戦略的イノベーション創造プログラム

Cross-ministerial Strategic Innovation Promotion Program (SIP) Second Phase / Automated Driving for Universal Services / Development, Pre-verification, Maintenance, and Management of Infrastructure Related to Tokyo Waterfront Area Demonstration Experiment

FY2020 Annual Report

Summary

Pacific Consultants Co., Ltd.
Nippo Corporation

March 2021

1.1 Project Purpose

[Goals of SIP Second Phase: R&D Planning of Automated Driving]

- Put automated driving into practice and expand its spread in order to contribute to solving social issues, such as **reducing traffic accidents, mitigating traffic congestion**, ensuring mobility of transportation-handicapped people, and improving driver shortages and reducing costs in logistics and mobility services, aiming to realize a society where everyone can live a high quality life.
- Establish **the technologies in cooperative areas that are necessary for the realization of automated driving** by 2023, **confirm their effectiveness by conducting demonstration experiment** involving various businesses and local governments while enhancing the prospect of social implementation by **creating multiple cases of practical application**.

[Purpose]

As a part of “Automated Driving for Universal Services” in the second phase of SIP, this project is intended to establish a mechanism for utilizing traffic environment information, such as traffic signal information and merging support information provided by the traffic infrastructure, and **put the infrastructure-coordinated advanced automated driving into practice at an early stage**.

1.2 Project Overview: Detailed Development Items of This Study

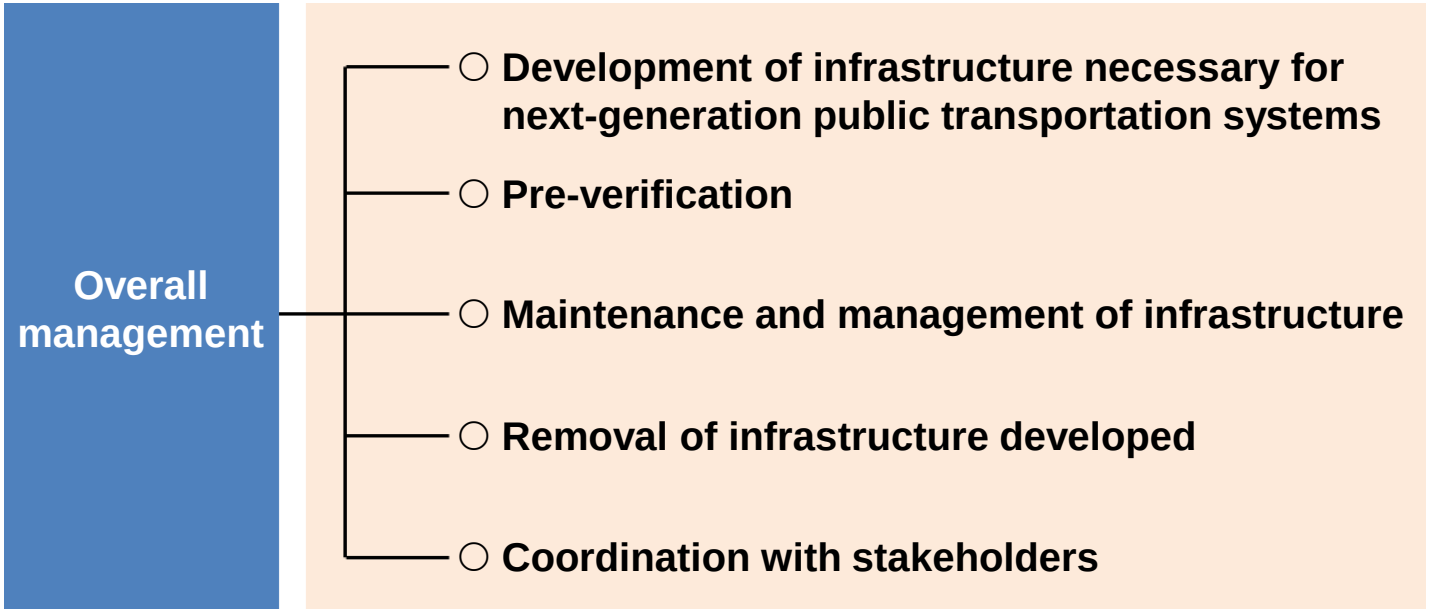
- The detailed development items of this study are listed below.
- These were conducted by Pacific Consultants and Nippo.

Project overview	Detailed development items (1) to (6) of this study
Development, pre-verification, maintenance, and management of the infrastructure in the Haneda Airport area (ordinary roads) In the area subject to the demonstration experiment in the Haneda area, design and develop the infrastructure (place magnetic markers, color the dedicated lane, build temporary bus stops, pave Zone 1, and so on) required for the next-generation public transportation systems (such as buses and small group transportation vehicles) and conduct pre-verification to ensure that there is no problem with the implementation of the demonstration experiment. The infrastructure developed will be maintained and managed until the end of the demonstration experiment. After the end of the demonstration experiment, the infrastructure will be withdrawn to restore the original state.	(1) Overall management [By Pacific Consultants Co., Ltd.] (2) Development of infrastructure necessary for next-generation public transportation systems [By Nippo Corporation] (3) Pre-verification [By Nippo Corporation] (4) Maintenance and management of infrastructure [By Nippo Corporation] (5) Removal of infrastructure developed [By Nippo Corporation] (6) Coordination with stakeholders [By Pacific Consultants Co., Ltd.]

2. Overall Management: Actions

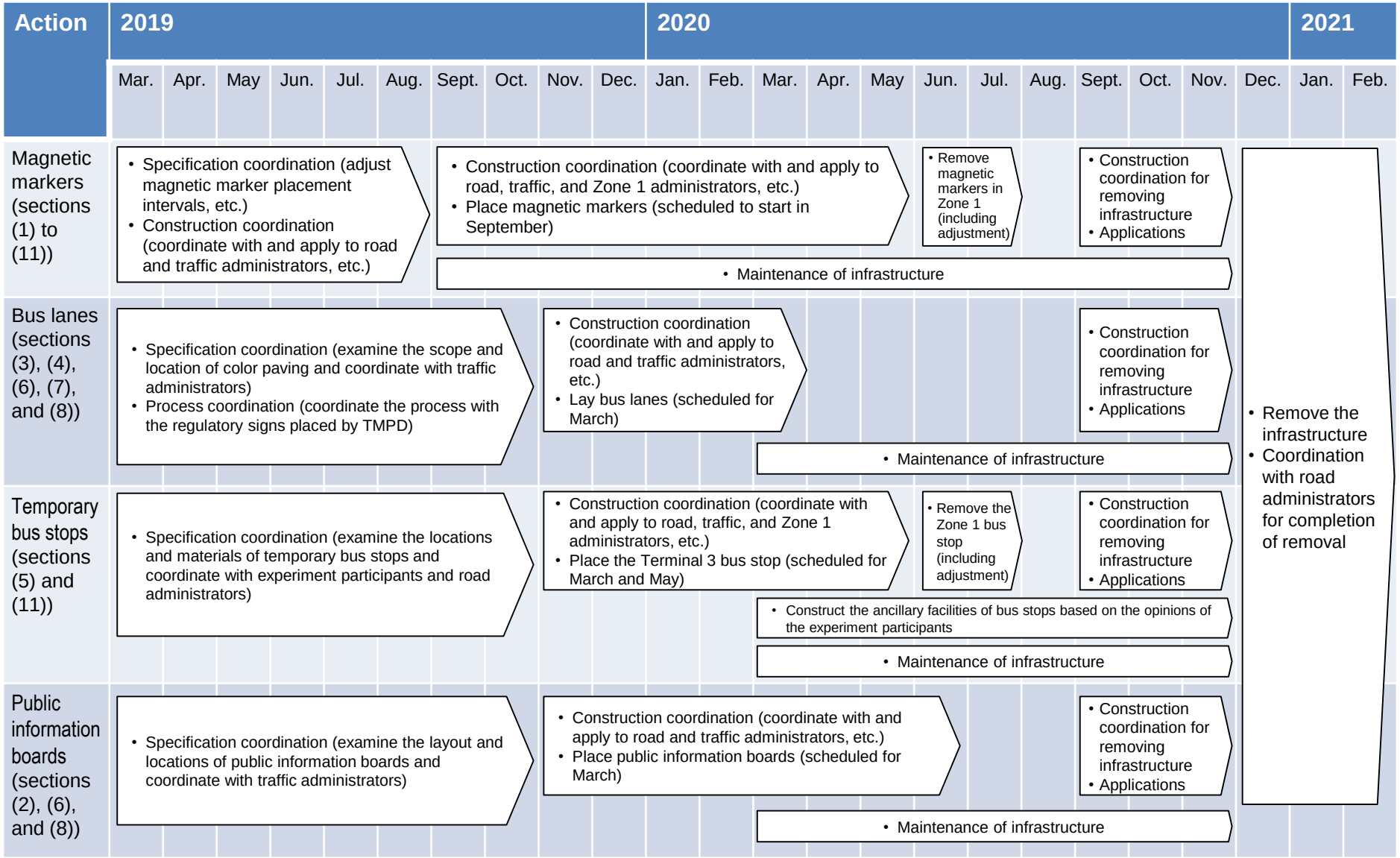
In preparation for the Tokyo Waterfront Area Demonstration Experiment, in order to design and develop the infrastructure (place magnetic markers, color the dedicated lane, build temporary bus stops, pave Zone 1, and so on) required for the next-generation public transportation systems (such as buses and small group transportation vehicles), pre-verify, maintain, and manage the infrastructure, and finally withdraw it to restore the original state, the overall research and development management and schedule adjustment were carried out.

The progress of the infrastructure development was reported to the relevant ministries, agencies, and organizations as well as the experiment participants at the “Tokyo Waterfront Area Demonstration Experiment Task Force” and “Tokyo Waterfront Area Demonstration Experiment Haneda Airport Area SWG” that are held on a regular basis.



2. Overall Management: Overall Schedule

The overall schedule of this project is shown below.



3. Development of Infrastructure Necessary for Next-generation Public Transportation Systems: Infrastructures

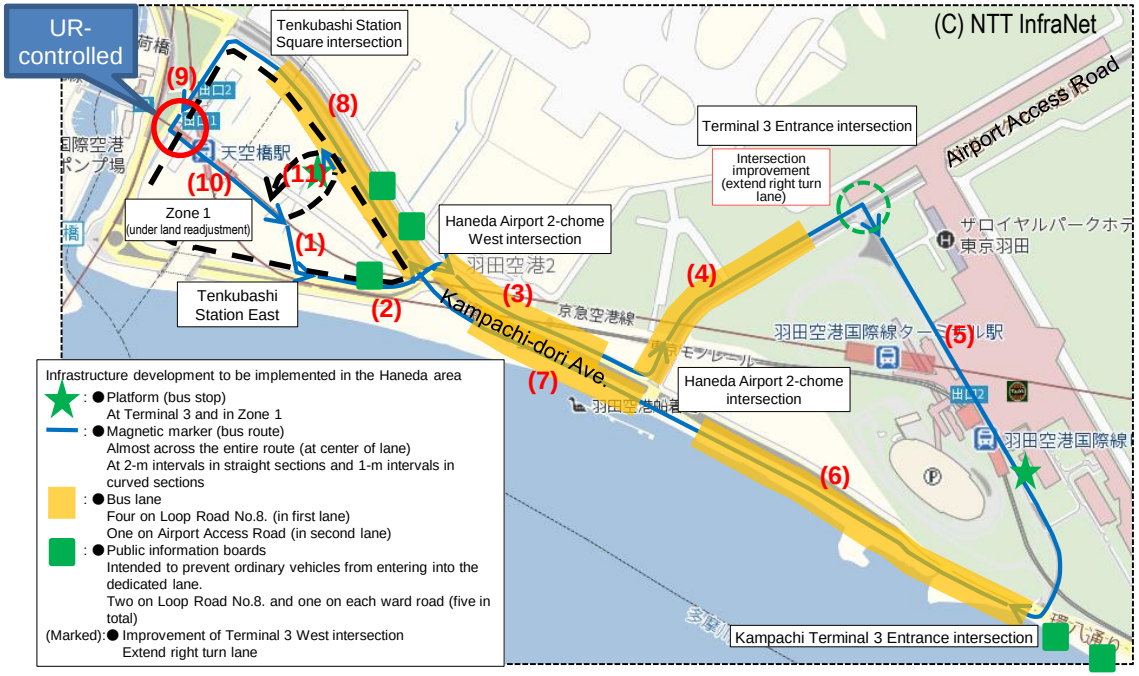
- Design, develop, maintain, and manage the infrastructure for building an automated driving system using magnetic markers. The infrastructure will be withdrawn to restore the original state after the end of the demonstration experiment.
- Place magnetic markers, color the dedicated lane, build temporary bus stops, and pave Zone 1, as the infrastructure.

Infrastructure	Location(s)	Notes
Magnetic markers	Entire automated driving experiment route	Total construction length: Approx. 4,000 m
Bus lanes	Loop Road No.8 and Airport Access Road within the automated driving experiment route	Paving color: Red Construction length: Approx. 2,700 m Construction width: 30 + 30 cm
Public information boards	Loop Road No.8 (4 places) and Ota ward road (1 place)	
Temporary bus stops	Near Terminal 3 and in Zone 1	Terminal 3 bus stop: Use steel materials Zone 1 bus stop: Construct in the same way as regular bus stops
Paving in Zone 1	Near Zone 1 bus stop	Pave to withstand the weight of the experimental automated bus

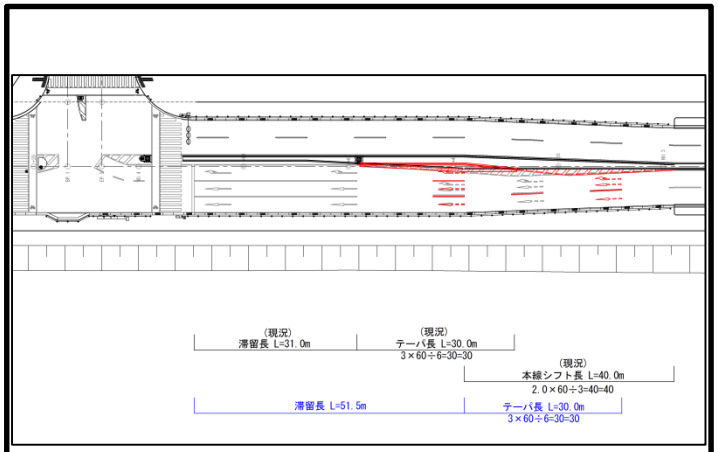
Section	Road administrators	Notes
(1), (10)	Ota Ward (Newly laid as UR-controlled roads)	Ota ward road
(2)	Ota Ward	Ota ward road
(3) to (9)	Tokyo Airport Office	Civil Aviation Bureau-controlled road
(11)	Zone 1 developer	

3. Development of Infrastructure Necessary for Next-generation Public Transportation Systems: Overview

The overview of the development of infrastructure is shown below.



Overview of improvement of Terminal 3 Entrance intersection



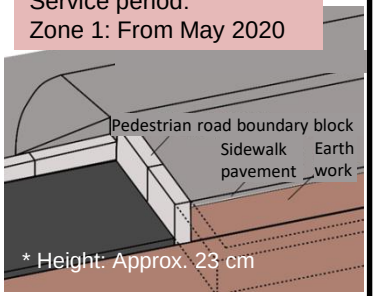
Extend the right turn lane to ease traffic congestion.
Extend the right turn retention length from the current approx. 30 m to approx. 50 m.

