Attachment 2

Review Status of Facilities to Secure Safety on the Handling of Water Treated with Multi-Nuclide Removal Equipment

TEPCO

1. **Introduction**
2. **Facility Design to Secure Safety**
3. **Operation of Facilities**
4. **Overall Schedule**
5. **Sea Area Monitoring**
6. **Rearing Test of Marine Organism**
7. **Investigation Regarding Tritium Separation Technology**
8. **Conclusion**

August 25, 2021

Tokyo Electric Power Company Holdings, Inc.

1. INTRODUCTION

1. Introduction

- Regarding the handling of water treated with multi-nuclide removal equipment (hereinafter referred to as ALPS treated water), the review of facility design and operation are in progress with a view to taking thorough action to minimize adverse impacts on reputation with premises securing safety based on the government's basic policy (see slides 3 and 4) announced on April 13th, 2021.
- The status of reviews mentioned above have been presented at the NRA's commission on supervision and evaluation of the specified nuclear facilities.
- This document summarizes the status of review of detailed designs and operation of facilities for securing safety, which includes that of intake/discharge facilities and sea area monitoring which have been considered.
- We will carefully listen to opinions from people in the region and parties concerned, and make changes to facility design and its operation if necessary. We will also achieve accountability to dispel concerns and to foster understanding regarding the handling of ALPS treated water.

[Reference] Excerpt from the Government's Basic Policy（1/2）

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2. The handling of ALPS treated water

(2) Direction of measures regarding discharge into the sea

○For the implementation of discharge into the sea, a method of discharge that minimizes the adverse impacts on reputation (including monitoring with objectivity and transparency) should be ensured, in addition to complying with the laws and regulations related to safety.

○It is requested that TEPCO independently and actively implement initiatives (omitted) to the maximum extent, together with the Government (omitted).

3. Specific method of discharge of the ALPS treated water into the sea

(1) Basic direction

○Based on the ALARA principle, discharge of the ALPS treated water into the sea will be implemented at Fukushima Daiichi NPS, on the premise to make best efforts to minimize the risks by taking measures such as purification and dilution, under strict control.

○The Government requires that TEPCO will proceed with concrete preparations such as the construction of facilities for discharge and other works, to start discharge of ALPS treated water into the sea approximately after two years.

(2) A method of discharge that minimizes adverse impacts on reputation

○Discharge of the ALPS treated water into the sea is conducted after sufficiently diluting the ALPS treated water. Prior to the discharge, third-party experts who have expertise in analysis of the radioactive materials shall be involved, and the concentration of tritium of the ALPS treated water and the purification of water until the level of radioactive materials other than tritium satisfies the regulatory standards for safety shall be confirmed and disclosed.

[Reference] Excerpt from the Government's Basic Policy （2/2）

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○ To allay the concerns of the consumers, the target concentration of tritium should be the same as the operational target (less than 1,500Bq/Liter-water*) for the currently implemented discharge of water pumped up via sub-drains, at Fukushima Daiichi NPS.

*1/40 of the legally required concentrations (60,000Bq/Liter) and approx. 1/7 of the WHO standard for drinking water (10,000Bq/Liter).

○To achieve this target concentration of tritium, prior to the discharge into the sea, the ALPS treated water needs to be sufficiently diluted (more than 100 times) by sea water. Radioactive materials other than tritium will also be significantly diluted with this dilution.

○The total annual amount of tritium to be discharged will be at a level below the operational target value for tritium discharge of the Fukushima Daiichi NPS before the accident (22 trillion Bq/year). The amount will be reviewed periodically.

○The Government and TEPCO will strengthen and enhance monitoring before and after the discharge by activities including newly introduced monitoring of tritium at fishing ground, swimming beaches and other areas.

○The discharge into the sea will be conducted in small amount at the initial phase, while confirming the impacts on the surrounding environment. Discharge will be securely stopped until the safety of the discharge is confirmed, if there is any malfunction of dilution facilities and other equipment due to a power or other failure, or if a radiation monitor detects an irregular value.

○Furthermore, considering relevant international law and international practice, measures shall be taken to assess the potential impact on the marine environment, and to ascertain the environmental situation through continuous monitoring stated above after discharge.

5. Further steps for the future

○TEPCO will also continue to decontaminate drainage channels to reduce the concentration of radioactive materials in the port of Fukushima Daiichi NPS, and to take other relevant measures to remove fish in the port.

2. FACILITY DESIGN TO SECURE SAFETY

2. Topics Regarding the Application for the Authorization of Changes in Implementation Plan (1/2)

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[Conceptual diagram of facilities for discharging ALPS treated water into the sea]

⑥General items

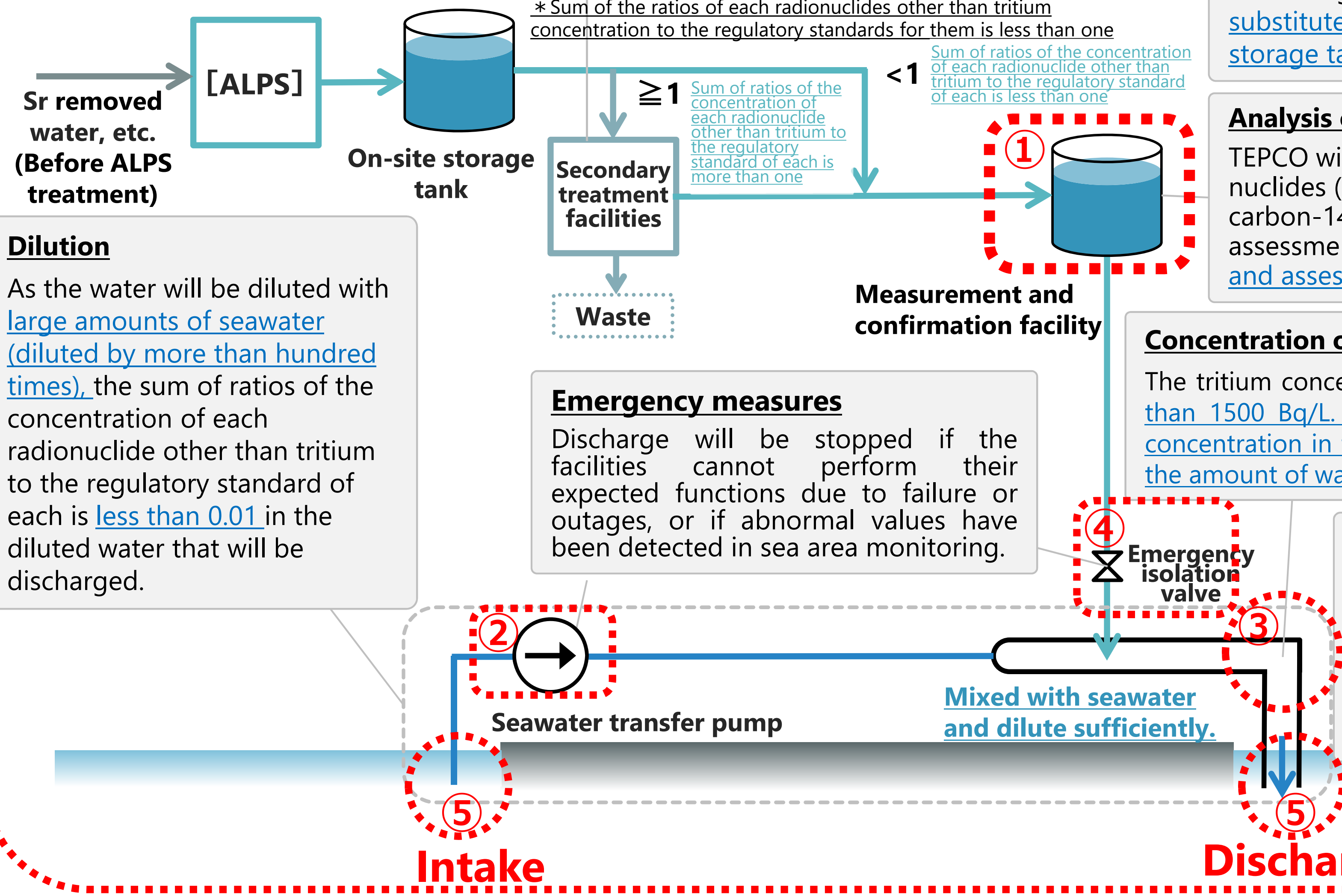
Secondary treatment

Secondary treatment will be conducted as necessary to ensure that the level of radioactive materials excluding tritium is lower* than the regulatory standard value for environmental discharge.

*Sum of the ratios of each radionuclides other than tritium concentration to the regulatory standards for them is less than one

Site use plan

In order to discharge ALPS treated water in a stable manner and move forward with the construction of facilities required for decommissioning, we are examining measurement/confirmation facility, substitute tank construction and the dismantling of storage tanks that will become empty.



Analysis of ALPS treated water

TEPCO will publish the concentration of tritium, 62 nuclides (nuclides subject to removal by ALPS), and carbon-14 in ALPS treated water and the results of assessments as well as the 3rd parties' measurement and assessment results.

Dilution

As the water will be diluted with large amounts of seawater (diluted by more than hundred times), the sum of ratios of the concentration of each radionuclide other than tritium to the regulatory standard of each is less than 0.01 in the diluted water that will be discharged.

Emergency measures

Discharge will be stopped if the facilities cannot perform their expected functions due to failure or outages, or if abnormal values have been detected in sea area monitoring.

Concentration of tritium inside discharged water

The tritium concentration of the discharged water will be less than 1500 Bq/L. This will be assessed based on the tritium concentration in the ALPS treated water before discharge and the amount of water it was diluted by.

Amount discharged

In the near term, discharge amounts will be within the threshold of 22 trillion Bq/year which is the target discharge management value for Fukushima Daiichi before the accident. This amount will be reviewed as needed based on progress made in decommissioning.

2. Topics Regarding the Application for the Authorization of Changes in Implementation Plan (2/2)

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- Six topics of facilities for securing safety have been presented at the NRA's commission on supervision and evaluation of the specified nuclear facilities, and we have discussed those topics sequentially. Topic ① was explained in June, and Topics ②, ③, ④ and ⑥ in July.

Topic ① (Measurement/ assessment)	● Method of collecting samples for thoroughly measuring and assessing tritium, 62 nuclides (subject to removal by ALPS) and the radiation concentration of Carbon-14; facilities required for the sampling method and its management. ● Securing tanks required for thoroughly measuring and assessing radiation concentration. ● Quality assurance in the strict measurement and assessment of radiation concentration. ⇒p.8～21
Topic ② (Specification of dilution facility)	● Specification of the seawater transfer pump (capacity) used for dilution and measurement method of seawater flow rate. ⇒p.22～28
Topic ③ (Assessment of dilution)	● Measurement of tritium concentration requires half a day to an entire day, so abnormality cannot be continuously detected through continuous measurement like those conducted for gamma emitting isotopes. The feasibility of confirming the tritium concentration of water discharged being less than 1,500 Becquerel/liter using measurement of tritium concentration prior to discharge and water for dilution (however, measure tritium concentration at the discharge end periodically) needs to be verified. ⇒p.29～34
Topic ④ (Measures in the event of abnormality)	● An interlock mechanism to stop the discharge in an emergency when the tritium concentration of the water discharged cannot be confirmed to be less than 1,500 Becquerel/liter. ● Redundancy of emergency isolation valve and location of its installation ● ALPS treated water is measured and assessed for its radiation concentration prior to dilution and discharge, and it is confirmed that the sum of ratios of the concentration of each radionuclide to the regulatory standard of each is less than one (excluding tritium). Radiation monitor (for gamma ray) and an emergency shutdown interlock in preparation for the unlikely discharge of particulate radioactive material. ⇒p.35～37
Topic ⑤ (Intake and discharge)	● Intake and discharge method (Preventing radioactive material near the sea floor of the harbor being blown upwards during intake and discharge, and promoting dispersion during discharge) ⇒p.38～45
Topic ⑥ (General items)	● Design of necessary facilities, organization for the conduct of construction and implementation ● Preparations for the reliable management of facilities in general (securing auxiliary parts and measures for natural disasters, etc.) ⇒p.46～48

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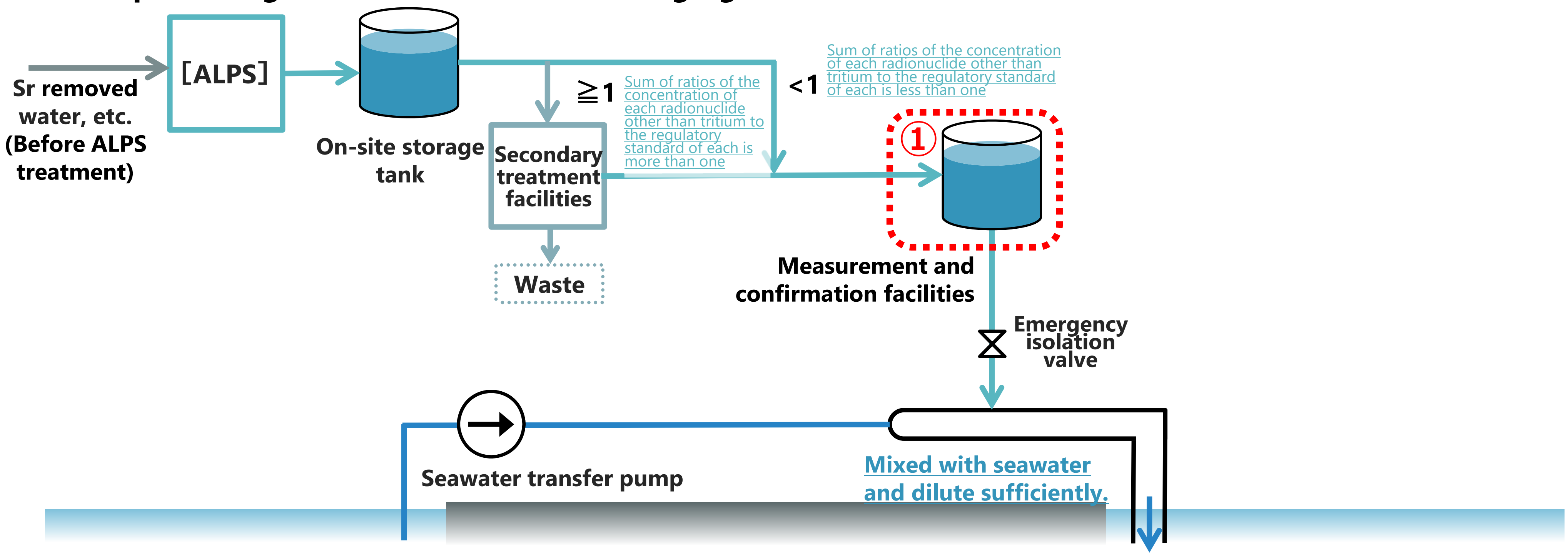
TOPIC ① Measurement/assessment

- Method of collecting samples for thoroughly measuring and assessing tritium, 62 nuclides (subject to removal by ALPS) and the radiation concentration of Carbon-14; facilities required for the sampling method and its management.
- Securing tanks required for thoroughly measuring and assessing radiation concentration.

[Conceptual diagram of facilities for discharging ALPS treated water into the sea]



2-(1)-1 Design Approach

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1. An important task when discharging ALPS treated water into the sea is to properly measure/assess the radiation concentration of tritium, 62 nuclides (nuclides subject to removal by ALPS), and carbon-14 prior to dilution and discharge in order to confirm that the sum of ratios of legally required concentrations for the 62 nuclides (nuclides subject to removal by ALPS) and carbon-14 is less than 1 (including measurement and assessment by third parties).

2. When engaging in this task the following two conditions must be considered.
   - Considerable time is required to measure/assess the radiation concentration of some nuclides
   - The storage capacity for ALPS treated water, etc. will be reduced in a planned manner in order to move forward with decommissioning

3. In order to achieve above conditions, three sets of tank groups will be prepared. Each tank group has three roles (receiving, measurement/confirmation, and discharge) and has a capacity of approximately 10,000m^3 (Total: approximately 30,000m^3.)

2-(1)-2 Approach to tank capacity (1/2)

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Prior to dilution and discharge, the measured/assessed radiation concentrations of tritium, the 62 nuclides (nuclides subject to removal by ALPS) and carbon-14 in ALPS treated water will be published, and measurement and assessment will be also conducted by third parties.

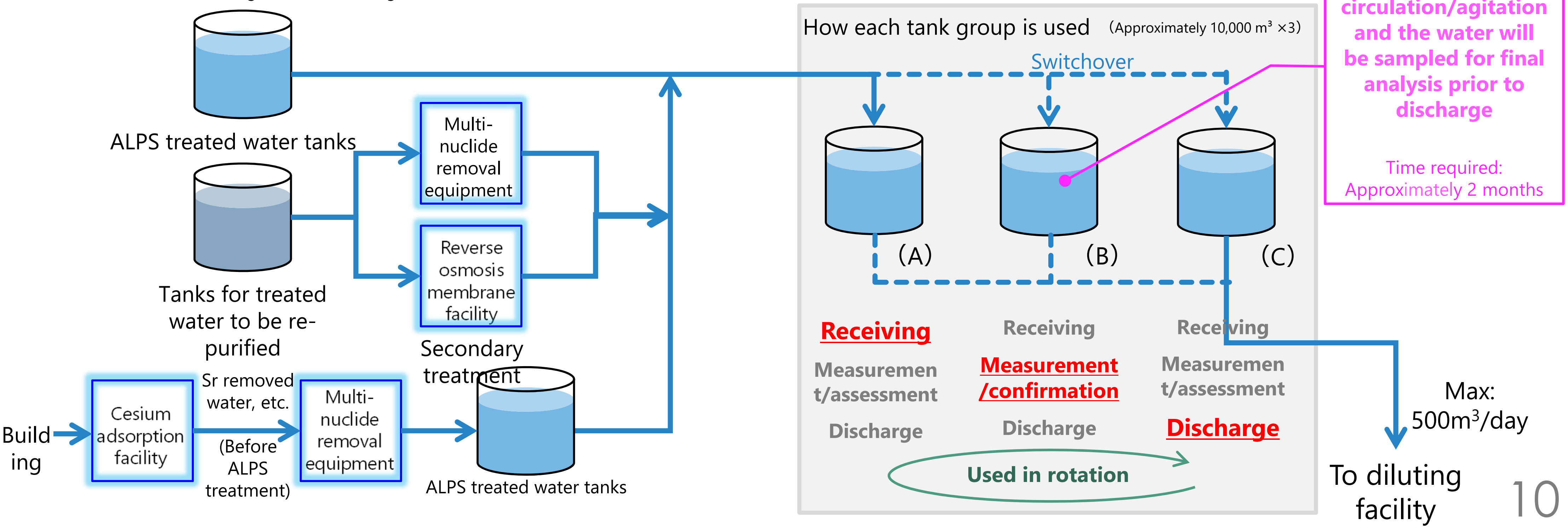
Some of these 62 nuclides take time to be measured/assessed. Secondary treatment performance confirmation tests* showed that some nuclides **required approximately two months for the measurement/assessment****. That makes us to secure **approximately 10,000m^3** of storage capacity (equal to the amount of water generated for two months (150m^3/day)).

Three sets of tank groups will be secured in order to make the measurement/assessment process smoothly. **Each tank group, with a capacity of approximately 10,000m^3** and **with three roles (receiving, measurement/confirmation and discharge) will be used on a rotating basis.** (Total capacity for all three set of tank groups: Approximately 30,000m^3)

Furthermore, **the water in each tank group will be homogenized by circulation/agitation and the water will be sampled for final analysis prior to discharge**. Therefore, the tank groups for the measurement/assessment differ from tanks for storing ALPS treated water, etc. in that they must be renovated and equipped with pumps for circulating and agitating the water, valves, piping for sampling materials, power sources, and control units.

* Secondary treatment performance confirmation tests (September - December 2020): https://www4.tepco.co.jp/en/decommission/progress/watertreatment/images/201224.pdf

** Methods for shortening this time are being deliberated.



2-(1)-2 Approach to tank capacity (2/2)

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As in the page 10, **three sets of tank groups, each with three roles (receiving, measurement/confirmation and discharge) and with a capacity of approximately 10,000m^3 (Total for all three sets of tank groups: Approximately 30,000m^3) will be used on a rotating basis** **(it will take six months for a rotation cycle of receiving, measurement/assessment and discharge)**. The amount of water to be generated daily is assumed to be 150m^3/day to ensure that the amount of ALPS treated water, etc. being stored does not increase any more.

- The amount of contaminated water being generated will be reduced to lower than 100m^3/day during 2025.
- Methods for shortening the time required to measure/assess the 62 nuclides will be examined in order to shorten the rotation cycle.

We will continue to engage in efforts above, in order to reduce the amount of ALPS treated water, etc. that has already accumulated.

Furthermore, we understand that there is a need to develop a wider perspective on operations, considering the fact including i) we need to consider certain operating rates for possible breakdowns and regular inspections of necessary facility for sea discharge, ii) the amount of stored ALPS treated water, etc. will be reduced in a planned manner. The following points will also be examined.

- Shorten the rotation cycle to four months, as only one month each is needed for the “receiving” and “discharge” process. This will lead to the necessity to improve the route of piping between tanks and increased complexity of ALPS treated water, etc. transfer procedures.
- Make the reduction rate of ALPS treated water, etc. stored in tanks larger, by discharging ALPS treated water with low tritium concentrations first. Detailed simulation will be needed for examination.

2-(1)-3 Approach to tank placement

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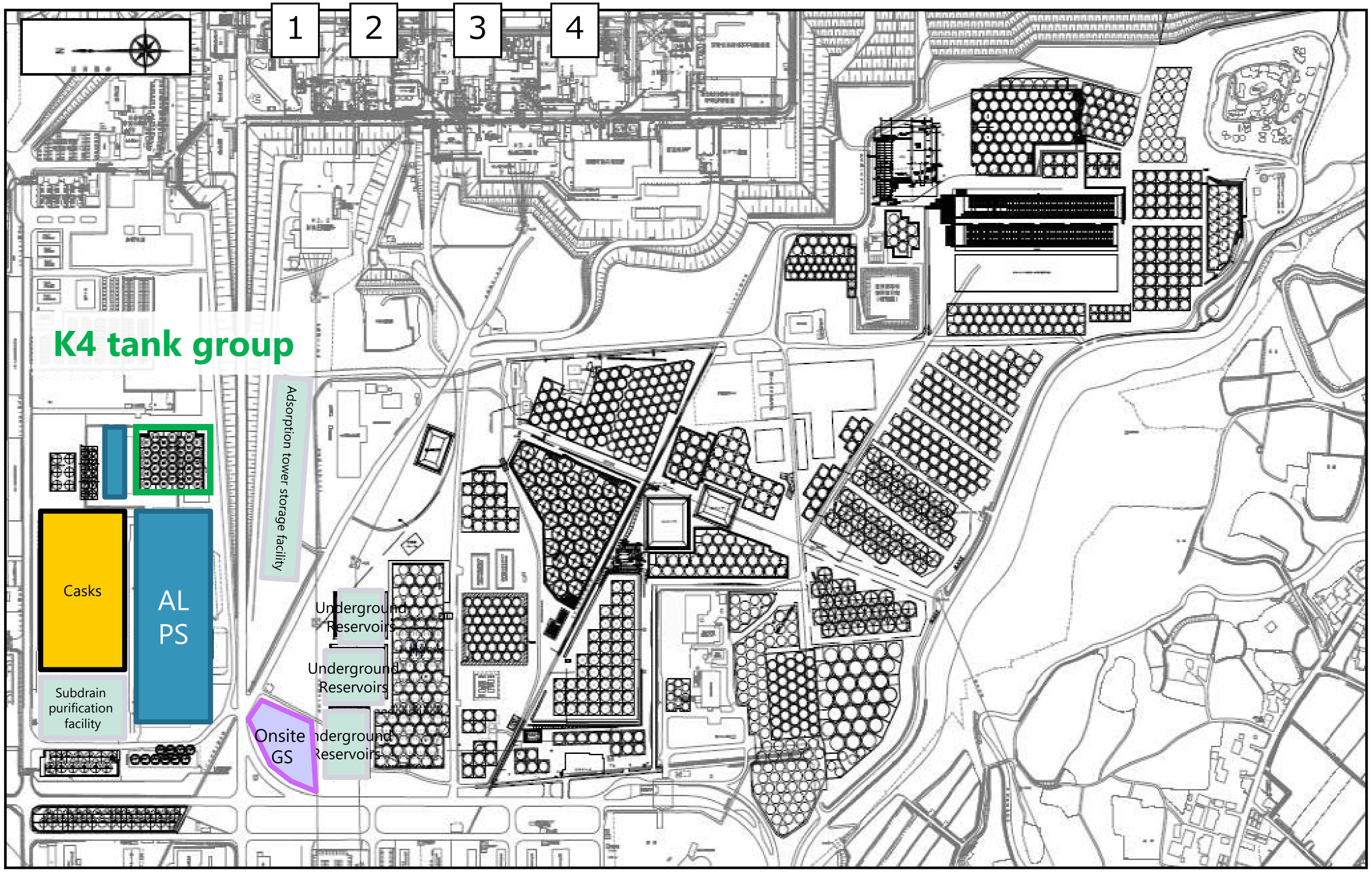
In order to transfer ALPS treated water to diluting facility, and also to prepare in any case that the sum of ratios of legally required concentrations, with the exception of tritium, equals, or exceeds, 1 and such water needs to be returned to ALPS for retreatment, **tanks for this purpose need to be built near ALPS**. However, since there is no space to newly construct tanks with a capacity of approximately 30,000m^3 near ALPS, **K4 tank group are to use for this purpose**.

In the vicinity of ALPS, the concentrations of a total of 64 nuclides* in K4 tank group have already been measured/assessed, and we have found that the sum of the ratios of concentrations required by law, with the exception of tritium in the **K4 tank group** is less than 1. (* tritium, 62 nuclides (nuclides subject to removal by ALPS) and carbon-14)



2-(1)-4 Repurposing the K4 tank group (1/2)

1. As previously mentioned, tanks will be prepared to thoroughly measure/assess radiation concentrations and engage in sea discharge in a stable manner. The K4 tank group is being examined for this purpose.

2. Therefore, the intended purpose of the K4 tank group (approximately 30,000m^3) will be changed from the long-term storage of ALPS treated water, etc., to part of discharge facility to thoroughly measure/assess of radiation concentrations. Accordingly, the K4 tank group, which will be part of discharge facility, will differ from tanks used to store ALPS treated water, etc. and will be renovated and equipped with pumps for circulating and agitating the water, valves, piping for sampling materials, power sources, and control units (detailed renovation plans and schedules are currently being examined). Substitute tanks with the same capacity as the K4 tank group will be needed temporality to accommodate the water drained from the K4 tank group.

3. These substitute tanks to be built in conjunction with the repurposing of the K4 tank group will be used after the commencement of discharge into the sea as well, to make up for the decrease in the ALPS treated water, etc. and Sr removed water (before ALPS treatment) storage capacity (approximately 30,000m^3; total planned capacity is approximately 1.37 million m^3).

2-(1)-4 Repurposing the K4 tank group (2/2)

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4. The area where flanged tanks were dismantled is a potential candidate for the construction location of the tanks with the same capacity as K4 tank group.

5. In consideration of the importance of using the K4 tank group to thoroughly measure/assess radiation concentrations, the plan to use the G4 North and G5 areas for the storage of materials/equipment and equipment used for the accident response shall be abandoned, and these area will instead be used to construct the substitute tanks to hold the water drained from the K4 tank group (**slide 15**). Materials/equipment shall be temporarily placed on the road and equipment used for the accident response will be left in its current location, until the dismantling of welded tanks proceeds.

