【Reference material】

Fukushima Daiichi Nuclear Power Station - Causes for the reduction in the water level of the outer dike in H4 area and related countermeasures

March 19, 2015

The Tokyo Electric Power Company, Inc.

東京電力
TEPCO

1. Overview (1)

- Around 22:30 on March 9, 2015, it was confirmed that the water level of the outer dike in H4 area had become approximately 15cm due to rainfall.
- When the water level was checked in the field, it was confirmed that the water level had dropped to approximately 10cm at around 6:24 on March 10.
- When the surrounding conditions were checked, it was confirmed that the water was flowing out from the eastern outer dike of H4 east and H4 north areas and air bubbles were coming out from the joints of the foundation area and the gutter between the inner dike and outer dike.
- The stagnant water in the outer dike started being transferred into the inner dike in H4 north area by means of a submersible pump or a suction vehicle from around 10:25 on March 10 and the transfer of water was concluded at around 14:52 as there was no more stagnant water. It was verified that outflow of water and the formation of bubbles had stopped.

1. Overview (2)

- Status of leakage
  - Volume of leakage: approx. 747m^3

※ Estimated as 747m^3 by subtracting the amount transferred to the inner dike (approx. 168m^3) from the total amount of rainfall and the amount of rain water flowing into the said outer dike (approx.915m^3)

  - Leaked water: Stagnant water inside the outer dike in H4 area

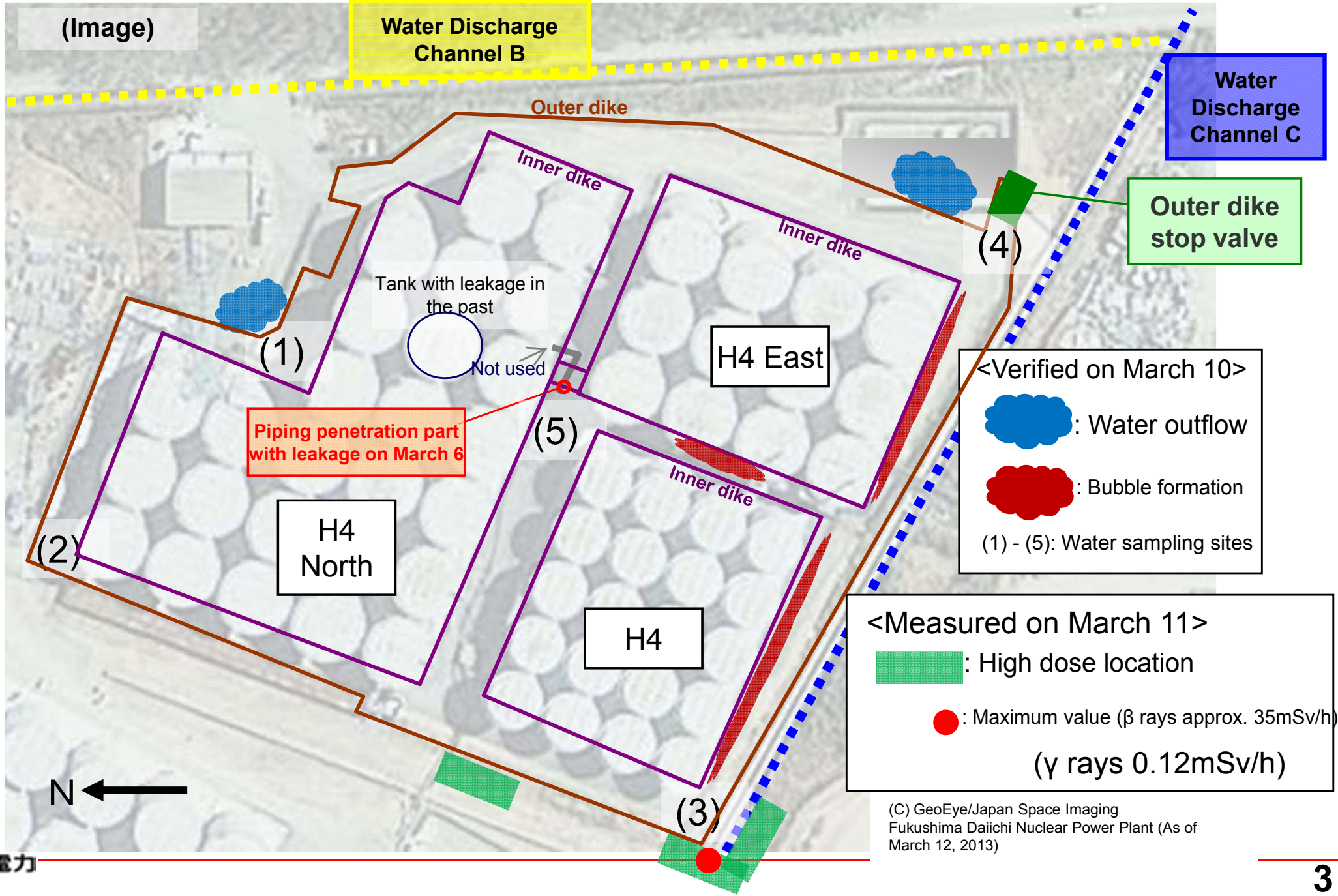
Since its influx into the drains in the periphery has not been confirmed and since there is no significant alteration in the readings of the gutter drainage radiation monitor in the premises, it is inferred that the water which flowed out from the outer dike did not flow into the sea although it had seeped into the ground in the vicinity of said outer dike.

