

Classification of Waste

Non-radioactive Waste	Domestic Waste	Garbage	Household garbage: General garbage (combustible/non-combustible), large items	
			Commercial garbage: Waste from offices, restaurants, etc.	
		Raw sewage		
	Specially controlled domestic waste *1			
	Industrial Waste	Of the waste generated in commercial activities, 20 types of waste stipulated by law *2		
		Specially controlled industrial waste *3		
Radioactive Waste	Low-level Radioactive Waste	Power plant waste	Waste having an extremely low radioactive level	
			Waste having a relatively low radioactive level	
			Waste having a relatively high radioactive level	
	Uranium waste			
	Transuranic (TRU) radioactive waste			
	High-level Radioactive Waste			

*1: Explosive, toxic, infectious and any other waste that is likely to result in damage to human health or the living environment.

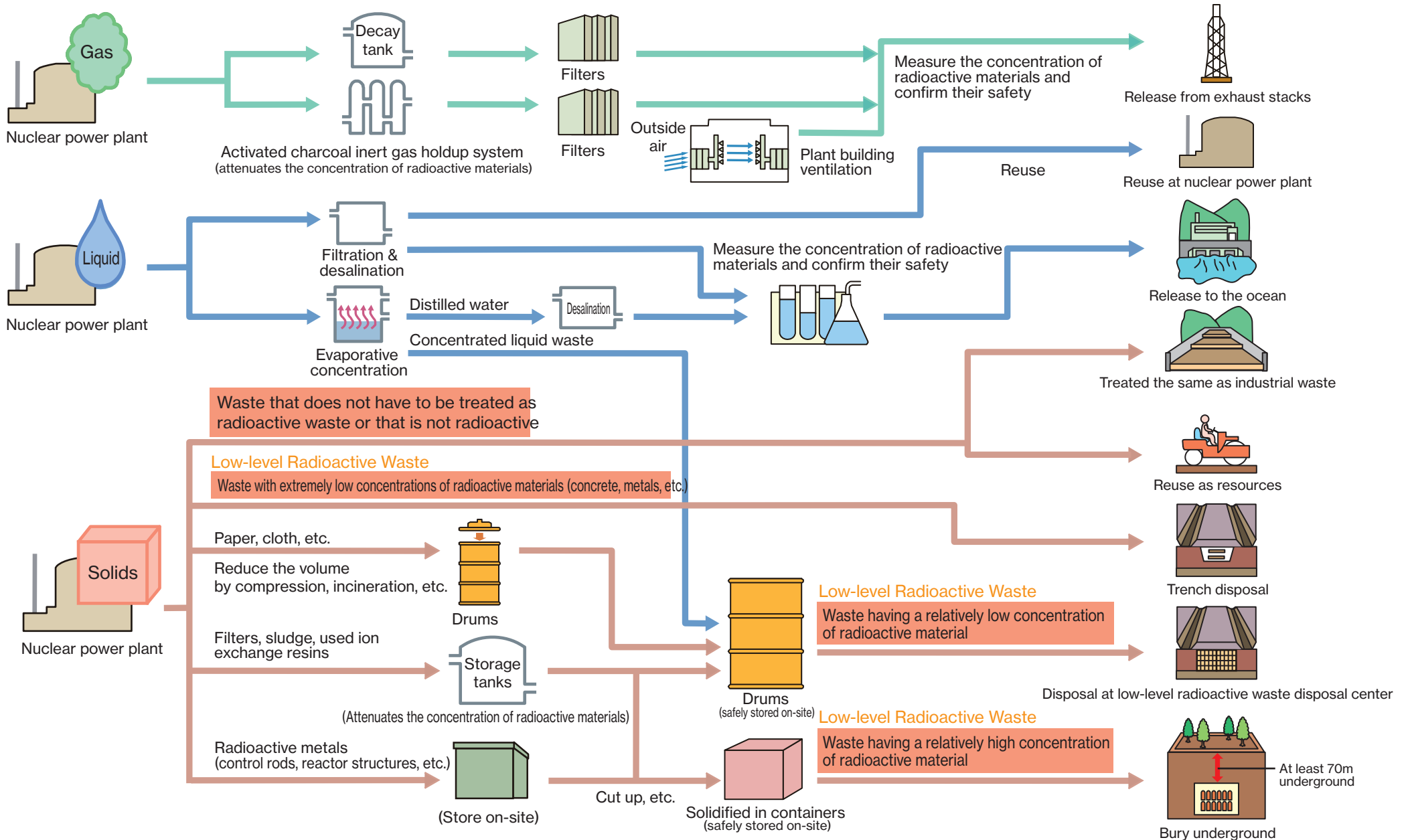
*2: Cinders, sludge, waste oil, scrap metal, glass & concrete waste, etc.

*3: Excluding domestic waste, explosive, toxic, infectious and any other waste that is likely to result in damage to human health or the living environment.

Quantity of Waste Generated in Japan

	Amount of Waste Generated (tons/day)		Notes
Domestic Waste	Mainly kitchen waste generated in the home, but also large items, and waste such as paper generated from offices	117,057	Data from 2017
Industrial Waste	Of the waste generated in commercial activities, includes waste plastics, acids and alkalis, etc.	1,060,274	Data from 2016
Radioactive Waste	Radioactive waste generated in the operation and maintenance of nuclear power facilities.	High Level 1.4	Estimates for 2000 to 2006
		Low Level 44	Data from 2017

Methods for Treating Nuclear Power Waste



Types of Radioactive Waste

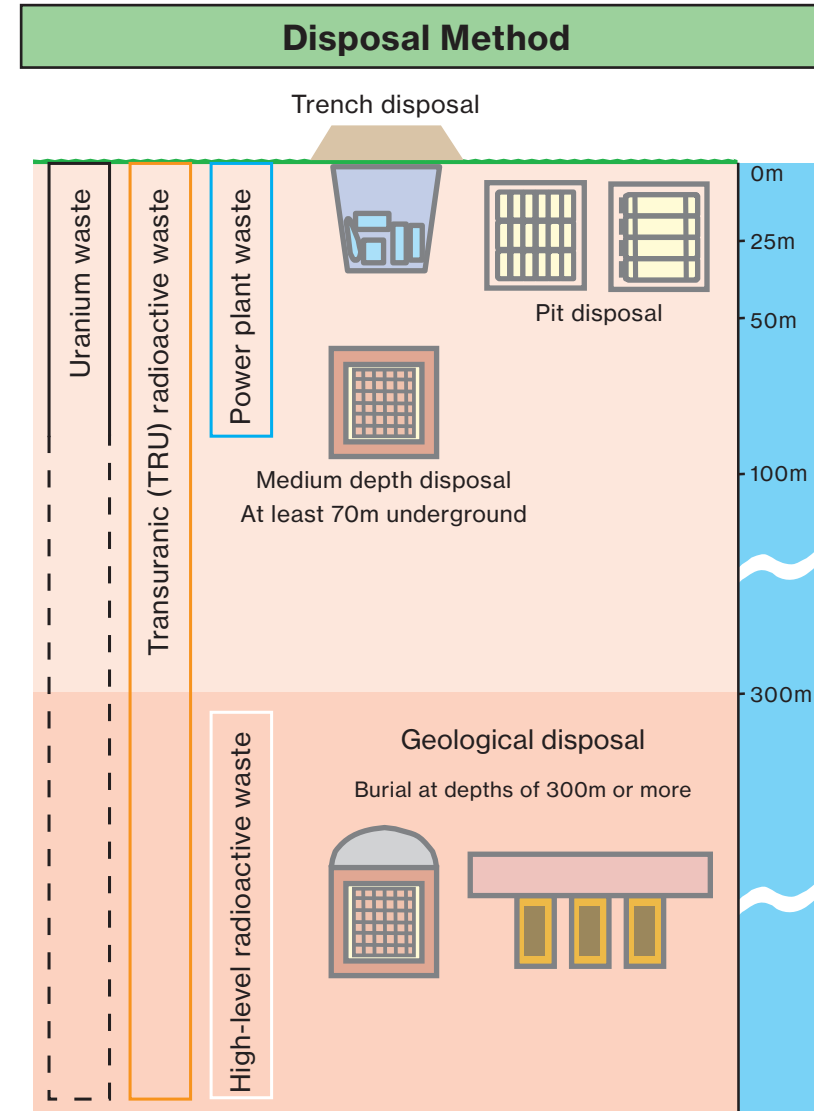
Waste Type		Example of Waste	Where Generated	Treatment Method	
Low-level Radioactive Waste	Power plant waste	Waste having an extremely low radioactive level	Nuclear power plant	Trench disposal	
		Waste having a relatively low radioactive level		Pit disposal	
		Waste having a relatively high radioactive level		Medium depth disposal	
	Uranium waste		Consumables, sludge, used tools and materials	Uranium enrichment and fuel fabrication plant	Medium depth disposal, pit or trench disposal; in some cases, deep geological disposal
	Transuranic (TRU) radioactive waste		Parts of fuel rods, liquid waste, filters	Reprocessing facilities, MOX fuel fabrication facilities	Geological, Medium depth disposal or pit disposal
High-level Radioactive Waste		Vitrified waste	Reprocessing plant	Geological disposal	