【Reference】Areas for tank construction (K4 tank group substitute)

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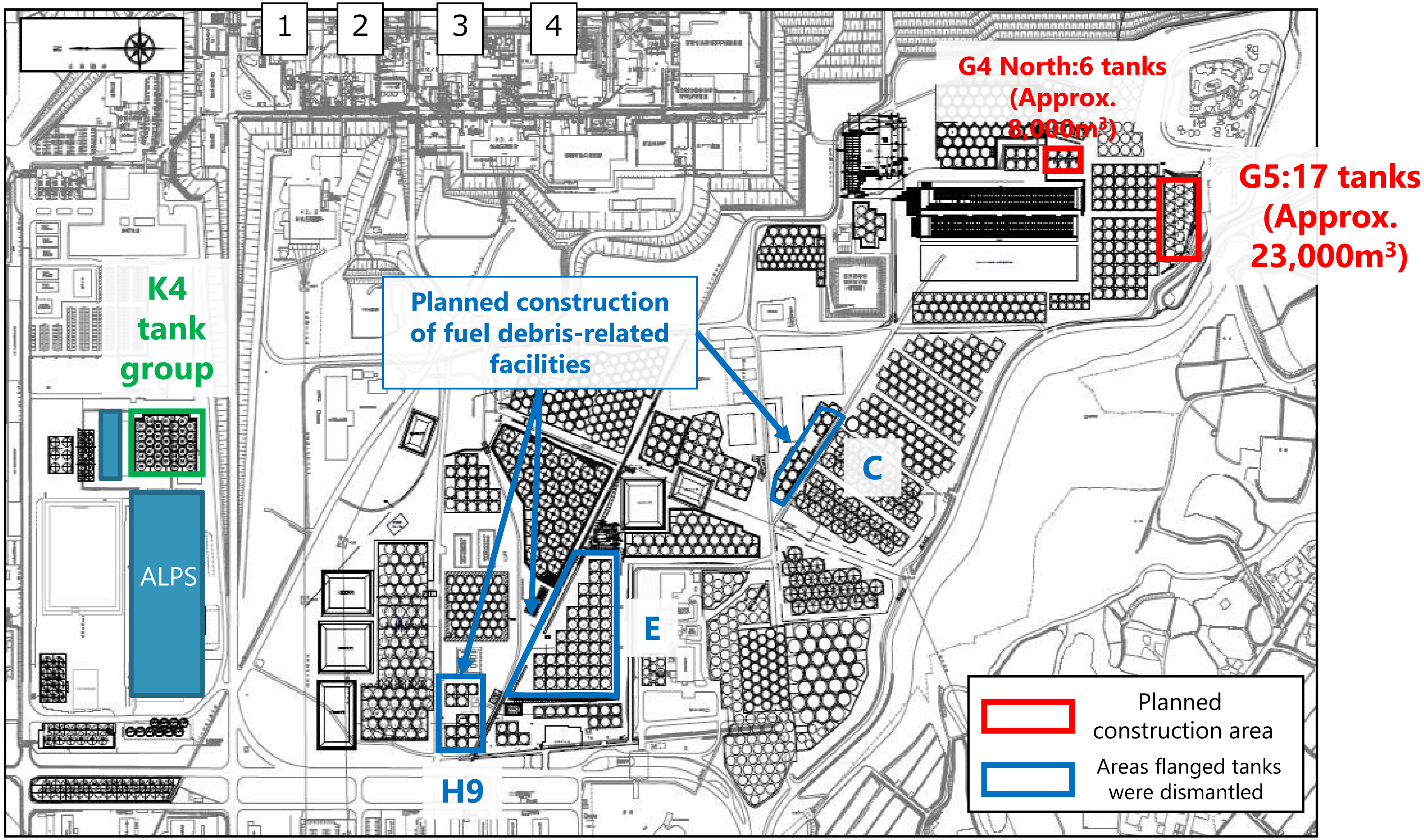

2-(1)-5 Tank area usage outlook

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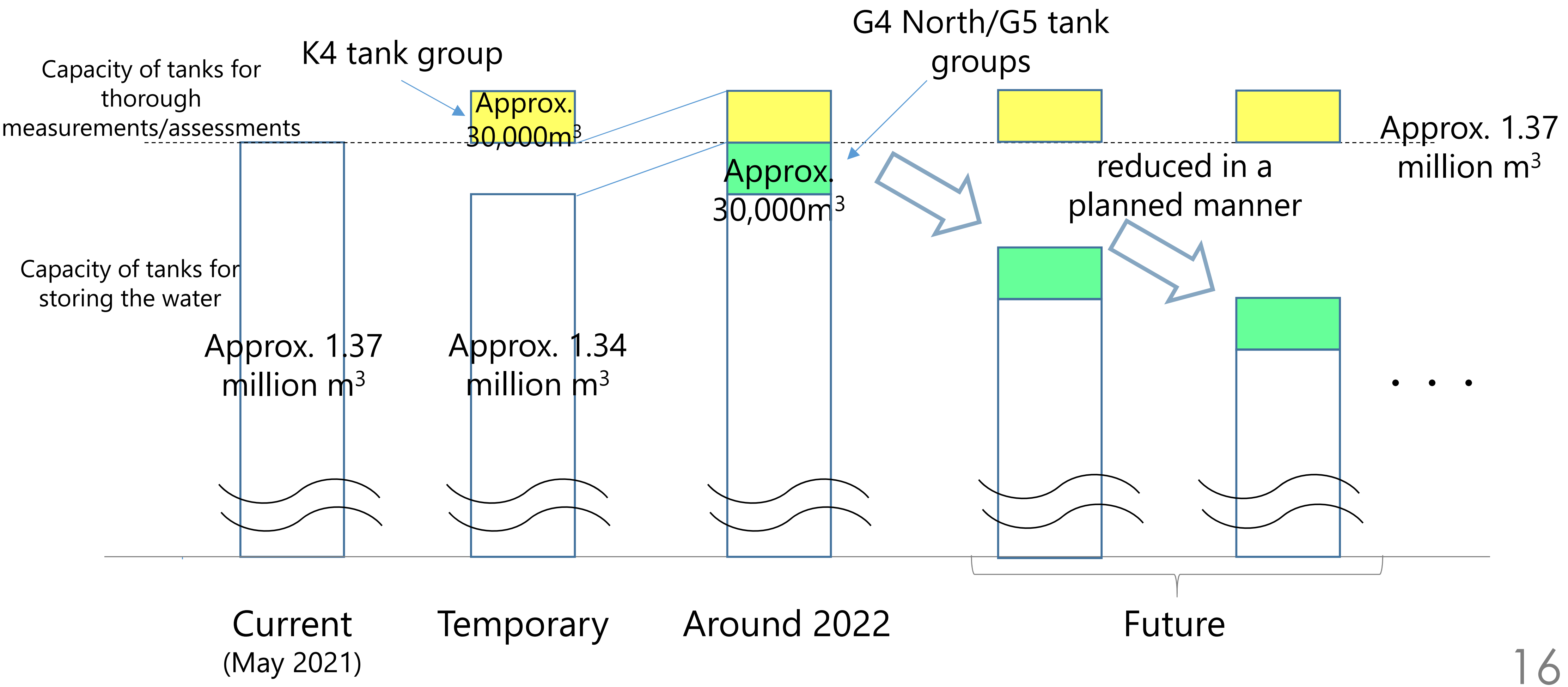
We plan to use the tank area for the construction of facilities required for decommissioning in the future, and the construction of most of these facilities will be commenced during the late 2020's. **<u>So as not to hinder decommissioning works</u>**, we need to discharge ALPS treated water into the sea in a planned manner through sea discharge and to **<u>dismantle the tanks by the time that construction of facilities commences</u>**.

If tanks with a capacity of approximately 30,000m^3 (The same as the capacity of K4 tank group) will be built in the area where flanged tanks were dismantled*, equal amount number of tanks will need to be dismantled during the early 2020s.



【Reference】Site usage

Repost of The commission on supervision and evaluation of the specified nuclear facilities (91st session)

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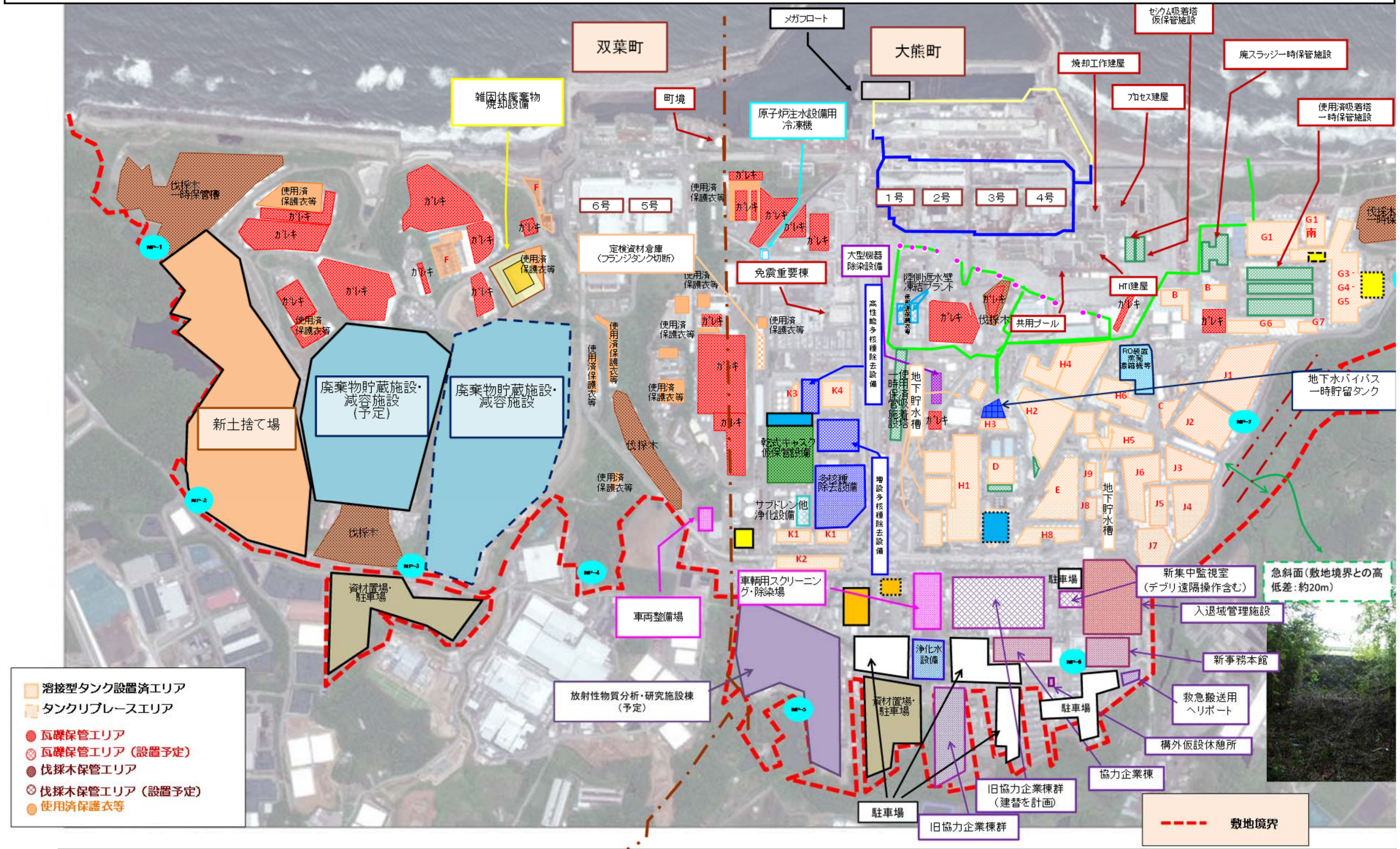
◇There is limited space at the Fukushima Daiichi Nuclear Power Station for the construction of tanks in addition to what is already planned.
◇The following facilities need to be constructed in order to move forward with decommissioning and remove spent fuel and fuel debris, which pose a higher risk than ALPS treated water.

- Storage facilities for removed spent fuel
- Maintenance facilities required for fuel debris removal
- Facilities required to store waste generated in the future
- Waste recycling facilities
- Storage facilities for removed fuel debris
- Fuel debris removal training facilities
  - Facilities to analyze various samples
  - Fuel debris/radioactive waste-related research facilities
- Facilities required to ensure that workers can engage in work safely, etc.

◇ALPS treated water must be disposed of, and tanks dismantled, in order to secure space on site for facilities that will ensure that decommissioning continues safely and smoothly.



Around FY2021
- Equipment used for the accident response storage
- Storage location for equipment/materials related to secondary waste generated from water treatment
- Subdrain water collection facility

Around FY2022
- Removal equipment maintenance facilities, trial removal equipment storage
- Dray cask temporary storage facility (For Units 1~6 SFP)

Around FY2023
- Bioassay facility

After FY2024
- General analysis facility
- Waste recycling facility
- Fuel debris storage facility #1
- Highly radioactive SFP internals storage facility
- Fuel debris storage facility #2
- Removal equipment maintenance facility
- Fuel debris removal training facility
- Fuel debris/waste transfer system
- Storage facility storage containers
- Fuel debris storage facility #3
- Dry cask temporary storage facility (for common pool)
- Volume reduction facility for highly radioactive waste
- Highly radioactive solid waste storage facility
- Fuel debris storage facility (#4 and onward)

※ In addition to facilities required into the 2030s in conjunction with decommissioning

Note 1: Time period when construction needs to commence is indicated. Tank dismantling will take one to two years.
Note 2: A site approximately two times the size will be needed temporarily if you consider the need for a work yard during construction.
Note 3: Facility area is only an estimate and may change in accordance with the progress of future deliberations and new knowledge, etc.

【Additional information】
○This diagram was created based upon current site usage and current usage plans.
○Plans will be revised as needed if facilities need to be constructed/dismantled in accordance with the progress of future decommissioning work.

【Reference】ALPS treated water, etc. stored status

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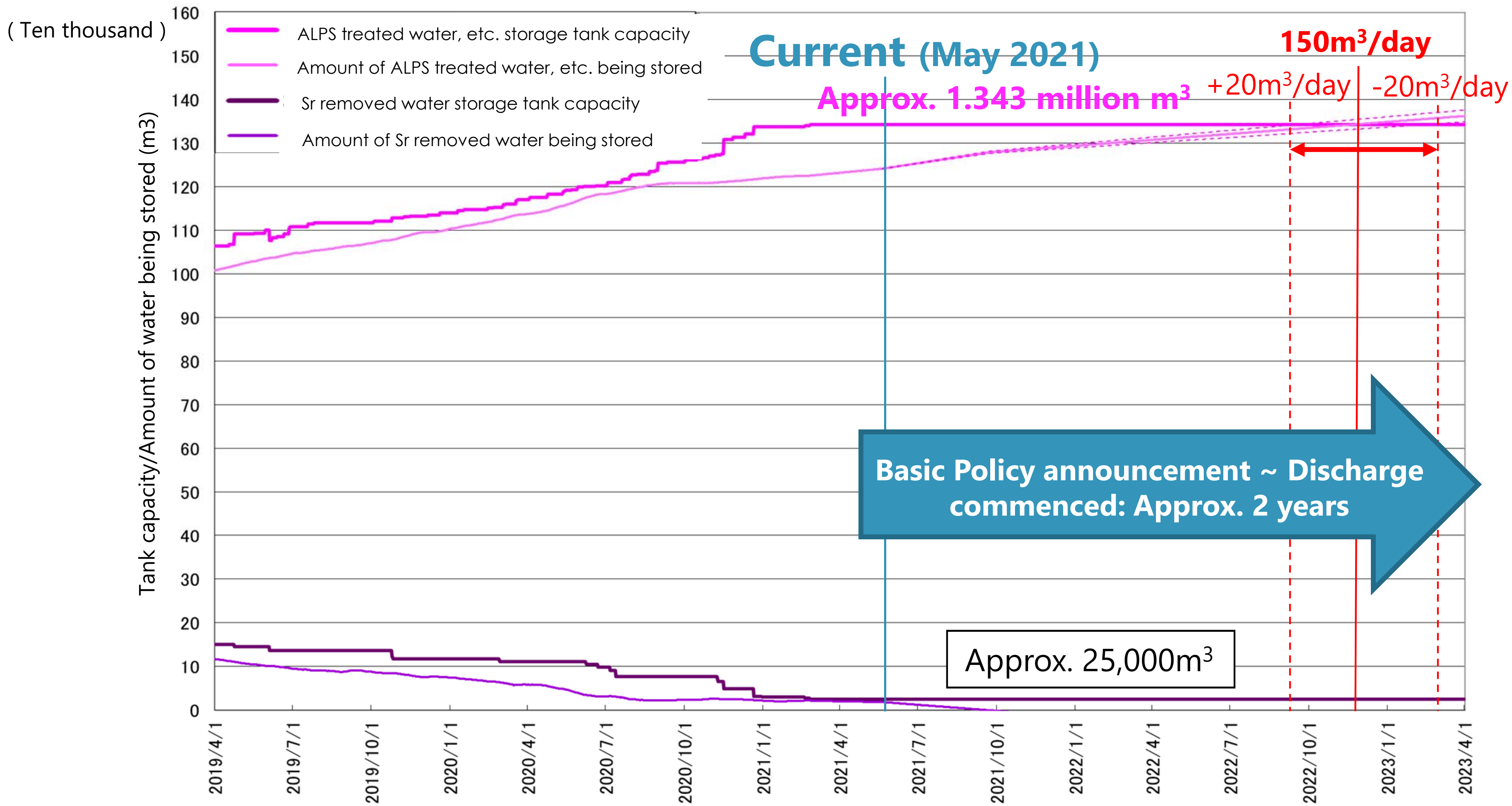
If 150m^3 of contaminated water is generated each day, the amount of ALPS treated water, etc. in storage **will reach approximately 1.34 million m^3 by around November 2022,** seeing that the volume of stored ALPS treated water, etc. and Sr removed water (before ALPS treatment) as of May 20, 2021 is approximately 1.26 million m^3.

By building substitute tanks to store water drained from K4 tanks and by putting them into use by November 2022, we can continue to store approximately 1.37 million m^3 of ALPS treated water, etc. as originally planned.

Repost of The commission on supervision and evaluation of the specified nuclear facilities (91st session)

Comparison of total tank capacity with the anticipated amount of water to be stored



[Reference] Relationship between storage tank and measurement/confirmation facilities (1/2)

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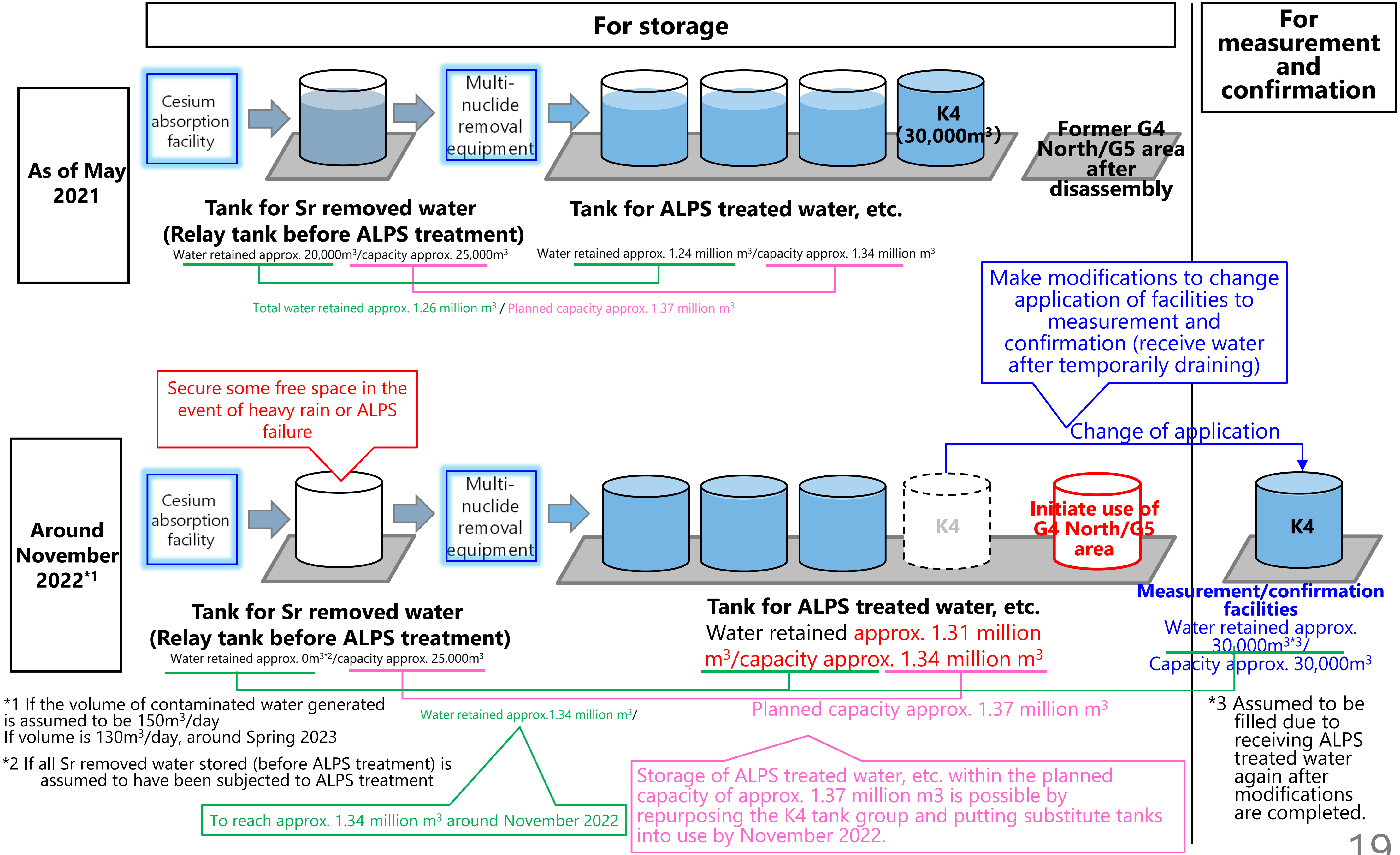
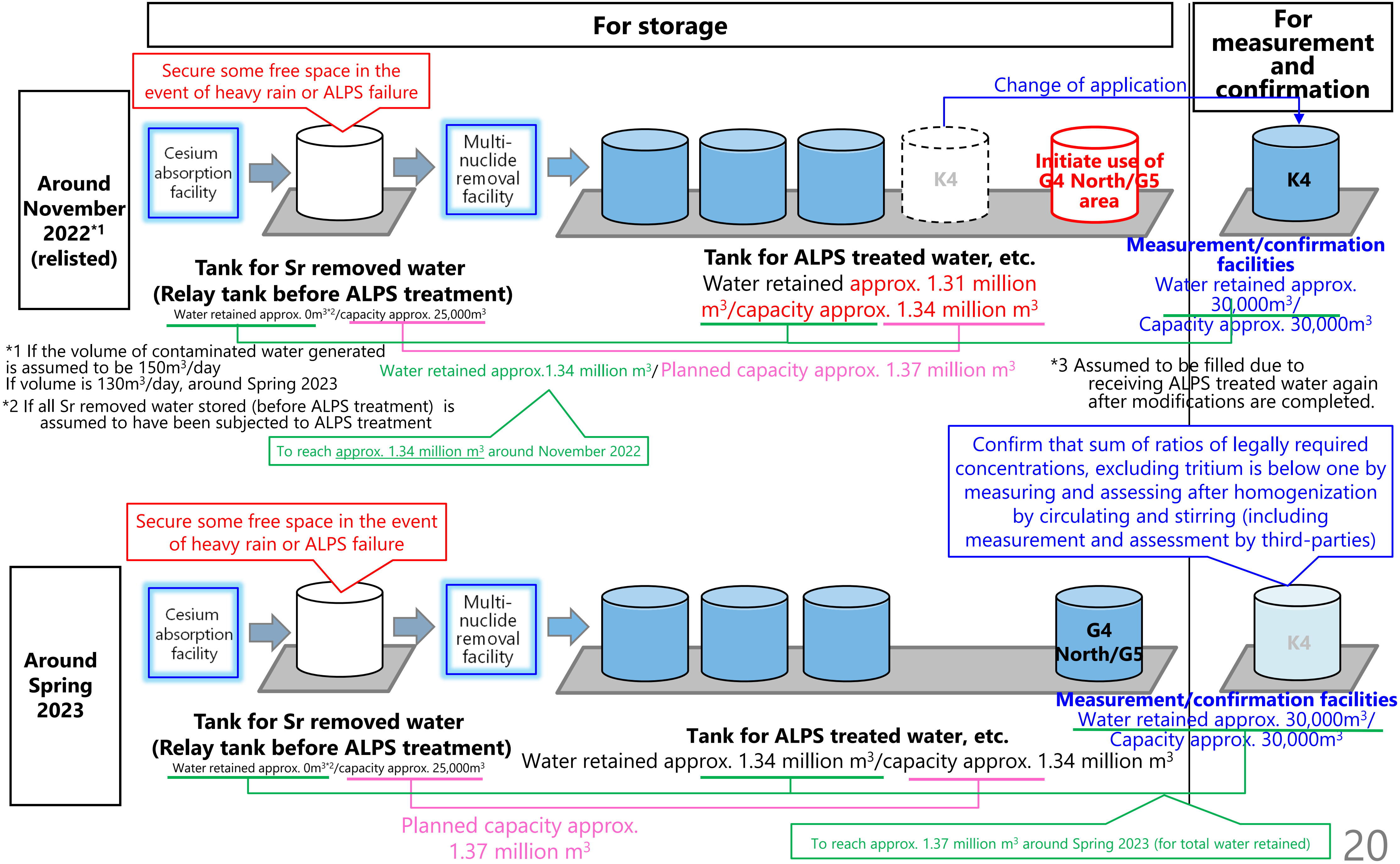


*1 If the volume of contaminated water generated is assumed to be 150m³/day
If volume is 130m³/day, around Spring 2023

*2 If all Sr removed water stored (before ALPS treatment) is assumed to have been subjected to ALPS treatment

*3 Assumed to be filled due to receiving ALPS treated water again after modifications are completed.

[Reference] Relationship between storage tank and measurement/confirmation facilities (2/2)



*1 If the volume of contaminated water generated is assumed to be 150m^3/day
If volume is 130m^3/day, around Spring 2023

*2 If all Sr removed water stored (before ALPS treatment) is assumed to have been subjected to ALPS treatment

*3 Assumed to be filled due to receiving ALPS treated water again after modifications are completed.

【Reference】G4 North, G5 area tank construction schedule

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The completion of tank construction in the G4 North and G5 area is planned for the end of October 2022 to ensure that ALPS treated water, etc. can be received in around November 2022

Schedule (tentative)

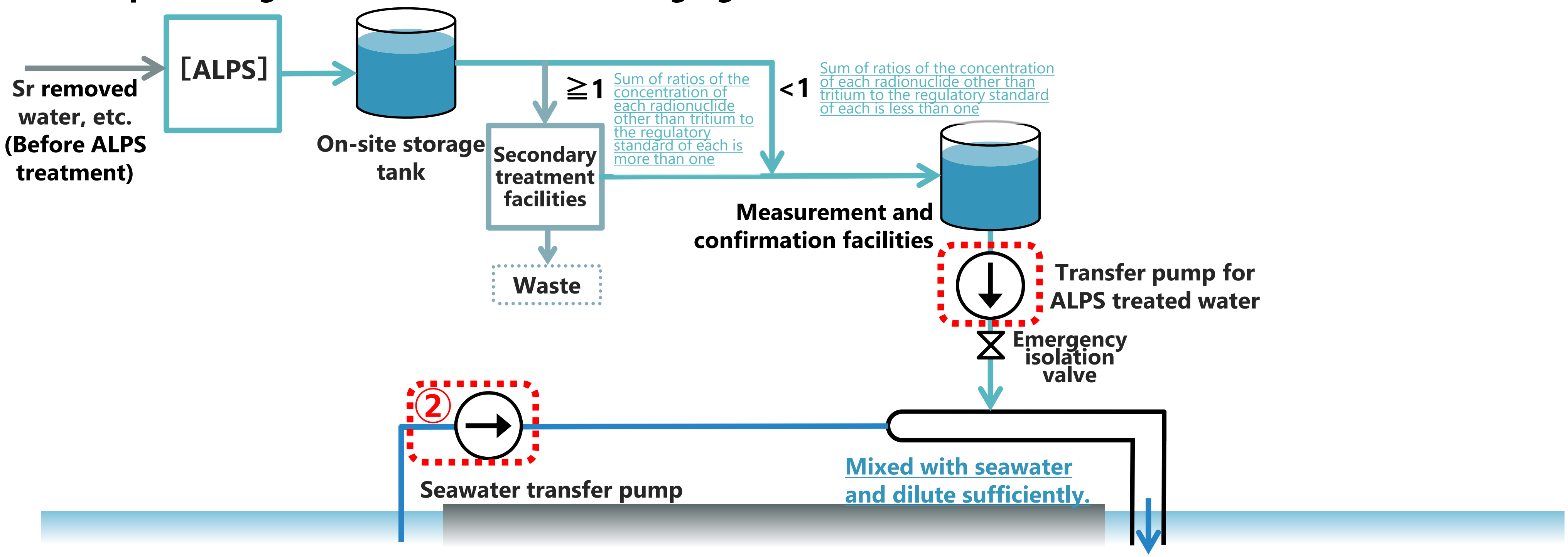
Repost of The commission on supervision and evaluation of the specified nuclear facilities (91st session)

Area name (Capacity)	FY2021												FY2022								
	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
G4 North (Approx. 8,000m^3)			Manufacturing at factory	Tank construction Water level gauge panel manufacturing/installation, etc. (methods for shortening schedule being examined)					Weir								Inspection	Authorization for usage		Put into use	
G5 (Approx. 23,000m^3)			Manufacturing at factory	Tank construction Water level gauge panel manufacturing/installation, etc. (methods for shortening schedule being examined)											Weir		Inspection	Authorization for usage		Put into use	

TOPIC ② Specification of dilution facility

- Specification of the seawater transfer pump used for dilution (capacity), and seawater flow rate measurement method

[Conceptual diagram of facilities for discharging ALPS treated water into the sea]



2-(2)-1 Design Principles of Transfer Pump for Transferring ALPS Treated Water

- **The tritium concentration of ALPS treated water, etc.** currently stored on the Fukushima Daiichi NPS site premises is **approx. 150,000-2,160,000 Becquerel/liter, with an average numbering at approx. 620,000 Becquerel/liter** (evaluated value on April 1, 2021)
- The amount of ALPS treated water transferred shall be set based on the standard for the amount of annual tritium discharged, and also considering the number of days discharged which accounts for facility maintenance and switching systems, and also the tritium concentration of ALPS treated water to be discharged.
- The flow rate of ALPS treated water is at its highest when its tritium concentration is at a low level of around 150,000 Becquerel/liter. The maximum flow rate would be **approx. 500m³/day**.