* This project only offers design, and the actual construction work will be carried out by the Civil Aviation Bureau.
Removal after the end of experiment (for restoration) will not be conducted.

Image of platform structure

Service period:
Terminal 3: From April 2020

Service period:
Zone 1: From May 2020



Structure
A gap mall and a wheel guard are provided on the roadway side of the Terminal 3 bus stop.
Provide fall prevention fences except for the bus doorways and slopes.
* It was agreed with the stakeholders on March 17, 2020 that no braille blocks would be placed.

Overview of magnetic marker

Construction period: From September 2019
(depends on the section)

1: Dimensions
Diameter: 30 mm
Height: 20 mm

Appearance of buried magnetic marker

* Where to place magnetic markers will be provided.
However, positional errors of up to 1 to 2 cm are expected in actual placement.

Image of colored bus lane

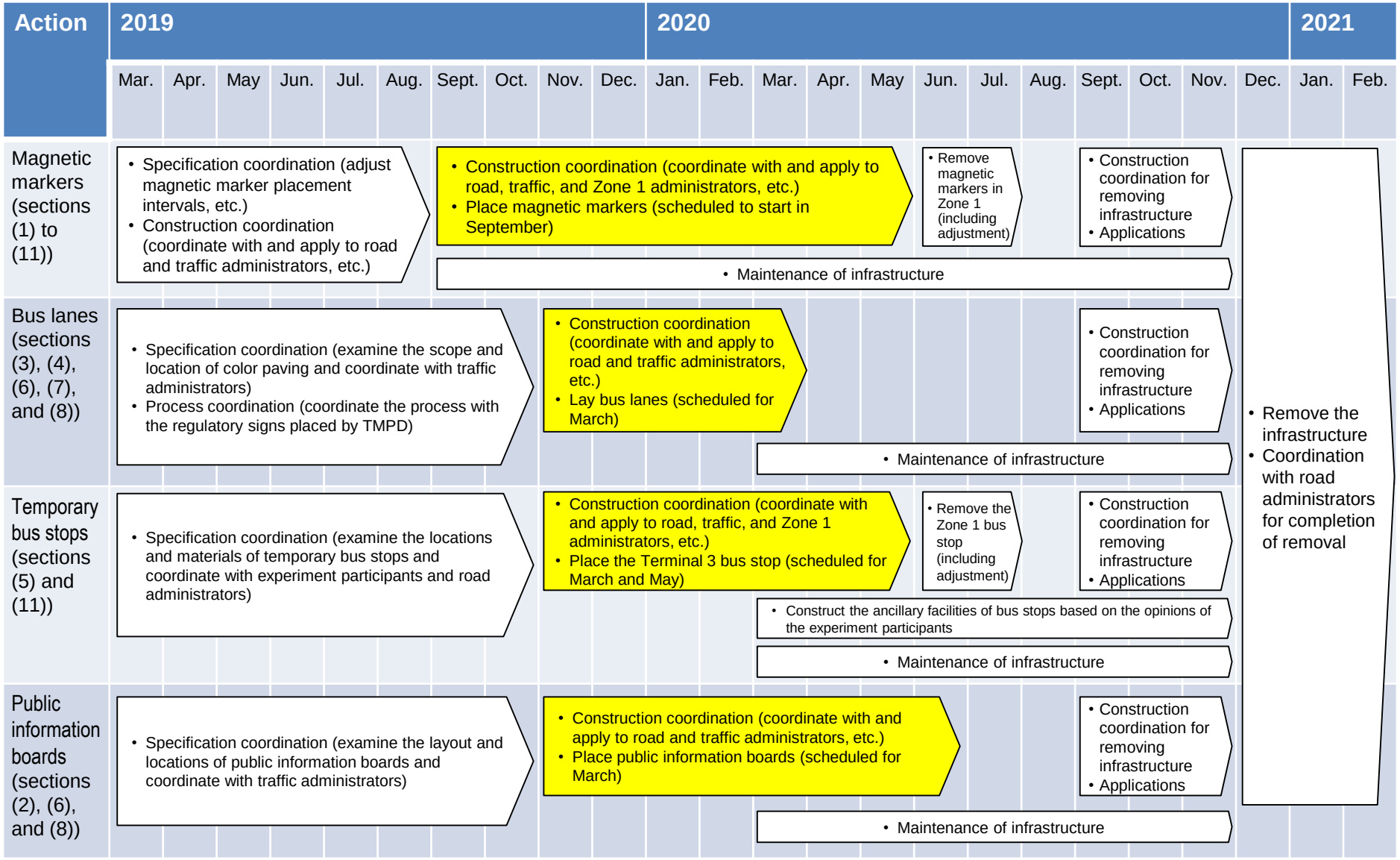
Service period: From April 2020

Color paving:
30 cm width at both ends of the lane
Operating hours:
10 a.m. to 5 p.m.

Image of public information board

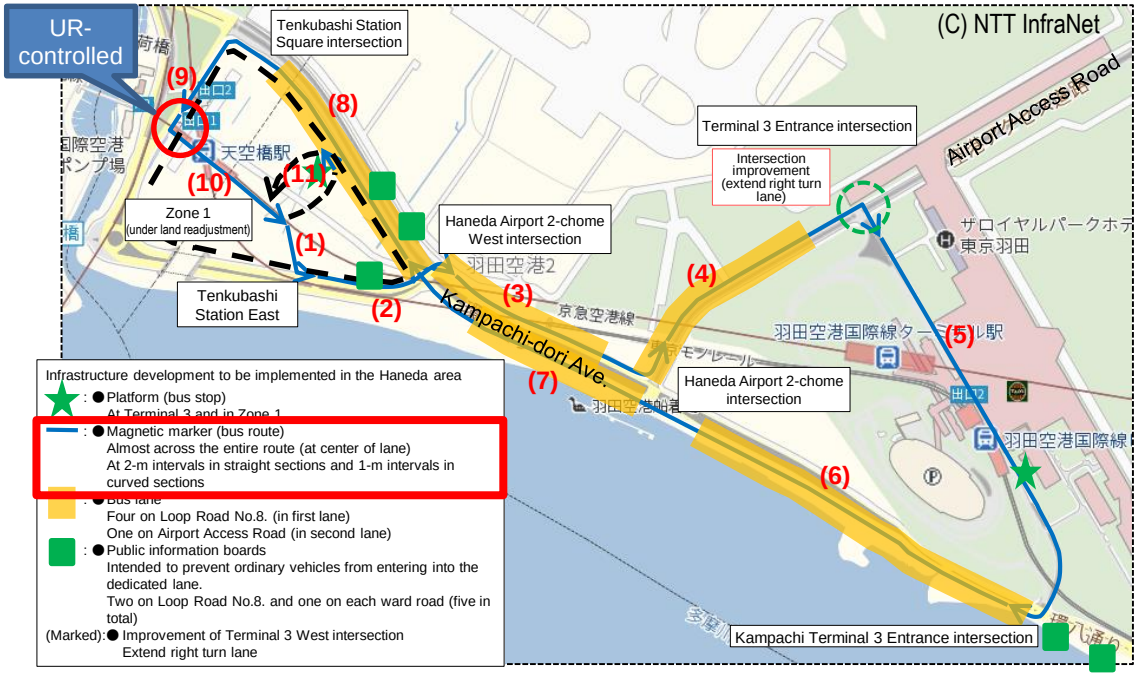
3. Development of Infrastructure Necessary for Next-generation Public Transportation Systems: Work Schedule

The schedule of this project is shown below in yellow.



3.1 Place Magnetic Markers: Magnetic Marker Overview

Place the magnetic marker shown in the red frames.



Overview of improvement of Terminal 3 Entrance intersection

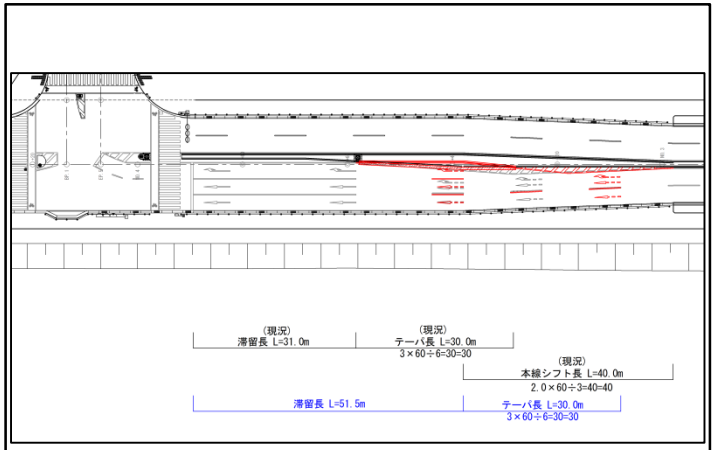


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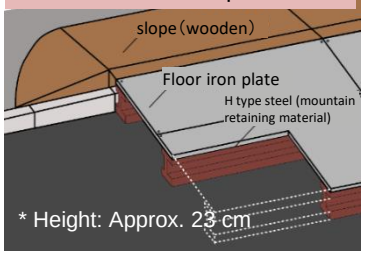
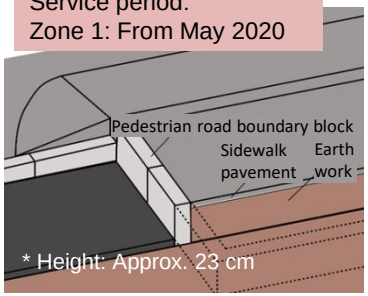
Image of platform structure

Service period:
Terminal 3: From April 2020



Service period:
Zone 1: From May 2020



Structure
A gap mall and a wheel guard are provided on the roadway side of the Terminal 3 bus stop.
Provide fall prevention fences except for the bus doorways and slopes.

* It was agreed with the stakeholders on March 17, 2020 that no braille blocks would be placed.

Overview of magnetic marker

Construction period: From September 2019
(depends on the section)

1: Dimensions
Diameter: 30 mm
Height: 20 mm

Appearance of buried magnetic marker

* Where to place magnetic markers will be provided.
However, positional errors of up to 1 to 2 cm are expected in actual placement.

Image of colored bus lane

Service period: From April 2020

Color paving:
30 cm width at both ends of the lane
Operating hours:
10 a.m. to 5 p.m.

Image of public information board

3.1 Place Magnetic Markers: Specifications

- Magnetic markers are buried in the pavement to improve the reliability of automated driving.
- The placement specifications were determined as follows after consultation with the stakeholders.

Action	Specification	Reason for determination
(1) Placement interval	In straight sections: 2 m	In general, the shorter the interval, the shorter the time interval for positioning and the higher the accuracy of self-position estimation, but the higher the maintenance cost. Although each company has a track record of driving without problems, a relatively large interval was adopted.
	In curved sections: 1 m	Because curved sections need more precise control than straight sections, and accordingly smaller positioning intervals. There are no curves with a radius of 30 or less in the actual scope of experiment, and therefore the curved sections mainly mean right and left turns at intersections.
	Near bus stops: 20 cm	Because more precise control is required for the accurate stop of automated buses at bus stops than in curved sections. * The interval was readjusted from its design value of 20 cm to 1 m during the actual construction for the purpose of cost reduction and in consideration of technological advances.
(2) Placement method	Food red method	The food red method determines the placement line by driving an actual vehicle on the planned route and marking the trace of the vehicle with food red. Whereas the reverse marking method creates a vehicle track on a CAD system or the like and determines the coordinates of the placement positions of magnetic markers one by one. This time, the food red method was adopted in most of the sections because the reverse marking method (1) has no track records of placement over long distances, (2) requires a longer construction period, and (3) may cost more. However, near bus stops, where precise control is required, the reverse marking method was adopted.
(3) Type of marker	Buried type	There are two types of magnetic markers: the buried type and sticking type. The sticking type requires a shorter construction period, but is inferior in durability. Since this demonstration experiment takes a long time, the buried type was adopted, placing emphasis on durability.
	Magnetic marker with RFID	In order to improve the control accuracy of automated vehicles, magnetic markers with RFID were used in addition to ordinary ones at a rate of one in five.
	Polarity	In the sections with 2-m intervals, magnetic markers with RFID were used as the S-pole, and the others, as the N-pole.

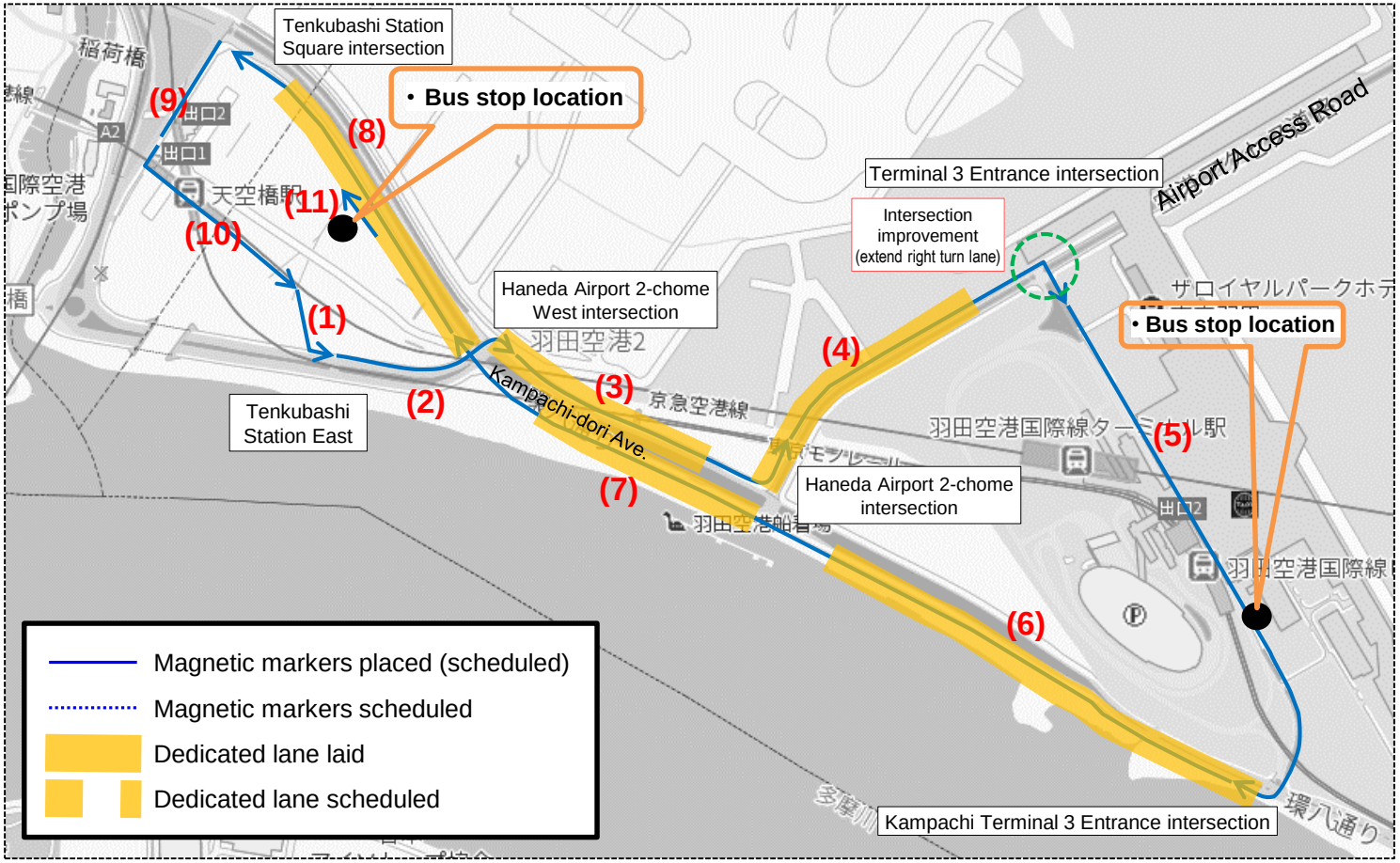
3.1 Place Magnetic Markers: Placement Locations

- In placing magnetic markers, the sections and locations of placing them were determined after consultation with the stakeholders.
  The locations to place the markers are listed below for each section.

