2019 年 8 月 27 日　10 時～13 時
10:00-13:00, August 27, 2019

Ｂ　都市工学専門
B Urban Engineering Subjects

受験番号
Examination I. D.

（１）　すべての答案用紙の所定の欄に、問題番号、受験番号を記入しなさい。氏名を記入してはならない。
Write the question number and your examination I.D. on all the answer sheets. Do not write your name.

（２）　問題冊子に受験番号を記入しなさい。
Write your examination I. D. on this sheet.

（３）　Ｂ－１～Ｂ－１５の１５問の中から５問を選択し、解答しなさい。ただし、５問の解答の中で以下の条件を満たすこと。
・専攻分野として「都市環境工学」を希望するものは、Ｂ－１～Ｂ－７のうちから３問以上選択しなければならない。
・専攻分野として「都市計画」を希望するものは、Ｂ－８～Ｂ－１５のうちから３問以上選択しなければならない。
Answer five questions out of the 15 questions (B-1 to B-15) following the instruction below:
- If your major field of study is “Urban Environmental Engineering,” then select at least three questions from B-1 to B-7.
- If your major field of study is “Urban Planning,” then select at least three questions from B-8 to B-15.

（４）　答案用紙は１問につき１枚（裏を含む）とし、問題毎に用紙を変えなさい。
Use one answer sheet for each question. You may write your answers overleaf.

B－1　Water and Wastewater Engineering

Q.1　Explain the following terms in 3 to 5 lines, respectively. Diagrams and formulae may be used in a supplemental manner.

(1) DLVO theory
(2) Advanced oxidation treatment
(3) F/M ratio
(4) Stokes' law

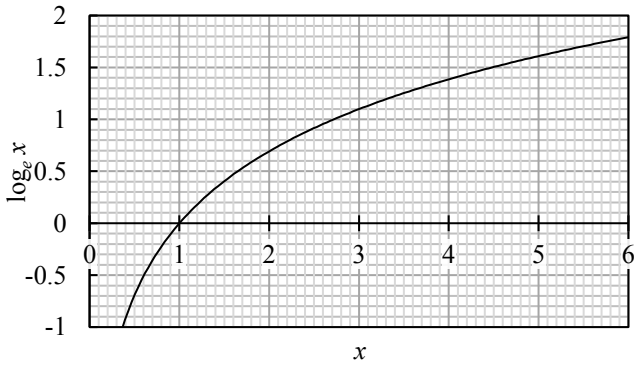
Q.2　Storage of stormwater and infiltration of stormwater are typical countermeasures for reducing the rapid stormwater runoff into the sewer system.

(1) Explain the characteristics of storage-type and infiltration-type countermeasures for reducing the stormwater runoff, respectively.
(2) Give two examples of facilities for storage-type and infiltration-type countermeasures, respectively , and compare them in view of the suitable installation site and the scale of the facility.

(to be continued)

Q.3 Water demand decrease associated with the population decline results in the elongation of retention time in the distribution network, which poses an issue of low residual chlorine concentration at water taps. Answer the following questions.

(1) At present, the residual chlorine concentration at the outlet of a water purification plant is 0.9 mg/L, the residual chlorine concentration at a water tap in the end of the water-supply area is 0.3 mg/L, and the hydraulic retention time from the water purification plant to the water tap in the end of the water-supply area is 50 hours. According to the future prospect, the water demand in the water-supply area will decrease by 30% in future. Calculate the residual chlorine concentration at the exit of the water purification plant that can achieve the same residual chlorine concentration at the water tap as the present residual chlorine concentration. Here, the decay of the residual chlorine through the water distribution pipes follows the first-order reaction of the residual chlorine concentration. Assume that the hydraulic retention time in the service pipes in each house is negligibly short. Use the following diagram, if necessary.



(2) Explain three countermeasures for mitigating the decrease of the residual chlorine concentration at the water tap, with the consideration of the disinfection by-products concentration at the water tap and the easiness of the implementation.

B－2　Hydraulics

Q.1　Concisely explain the following terms.