  - Results of the analysis of the stagnant water inside the outer dike in H4 area (Collected and analyzed on March 10, 2015)

Water sampling site (Water sampling time)	**(1)**(9:10)	**(2)**(9:15)	**(3)**(9:20)	**(4)**(9:25)	**(5)**(9:30)
Total beta [Bq/L]	1,900	1,500	8,300	150	370
Cesium 134 [Bq/L]	ND(11)	ND(10)	ND(12)	ND(10)	ND(11)
Cesium 137 [Bq/L]	18	ND(17)	ND(16)	ND(16)	ND(17)

Please refer to “1. Overview (Reference: Conditions in the Field)” for the water sampling site numbers. ND in the table refers to the values below detection limit.

1. Overview (Reference: Conditions in the Field)



(C) GeoEye/Japan Space Imaging
Fukushima Daiichi Nuclear Power Plant (As of March 12, 2013)

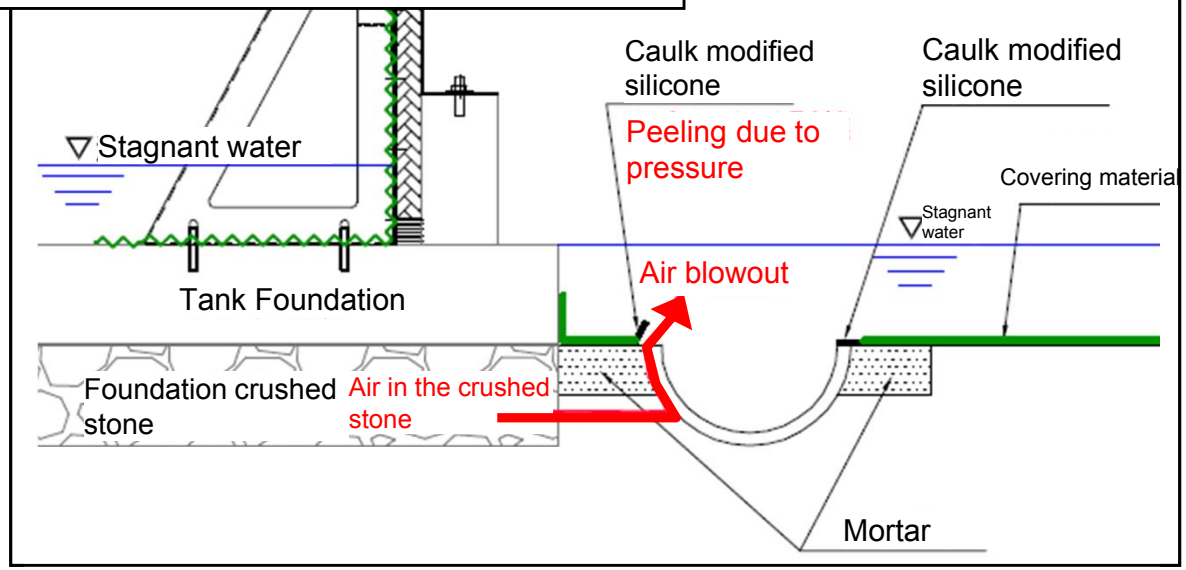
2. Cause Analysis (Reduction in water level in the outer dike)

