Workshop on Geotechnical Design and Practice
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Geo-environmental engineering: Practice, regulation, and standardization

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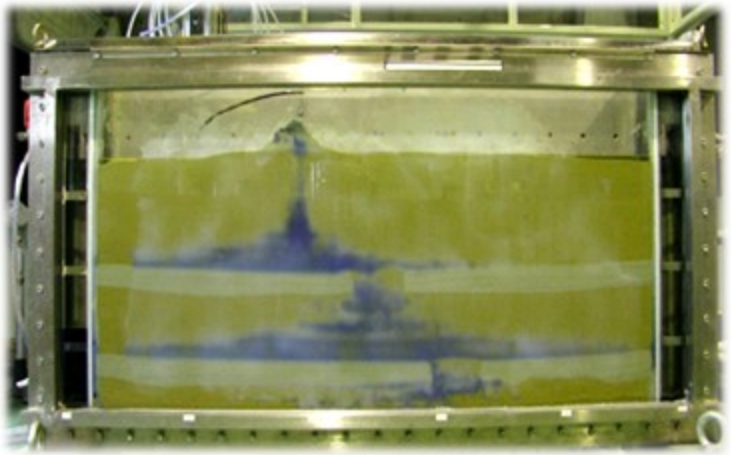
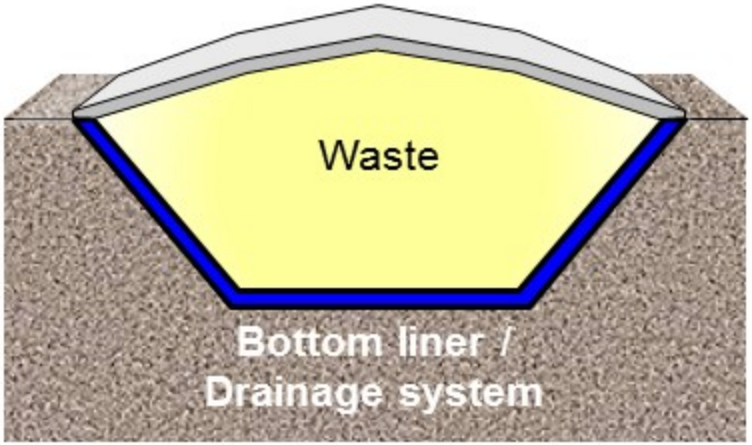
1. Introduction – Topics in geoenvironmental engineering

Use of by-products –
Construction & environmental concerns



Subsurface contamination –
Remediation & construction at contaminated sites



Waste landfills –
Containment & land use

Global environmental issues –
Extreme weather & geo-disaster

1. Introduction – Management of soils required

- ✓ Soils generated from construction works
- ✓ Soils recovered from disaster wastes
- ✓ Soils contaminated with nuclides

