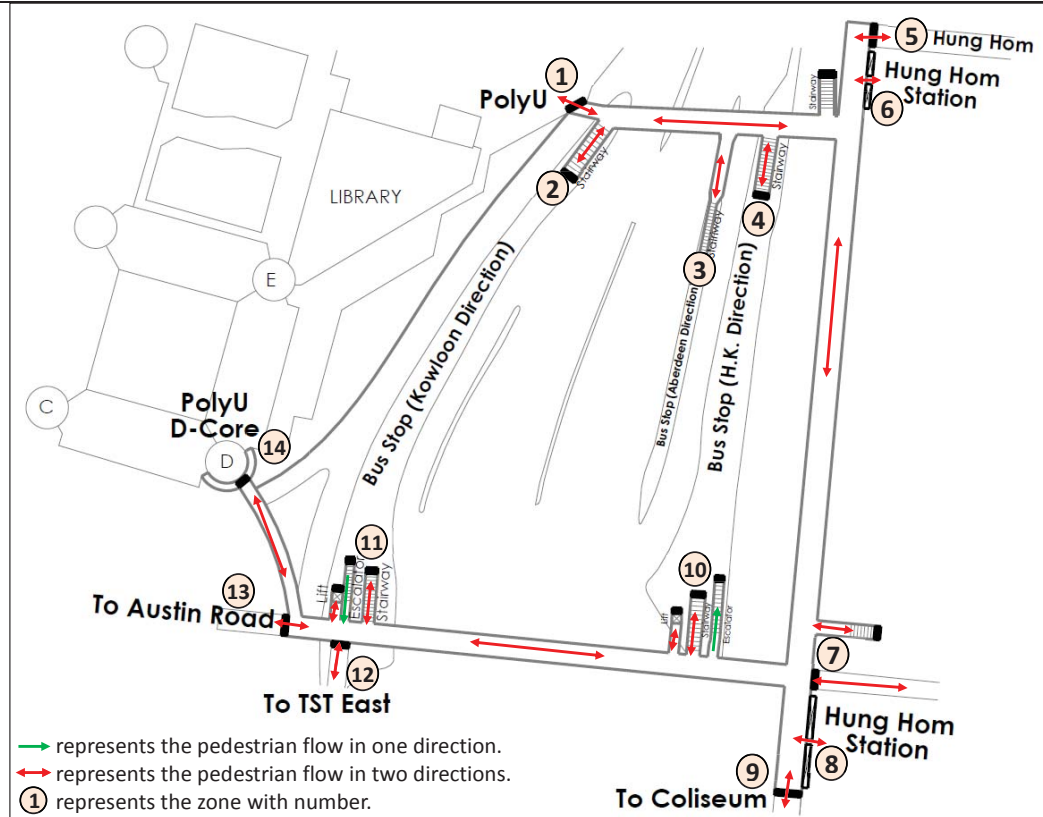
**Table 3.1**  
**Description of the 14 Pedestrian Origin and Destination Zones**

Zone No.	Location
1	PolyU Library
2	Bus Stop (Kln Bound) next to PolyU Library
3	Bus Stop (HK Bound to Aberdeen) next to PolyU Library
4	Bus Stop (HK Bound others) next to PolyU Library
5	Hung Hom close to PolyU Library
6	Hung Hom MTR Station Exit connecting to PolyU Library
7	Hung Hom close to PolyU D-core
8	Hung Hom MTR Station Exit connecting to PolyU D Core
9	Hong Kong Coliseum
10	Bus Stop (HK Bound others) next to PolyU D Core
11	Bus Stop (Kln Bound) next to PolyU D Core
12	Tsim Sha Tsui East
13	Austin Road
14	PolyU D Core

#### 3.2 Pedestrian Flow Survey

To understand the existing pedestrian flow in the study area, a pedestrian flow survey was undertaken on 15 November 2013 (Friday) during the periods 07:30 – 10:30 in the morning and 16:30 – 20:30 in the evening. It was observed from the survey that the most congested periods were 08:15-09:15 in the morning and 18:00-19:00 in the evening. The observed pedestrian flows for the congested peak hours are depicted in Figure 3.2. The total pedestrian trips generated from the 14 zones were 26,581 trips per hour in the morning and 29,245 trips per hour in the evening. Moreover, the total pedestrian trips attracted to the 14 zones were 25,915 trips per hour in the morning and 29,661 trips per hour in the evening. The most congested zone was the Hung Hom Mass Transit Railway (MTR) Station. There were 10,102 pedestrian trips per hour generated from the MTR station in the morning peak period and 10,394 pedestrian trips per hour attracted to the MTR station in the evening peak period.





**Figure 3.1 The Existing Pedestrian Circulation System**

In order to investigate the potential impacts induced by the proposed Green Deck on the most congested sections within the Study Area, the hourly pedestrian flows generated from and attracted to each zone were further broken down into 15-min flows. It was found that the most congested periods were 08:30-08:45 in the morning and 18:30-18:45 in the evening. The pedestrian OD matrices during the morning and evening peak 15-min periods are shown in Table 3.2 and Table 3.3 respectively.

From Table 3.2, the most critical pedestrian flows were going from Hung Hom Station to cross harbour bus stops (HK Bound) (i.e. from zone 6 to zone 4 and from zone 8 to zone 10). It is believed that these trips were mainly home-to-work trips making transfer between MTR and cross harbour bus services to their workplaces on Hong Kong Island. In the evening, the largest flows were observed from PolyU and cross harbour bus stops (Kln Bound) to Hung Hom Station (i.e. from zone 1 and zone 2 to zone 6). These trips mainly included passengers making transfers between cross harbour bus services (Kln Bound) and MTR, as well as walking trips from PolyU to MTR Hung Hom Station.