- Partial peeling of the covering material of the earth-fill dam was noticed at the location where there was leakage from the earth-fill dam on the east side of H4 North.
- Gaps have been formed between the gutter and the surrounding mortar on the side of the gutter on the south side of H4 and it is assumed that there is seepage into the ground from these gaps.
- Further, it is inferred that the air that is accumulated in the crushed stones beneath the tank foundation is escaping from the gaps due to which air bubbles are being forming from the side of the gutter.

H 4 North-east side earth-fill dam

Peeling of covering material

Assumed causes of air bubbles



H 4 South side gutter

No obvious gap was noticed, but formation of air bubbles was verified

Gap on the side of the gutter

2. Cause Analysis (Contamination inside the outer dike due to β nuclide)

Possibility of leakage from the inner dike to the outer dike

- It is inferred that the impact of the rain water in the tank and inner dike is not a direct cause of the contamination in the outer dike because there is no significant variation in the water level of the contaminated water tank in H4 area and bacause there is no variation in the water level in the inner dike as well and the contamination level in the inner dike (Total β 1,000Bq/L or less) is lower than that in the outer dike (Maximum total β 8,300Bq/L).

Results of the analysis of the water inside the inner dike (Collected and analyzed on March 10, 2015)

Sampling area (sampling time)	H4 North (10:15)	H4 East (10:20)	**H4** (10:10)
Total beta [Bq/L]	730	450	400
Cesium 134 [Bq/L]	ND(11)	ND(11)	ND(12)
Cesium 137 [Bq/L]	ND(17)	ND(17)	ND(17)

Sampling area (sampling time)	H4 North (5:10 PM)	H4 East (5:10 PM)	**H4** (5:10 PM)
Total beta [Bq/L]	960	440	85
Cesium 134 [Bq/L]	ND(10)	ND(9.9)	ND(11)
Cesium 137 [Bq/L]	ND(17)	ND(16)	ND(17)

ND in the table refers to the values below detection limit.

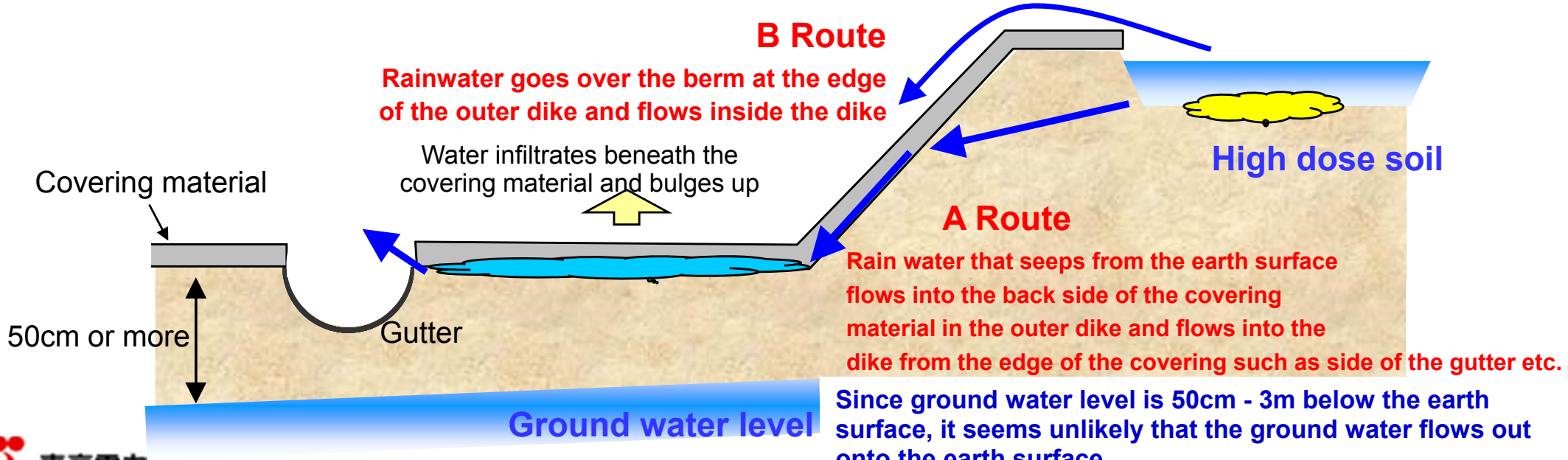
2. Cause Analysis (Contamination inside the outer dike due to β nuclide)