Disaster wastes at 2011 disaster

30 million ton

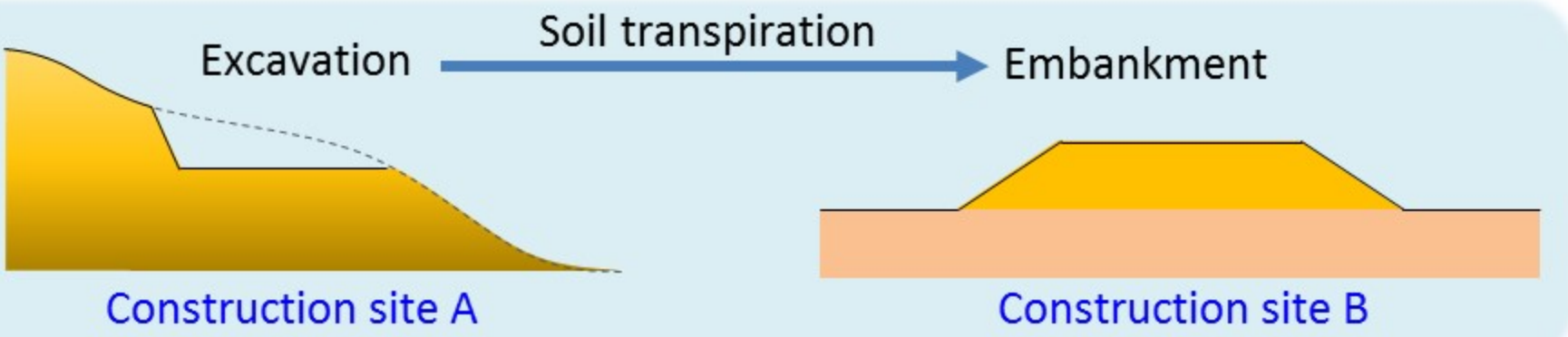
Excavated soils from big projcts

Radio Cesium contaminated soil

20 million ton

2. Utilization of excavated soils

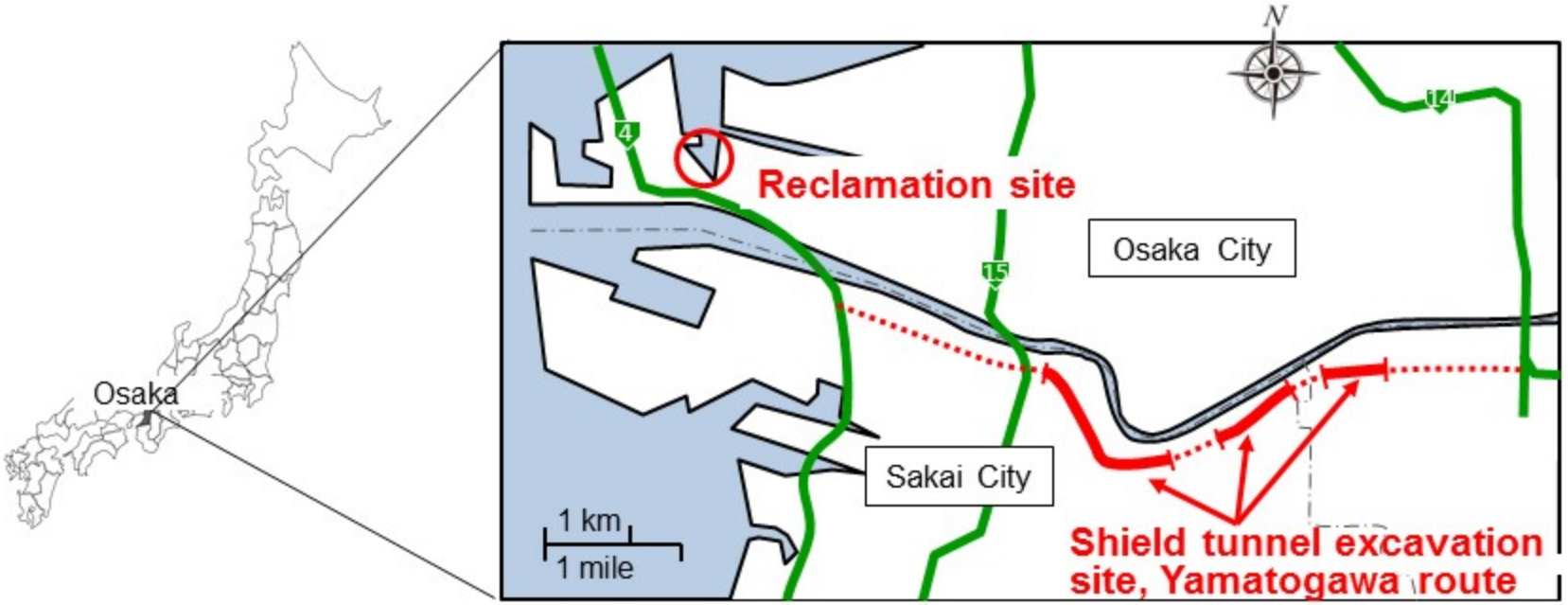
- ✓ (1) Reduction of excavation, (2) use of soils at the site of excavation, and (3) use of soils at different construction sites have been promoted.
  - ✓ Standards of the Soils for Utilization (proposed 1994, fixed 2008)
  - ✓ Construction Material Recycling Act (2000)
  - ✓ Action Plan for Use of Excavated Surplus Soils (MLIT, 2003)



- ✓ Recent concerns:
  - ✓ Large volume of excavations from big projects (new bullet train, Tokyo ring road, etc.)
  - ✓ Natural contaminations (As, Pb, F, B, etc.)

2.1 Tracing technology – Application to the use excavated soils

- "Tracing technology" has been applied to achieve (1) real-time management, (2) proper construction & transportation, & (3) environmental safety, because of the large volume of excavated soils.
- Soils discharged from shield tunnel excavations are utilized at a land reclamation site using ICT utilizing ETC (Electronic Toll Collection) system.