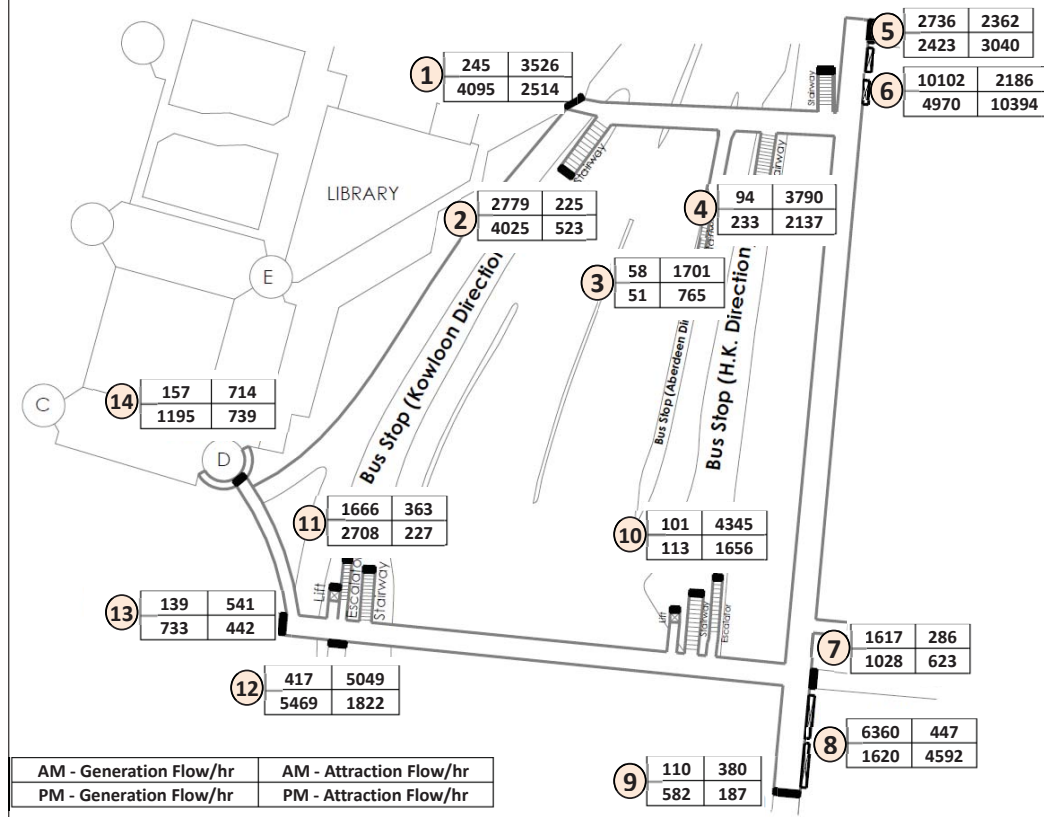


Figure 3.2 Pedestrian Flows for the AM (08:15-09:15) and PM (18:00-19:00) Congested Peak hours

Table 3.2  
 Pedestrian Origin-Destination Flow Matrix for the Most Congested AM Period (08:30-08:45)

Origin Zone	Destination Zones														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	0	4	15	28	10	37	0	0	0	0	0	0	0	0	94
2	241	0	0	0	91	319	0	0	0	0	0	0	0	0	651
3	4	0	0	0	2	9	0	0	0	0	0	0	0	0	15
4	6	0	0	0	5	17	0	0	0	0	0	0	0	0	28
5	86	14	79	169	0	426	0	0	0	0	0	0	0	0	775
6	583	91	544	1,204	818	0	0	0	0	0	0	0	0	0	3,239
7	0	0	0	0	0	0	0	36	11	194	15	176	17	25	475
8	0	0	0	0	0	0	52	0	76	863	68	743	71	108	1,980
9	0	0	0	0	0	0	1	3	0	13	1	12	1	2	34
10	0	0	0	0	0	0	1	2	1	0	1	16	1	2	25
11	0	0	0	0	0	0	5	15	5	124	0	236	23	33	442
12	0	0	0	0	0	0	2	6	2	49	9	0	9	13	91
13	0	0	0	0	0	0	0	1	1	12	2	24	0	4	44
14	0	0	0	0	0	0	1	2	1	15	2	28	3	0	52
<b>Total</b>	<b>920</b>	<b>109</b>	<b>638</b>	<b>1,401</b>	<b>926</b>	<b>807</b>	<b>62</b>	<b>66</b>	<b>97</b>	<b>1,270</b>	<b>99</b>	<b>1,235</b>	<b>127</b>	<b>187</b>	<b>7,945</b>

Source: Estimated in this Study, 2013

**Table 3.3**  
**Pedestrian Origin-Destination Flow Matrix for the Most Congested PM Period**  
**(18:30-18:45)**

Origin Zone	Destination Zones														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	0	37	31	93	81	1,172	0	0	0	0	0	0	0	0	1,414
2	231	0	0	0	85	1,224	0	0	0	0	0	0	0	0	1,541
3	2	0	0	0	1	18	0	0	0	0	0	0	0	0	21
4	7	0	0	0	5	72	0	0	0	0	0	0	0	0	84
5	39	7	9	32	0	777	0	0	0	0	0	0	0	0	864
6	478	80	117	409	659	0	0	0	0	0	0	0	0	0	1,743
7	0	0	0	0	0	0	0	142	4	26	3	25	3	8	212
8	0	0	0	0	0	0	62	0	25	117	13	106	14	35	373
9	0	0	0	0	0	0	5	77	0	10	1	10	1	3	108
10	0	0	0	0	0	0	1	11	0	0	0	3	0	1	17
11	0	0	0	0	0	0	27	273	8	80	0	158	22	49	619
12	0	0	0	0	0	0	57	556	17	161	41	0	45	103	980
13	0	0	0	0	0	0	6	60	2	18	5	36	0	14	141
14	0	0	0	0	0	0	12	114	4	33	8	64	11	0	245
<b>Total</b>	<b>757</b>	<b>123</b>	<b>157</b>	<b>534</b>	<b>831</b>	<b>3,264</b>	<b>170</b>	<b>1,232</b>	<b>60</b>	<b>445</b>	<b>73</b>	<b>403</b>	<b>97</b>	<b>214</b>	<b>8,360</b>

**Source:** Estimated in this Study, 2013

### 3.3 Existing Pedestrian Circulation Conditions

Based on the observed pedestrian flows from the survey, the performance of the existing pedestrian circulation system in the Study Area was analysed. The results are based on the pedestrian Level of Service (LOS) standards for walkway as stipulated in the Highway Capacity Manual (2000) which are classified into 6 classes from LOS A (best) to LOS F (worst). The detailed definitions for each LOS are shown in Table 3.4.

**Table 3.4**  
**Pedestrian LOS Standards for Walkways**

LOS Standard	Flow Rate (ped/min/m)	Description
LOS A	<16	Free circulation
LOS B	16-23	Free circulation for one directional flow. Minor conflicts for reverse and crossing flows.
LOS C	23-33	Some restriction in the selection of walking speed and the ability to pass others. High probability of conflict.
LOS D	33-49	Restricted and reduced walking speed for most pedestrians. Difficulties in passing. Multiple conflicts with momentary stop pages of flow.
LOS E	49-75	Restricted and reduced walking speed for all pedestrians. Shuffling progress at higher densities. Extreme difficulties in reverse or crossing flows.
LOS F	>75	Circulation reduced to shuffling. Reverse and crossing flows almost impossible. Frequent contact. Sporadic forward flow.