Section	Location(s)
(1)	At the center of the lane.
(2)	At the center of the lane.
(3)	At the center of the first lane.
(4)	Placed at the center of the second lane (or the right turn lane in front of intersections), assuming a right turn at the next intersection.
(5)	In front of bus stops, placed in the third lane in front of the terminal on routes that require no lane change. Beyond bus stops, placed at the center of each of the first and second lanes at the point where the bus changes lanes from the first to the second lane. Beyond that, placed at the center of the second lane.
(6)	At the center of the first lane.
(7)	At the center of the first lane.
(8)	At the center of the first lane. Placed in the left turn lane in front of intersections, assuming a left turn at the coming intersection.
(9)	At the center of the lane.
(10)	At the center of the lane. Connected to section (1).

3.1 Place Magnetic Markers: Progress as of June 2020

- Placement of magnetic markers had been completed as of June 2020 as below.

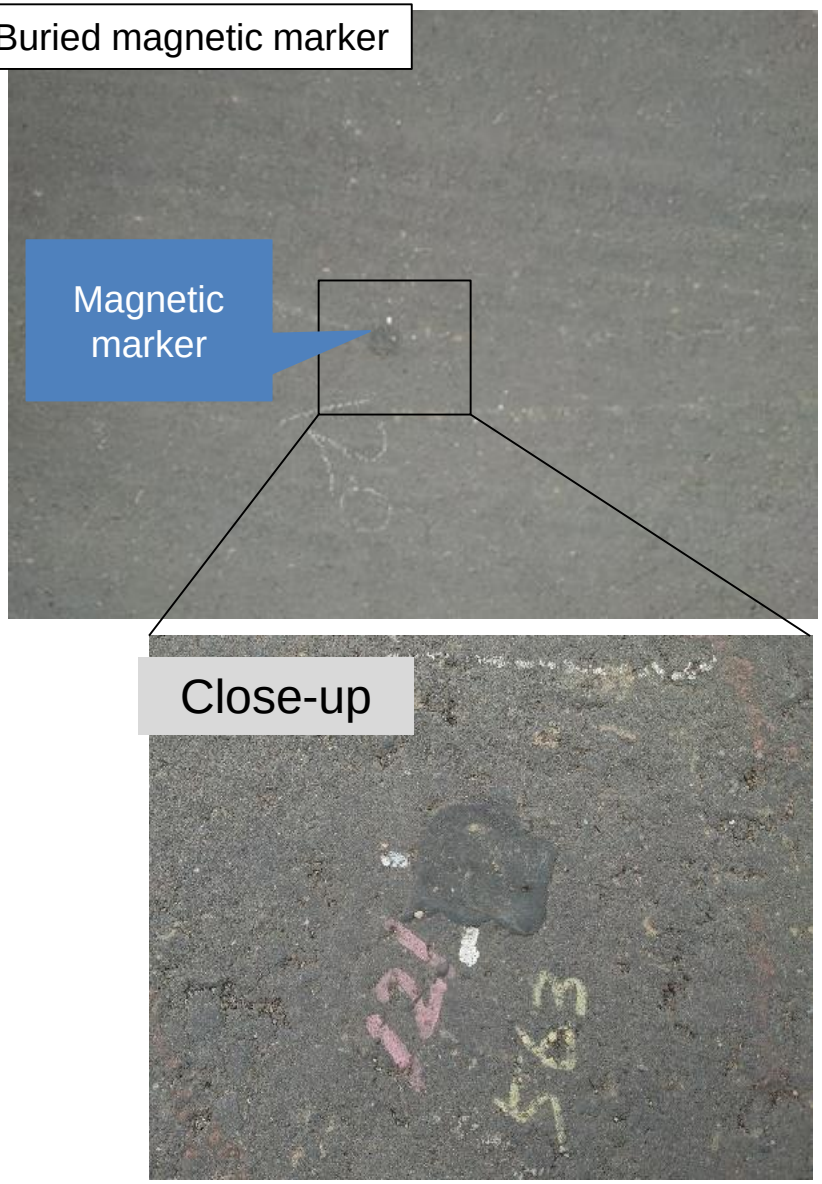


(C) NTT InfraNet

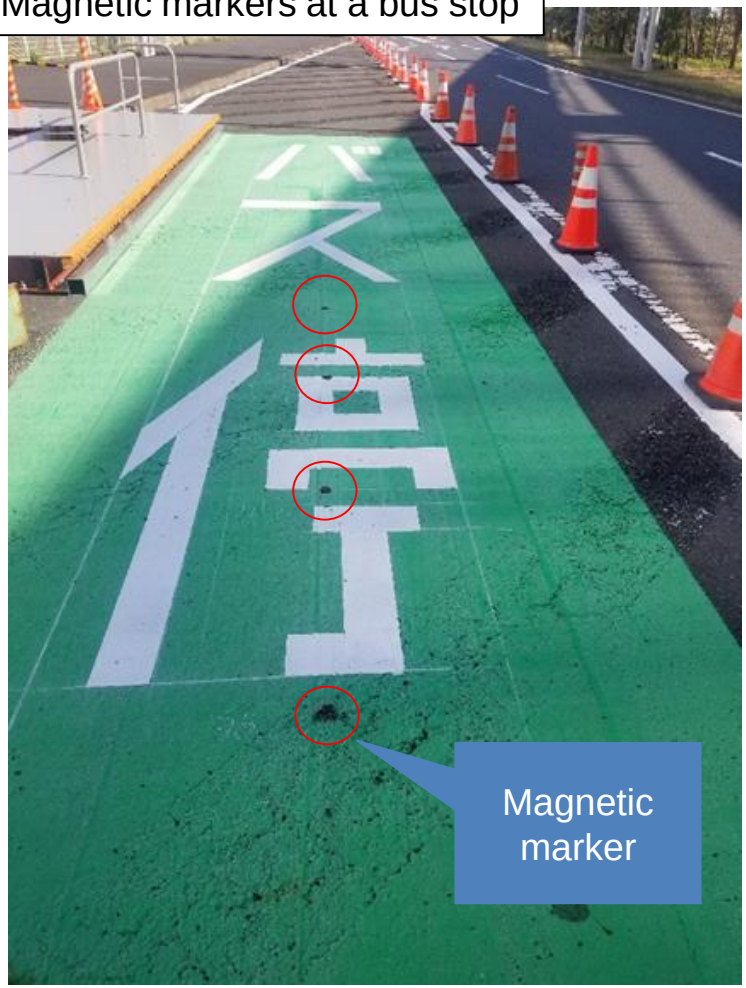
3.1 Place Magnetic Markers: Photos after Construction

- The following are photos of magnetic markers after placement.

Buried magnetic marker

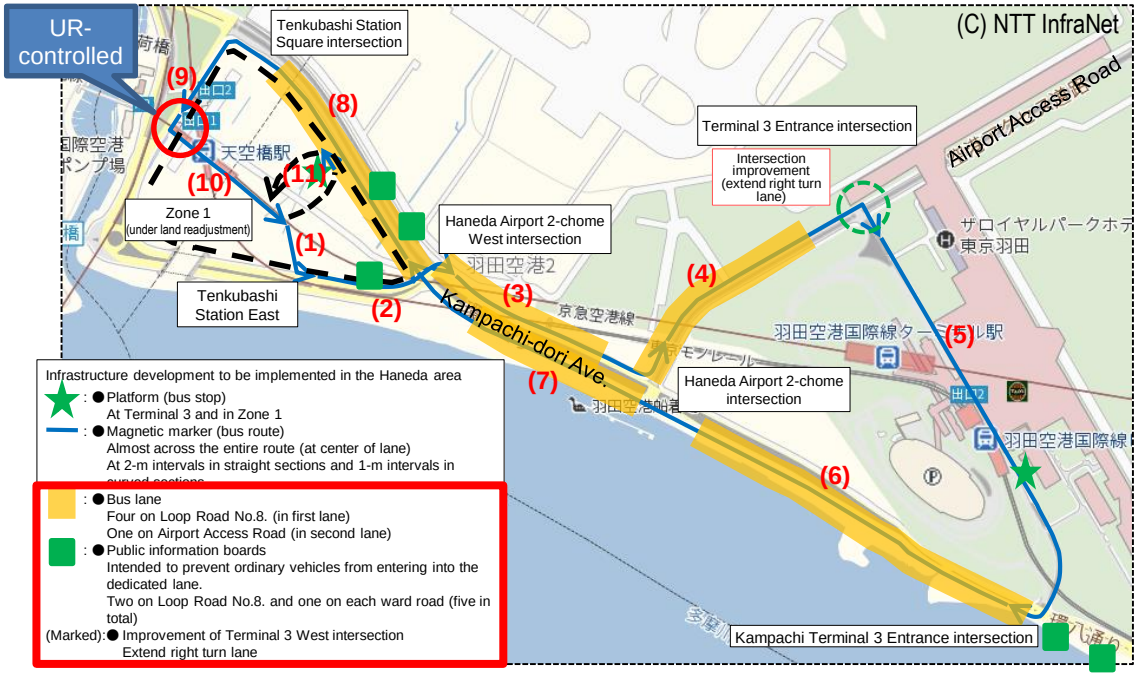


Magnetic markers at a bus stop

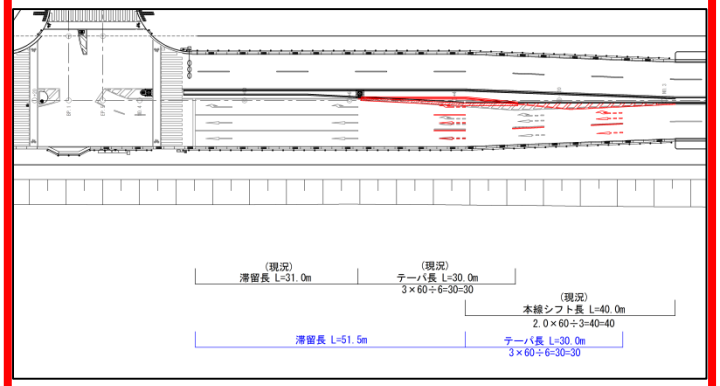


3.2 Paving of Dedicated Lanes: Dedicated Lane Overview

Pave the bus lanes and place the public information boards as shown in the red frames below. Improvement of the intersection was designed.



Overview of improvement of Terminal 3 Entrance intersection



Extend the right turn lane to ease traffic congestion.
Extend the right turn retention length from the current approx. 30 m to approx. 50 m.

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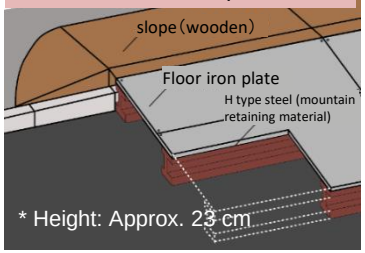
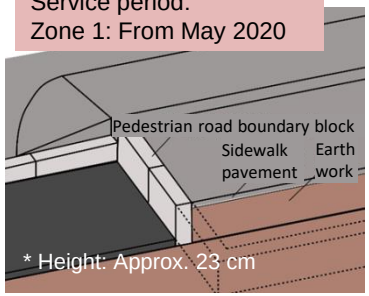
Removal after the end of experiment (for restoration) will not be conducted.

Image of platform structure

Service period:
Terminal 3: From April 2020



Service period:
Zone 1: From May 2020



Structure
A gap mall and a wheel guard are provided on the roadway side of the Terminal 3 bus stop.
Provide fall prevention fences except for the bus doorways and slopes.
* It was agreed with the stakeholders on March 17, 2020 that no braille blocks would be placed.

Overview of magnetic marker

Construction period: From September 2019
(depends on the section)

1: Dimensions
Diameter: 30 mm
Height: 20 mm

Appearance of buried magnetic marker

* Where to place magnetic markers will be provided.
However, positional errors of up to 1 to 2 cm are expected in actual placement.

Image of colored bus lane

Service period: From April 2020

Color paving:
30 cm width at both ends of the lane
Operating hours:
10 a.m. to 5 p.m.

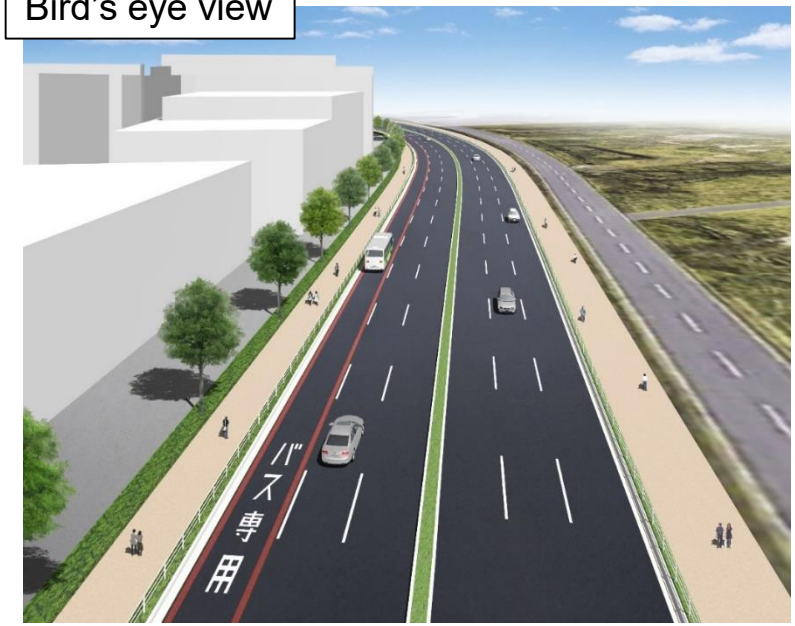
Image of public information board

3.2.1 Color Paving of Dedicated Lanes: Specifications for Color Paving

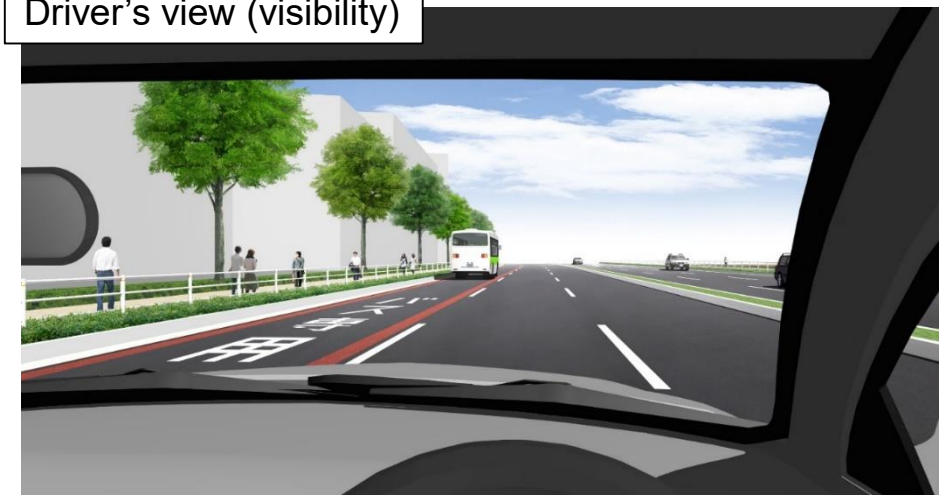
- The specifications for color paving of the dedicated lane were determined as follows after consultation with the stakeholders.