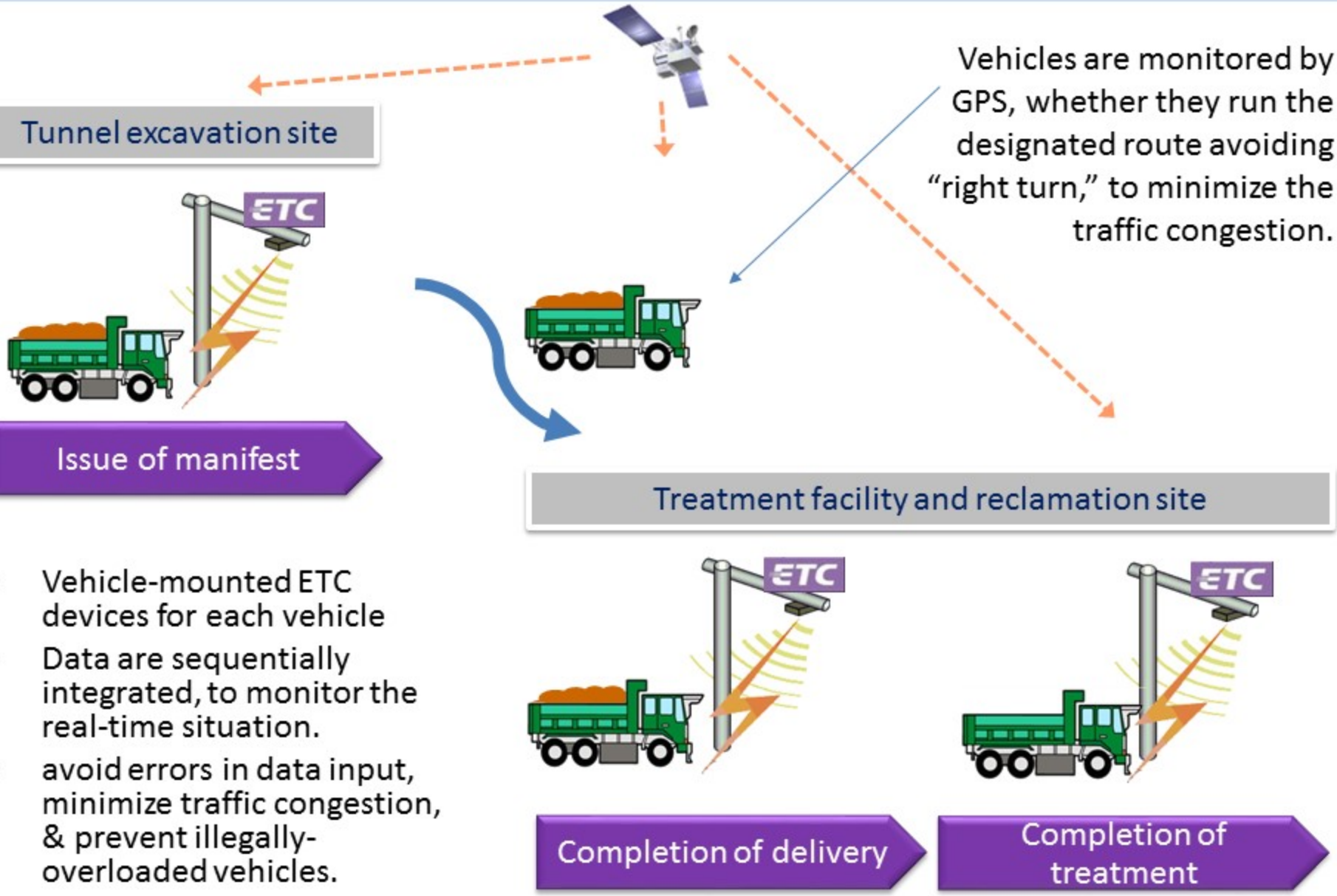


2.1 Tracing technology – Tunnel excavation & reclamation sites

- 3 shield tunnel excavation sections = 3.9-km length
  - From early 2011 to mid 2013 as planned (changed to 2015 November).
  - 760,000 m^3 of soils = 158,000 vehicle transportations
  - Excavated "soft soil" should be managed as "waste."
- 83,000 m^2 old lumber yard is reclaimed with "treated" soils.
  - 5 – 8 km distance from tunnel excavation sites
  - Soil treatment facility has been installed.


On-going tunnel excavation (Yamatogawa route)

