Note: This is the informal translation of questions in Japanese and was offered as reference materials.

2021 年 8 月 28 日　16:00～18:00

C ［計画・設計］・［論文］

C Planning, Design, Essay

（１） すべての解答用紙と下書用紙の所定の欄に、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 examinee number in the specified place of all answer sheets and the draft paper.
Do not write your name.

（２） 問題ファイル（このファイル）は、答案アップロード終了後、指示に従い削除すること。削除していないことが判明した場合には不正行為となることがある。
After uploading your answer sheets, delete this file containing question sheets following the instruction. In case you do not follow this instruction, it will be regarded as misconduct behavior.

（３） 都市環境工学専攻分野志望の受験者は、C-1、C-2 からいずれか１問を選択し、該当する解答用紙に解答しなさい。
Those who apply to the Urban Environmental Engineering should choose and answer one question from C-1 to C-2. Use the relevant answer sheets for the question you chose.

（４） 都市計画専攻分野志望の受験者は、C-3、C-4 からいずれか１問を選択し、該当する解答用紙に解答しなさい。
Those who apply to the Urban Planning should choose and answer one question from C-3 to C-4. Use the relevant answer sheet(s) for the question you chose.

（５） 解答終了後は監督者の指示に従い、選択した問題の答案のみをアップロードすること。
Upload answer sheet(s) of only a chosen question following the instruction.

（６） 問題のスクロールと拡大縮小のため、パソコンのマウスやトラックパッドの使用は認めるが、キーボードには触れてはならない。
Note that using a mouse or trackpad for scrolling and zooming in/out is allowed but touching a keyboard is prohibited.

English translation of question sheets follows Japanese version.

C-1 計画・設計
(専攻分野：都市環境工学)

C-1 Planning and Design
(Major field of study:
Urban Environmental Engineering)

English translation of question sheets follows Japanese version.

C－1　Planning and Design (Urban Environmental Engineering)

A new residential city is to be constructed. Answer the following questions from Q.1 to Q.4 related to a sewerage system in the city.

District A, which is the site for the new residential city, faces an inner bay, Bay B, on the south side. Land use before the city construction and after the completion of the city construction in District A are shown in Figures 1a and 1b. The size of one cell is 200 m square in Figures 1a and 1b. There are no inhabitants in District A before the city construction and 300 milk cows are pastured. After the completion of the city construction, population is 30,000 and the sewerage system in the city is completed. The separate sewer system is adopted in the city and the treated wastewater is directly discharged to Bay B.

Make sure to write the derivation processes for the questions that require calculation. Use the values in Tables 1 to 5 if necessary. Assume appropriate values by yourself, if they are not provided.

Q.1　Answer the following questions (1) and (2) about the stormwater drainage.

(1)　Calculate the overall runoff coefficient of Block C shown in Figure 1b after the completion of the city construction.

(2)　Assuming stormwater drainage pipes are constructed in Block C as shown in Figure 1c, calculate the design peak discharge at Terminal D of the pipes. The design rainfall intensity I is given by the following equation. Inlet time is 7 minutes and the average flow velocity in the stormwater drainage pipes is 1.0 m/s.

$I=5000/(t+40)$　　t: rainfall duration (minutes)

Q.2 A wastewater treatment plant that treats all domestic and commercial wastewater in the city is to be constructed. Assume that the water use per person per day in this city is the same as that in an existing city, City E (Table 3). The conventional activated sludge process is adopted for the treatment. Answer the following questions (1) to (6).

(1) Answer the design daily average wastewater flow and the design daily peak wastewater flow.

(2) Assume all wastewater flows into the wastewater treatment plant through a single sewer pipe. Suppose the sewer pipe is a circular tube, give the appropriate diameter of the pipe. Set the flow velocity in the sewer pipe at the maximum flow to be 2.0 m/s.

In the following questions (3) to (5), the size of the facilities corresponding to the wastewater flows calculated above are to be considered.

(3) Calculate the required surface area of the primary settling tank.

(4) Calculate the required effective volume and the surface area of the reaction tank.

(5) Calculate the required surface area of the secondary settling tank.

In the following question (6), the necessary facilities in the wastewater treatment plant are to be considered.