Tritium discharged annually
22 trillion Becquerel/year

Number of days discharged 292 days
(availability factor 80%)

⇒

Amount of tritium discharged per day
75.3 billion Becquerel/day

⇓

Tritium concentration in ALPS treated water, etc.
Approx. 150,000-approx. 2,160,000 Becquerel/liter

⇒

75.3 billion Becquerel/day
÷ 150,000 Becquerel/liter
= approx. $500m^3$/day

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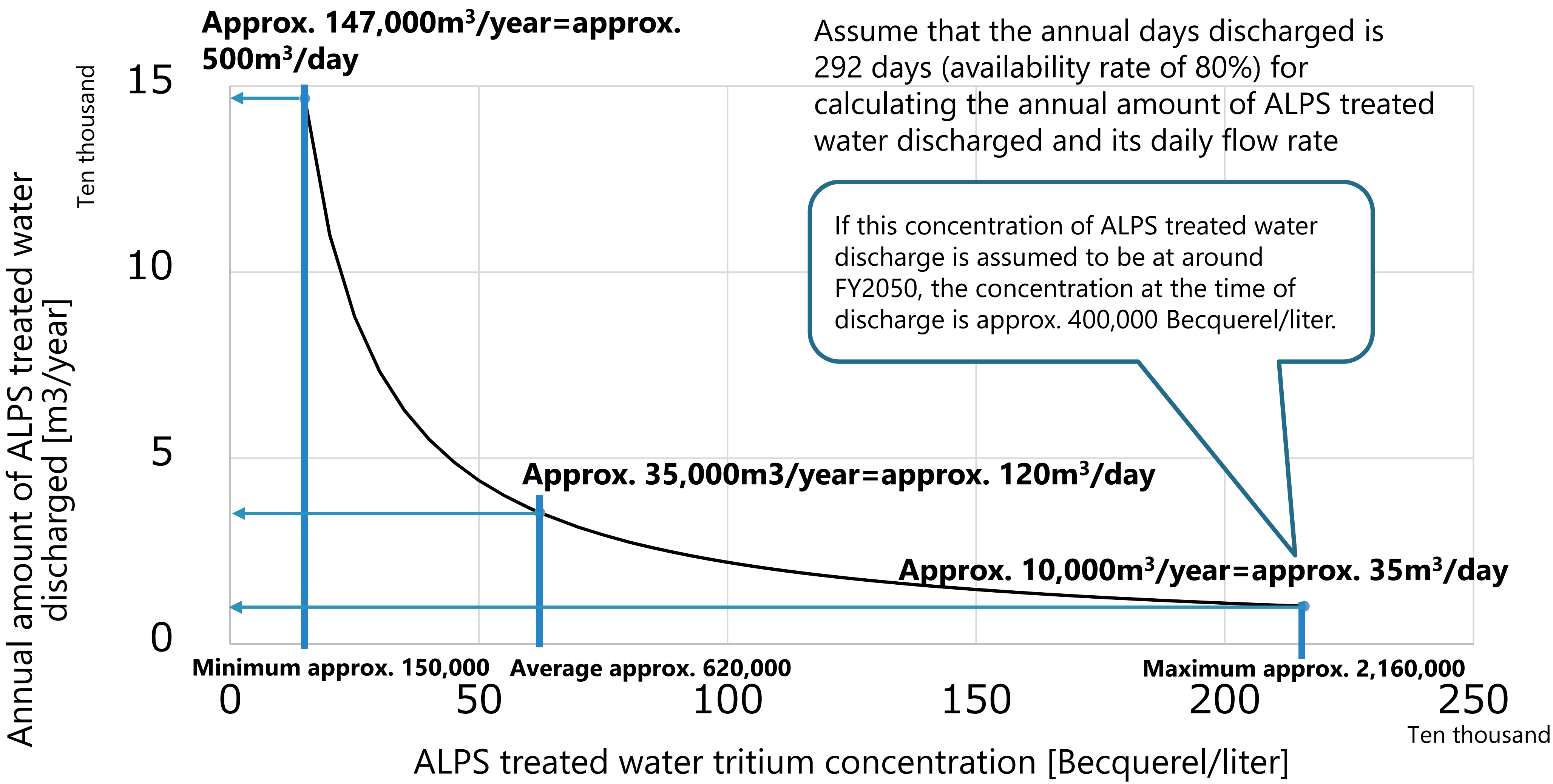
【Reference】Relationship Between Anual Amount of Tritium Discharged and Amount of Water Discharged of ALPS Treated Water

- If the standard for annual discharge of tritium is set below 22 trillion Becquerel, the amount of water that can be discharged fluctuates in accordance with the tritium concentration in the ALPS treated water (less concentration equates to more discharge being possible)



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2-(2)-2 Design Principles Regarding the Sea Water Transfer Pump (1/4)

- Consider the points below to secure the flexibility in pump management while keeping the tritium concentration after seawater dilution to less than 1,500 Becquerel/liter and keeping the annual tritium discharged to below 22 trillion Becquerel.

① Discharge of ALPS treated water can be responded to various tritium concentration ranging from approx. 150,000-2,160,000 Becquerel/liter in a flexible manner.

② The maximum amount of ALPS treated water that can be discharged shall be set up to approx. 500m^3/day, and action can be taken in a flexible manner to respond to the increase of treated water caused by heavy rain, and fluctuating work speed to disassemble tanks for the construction of facilities required for the decommissioning project.

③ A wide range of action is available in implementing the seawater transfer pump and conducting its maintenance and inspection.

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2-(2)-2 Design Principles Regarding the Sea Water Transfer Pump (2/4)

- From the perspectives of ① and ②:
  - **Risk case (Part 1: Discharge of ALPS treated water with high concentration)**
    Assume a situation where ALPS treated water with approx. 2,160,000 Becquerel/liter needs to be temporarily discharged with contaminated water of 150m^3/day being generated (to prevent the total amount stored from increasing).

    The seawater flow rate necessary to bring the tritium concentration to less than 1,500 Becquerel/liter after seawater dilution is:
    2,160,000 Becquerel/liter ÷ 1,500 Becquerel/liter ×150m^3/day=approx. 220,000m^3/day

  - **Risk case (Part 2: Discharge of a large amount of ALPS treated water)**
    As approx. 400m^3/day of contaminated water is generated when there is heavy precipitation (maximum rainfall recorded in 2020), assume a situation where approx. 400m^3/day of ALPS treated water with an average of approx. 620,000 Becquerel/liter needs to be discharged.

    The seawater flow rate necessary to bring the tritium concentration to less than 1,500 Becquerel/liter after seawater dilution is:
    620,000 Becquerel/liter ÷1,500 Becquerel/liter ×400m^3/day=approx. 170,000m^3/day

2-(2)-2 Design Principles Regarding the Sea Water Transfer Pump (3/4)

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- From the perspectives of ① and ②:
  - **Risk case (Part 3：Drop in the availability factor)**
    Assume a situation where long-term maintenance of facilities decrease the availability factor, and ALPS treated water with 22 trillion Becquerel (220billion Becquerel/day) with the annual days discharged being at 100 days.

    The seawater flow rate necessary to bring the tritium concentration to less than 1,500 Becquerel/liter after seawater dilution when discharging at 220billion Becquerel/day is:
    220billion Becquerel/day ÷ 1,500 Becquerel/liter ＝approx. 150,000m^3/day
  - Due to the points described, a minimum seawater flow rate of 220,000m^3/day is necessary when considering various risk cases. Further design margin of 50% margin shall be accounted for, **and a capacity for approx. 330,000m^3/day of seawater flow rate shall be prepared.**

TEPCO

2-(2)-2 Design Principles Regarding the Sea Water Transfer Pump (4/4)

- From the perspective of ③
  - Prepare three pumps to allow response when one pump fails and also considering maintenance and inspection. Reliable discharge can be achieved with two units operating and one unit on standby.
  - In other words, **reliable discharge can be achieved by securing three seawater transfer pumps.**

- To secure the necessary flow rate based on the information above, **Select a pump with the capacity of approx. 170,000m³/day** based on approx. 330,000m³/day ÷2 units
  - In the previously mentioned risk cases (2 and 3), the value of less than 1,500 Becquerel/liter can be secured with only one pump unit.
  - To verify that ALPS treated water has been diluted to less than 1,500 Becquerel/liter by seawater, it is important to precisely measure the ALPS treated water tritium concentration before dilution, ALPS treated water flow rate and the seawater flow rate. It has been confirmed that a pump with capacity of 170,000m³/day for each unit is equipped with a flow meter (orifice type) which can measure the required values.
  - The design review assumes a two-unit operation to be normal, but three units can also be operated depending on the circumstances.

- Tritium concentration after seawater dilution is assumed to be approx. 440 Becquerel/liter and is well below 1,500 Becquerel/liter even if the annual operation rate is 80%, annual tritium discharge volume is 22 trillion Becquerel and one pump being online. (See slide 31)

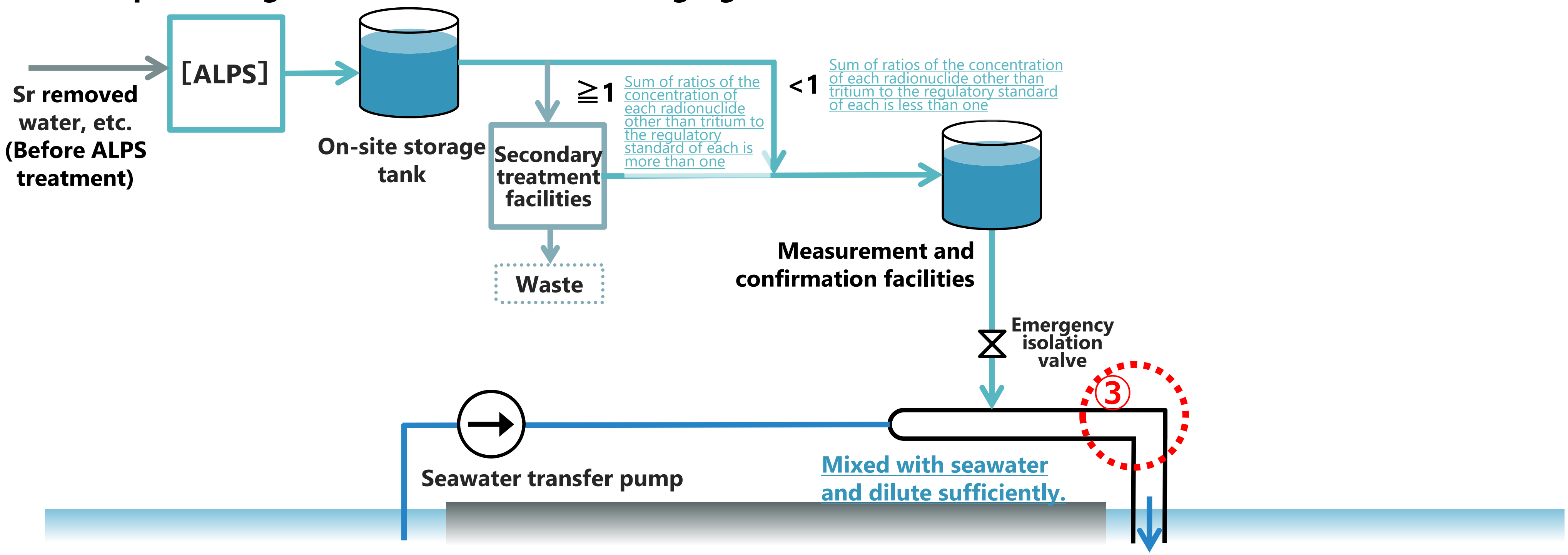
2-(3)

TEPCO

TOPIC ③ Method for assessing dilution

- Feasibility of assessing tritium concentration of discharged water using measurement of tritium concentration prior to discharge and water for dilution

[Conceptual diagram of facilities for discharging ALPS treated water into the sea]



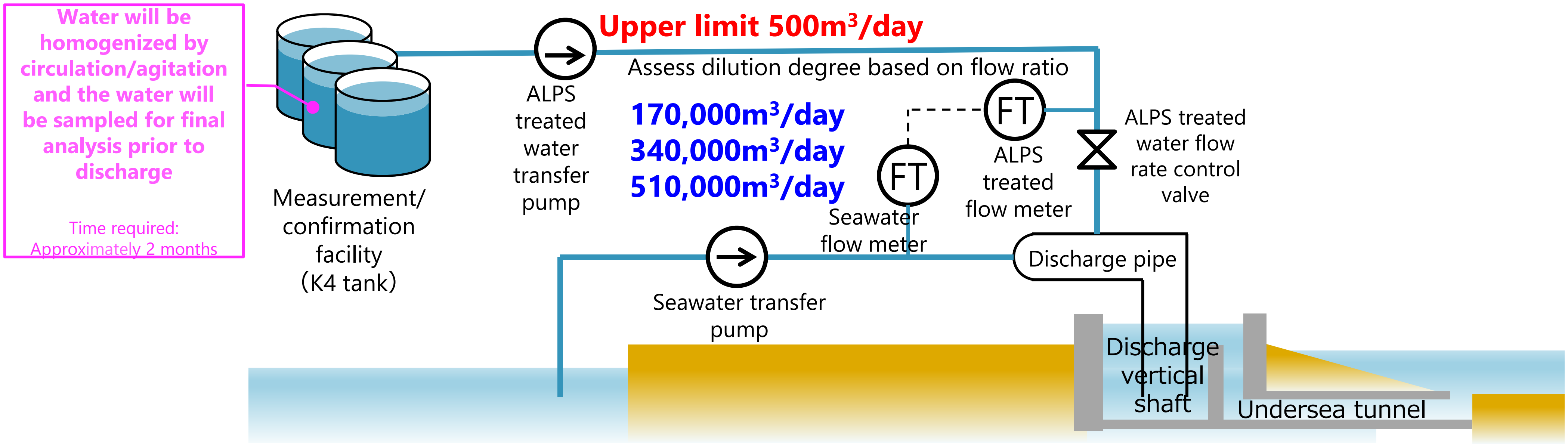
2-(3)-1 Tritium Concentration After Dilution with Seawater

TEPCO

- In general nuclear power stations, tritium concentration is measured prior to dilution, but due to the vast amount of seawater used for dilution, the amount of seawater is not constantly measured to assess tritium concentration.
- Due to ALPS treated water being designed to be discharged with an upper limit of 500m^3/day, and the seawater flow rate per day being either 170,000m^3, 340,000m^3 or 510,000m^3, **the design shall be to dilute at approx. 340 times or more, approx. 680 times or more, approx. 1020 times or more respectively**. Also, **analysis has confirmed that seawater and ALPS treated water are** mixed in the discharge pipe.

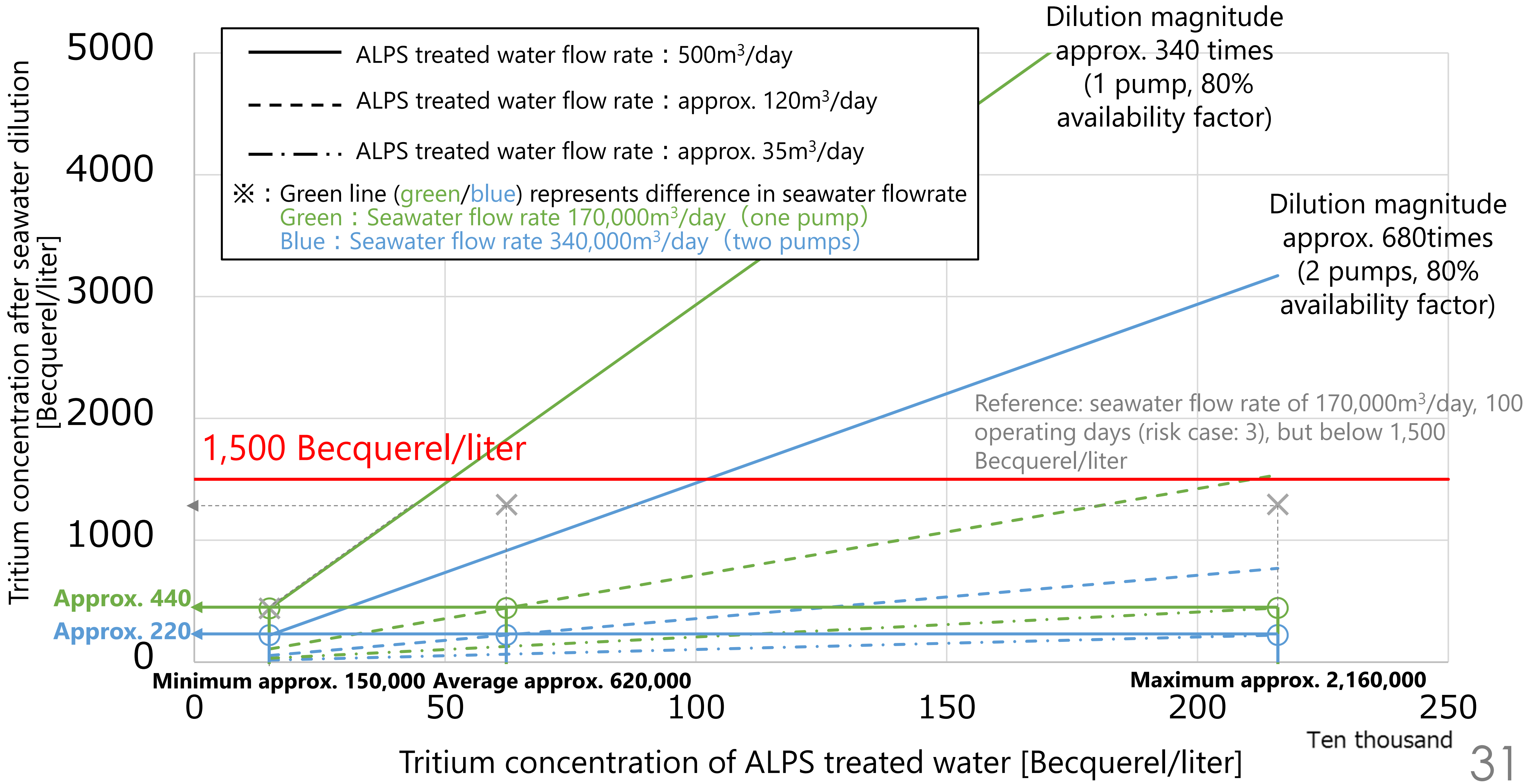
$$\text{Tritium concentration after seawater dilution} = \frac{\text{ALPS treated water tritium concentration} \times \text{ALPS treated water flow rate (controlled using flow rate control valve)}}{\text{ALPS treated water flow rate (controlled using flow rate control valve)} + \text{sea water flow rate}}$$

- During normal operation, it shall be assured that the tritium concentration after seawater dilution be kept below 1,500 Becquerel/liter after seawater dilution based on the tritium concentration derived from analysis results of measurement and confirmation facilities and ALPS treated water and seawater flow ratio. Specific details on the implementation of pumps shall be reviewed based on the information above.
- Details on the method for confirming at the discharge end that water has been mixed, diluted as designed, and the tritium concentration being below 1,500 Becquerel/liter, shall be reviewed by the following two methods:
  - ① **ALPS treated water after seawater dilution shall be sampled every day during discharge, and its tritium concentration to be confirmed well below 1,500 Becquerel/liter, and the information will be made public promptly.**
  - ② **For the time being, the status of mixture and dilution prior to discharge into the sea shall be directly confirmed utilizing the discharge vertical shaft. (See slide 54)**

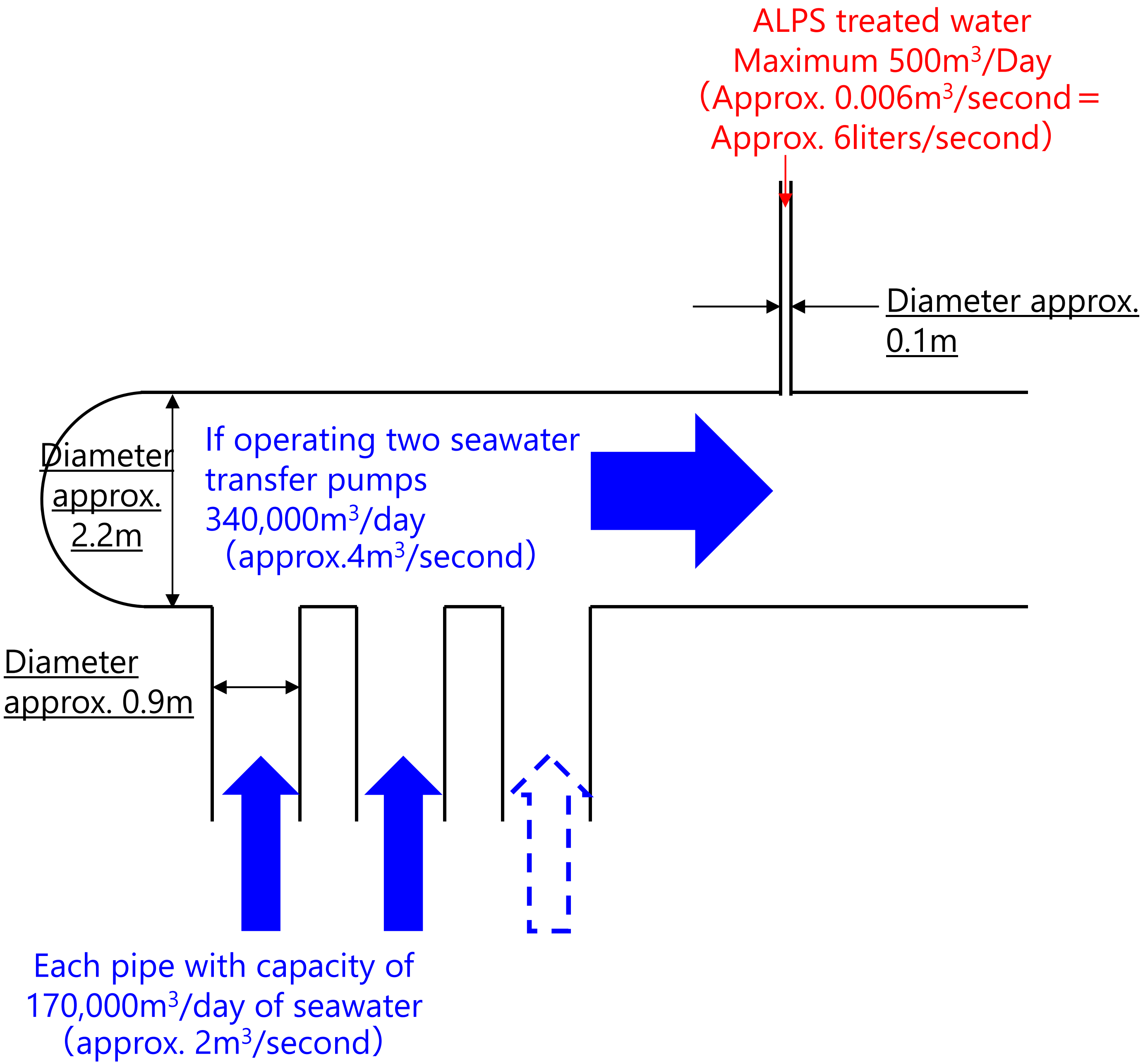


【Reference】Relationship Between Tritium Concentration and Flow Rate of ALPS Treated Water

- By combining ALPS treated water tritium concentration, ALPS treated water flow rate and seawater flow rate, keep tritium concentration after seawater dilution below 1,500 Becquerel/ liter, and realize a facility that can reliably continue discharge of ALPS treated water.