Reason why total β radioactivity (8,300Bq/L) is high in Location (3)

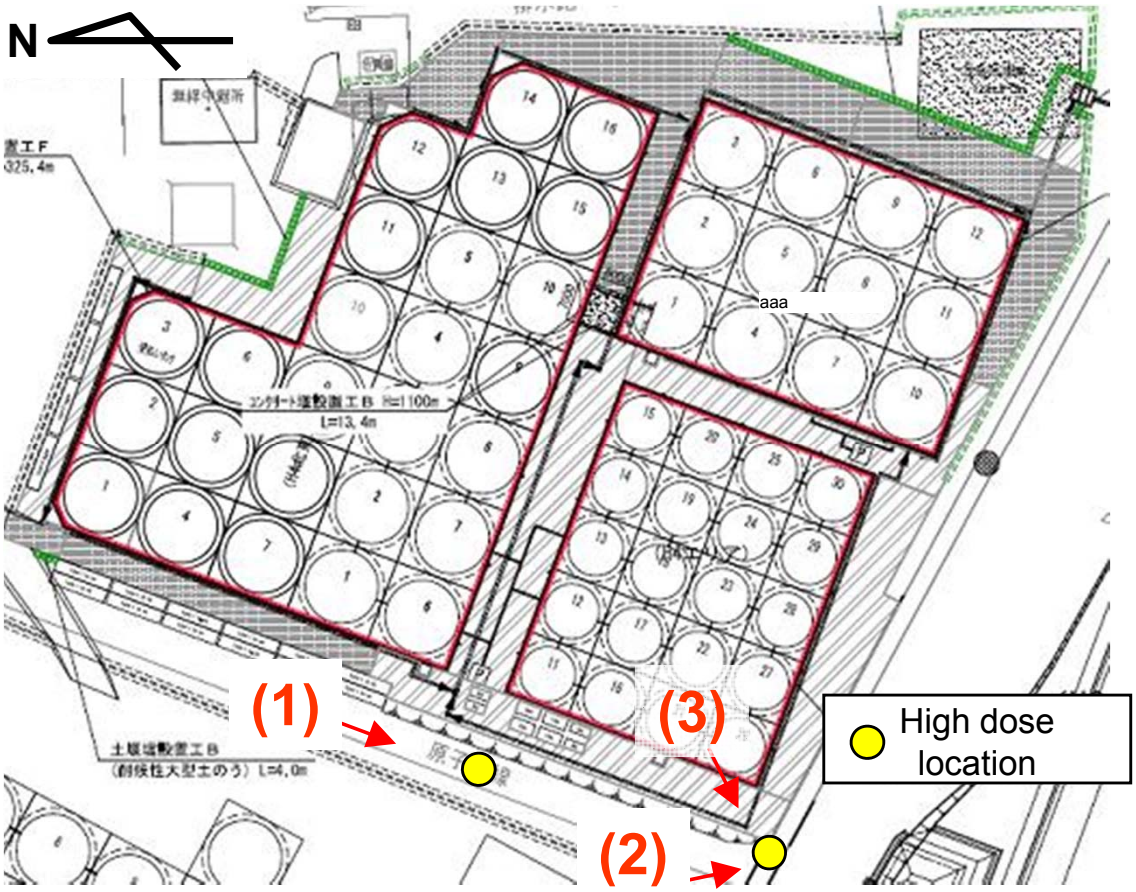
- It was confirmed that the high dose soil is distributed in 2 locations on the elevated area on the west side of outer dike in H4 area. These are the locations where there had been leakage from the concentrated water transfer pipe in March 2012.
- It is very likely that rain water that had come in contact with the contaminated soil during rainfall flowed into the dike via the route specified below and contaminated the water in the dike.