(1) Velocity potential
(2) Reynolds stress
(3) Venturi meter
(4) Normal depth

Q.2　A straight pipe of diameter D (m) and length L (m) is set horizontally in which water at 20 °C is flowing steadily under full pipe, where friction head loss is h_f (m), Manning roughness coefficient is $n = 0.013$, average velocity of Hagen Poiseuille Flow is

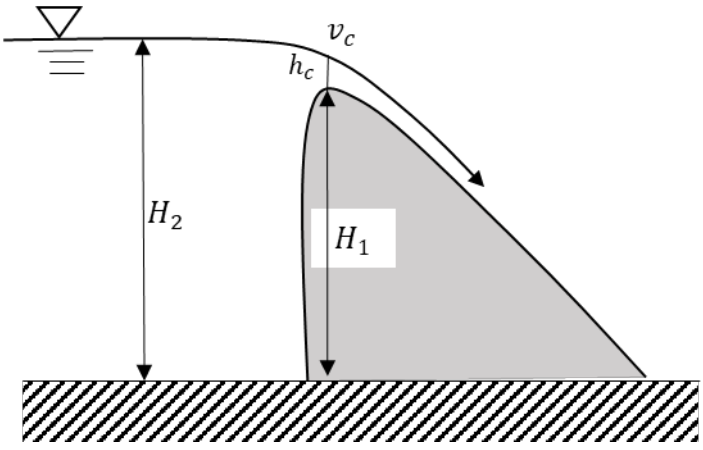
$U = \left(-\frac{dp}{dx} \right) \cdot \frac{a^2}{8\mu}$, ($a$: radius, μ: coefficient of viscosity, $\mu = 1.0 \times 10^{-3}$Pa·s at 20 °C),

and $(0.0025)^{2/3} = 0.018$.

(1) Answer the minimum velocity at which flow can be turbulent at $D = 0.01$ and $L = 1$.
(2) Answer the average velocity at $D = 0.01$, $L = 20$, and $h_f = 0.1$.
(3) Answer the average velocity and friction factor at $D = 0.5$, $L = 4$, and $h_f = 1$

Q.3　Consider a dam with height H_1 and the reservoir with depth of H_2 as shown in the figure below. The top of the dam becomes the control section with critical flow, where the depth is h_c, the velocity is v_c and the channel width is b.

(1) Give the equation to express specific energy at the center of reservoir and at the top of the dam, respectively.
(2) Give the relation between h_c and v_c.
(3) Answer the flow rate of the dam, given $H_1 = 15$ m, $H_2 = 16$ m, $b = 10$ m, and $\sqrt{30} = 5.5$.



Ｂ－３　Water Environment

Q.1　Answer the following questions regarding environmental standards for water pollution in Japan.

(1) There are two types of standards, “Environmental Standards for the Protection of Human Health” and “Environmental Standards for the Conservation of Living Environment”. Explain how the period necessary to achieve the standard after the enactment of the environmental standards (including category assignment) is set in each type of the standard.
(2) The table below shows part of “Environmental Standards for the Conservation of Living Environment”. Answer parameters corresponding to (a), (b), (c), and (d) in the table.
(3) Either BOD or COD is used as one of the parameters in environmental standards. Explain the principle and methodology of the measurement of BOD and COD.

Table　Environmental Standards for the Conservation of Living Environment

Parameter / Category	Standard value			
	(a)	(b)	(c)	(d)
AA	Above 6.5 Below 8.5	Below 25mg/L	Above 7.5mg/L	Below 50MPN/100ml
A	Above 6.5 Below 8.5	Below 25mg/L	Above 7.5mg/L	Below 1,000MPN/100ml
B	Above 6.5 Below 8.5	Below 25mg/L	Above 5mg/L	Below 5,000MPN/100ml
C	Above 6.5 Below 8.5	Below 50mg/L	Above 5mg/L	-
D	Above 6.0 Below 8.5	Below 100mg/L	Above 2mg/L	-

(To be continued)

Q.2 Concisely explain the following terms related to the water environment, including the outline of the problem, the mechanism of the problem and the countermeasures for the problem.

(1) Eutrophication of lakes
(2) Minamata disease

Q.3 Cryptosporidiosis is a typical waterborne disease in Japan. Explain about the infection route of cryptosporidiosis and its countermeasures.

B－4　Environmental Microbiology

Q.1　Answer the following questions on biological treatment of organic wastewater.

(1) When treating domestic wastewater by the conventional activated sludge process, how are dissolved nitrogen and phosphorus compounds treated? Explain them by paying attention to the form of the compounds.
(2) Explain Upflow anaerobic sludge blanket (UASB) process by sentences and a conceptual diagram.