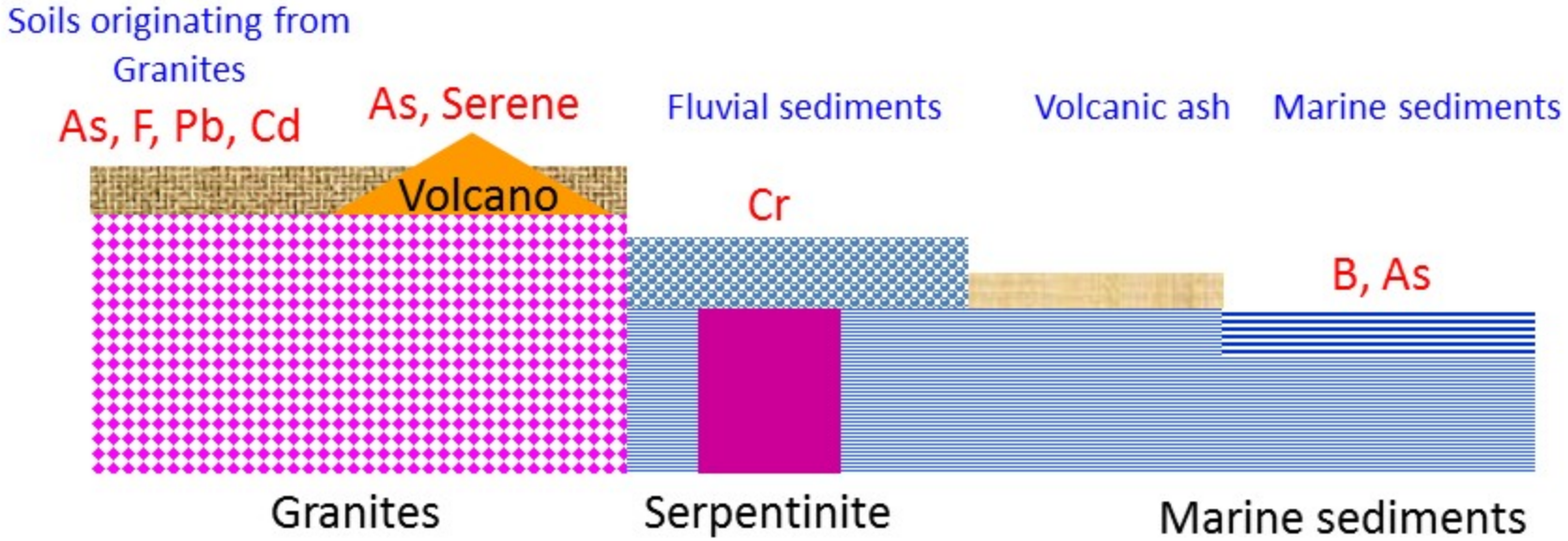
2.1 Tracing technology – Application of ICT to soil transportation



- Vehicle-mounted ETC devices for each vehicle
- Data are sequentially integrated, to monitor the real-time situation.
- avoid errors in data input, minimize traffic congestion, & prevent illegally-overloaded vehicles.

2.2 Natural contamination

- Natural contamination (As, Pb, F, B, etc) has been an important consideration when soils of concern are used in embankments.
  - Environmentally-safe and cost-effective measures should be established, because leaching concentrations are slightly higher than regulatory limits in most cases.
- Construction of mega-projects (new bullet train & Maglev lines, Tokyo ring roads, 2020 Tokyo Olympic, etc.)



2.2 Natural contamination – Issues for excavated soils

- ✓ *How should the environmental suitability be evaluated?*
- ✓ *What sampling method?*
- ✓ *What testing method?*

- ✓ *Do the temporary storage sites have sufficient capacity in terms of air apace and logistics, to store them during test and transport?*

Temporary storage of excavated soils

Not satisfy the environmental limit

Satisfy the environmental limit

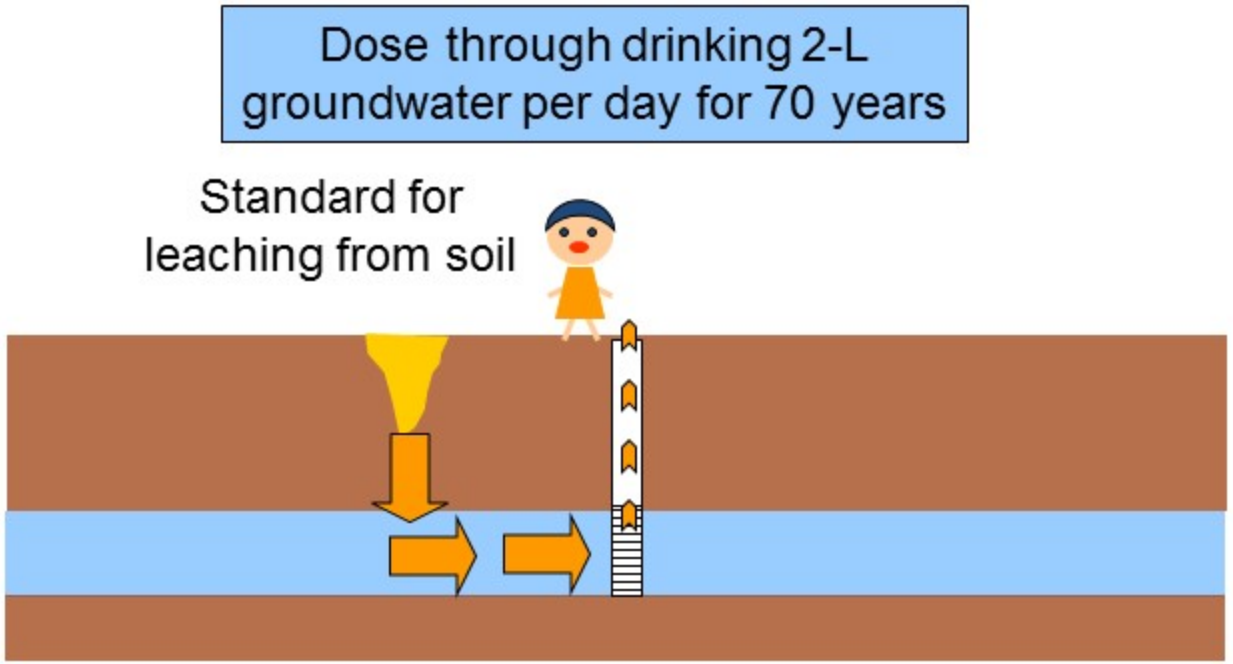
Use of the excavated soils in embankment under control

