



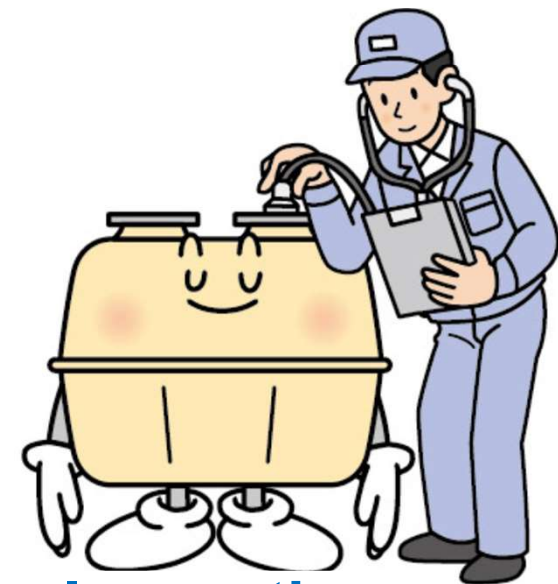
# Situation of wastewater management under disasters



**Desludging**



**Operation**



**Inspection**

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# 1. Tsunami traces when the Great East Japan Earthquake (Former Kitakami River mouth, Ishinomaki City, Miyagi Prefecture)



**Damaged vehicle collection area**



**Temporary storage area of debris**



19. April. 2011



## 2. Situation of damaged sewer system



Treatment facility	Immediately after the disaster	2 <sup>nd</sup> May, 2011
Shut down	46	18
Damaged	63	44
Normal operation		48
unknown	11	10
Total	120	120

**It took about 2 to 3 years to fully recover.**

Pump facility	Immediately after the disaster	2 May 2011
Shut down	78	41
Damaged	30	31
Normal operation		36
unknown	1	1
Total	109	109

Source : MLIT



### 3. Johkasou is more earthquake-resilient — Outcome from the previous damage situation survey on Johksou —

○2011 Emergency investigation of damage to septic tanks after the Great East Japan Earthquake (April 2012) — Survey results of 3 prefectures (Iwate・Miyagi・Fukushia)

Survey target	Number of surveys	Emergency repair	completely destroyed
All facilities	1,099	24.6%	3.8%
Tsunami inundation area	278	52.9%	2.5%
outside of Tsunami inundation area	821	14.9%	4.3%

※ Facilities where houses were washed away were excluded from the survey

○Results of past "Large-scale earthquake damage survey" by the Johkasou function guarantee system

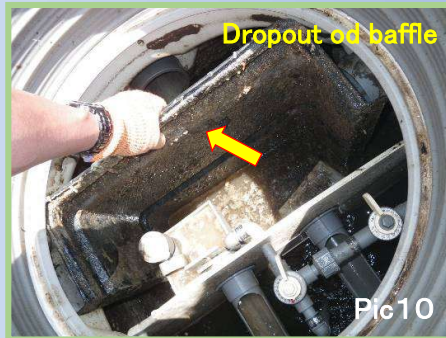
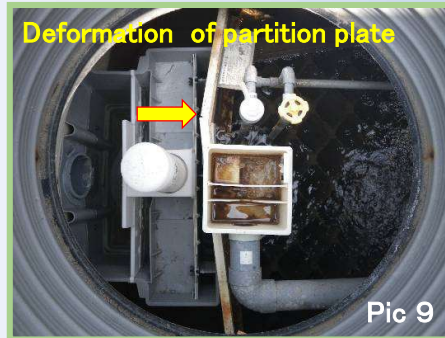
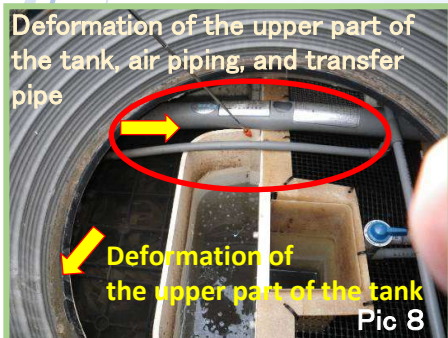
Month, Year	epicenter	Number of surveys	Number of damaged Johkasou	Damaged ratio	Investigator
5, 2003	Off Miyagi Prefecture Magnitude 7.1	1,034	5	0.5%	Miyagi Prefectural Authority for Living Environment Secretary
9, 2003	Tokachi region Magnitude 8.0	615	11	2.0%	Hokkaido Joukasou Association
10, 2004	Niigata Prefecture Magnitude 6.8	1,428	51	3.6%	Niigata Johkasou Seibi Association
3, 2007	Noto Peninsula Magnitude 6.9	971	39	4.0%	Ishikawa Johkasou Association
7, 2007	Niigata Prefecture Magnitude 6.8	1,393	60	4.3%	Niigata Johkasou Seibi Association
6, 2008	Miyagi/ Iwate Prefecture Magnitude 7.2	2,626	14	0.5%	Miyagi Prefectural Authority for Living Environment Secretary
4, 2016	Kumamoto Prefecture Magnitude 6.5	12,429	299	2.4%	Kumamoto Johkasou Association