  A. Rain water that seeps from the earth surface flows into the back side of the covering material in the outer dike and flows into the dike from the edge of the covering such as side of the gutter etc.

  B. Rainwater goes over the berm at the edge of the outer dike and flows inside the dike.
- Further, both Location (1) (1,900Bq/L) and Location (2) (1,500Bq/L) are locations that were contaminated due to leakage of H4 tank in August, 2013 and leakage from the concentrated water transfer pipe in March 2012 respectively.



2. Cause Analysis (Reference: Pictures showing the condition of the high dose locations and other areas



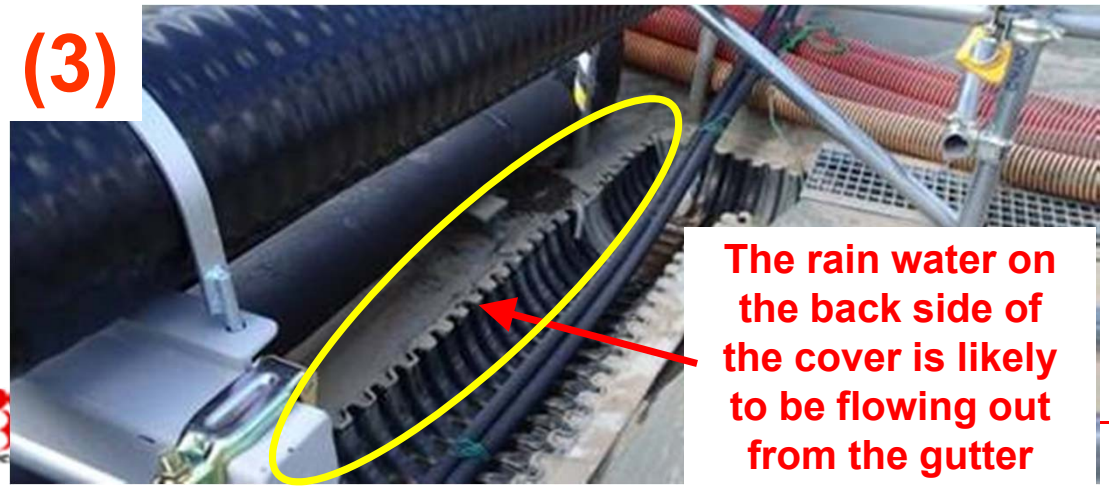
(1)

3/10 γ+β rays 4-11mSv/h (at 5cm)

(2)

3/11 β rays maximum 35mSv/h

(3)



The rain water on the back side of the cover is likely to be flowing out from the gutter