Action	Specification	Reason for determination
(1) Coloring width	30 cm at both ends of lane	Comparing the full lane coloring and lane end coloring, the former was found to be good in visibility but cost more. Considering that, lane end coloring of 30 cm width was adopted (see the figures below for visibility).
(2) Coloring method (paving material)	Product A	Based on the fact that the demonstration experiment will be continued only until FY2020, placing emphasis on economic efficiency while ensuring the minimum necessary functionality, Product A, which is originally used for pedestrian crossings, was adopted.

Bird's eye view

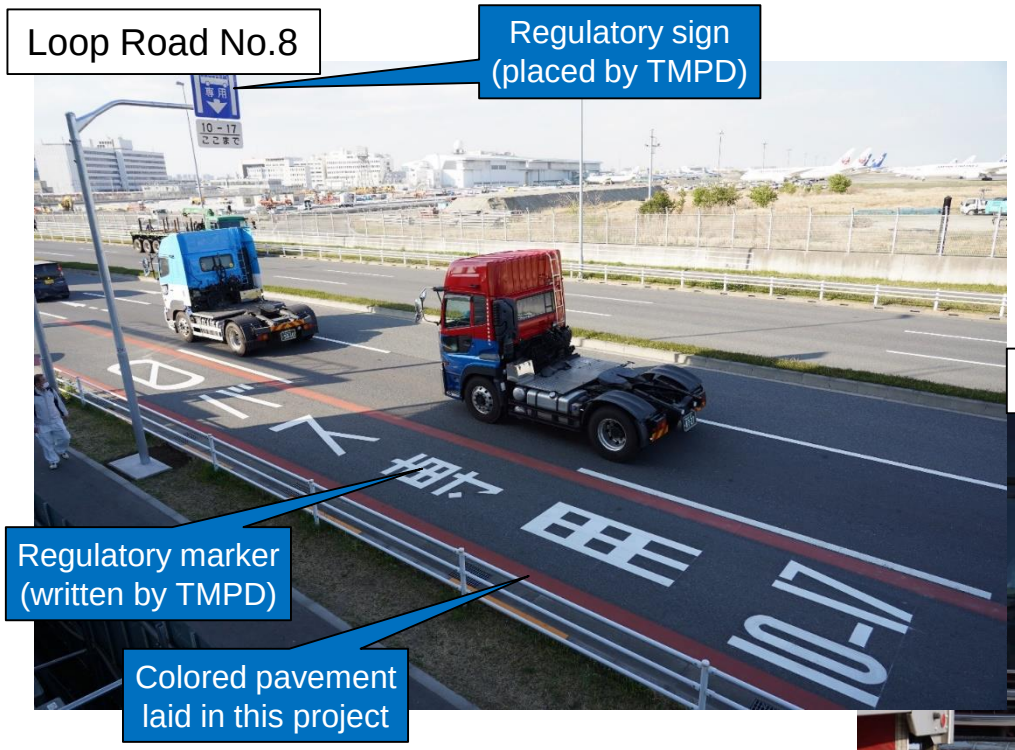


Driver's view (visibility)



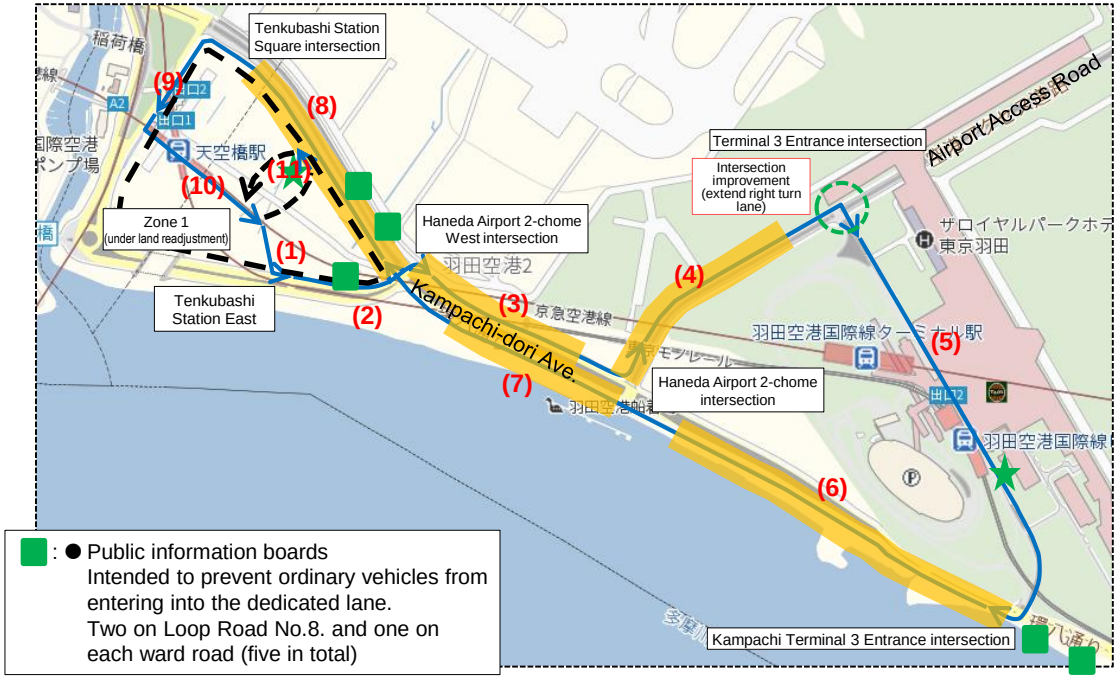
3.2.1 Color Paving of Dedicated Lane: Photos after Construction

- Color paving was completed and put into service in March 2020.
- The following are photos of the current state of the colored lane.



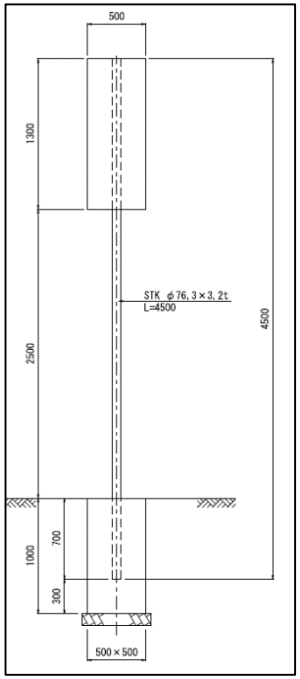
3.2.2 Public Information Boards: Public Information Board Overview

- In consultation with the stakeholders, public information boards were decided to be placed at the five locations shown in the left figure below (where drivers need to be informed that there is a bus lane ahead).
- In FY2019, information boards were placed at four locations on the Loop Road No.8. On the former Loop Road No.8. in section (2), information boards were placed in FY2020.

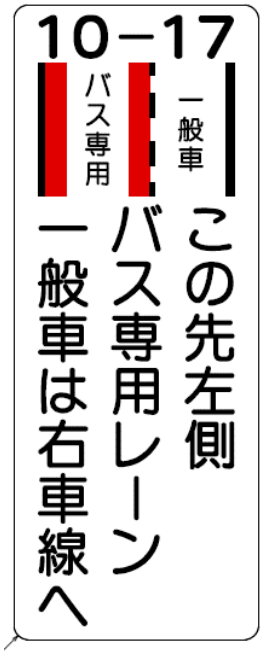


(C) NTT InfraNet

Structure



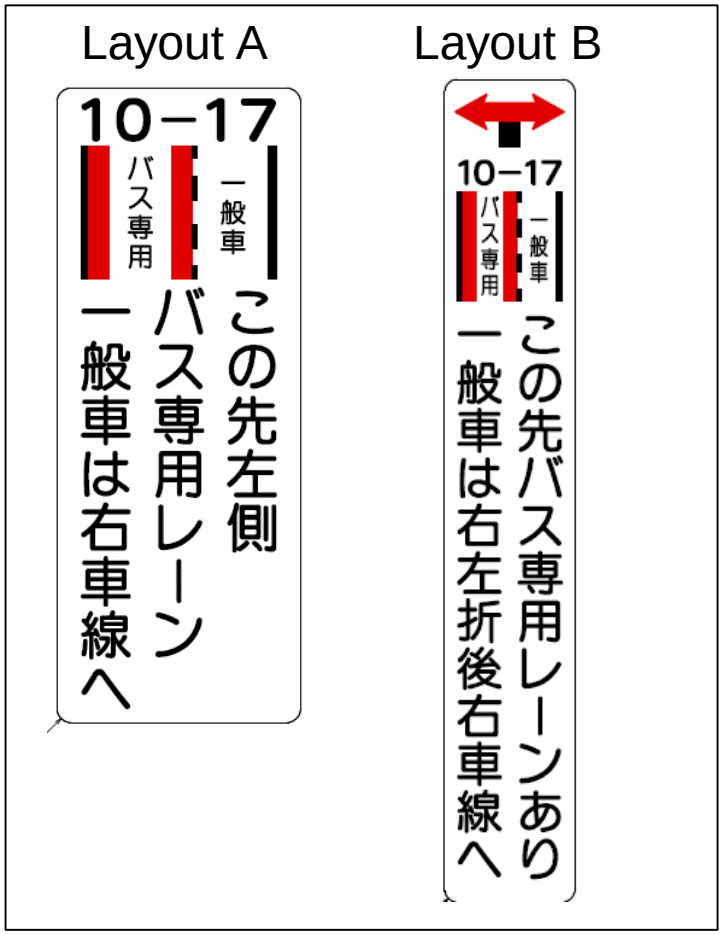
Layout



3.2.2 Public Information Boards: Specifications

- The placement locations were determined as shown below after consultations.
- A new layout of the public information board shown below was additionally adopted depending on the location.

Location	Layout
Loop Road No.8 (section (8))	Layout A
Loop Road No.8 (near the Kampachi Terminal 3 Entrance intersection)	
Ota ward road (section (2))	Layout B



3.2.2 Public Information Boards: Photos after Placement

- The following are photos of public information boards after placement.

Loop Road No.8
(near the Kampachi Terminal 3 Entrance intersection)

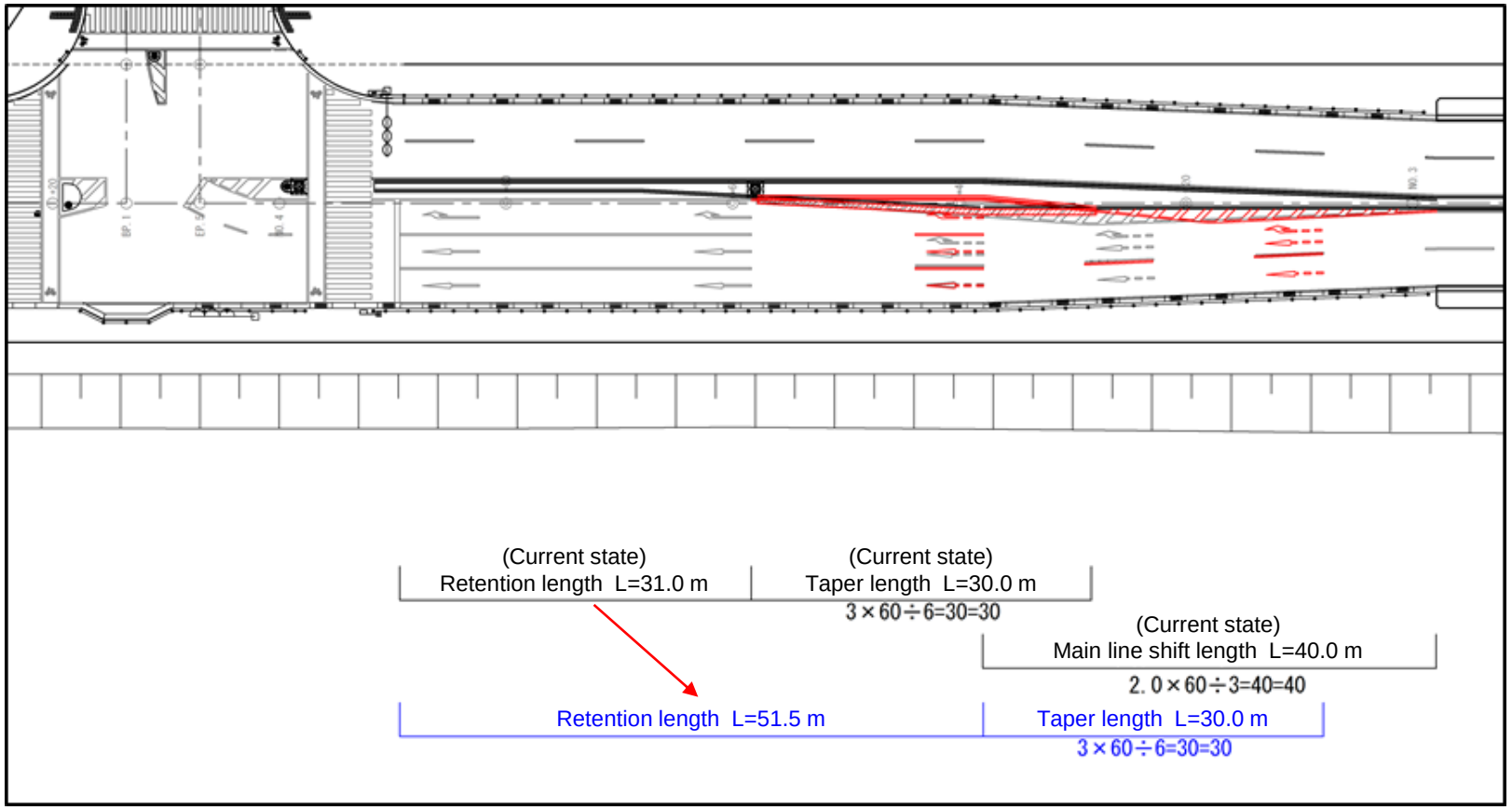
Ota ward road
(section (2))

3.2.3 Extension of Right Turn Lane at International Terminal West Intersection: Overview and Design Drawing

- Extend the right turn lane to ease traffic congestion.
- Extend the right turn retention length from the current approx. 30 m to approx. 50 m.