【Reference】Image of ALPS Treated Water and Seawater Joining



【Reference】 Result of Analyzing Diffusive Mixing Within Discharge Pipe Interior （1/2）

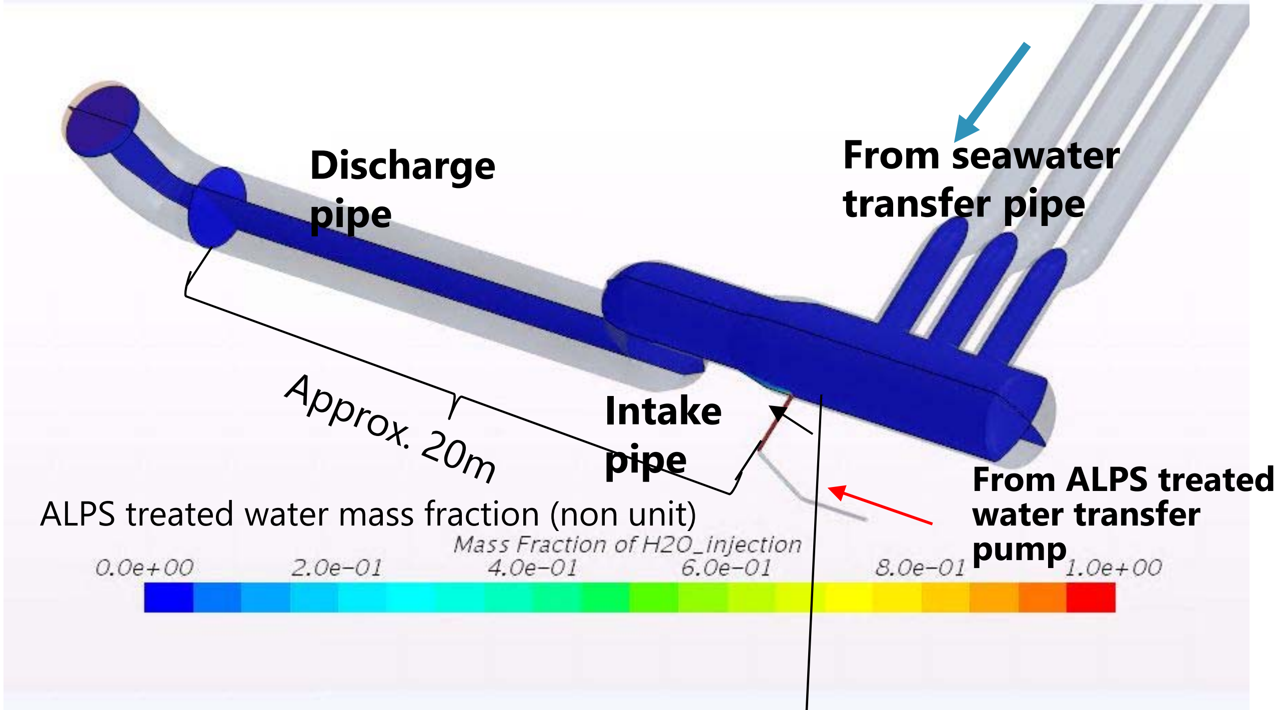
Result of analyzing diffusive mixing within discharge pipe if diluted at ALPS treated water flow rate 500m³/day and seawater flow rate 340,000m³/day

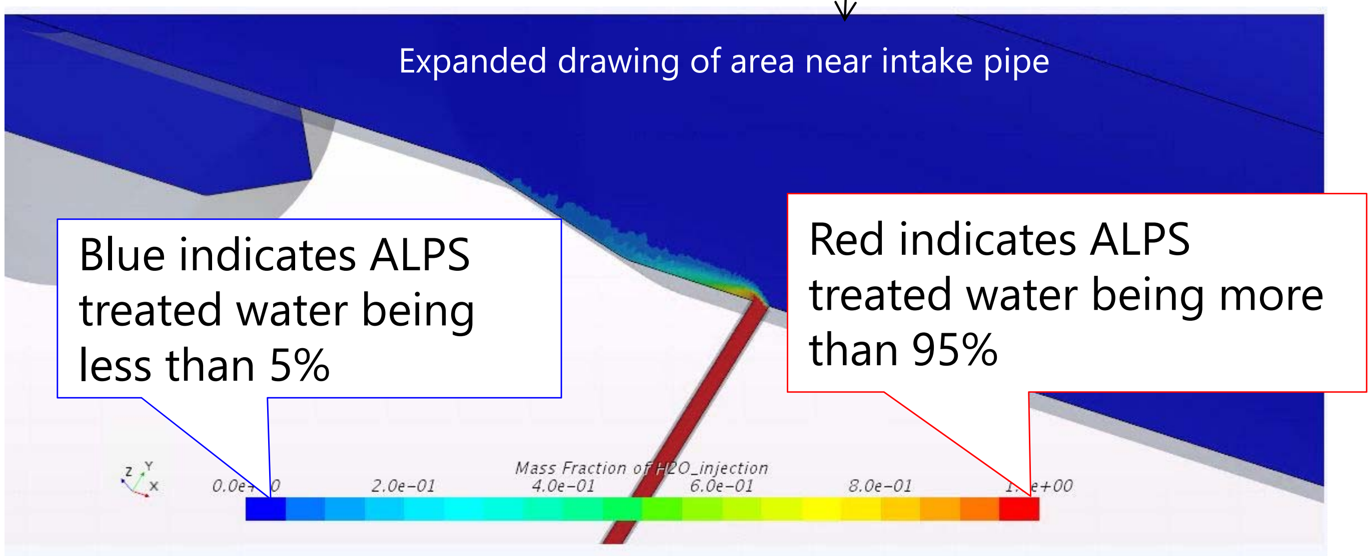
⇩

Confirmed that dilution is below 5% near the intake pipe (below 1/20)

⇩

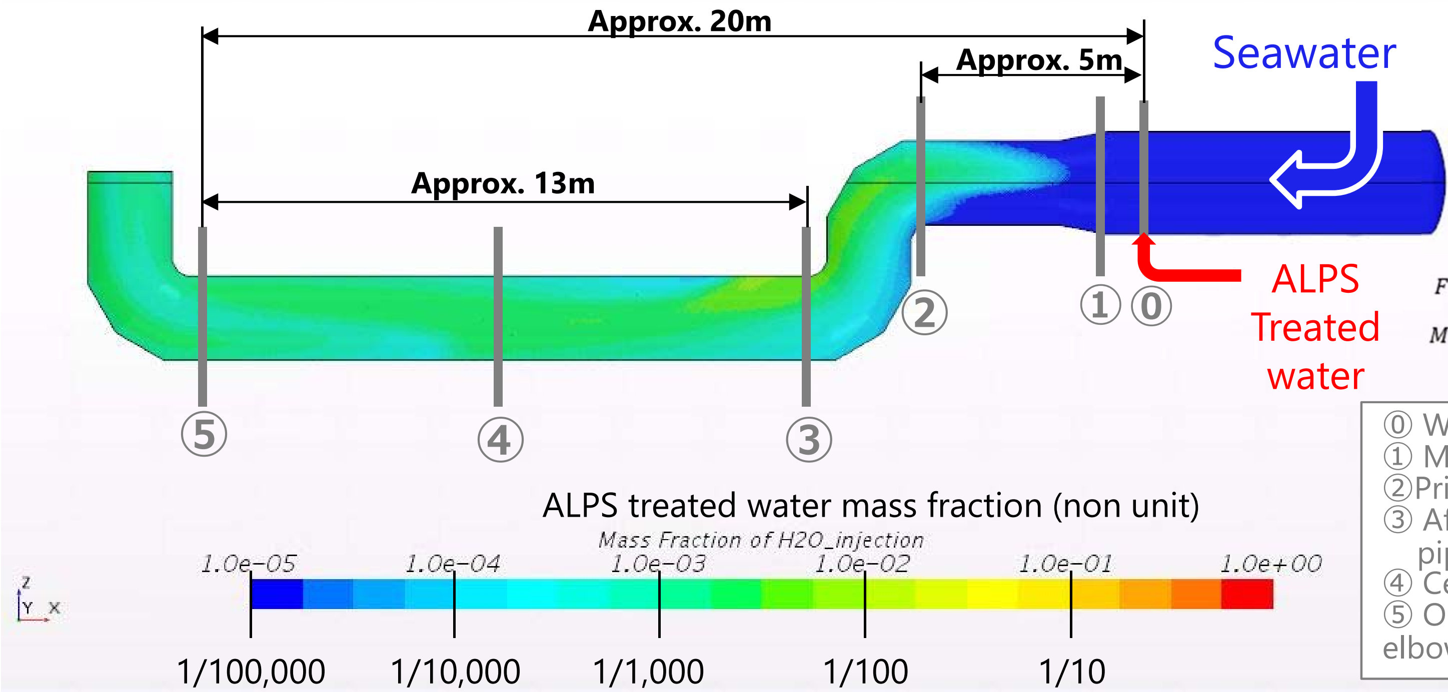
The drawing to the right does not indicate a dilution of below 5%, so a logarithmic representation shall be presented in the next slide





【Reference】Result of Analyzing Diffusive Mixing Within Discharge Pipe Interior（2/2）

TEPCO



Reference：
Convert from mass fraction to volume fraction

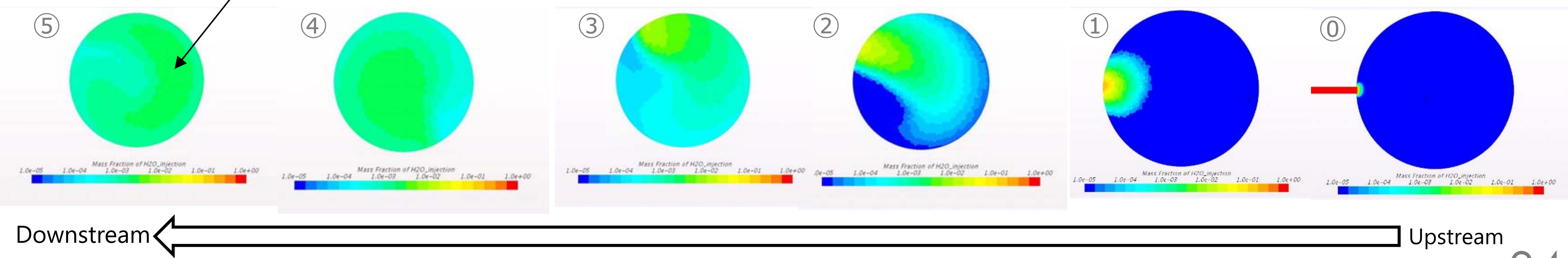
$$F = \frac{M}{(1-M)\frac{\rho_i}{\rho_R} + M}$$

F: Volume fraction(−) ρ_i: ALPS treated water density(998.3 kg/m^3)

M: Mass fraction(−) ρ_R: seawater density(1025 kg/m^3)

⓪ Water injection position
① Mix header outlet
②Prior to dropping elbow joint
③ After dropping elbow joint (entrance to straight pipe)
④ Center of straight pipe
⑤ Outlet of straight pipe (entrance to ascending elbow joint)

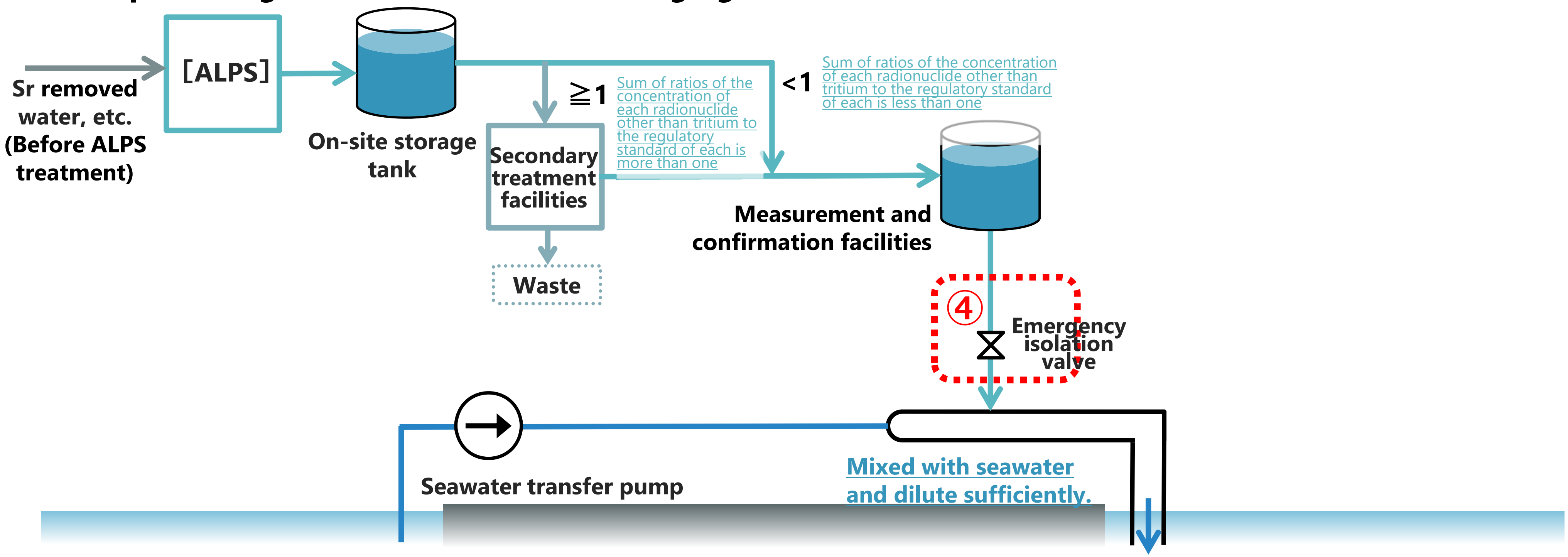
- The mass fraction of the ALPS treated water is 0.23% at maximum (approx. 1/430), and diluted to 0.14% on average (approx. 1/710)
- If ALPS treated water of 150,000 Becquerel/liter is discharged, the maximum is approx. 350 Becquerel/liter and the average is approx. 220 Becquerel/liter. (Average concentration is equivalent to tritium concentration after seawater dilution calculated (see slide 31))



TOPIC ④ Measures in the event of abnormality

- Interlock for emergency shutdown of discharge
  (Abnormal concentration of discharge water, detection of gamma ray)
- Redundancy of emergency shut-off valve, installation location

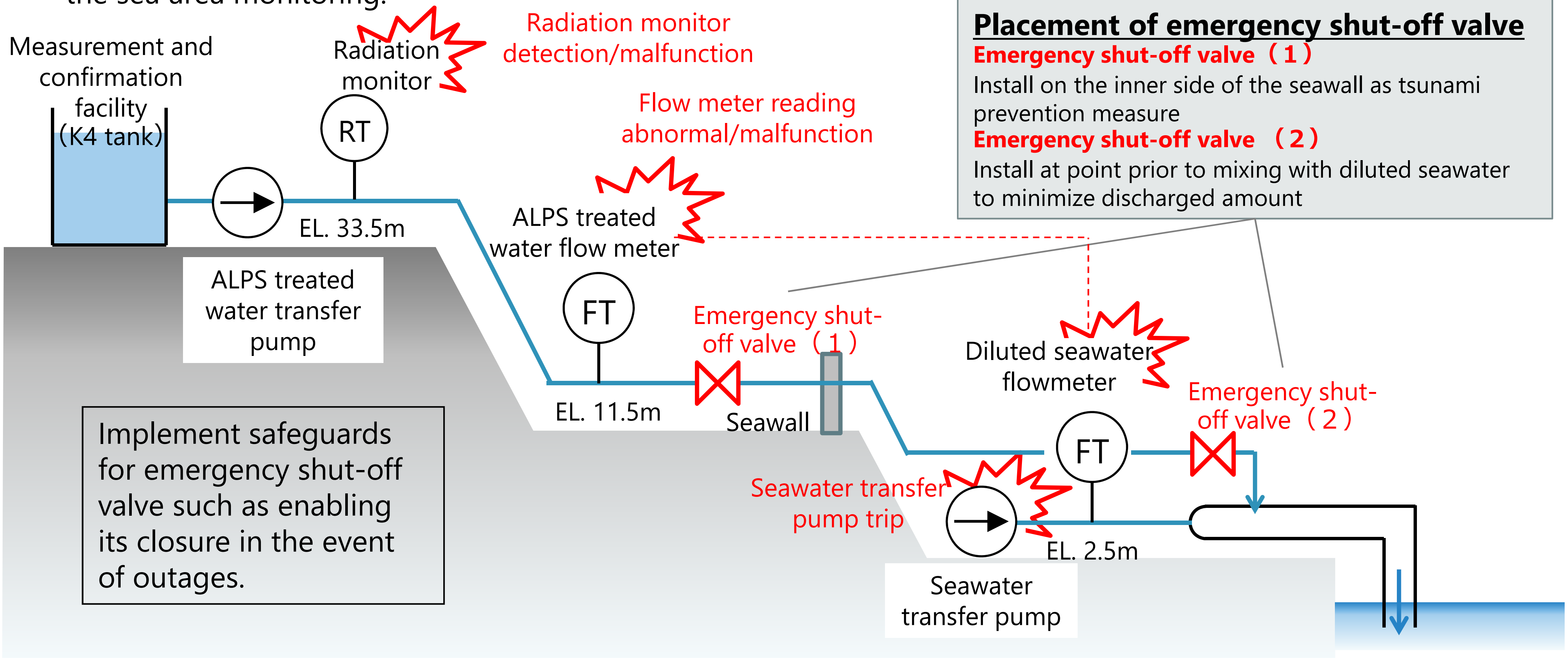
[Conceptual diagram of facilities for discharging ALPS treated water into the sea]



2-(4)-1 Response to Abnormality

TEPCO

- In the event of an abnormality in the dilution rate of ALPS treated water (shutdown of seawater pump, decrease in seawater flow rate, increase in ALPS treated water flow rate, malfunction of flowmeter) or when the properties of the ALPS treated water is abnormal (actuation/malfunction of radiation monitor), close the two emergency shut-off valves promptly, and shutdown the ALPS treated water transfer pump.
- One of the emergency shut-off valves shall be installed near the seawater transfer pipe to minimize the discharge of ALPS treated water in an abnormal event, and the other valve shall be installed on the inner side of the seawall to protect against flooding caused by tsunami.
- Although not an abnormality in facilities, discharge shall also be stopped if abnormal values are confirmed in the sea area monitoring.



2-(4)-2 Interlock

TEPCO

<Detected signal>

If ALPS treated water dilution rate is abnormal or cannot be confirmed.

Seawater transfer system
- Pump failure
- Flow meter failure
- Flow rate low

ALPS treated water transfer system
- Pump failure
- Flow meter failure
- Flow meter high

If ALPS treated water radiation is abnormal or cannot be confirmed.

Radiation monitor
- malfunction
- Level high

Other facility abnormality and voluntary emergency shutdown

Other
- Emergency shutdown
- Communication abnormal

Manual shutdown if sea area monitoring shows abnormal value

↓

Emergency shutdown valve Close※1

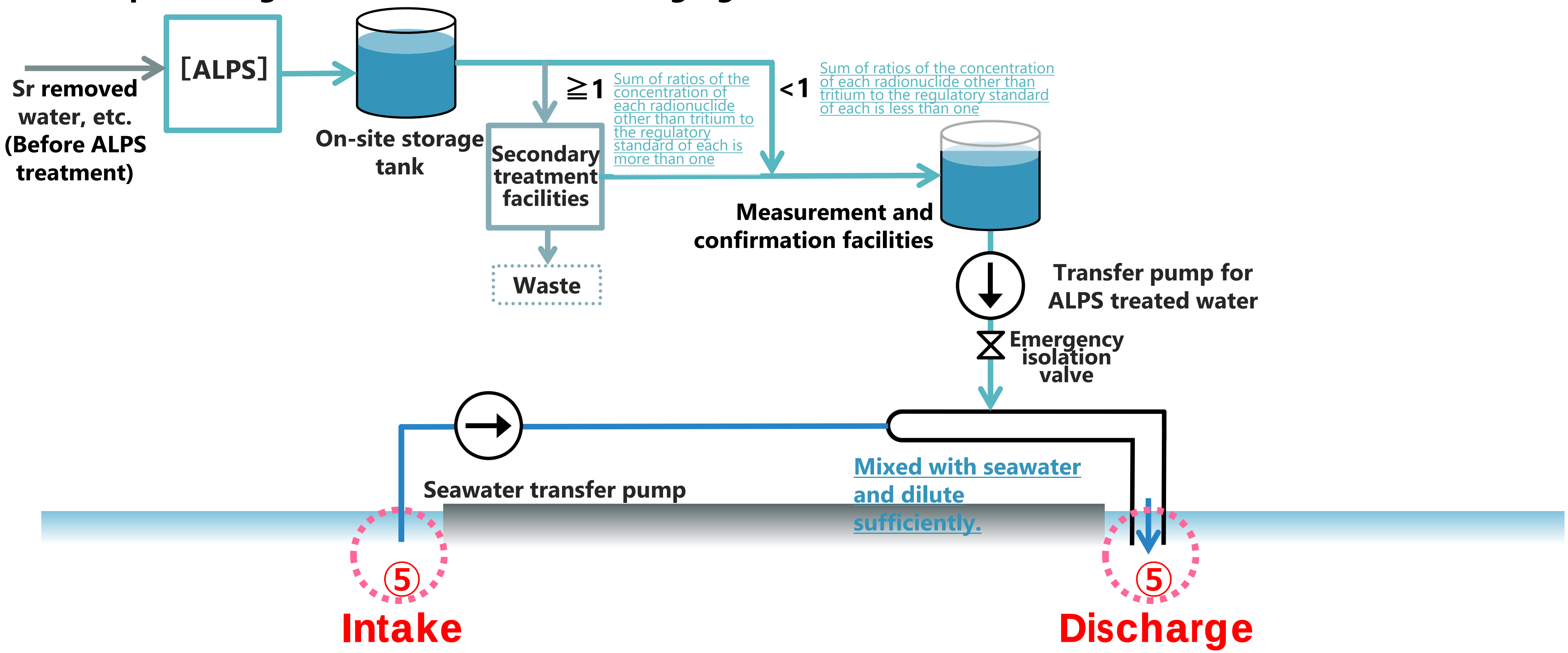
ALPS treated water transfer pump shutdown※2

※1：Design shall allow ALPS treated water to shutoff discharge if abnormality such as outages occurs
※2：Continue operation of normal seawater transfer pump so that ALSP treated water can be diluted

TOPIC ⑤ Intake and discharge

- Intake and discharge method (Preventing radioactive material near the sea floor of the harbor being blown upwards during intake and discharge, and preventing recirculation during discharge)

[Conceptual diagram of facilities for discharging ALPS treated water into the sea]



2-(5)-1 Proceeding with the design of intake and discharge facilities

TEPCO

1. Ways to implement the discharge channel of Units 5 and 6 were reviewed based on the discharge method used prior to the accident **(Proposal A: slide 40)**

2. Proposal A poses issues such as seawater in the harbor to be used for dilution, etc., and the installation of sheet piles and modification of seawall were reviewed as solutions **(Proposal B: slide 41)**.

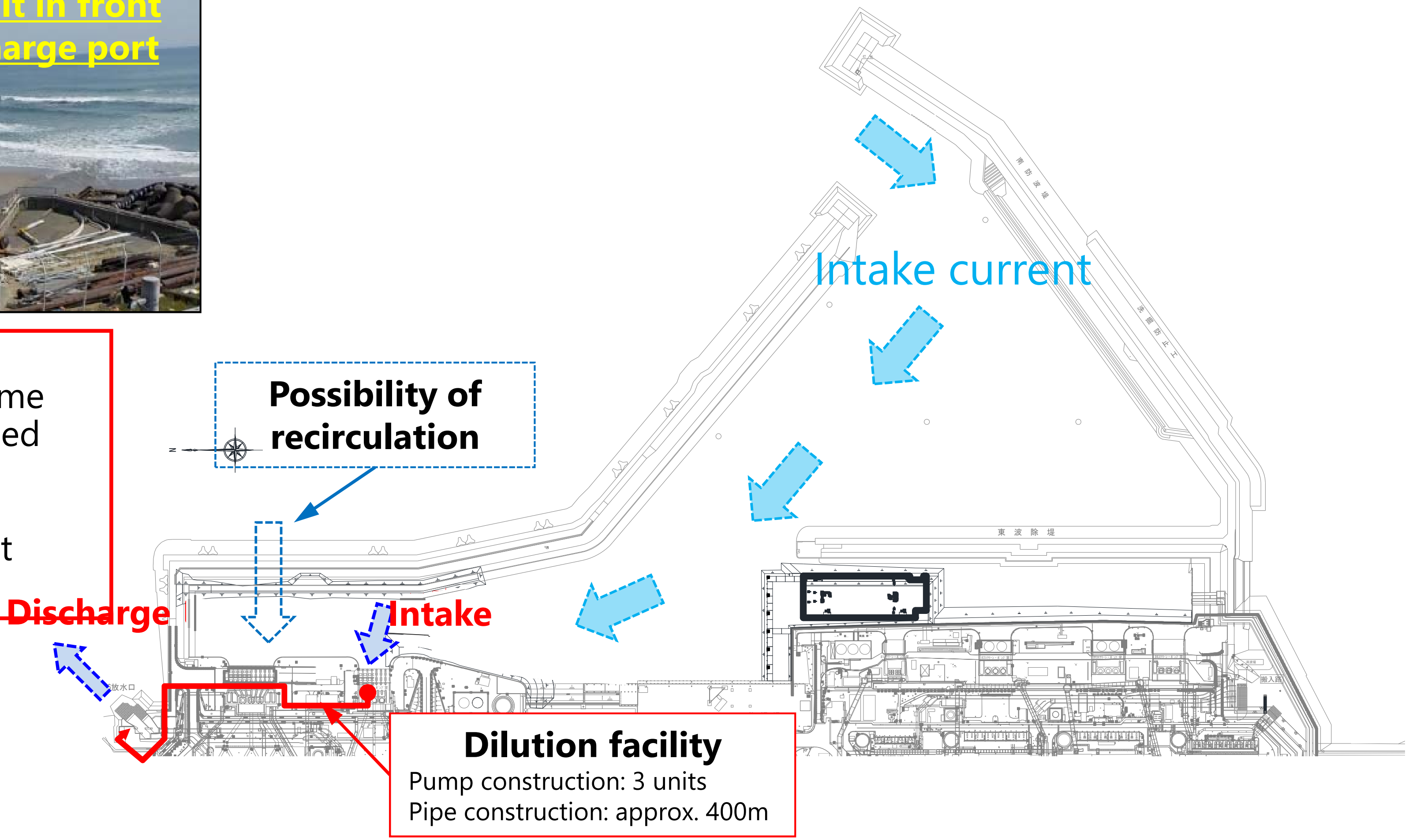
3. Methods for discharge were reviewed referring to case studies from other power stations both domestic and abroad **(Proposal C: slide 42).**

2-(5)-2 Proposal A: Intake and discharge facilities (Intake inside the harbor – discharge outside the harbor)

TEPCO

Regarding the intake and discharge points for dilution facilities, a proposal was reviewed which takes in seawater in the harbor from the Unit 5 intake and discharges from the Units 5 and 6 discharge ports in a similar fashion to when Units 5 and 6 are under normal operation. This proposal **minimizes the risk of the installation period becoming long term**.
However, the **intake current could cause the radioactive material in the harbor to swirl up**. Also, the seawall on the Units 5 and 6 side has no permeation prevention features, so **the water could recirculate**.

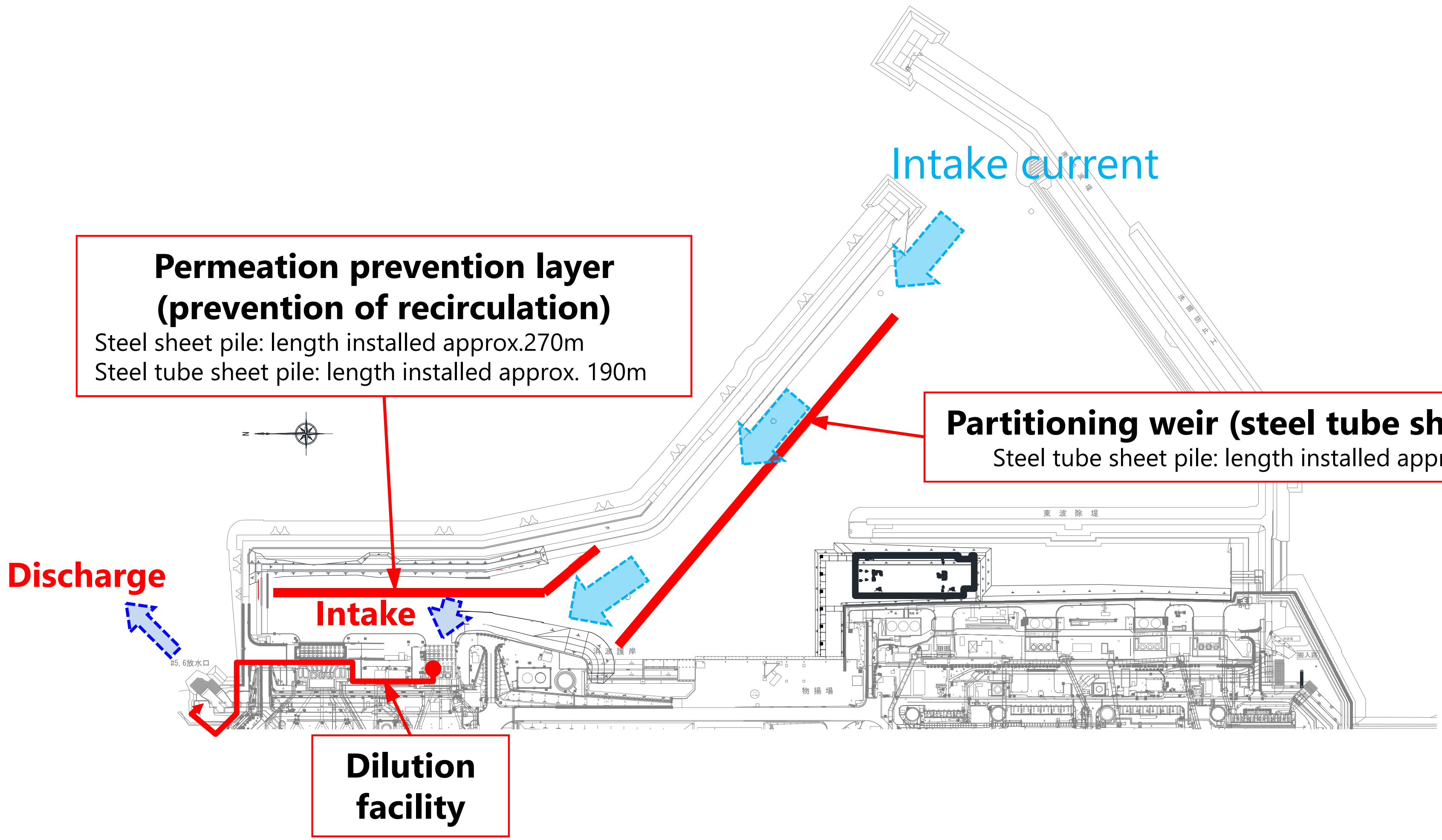
The front of the Units 5/6 discharge ports have become shallow with ground exposed due to silt deposits.
⇒ Difficult as water is discharged to inside the silt deposits.