Use of the excavated soils in embankment

- ✓ *Do the anticipated embankments have sufficient space to accept excavated soils?*
- ✓ *How much soils will not satisfy the environmental suitability?*
- ✓ *How should the embankments be future managed technically and institutionally?*

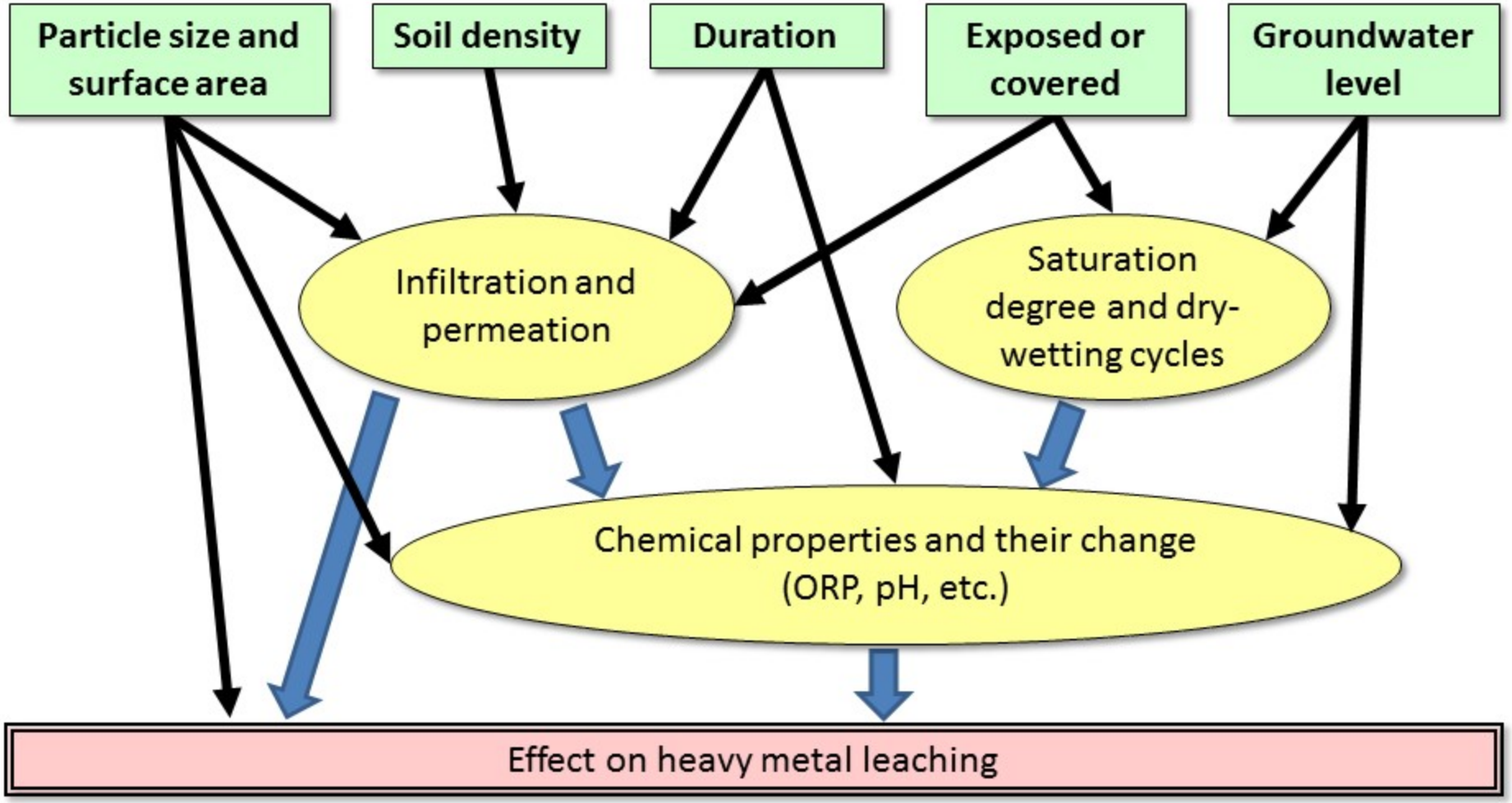
3. Regulation on soil contamination

- ✓ Soil Contamination Countermeasures Law (2003) established for heavy metals and organic chemicals.
- ✓ Both artificial and natural contaminations considered.
- ✓ Whether the soil is contaminated or not is evaluated based on composition & leaching values.