- In the sewerage system, the pipes are connected by "lines" like a mesh, while the Johkasou is **resistant to ground displacement** because it exists at "points" (advantages of decentralized system, Johkasou).
- The impact on Johkasou is local and limited, and even if there is a total loss, **recovery within a few weeks after the start** of recovery is a great advantage when considering the lives of those affected by the disaster.

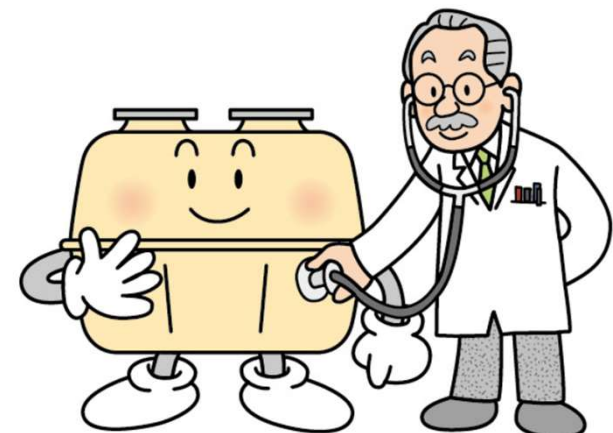
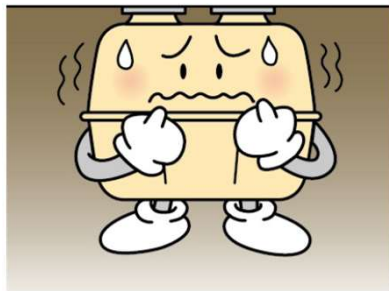
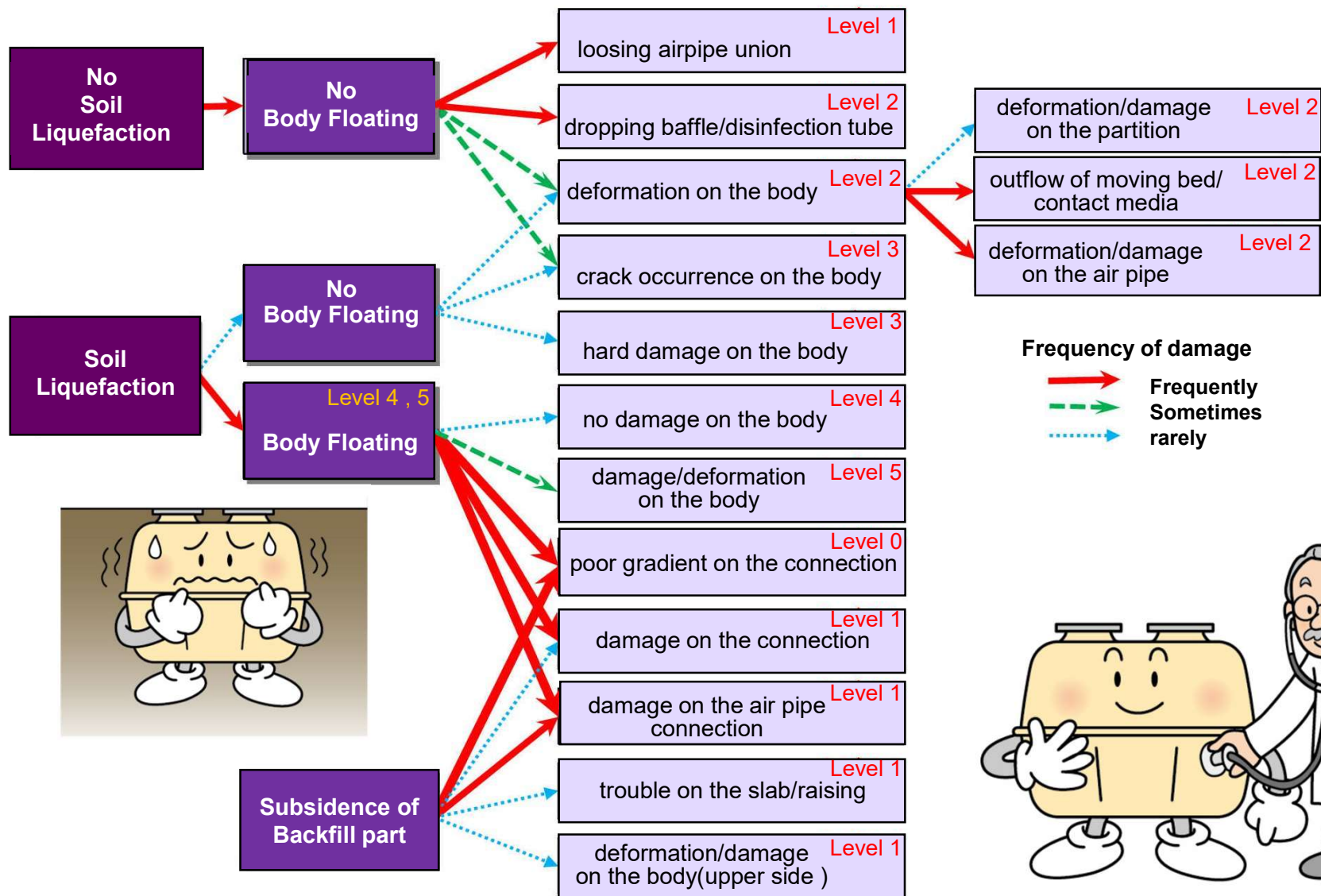


# 4. What happened to the Johkasou?— From the damage situation— 4.1 Cases of Johkasou damage caused by an earthquake




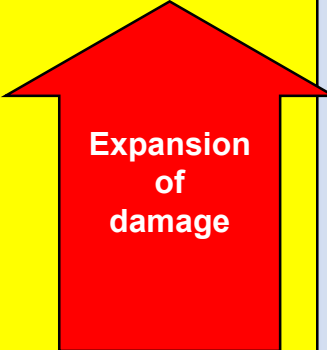


# 4.2 Classification of damage for Johkasou caused by an earthquake (Classified by the presence or absence of liquefaction)