2-(5)-3 Proposal B: Intake and discharge facilities (Intake at the mouth of the harbor – discharge outside the harbor)

TEPCO

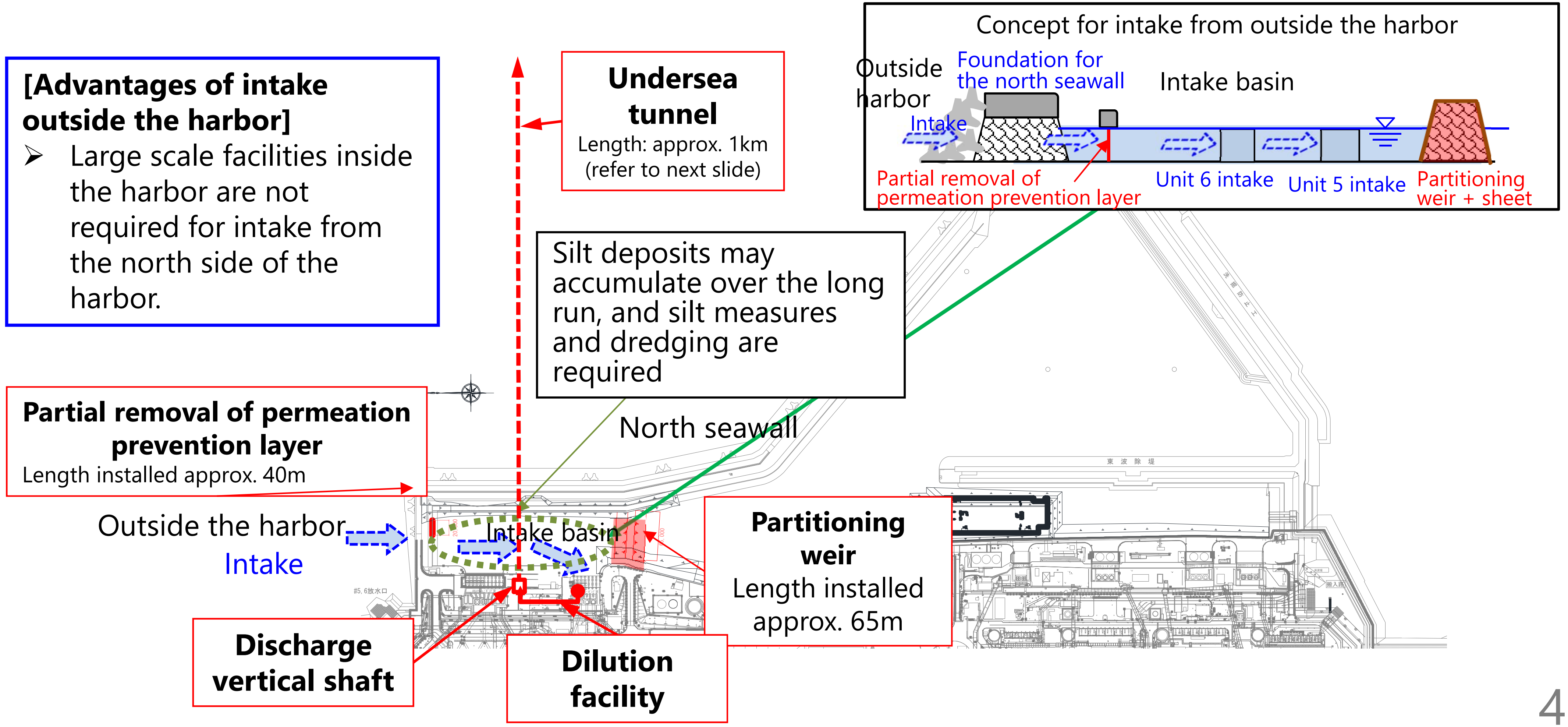
To resolve the issues in proposal A, an improved plan was reviewed where the mouth of the harbor was set as the intake point, and a permeation prevention layer was installed on the seawall of the Units 5/6 side.
However, work to install sheet piles in the harbor pose risks such as **marine sediment being stirred up, and installation requiring a long duration due to the large-scale work involved on the sea**.
Also, **seawater from inside the harbor will partially be taken in** for securing a sailing route.



2-(5)-4 Proposal C: Intake and discharge facilities (Intake outside the harbor - discharge from undersea tunnel)

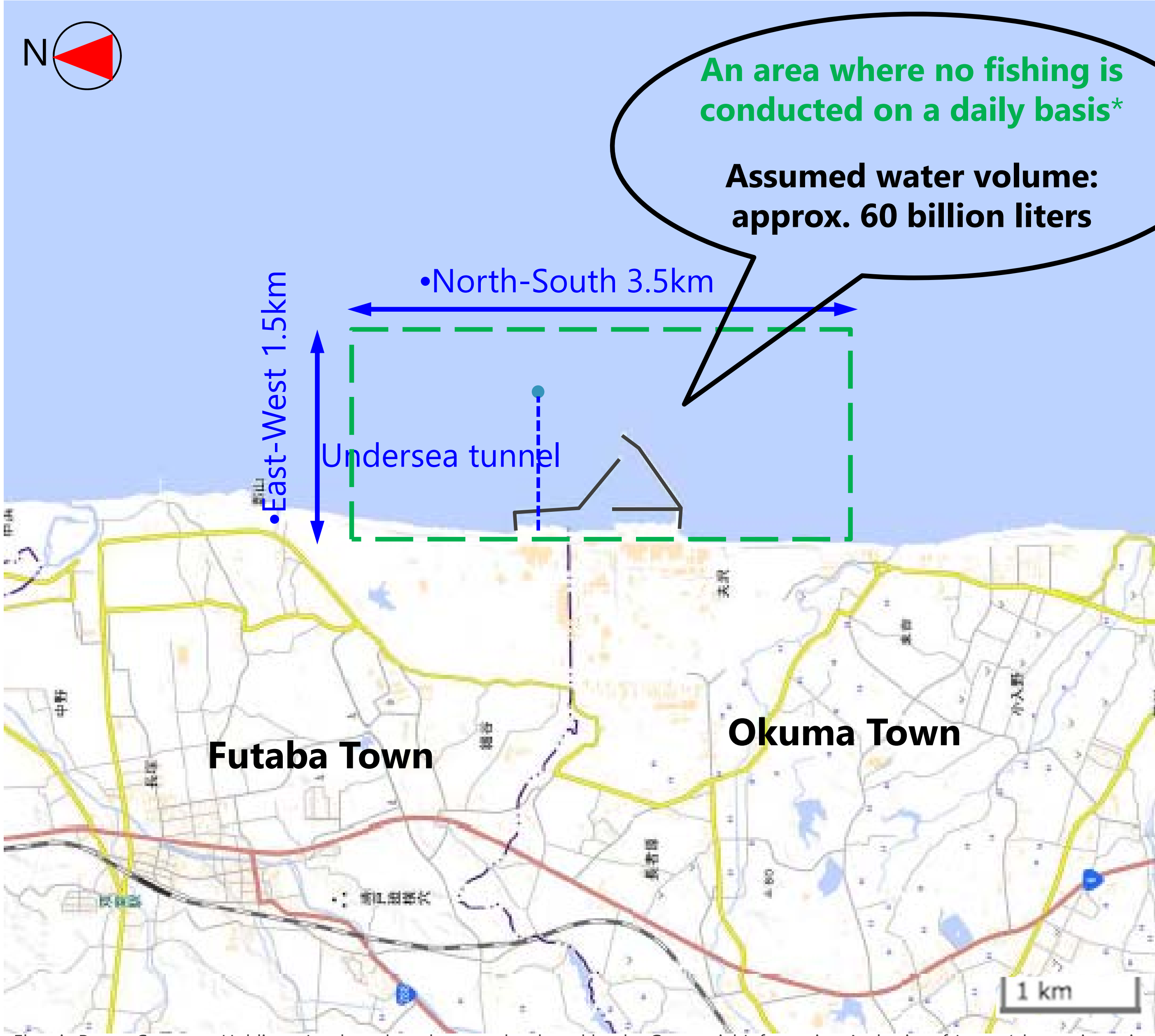
TEPCO

A plan to **discharge from an undersea tunnel dug in stable bedrock was reviewed** while referring to actual applications in power station both domestic and abroad.
The plan also involves taking in seawater from outside the harbor through separation with the inner harbor using a partitioning weir. This **prevents seawater inside the harbor from mixing directly with the seawater used for dilution**. Also, discharging away from the coast makes it **difficult for seawater to recirculate** (taken in again as dilution seawater).



[Reference] Layout of sea area

TEPCO



* area where common fishery rights are not set

Source: Developed by Tokyo Electric Power Company Holdings, Inc. based on the map developed by the Geospatial Information Authority of Japan (electronic territory web)
https://maps.gsi.go.jp/#13/37.422730/141.044970/&base=std&ls=std&disp=1&vs=c1j0h0k0l0u0t0z0r0s0m0f1

2-(5)-5 Assessment of intake and discharge facilities

TEPCO

1. While proposal A only requires a short duration for installation, there are issues such as seawater in the harbor area having to be used as dilution water.

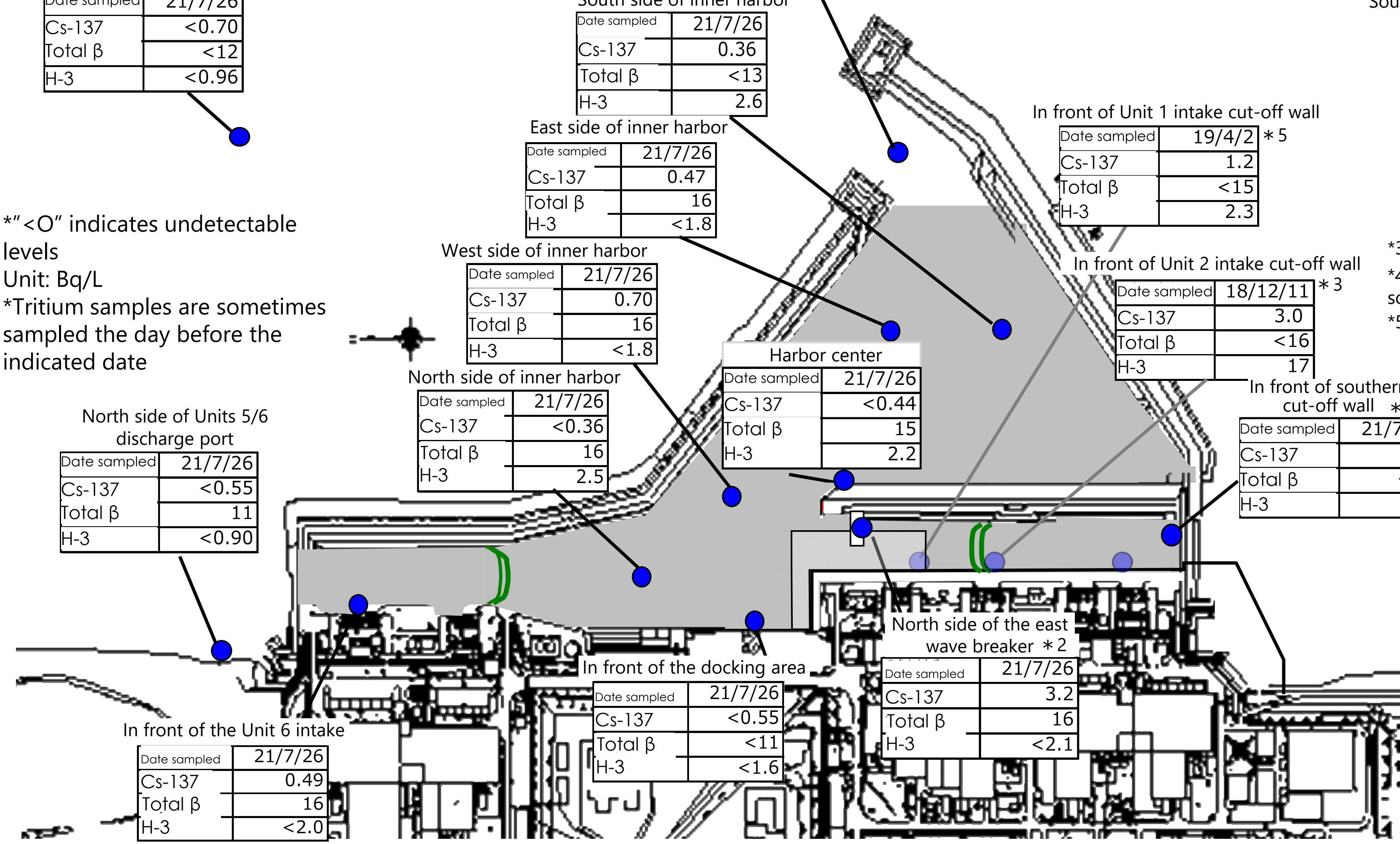
2. Proposal B solves the issues in proposal A, but there are risks such as work to install sheet piles in the harbor causing marine sediment to swirl up, and a long duration being required as the project would involve large-scale works on the sea.

3. Proposal C poses the same risk where installation would require a long duration, but it also offers advantages such as seawater from outside the harbor being used for intake (does not impact the radiation concentration of seawater used for dilution), seawater taken in is not directly mixed with seawater inside the harbor and discharge away from the coast making it difficult for seawater to recirculate.
   Future preparations shall be made based on this proposal from the perspective of securing safety and minimizing adverse impacts on reputation.

4. Details for the undersea tunnel shall be reviewed after conducting the marine boring survey.

[Reference] Seawater concentration inside and outside the harbor

TEPCO



Northeast side of harbor entrance

Date sampled	21/7/26
Cs-137	<0.69
Total β	<12
H-3	<0.97

Harbor entrance

Date sampled	21/7/26
Cs-137	<0.52
Total β	<12
H-3	<1.5

East side of harbor entrance

Date sampled	21/7/26
Cs-137	<0.65
Total β	15
H-3	<0.97

Southeast side of harbor entrance

Date sampled	21/7/26
Cs-137	<0.65
Total β	<12
H-3	<0.96

North side of northern seawall

Date sampled	21/7/26
Cs-137	<0.70
Total β	<12
H-3	<0.96

South side of inner harbor

Date sampled	21/7/26
Cs-137	0.36
Total β	<13
H-3	2.6

South side of southern seawall

Date sampled	21/7/26
Cs-137	<0.75
Total β	17
H-3	<0.97

East side of inner harbor

Date sampled	21/7/26
Cs-137	0.47
Total β	16
H-3	<1.8

In front of Unit 1 intake cut-off wall

Date sampled	19/4/2 ＊5
Cs-137	1.2
Total β	<15
H-3	2.3

West side of inner harbor

Date sampled	21/7/26
Cs-137	0.70
Total β	16
H-3	<1.8

In front of Unit 2 intake cut-off wall

Date sampled	18/12/11 ＊3
Cs-137	3.0
Total β	<16
H-3	17

Harbor center

Date sampled	21/7/26
Cs-137	<0.44
Total β	15
H-3	2.2

North side of inner harbor

Date sampled	21/7/26
Cs-137	<0.36
Total β	16
H-3	2.5

North side of Units 5/6 discharge port

Date sampled	21/7/26
Cs-137	<0.55
Total β	11
H-3	<0.90

In front of southern cut-off wall ＊4

Date sampled	21/7/26
Cs-137	4.9
Total β	<11
H-3	45

Around the southern discharge port＊1

Date sampled	21/7/26
Cs-137	<0.65
Total β	14
H-3	<0.92

North side of the east wave breaker ＊2

Date sampled	21/7/26
Cs-137	3.2
Total β	16
H-3	<2.1

In front of the docking area

Date sampled	21/7/26
Cs-137	<0.55
Total β	<11
H-3	<1.6

In front of the Unit 6 intake

Date sampled	21/7/26
Cs-137	0.49
Total β	16
H-3	<2.0

*"<O" indicates undetectable levels
Unit: Bq/L
*Tritium samples are sometimes sampled the day before the indicated date

*3 Removed on and after 12.12.2018
*4: Moved to a point 80m southeast on and after 2.6.2019
*5: Removed on and after 4.3.2019

*1: Moved to a point approx. 320m south from the south discharge port on and after 3.23.2018

*2: Moved to a point 50m south on and after 2.11.2017
Further moved 25m north on and after 1.12.2021

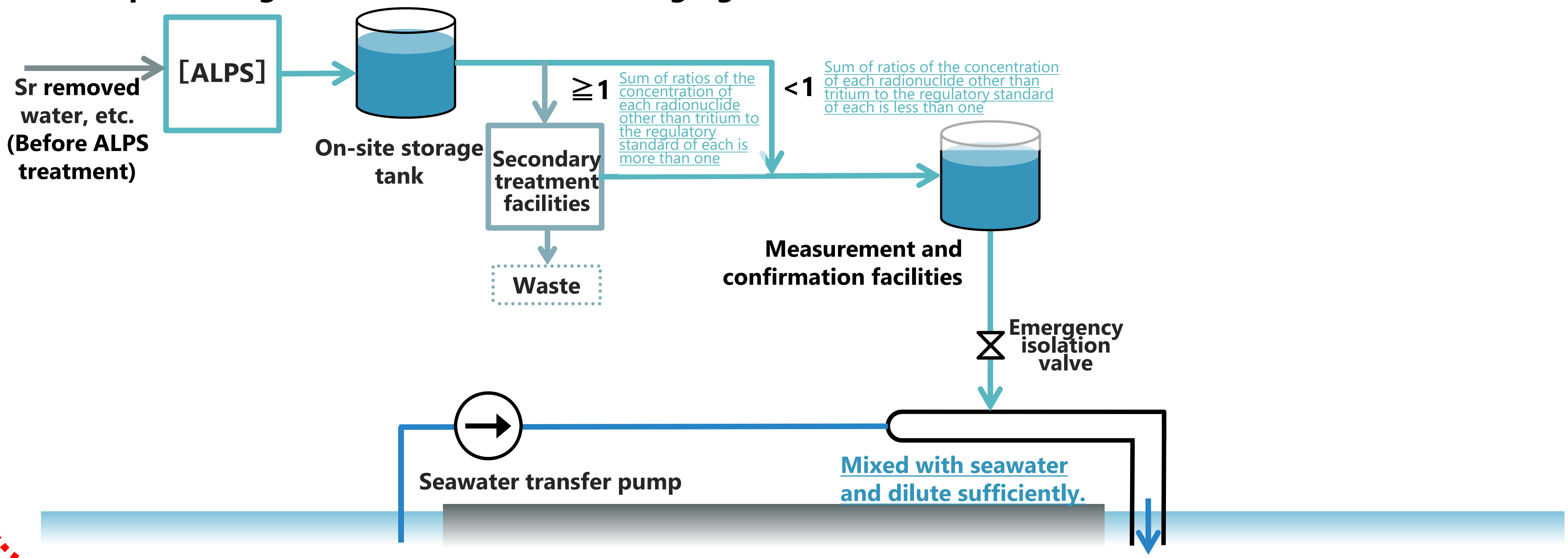
2-(6)

TOPIC⑥ General items

- Design of necessary facilities, organization for the conduct of construction and implementation
- Preparations for the stable operation of facilities in general

⑥ General items

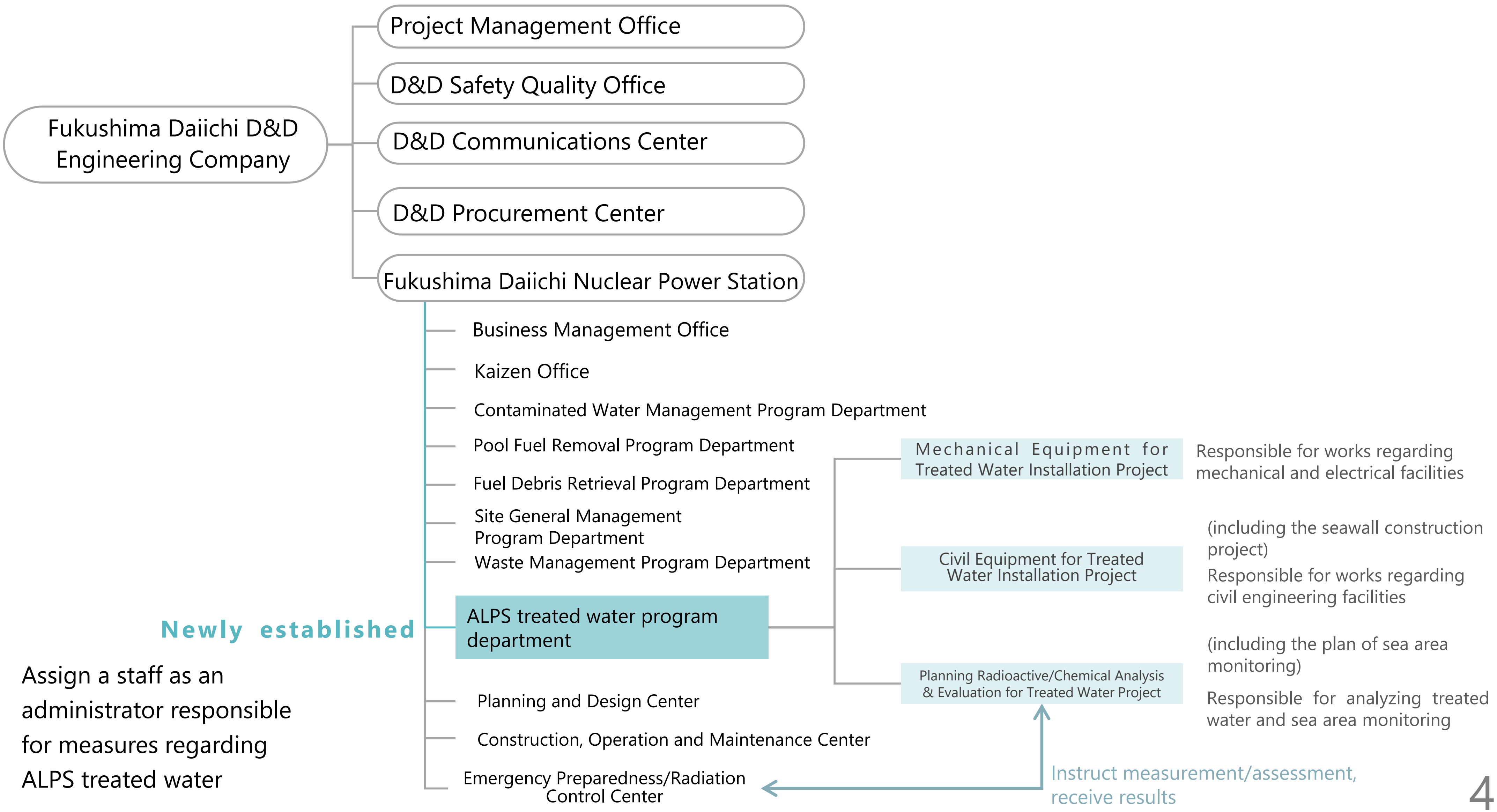
[Conceptual diagram of facilities for discharging ALPS treated water into the sea]



2-(6)-1 Establishment of a Project Organization

TEPCO

- Following the government's policy, we plan to establish an organization specialized for ALPS treated water discharge work to execute the discharge of ALPS treated water into the sea.



2-(6)-2 Preparation for the stable operation of facilities in general

TEPCO

[Aseismic design]

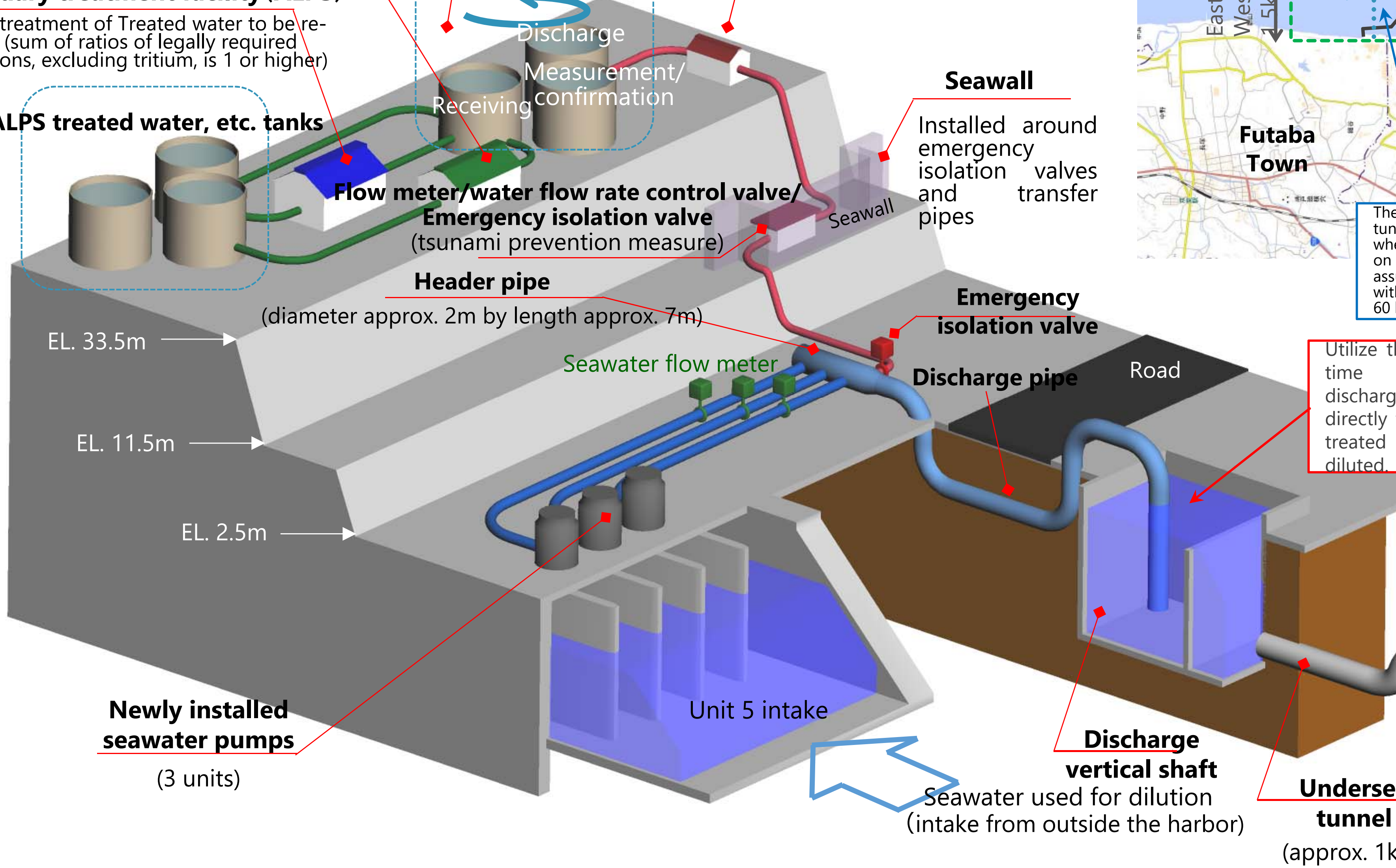
- Facilities belonging to the ALPS treated water system (ALPS treated water transfer pump, ALPS treated water transfer pipes, etc.) are to be designed as seismic class B similar to existing equipment handling ALPS treated water, etc.
- Facilities belonging to the seawater system (seawater transfer pump, seawater transfer pipes, discharge vertical shaft, etc.) are to be designed as seismic class C as they do not house radioactive fluids.