Waste below clearance level	Most of the waste from demolition of nuclear power plant	All power plants indicated above	Reuse or dispose of as general garbage
-----------------------------	--	----------------------------------	--

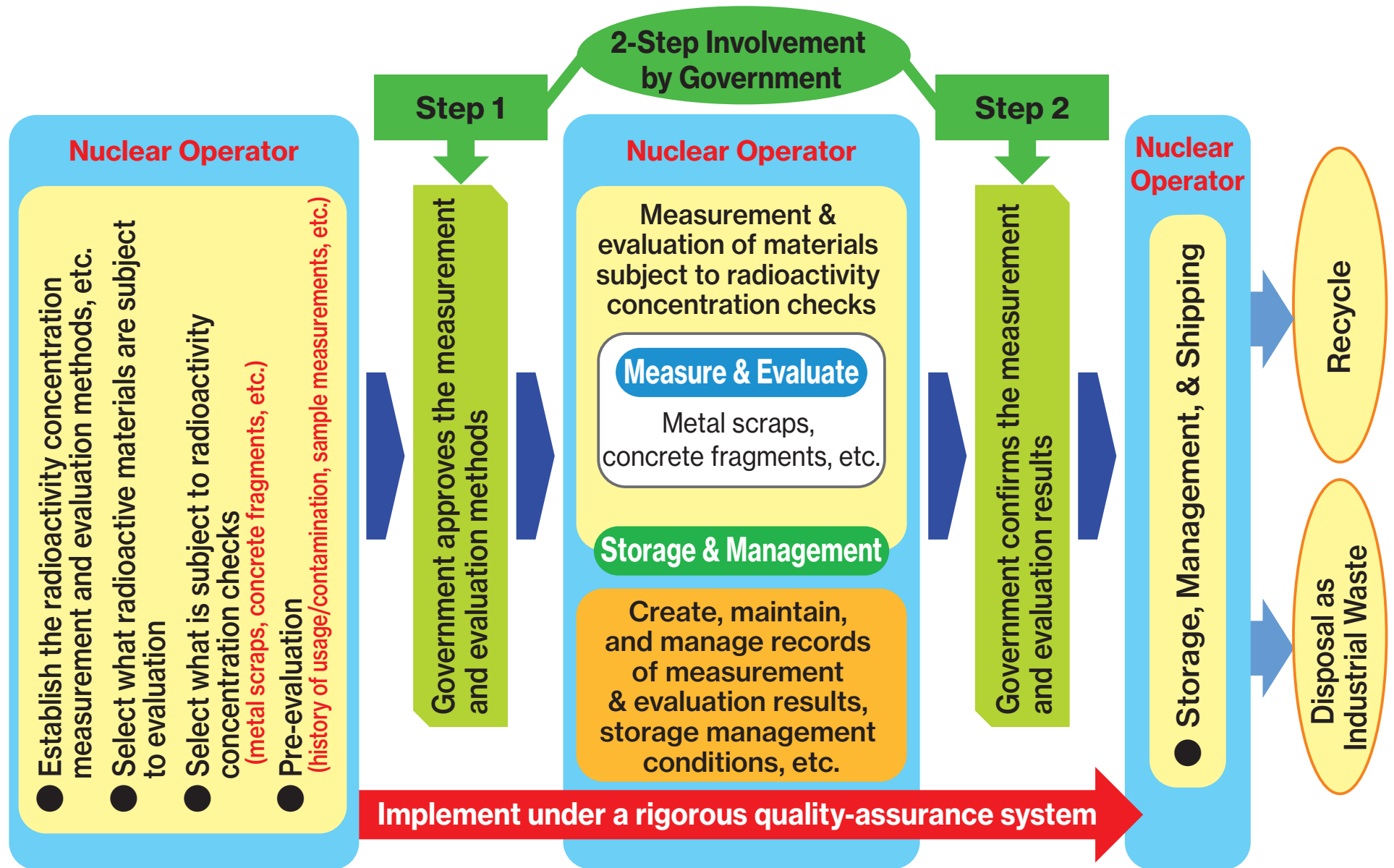
Radioactive Waste Types and Disposal

The depths and barriers are selected based on the radioactivity level, and the disposal of radioactive waste is performed using divided trench and pit disposal, medium depth disposal, and geological disposal.

Source	Waste Types		
Nuclear power plant	Low-level radioactive waste	Power plant waste	Waste having an extremely low radioactive level
			Waste having a relatively low radioactive level
			Waste having a relatively high radioactive level
Uranium enrichment and fuel fabrication plant	Low-level radioactive waste	Uranium waste	
MOX fuel fabrication plant		Transuranic (TRU) radioactive waste	
Reprocessing plant	High-level radioactive waste		