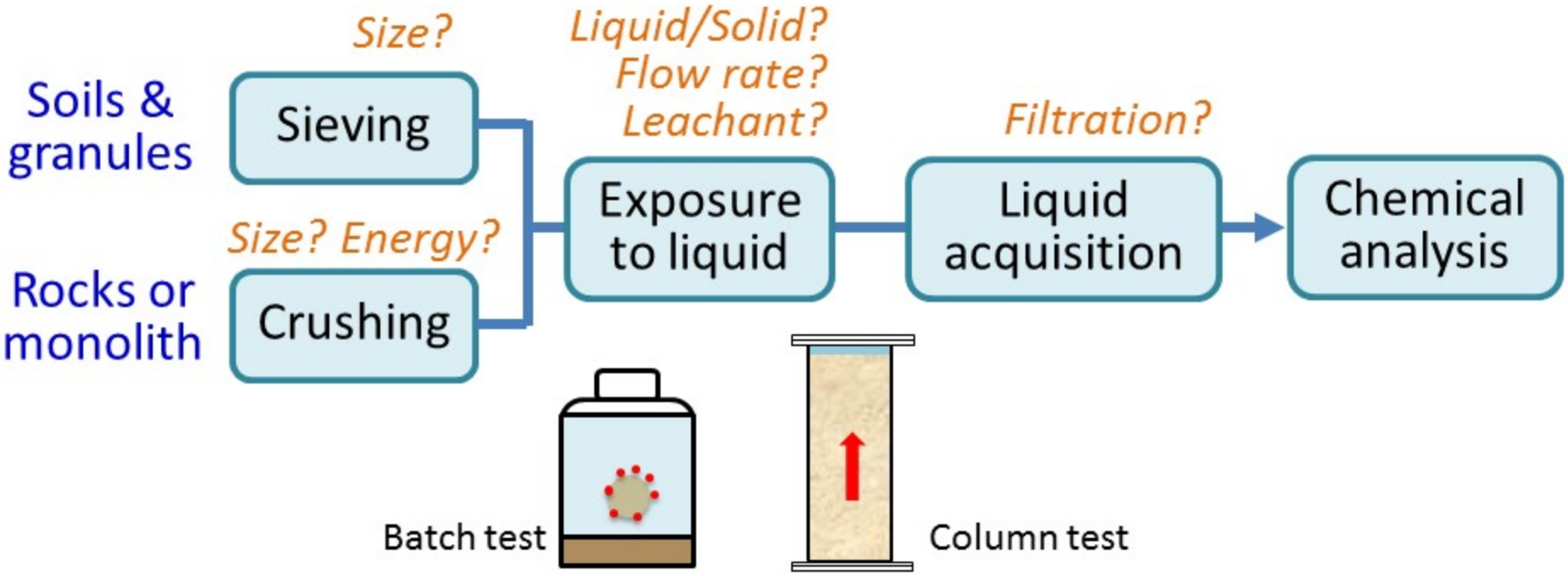


Drawing by T. Yasutaka

3.1 Leaching test – Factors affecting leaching of heavy metal



3.1 Leaching test – Procedures



Requirement for leaching test (and other tests)

- Rationale
- Reproducibility; repeatability; duplicability
- Reflection of practical conditions
- Cost and time, etc.

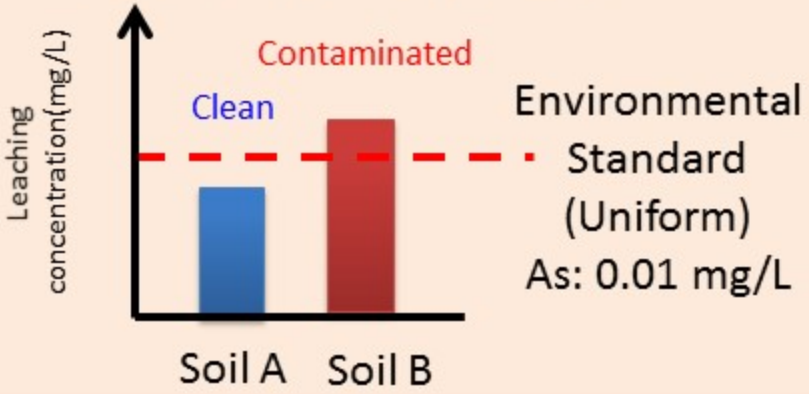
3. Leaching tests – Application to environmental suitability assessment

- ✓ Batch leaching tests are usually used for regulation.
- ✓ Column tests may be necessary to characterize the leaching behavior.