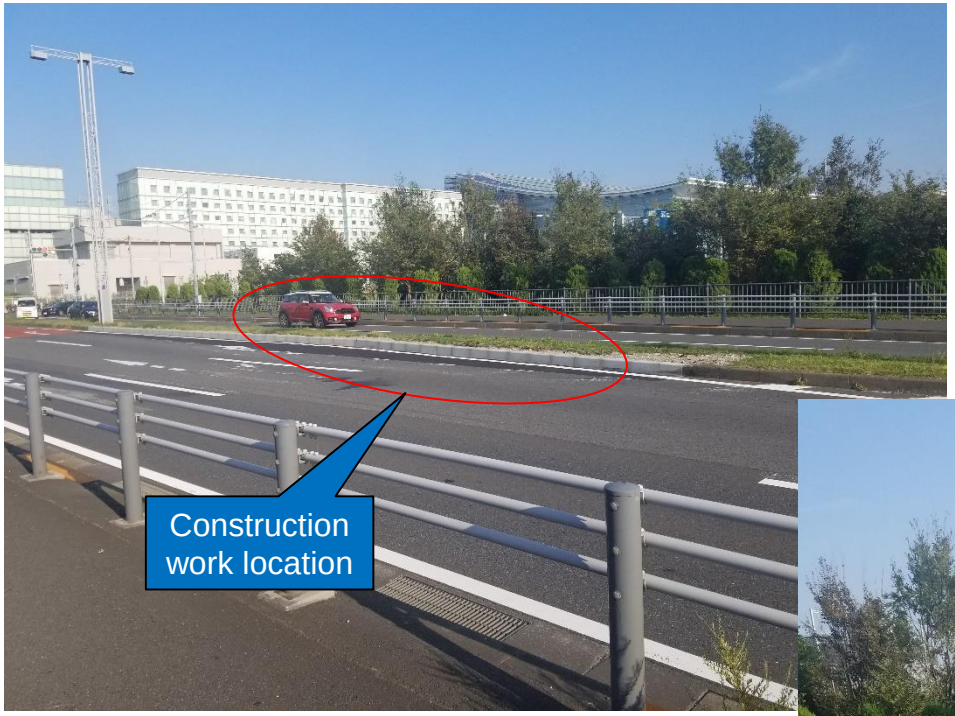
* This project only offers design, and the actual construction work will be carried out by the Civil Aviation Bureau (in FY2019).

Design drawing of the extension of the right turn lane at the International Terminal West intersection



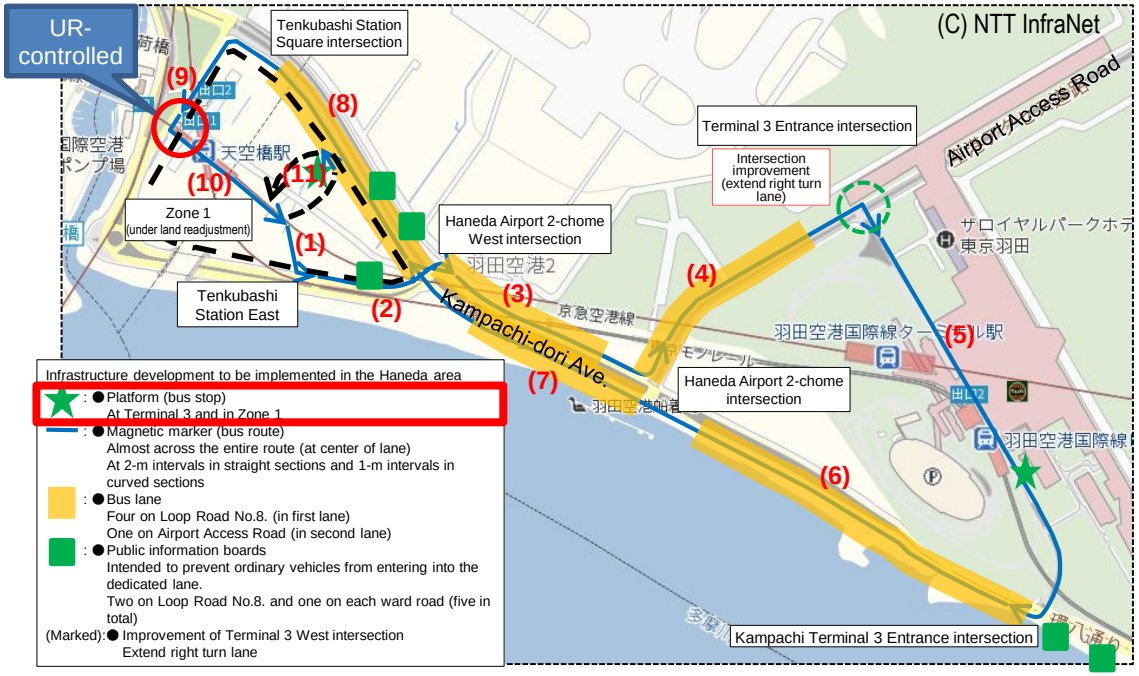
3.2.3 Extension of Right Turn Lane at International Terminal West Intersection: Photos after Construction

- The following are photos after the construction work by the Civil Aviation Bureau.



3.3 Place Temporary Bus Stops: Temporary Bus Stop Overview

Build two temporary bus stops (platforms) as shown in the red frames below.



Overview of improvement of Terminal 3 Entrance intersection

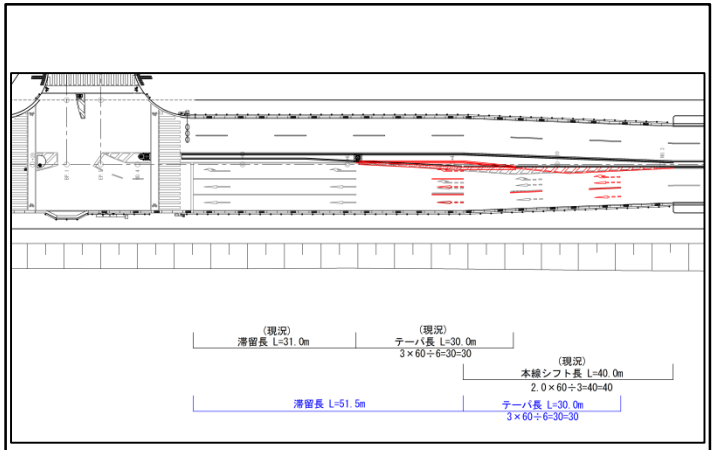


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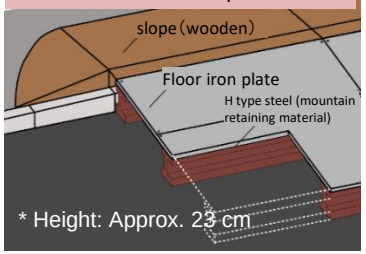
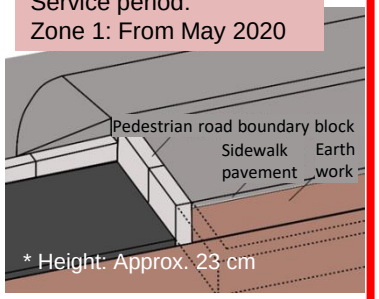
Image of platform structure

Service period:
Terminal 3: From April 2020



Service period:
Zone 1: From May 2020



Structure
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Provide fall prevention fences except for the bus doorways and slopes.
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Overview of magnetic marker

Construction period: From September 2019
(depends on the section)

1: Dimensions
Diameter: 30 mm
Height: 20 mm

Appearance of buried magnetic marker

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However, positional errors of up to 1 to 2 cm are expected in actual placement.

Image of colored bus lane

Service period: From April 2020

Color paving:
30 cm width at both ends of the lane
Operating hours:
10 a.m. to 5 p.m.

Image of public information board

3.3 Place Temporary Bus Stops: Construction Schedule

- The construction schedule for the temporary bus stops is as follows.

	2020						
	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.
Terminal 3 bus stop	Place the bus stop	Place protective curbs				Relocate temporary guardrails and remove crossing prevention fences	
Zone 1 bus stop			Place the bus stop			Remove crossing prevention fences	

3.3.1 Place Terminal 3 Bus Stop: Specifications

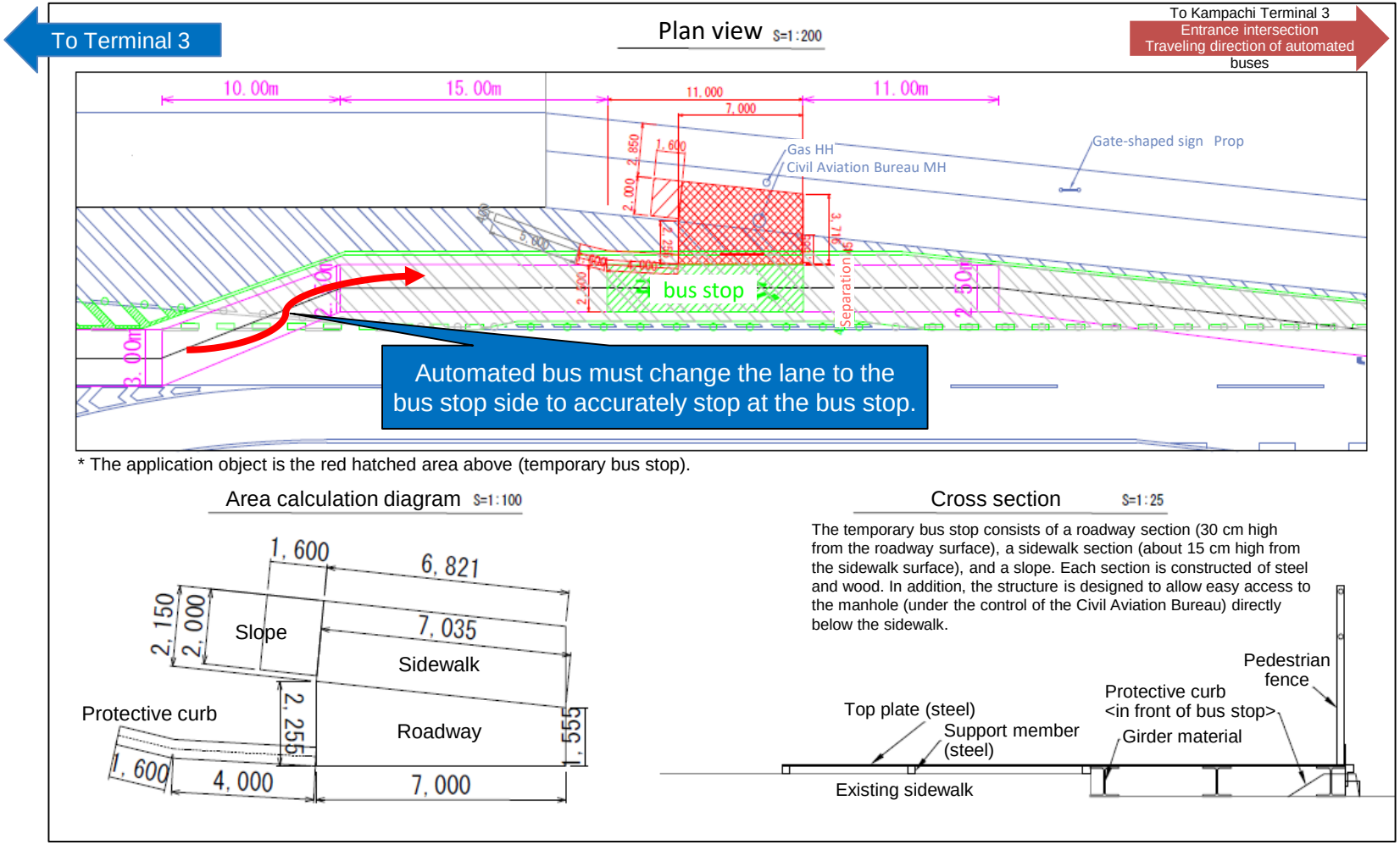
- Placed a temporary bus stop in the zebra zone at Terminal 3 in order to conduct accurate stop control at a bus stop in the automated bus demonstration experiment.
- The specifications for the Terminal 3 bus stop are as follows.

Placement location	Action	Specification	Reason for determination
Terminal 3 bus stop	Placement location	In the zebra zone at Terminal 3	Placed at the foremost part of the parking space at Terminal 3 that was used as a bus stop for route buses, including limousine buses. This area was originally a zebra zone, and therefore using part of it will not interfere with the operation of existing route buses.
	Structure	Using steel materials	Because it is durable enough to withstand the demonstration experiment and can be maintained at low cost.
	Height	23 cm	The height of the bus stop was set to “23 cm from the road surface” in accordance with the height of the entrance of an accurately stopped non-step bus.
	Damage protection	Attach a gap mall and a wheel guard	Attach a gap mall and a wheel guard at the front of the bus stop to protect the bus and bus stop from damage. [Gap mall] A rubber mall to minimize the damage to the bus body caused by collision with the bus stop. [Wheel guard] Projects more to touch the tires of the bus coming to the bus stop earlier than the gap mall to cushion the impact of contact.
	Ancillary facilities	Place protective curbs and temporary guardrails	[Protective curbs] Placed to prevent automated buses from crashing into the bus stop in the event of sudden braking. [Temporary guardrails] Placed in front of the bus stop to prevent buses from crashing into the bus stop in response to the expansion of the zebra zone.

3.3.1 Place Terminal 3 Bus Stop: Design Drawing

- The Terminal 3 bus stop was built in March 2020.
- The following are the design drawing of the Terminal 3 bus stop.

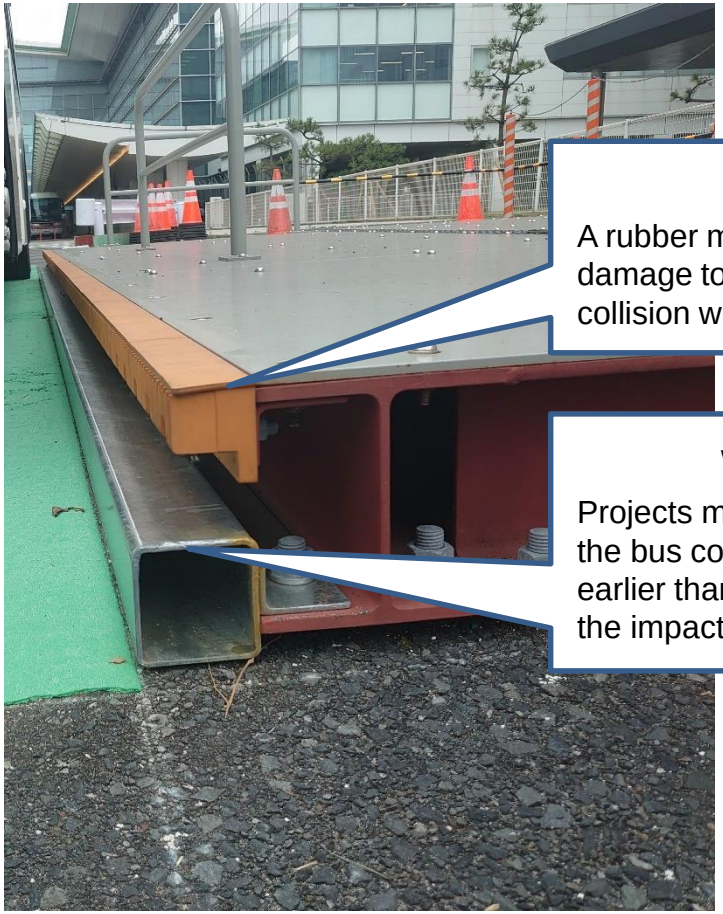
Design drawing of Terminal 3 bus stop



3.3.1 Place Terminal 3 Bus Stop: Gap Mall and Wheel Guard

- A gap mall and a wheel guard are provided to the Terminal 3 bus stop for damage protection.