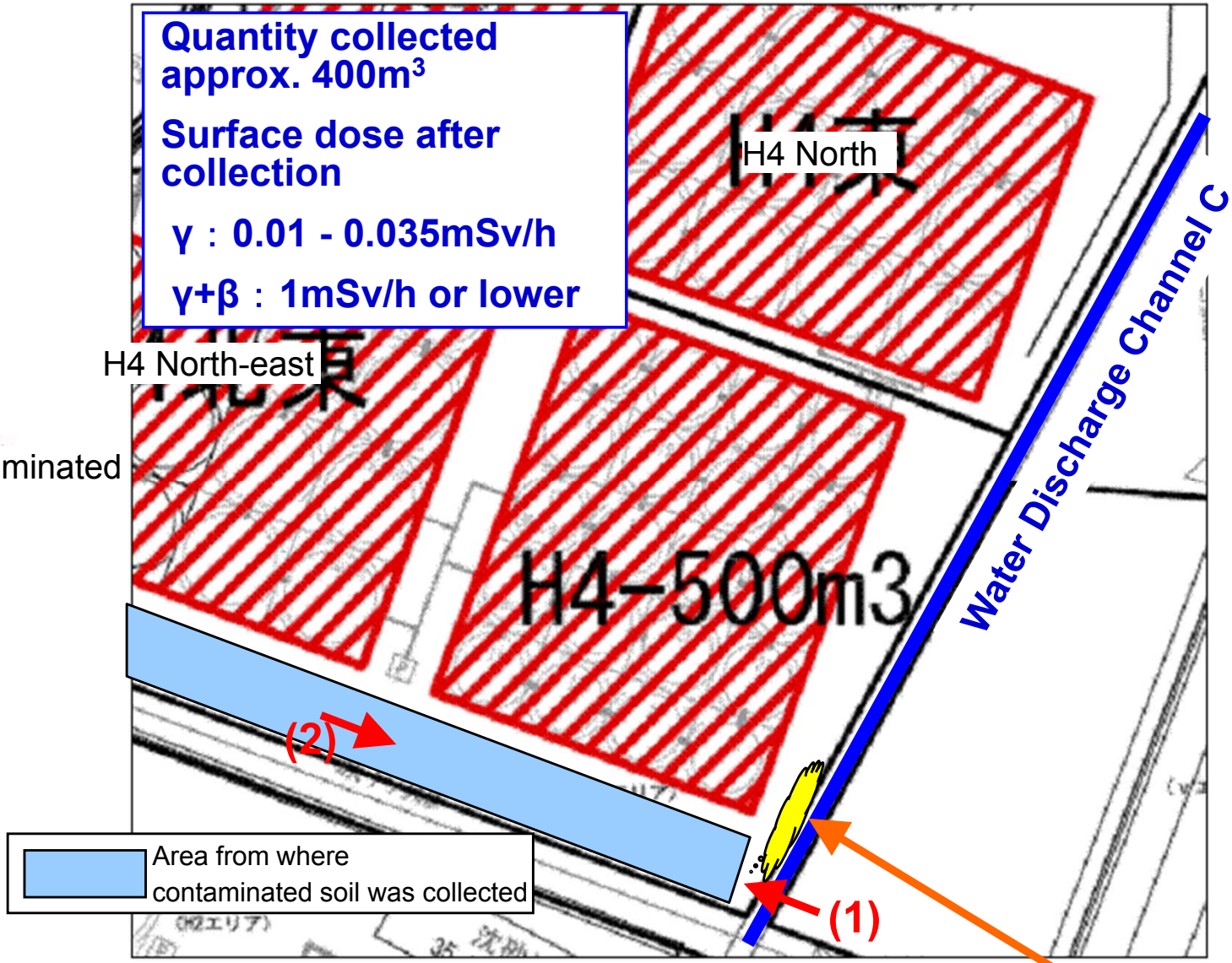
2. Cause Analysis (Reference: Leakage from the piping that transports concentrated salt water (occurred in March 2012)

(1)

(2)

Contaminated soil

After removal of contaminated soil



The water discharge channel had an open culvert at the time and based on the impact on the water discharge channel, it is likely that the surrounding soil was not collected adequately

3. Measures for H4 area

- H4 outer dike measures

1) Making the necessary fixes with respect to the peeling of the covering material and formation of bubbles from the gaps in the gutters (completed on March 16)

2) Inspection and maintenance of the covering material and the gaps in the gutters in the H4 area dike

3) Covering the entire inner surface of the outer dike to prevent recontamination

(spraying)

- Measures for soil contaminated with β nuclide

1) Compartmentalizing the soil contaminated with β nuclide and covering it with a sheet (implemented)

2) Manually collecting the soil contaminated with β nuclide (combing out) and covering it

3) Carrying out facing for the elevated area on the western side of the outer dike including the low contamination areas to prevent seepage of rain water

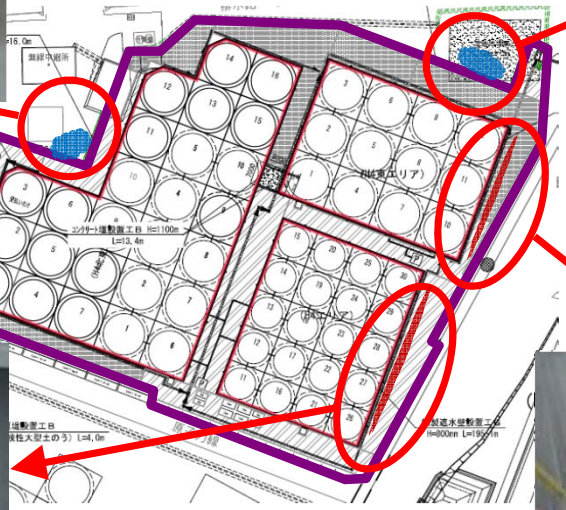
- Inspection and maintenance of tank areas other than the H4 area

3. Measures for the H4 area (repairs of the covering, gaps in the gutter etc.)

- As emergency measures, necessary fixes were made with respect to the peeling of covering material and gaps in the gutters. (3/14 - 3/17)
- Inspection and maintenance of the entire area was carried out, and facing is carried out to prevent recontamination.