Q.2　Methane (CH_4) is a compound that is formed and consumed by microorganisms. Answer the following questions by using Table 1 as reference.

(1) Write an overall reaction equation for methane formation and for methane consumption, respectively, by using substances shown in Table 1.
(2) Calculate standard free energy change per 1 mol of methane in the reaction of methane consumption that you answered in (1). Faraday constant is 96,500 C/mol.

Table 1　Oxidation-reduction couples (redox couples) related to methane formation and consumption

Redox couples	Standard oxidation-reduction potential at pH 7 ($E^{0'}$)
H^+/H_2	−0.42 V
CO_2/CH_4	−0.24 V
O_2/H_2O	+0.82 V

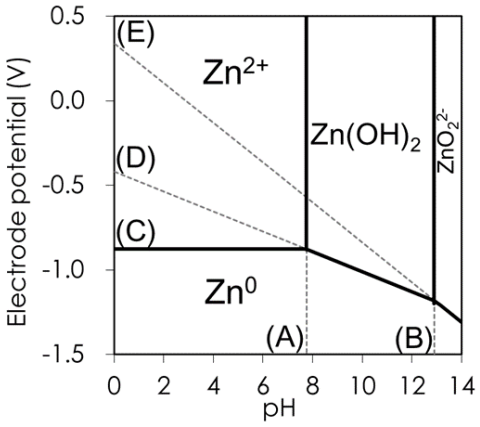
Q.3　Explain catabolic metabolism of glucose as a substrate by using all the terms below.
glycolysis, TCA cycle, electron transport chain, fermentation

Q.4　Explain the following term in one or two lines, respectively.

(1) Chemoautotrophic organisms
(2) Bulking of activated sludge
(3) Cometabolism

B－5　Environmental Chemistry and Reaction

Q.1　It is known that Zn^{2+} in aqueous solution precipitates as $Zn(OH)_2$ along with the increase of pH while it dissolves again as ZnO_2^{2-} when pH further increases. Also, Zn^0 (metal) appears in a reduced condition.



The figure on the right indicates the potential-pH diagram, where the concentration of dissolved zinc species in aqueous solution is 1.0×10^{-4}mol/L at 25°C. Answer the values of (A) and (B) on the pH-axis and the values of (C), (D) and (E) on the electrode potential-axis, while showing the process of calculation.

Note the information below is available. The values of $\log_{10}3.2 = 0.51$ and $\log_{10}1.6 = 0.20$ may be used.

$Zn^{2+} + 2e^- \rightleftarrows Zn^0$,　$E^0 = -0.76$V

$Zn(OH)_2 \rightleftarrows Zn^{2+} + 2OH^-$,　$K_{sp1} = 3.2\times10^{-17}$

$Zn(OH)_2 \rightleftarrows ZnO_2^{2-} + 2H^+$,　$K_{sp2} = 1.6\times10^{-30}$

$Zn(OH)_2 + 2H^+ + 2e^- \rightleftarrows Zn^0 + 2H_2O$,　$E^0 = -0.42$V

$ZnO_2^{2-} + 4H^+ + 2e^- \rightleftarrows Zn^0 + 2H_2O$,　$E^0 = +0.46$V

At 25°C, the electrode potential, E, in the half cell reaction of an oxidation-reduction couple, Ox + ne^- $\rightleftarrows$ Red, can be approximated as follows:

$$E = E^0 - \frac{0.059}{n}\log_{10}\frac{a_{\mathrm{Red}}}{a_{\mathrm{Ox}}}$$

where E^0 is the standard redox potential (vs. standard hydrogen electrode), K_{sp1} and K_{sp2} are the solubility products of $Zn(OH)_2$ in each reaction, n is the number of electron that moves in the reaction, a_{Red} and a_{Ox} are the activities of Red and Ox, respectively, in the half cell reaction. Note that the activity, a, of an aqueous solution may be approximated by the molarity.

Q.2　Answer concisely the definition of each technical term below. Also, explain how the term is used in environmental chemistry by giving an example.

(1) Octanol-water partition coefficient

(2) Specific surface area

(3) Critical micelle concentration

Ｂ－６　Global Environment Engineering

Q.1　Explain the following terms in 7 to 10 lines in each of them.

(1) Precautionary principle
(2) Carbon neutral
(3) El Niño and La Niña

Q.2　Answer the following questions about air pollution problem.