Appearance of Terminal 3 bus stop



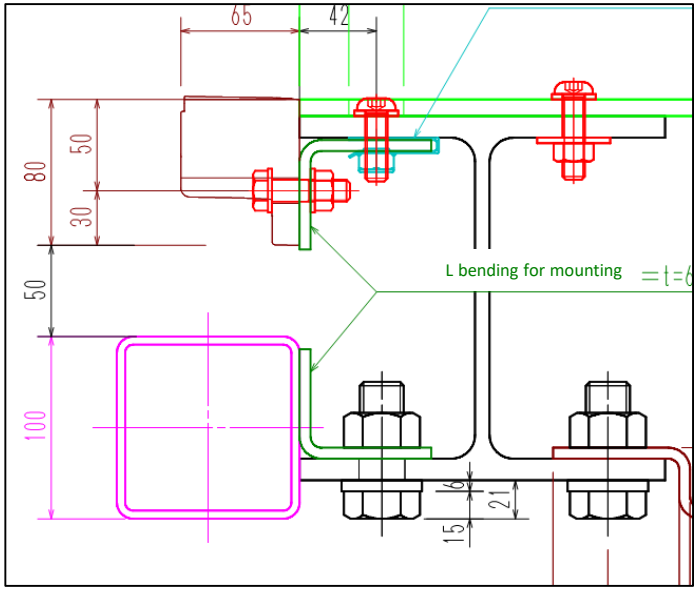
Gap mall

A rubber mall to minimize the damage to the bus body caused by collision with the bus stop.

Wheel guard

Projects more to touch the tires of the bus coming to the bus stop earlier than the gap mall to cushion the impact of contact.

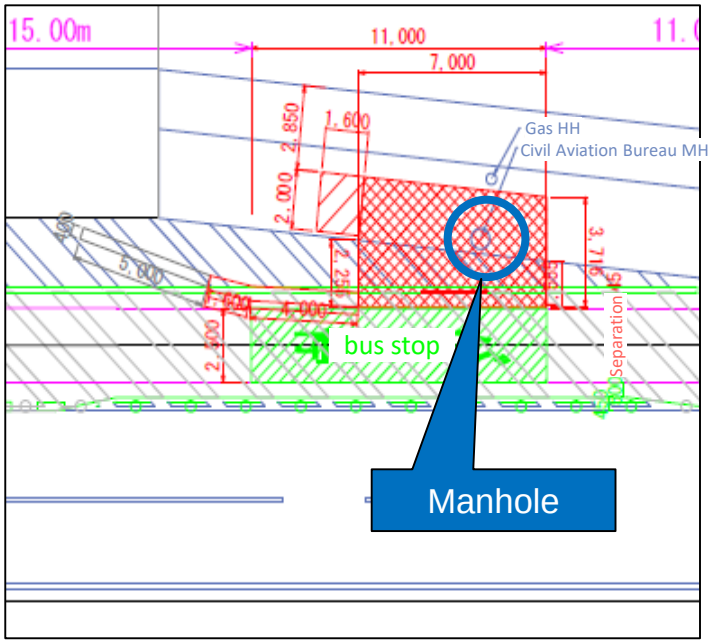
Cross section of design drawing



3.3.1 Place Terminal 3 Bus Stop: Consideration for Manhole

- There was a manhole at the location to place the Terminal 3 bus stop. The manhole section was designed to be detachable in consideration of maintenance work inside the manhole by the road administrator.
- The location and appearance of the manhole are as follows.

Detailed dimensions of manhole section



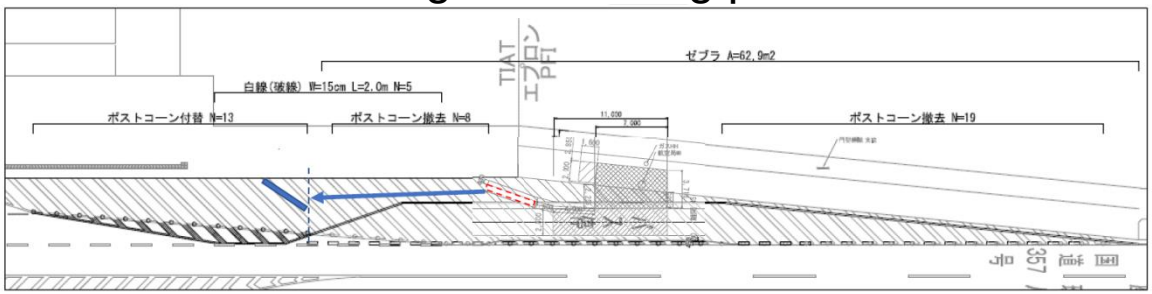
Appearance of manhole

3.3.1 Place Terminal 3 Bus Stop: Relocate Temporary Guardrails and Remove Crossing Prevention Fences

- After the bus stop was placed, the following opinions were raised by the experiment participants, and accordingly, temporary guardrails were relocated and crossing prevention fences were removed in August 2020.

Action	Reason
Relocate temporary guardrails	Because the bus under accurate stop control comes too close to the temporary guardrail, failing to keep a safe distance for manual intervention.
Remove crossing prevention fences	Because if the bus accidentally run on to the bus stop during accurate stop control, it will crash into the crossing prevention fence.

Relocation drawing for crossing prevention fences



Before relocation and removal

After relocation and removal

3.3.1 Place Terminal 3 Bus Stop Photos after Placement

- Placement was completed in March 2020. The temporary guardrails were relocated and crossing prevention fences were removed in August 2020.
- The following are photos of the current state.

3.3.2 Place Zone 1 Bus Stop: Specifications

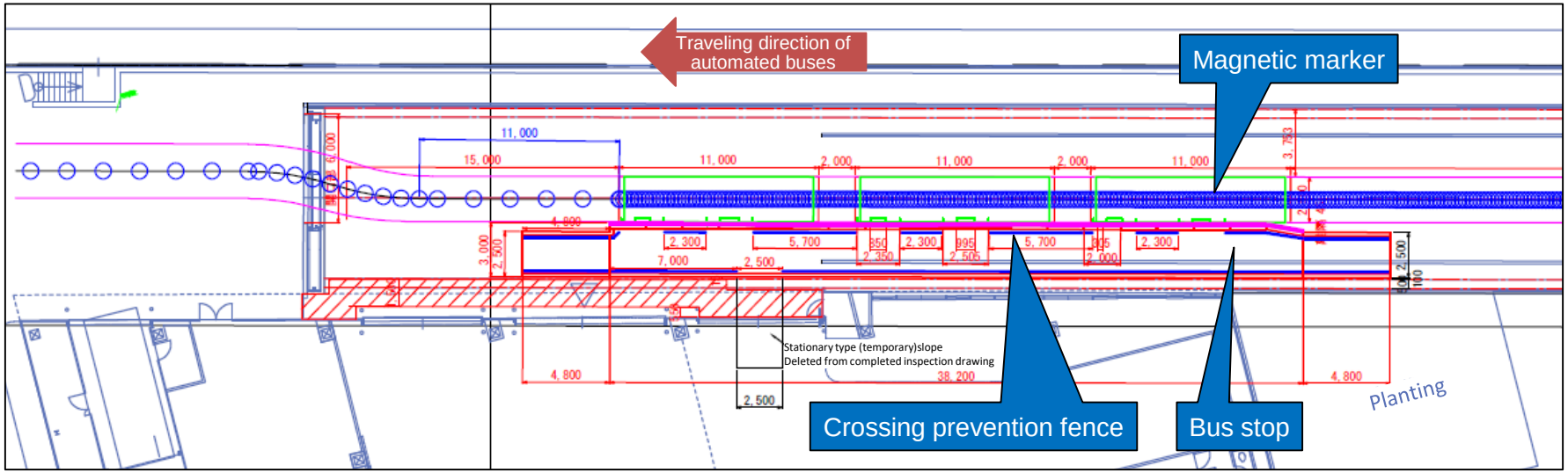
- Placed a temporary bus stop in the zebra zone at Terminal 3 in order to conduct accurate stop control at a bus stop in the automated bus demonstration experiment.
- The specifications for the Terminal 3 bus stop are as follows.

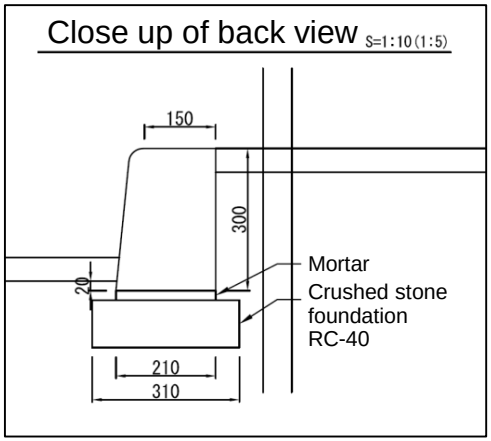
Placement location	Action	Specification	Reason for determination
Zone 1 temporary bus stops	Structure	Constructed in the same way as ordinary bus stops	Because, unlike Terminal 3, pavement was planned to be placed and removed together with the bus stop, so portability was not required, and also because doing so can shorten the construction period and reduce costs.
	Height	23 cm	As with the Terminal 1 bus stop, the height was set to 23 cm in accordance with the vehicle.
	Damage protection	None	As with Terminal 3, the cross section was designed to be provided with a “gap mall” and a “wheel guard.” In order to attach these components, a special curb with flat sides was created. However, in the construction stage, the “gap mall” and “wheel guard” were omitted in order to reduce costs.

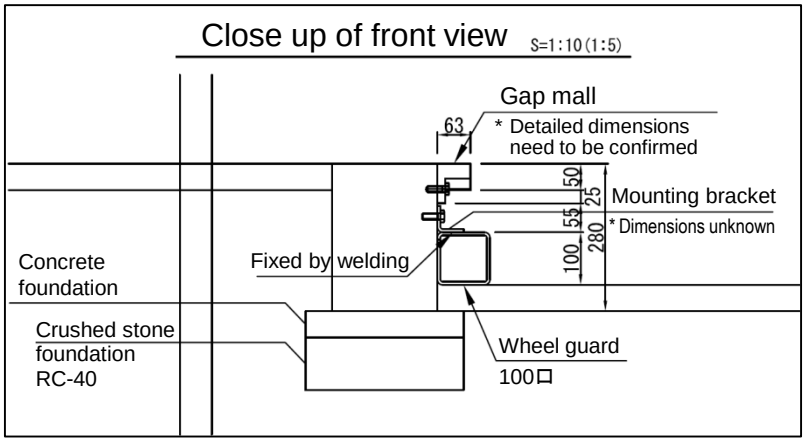
3.3.2 Place Zone 1 Bus Stop: Design Drawing

- The Zone 1 bus stop was placed in May 2020.
- The following is the design drawing of the Zone 1 bus stop.

Design drawing of Zone 1 bus stop







3.3.2 Place Zone 1 Bus Stop: Remove Crossing Prevention Fences

- After the bus stop was placed, the following opinion was raised by the experiment participants, and accordingly, crossing prevention fences were removed.

Action	Reason
Remove crossing prevention fences	Because if the bus accidentally run on to the bus stop during accurate stop control, it will crash into the crossing prevention fence.

Zone 1 bus stop
before removing the crossing prevention fences

Zone 1 bus stop
after removing the crossing prevention fences

3.4 Paving of Zone 1: Overview and Photos after Paving

- Since the only automated bus route in Zone 1 was not paved, a temporary pavement with a bearing capacity enough to withstand bus traffic was laid together with a temporary bus stop.
- In addition, temporary pavement was laid in unpaved areas other than the bus route.
- The paving in Zone 1 was carried out in April 2020.

4. Pre-verification: Overview

- In order to verify in advance whether there are any problems in conducting the demonstration experiment, accurate position information (latitude and longitude data) was obtained on the buried magnetic markers, then reflected in the detailed design drawing and provided to the experiment participants.

Pre-verification

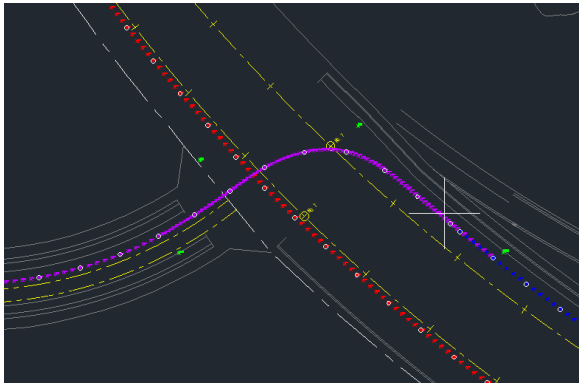
Place magnetic markers → **Field measurement** → **Reflect data in detailed design drawing**

Field measurement

Measure the buried positions of magnetic markers by using Total Station.

Reflect detailed design drawing

Reflect the measured locations in the drawing, organize the latitude and longitude coordinate data, and provide it to the experiment participants.



磁気マーカー測定座標値・緯度経度一覧表

1路線

点名	公共座標9系（世界測地系：測地成果2011） X座標	Y座標	緯度経度（60進法） 緯度	経度	緯度経度（10進法） 緯度	経度	磁気マーカ RFID-No.
1-1	-50508.708	-6470.332	35-32-40.9722	139-45-42.9007	35.5447145O	139.7619188	101
1-2	-50507.817	-6477.118	35-32-41.0011	139-45-42.8299	35.5447225S	139.7618971	
1-3	-50506.913	-6478.883	35-32-41.0304	139-45-42.7596	35.5447308T	139.7618776	
1-4	-50506.018	-6480.684	35-32-41.0594	139-45-42.6882	35.5447387Z	139.7618576	
1-5	-50505.115	-6482.466	35-32-41.0886	139-45-42.617A	35.5447468J	139.7618381	
1-6	-50504.216	-6484.257	35-32-41.1178	139-45-42.5463	35.5447548A	139.7618184	102
1-7	-50503.304	-6486.041	35-32-41.1473	139-45-42.4754	35.5447631A	139.7617987	
1-8	-50502.404	-6487.824	35-32-41.1765	139-45-42.4046	35.5447712S	139.7617790	
1-9	-50501.497	-6489.610	35-32-41.2059	139-45-42.3338	35.5447794Z	139.7617593	
1-10	-50500.589	-6491.390	35-32-41.2353	139-45-42.2629	35.5447875R	139.7617396	
1-11	-50499.688	-6493.175	35-32-41.2645	139-45-42.1920	35.5447958V	139.7617200	103
1-12	-50498.784	-6494.959	35-32-41.2938	139-45-42.1212	35.5448038S	139.7617003	
1-13	-50497.878	-6496.743	35-32-41.3232	139-45-42.0503	35.5448120O	139.7616806	
1-14	-50496.978	-6498.524	35-32-41.3523	139-45-41.9796	35.5448200B	139.7616610O	
1-15	-50496.072	-6500.312	35-32-41.3817	139-45-41.9088	35.5448282S	139.7616412B	
1-16	-50495.178	-6502.100	35-32-41.4106	139-45-41.8375	35.5448362S	139.7616215J	104
1-17	-50494.289	-6503.882	35-32-41.4401	139-45-41.7668	35.5448444Y	139.7616018B	
1-18	-50493.387	-6505.667	35-32-41.4693	139-45-41.6959	35.5448525R	139.7615821R	
1-19	-50492.459	-6507.449	35-32-41.4987	139-45-41.6251	35.5448607S	139.7615625J	
1-20	-50491.561	-6508.236	35-32-41.5278	139-45-41.5541	35.5448688J	139.7615428J	
1-21	-50490.686	-6511.026	35-32-41.5568	139-45-41.4830	35.5448768Y	139.7615230R	105
1-22	-50489.770	-6512.810	35-32-41.5859	139-45-41.4122	35.5448849T	139.7615033B	
1-23	-50488.874	-6514.604	35-32-41.6149	139-45-41.3409	35.5448930S	139.7614835R	

5. Maintenance and Management of Infrastructure

Regularly check and manage the infrastructure developed.