**Source:** Highway Capacity Manual (2000)

Pedestrian circulation system was first partitioned into different sections for detailed analysis. The LOS standard for each section is illustrated in Figure 3.3 for the morning peak period and Figure 3.4 for the evening peak period. For the morning peak period (08:30-08:45) shown in Figure 3.3, there were 2 sections of walkway with LOS E. When pedestrians walked along these two sections, their walking speed might be restricted and reduced due to congestion.

This situation became worse during the evening peak period (18:30-18:45). There were 7 sections of walkway with LOS E covering the whole footbridge connecting PolyU and Hung Hom MTR Station. When pedestrians walked on the footbridge during the evening peak period, they were required to follow the crowd in the front under such a high density of pedestrians. As shown in Figure 3.5 were two photos taken at the above mentioned footbridge illustrating the congested condition during the evening peak period.

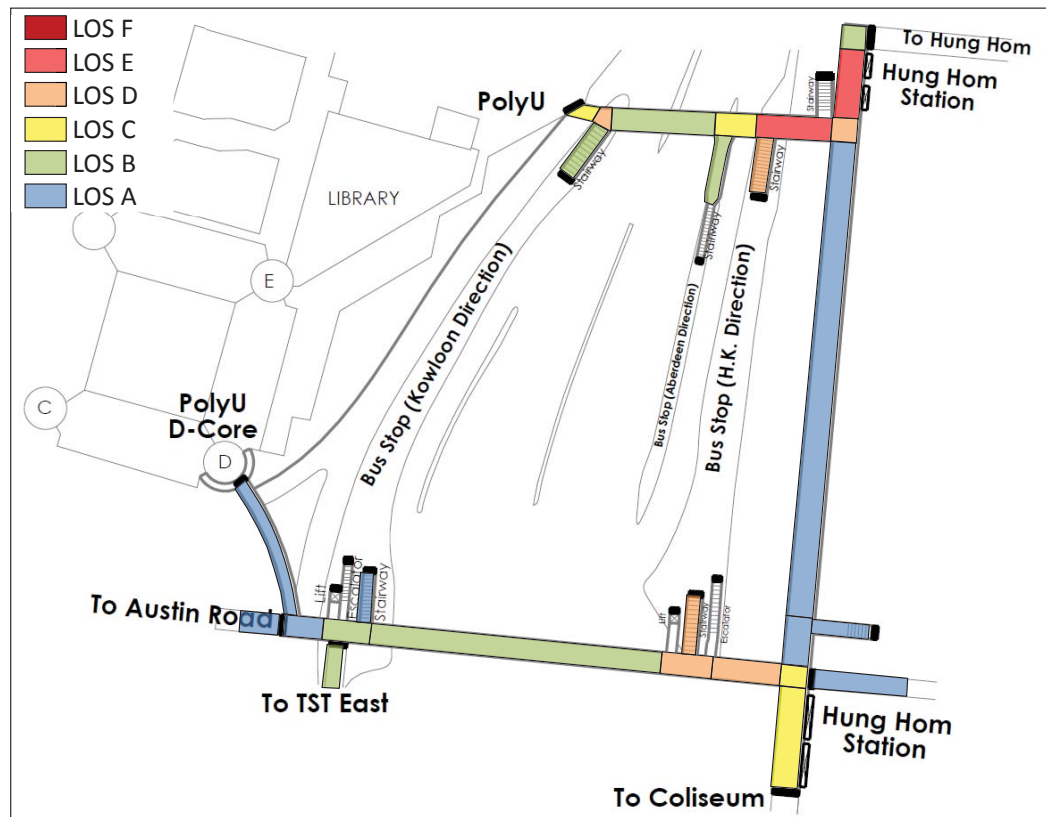


Figure 3.3 LOS Standards for Pedestrian Circulation System (08:30-08:45)

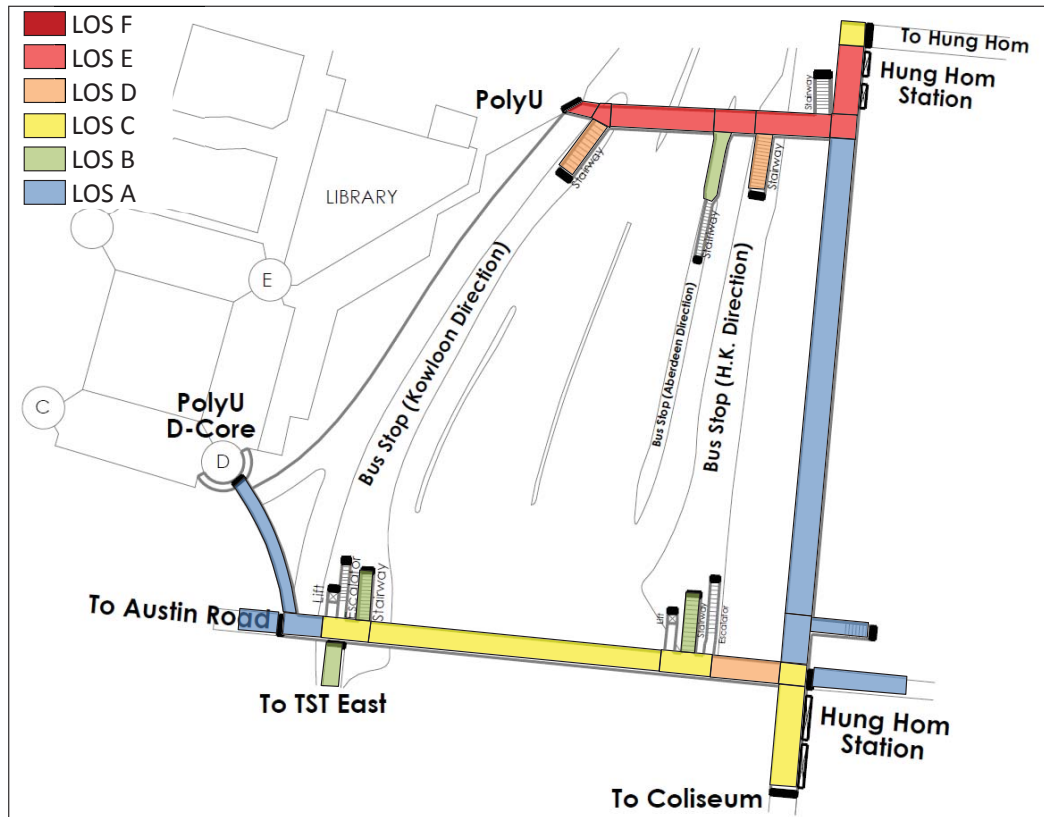


Figure 3.4 LOS Standards for Pedestrian Circulation System (18:30-18:45)



Figure 3.5 Congestion Condition at the Footbridge (18:30-18:45)

### 3.4 Future Pedestrian Circulation Assessment

Upon completion of the proposed Green Deck, there would be significant enhancement to the existing pedestrian circulation network. Based on the existing pedestrian flow, two pedestrian simulation models – Base Case Model and Project Case Model were built using pedestrian modelling software VISSIM. Base Case Model is for the situation before (i.e. existing situation) and the Project Case Model



is for the situation after installing the proposed Green Deck. The pedestrian flow OD matrices were used as an input for the development of pedestrian circulation for both Base Case and Project Case Models which were collected from the pedestrian flow survey mentioned in Section 3.2. The performance of the Project Case Model was assessed and compared with the Base Case Model (i.e. existing arrangement with do nothing). The assessment would be based on the LOS along a selected section of the critical pedestrian footbridge for both Case Models. The selected section for investigation is the footbridge near PolyU Library as shown in Figure 3.6.