# 4.3 Estimation of damage to the Johkasou based on the previous large-scale earthquakes

Seismic intensity	Damage estimation of Johkasou	
	Plate boundary type earthquake (M7)	Direct type earthquake (M6)
Over lower 6	<b>Whole</b> <ul style="list-style-type: none"> <li>• Body</li> <li>• Inflow/discharge(pit) pipe</li> <li>• Air pipe</li> <li>• Other features</li> </ul> 	<b>Whole</b> <ul style="list-style-type: none"> <li>• Body</li> <li>• Inflow/discharge(pit) pipe</li> <li>• Air pipe</li> </ul> 
Upper 5		
Lower 5	<b>A part of</b> <ul style="list-style-type: none"> <li>• Body</li> <li>• Inflow/discharge(pit) pipe</li> <li>• Air pipe</li> </ul>	<b>A part of</b> <ul style="list-style-type: none"> <li>• Body</li> <li>• Inflow/discharge(pit) pipe</li> <li>• Air pipe</li> </ul>
4		
Damage estimated range	<b>Wide range</b>	<b>Around the epicenter area</b>

※ If the magnitude (M) increases 1, the energy of the seismic wave will increase by about 30 times, and if it increases 2, it will increase by about 1,000 times.



## 4.4 Future of Johkasou construction (disaster prevention / mitigation)

The three points of Johkasou damage that can be seen from the case of the Great East Japan Earthquake

- ① The Johkasou with support post, there is almost no surfacing due to liquefaction.
- ② Most of the surfacing of the body is due to the liquefaction of the backfilled part.
- ③ Floating prevention metal fittings are intended for static groundwater and are not supposed soil liquefaction around the Johkasou.



### Concept of disaster mitigation measures

Preventing soil liquefaction of backfill part is the "basic concept of an earthquake-resistant Johkasou."



Eliminate one of the following three factors which lead soil liquefaction.

- ① The ground water level in the backfill area is high.
- ② The grain size distribution of soil used for backfill area is easily liquefied.
- ③ Low degree of sand compaction of backfill area.

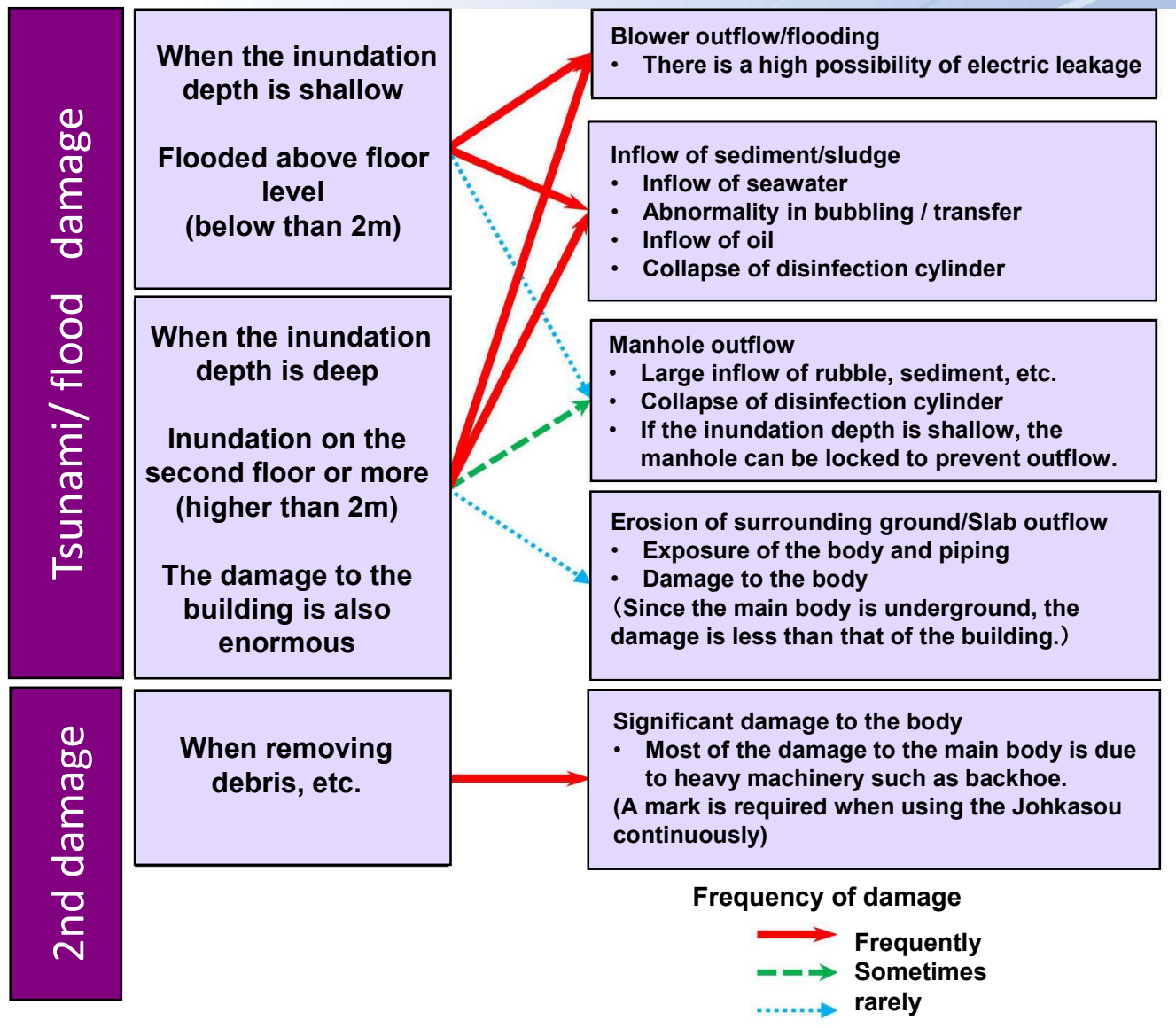
### Prevention method on Soil liquefaction of sewer