5.1 Maintenance and Management of Magnetic Markers

- Visually check the magnetic markers (once every three months).
- Receive information on whether the markers maintain their performance from the vehicle supplier participating in the experiment. If there are any markers that need to be replaced, discuss how to deal with it with the stakeholders.
- At present, no abnormality is found with the markers that are already placed.

5.2 Maintenance and Management of Dedicated Lane

- As the dedicated lane is colored, visually check the pavement of the lane for any deterioration in color (once every three months).
- Since the color paving of the dedicated lane was completed in March, visual inspection is scheduled to be carried out in FY2020.

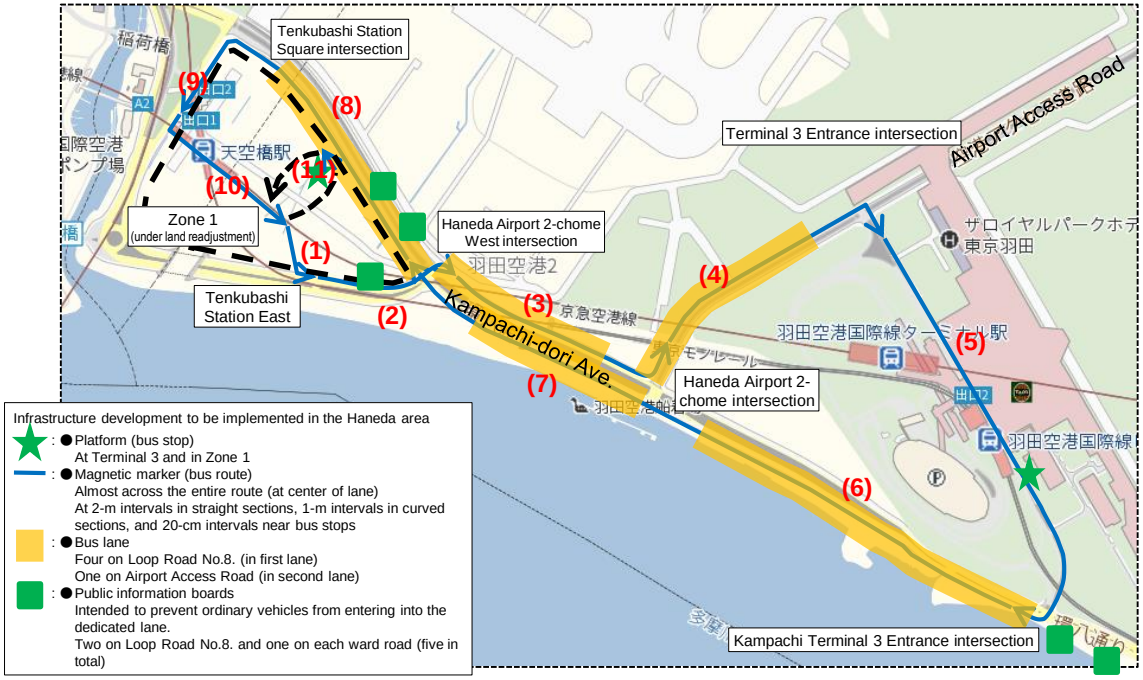
5.3 Maintenance and Management of Temporary Bus Stops

- Visually check the temporary bus stops (once every three months). Since the temporary bus stops were completed in March, visual inspection is scheduled to be carried out in FY2020.

6. Removal of Infrastructure Developed: Overview

- After the end of the demonstration experiment, the infrastructure developed will be withdrawn to restore the original state.
- The withdrawal is scheduled to be carried out in FY2020 after the end of the Tokyo waterfront area demonstration experiments.

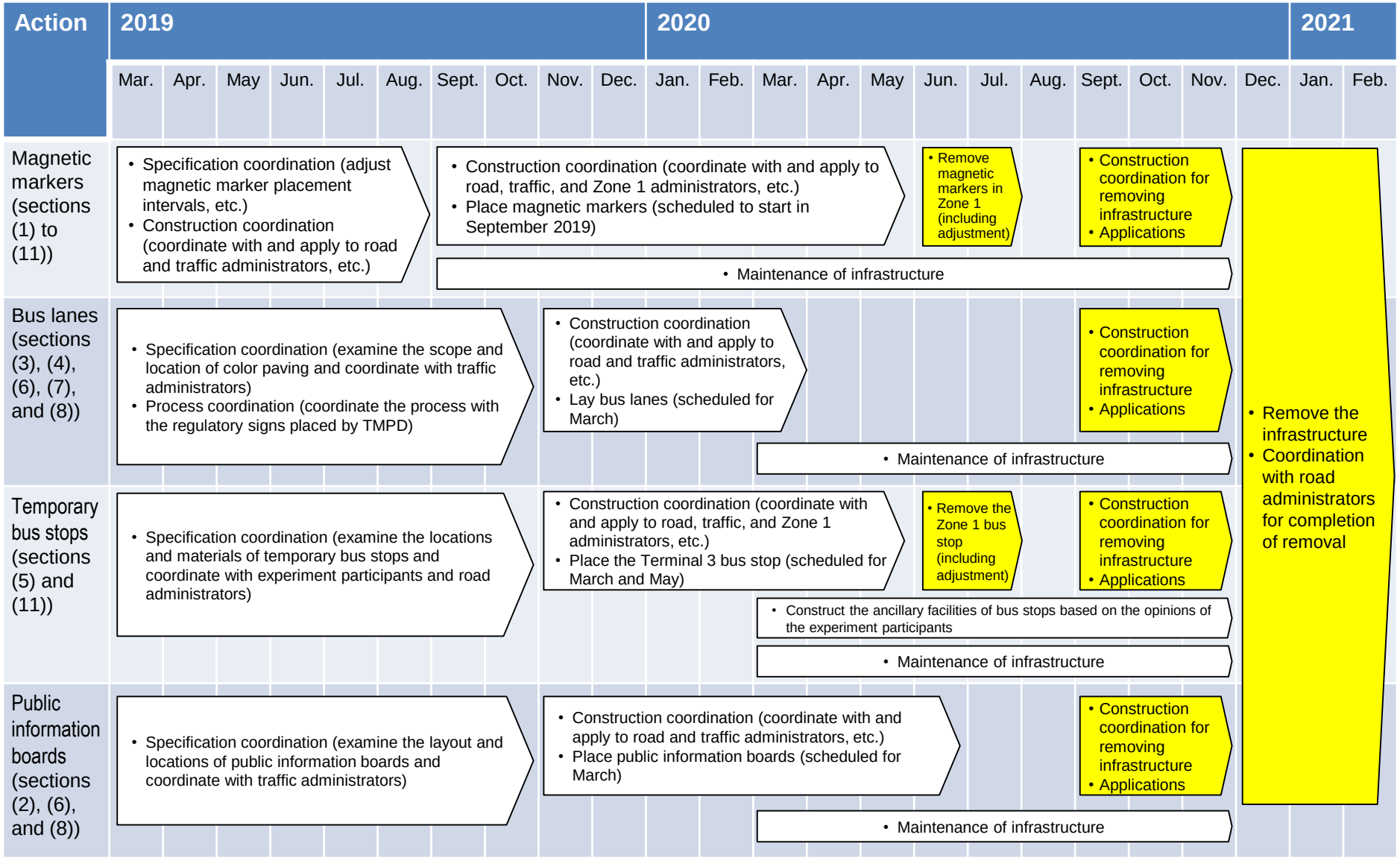
Infrastructure to be withdrawn in FY2020



(C) NTT InfraNet

6. Removal of Infrastructure Developed: Schedule

The schedule of this project is shown in yellow in the figure below.



6. Remove Infrastructure Developed: Restoration Level and Method

- The results of coordination with the stakeholders on the restoration levels and methods are as follows.

Infrastructure to be removed	Action	Coordination results
Magnetic markers	Restoration method	Although there was an option to remove only the magnetic markers by removing the cores, it was decided to perform cutting OL on the entire single lane in consideration of the simultaneous removal of the dedicated lane, the removal work process, and the removal cost.
	Restoration level	The existing section lines, escort zones, and anti-slip pavement that are removed by cutting OL on the entire single lane are also restored.
Bus lanes	Restoration method	Remove together with magnetic markers by cutting OL on the entire single lane. However, regulatory markers are scraped off with water jets in advance in order to invalidate the bus lanes earlier.
Public information boards	Restoration method	As for public information board placed on the Civil Aviation Bureau-controlled roads, the foundation concrete are crushed and removed, followed by backfilling. Signboards placed on the Ota ward road are hung on existing sign posts, and therefore are merely removed.
Regulatory signs	Restoration method	Only sign panels are removed in advance in order to invalidate the bus lanes earlier, and then the remaining sign posts are removed by crushing and removing foundation concrete.
Temporary bus stops	Restoration method	As for the temporary bus stop placed at Terminal 3, the zebra zone and post cones are restored together with the removal of the bus stop. The temporary bus stop placed in Zone 1 is integrated with the temporary pavement, and therefore they are removed together.
Temporary paving in Zone 1	Restoration level	The temporary pavement are removed including the roadbed.

6. Remove Infrastructure Developed: Photos after Removal of Magnetic Markers

- The following are photos after the removal of the infrastructure.

After the removal of magnetic markers (in front of Terminal 3)

After the removal of magnetic markers (on Ota ward road)

After the removal of magnetic markers (at Kampachi Terminal 3 Entrance)

After the removal of magnetic markers (at Haneda 2-chome West intersection)

6. Remove Infrastructure Developed: Photos after Removal of Bus lanes and Platforms

After the removal of the bus lane (Loop Road No.8)

After the removal of the bus lane (on Airport Access Road)

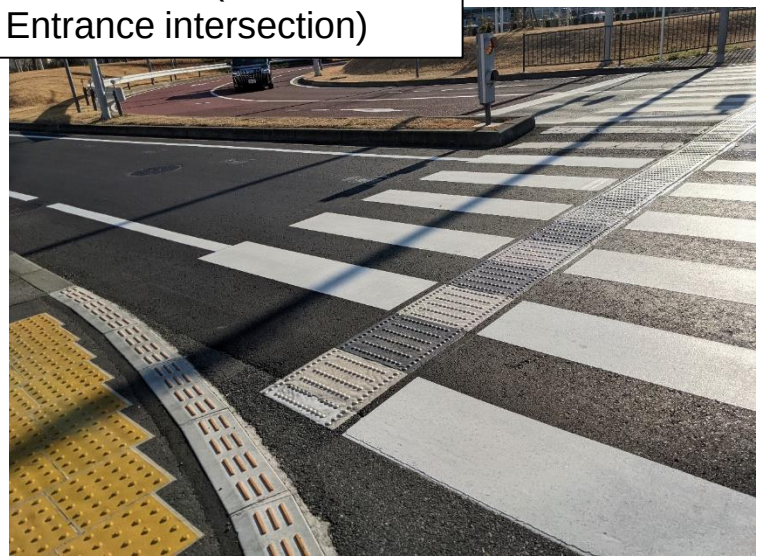
After the removal of the Terminal 3 platform

6. Remove Infrastructure Developed: Photos after Removal of Public Information Boards and Escort Zones

After the removal of public information boards (on Ota ward road)

After the removal of public information boards (on Loop Road No.8)

Escort zone (at Terminal 3 Entrance intersection)



7. Coordination with Stakeholders: Coordination Items

- In preparation to the above-mentioned research and development, coordinate with the traffic and road administrators and other stakeholders.
- In this project, the following matters were coordinated with the stakeholders regarding the construction and removal of infrastructure.

Action	Matters coordinated
(1) Placement of magnetic markers	• Detailed design (with experiment participants and road and traffic administrators) • Construction methods (with road and traffic administrators and Zone 1 developer) • Applications (with road administrators) • Removing methods (with road administrators and Zone 1 developer)
(2) Paving of dedicated lanes	• Detailed design (with road and traffic administrators) • Detailed design of public information boards (with traffic administrators) • Extension of right turn lane at International Terminal West intersection (with road and traffic administrators) • Construction methods (with road and traffic administrators) • Applications (with road administrators) • Removing methods (with road administrators and Zone 1 developer)
(3) Placement of temporary bus stops	• Detailed design (with experiment participants, road and traffic administrators, and Zone 1 developer) • Construction methods (with road and traffic administrators and Zone 1 developer) • Applications (with road administrators) • Removing methods (with road administrators and Zone 1 developer)
(4) Temporary paving in Zone 1	• Detailed design (with experiment participants and Zone 1 developer) • Construction methods (with Zone 1 developer) • Applications (with Zone 1 developer) • Removing methods (with Zone 1 developer)
(5) Removal of infrastructure developed	• Detailed design (with experiment participants and road and traffic administrators) • Construction methods (with road and traffic administrators and Zone 1 developer) • Applications (with road administrators) • Removing methods (with road administrators and Zone 1 developer)

7. Coordination with Stakeholders: Details of Applications

- Applications made to the road administrators are as follows.

Road administrators	Details of application	Notes
Tokyo Airport Office	Application for the use of national property	An application made by NEDO for the use of national property for placing magnetic markers, bus lanes, platforms, and public information boards on the Civil Aviation Bureau-controlled roads (fees are required, and it takes about three months to obtain permission).
	Application under Article 7 of Airport Management Regulations (application for construction work)	An application made by NEDO for the construction work for placing magnetic markers, bus lanes, platforms, and public information boards on the Civil Aviation Bureau-controlled roads.
	Application under proviso to Article 8 of Airport Management Regulations	An application made by NEDO for placing and relocating temporary guardrails and placing protective curbs, and placing and removing road signs (such as zebra zones) on and from the Civil Aviation Bureau-controlled roads.
	Application under Article 8 of Airport Management Regulations (application for removal work)	An application made by NEDO for removing infrastructure placed on the Civil Aviation Bureau-controlled roads.
Ota Ward	Request for cooperation	Submitted by the Cabinet Office for placing magnetic markers on Ota ward roads.
	Application for road occupancy permit	An application made by NIPPO for placing public information boards on Ota ward roads.
	Application for approval of road construction work	An application made by NIPPO for removing infrastructure placed on Ota ward roads.
UR	Application for temporary use permission for contractor-controlled land	Application for the use of UR-controlled land for placing magnetic markers on the UR-controlled roads.
	Application for approved construction work	Application for construction work in the area where the land readjustment project is implemented by UR.