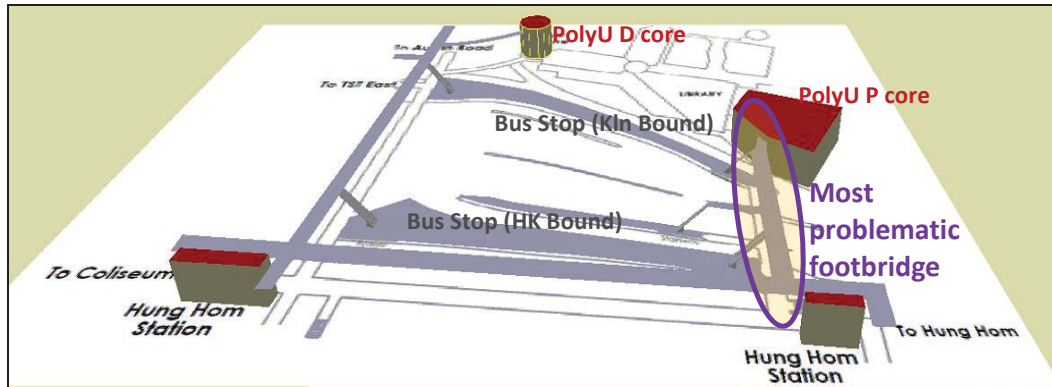


Figure 3.6 Base Case Model

**Base Case Model (Existing Situation Without Green Deck)**

The Base Case Model was developed as shown in Figure 3.6. It is assumed that all the pedestrian facilities within the Study Area remain unchanged. Figure 3.6 shows the screen capture of the simulation output of the Base Case Model. Pedestrians walking on the problematic footbridge section would be extremely difficult to pass/weave through the reverse or crossing flows. Their walking speeds are restricted and reduced as they have to shuffle under high pedestrians density.

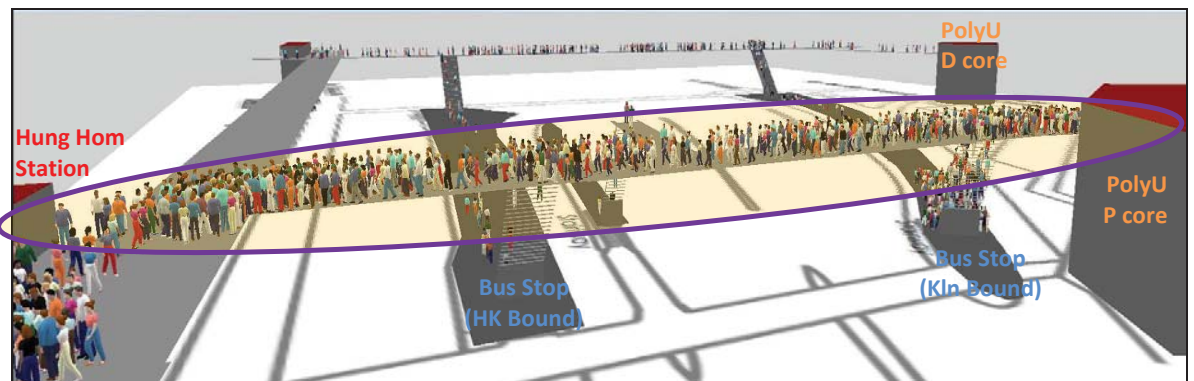


Figure 3.7 Screen Capture of the Base Case Model Simulation Output

Table 3.5 summarises the simulation results of the selected sections of pedestrian

footbridge for the Base Case Model. The existing two-way pedestrian flows for morning and evening peaks are 220 ped/min and 260 ped/min respectively. The corresponding LOS standards for AM and PM periods are LOS D and E respectively.

**Table 3.5**  
**Existing Pedestrian Flows and LOS Standards for the Base Case Model**

<b>AM (08:15-09:15)</b>	<b>Existing Footbridge</b>
<b>Two-way Pedestrian Flow</b>	220 ped/min
<b>LOS Standard</b>	LOS D
<b>PM (18:00-19:00)</b>	<b>Existing</b>
<b>Two-way Pedestrian Flow</b>	260 ped/min
<b>LOS Standard</b>	LOS E

Source: Estimated in this Study, 2013

**Project Case Model (Situation After Installing the Proposed Green Deck)**

For the situation after installing the proposed Green Deck, an assessment of its potential effect on pedestrian circulation in the study area was conducted. The impact of the proposed Green Deck on the walking environment would be reflected in the changes in pedestrian flow and walking time within the study area and in turn affects the improvement of congestion levels of some pedestrian facilities.

It is believed that the upper deck of the proposed Green Deck would have significant effect in diverting a certain proportion of pedestrians away from the existing problematic footbridge sections. While it is difficult to accurately predict how much pedestrian would swap to use the new pedestrian circulation system in the upper deck, a sensitivity analysis for each of the above mentioned enhancement proposals would be conducted by assuming different levels of pedestrian diversion during the morning and evening peak periods so as to quantify the potential impacts. It is believed that the diverted trips in the morning peak are mainly PolyU students going from Hung Hom MTR Station to PolyU for attending lessons and going to the sport complex on the Green Deck level. It is estimated that about 10-30% of these trips would be diverted to the Green Deck level. However, in the evening, divert trips may include some more pedestrians from Tsim Sha Tsui to Hung Hom MTR Station via PolyU. Given the worse walking environment along the footbridge in the evening peak period, it is estimated that about 30-50% of the trips to and from PolyU would be diverted to the Green Deck level.