Re-covering (3/14)

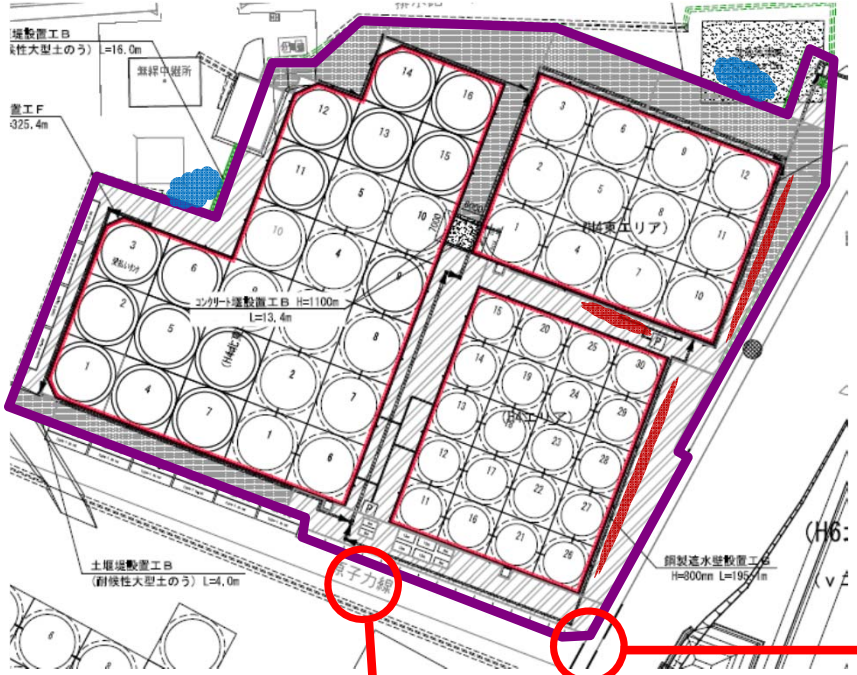
Re-covering (3/16)



Filling the gaps (3/14 - 3/17)

Filling the gaps (3/15)