[Secure auxiliary parts]

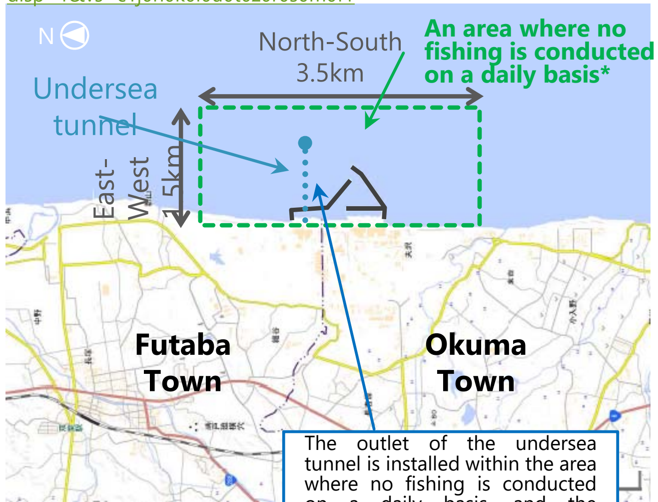
- Secure auxiliary parts for equipment such as seawater transfer pumps and orifice type flow meter, subject to the conditions below, to minimize time for restoration required after experiencing an accident caused by tsunami.
  - ✓ Equipment except for pipes that are vulnerable to flooding from tsunami caused by the Japan Trench
  - ✓ Items critical for the operation of subject facilities
  - ✓ Items which require more than six months to be procured

2-(7) Overview of facilities for securing safety (minimize adverse impacts on reputation)

TEPCO

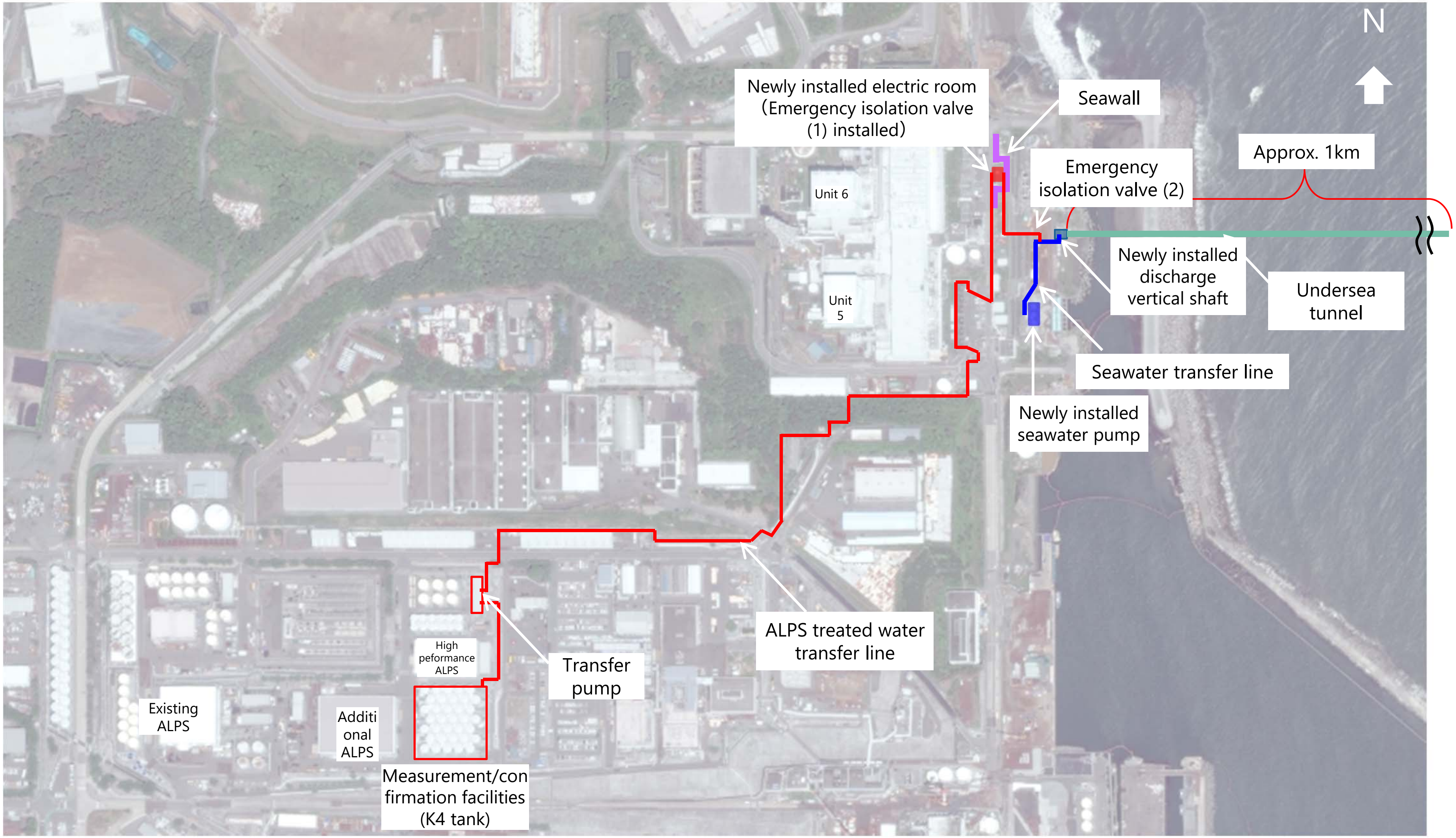


Source: Developed by Tokyo Electric Power Company Holdings, Inc. based on the map developed by the Geospatial Information Authority of Japan (electronic territory web)
https://maps.gsi.go.jp/#13/37.422730/141.044970/&base=std&ls=std&disp=1&vs=c1j0h0k0l0u0t0z0r0s0m0f1



2-(8) Overview of facilities for securing safety, Layout

TEPCO



3. OPERATION OF FACILITIES

3-(1) Discharge control（1/2）

TEPCO

- Radioactive materials, other than tritium, inside water stored in tanks shall be **repeatedly treated prior to discharge until values are definitely lower than the regulatory requirements for environmental discharge.**

- After homogenizing the ALPS treated water in the measurement/confirmation facility (tanks), a **third-party shall measure and assess concentration of radioactive material in addition to measurements and assessments conducted by TEPCO, and the results shall be disclosed each time.**
  - Measurement/assessment takes approx. two months. Considering the tank capacity of approx. 10,000m^3 required to receive water generated each day, three sets of tanks for receiving, measurement/confirmation and discharge, amounting to a total capacity of 30,000m^3, shall be prepared.

- Also, ask the agricultural, forestry, and fishery producers and local government officials to observe in sampling at the measurement/confirmation facilities to ensure transparency.

- Furthermore, continue to measure concentration after dilution for peace of mind, considering comments that tritium concentration should also be measured after dilution (refer to next slide for details).

3-(1) Discharge control （2/2）

TEPCO

- In initiating discharge and for the immediate future, use the methods below to confirm that water measured through measurement/confirmation facilities (approx. 10,000m^3/tank group) have a tritium concentration of under 1,500 Bq/liters after dilution.

➢ Empty the vertical shaft (approx. 2,000m^3) temporarily, and run a small volume (below 20m^3) of ALPS treated water while one seawater transfer pump is operated for approx. ten minutes then shut down. Sample from the vertical shaft to confirm that the measured tritium concentration is equivalent to calculated tritium concentration and under 1,500 Bq/liter (approx. two days).

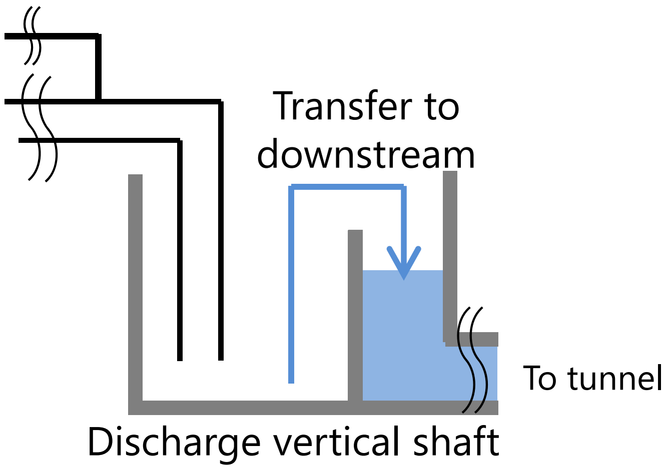
➢ After confirming, discharge the remaining water measured (approx. 10,000m^3/tank group) continuously or in intervals.

- When initiating discharge, carefully start with discharging small amounts.
  - ➢ Combine various number of seawater transfer pumps in operation (one-three units) with the flow rate of ALPS treated water to gradually extend the duration of continuous discharge by units of days, weeks and months, and conduct any reviews deemed necessary.
  - ➢ Be aware that the volume discharged will be limited by the storage capacity of ALPS treated water , etc.
- After initiating discharge, evaluate the quantity of tritium in water measured at measurement/confirmation facilities (approx. 10,000m^3/tank group), control accumulated value and confirm that values fall below 22 trillion Bq/year.

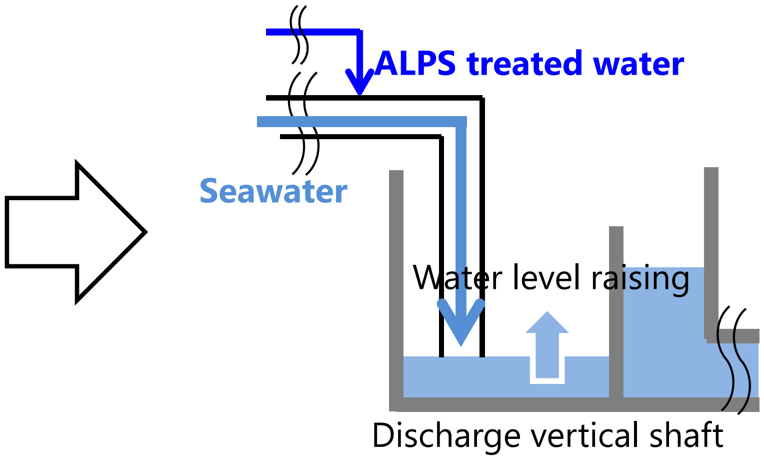
[Reference] Confirming concentration after dilution with seawater

- Use steps below to confirm that the measured tritium concentration diluted with seawater is equivalent to calculated tritium concentration and under 1,500 Bq/liter

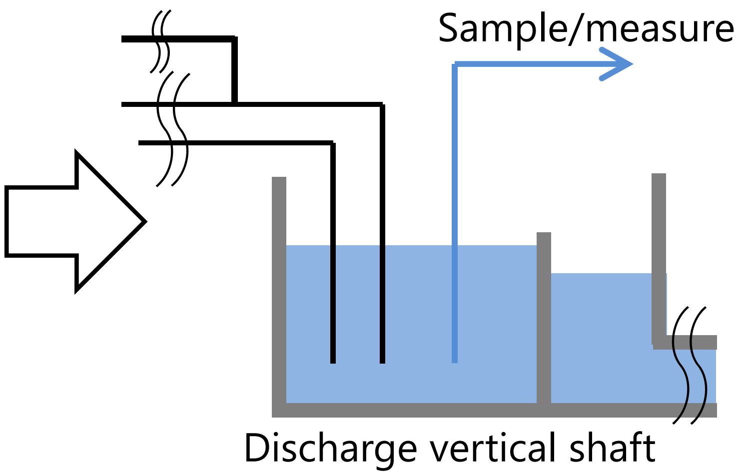
A. Temporarily empty vertical shaft



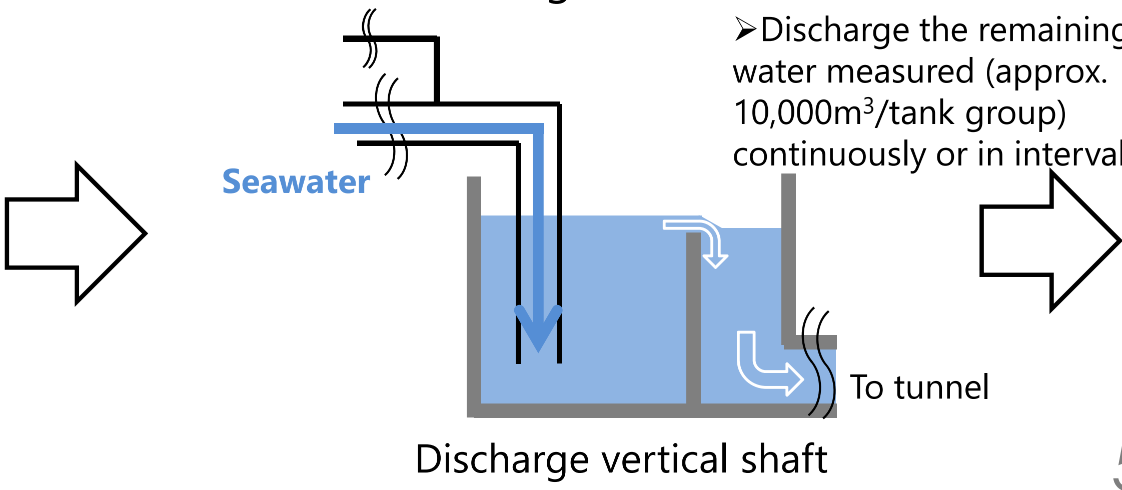
B. Dilute by accumulating seawater in the vertical shaft and pouring small volumes of ALPS treated water



C. Shut down pump before vertical shaft is filled, and sample/measure water in the vertical shaft



D. Transfer seawater again and discharge after confirming tritium concentration



➢Discharge the remaining water measured (approx. 10,000m^3/tank group) continuously or in intervals

3-(2) Simulation of discharge

- Case A and case B where entire quantity tritium at the time of accident existed, and where total tritium quantity was the least according to current information respectively, were assessed.

- The total annual quantity of tritium released was changed for each case so as not to impact the site utilization plan. If the **total discharge quantity was set so that sea discharge would be completed in FY2051**, Case A would have an annual maximum of 22 trillion Bq and Case B would have an annual maximum of 16 trillion Bq.

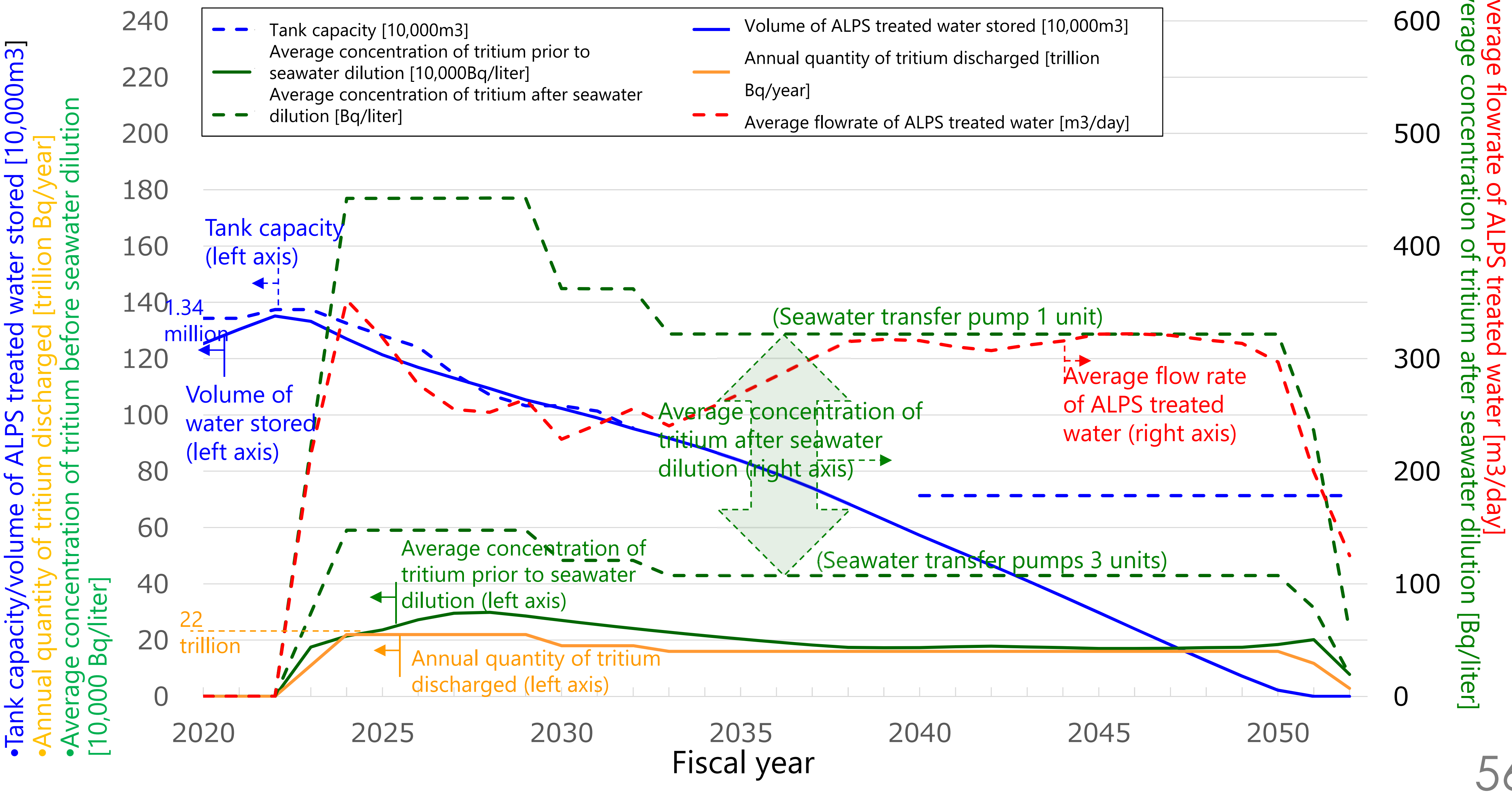
<Reference: Storage status of ALPS treated water, etc. and Sr removed water (before ALPS treatment) as of April 2021>

Tritium concentration [Bq/liter]	~300,000	300,000~ 600,000	600,000~ 1.2 million	1.2 million ~ 1.8 million	1.8 million ~ 2.4 million	Assumed to be 450,000
Volume stored	Approx. 219,000m³	Approx. 391,000m³	Approx. 473,000m³	Approx. 50,000m³	Approx. 24,000m³	Estimated as of December 2020 Approx. 96,000m³

3-(2)-1 Case A (maximum total tritium amount inside building)

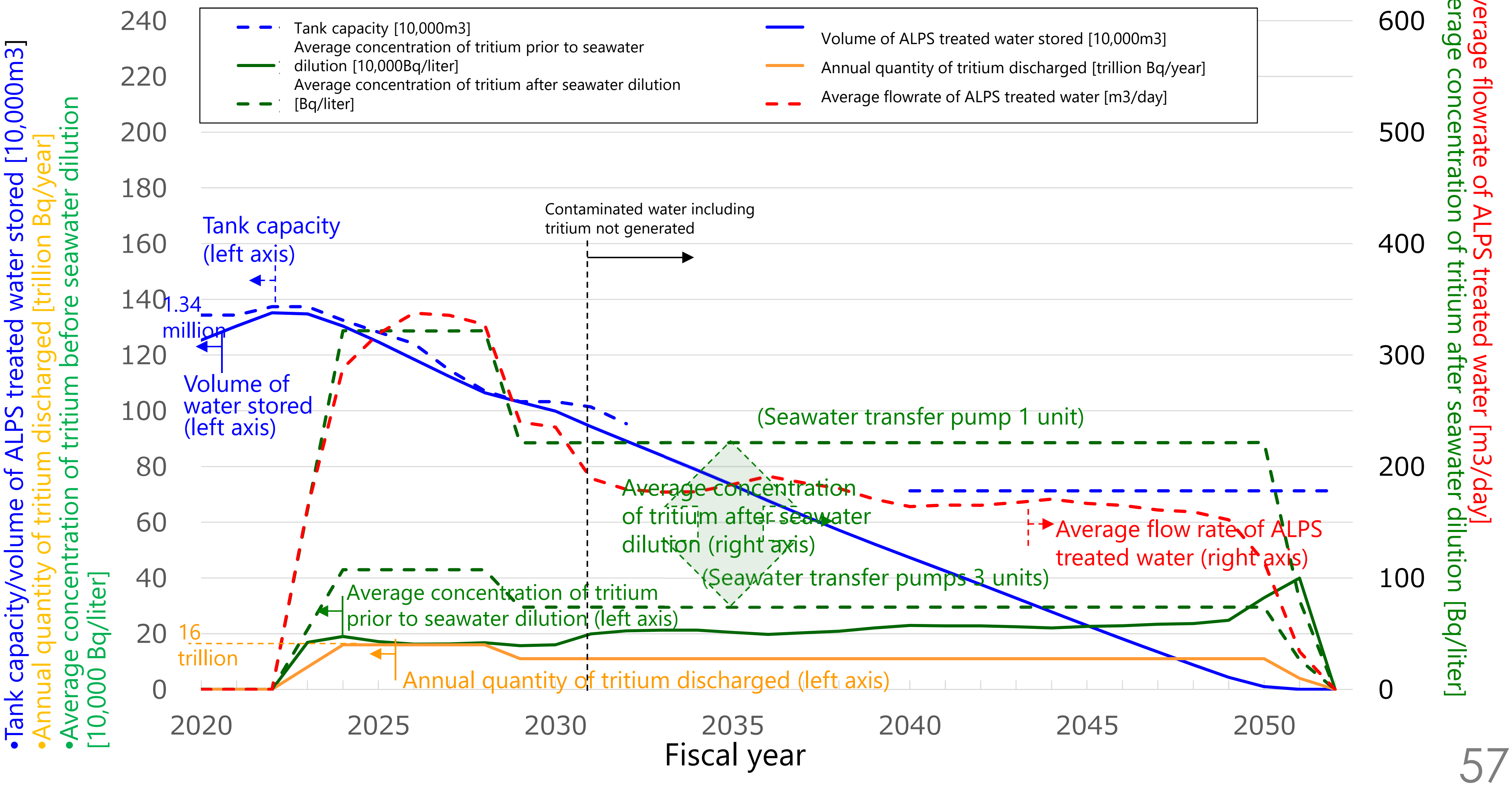
TEPCO

- FY2023: 11 trillion Bq/year (carefully start with discharging small amounts = set to be half the volume of that in and after FY2024)
- FY2024-FY2029: 22 trillion Bq/year
- FY2030-FY2032: 18 trillion Bq/year
- In and after FY2033: 16 trillion Bq/year



3-(2)-2 Case B (minimum total tritium amount inside building)

- FY2023: 8 trillion Bq/year (carefully start with discharging small amounts = set to be half the volume of that in and after FY2024)
- FY2024-FY2028: 16 trillion Bq/year
- In and after FY2029: 11 trillion Bq/year



3-(3) Current issues and course of action

TEPCO

- The initiatives below shall be taken to further reduce the quantity of tritium discharged annually.
  1. Measures such as maintenance of building roof and paving shall continue to be implemented to suppress the volume of contaminated water generated. Not only will efforts be made to reduce the total volume of contaminated water generated to **100m3/day by 2025, further initiatives shall be taken to suppress the volume of contaminated water generated over the long term**.

  2. The status of contaminated water generated (fluctuation), tritium concentration (fluctuation) in newly generated ALPS treated water and future on-site utilization plan (necessary area, period) are to be reviewed in detail by the end of the fiscal year in time for the annual announcement for the total quantity of tritium discharged for the fiscal year. **The discharge plan for the next fiscal year shall be reviewed to minimize the annual tritium discharged.**
     It is currently assumed that Case B better reflects the actual situation based on the evaluation of tritium concentration inside each building and the volume of water accumulated. However, the status of contaminated water generated and the tritium concentration in newly generated ALPS treated water shall be considered at the end of FY2022 to establish the first discharge plan.
     The discharge plan shall be reviewed at the end of each fiscal year, so the annual quantity of tritium discharged may be increased from the previous fiscal year's plan if the total quantity of tritium discharged and tritium concentration of ALPS treated water is higher than the values predicted in the previous fiscal year.

[Reference] Common conditions and parameters

TEPCO

Common conditions

Annual quantity of tritium discharged (below 22 trillion Bq/year)	Set total discharge quantity so that sea discharge will be completed in FY2051 while not impacting the on-site utilization plan
Date for initiating simulation evaluation	April 1, 2021 (simulation by the year)
Date initiating discharge	April 1, 2023
Flow rate of ALPS treated water	Maximum $500m^3$/day
Flow rate of seawater for dilution	170,000m^3/day (one sea water pump) ~ 510,000m^3/day (three sea water pumps)
Order for discharge of ALPS treated water	Discharge from the K4 tank used as measurement/confirmation facility, approx. 30,000m^3, with water with thinnest concentration of tritium discharged first Then, discharge from other tanks and newly generated ALPS treated water in the order of thinnest tritium concentration first.
Tritium decay	A half-life of 12.32 years is considered (approx. 5.5% decay annually), consider decay factor for newly generated volumes as well.
Volume of ALPS treated water generated	Assume that the volume of contaminated water generated will gradually drop 10m^3/day every year and reach 100m^3/day after FY2025.
Days discharged	292 days (availability factor 80%)

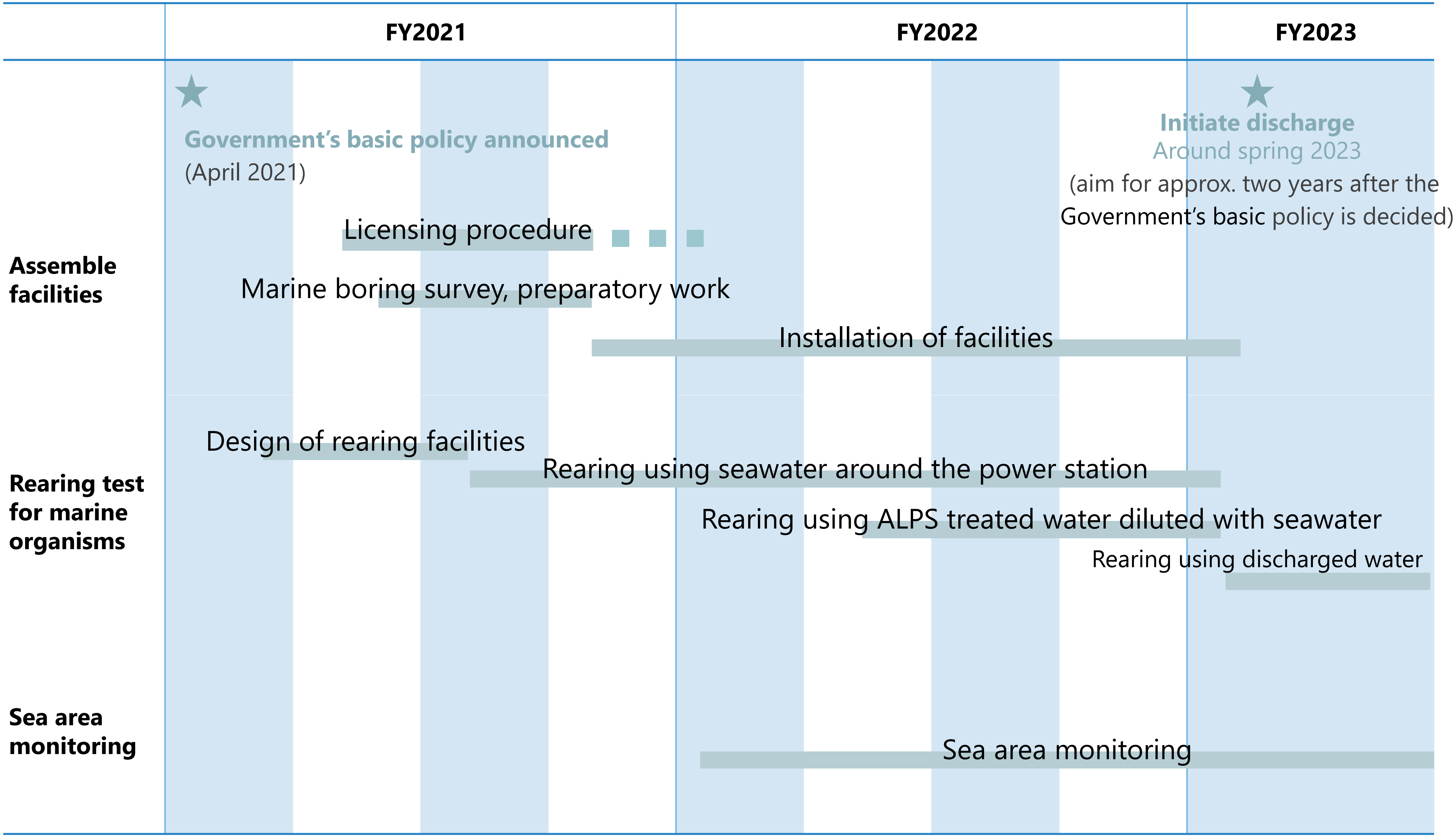
Parameters

Case	**A (Case with maximum total tritium quantity)**	**B (Case with minimum total tritium quantity according to current information)**
Concentration of newly generated tritium	448,000 Bq/liter (January 5, 2021, maximum in 2021)	215,000 Bq/liter (June 1, 2021, minimum in 2021
Total quantity of tritium inside building (as of April 1, 2021)	Approx. 1150 trillion Bq (total of 3400 trillion Bq from the accident still inside buildings and tanks)	Approx. 81 trillion Bq (Estimated based on volume of accumulated water in buildings and its concentration)

4. OVERALL SCHEDULE

4-1. Current Draft of Overall Schedule

TEPCO



- The duration for licensing procedure is not final.
- This draft schedule is subject to revision in accordance with future survey and review results.
- In addition to the above, the assessment results regarding the impact of radiation on humans and the environment shall be disclosed in the future

5. SEA AREA MONITORING

5-1 Simulation of sea discharge dispersion (relisting of draft study)

TEPCO

- Simulation conditions (model reviewed using measured data on Cesium-137)
  - Subject sea area: an area approx. 500km north-south with Fukushima Prefecture at its center, and up to approx. 600km off its coast
  - Resolution: 1km mesh horizontally, 30 layers vertically in proportion with depth (depth up to 1km)
  - Weather conditions: wind velocity, barometric pressure, temperature, humidity, precipitation from January-December 2014 considered

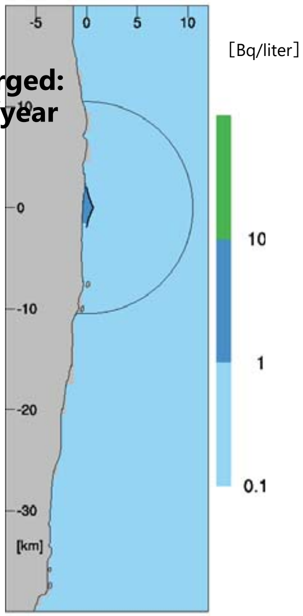
  (includes tides off the coast of Fukushima Prefecture (Black Current, mesoscale eddies)