It is proposed that an extension of the wall is introduced to cover the two areas siting the cross harbour bus stops (HK Bound) (Figure 3.6). The extension is at least 35 meters. This enhancement provides more pedestrian circulation spaces from Hung Hom Station to the cross harbour bus stops (HK Bound) and thus can divert some trips away from the problematic section of the footbridge. Moreover, it is also proposed that the exiting problematic pedestrian footbridge connecting PolyU and

Hung Hom MTR Station is widened as indicated in Figure 3.6. The existing width of the pedestrian footbridge is about 5.3 meters. The extension is at least 5 meters. This enhancement provides more pedestrian circulation spaces within the problematic section of the footbridge.

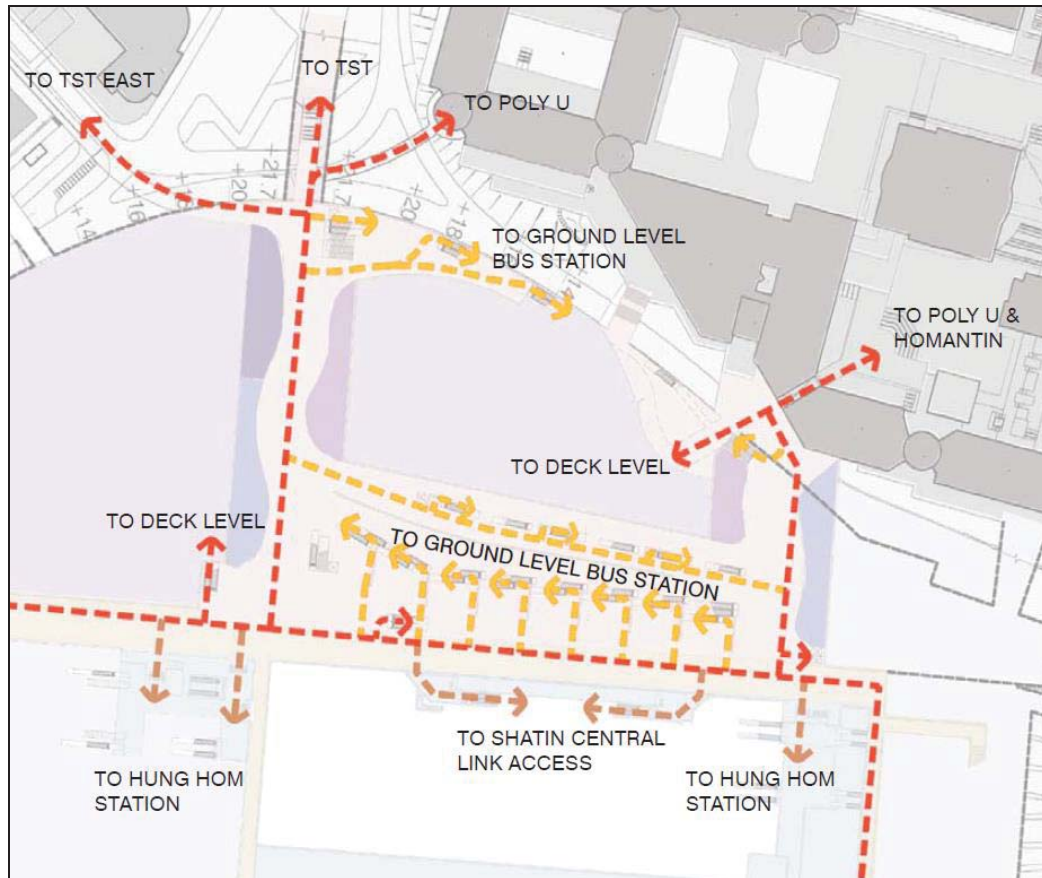


Figure 3.8 Proposed Footbridge Level of the Project Case Model

Figure 3.6 shows the screen capture of the simulation output of the Project Case Model. Pedestrians walking on the problematic footbridge could easily pass through the reverse or crossing flows. They can choose their walking speed freely and would not be restricted by the surrounding pedestrians.

**Error! Reference source not found.** summarises the simulation results of the selected sections of pedestrian footbridge for the Project Case Model. The existing two-way pedestrian flows for morning and evening peaks are 220 ped/min and 260 ped/min respectively. The corresponding LOS standard is LOS E in the evening which is more critical than that in the morning (i.e. LOS D). After the introduction of the Green Deck and the extension of the footbridge level, pedestrian circulation within the study area is improved. It is estimated that the two-way pedestrian flow will be decreased to 201-223 ped/min in the evening peak. The corresponding LOS



standard would be improved to LOS B.

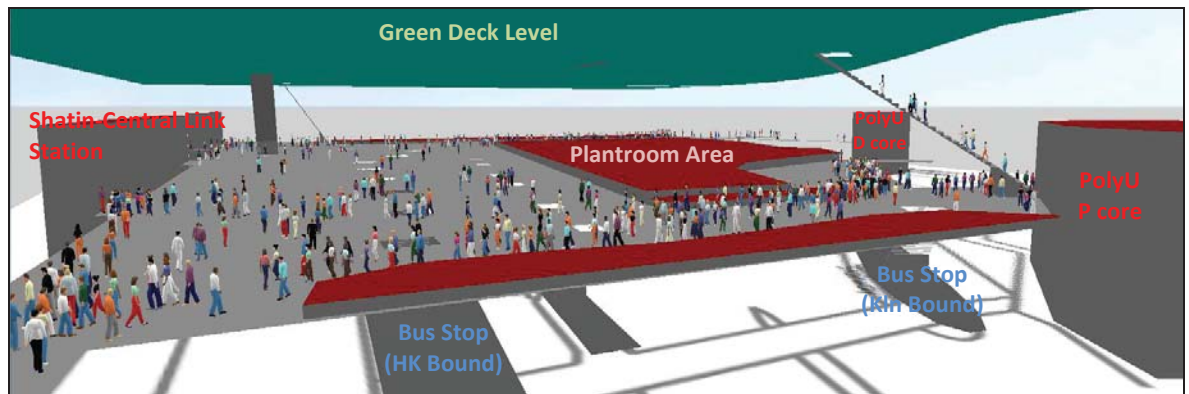


Figure 3.9 Screen Capture of the Project Case Model Simulation Output

Table 3.6 Simulated Pedestrian Flows and LOS Standards for Project Case Model

AM (08:15-09:15)	Existing	Reduce 10%*	Reduce 30%*
Two-way Pedestrian Flow	220 ped/min	213 ped/min	204 ped/min
Desired LOS Standard	LOS D	LOS B	LOS B
PM (18:00-19:00)	Existing	Reduce 30%*	Reduce 50%*
Two-way Pedestrian Flow	260 ped/min	223 ped/min	201 ped/min
Desired LOS Standard	LOS E	LOS B	LOS B

Source: Estimated in this Study, 2013

\* Percentage of pedestrian trips to and from PolyU diverted to the Green Deck level

### 3.5 Sensitivity Tests on Project Case Model (Situation After Installing the Proposed Green Deck)

Once the project case model has been built, some sensitivity tests can then be carried out so as to assess the potential effects on pedestrian circulation with an assumption of pedestrian flows increment of 10%, 20% and 30%. It is assumed that 50% of pedestrian flows will be diverted to the Green Deck level. The impacts of the increment of pedestrian flows on the proposed Green Deck and the surrounding walking environment are estimated and in turn the congestion levels of some pedestrian facilities are assessed.