(6) Draw a ground plan of the treatment plant on the answer sheet for Q.2(6). Specify the size of a cell of the plan. Design primary settling tanks, reaction tanks and secondary settling tanks based on the calculation in the questions (3) to (5). In addition, draw three facilities that are normally essential to wastewater treatment plants (the sizes do not matter).

Q.3 Answer the following questions (1) to (3) about the impact of the city construction on Bay B.

(1) Estimate the pollution load of COD, TN and TP, respectively, discharged to Bay B from District A before the city construction.

(2) Estimate the pollution load of COD, TN and TP, respectively, discharged to Bay B from District A after the completion of the city construction.

(3) What kind of environmental impact can occur on Bay B by the construction of the city? Answer two kinds of effect that you think important and briefly explain the reasons respectively.

Q.4 Answer the following questions (1) to (3) about the effective use of resources and energy obtained from sewerage systems including wastewater treatment plants.

(1) If the treated wastewater is used as toilet flushing water, what kind of treatment processes should be added to the treatment facilities designed in Q.2? Answer the processes with their advantage and disadvantage in the light of their purpose of use.

(2) If the treated wastewater is used as a part of drinking water source, what kind of treatment processes should be added to the treatment facilities designed in Q.2? Answer the processes with their advantage and disadvantage in the light of their purpose of use.

(3) Answer two examples of the effective use other than the use of the treated wastewater, and explain things to be considered in these applications, respectively.

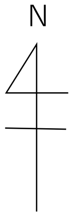

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Figure 1a Land use in District A before the city construction

Legend for the land use
1 Mountainous forest
2 Meadow
3 Low-rise residential area
4 Mid/high-rise residential area (including business facilities)

200m × 200m

The size of a cell in Figure 1a-1c

1	1	1	1	1	1	1	1	1	1	1	1	1	1
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3	3	3	3	3	4	4	4	4	3	3	3	3	3
3	3	3	3	3	4	4	4	4	3	3	3	3	3

Figure 1b Land use in District A after the completion of the city construction (Shaded area is Block C)

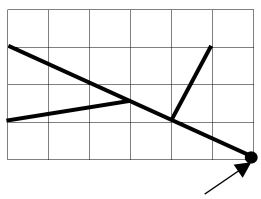


Figure 1c Stormwater drainage pipes in Block C (The bold solid lines are the pipes)

Table 1 Runoff coefficient for the land use

Mountainous forest	0.3
Meadow	0.2
Low-rise residential area	0.4
Mid/high-rise residential area	0.7

Table 2 Values for wastewater treatment facilities

Hourly peak wastewater flow (m^3/day) / Daily peak wastewater flow (m^3/day)	1.5
Water surface loading (m^3/m^2/day)	
Primary settling tank	35-70
Secondary settling tank	20-30
Removal ratio of the pollutants by conventional activated sludge process (%)	
COD	90
TN	50
TP	50

Table 3 Daily water supply per capita in City E* (L/capita/day)

	Minimum	Maximum	Average
January	310	340	320
February	290	330	310
March	310	350	330
April	320	350	330
May	330	360	350
June	340	370	350
July	340	390	370
August	350	410	380
September	330	380	360
October	330	370	350
November	310	350	320
December	300	330	310

* Including commercial water use

Table 4 Pollution load per unit sources (non point sources) (kg/ha/year)

	COD	TN	TP
Mountainous forest	10	5	0.2
Meadow	50	20	1
Residential area	50	5	1

Table 5 Pollution load per unit sources (point sources)

	COD	TN	TP
Domestic wastewater (g/capita/day)			
Human excreta	10	9	0.9
Gray water	17	2	0.4
Milk cows (g/cow/day)			
emission*	300	200	40