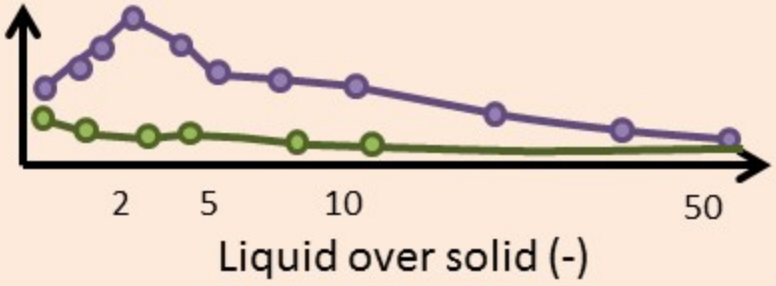
Batch Leaching Test

e.g., JLT-46 (> 2 mm, L/S = 1/10,
6-hour shaking, 0.45 MF filtration)

Compared with
Environmental standard

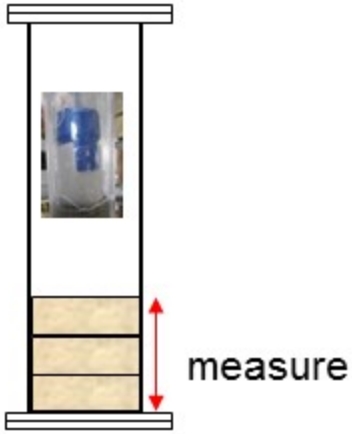


Column Leaching Test

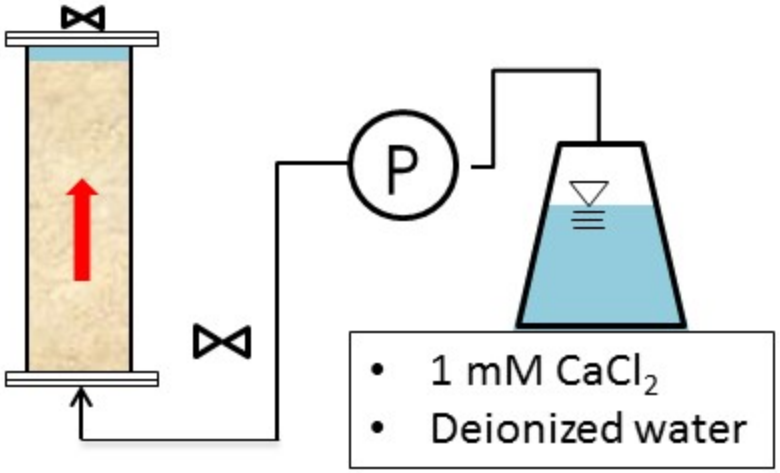


3.1 Leaching test – How to design the test

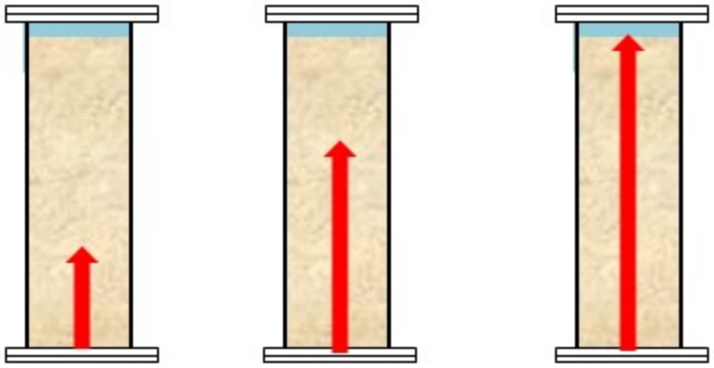
Soil packing method



Leachant chemistry



Flow rate of leachant



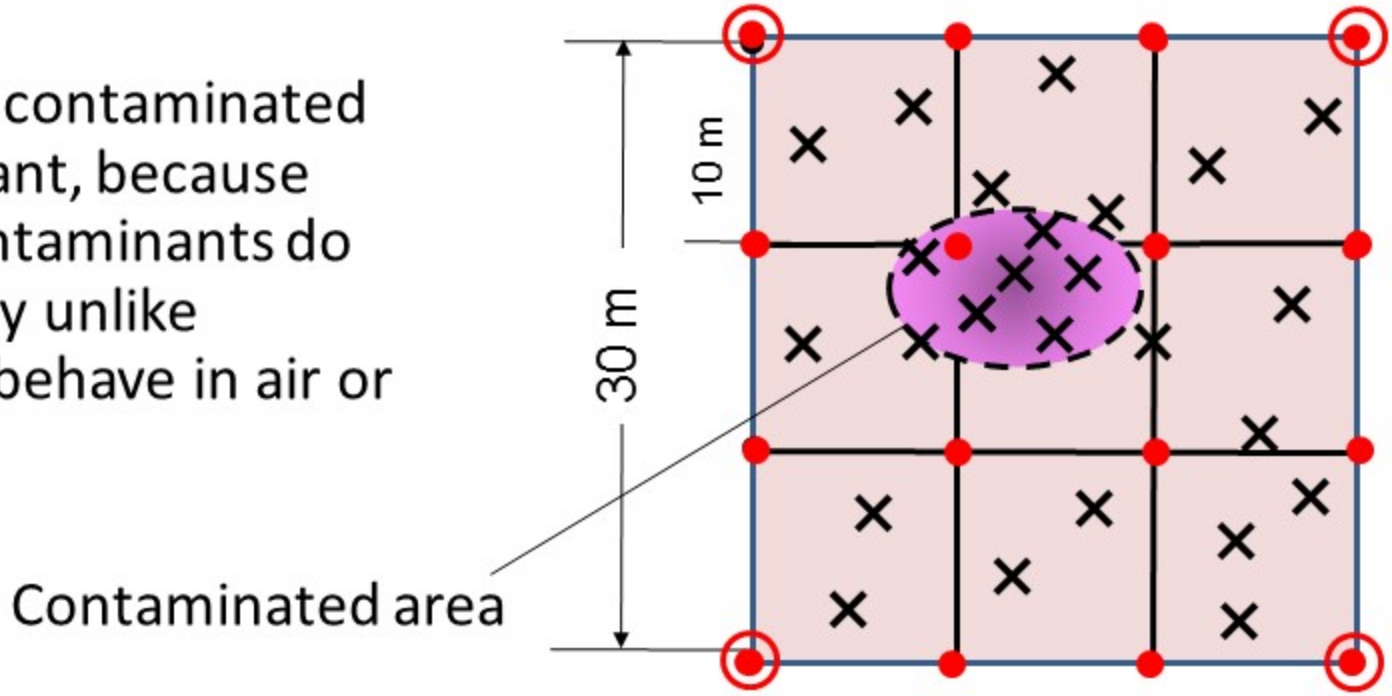
12 mL/min 24 mL/min 36 mL/min

JGS (Japanese Geotechnical Society) now takes an initiative to upgrade ISO for column test, with JISC (Japanese Industrial Standards Committee) and other institutions.

(Courtesy of Dr T. Yasutaka)

3.2 Screening – Basic idea

Evaluating the contaminated area is important, because subsurface contaminants do not move easily unlike contaminants behave in air or water.

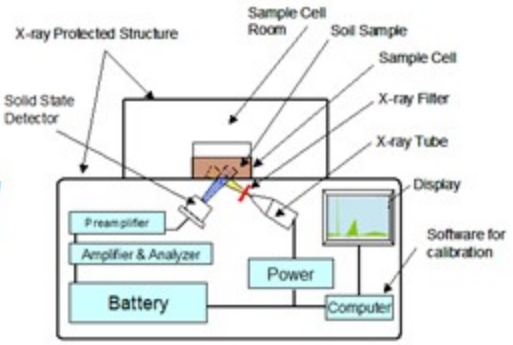


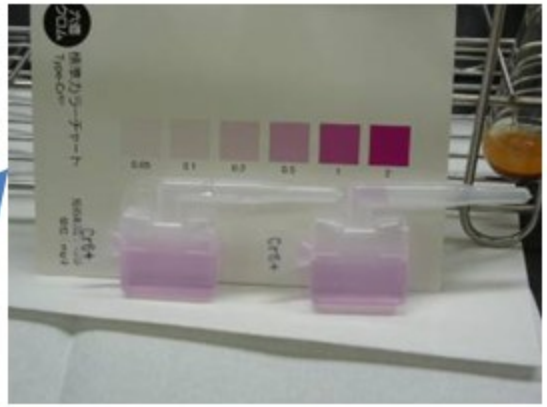
	Regulatory method	Screening method
Sampling	10 or 30 m intervals (red)	As many as possible (x)
Time	Several days	5 to 10 minutes
Place	Laboratory	On-site
Cost	Expensive	Economic

(Courtesy of Dr H. Sakai)

3.2 Screening – Standardized methods

Item	Method & concept	ISO
Guidance	Concepts and outlines of screening methods	ISO 12404
Heavy metals	X-ray fluorescence spectrometry	ISO 13196
Total carbon & nitrogen	Near-infrared spectrometry, for agricultural purposes	ISO 17183
Chromium (VI)	Detection using test-kits developed for water analysis	ISO/TR 18105
Petroleum	Turbidity analysis	ISO 17184 (Published soon)
Water content	Refractometry, for geotechnical and agricultural purposes	ISO/WD 20244 (Being standardized)





(Courtesy of Dr H. Sakai)

4. Concluding remarks

- Numerous achievements in geoenvironmental engineering (e.g., use of excavated soils, countermeasures of soils, waste landfills, etc.)
  - Innovative practices
  - Contributions to regulations
  - Contributions to domestic and international standardizations

- Further developments required for better practice, regulation, and standardization.
- Environmentally-safe and cost-effective measures should be promoted.