- Close up of the coast of Fukushima Prefecture

<Legend>
Black line: Scope of 1Bq/liter (concentration level of tap water within Fukushima Prefecture before the earthquake)
Semi-circle: 10km from the Fukushima Daiichi NPS
Background level: 0.1-1Bq/liter (concentration level off the coast of Fukushima Prefecture after the earthquake)

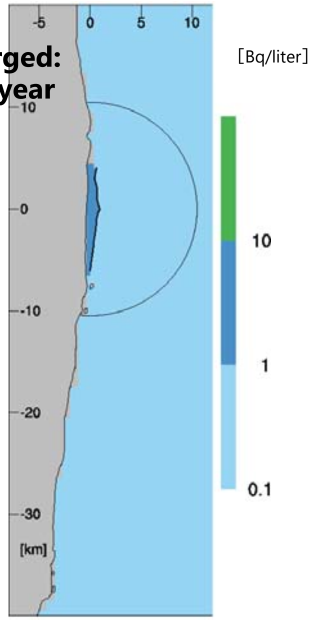
Quantity discharged: 22 trillion Bq/year

Target value for discharge at Fukushima Daiichi before the accident



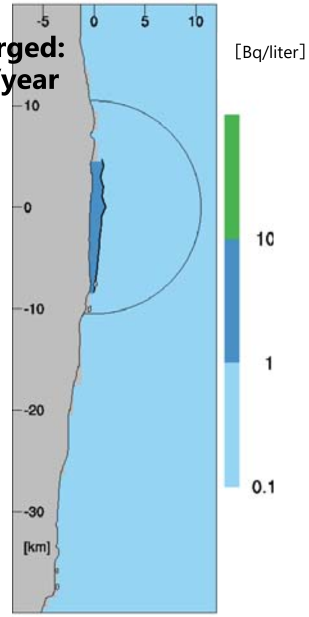
Scope of 1Bq/liter
•Approx. 1.5km north (north end of area where common fishery rights are not set)
•Approx. 1.5km south (south end of area where common fishery rights are not set)
•Approx. 0.7km off the coast

Quantity discharged: 40 trillion Bq/year



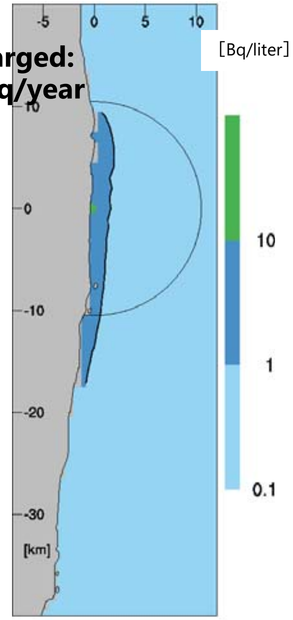
Scope of 1Bq/liter
•Approx. 6.5km north near Ukedo, Namie Town
•Approx. 8km south near Oragahama, Tomioka Town
•Approx. 1km off the coast

Quantity discharged: 50 trillion Bq/year



Scope of 1Bq/liter
•Approx. 7km north (near Ukedo, Namie Town)
•Approx. 10km south (near Kobama, Tomioka Town)
•Approx. 1.5km off the coast

Quantity discharged: 100 trillion Bq/year



Scope of 1Bq/liter
•Approx. 10km north (near border of Minamisoma City and Namie Town)
•Approx. 20km south (near Iwasawa beach, Hirono Town)
•Approx. 2km off the coast

<TEPCO Draft Study Responding to the Subcommittee Report on Handling ALPS Treated Water>
Japanese：https://www.tepco.co.jp/decommission/progress/watertreatment/images/200324.pdf
English：https://www.tepco.co.jp/en/decommission/progress/watertreatment/images/200324.pdf

5-2 Sea area monitoring (plan) (seawater)（1/5）

TEPCO

- Simulation results (previous slide) where values are above 1Bq/liter* are limited. To identify the status of dispersion, add measurement of tritium to points where cesium are measured to strengthen monitoring. *The tritium concentration in tap water in Fukushima Prefecture is around 1Bq/liter; therefore, increase the measurement frequency for areas that exceed this concentration. This value is adequately below the 10,000Bq/liter guideline for drinking water set by the WHO.
- Frequency of measurement shall be changed according to the distance from Fukushima Daiichi Nuclear Power Station.
  - ✓ Frequency for areas outside the harbor shall be consistent with the current frequency for sampling.
  - ✓ Frequency for areas inside the harbor shall be everyday for discharge vertical shafts (discharge end), but other areas shall be subjected to measurement on a weekly basis.
  - ✓ Add three locations for sampling.

Seawater tritium measurement (Draft)

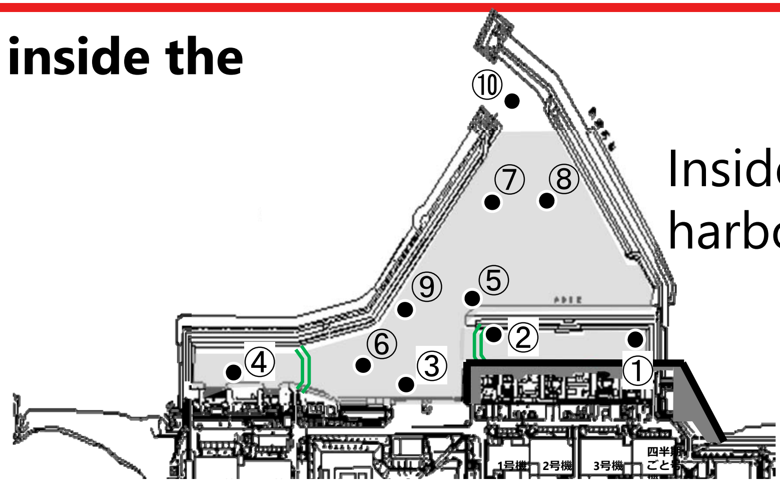
Location	Number of points	Current frequency		After change (draft)	Remarks
		Cesium	Tritium	Tritium	
Inside harbor	10	Daily	Weekly	･Weekly * 1	*1 Daily for the discharge vertical shaft (discharge end) ・ No change for other areas
Within 2km	7	Weekly	Weekly	･Weekly * 2	*2 Add three locations for sampling.
Within 20km	6	Weekly	Once in two weeks	･Weekly	
Outside 20km (offshore of Fukushima Prefecture)	9	Monthly	none	･Monthly	

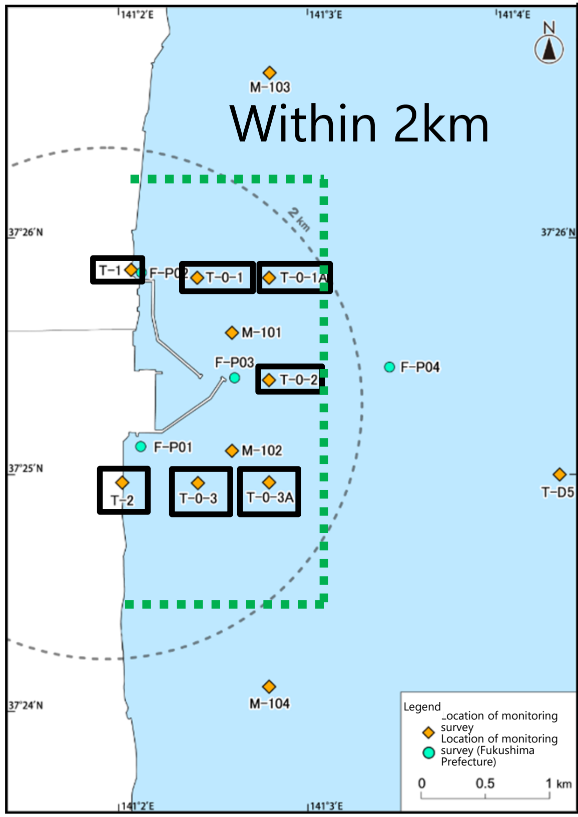
5-2 Sea area monitoring (plan) (seawater) （2/5）

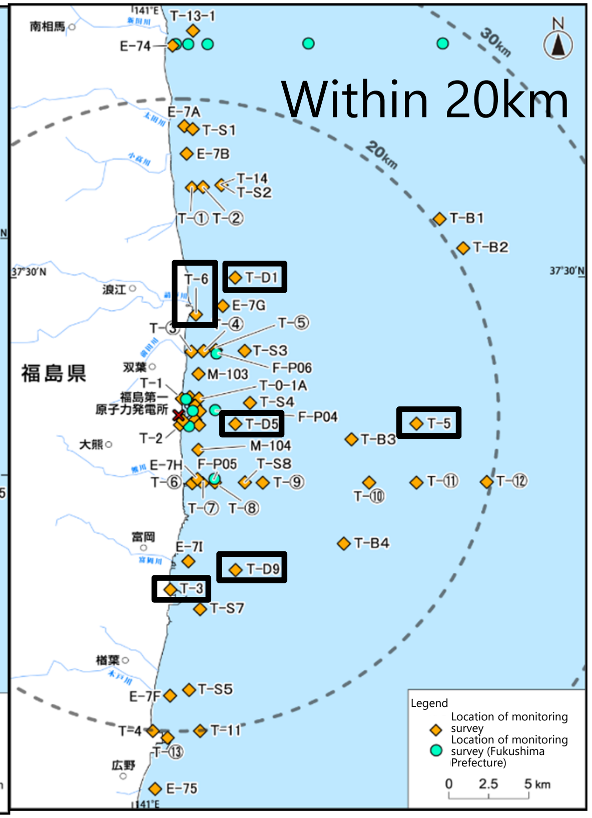
TEPCO

(Current status) Sea water monitoring from inside the harbor to within 20km: tritium

Location	Sample title	Frequency
Inside harbor	②East wave breaker, north side	Weekly
	①In front of cut-off wall, south side	Weekly
	③Seawater in front of docking area	Weekly
	④Seawater in front of Unit 6 intake	Weekly
	⑩Seawater at harbor entrance	Weekly
	⑦Seawater at east side inside harbor	Weekly
	⑨Seawater at west side inside harbor	Weekly
	⑥Seawater at north side inside harbor	Weekly
	⑧Seawater at south side inside harbor	Weekly
	⑤Center of harbor	Weekly
Within 2km	Near south discharge (T-2)	Weekly
	Unit 5/6 discharge, north side (T-1)	Weekly
	Seawater at harbor entrance, east side（T-0-2）	Weekly
	Seawater at the north side of northern sea wall（T-0-1）	Weekly
	Seawater at the south side of southern sea wall（T-0-3）	Weekly
	Seawater at harbor entrance, northeast side（T-0-1A）	Weekly
	Seawater at harbor entrance, southeast side（T-0-3A）	Weekly
Within 20km	2F north discharge (T-3)	Twice a month
	Ukedo Port, south side (T-6)	Twice a month
	3km offshore of Ukedo River (T-D1)	Twice a month
	15km offshore of 1F site (T-5)	Twice a month
	3km offshore of 1F site (T-D5)	Twice a month
	3km offshore of 2F site (T-D9)	Twice a month







Area where no fishing is conducted on a daily basis*
East-west 1.5km North-south 3.5km

Tritium analysis point (analyze at all points in the harbor)

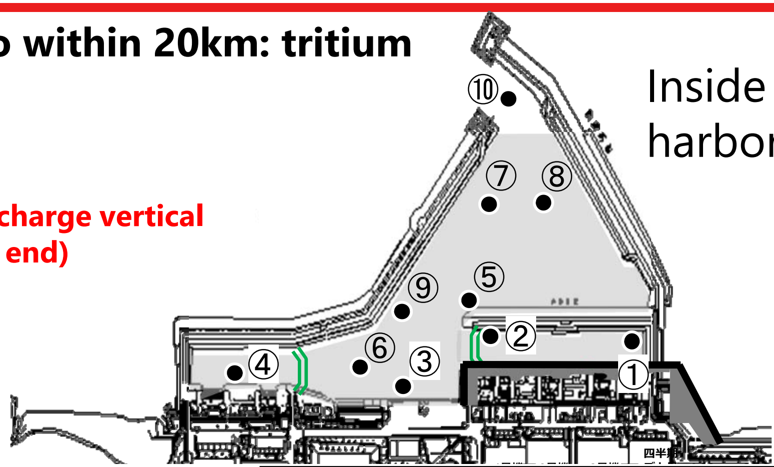
*：area where common fishery rights are not set

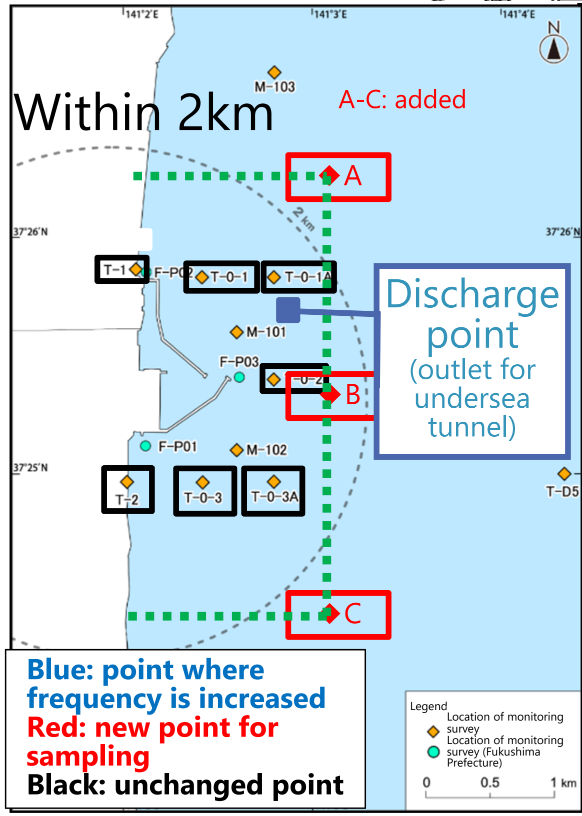
5-2 Sea area monitoring (plan) (seawater) （3/5）

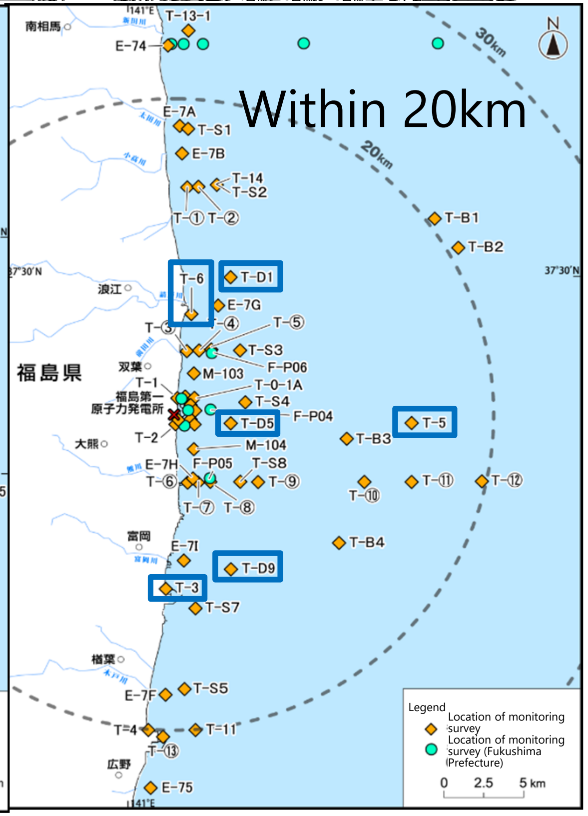
TEPCO

（After review） Sea water monitoring from inside the harbor to within 20km: tritium

Location	Sample title	Frequency
Inside harbor	②East wave breaker, north side	Weekly
	①In front of cut-off wall, south side	Weekly
	③Seawater in front of docking area	Weekly
	④Seawater in front of Unit 6 intake	Weekly
	⑩Seawater at harbor entrance	Weekly
	⑦Seawater at east side inside harbor	Weekly
	⑨Seawater at west side inside harbor	Weekly
	⑥Seawater at north side inside harbor	Weekly
	⑧Seawater at south side inside harbor	Weekly
	⑤Center of harbor	Weekly
Within 2km and its periphery	Near south discharge (T-2)	Weekly
	Unit 5/6 discharge north side (T-1)	Weekly
	Seawater at harbor entrance, east side （T-0-2）	Weekly
	Seawater at the north side of northern sea wall （T-0-1）	Weekly
	Seawater at the south side of southern sea wall （T-0-3）	Weekly
	Seawater at harbor entrance, northeast side （T-0-1A）	Weekly
	Seawater at harbor entrance, southeast side （T-0-3A）	Weekly
	Area where no fishing is conducted on a daily basis* Eastern end, north side (new sampling point: A)	Weekly
	Area where no fishing is conducted on a daily basis* Mid-point at the eastern end (new sampling point: B)	Weekly
	Area where no fishing is conducted on a daily basis* Eastern end, south side (new sampling point: C)	Weekly
Within 20km	2F north discharge (T-3)	Weekly
	Ukedo Port, south side (T-6)	Weekly
	3km offshore of Ukedo River (T-D1)	Weekly
	15km offshore of 1F site (T-5)	Weekly
	3km offshore of 1F site (T-D5)	Weekly
	3km offshore of 2F site (T-D9)	Weekly







Area where no fishing is conducted on a daily basis*
East-west 1.5km North-south 3.5km

Tritium analysis point (analyze at all points in the harbor)

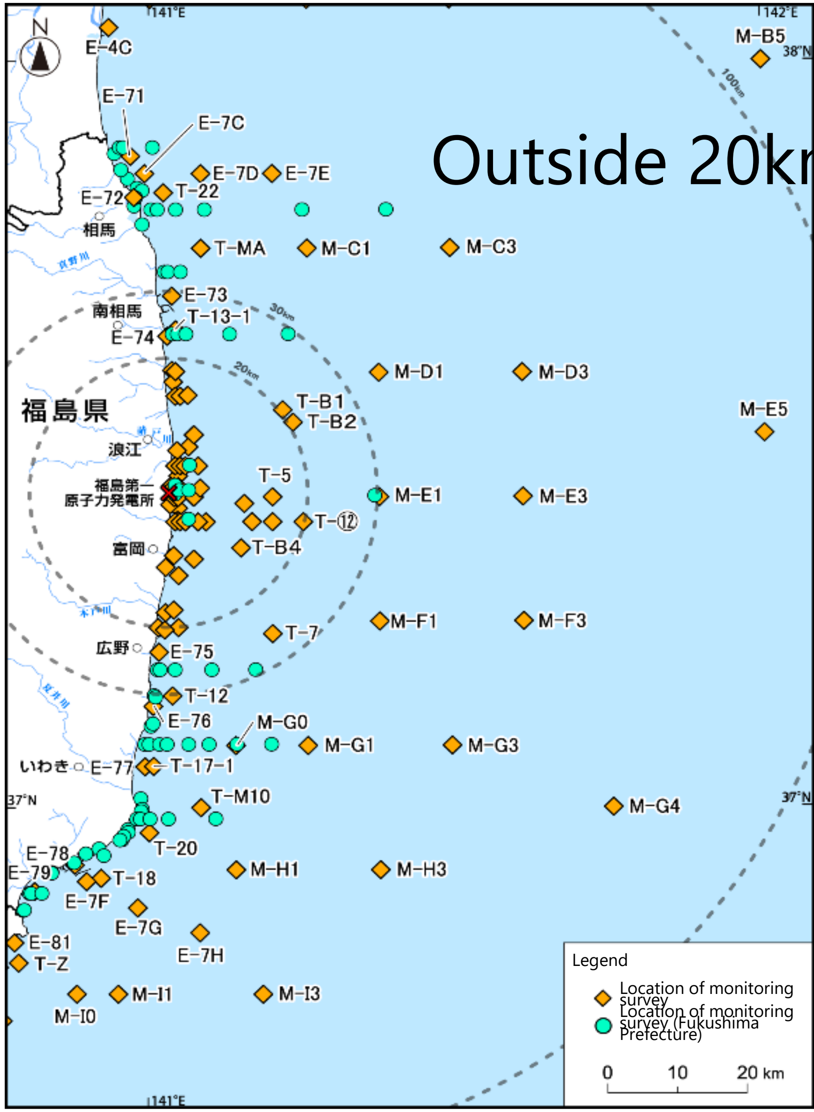
*：area where common fishery rights are not set

5-2 Sea area monitoring (plan) (seawater) （4/5）

TEPCO

（Current status）Seawater monitoring outside 20km: tritium

Location	Sample title	Frequency
Outside 20km (Fukushima)	3km Offshore of Soma (T-22)	0
	5km offshore of Kashima (T-MA)	0
	1km offshore of Niida River (T-13-1)	0
	15km offshore of Iwasawa beach (T-7)	0
	3km offshore of northern area of Iwaki City (T-12)	0
	1km offshore of Natsui River (T-17-1)	0
	5km offshore of Numanouchi (T-M10)	0
	3km offshore of Toyoma (T-20)	0
	3km offshore of Onahama Port (T-18)	0



Tritium is not analyzed outside 20km, but sampling is conducted monthly to analyze cesium.

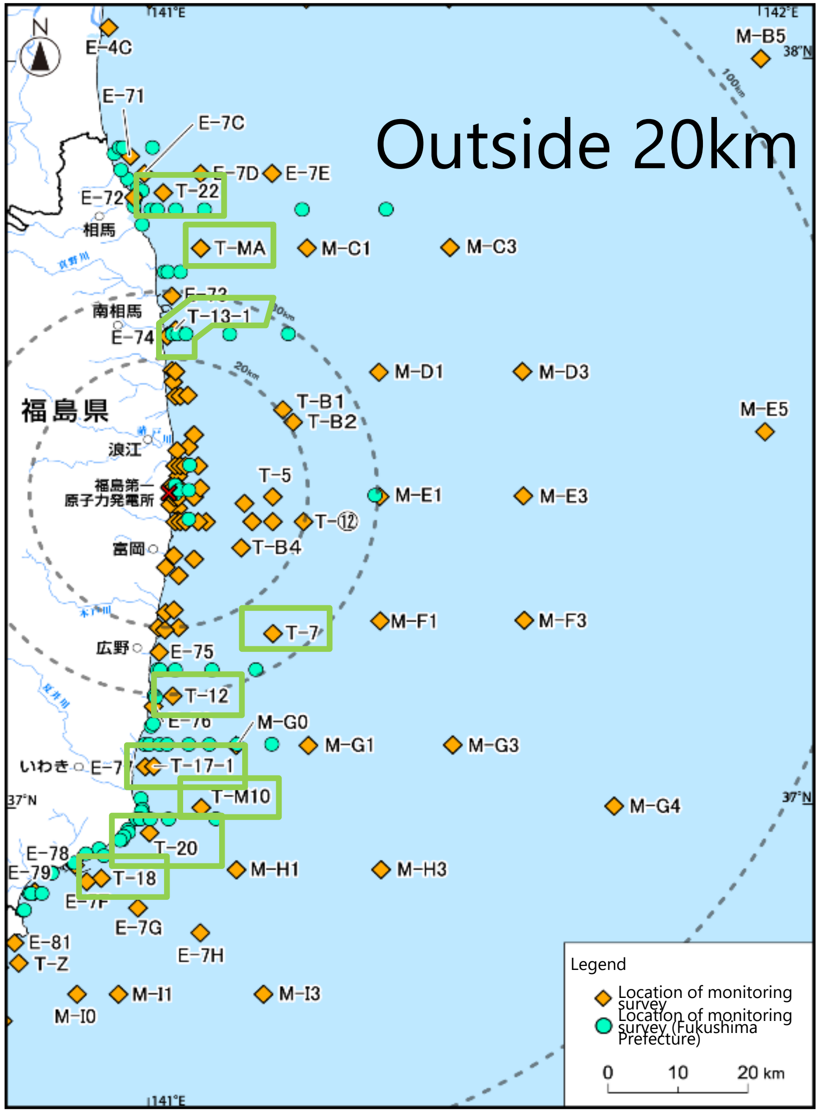
5-2 Sea area monitoring (plan) (seawater) （5/5）

TEPCO

（After review）Seawater monitoring outside 20km: tritium

Green: additional analysis points

Location	Sample title	Frequency
Outside 20km (Fukushima)	3km Offshore of Soma 3km(T-22)	Monthly
	5km offshore of Kashima (T-MA)	Monthly
	1km offshore of Niida River (T-13-1)	Monthly
	15km offshore of Iwasawa beach (T-7)	Monthly
	3km offshore of northern area of Iwaki City (T-12)	Monthly
	1km offshore of Natsui River (T-17-1)	Monthly
	5km offshore of Numanouchi (T-M10)	Monthly
	3km offshore of Toyoma (T-20)	Monthly
	3km offshore of Onahama Port (T-18)	Monthly



5-3 Sea area monitoring (plan) (fish/seaweed) (1/5)

TEPCO

- Conduct measurement to confirm the transfer status of radioactive materials in fish and seaweed by discharge.
- Regarding fish, samples are currently taken at 11 locations within 20km off the coast of Fukushima Prefecture to analyze cesium (of which one location is currently subjected to tritium analysis). To confirm the impact of tritium concentration, analysis of tritium in fish shall be conducted in all 11 locations, and sea water shall also be analyzed for tritium as well.
- Regarding seaweed, gamma emitting nuclide analysis is currently conducted at one location inside the harbor. To confirm iodine and tritium concentration, seaweed shall be sampled at additional two points outside the harbor, and tritium and iodine 129 shall be added to the analysis for gamma emitting nuclide.