* pollution load emitted to the meadow

Square root transformation

a	$\sqrt{a}$	a	$\sqrt{a}$	a	$\sqrt{a}$	a	$\sqrt{a}$
1	1	26	5.10	51	7.14	76	8.72
2	1.41	27	5.20	52	7.21	77	8.77
3	1.73	28	5.29	53	7.28	78	8.83
4	2	29	5.39	54	7.35	79	8.89
5	2.24	30	5.48	55	7.42	80	8.94
6	2.45	31	5.57	56	7.48	81	9
7	2.65	32	5.66	57	7.55	82	9.06
8	2.83	33	5.74	58	7.62	83	9.11
9	3	34	5.83	59	7.68	84	9.17
10	3.16	35	5.92	60	7.75	85	9.22
11	3.32	36	6	61	7.81	86	9.27
12	3.46	37	6.08	62	7.87	87	9.33
13	3.61	38	6.16	63	7.94	88	9.38
14	3.74	39	6.24	64	8	89	9.43
15	3.87	40	6.32	65	8.06	90	9.49
16	4	41	6.40	66	8.12	91	9.54
17	4.12	42	6.48	67	8.19	92	9.59
18	4.24	43	6.56	68	8.25	93	9.64
19	4.36	44	6.63	69	8.31	94	9.70
20	4.47	45	6.71	70	8.37	95	9.75
21	4.58	46	6.78	71	8.43	96	9.80
22	4.69	47	6.86	72	8.49	97	9.85
23	4.80	48	6.93	73	8.54	98	9.90
24	4.90	49	7	74	8.60	99	9.95
25	5	50	7.07	75	8.66	100	10

C-2 論文
(専攻分野：都市環境工学)

C-2 Essay
(Major field of study:
Urban Environmental Engineering)

English translation of question sheets follows Japanese version.

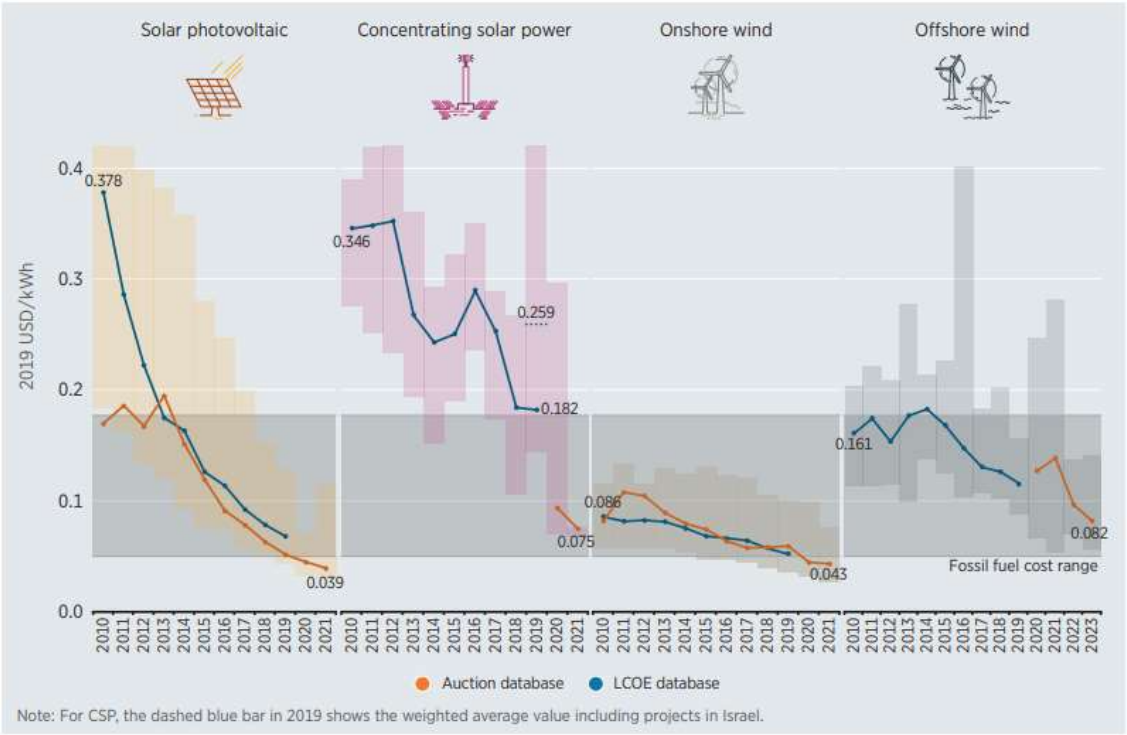
C－2　Essay　(Urban Environmental Engineering)

Answer the following Questions 1 to 4.