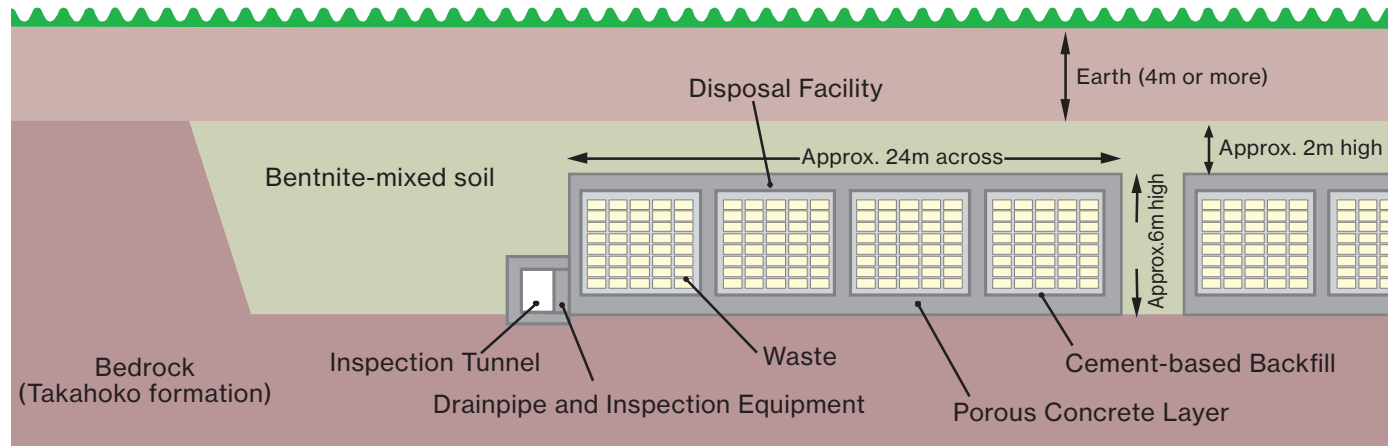


Overview of the Clearance System

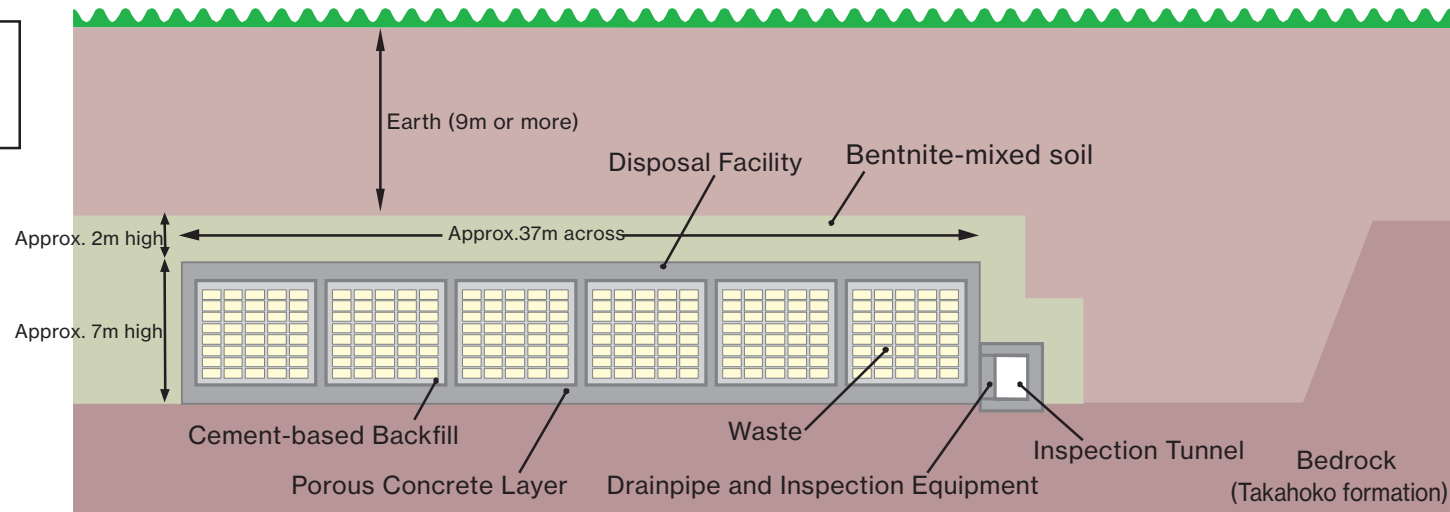


Structure of Low-level Radioactive Waste Disposal Facility

Structure of No.1 Disposal Facility



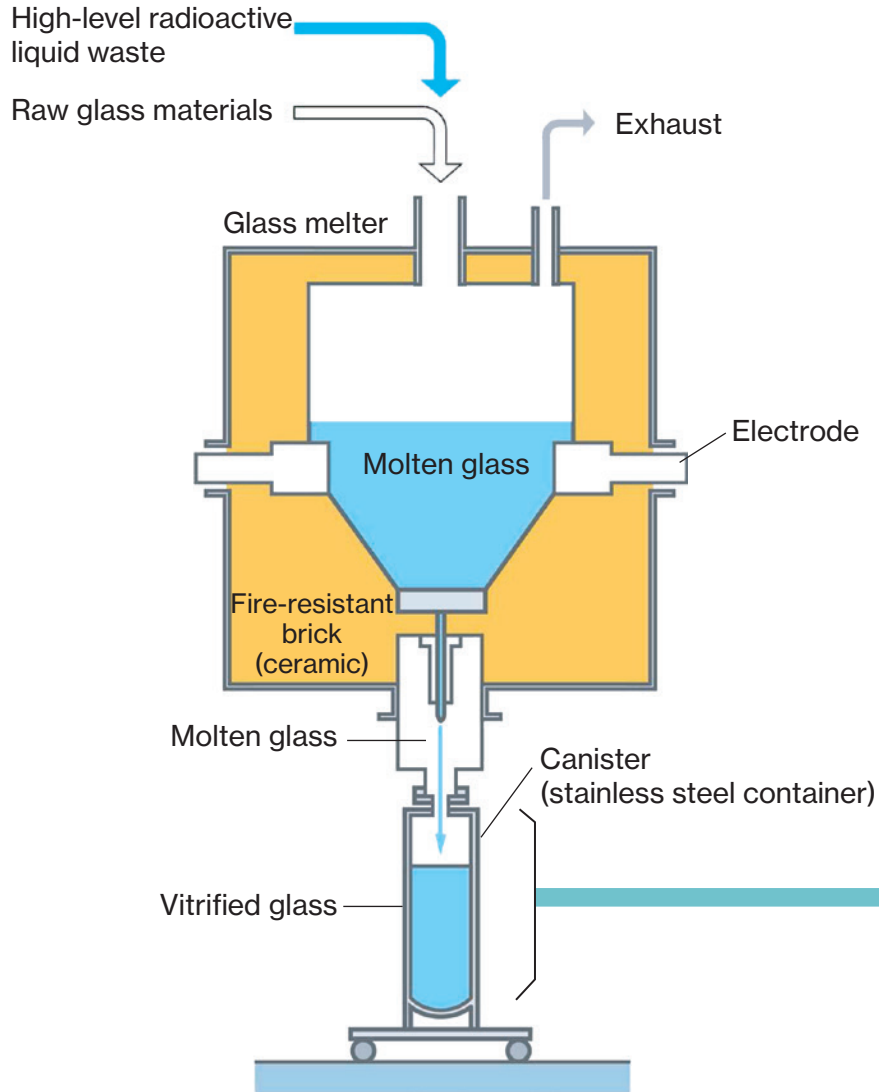
Structure of No.2 Disposal Facility



Stages in the Management After Underground Storage of Waste With Relatively Low Radioactivity Level