(1) Describe one example of trans-boundary air pollution, and explain ① the background and the causes of the pollution, ② the spatial scale of the pollution and its effects on the environment and human health, and ③ the countermeasures to reduce and prevent the pollution of that example.
(2) Describe the sources, generation mechanisms, and human health effects of air pollution by photochemical smog. Explain the countermeasures taken in Japan to reduce photochemical smog and their effectiveness.

Q.3　Answer the following questions about Feed-in Tariff (FIT) of renewable energy.

(1) Explain ① the purpose, ② the advantages, ③ the effects after introduction, and ④ the shortcomings of FIT.
(2) List all of the renewable energies that are included in the FIT, and explain the characteristics of each energy.
(3) List any other policy measures than FIT to promote introduction of renewable energy. Explain the pros-and-cons of these methods in comparison with FIT.

Ｂ－７　Waste Management and Material Cycles

Q.1　The below sentence is the target 12.3 included in Goal 12 “ensure sustainable consumption and production patterns” of the Sustainable Development Goals (SDGs). In addition, the below table shows estimates of the annual generation amounts of waste and losses originating from X (hereinafter, referred to as “X waste” and “X losses”, respectively) in Japan for fiscal year 2016. Relating to them, answer the questions (1) to (5).

12.3	By 2030, halve per capita global [X] waste at the retail and consumer levels and reduce [X] losses along production and supply chains, including [Y] losses

	Annual amount of X waste generation	
		X losses out of X waste
Household waste	7.89 million ton	2.91 million ton
Business waste and valuables	19.70 million ton	3.52 million ton

(1) Provide appropriate words for the boxes X and Y, respectively.
(2) Explain briefly which part of X waste so-called X losses indicate.
(3) Answer the amount of waste that is subject to the Japanese individual recycling law for X according to the values shown in this table.
(4) X losses generated from households are divided into three categories. Provide two categories other than “direct disposal” among them. Furthermore, explain each of three categories including direct disposal in about one line, respectively.
(5) What kinds of efforts are considered to be effective toward the achievement of the “waste-halving” goal described in the target 12.3 of the SDGs in Japan? Explain retail- and consumer-level efforts in about three lines, respectively, by giving specific examples.

Q.2　Explain the following terms in three to five lines, respectively.

(1) Resource productivity
(2) Energy recovery

Ｂ－８　Urban Planning

Q.1　Compare the urban planning systems between Japan and the UK, and explain the characteristics of each from the following perspectives.

(1)　Spatial areas covered by urban planning
(2)　Development control

Q.2　Based on the results of the above comparison, briefly describe the issues of Japanese urban planning system.

Ｂ－９　Urban Design

Q.1　Explain the following urban design terms in about five lines each with reference to their actual examples.

(1)　Incentive Zoning
(2)　LEED (Leadership in Energy & Environmental Design)
(3)　New Urbanism

Q.2　It is widely recognized that there are two approaches in urban design with different scales, namely (a) designing an urban structure and (b) designing individual urban spaces. Answer the following questions regarding these two urban design approaches.

(1)　Discuss the differences between the two approaches by focusing on players, processes, methods, etc. of each.
(2)　Take one example that successfully integrates the two approaches, either in Japan or abroad, and examine its success factors.

Ｂ－１０　Urban Housing

Q.1 Suppose that the table below shows the estimation result of a hedonic model which describes the relationship between land price and lot attributes:

$$P/S = const + \sum_i c_i \cdot (X_i/S) + \sum_i d_i \cdot X_i + \varepsilon$$

where P is the land price (million yen); S is the lot area (m^2); *const* is the constant; X_i are independent variables representing attribute i; c_i and d_i are parameters; and ε is an error term. Answer the following questions.

Attribute	Coefficient	*t* value
Constant	0.90	9.17
Greenery /S	24.0	3.14
T.station	−0.015	−9.61
T.terminal	−0.018	−6.60
Actual FAR	0.12	3.22
W.road	0.020	2.86
Greenery	−0.16	−2.97

Note: $R^2 = 0.756$, adjusted $R^2 = 0.734$

Greenery: Adjacency to public green space (Yes=1/No=0)

T.station: Time to the nearest railway station (minutes)

T.terminal: Time from the nearest railway station to the terminal station (minutes)

Actual FAR: Ratio of building floor area to lot area

W.road: Width of front road (meters)

(1) Compare the estimated prices of housing lots A (*T.station* = 10, *T.terminal* = 20) and B (*T.station* = 15, *T.terminal* = 15), provided that other attributes of the two lots are the same.