Question 1.

The graph below shows the costs and purchasing/sales prices of power generated by renewable energies from 2010 to 2021 (and estimation until 2023). Explain the trends of the changes in costs and prices of electric power generated by renewable energies based on this graph. In addition, state your thoughts about the reasons why such changes have happened.

Figure ES.2 Global weighted average LCOE and Auction/PPA prices for CSP, onshore and offshore wind, and solar PV, 2010 to 2023



Note: The thick lines are the global weighted average LCOE, or auction values, by year. The grey bands that vary by year are cost/price range for the 5th and 95th percentiles of projects.. For the LCOE data, the real WACC is 7.5% for OECD countries and China, and 10% for the rest of the world. The band that crosses the entire chart represents the fossil fuel-fired power generation cost range.

Source:　International Renewable Energy Agency

Abbreviations:　LCOE: Levelized Cost of Electricity

PPA: Power Purchase Agreement

CSP: Concentrated Solar Power

Solar PV: Solar Photovoltaic (Power Generation)

WACC: Weighted Average Cost of Capital

Question 2.

The following table shows the percentage ratios of energy sources used for electric power generation in each country. Based on this table, explain the characteristics of the energy source ratio of Japan in comparison with other countries.

	Asia-Pacific					Europe									America			
	Australia	China	India	Japan	S. Korea	Denmark	France	Germany	Ireland	Italy	Portugal	Spain	Sweden	UK	Brazil	Canada	Chile	US
Coal	54	63	68	31	37	10	1	24	10	7	4	2	0	2	3	7	30	20
Oil	1	0	1	4	1	1	1	1	1	3	2	4	0	0	1	1	5	1
Gas	19	3	5	34	26	4	7	16	48	46	33	26	0	36	9	9	18	39
Nuclear	0	5	3	4	27	0	66	11	0	0	0	22	30	15	2	15	0	19
RE	26	29	23	22	7	82	25	47	40	43	60	45	69	45	85	69	48	21
Other	0	0	0	5	2	3	1	1	1	1	0	0	1	2	0	0	0	0
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Unit: %

Notes: "RE" (renewable energy) includes hydro, wind, bioenergy and geothermal. "Other" includes non-renewable waste and non-specified sources. Based on "net" generation.

Sources: IEA, Monthly Electricity Statistics: Data up to December 2020 (March 2021) (downloaded March 16, 2021).

Question 3.

Explain the outline of policies for and constraints of introduction of renewable energies in Japan.

Question 4.

Although Covid-19 pandemic brought about immeasurable tragedies on human being, it is considered that the pandemic would accelerate the changes of social structures and human behavior, and thereby could be an opportunity to advance poverty reduction in developing countries and to mitigate global warming. State what kind of changes in social structures and human behavior could happen after the Covid-19 pandemic, and your thoughts on how to make use of those changes for poverty reduction in developing countries and mitigation of global warming.

C-3　計画・設計
（専攻分野：都市計画）

C-3　Planning and Design
(Major field of study: Urban Planning)

English translation of question sheets follows Japanese version.

C— 3　Planning and Design

While referring to Figure. 1 (Core Zone Urban Development Policy) and Figure. 2 (Current Situation of Block X), read the following text carefully and propose a development plan for Block X (approx. 4.0 ha) of the housing complex.

■Background

A Town is a small local city with a population of about 32,000. The town is bordered by B City (population 200,000) to the west and C City (population 100,000) to the east, forming a city-region with both cities. In the center of A Town flows D River, which is known for its abundant spring water. As the land in the town is flat and blessed with water, agriculture, mainly rice farming, has originally prospered. Since the high economic growth era, the town has become a commuter town for B City and C City, and the rice fields have been converted into housing lots. In recent years, people from B City and C City continued to move to A Town and the sprawl by the conversion of the remaining collective farmland into residential land has become a problem.