Tritium and iodine 129 in fish/seaweed measurement (Draft)

		Current frequency	After change (draft)	Remarks
Fish	Within 20km	Monthly (one location)	Monthly (11 locations)	[Current] Sample fish at 11 locations, and analyze tritium in flounder at one location. [After change] Conduct tritium analysis at the ten locations where samples are taken for cesium analysis.
Seaweed	Inside the harbor	3 times/year (one location)	3 times/year (one location)	[Current] Conduct three times annually in March, May and July at one location inside the harbor. (no growth in summer and winter) [After change] Add two locations outside the harbor for analysis of gamma emitting nuclide, iodine 129 and tritium (review based on survey of habitat)
	Outside the harbor	none	3 times/year (two locations)	

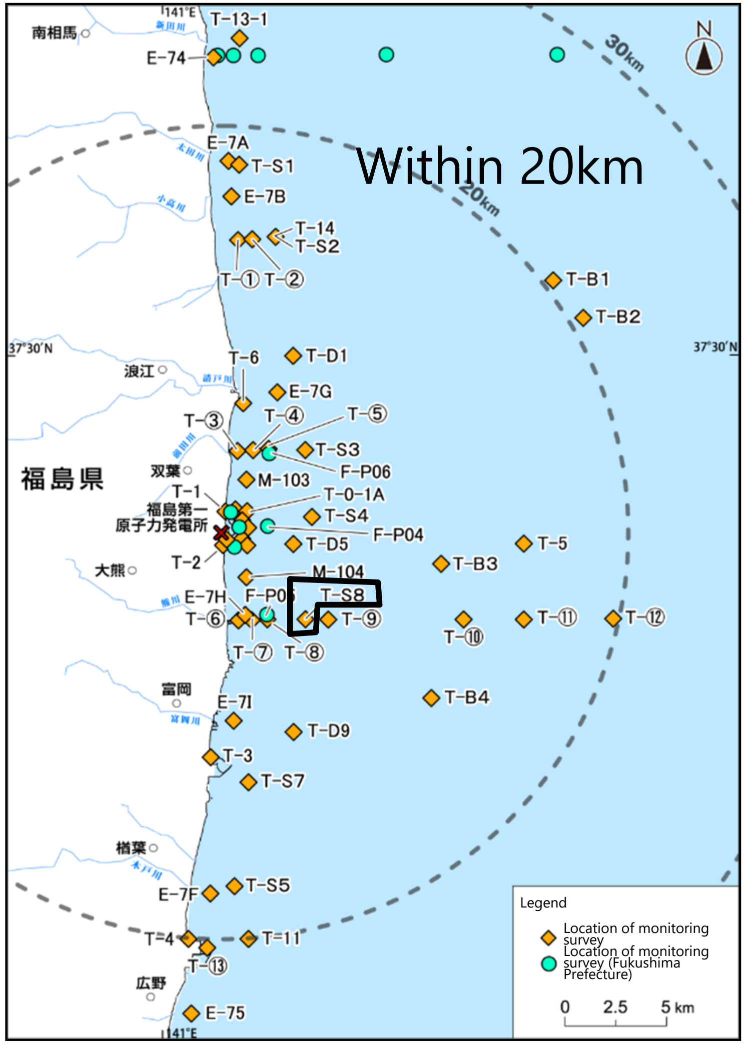
5-3 Sea area monitoring (plan) (fish) (2/5)

TEPCO

(Current status) Monitoring of marine products (fish): tritium

Sample title	Fish	Seawater
	Frequency	Frequency
Around 1km offshore of Ota River (T－S 1)	－	－
Around 3km offshore of Odaka Ward (T－S 2)	－	－
Around 3km offshore of Ukedo River (T－S 3)	－	－
Around 3km offshore of 1F site (T－S 4)	－	－
Around 2km offshore of Kido River (T－S 5)	－	－
Around 2km offshore of 2F site (T－S 7)	－	－
Around 4km offshore of Kumagawa (T－S 8)	Monthly (Detailed analysis)	Monthly (Detailed analysis)
Around 15km offshore of Odakaku (T－B 1)	－	－
Around 18km offshore of Ukedo River (T－B 2)	－	－
Around 10km offshore of 1F site (T－B 3)	－	－
Around 10km offshore of 2F site (T－B 4)	－	－

	Detailed analysis
Detectable threshold	Approx. 0.1Bq/liter



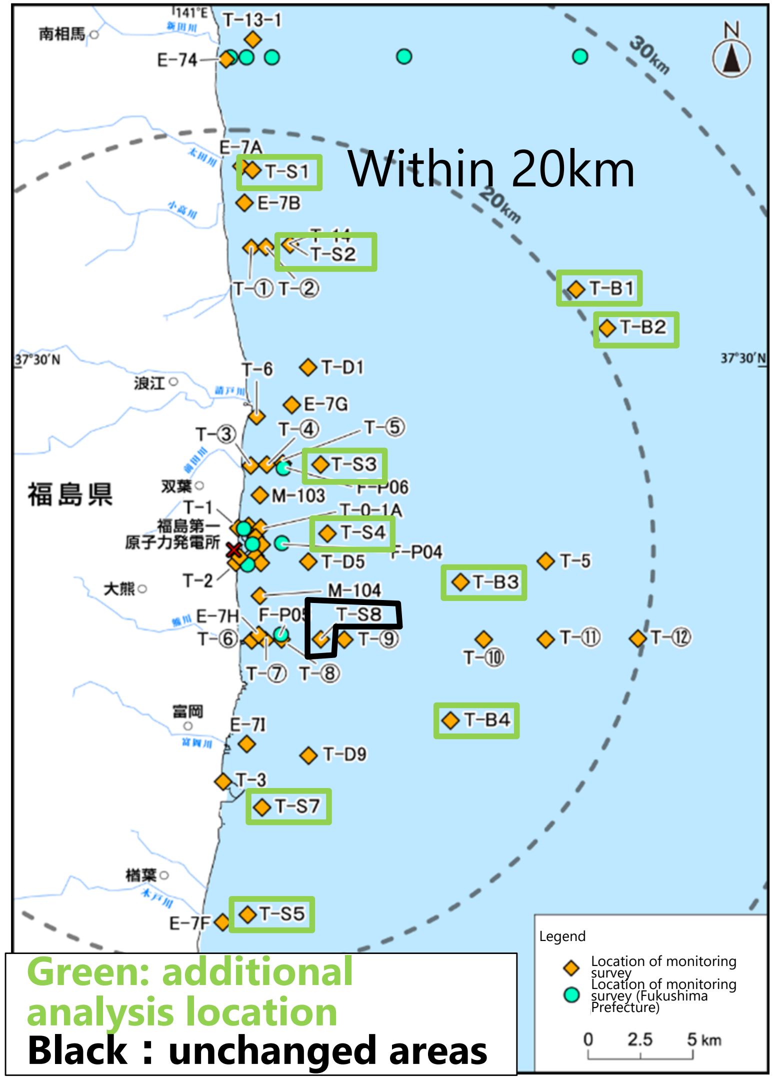
Fish analysis location (tritium)

5-3 Sea area monitoring (plan) (fish) （3/5）

TEPCO

（After review） Monitoring of marine products (fish): tritium

Sample title	Fish	Seawater
	Frequency	Frequency
Around 1km offshore of Ota River（T－S 1）	Monthly	Monthly
Around 3km offshore of Odaka Ward（T－S 2）	Monthly	Monthly
Around 3km offshore of Ukedo River（T－S 3）	Monthly	Monthly
Around 3km offshore of 1F site（T－S 4）	Monthly	Monthly
Around 2km offshore of Kido River（T－S 5）	Monthly	Monthly
Around 2km offshore of 2F site（T－S 7）	Monthly	Monthly
Around 4km offshore of Kumagawa（T－S 8）	Monthly（Detailed analysis）	Monthly（Detailed analysis）
Around 15km offshore of Odakaku（T－B 1）	Monthly	Monthly
Around 18km offshore of Ukedo River（T－B 2）	Monthly	Monthly
Around 10km offshore of 1F site（T－B 3）	Monthly	Monthly
Around 10km offshore of 2F site（T－B 4）	Monthly	Monthly

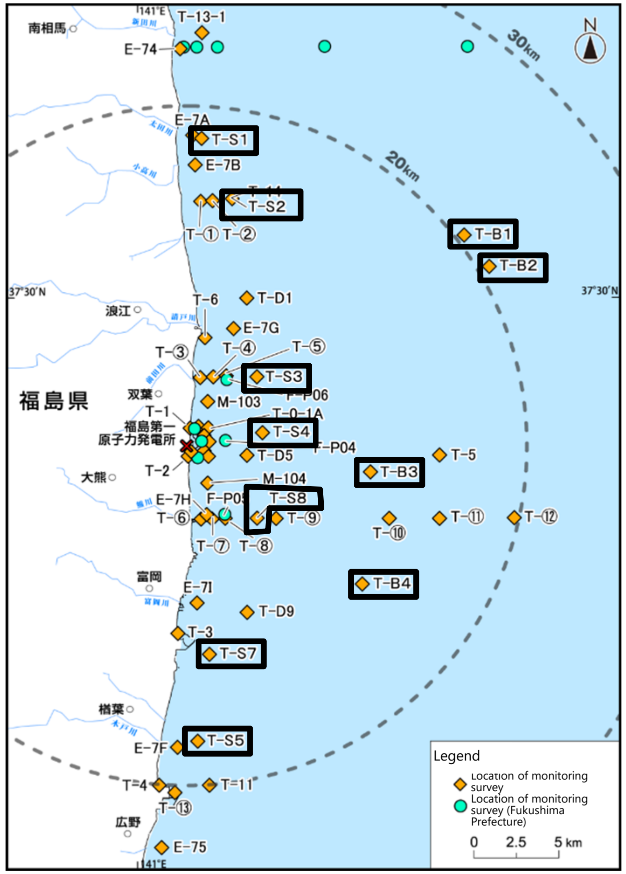


5-3 Sea area monitoring (plan) (fish) （4/5）

TEPCO

（No change） Monitoring of marine products (fish): cesium, strontium

Sample title	Cesium	Strontium
	Frequency	Frequency
Around 1km offshore of Ota River（T－S１）	Monthly	20 times annually Measure samples with the top five highest cesium concentration every quarter
Around 3km offshore of Odaka Ward（T－S２）	Monthly	
Around 3km offshore of Ukedo River（T－S３）	Monthly	
Around 3km offshore of 1F site（T－S４）	Monthly	
Around 2km offshore of Kido River（T－S５）	Monthly	
Around 2km offshore of 2F site （T－S７）	Monthly	
Around 4km offshore of Kumagawa（T－S８）	Monthly	
Around 15km offshore of Odakaku（T－B１）	Monthly	
Around 18km offshore of Ukedo River（T－B２）	Monthly	
Around 10km offshore of 1F site（T－B３）	Monthly	
Around 10km offshore of 2F site（T－B４）	Monthly	



Fish analysis location (cesium, strontium)

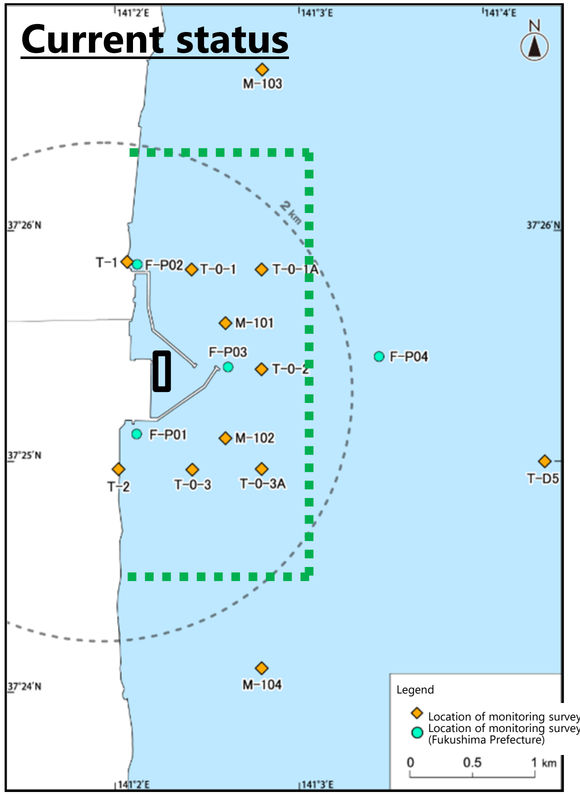
5-3 Sea area monitoring (plan) (seaweed) （5/5）

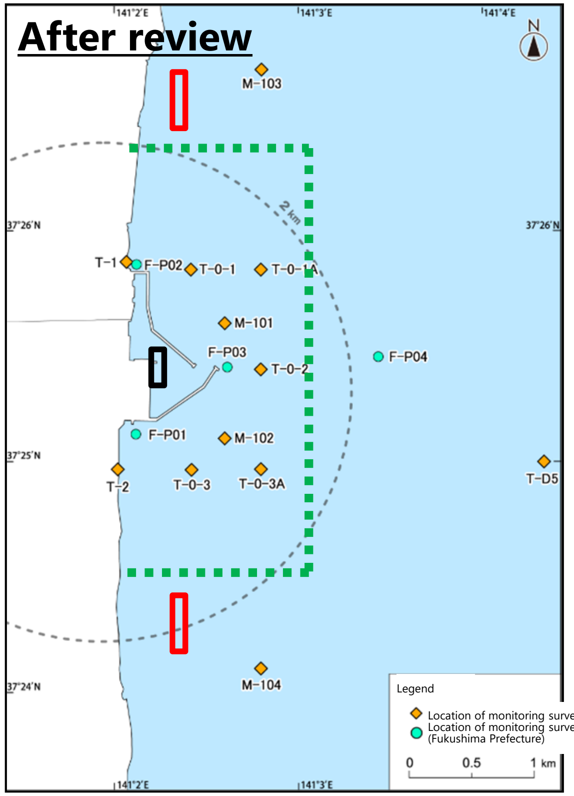
TEPCO

（Current status /after review） Seaweed monitoring: cesium, iodine 129, tritium

(per year)

Sample locations	Analysis subjects	Current frequency	After review
Inside the harbor (Inner side of the south seawall)	Cesium 134, 137	3	3
	Iodine 129	0	0
	Tritium	0	0
Outside the harbor	Cesium 134, 137	0	**3 ×2 locations**
	Iodine 129	0	**3 ×2locations**
	Tritium	0	**3×2locations**





Red: new sample points (conduct review based on survey of its habitat)
Black: same as before

Sampling locations outside the harbor shall be set outside the area where no fishing is conducted on a daily basis*

Area where no fishing is conducted on a daily basis*
East-west 1 .5km North-south 3.5km

＊：area where common fishery rights are not set

5-4 Items to consider for sea area monitoring

TEPCO

- Sea area monitoring is planned to be initiated approx. one year before the scheduled date for initiating discharge (around Spring 2022).

- Local agricultural, forestry, and fishery producers and local government officials are to participate and observe in sampling during sea area monitoring (sampling, taking radiation measurements).

- Proposals to strengthen sea area monitoring is currently being reviewed in accordance with the distance from Fukushima Daiichi Nuclear Power Station as described previously. The necessity to further strengthen and expand sea area monitoring as well as its method shall be reviewed while considering the Government's monitoring meeting.

- Simulation regarding the dispersion of discharged water into the sea shall continue to be reviewed while further enhancing its precision, and the impact assessment of radiation on humans and the environment shall be conducted as well.

6. REARING TEST OF MARINE ORGANISMS

6-1 Purpose

TEPCO

Cultivate understanding for the discharge of ALPS treated water into the sea, which would contribute to avoiding the adverse impacts on reputation, by rearing marine organisms in a seawater environment containing the water treated with the Multi-nuclide Removal Equipment (hereinafter "ALPS treated water"), and presenting the status to society in a highly transparent manner.

- Conduct rearing tests on fish, etc. in a marine environment containing ALPS treated water prior to and after the discharge of ALPS treated water into the sea.

- Opinions from experts and fisheries stakeholders shall be considered in preparing the trial environment, selecting trial subjects and setting items to be confirmed in the rearing tests.

- Conduct risk communication activities with the local community and other various stakeholders from the stage of planning rearing tests. If necessary, apply feedback received from the activity to the plan.
  - The status/progress of the fish rearing tests shall be disclosed when necessary to ensure transparency.

6-2 Rearing test : ①Prior to discharge of ALPS treated water into the sea

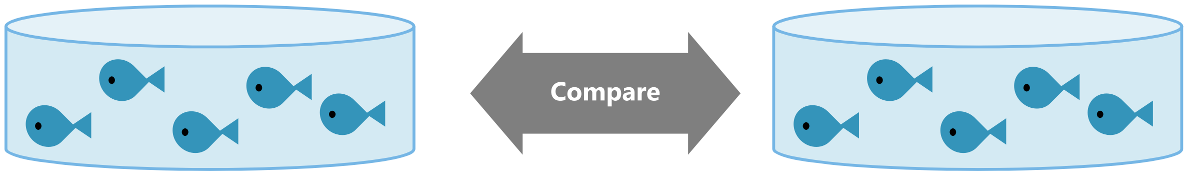
TEPCO

Conduct rearing tests on marine organisms in seawater and ALPS treated water diluted using seawater, and confirm the status of its development.

Trial environment	• Comparative trial using seawater in the periphery of Fukushima Daiichi NPS [test tank 1] and ALPS treated water diluted using seawater in the periphery of Fukushima Daiichi NPS [test tank 2]. • Rearing shall be conducted on land using a closed circulation system*, and its surrounding area shall be designated as a radiation controlled area. • Other than the difference in water used for test tanks 1 and 2, the rearing conditions shall be identical . ※ Water used for rearing shall be cleaned and circulated using a filtration system
Trial subjects	• Subject organisms shall be selected from those that have previously been farm-raised within the country. • Details on the species (of fish, shellfish, seaweed etc.) and morphology (young or matured) of marine organisms shall be decided based on input from experts. • Rearing shall be initiated from test tank 1, and rearing in test tank 2 shall be initiated after collecting data for rearing. Comparative tests shall be conducted after this.
Information to be disclosed	• Health-related abnormalities or lack, comparison of concentration of radioactive materials including tritium in water used for trial and subjects' body. • Hatching rate of eggs, survival rate of matured fish (or number of deaths) • Live streaming of the rearing status

Test tank 1: Seawater around the power station
(Tritium concentration approx. 1Bq/liter)

Test tank 2: ALPS treated water diluted using seawater around the power station
(Tritium concentration approx. 1,500Bq/liter)



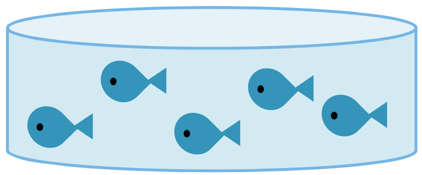
6-2 Rearing test : ②After initiating the discharge of ALPS treated water into the sea

TEPCO

Conduct rearing tests on marine organisms under an environment where water is diluted with seawater and actually discharged into the environment and confirm the status of their development.
Rearing is planned to be continued for a while after sea discharge has been initiated. The timing of conclusion will be determined based on whether the objectives of the rearing tests has been achieved.

Trial environment	• Rear organisms using water diluted with seawater and actually discharged into the environment. • Rearing shall be conducted on land using a free-flowing system*, and its surrounding area shall be designated as a non-radiation controlled area. ※ Continuous intake of seawater from the natural environment and used as rearing water
Trial subjects	• Subject organisms shall be selected from those that have previously been farm-raised within the country. • Details on the species (of fish, shellfish, seaweed, etc.) and morphology (young or matured) of marine organisms shall be decided based on input from experts.
Information to be disclosed	• Health-related abnormalities or lack, comparison of concentration of radioactive materials including tritium in water used for trial and subjects' body. • Hatching rate of eggs, survival rate of matured fish (or number of deaths) • Live streaming of the rearing status

Test tank: water discharged into the environment
(Tritium concentration ≦ approx. 1,500Bq/liter)



6-3 Challenges

Challenges for conducting trials include working around legal constraints and setting appropriate confirmation items

legal constraints	[Rearing test (1) prior to initiating the discharge of ALPS treated water into the sea] • Water used for rearing must be handled in accordance with the Reactor Regulation Act, which involves actions such as setting the rearing area as a radiation controlled area. [Rearing test (2) after initiating the discharge of ALPS treated water into the sea] • Seawater (from the natural environment) will be used for rearing; thus, it must be handled in the same manner as “environmental samples”. – The location of water intake shall be selected so that rearing is conducted using “environmental samples”.
Setting confirmation items	• Identifying the cause in the event of a developmental abnormality - Test tank may require partitioning in accordance with water quality and environmental conditions. • Identifying cause of death when survivability is set as a confirmation item – Difference in individual specimen. – Confirmation over a long term becomes difficult if an annual algae is selected for rearing. • Isotope to be measured – Consider the perspective of avoiding the adverse impacts on reputation.

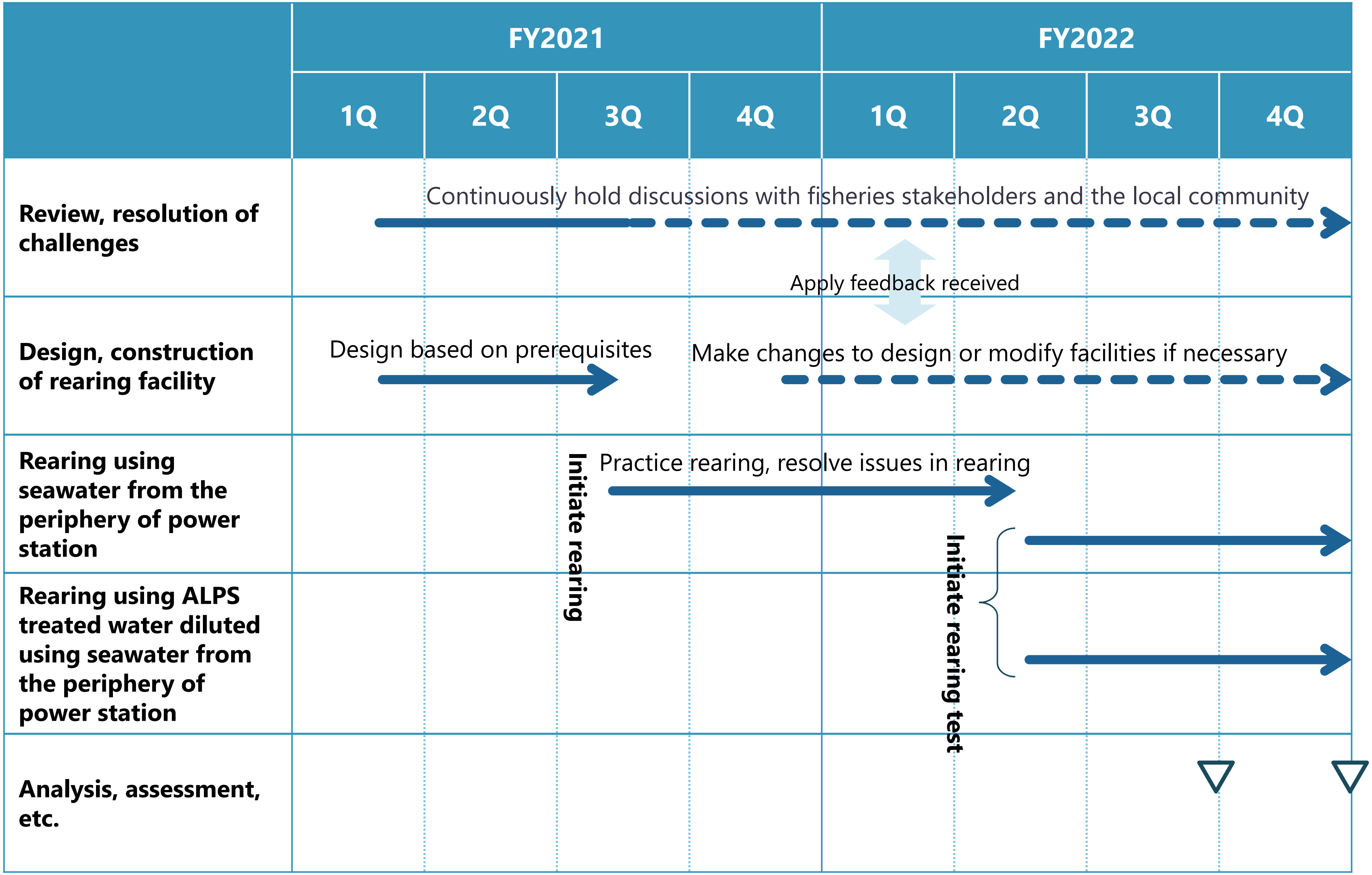
6-4 Ensuring transparency of the initiative

TEPCO

Disclose information on the initiation of rearing tests and its following status in a timely and appropriate manner

Initiation of rearing test	• Purpose and overview of the rearing tests, fundamental information on organic contamination of tritium – For example, the amount of tritium in fish being equivalent to the concentration in its rearing environment
▼	
Status of rearing test	• Constant: Live streaming using monitoring camera • Periodic: rearing environment (water quality, temperature, etc.), rearing condition (fluctuation in the number of organisms being reared, etc.), analysis results (comparison of internal tritium concentration and tritium concentration in seawater, etc.)
▼	
Occurrence of abnormality	• Details and cause of abnormality
▼	
Conclusion of Rearing test	• Summary of the rearing tests

6-5 Schedule


FY2021
FY2022
1Q
2Q
3Q
4Q
1Q
2Q
3Q
4Q
Review, resolution of challenges
Continuously hold discussions with fisheries stakeholders and the local community
Apply feedback received
Design, construction of rearing facility
Design based on prerequisites
Make changes to design or modify facilities if necessary
Rearing using seawater from the periphery of power station
Initiate rearing
Practice rearing, resolve issues in rearing
Rearing using ALPS treated water diluted using seawater from the periphery of power station
Initiate rearing test
Analysis, assessment, etc.

[Reference] Current status on the review of rearing facilities

- Tentative parameters set for reviewing rearing facilities
  - Isotopes subject to assessment: tritium
  - Marine organism to be reared: flounder (size of specimen should be around 30cm – 40cm or below to facilitate ease in handling)

    Shellfish (details currently under review)

    Seaweed (details currently under review)

- Multiple pools with dimensions of $3m^2$ by 1m in depth shall be connected for rearing flounders
  - The dimension above is optimal for rearing based on past experience.

    ✓Easy to cleanup leftover food and to capture flounders for analysis.
  - Connecting the pools increases the volume of water, making it easier to maintain the rearing environment (water control).

Details such as the number of pools and the location of its installation shall be reviewed in the future.

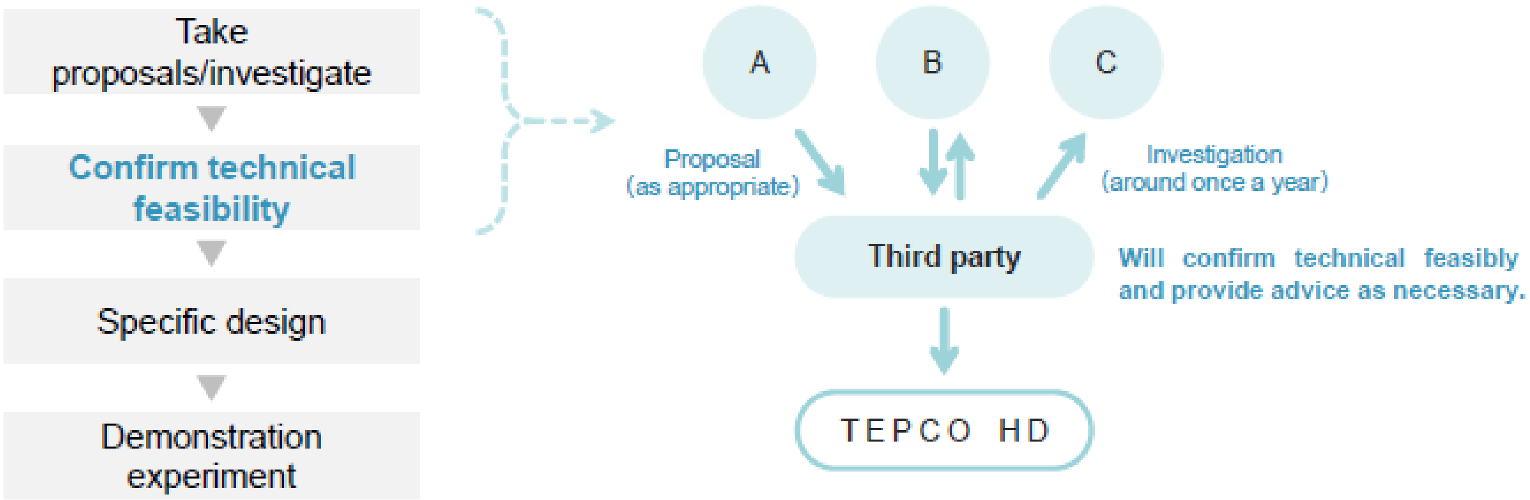
TEPCO

7. INVESTIGATION REGARDING TRITIUM SEPARATION TECHNOLOGY

7-1 Investigation Regarding Tritium Separation Technology

We will continue to keep a close eye on new technological developments in tritium separation technology.

- In accordance with TEPCO's plan announced on April 16, we have devised a new model for eliciting proposals and promoting widescale research on tritium separation technology that employs the help of a third party in order to ensure transparency.
- NineSigma Holdings, Inc. has been selected as our third-party partner. On May 27, NineSigma posted links on its website that give details on the open call project and where to apply. This marks the commencement of our public appeal to Japan and the rest of the world for proposals and research related to tritium separation technology.
  Links： (Japanese) https://www.ninesigma.com/s/TEPCO-galleryJP
  (English) https://www.ninesigma.com/s/TEPCO-galleryEN
- Going forward, when technologies are proposed via NineSigma's website, NineSigma shall confirm/evaluate the details of such technology and provide advice as necessary. The results will then be examined by TEPCO, and if it turns out that the technology is able to be realistically applied to water purified with multi-nuclide removal equipment (ALPS treated water, etc.), detailed designs will be drawn up and verification tests of the technology conducted with the aim of establishing the technology.



【Reference】Overview of technology being sought

TEPCO

- Proposed technologies will be assessed based on the following criteria first by NineSigma and then subjected to secondary assessment by TEPCO.
- All of the following requirements need not be fulfilled at the time the proposal is submitted, but must be fulfilled at some point in the future.

<Requirements>

Separation/ measurement	All of the following requirements must be met: • The concentration of tritium after treatment must be less than 1/1,000 of that prior to treatment. （Technology that can reduce the concentration of tritium to 1/100 or less at present is anticipated, which was required in the government's Demonstration Project for Verification Tests of Tritium Separation Technologies) • The reliability of measurement of tritium concentration can be explained. • The material balance of tritium throughout the tests can clearly be indicated.
Treatment capacity	• There is a technical prospect that is able to be increased to target operating capacity levels (50~500 m^3/day)

＜ Recommended items ＞

Principle	It is recommended that one, or both, of the following conditions be fulfilled: • The principle of separation technology has been widely recognized at academic conferences, etc. • The principle of separation technology has been recognized by third parties, e.g., included in peer-reviewed papers.

- Regarding Technologies for which practical application has been deemed feasible by the primary and secondary assessments, nature and volume of waste generated, compliance with the Nuclear Reactor Regulation Law, and the size of the area required for equipment installation, etc. will be reviewed by TEPCO.

8. CONCLUSION

8. Conclusion

TEPCO

- TEPCO will continue to carefully hold discussions with the local community and parties concerned, and listen to opinions in continuing our review.
- Furthermore, information shall be communicated swiftly and precisely to both domestic and abroad with a high degree of transparency to dispel concerns of the local community and society regarding our initiatives to decommission the Fukushima Daiichi Nuclear Power Station which includes the handling of ALPS treated water. We shall also put all our efforts into measures against adverse impacts on reputation.
- We shall also thoroughly provide information and explanation through the government for the planned safety review by the International Atomic Energy Agency (IAEA) regarding the discharge of ALPS treated water into the sea.