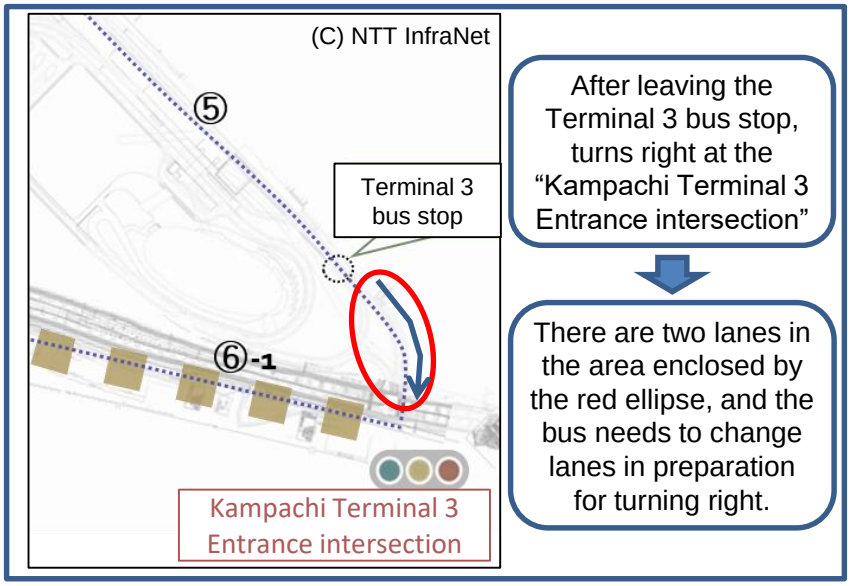
8. Issues in Infrastructure Development: Infrastructure Design Stage

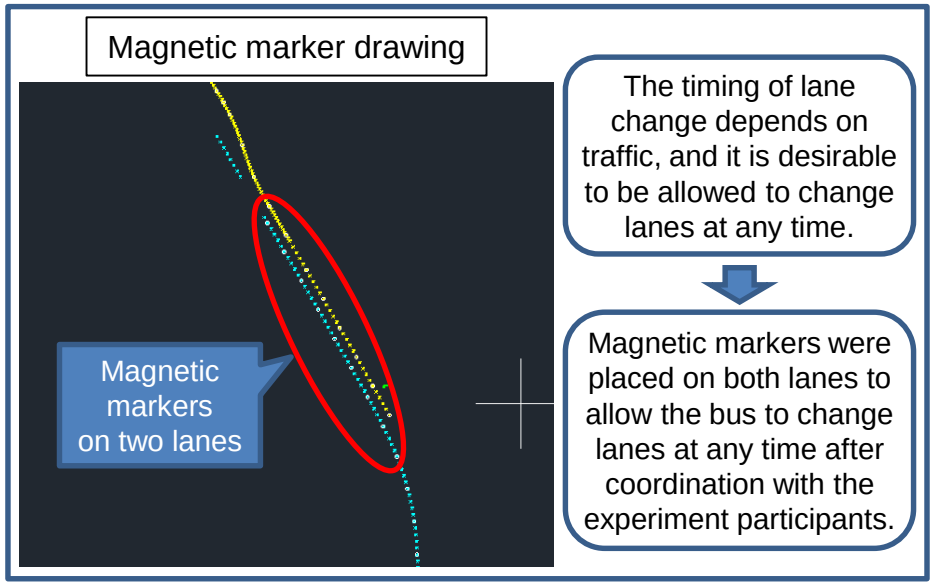
- This project developed, maintained, and removed infrastructure.
- The following are the issues recognized through this project.

(1) Infrastructure design stage

	Action	Issue	Correspondence in this project
1	Magnetic markers	A lane change is required between the Terminal 3 bus stop and the Terminal 3 Entrance (see the description below).	In order to make it easier for vehicles to change lanes at their own timing, magnetic markers were decided to be placed on both lanes.
2	Temporary bus stops	Since the automated bus under accurate stop control approaches the bus stop by a few millimeters, measures should be taken to prevent damage when the bus comes into contact with the bus stop(see the description below).	A “gap mall” and a “wheel guard” were decided to be provided at the front of the Terminal 3 bus stop after coordination with the experiment participants.

(1)-1 Consideration for Lane Change





8. Issues in Infrastructure Development: Infrastructure Design and Coordination Stages

(1)-2 Prevention of Damage Caused by Contact with Bus Stop

[Gap mall]
A rubber mall to prevent damage to the bus body and cushion the impact on the bus stop.

[Wheel guard]
A steel material that first touches the tire of the bus approaching to the bus stop, preventing the bus body from coming into contact with the bus stop.

Terminal 3 temporary bus stop

(2) Infrastructure Coordination Stage

	Action	Issue	Correspondence in this project
1	Magnetic markers	If there is any road maintenance work (such as water supply, gas fitting, and electrical works) after magnetic markers are placed, the markers may be removed for that purpose.	Made known about the infrastructure development in advance and coordinated with the stakeholders to avoid maintenance work after the placement of magnetic markers.
2	Magnetic markers	Although objects to be placed on public roads are normally regarded as occupation or road accessories by the Road Act, but magnetic markers are not mentioned in the Act, and therefore how to apply for placing magnetic markers was unknown.	Placed magnetic markers by making an application for the use of national property.

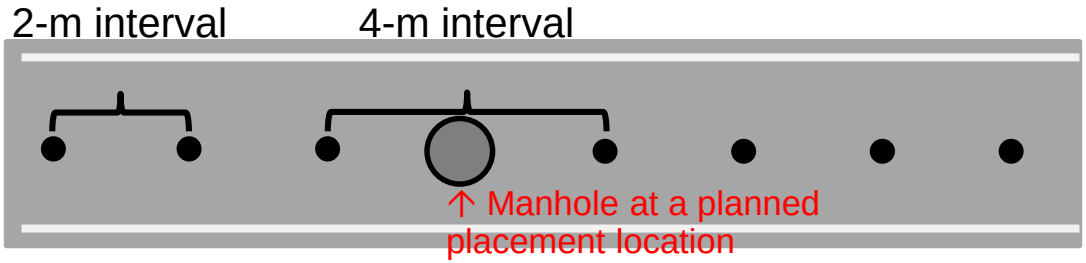
8. Issues in Infrastructure Development: Infrastructure Construction Stage

(3) Infrastructure Coordination Stage

	Action	Issue	Correspondence in this project
2	Magnetic markers	Consideration for cases where there is a manhole at the planned placement location of a magnetic marker (see the description below)	If there was a manhole at the planned placement location of a magnetic marker, the marker was omitted (if the markers were placed at 2-m intervals, a 4-m interval was put only there).
3	Magnetic markers	There are cases where you cannot keep 2-m intervals but have to put larger intervals (when placing at 2-m intervals) for construction reasons, such as in a discontinuous part of placement (see the description below).	Put 2- to 4-m intervals (and 1- to 2-m intervals when placing at 1-m intervals). → Since there was an opinion from the experiment participants that if there is a discontinuous part of placement in a curved section, it is difficult to control, discontinuous parts of placement are desirable to be in straight sections.
4	Magnetic markers	Consideration for intersections of magnetic markers (see the description below)	If the distance between two magnetic markers is within 1 m, one was removed.
5	Magnetic markers	Although the placing locations of magnetic markers are determined by dropping food red from an actually running vehicle, further accurate control beyond human ability is required for accurate stop control of buses.	For accurate stop control of buses, the reverse marking method, which visualizes the placement locations of magnetic markers from the vehicle track and places the markers while measuring the location, was adopted.

8. Issues in Infrastructure Development: Infrastructure Construction Stage

(3)-2 Consideration for Manholes

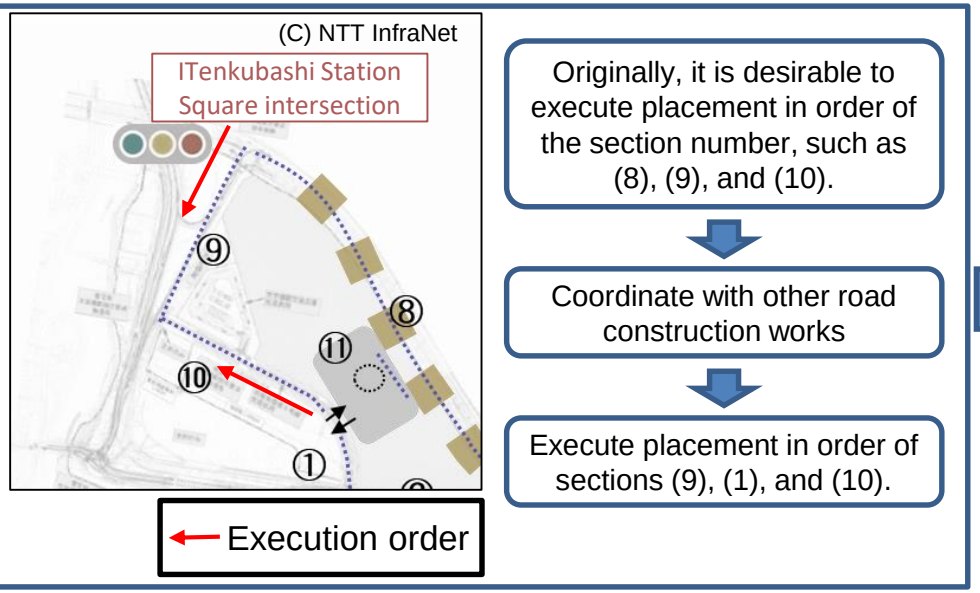


If there is a manhole at the planned placement position of a magnetic marker, the marker is omitted.

Magnetic marker

Manhole

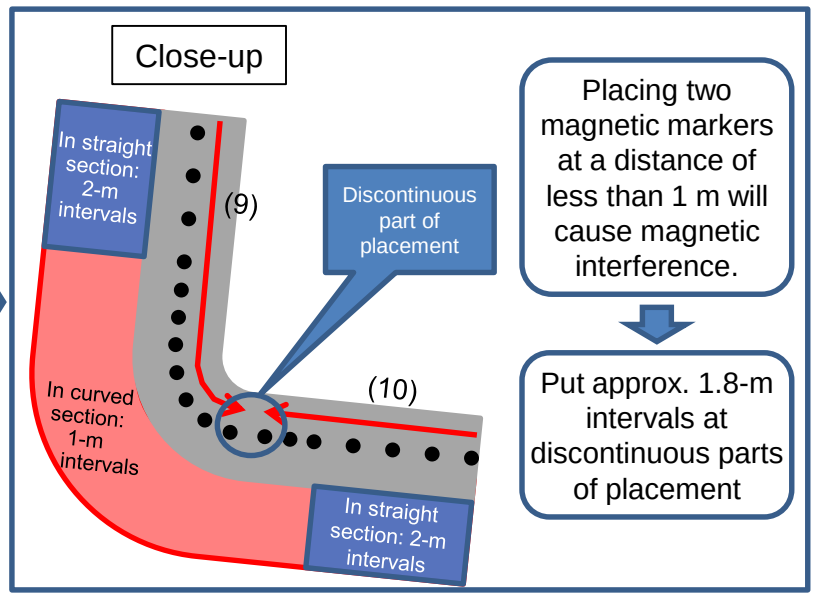
(3)-3 Discontinuous Part of Placement



Originally, it is desirable to execute placement in order of the section number, such as (8), (9), and (10).

Coordinate with other road construction works

Execute placement in order of sections (9), (1), and (10).



Placing two magnetic markers at a distance of less than 1 m will cause magnetic interference.

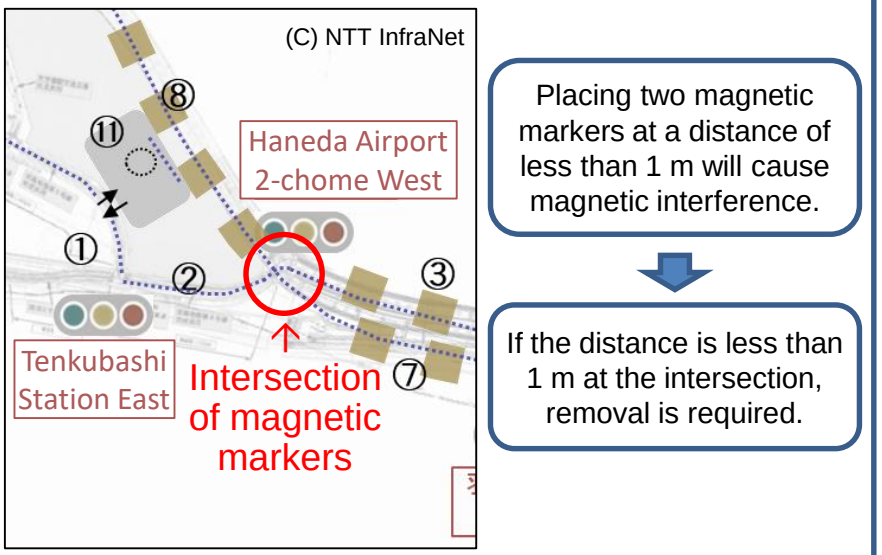
Put approx. 1.8-m intervals at discontinuous parts of placement

⇒ There was an opinion from the experiment participants that if there is a discontinuous part of placement in a curved section, it is difficult to control.

⇒ Discontinuous parts of placement are desirable to be in straight sections.

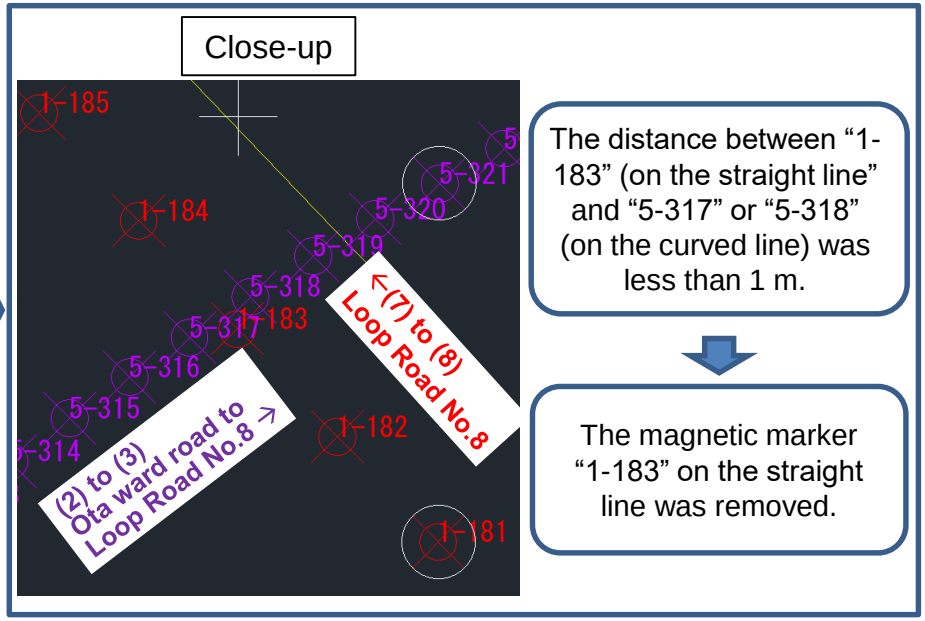
8. Issues in Infrastructure Development: Infrastructure Construction Stage

(3)-4 Consideration for Intersections of Magnetic Markers



Placing two magnetic markers at a distance of less than 1 m will cause magnetic interference.

If the distance is less than 1 m at the intersection, removal is required.



The distance between “1-183” (on the straight line” and “5-317” or “5-318” (on the curved line) was less than 1 m.

The magnetic marker “1-183” on the straight line was removed.

(3) Infrastructure Coordination Stage

	Action	Issue	Correspondence in this project
1	Magnetic markers	At busy intersections of Loop Road No.8, there was concern that the magnetic markers could be damaged or removed by the turning tires of large vehicles.	After about one year has elapsed after the placement of magnetic markers, there was no particular deformation of the markers and no need for maintenance during that period.