Figure 3.10 shows the screen capture of the simulation output of the Project Case Model with an increment of 30% pedestrian flows. Pedestrians walking on the problematic footbridge could have some restriction in the selection of their walking speed. They are able to pass through the reverse or crossing flows with some conflicts by the surrounding pedestrians.

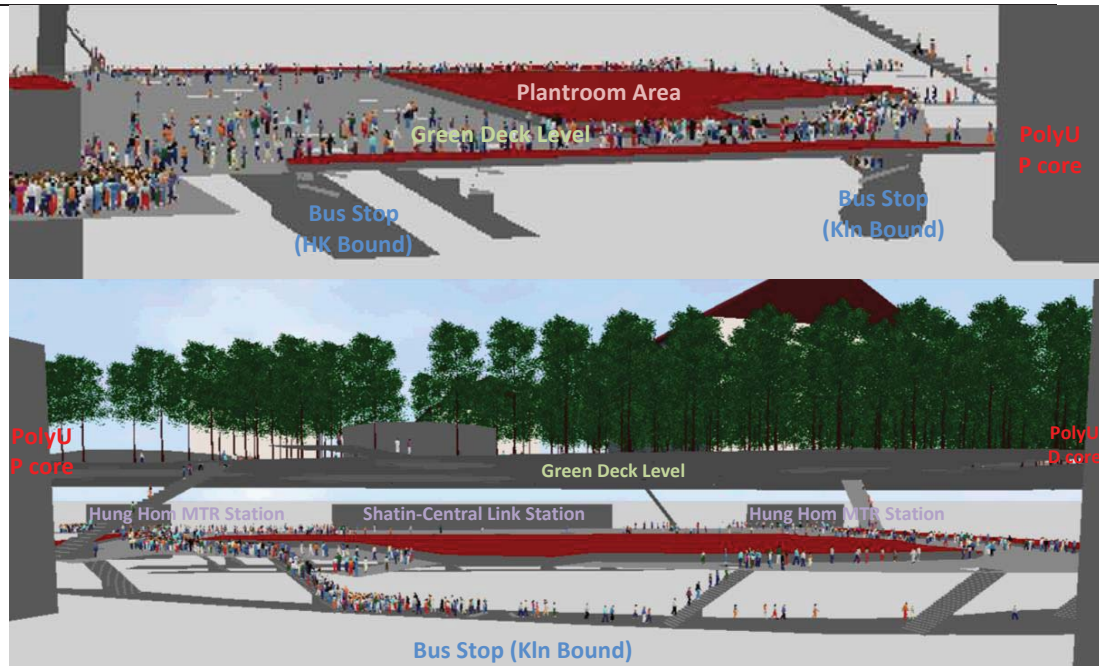


Figure 3.10 Screen Capture of the Project Case Model (30% Increment of Flow)

Table 3.7 summarises the simulation results of the sensitivity tests for the selected sections of pedestrian footbridge for the Project Case Model. The existing two-way pedestrian flows for morning and evening peaks are 220 ped/min and 260 ped/min respectively. The corresponding LOS standard is LOS E in the evening which is more critical than that in the morning (i.e. LOS D). After the introduction of the Green Deck (i.e. assumed that 50% of pedestrian flows are diverted to the Green Deck level) and the extension of the footbridge level, pedestrian circulation within the study area is improved significantly even with the assumption of 30% increment of pedestrian flows. It is estimated that the two-way pedestrian flow will be decreased to 149-176 ped/min in the evening peak. The corresponding LOS standard would be improved to LOS C.

Table 3.7 Simulated Pedestrian Flows and LOS Standards for Project Case Model (Sensitive Tests)

AM (08:15-09:15)	Existing (w/o Green Deck)	Increment of Pedestrian Flows (with Green Deck)		
		10%	20%	30%
Two-way Pedestrian Flow	220 ped/min	59 ped/min	64 ped/min	70 ped/min
Desired LOS Standard	LOS D	LOS A	LOS A	LOS A
PM (18:00-19:00)	Existing (w/o Green Deck)	Increment of Pedestrian Flows (with Green Deck)		
		10%	20%	30%
Two-way Pedestrian Flow	260 ped/min	149 ped/min	163 ped/min	176 ped/min
Desired LOS Standard	LOS E	LOS C	LOS C	LOS C

Source: Estimated in this Study, 2013

## 4 TRAFFIC EMISSIONS ASSESSMENTS

### 4.1 Existing Vehicular Traffic Conditions

According to the Annual Traffic Census 2012 from the Transport Department, the 2-way average annual daily traffic (AADT) for CHT, Salisbury Road (along the section within the Study Area) and Hong Chong Road (along the section within the Study Area) are 118,213, 2430 and 27,760 trips respectively. The traffic flow characteristics along the Salisbury Road and Hong Chong Road within the Study Area were also collected through a traffic count survey conducted on 15 November 2013 (Friday) during the periods 07:30 – 10:30 in the morning and 16:30 to 20:30 in the evening for the purpose of determining the compositions of traffic passing through the Study Area.

### 4.2 Base Case Traffic Emissions

To characterise the traffic emission for the Base condition in the Study Area (i.e. without the Green Deck), the EMFAC-HK model (a model adopted by the Hong Kong Environmental Protection Department (HKEPD)) was developed. The assessment of the impact of traffic emissions on the air quality in the Study Area would be based on the tonnes of pollutants (VOC, CO, CO<sub>2</sub>, NO<sub>x</sub> and PM<sub>10</sub>) emitted per day output from the EMFAC-HK model.

Based on the traffic flow characteristics mentioned in section 4.1, total vehicular kilometre travelled (VKT) within the Study Area was estimated to be 513,880 km per day. Vehicle composition shown in Table 4.1 was estimated with reference to the data collected from the traffic count survey and the 16-hour vehicle proportions information from ATC 2012. The vehicles speed fractions (Table 4.2) within the Study Area were roughly estimated based on site observations during the traffic count survey. It was observed that the CHT toll plaza area was congested most of the time throughout the period 08:00 to 21:00. Therefore, a larger proportion of speed fractions is estimated to be spent on low speed driving.