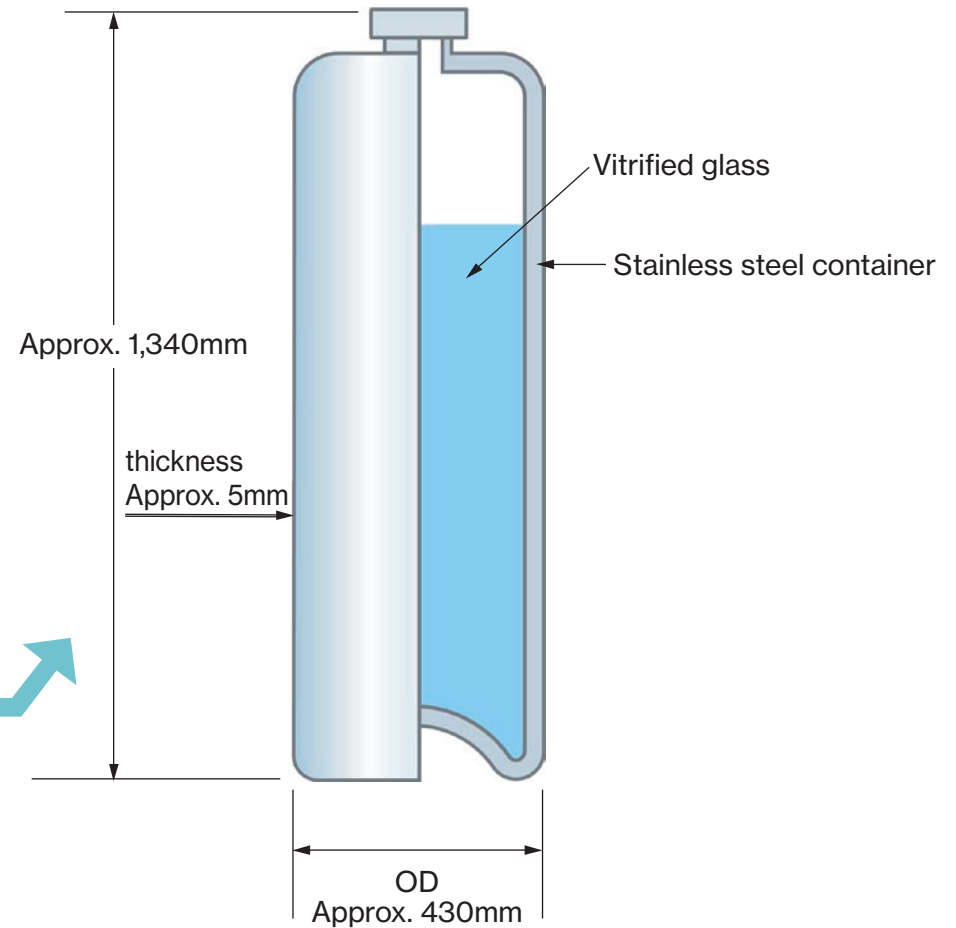
Stage	From start of acceptance until soil-cover completion	From soil-cover completion until before the start of decommissioning
Scheduled End Date	<ul style="list-style-type: none"> ● Underground Waste Storage Facility No. 1 Underground storage facilities Group 1 to Group 6 Within 35 years after the start of underground storage Underground storage facilities Group 7 and Group 8 Within 43 years after the start of underground storage 	About 300 years after soil-cover completion
	<ul style="list-style-type: none"> ● Underground Waste Storage Facility No. 2 Within 30 years after the start of underground storage 	
	<ul style="list-style-type: none"> ● Underground Waste Storage Facility No. 3 Within 27 years after the start of underground storage 	
Concept	Prevents leakage from underground equipment	Suppresses migration of radioactive materials into groundwater
Details of Management	<ul style="list-style-type: none"> • Establishing of underground storage conservation areas, and installing signage at underground waste storage sites • Patrolling and inspecting the underground waste storage facilities • Monitoring and measuring to determine the status of underground waste storage sites and their groundwater, in order to conduct periodic evaluations and obtain the data needed for these evaluations 	
	<ul style="list-style-type: none"> • Restoring underground storage equipment and soil-cover 	<ul style="list-style-type: none"> • Restoring soil-cover
	<ul style="list-style-type: none"> • Establishing peripheral monitoring areas, and prohibiting residence and restricting entry • Monitoring the radiation levels near the borders of the peripheral monitoring areas, and monitoring the concentrations and dosage of radioactive materials in groundwater 	<ul style="list-style-type: none"> • Prohibiting use of stream water and prohibiting residence • Restricting surface-excavation (restricting installation of wells and restricting unnecessary drilling) • Monitoring of radiation levels within facility premises, and monitoring of concentrations and dosages of radioactive waste in groundwater
	<ul style="list-style-type: none"> • Drainage from equipment for drainage and monitoring • Monitoring to ensure there is no leakage from underground equipment (in the limited areas of underground waste storage sites) 	<ul style="list-style-type: none"> • Monitoring for leakage from underground waste storage sites

How Vitrified Waste is Created

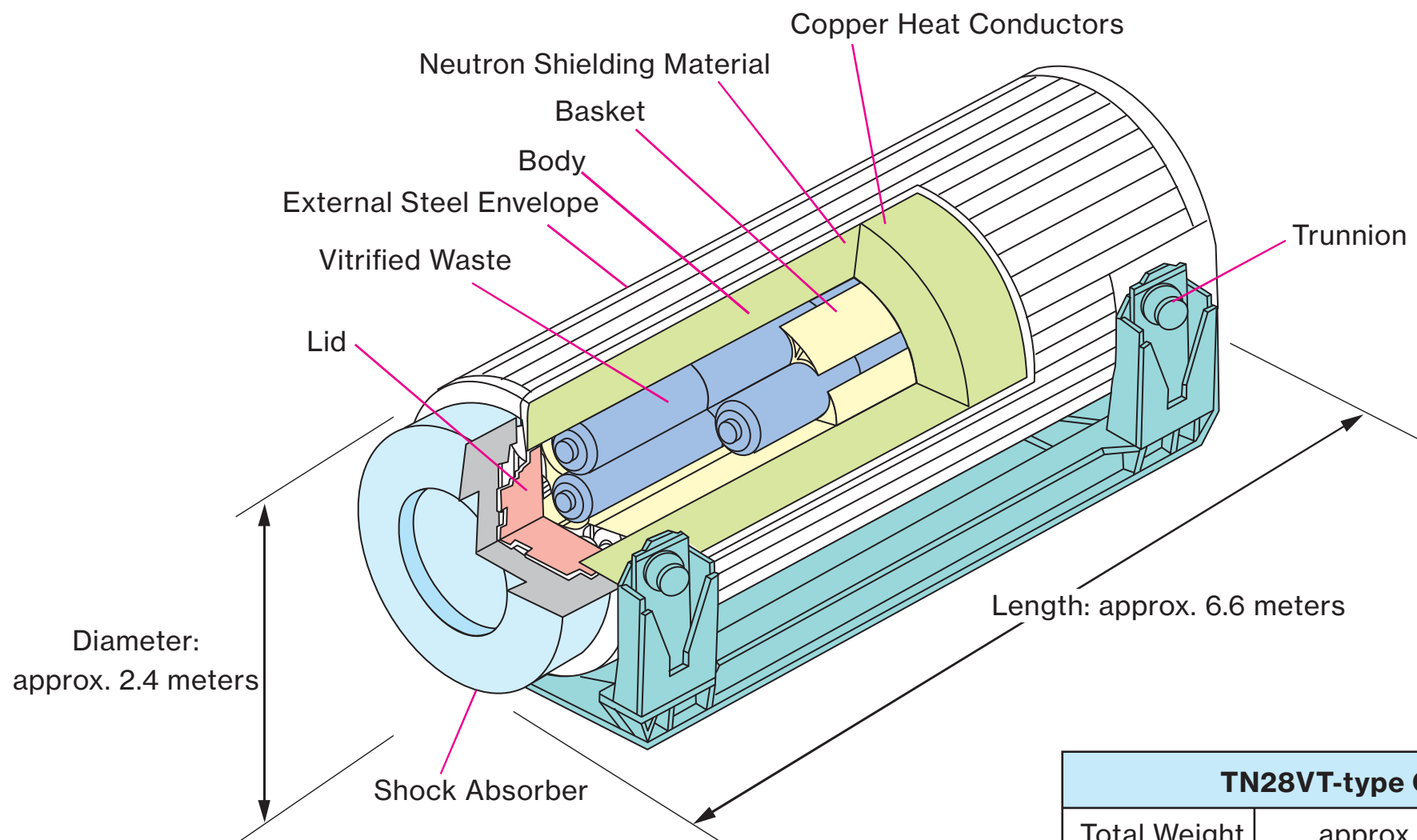


Properties of Vitrified Glass

Volume: Approx. 150ℓ of vitrified glass
Mass: Approx. 490kg (empty container: 90kg)



Transport Casks for High-level Radioactive Waste (Vitrified Waste) Shipment Container



TN28VT-type Cask	
Total Weight	approx. 113.5 tons
Capacity	28 canisters

Transport Vessels for High-level Radioactive Waste (Vitrified Waste)

Satellite Navigation and Communication System

Twin Radars

Safety Features of Transport Vessels for HLW (vitrified waste)

- Double hulls and hull reinforcement to withstand collision damage
- Enhanced buoyancy to ensure the ship will continue to float even in extreme circumstances
- Dual navigation, communication, cargo monitoring and cooling systems
- Satellite navigation and tracking
- Twin engines, rudders and propellers
- Additional firefighting equipment, including hold spray and flooding systems, and spare electrical generators
- Fixed radiation monitors for each hold that are linked to an alarm system on the bridge