In light of this situation, A Town has set the planned formation of the town's core zone as the most important theme in its future urban development policy. Specifically, the core zone was defined as the area including 1)the green belt along D River, 2)the large-scale commercial complex along Road E, and 3)the town hall, distribution complex along Road F, and the "Core Zone Urban Development Policy" (Figure 1) was established. In addition to existing Road G, Road H will be constructed in the north-south direction, and urban functions that support the life of the entire town will be concentrated along Road H. The remaining collective farmland in the area around Road H will be systematically converted into urban areas, with the aim of creating a "walkable residential area" with a network of green pathway.

This time, out of that core zone, the town decided to plan a collective housing block that would serve as a model for converting existing farmland into residential land.

■Status of the target site, planning conditions, and required plan documents

Based on the "Core Zone Urban Development Policy"(Figure. 1) and under the planning

conditions described below, draw up a development plan for Block X, which will include a library and health center complex, parks and green spaces. Block X is expected to embody the new walkable lifestyle in A Town.

1) Current situation of the target site Block X

As shown in Figure. 2, Block X is a flat area of about 4.0 ha, sandwiched between Road G (10m wide, with 1m sidewalks on both sides) and Road H (27m wide, with 2.5m sidewalks on both sides). Currently, the entire area is used as a rice field. An agricultural waterway (2m wide) runs north-south in the Block X, adjacent to Road H. Since it will no longer serve as an agricultural waterway, it can be used for multi purposes. In addition, there is an existing east-west road running through the center of the block, but there is no need to leave it in your plan. In the vicinity of Block X, a community center is located to the northwest and an elementary school to the southwest. On Road G, there is a bus stop for buses heading to the stations of B City and C City. In addition, the area between Road G and D River is a good residential area of detached single family housing.

2) Planning and design conditions

-Collective housing complex
Large unit for families (exclusive area: 100m^2):110 units
Medium unit for families (exclusive area: 80 m^2) :30 units
Small unit for single persons or couples (exclusive area: 50 m^2): 40 units
-In order to maintain harmony with the surrounding low-rise residential area and natural environment, the maximum height of the housing complex shall be 4 stories or 12 meters.
-180 parking spaces for housing units shall be provided as flat parking spaces within Block X (mechanical parking is not permitted).

-Library and health center complex
The floor area shall be 3,000 m^2 (2,000 m^2 for the library and 1,000 m^2 for the health center).
-50 parking spaces for users of the facilities shall be provided adjacent to the facilities (mechanical parking is not permitted).

-Commercial and business facilities
Floor space of about 2,000 m^2.
-It may be distributed.
-20 parking spaces for users of the facilities shall be provided as flat parking spaces (mechanical parking is not permitted).

-Parks and green spaces
Area of about 8,000 m^2.
-It may be distributed.
-It should be distinguished from the open space between residential buildings that is used only by residents of the housing complex.

-Other spaces necessary for housing complexes, such as bicycle parking lots, garbage collection areas, and meeting places, shall be provided as appropriate.

-There shall be one bus stop along Road G and one along Road H, respectively. There is no need to stick to the current location.

3) Required Plan Document

"Development plan for Block X (1:1000)"

(1) Housing complex (footprint of buildings, location of entrances, number of floors, number of units per dwelling type)
(2) Library and health center complex
(3) Commercial and business facilities
(4) Parking lots (distinguish between those for visitors and those for residents)
(5) Parks and green spaces
(6) Various spaces required for housing complexes, such as bicycle parking lots, garbage collection areas, and meeting places
(7) Road and footpath for circulation in the block
(8) Other open spaces
(9) Planting
(10) Bus stops

In the "Free space" column at the bottom of the answer sheet, you may freely write the statement of purpose of the plan, legends, diagrams, sketches, etc.