3. Measures for the H4 area (measures for soil contaminated by β nuclide)

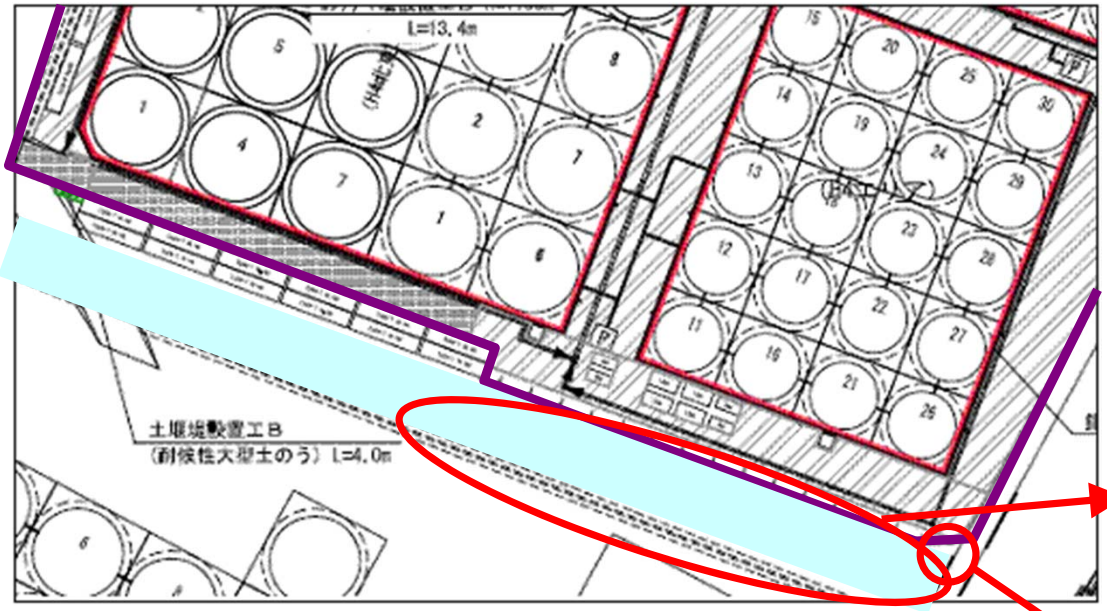


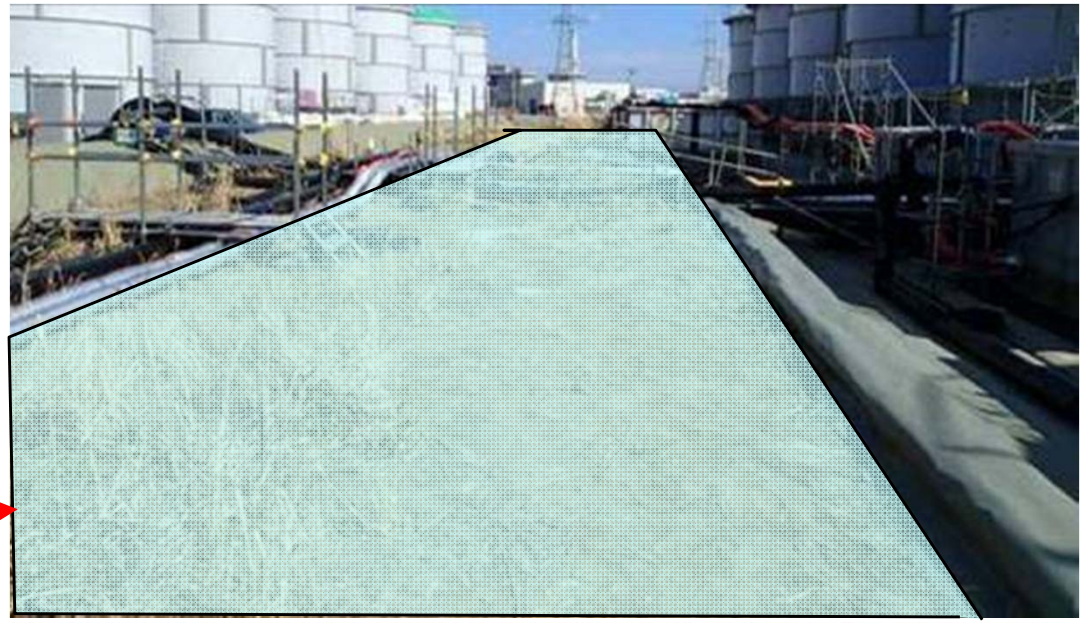
- The soil near the surface of the earth is collected manually and facing is carried out.
- Since the high dose locations in the south-western parts are lower than the peripheral ground, it is covered so that rainwater does not get accumulated.
- Large scale collection is difficult due to the following problems, and is carried out along with tank replacement
  1) Moving obstacles such as cables
  2) Transporting the water accumulated at the time of rainfall
  3) Manual collection in narrow places

Direction in which contaminated soil is removed

The soil near the surface of the earth is collected manually (combed out)
Facing is carried out and cover is installed

3. Measures for the H4 area (controlling seepage of rainwater from the western side)





Facing

- The soil near the surface of the earth, which is contaminated by β nuclides, is manually collected, and the seepage of contaminated rainwater is controlled and spread of contamination is prevented by carrying out overall facing of the western side of H4 including the low contamination areas.

3. Inspection and maintenance of tank areas other than the H4 area

- For areas other than H4 area, the locations that are likely to cause leakage and seepage of rainwater such as peeling of covering, gaps in gutters etc. are planned to be visually identified and fixed.
- Further, samples of water will be collected from the vicinity of the water discharge pit in B North & H6, where there was leakage from the tank in the past, and will be analyzed. If the results of the analysis indicate that there is no significant difference in the contamination of water when compared to the water flowing through water discharge channel B and C, "open operation of the outer dike" will be continued.
- After completing the implementation of the measures this time, the water quality of H4 will be analyzed, and after verifying that the quality of water is of the same level as that of the water flowing through water discharge channel B & C, "open operation of the outer dike" will be resumed.