Twin Propellers and Rudders

Independent Engine & Gearbox

Main Electricity Generator

Collision Reinforcement

Reinforced Hatch Cover

Emergency Generator

Salvage Towing Brackets

Secondary Collision Bulkhead

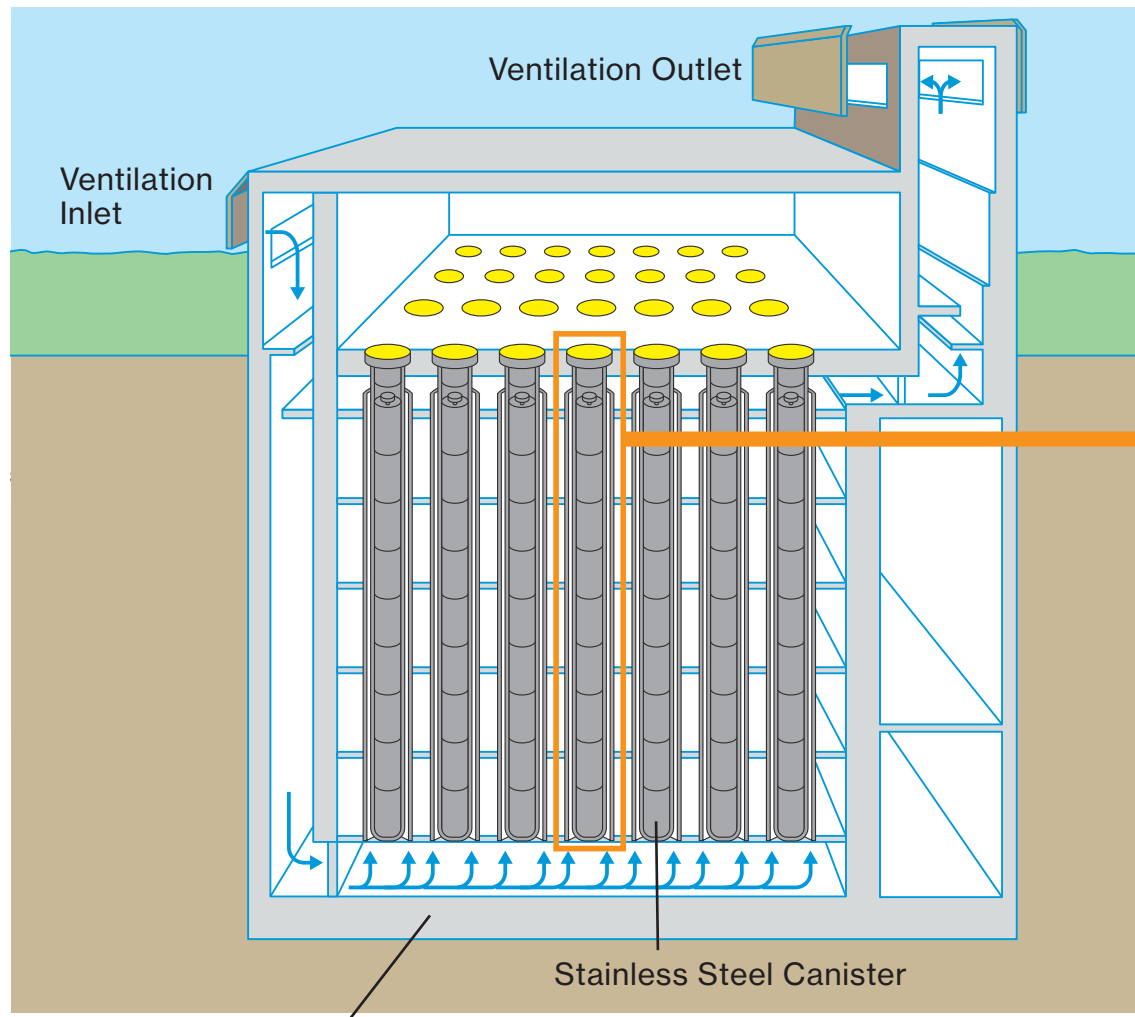
Generator
Bow Thruster

Primary Collision Bulkhead

Transport Vessel Specifications Example

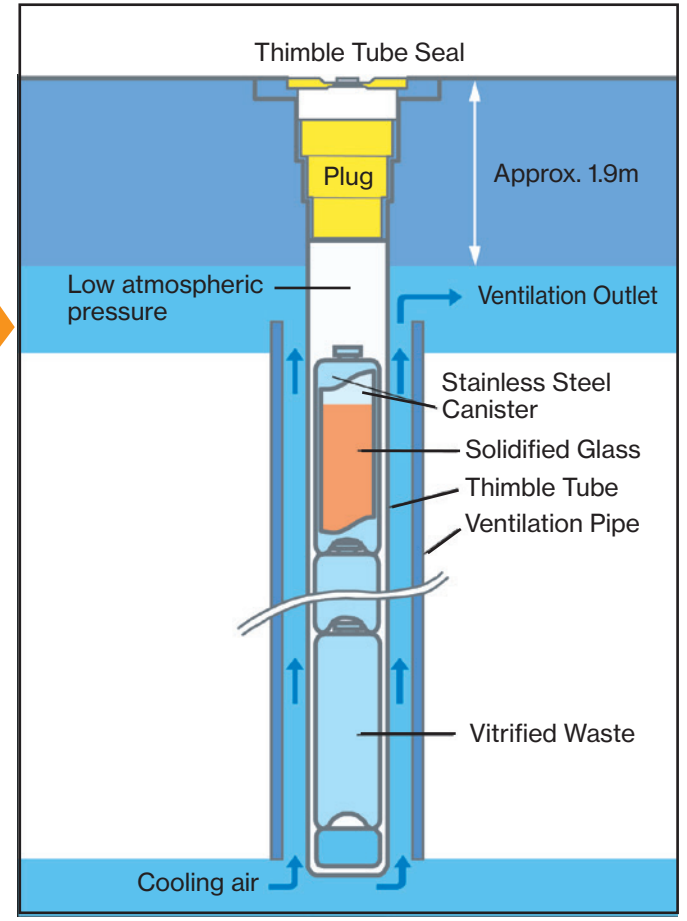
Size	Length: approx. 104 meters Width: approx. 17 meters
Gross Tonnage	approx. 5,000 tons
Deadweight	approx. 3,500 tons

Temporary Storage for High-level Radioactive Waste (Vitrified Waste)



Storage Pits

Enlarged image of storage pits



Record of Return and Acceptance of High-Level Radioactive Waste (Vitrified)

(As of Feb. 2018)

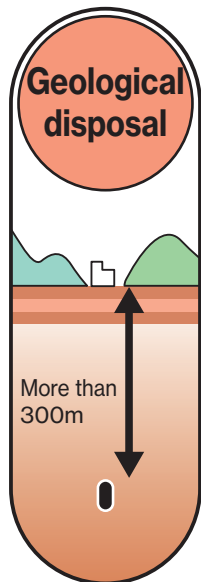
Returned Shipment Count	Name of Transport Ship	Transport Containers	Route	Qty of Returned Vitrified Canisters	Origin	Destination	Receipt Complete
1st	Pacific Pintail	1	Via S. America/Cape Horn	28	France, Cherbourg Harbor 2/23/1995	Mutsu-Ogawara Port 4/26/1995	October 12, 1995
2nd	Pacific Teal	2	Via Cape of Good Hope/SW Pacific	40	France, Cherbourg Harbor 1/13/1997	Mutsu-Ogawara Port 3/18/1997	July 29, 1997
3rd	Pacific Swan	3	Via Panama Canal	60	France, Cherbourg Harbor 1/21/1998	Mutsu-Ogawara Port 3/13/1998	September 15, 1998
4th	Pacific Swan	2	Via Panama Canal	40	France, Cherbourg Harbor 2/25/1999	Mutsu-Ogawara Port 4/15/1999	July 26, 1999
5th	Pacific Swan	4	Via Panama Canal	104	France, Cherbourg Harbor 12/29/1999	Mutsu-Ogawara Port 2/23/2000	August 21, 2000
6th	Pacific Swan	8	Via S. America/Cape Horn	192	France, Cherbourg Harbor 12/19/2000	Mutsu-Ogawara Port 2/20/2001	May 17, 2002
7th	Pacific Sandpiper	6	Via Panama Canal	152	France, Cherbourg Harbor 12/5/2001	Mutsu-Ogawara Port 1/22/2002	June 11, 2003
8th	Pacific Swan	6	Via Panama Canal	144	France, Cherbourg Harbor 6/4/2003	Mutsu-Ogawara Port 7/23/2003	June 2, 2004
9th	Pacific Sandpiper	5	Via Panama Canal	132	France, Cherbourg Harbor 1/19/2004	Mutsu-Ogawara Port 3/4/2004	July 20, 2005
10th	Pacific Sandpiper	5	Via Cape of Good Hope/SW Pacific	124	France, Cherbourg Harbor 2/17/2005	Mutsu-Ogawara Port 4/20/2005	April 26, 2006
11th	Pacific Sandpiper	7	Via Panama Canal	164	France, Cherbourg Harbor 2/1/2006	Mutsu-Ogawara Port 3/23/2006	April 10, 2007
12th	Pacific Sandpiper	6	Via Panama Canal	130	France, Cherbourg Harbor 2/8/2007	Mutsu-Ogawara Port 3/27/2007	August 31, 2007
13th	Pacific Sandpiper	1	Via Panama Canal	28	UK Barrow Harbor 1/21/2010	Mutsu-Ogawara Port 3/9/2010	June 4, 2010
14th	Pacific Glebe	3	Via Panama Canal	76	UK Barrow Harbor 8/3/2011	Mutsu-Ogawara Port 9/15/2011	August 31, 2012
15th	Pacific Glebe	1	Via Panama Canal	28	UK Barrow Harbor 1/9/2013	Mutsu-Ogawara Port 2/27/2013	April 9, 2013
16th	Pacific Glebe	5	Via Cape of Good Hope/SW Pacific	132	UK Barrow Harbor 2/14/2014	Mutsu-Ogawara Port 4/22/2014	January 29, 2015
17th	Pacific Glebe	5	Via Panama Canal	124	UK Barrow Harbor 7/28/2015	Mutsu-Ogawara Port 9/16/2015	March 27, 2016
18th	Pacific Glebe	5	Via Panama Canal	132	UK Barrow Harbor 9/1/2016	Mutsu-Ogawara Port 10/20/2016	March 10, 2017