**Table 4.1**  
**Estimated Vehicle Composition**

Vehicle Type	Proportion	Vehicle Type	Proportion
Private Cars (PC)	46.9%	Private Light Buses <=3.5t	0.2%
Taxi	20.3%	Private Light Buses >3.5t	0.1%
Light Goods Vehicles<=2.5t	0.2%	Non-franchised Buses<=6.4t	1.2%
Light Goods Vehicles 2.5-3.	9.2%	Non-franchised Buses 6.4-15	0.9%
Light Goods Vehicles>3.5t	7.4%	Non-franchised Buses >15t	0.9%
Medium and Heavy Goods Vehicle	1.0%	Franchised Buses (SD)	0.1%
Medium and Heavy Goods Vehicle	2.7%	Franchised Buses (DD)	4.6%
Public Light Buses	1.3%	Motorcycles (MC)	3.0%

**Source:** Estimated in this Study, 2013

**Table 4.2**  
**Estimated Vehicle Speed Fractions**

Speed Range (kph)	0:00-07:00	07:00-08:00	08:00-21:00	21:00-23:00	23:00-24:00
0-8	0.00%	0.00%	45.00%	0.00%	0.00%
8-16	0.00%	0.00%	20.00%	0.00%	0.00%
16-24	0.00%	0.00%	12.50%	0.00%	0.00%
24-32	5.41%	5.89%	12.50%	5.89%	5.41%
32-40	9.80%	10.53%	5.00%	10.53%	9.80%
40-48	0.00%	0.00%	2.50%	0.00%	0.00%
48-56	19.93%	20.72%	1.25%	20.72%	19.93%
56-64	6.03%	7.48%	1.25%	7.48%	6.03%
64-72	27.31%	26.70%	0.00%	26.70%	27.31%
72-80	18.17%	16.92%	0.00%	16.92%	18.17%
80-88	0.00%	0.00%	0.00%	0.00%	0.00%
88-96	0.00%	0.00%	0.00%	0.00%	0.00%
96-104	12.03%	10.26%	0.00%	10.26%	12.03%
104-112	1.32%	1.50%	0.00%	1.50%	1.32%

Source: Estimated in this Study, 2013

Hourly temperatures for each month of a year were estimated based on the hourly temperature and monthly average temperature record of the past 12 months (i.e. December 2012 to November 2013) from the Hong Kong Observatory monitoring station. The average monthly average temperature and hourly variations are summarised in Table 4.3 and Table 4.4. The relative humidity profile was based on the default values provided in the EMFAC-HK model.

**Table 4.3**  
**Estimated Average Monthly Temperature Variation**

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (C°)	16.3	16.8	19.1	22.6	25.9	27.9	28.8	28.6	27.7	25.5	17.9	21.8

Source: Estimated in this Study, 2013

**Table 4.4**  
**Estimated Average Hourly Temperature Variation**

Time of the Day	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00
Temperature (C°)	19.7	19.7	19.2	19.7	18.7	18.2	18.2	18.7	19.2	19.7	20.2	20.7
Time of the Day	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Temperature (C°)	23.3	22.2	22.2	21.7	21.7	20.7	20.2	20.2	19.7	19.7	19.7	23.3

Source: Estimated in this Study, 2013

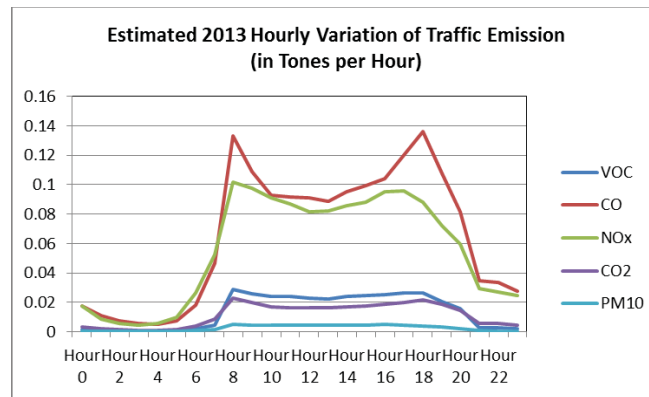
For comparison purpose, the Base case traffic emission levels for model years 2013, 2015 and 2020 were estimated. The only differences for different model years were the increased estimated total VKT and number of trips for future years. The speed

fractions, vehicle composition as well as the hourly and monthly temperature variations for future years (i.e. 2015 and 2020) were all the same as for the year 2013. Other model parameters such as changes in vehicle technologies were all based on the default values adopted in the EMFAC-HK model. The estimated traffic emissions in the Study Area for the Base condition are summarised in Table 4.5. For illustrative purpose, the hourly variations in traffic emissions were also estimated and presented in Figure 4.1 to Figure 4.3.

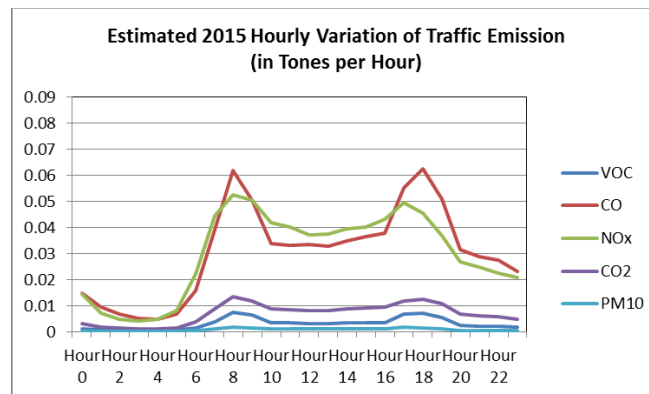
**Table 4.5**  
**Estimated Traffic Emissions Per Day (Base Case)**

	2013	2015	2020
VOC Emissions (ton)	0.32871	0.07509	0.04160
Carbon Monoxide Emissions (ton)	1.61212	0.76193	0.55592
Oxides of Nitrogen Emissions (ton)	1.29404	0.69710	0.36452
Carbon Dioxide Emissions (ton)	0.27604	0.16885	0.17602
PM10 Emissions (ton)	0.05757	0.01980	0.01391

Source: Estimated in this Study, 2013



**Figure 4.1** Estimated 2013 Hourly Variation of Traffic Emissions



**Figure 4.2** Estimated 2015 Hourly Variation of Traffic Emissions

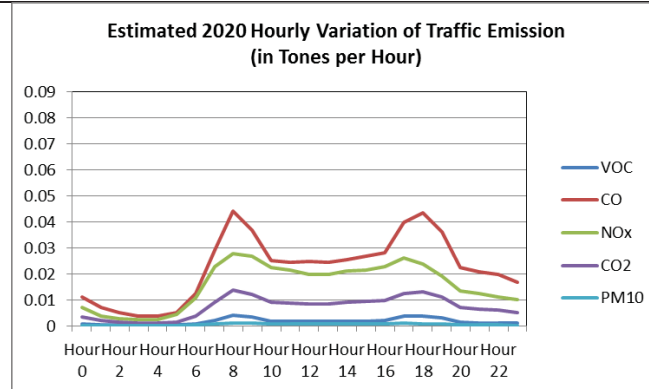


Figure 4.3 Estimated 2020 Hourly Variation of Traffic Emissions

### 4.3 Project Traffic Emissions Assessment

It is believed that the proposed Green Deck will not introduce significant changes to the vehicular traffic in the Study Area. All the traffic emission assessments were conducted on the basis of the existing traffic flow information and speed fraction estimation mentioned in section 4.2. It is anticipated that the potential impacts induced by the proposed Green Deck on the air quality would be reflected in the changes in ambient temperature within the Study Area.