(2) Explain the relationship between the lot area and the land price which is adjacent to public green space.

(3) Suppose that you plan 10 housing lots (each lot occupies 100 m^2) and a public green space (250 m^2) on a land of 25 meters by 50 meters which is encompassed by the roads with the same width. Answer with figures and texts how to lay out the lots in order to achieve the higher land price as a whole.

Q.2 The sentences below are about the housing safety net in Japan. Answer the following questions.

B_____ (approved in 2011 by the Cabinet) based on A_____ (enacted in 2006) set goals which included the "stabilization of living for those who require special consideration in securing housing". National policies to achieve this objective included the promotion of providing D_____ which started the registration by the revision of C_____ in 2011, and support for establishing "housing support councils".

(1) Fill in the blanks from A to D, where A and C are the names of acts.

(2) List three attributes included in "people who require special consideration in securing housing", except for low-income earners and elderly people.

(3) Explain what a "housing support council" is, using all of the following terms in two or three lines.

【"people who require special consideration in securing housing", privately-rented housing, local authorities】

Ｂ－１１　Urban Disaster Management and Planning

Q.1　Explain each of the following pairs of terms in Japan in about three lines respectively.

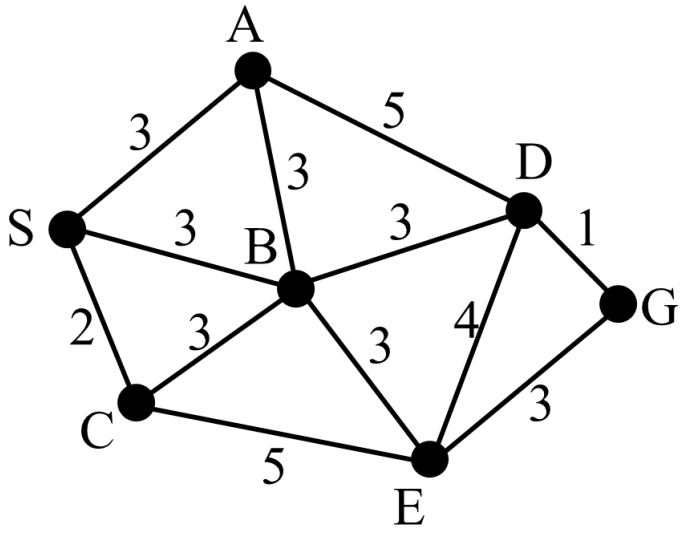
(1)　“fire prevention district” and “quasi-fire prevention district”
(2)　“emergency temporary houses” and “apartments as emergency temporary houses”
(3)　“evacuation order (emergency)” and “evacuation advisory”

Q.2　Explain problems and solutions on disaster prevention measures peculiar to “Preservation Districts for Groups of Traditional Buildings” in Japan.

Q.3　Nominate four of the main causes of post-earthquake fire ignition, and explain the mechanisms of post-earthquake fire ignition by those causes respectively.

Ｂ－１２　Urban Analysis

Q.1　There are nodes S, G, A, B, C, D, E in the network of the figure below. The time [unit: hour] required to travel between the nodes is given by the number along each edge. For example, it takes 3 hours from S to A, and 3 hours from A to S. Answer the following questions.



(1)　One wants to travel from node S to node G in a shortest time. (There is no need to visit all the nodes.) How should one travel on the network?　Answer the path with its reason.

(2)　One wants to travel from node S to node G in a shortest time with visiting all the nodes at least once. How should one travel on the network?　Answer the path with its reason.

Q.2　When we conduct a questionnaire survey to citizens, what kind of precautions do we need from the following points of view in general?

(1)　Precautions when we determine survey respondents.

(2)　Precautions when we design the questionnaire survey form.

(3)　Precautions when we analyze the questionnaire data.

Ｂ－１３　Urban Transportation Planning

Q.1　Explain the institutional framework in Japan to promote barrier-free access in an area intensively and integratedly, based on the Barrier-free Act (Act on Promotion of Smooth Transportation, etc. of Elderly Persons, Disabled Persons, etc.) which has been enforced since 2006, using all of the following terms. In the explanation, show the meaning of the terms “priority improvement area” and “life-related facilities”.