Figure .1 Core Zone Urban Development Policy

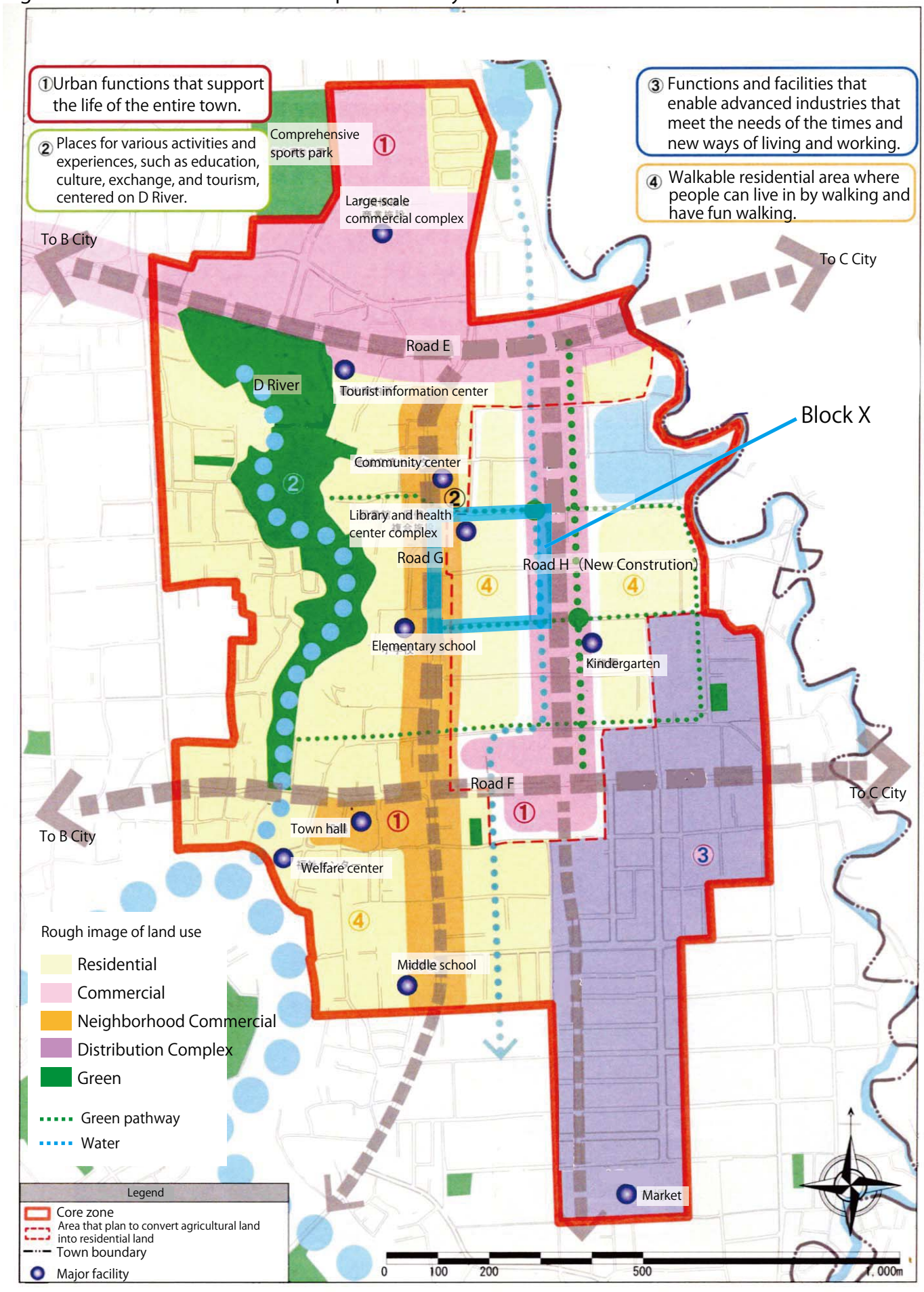
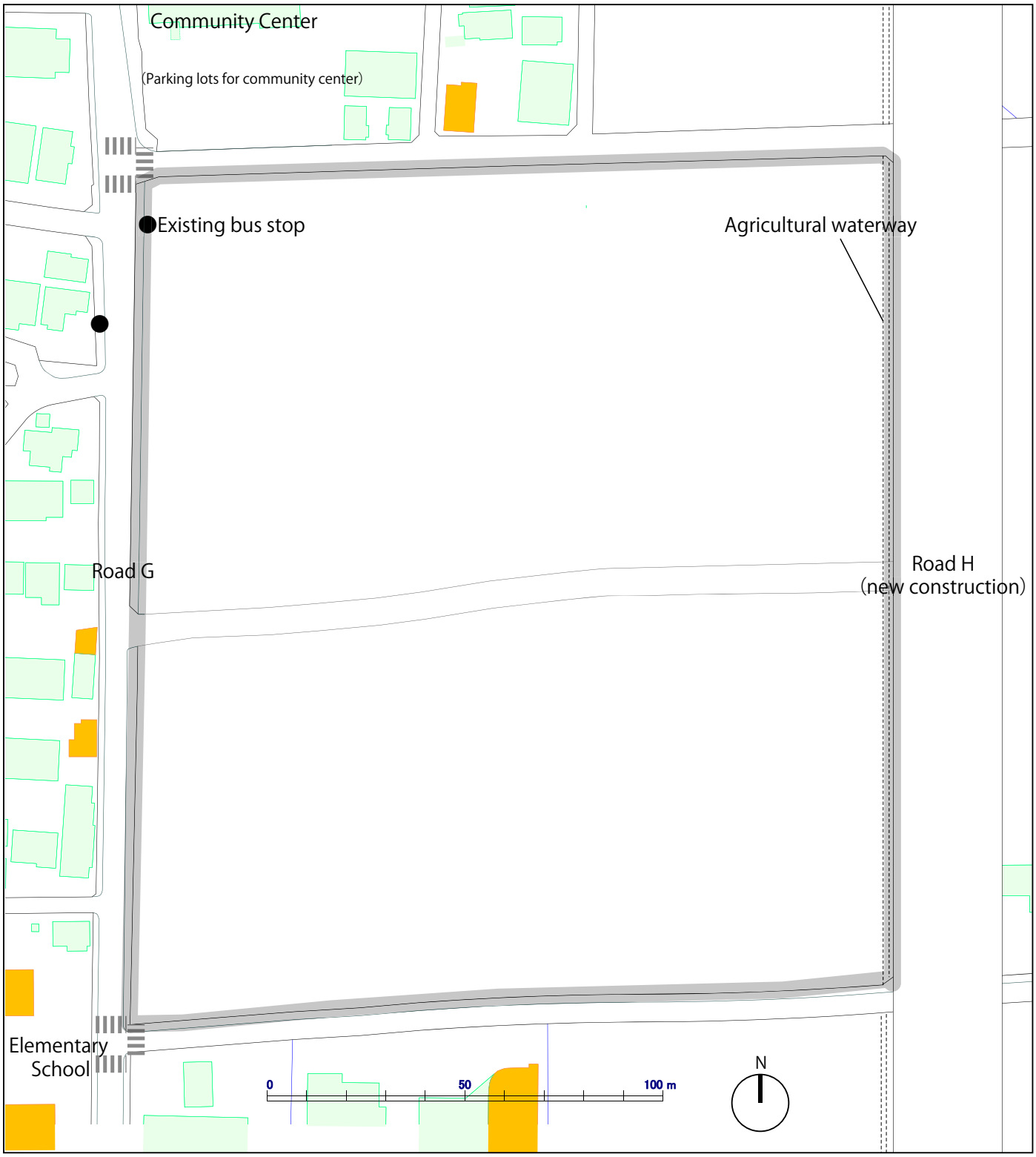


Figure.2　Current Situation of Block X



C-4　論文
（専攻分野：都市計画）

C-4　Essay
(Major field of study: Urban Planning)

English translation of question sheets follows Japanese version.

C－4　Essay

Application of a concept of urban development called TOD (Transit-Oriented Development) has been considered in many cities in the world and some developments based on the concept of TOD have been already implemented. Answer the following questions.

(1)　Systematically discuss positive effects which are expected by applying TOD and negative effects which are brought by TOD from different points of view.

(2)　What kind of projects and/or policies should be implemented in order to promote TOD in districts centered by public transportation hubs like railway stations in the manner that maximizes the positive effects and minimizes the negative effects described in (1)? Discuss this point with picking up two projects and/or policies for each of the transportation sector and the urban development sector concretely, along with a brief explanation on the relationship among these projects and/or policies.

(3)　It is said that lifestyles and mobility of the people will be radically changed by the introduction of advanced technologies in the near future, which are presently on the way of development. Pick up and explain briefly one of such advanced technologies which will give a strong impact on TOD, and describe your idea on the expected influence of the technology on TOD and its mechanism of how the technology will affect TOD.