Total Received: 1,830

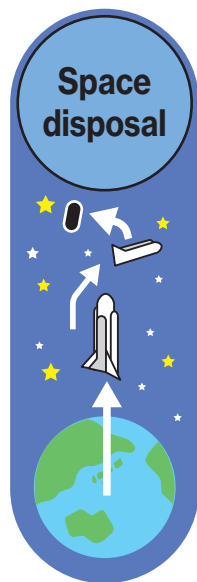
Examination of Methods for Disposing of High-Level Radioactive Waste

Given the difficulties of people managing wastes into perpetuity and not burdening future generations with monitoring them, methods have been examined that would allow safe disposal without the need for human management.

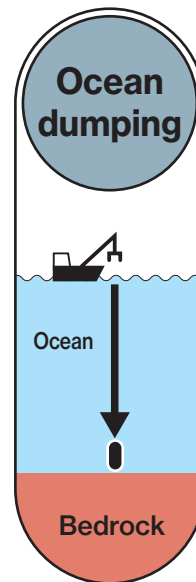
- Disposal in geological formations are considered highly feasible, given the numerous examples of underground resources already being maintained for a long time.
- With disposal in space, problems exist in reliability of launching technologies.
- Ocean dumping, in which waste is discarded in deep parts of the sea, is banned under the London Convention.
- Disposal in polar ice is banned under the Antarctic Treaty. Further, features of the ice sheet are not fully known.



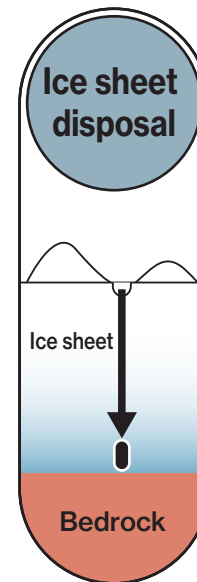
- Use the properties inherent to geological formation to lock up materials



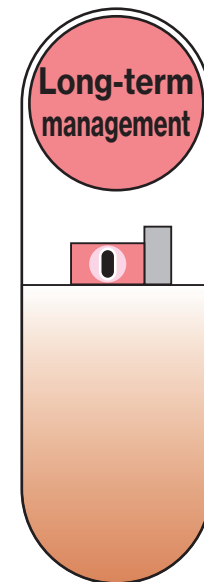
- Problems with reliability of launch technologies



- Banned by London Convention regulating ocean dumping

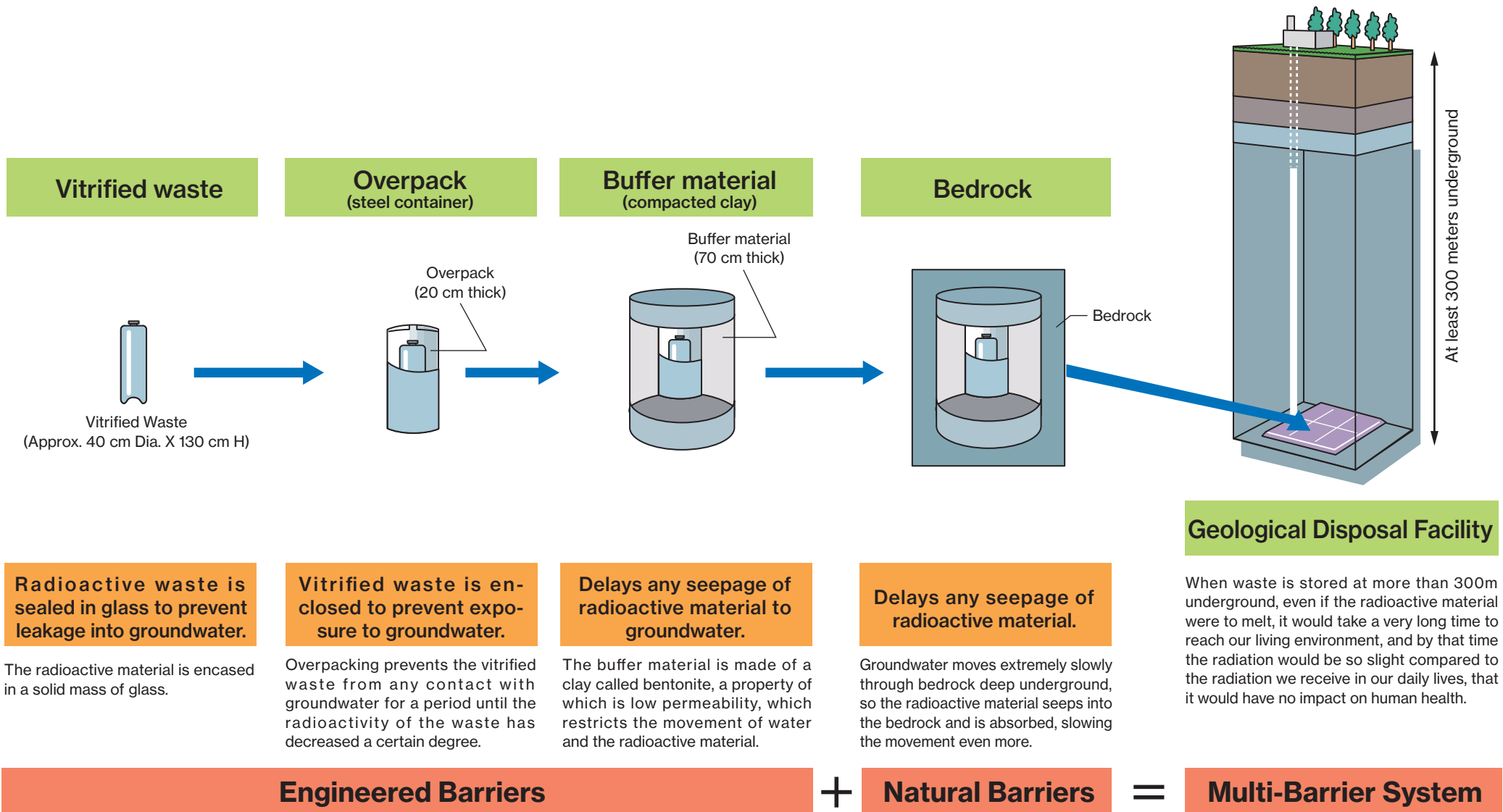


- Banned by Antarctic Treaty
- Features of ice sheet not fully known



- Human management in perpetuity difficult
- Burdens future generations with monitoring