[Terms to be used]　barrier-free standards, basic concept for barrier-free access, priority improvement area, life-related facilities, project

Q.2　In developing the future regional trunk transportation network plan, it is a common practice to input the plans and the land-use scenarios into the travel demand forecasting model and evaluate them. Explain the important points in setting these inputs, along with the reasons why they are important, in about seven lines.

Q.3　Explain each of the following pairs of terms by paying attention to mutual relationships and/or differences.

(1)　“Net freight flow” and “Gross freight flow” in freight transport
(2)　“Basic traffic capacity” and “Possible traffic capacity”
(3)　“Rational choice theory” and “Random utility theory”

Ｂ－１４　Regional Planning

Q.1　Answer the following questions on amalgamation of local governments.

(1)　Choose a country or a region where large-scale amalgamation of local governments was implemented during a certain period after 1970s. Indicate the country or the region you selected and the approximate period of large-scale amalgamation, and describe two major reasons why the amalgamation was promoted during that period in eight to ten lines, associating with the expected positive effects of the amalgamation.

(2)　On the other hand, many opposing opinions were often heard in the process of amalgamation in the country or the region, and there were many cases where amalgamation was not realized. Describe in six to eight lines two major reasons why the amalgamation was opposed in that period in the selected country or region in (1), associating with the expected negative impacts of the amalgamation.

(3)　Effectiveness of inter-municipal cooperation is usually discussed together when amalgamation is under controversial discussion. Raise and discuss two advantages and two disadvantages of inter-municipal cooperation, in comparison with the amalgamation in the selected country or region in total of six to eight lines

Q.2　Answer the following questions on location quotient which is one of the most popular indices for analyzing regional economy.

(1)　Explain how to calculate location quotient in about two lines. You may raise an example of the production volume, the number of persons engaged, etc.

(2)　Discuss strengths and limitations of location quotient for analyzing major industries that sustain regional economy in four to six lines.

Ｂ－１５　Landscape Planning and Environmental Design

Q.1 The figure below shows the relationship between urban heat island intensity (UHI Intensity*) and the distance from a large-scale greenspace located in the urban center in City L observed in a summer night. Examine the graph and explain what can be identified as the effect of the greenspace in approximately five lines.

*UHI Intensity: The difference between the air temperature measured at each monitoring point in the greenspace (0m in the figure) and around the greenspace (within 400m in the figure) and that measured at a weather station in the rural area surrounding the city.

Q.2 What kind of urban planning measures should be taken in order to utilize the effect of greenspaces that you mentioned in Question 1 to mitigate urban heat island? Answer in approximately eight lines.

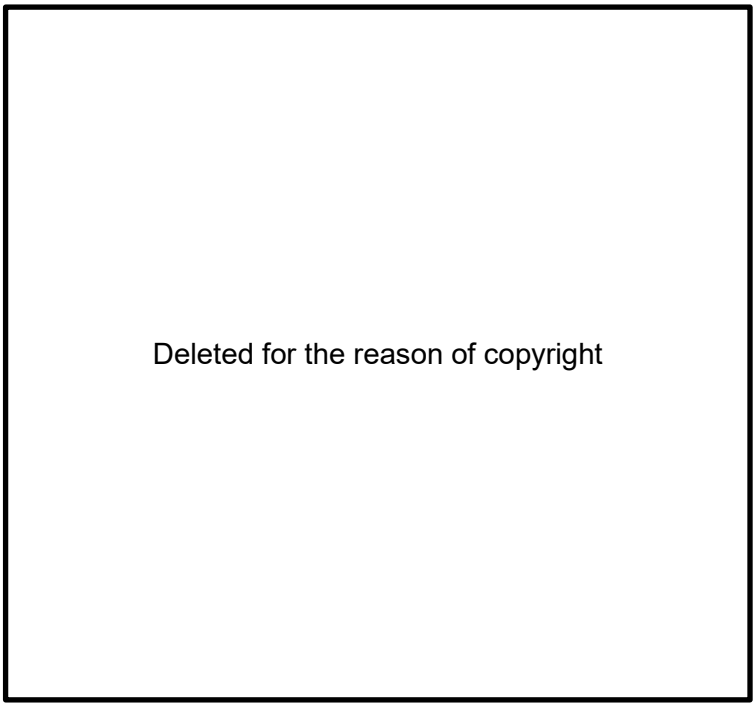


Figure: Relationship between UHI Intensity and distance from the greenspace
(Reference: Doick et al. 2014）