It is believed that due to the introduction of the Green Deck, the temperature within the Study Area would become more stable in a lower range than the Base condition. To gauge their potential impacts on air quality, the Project conditions including the following scenarios of changes in ambient temperature were assessed (Table 4.6).

Table 4.6  
 Details of Project Scenarios Assessed

Scenario	Changes in Ambient Temperature (C°)					
	May	Jun	Jul	Aug	Sep	Oct
1	-1	-1	-1	-1	-1	-1
2	-1	-2	-2	-2	-2	-2
3	-1	-3	-3	-3	-3	-3
4	-1	-5	-5	-5	-3	-3

The estimated traffic emission levels for the three model years are shown in Table 4.7 to Table 4.9 respectively. The corresponding changes in traffic emissions for the three model years when compared with the Base condition were also included in the tables for easier references. The results showed that the total VOC, CO and CO<sub>2</sub> emissions per day in 2013 would be reduced by 0.30% to 4.53% while NO<sub>x</sub> emissions per day would be increased by about 0.93% to 3.25%. Similar patterns are also observed for years 2015 and 2020.

**Table 4.7**  
**Estimated Traffic Emissions Per Day (2013)**

	Base	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Tons	Tons	Change	Tons	Change	Tons	Change	Tons	Change
VOC	0.329	0.328	-0.30%	0.318	-3.34%	0.327	-0.61%	0.327	-0.61%
CO	1.612	1.598	-0.87%	1.539	-4.53%	1.575	-2.30%	1.565	-2.92%
NOx	1.294	1.306	0.93%	1.314	1.55%	1.325	2.40%	1.336	3.25%
CO <sub>2</sub>	0.276	0.275	-0.36%	0.272	-1.45%	0.274	-0.72%	0.273	-1.09%
PM <sub>10</sub>	0.058	0.058	0.00%	0.057	-1.72%	0.058	0.00%	0.058	0.00%

Source: Estimated in this Study, 2013

**Table 4.8**  
**Estimated Traffic Emissions Per Day (2015)**

	Base	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Tons	Tons	Change	Tons	Change	Tons	Change	Tons	Change
VOC	0.075	0.075	0.00%	0.075	0.00%	0.075	0.00%	0.075	0.00%
CO	0.762	0.755	-0.92%	0.748	-1.84%	0.743	-2.49%	0.737	-3.28%
NOx	0.697	0.704	1.00%	0.709	1.72%	0.714	2.44%	0.720	3.30%
CO <sub>2</sub>	0.169	0.168	-0.59%	0.168	-0.59%	0.168	-0.59%	0.167	-1.18%
PM <sub>10</sub>	0.020	0.020	0.00%	0.020	0.00%	0.020	0.00%	0.020	0.00%

Source: Estimated in this Study, 2013

**Table 4.9**  
**Estimated Traffic Emissions Per Day (2020)**

	Base	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Tons	Tons	Change	Tons	Change	Tons	Change	Tons	Change
VOC	0.042	0.042	0.00%	0.041	-2.38%	0.041	-2.38%	0.041	-2.38%
CO	0.556	0.551	-0.90%	0.547	-1.62%	0.543	-2.34%	0.539	-3.06%
NOx	0.365	0.368	0.82%	0.371	1.64%	0.374	2.47%	0.377	3.29%
CO <sub>2</sub>	0.176	0.176	0.00%	0.175	-0.57%	0.175	-0.57%	0.175	-0.57%
PM <sub>10</sub>	0.014	0.014	0.00%	0.014	0.00%	0.014	0.00%	0.014	0.00%

Source: Estimated in this Study, 2013



## 5 CONCLUSIONS

The proposed Green Deck consists of a two level structure covering the toll plaza area of the Cross Harbour Tunnel (CHT). Upon its completion, the Green Deck could enhance the existing pedestrian circulation system and the walking environment, as well as improving the air quality in the vicinity. It is anticipated that the Green Deck level (i.e. the upper deck) could attract 10-30% of current pedestrians in the morning peak and 30-50% of current pedestrians in the evening peak to use it instead of the existing footbridges circulation systems between the Hung Hom MTR Station and the PolyU main campus.

Two pedestrian simulation models were developed for the Base Case (without the Green Deck) and the Project Case (with the Green Deck). Using the two models, the potential impacts of the proposed Green Deck on the pedestrian circulation system was critically assessed at the model year of 2013 taken into account of different enhancements to the existing pedestrian system. Assessment results indicated that the differences in level of services (LOS) between the Base and Project Case Models were significant. The LOS standard of the problematic footbridge was improved from LOS E to LOS B. **It is reasonable to conclude that the introduction of the Green Deck would positively affect the future pedestrian circulation system in terms of improved level of services and reduction of pedestrian flows. The pedestrians' walking environment would be significantly improved.**

The potential impact of the proposed Green Deck on the air quality in the Study Area was also critically assessed in the "Base" and "Project" conditions at the model years of 2013, 2015 and 2020 for four scenarios reflecting the changes in the ambient temperature in the Study Area. **Assessment results indicated that, in the base case (i.e. year 2013), there would be about 0.329 ton of VOC, 1.612 tonnes of CO, 1.294 tonnes of NO<sub>x</sub>, 0.276 ton of CO<sub>2</sub> and 0.058 ton of PM<sub>10</sub> emissions per day in the Study Area.** Comparison across different hypothetical scenarios showed that VOC, CO and CO<sub>2</sub> emission levels per day would be reduced by about 1% to 5% while NO<sub>x</sub> would be slightly increased by similar magnitude. **Though the changes in the total emission levels per day is not very significant, the proposed Green Deck provides a potential to capture the tonnes of pollutants emitted as effective ventilation and exhaust emission treatment systems can be incorporated within the enclosed areas underneath the Green Deck.**