Multi-Barrier System for Disposing of High-Level Radioactive Waste

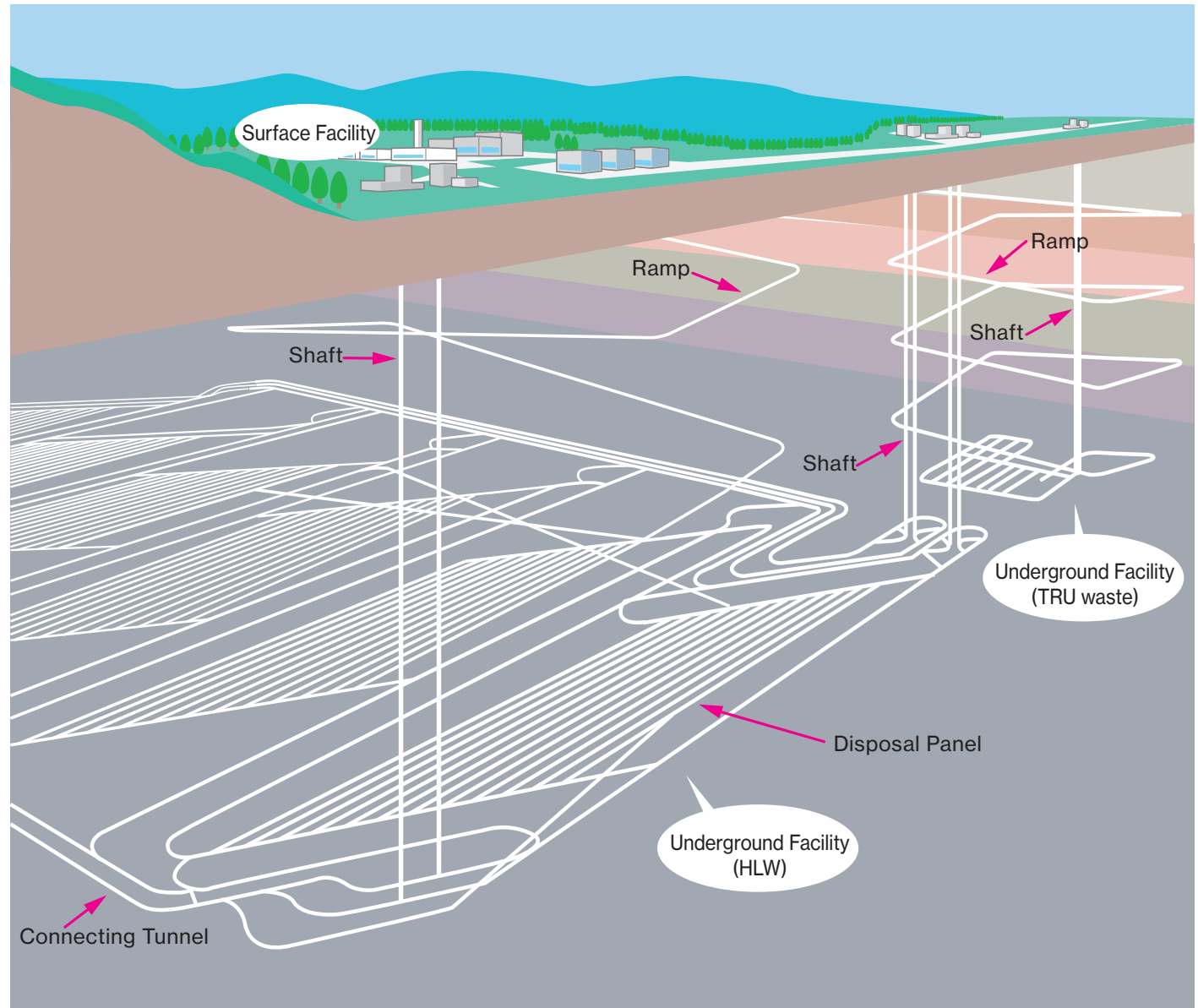


Geological Disposal of High-level Radioactive Waste

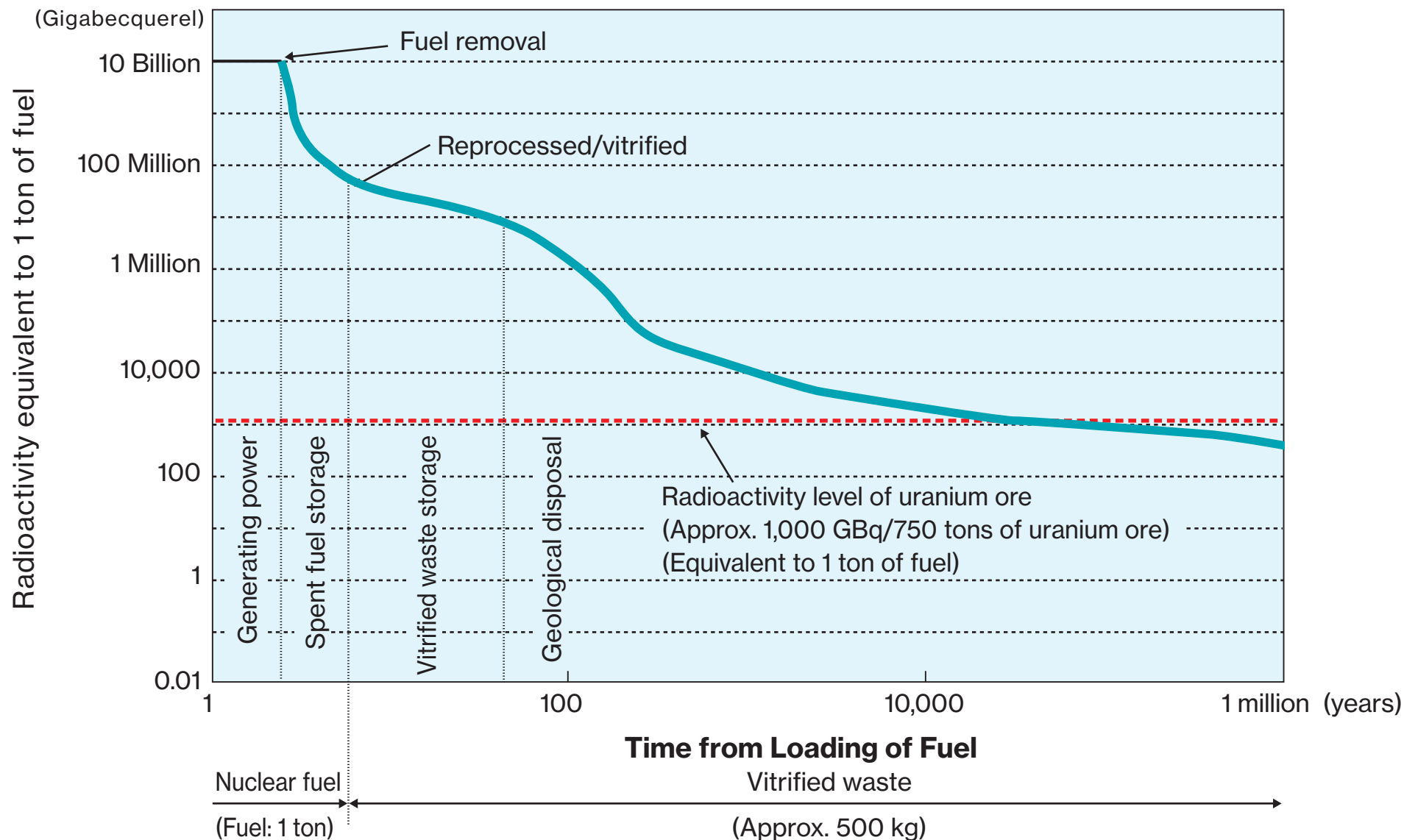
Example of layout in case of co-location with TRU waste disposal facility

Example of specifications
(crystalline basement, depth of 1,000m)

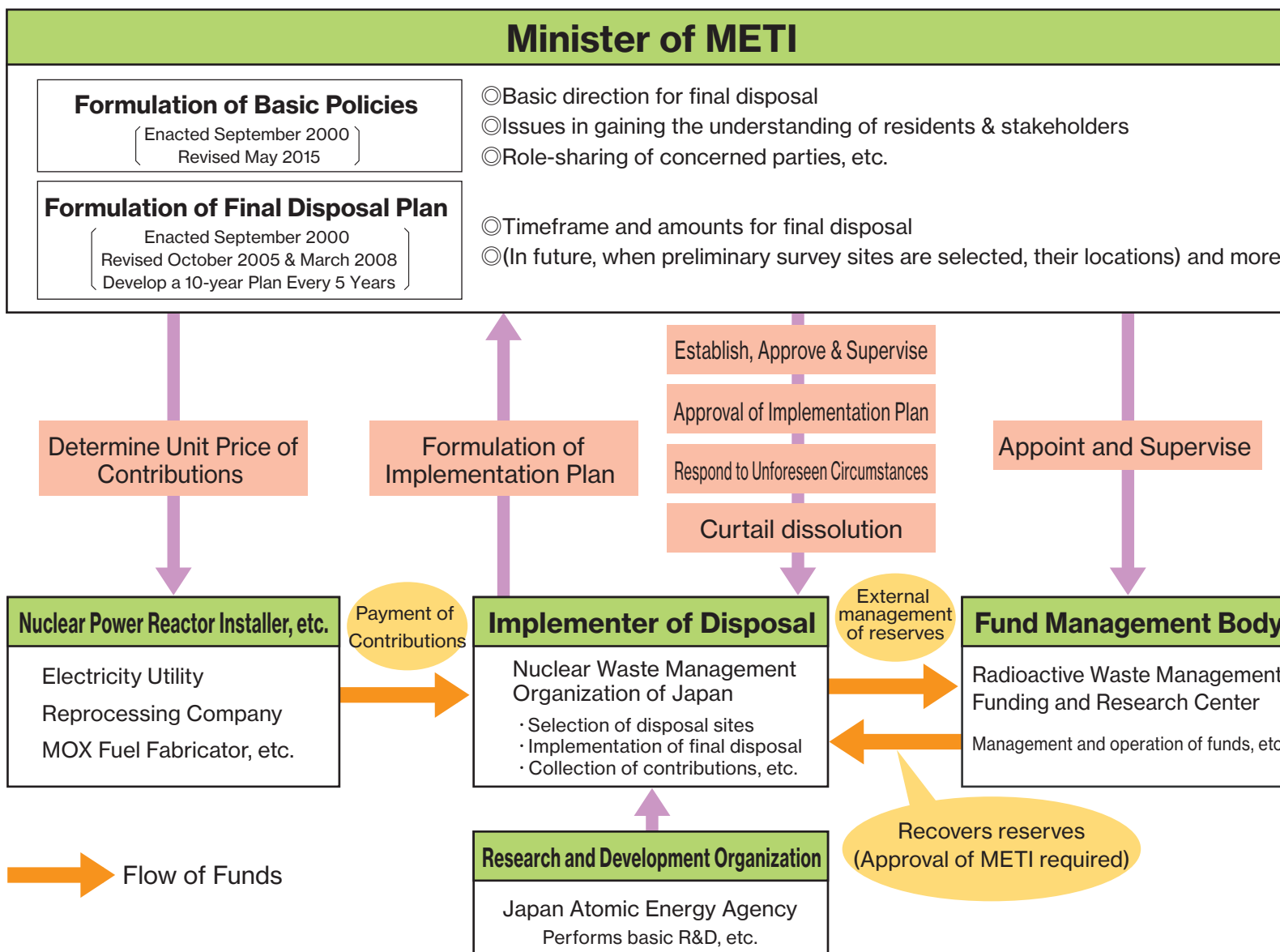
Surface Facility	Ground area: 1 ~ 2km ²
Underground facility for HLW	Disposal area: Approx. 3km x 2km
Underground facility for TRU waste	Disposal area: Approx. 0.5km x 0.3km



Decay of Radioactivity of High-Level Radioactive Waste



Systems for Handling the Treatment and Disposal of High-Level Radioactive Waste



(Note) In terms of final disposal methods, high-level radioactive waste generated from nuclear power generation is referred to as "specific radioactive waste" and geological disposal is referred to as "final disposal".

Geological Disposal Site Selection Process

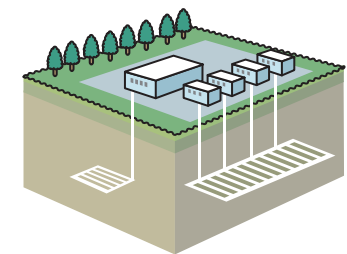
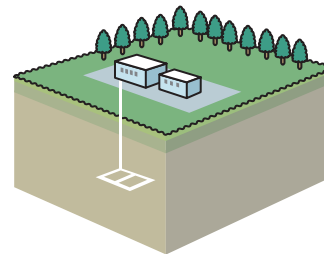
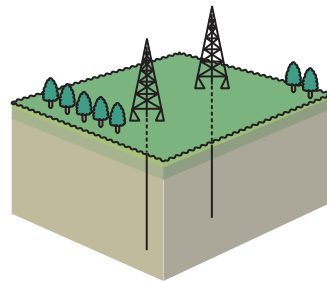
Proposal of nationwide map of scientific features for geological disposal (mapping)

Activities focused on gaining understanding (holding explanatory meetings etc.)

- Applicants from municipalities
- Proposals from the Government for multiple locations

Add a new process for the start of literature surveys

Selection process determined by the final disposal Act



(1) Literature surveys

(2) Preliminary Investigations
(Implementation of boring etc.)

(3) Detailed Investigation
(Construction and testing of underground facilities)

Facilities construction
Start of waste introduction

Approximately 20 years

(Note) The opinions of local governments at each survey stage are listened to and fully respected (in the case of opposition, do not proceed to the next stage).

Disposal Plans for High-Level Radioactive Waste by Country

(as of the end of December 2024)

Country	Implementing Body	Type of Waste	Amount	Disposal Sites (Candidate) & Rock Types	Disposal Depth	Scheduled Start Operation Time
France	French National Radioactive Waste Management Agency (ANDRA)	High-level, vitrified waste	11,800m ³ (if all is reprocessed)	Meuse , 11 municipalities of Haute-Marne (Near the Bure Underground Laboratory) Rock type: clay layer	About 500m	2040s
Japan	Nuclear Waste Management Organization of Japan (NUMO)	High-level, vitrified waste	40,000 + canisters	Site to be determined Rock type: to be determined	300m+	To be determined
Belgium	National Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS)	High-level, vitrified waste & spent fuel (Category C)	11,700m ³ (if reprocessed)	Site to be determined Rock type: to be determined	To be determined	2080
Switzerland	National Cooperative for the Disposal of Radioactive Waste (NAGRA)	High-level, vitrified waste & spent fuel	1,490m ³	Noerdlich Laegern Rock type: Opalinus clay	About 800m	Around 2060
U.S.A.	Department of Energy (DOE)	Spent fuel (mainly for commercial use) High-level, vitrified waste (mainly for national defense)	70,000 tons (Uranium heavy metal basis)	Nevada Yucca Mountains (Nuclear Waste Policy Act) Rock type: tuff	200 to 500m	2048
Germany	Bundesgesellschaft für Endlagerung (BGE)	High-level, vitrified waste & spent fuel	27,000m ³ (Volume value includes waste container)	Site to be determined Rock type: to be determined	300m+	To be determined
Finland	Posiva Oy	Spent fuel	6,500 tons (uranium basis)	Olkiluoto, Eurajoki Rock type: crystalline rock	About 400m to 450m	2020s
Sweden	Swedish Nuclear Fuel and Wastes Management Co. (SKB)	Spent fuel	12,000 tons (uranium basis)	Forsmark, Östhammar Rock type: Crystalline rock	About 500m	2030s