埋戻し土の締固め	砕石による埋戻し	埋戻し土の固化
良質土で締固め（締固め度 90%以上）ながら、埋戻す。	地下水位以深を透水性の高い材料（砕石）で埋戻す。	地下水位以深をセメント固化改良土等で埋戻す。
十分な締固めを行うことにより、埋戻し部の過剰間隙水圧を小さくすることが出来るため、液状化に対する効果は大きい。	マンホール・管路近傍部の過剰間隙水圧が消散するため、液状化に対する効果は大きい。	埋戻し部が非液状化層となるため、液状化に対する効果は大きい。





# 4.5 Classification of damage for Johkasou caused by tsunami (flood) and damaged case of Johkasou





## 4.6 Judgment of availability of provisional use

In the case of the Great East Japan Earthquake, it is difficult to judge whether "Available" or not without sufficient experience, except for a clear situation of floating and an abnormal low water level in the Johkasou immediately after the earthquake. Therefore, it has been judged just "provisional use is possible" or "non available". However, as conditions for "provisional use is possible", it is necessary to satisfy the following conditions.

- ① The inflow water and the water in the tank are not leaking or overflowing.
- ② Disinfection process is certainly done.

Under those conditions, even if the blower is stopped due to a power failure, electric leakage, damage, etc., provisional use is possible by performing simple processing.

As stated in the manual provided by Ministry of the Environment, **the period of provisional usage is about 3 months** at the maximum, and during this period the restoration work shall be completed.



# 5. Johkasou installed at temporary housing

## 5.1 Situation

- In the Great East Japan Earthquake, Johkasou can be restored and installed more quickly compared with sewers or rural sewerage system which take a long time to recover, therefore Johkasou have been widely adopted in temporary housing and temporary stores.  
**Approximately 1,700 units were installed** in Iwate, Miyagi, and Fukushima prefectures.
- In the mountainous area or area with many small scale colonies, installation of Johkasou in such temporary housing seems the **most effective (financially and timely) development procedure**.
- However, since it was necessary to construct a huge number of Johkasou along with temporary housing in a very short term, many of the **Johkasou had been installed on the ground (not underground), and there were problems in terms of maintenance works and its system**.
- In addition, it was an urgent move-in in a disaster, there was a problem which a large inflow of fats & oils and impurities, therefore, it was **necessary to explain to the residents how to use the Johkasou** installed at the temporary housings.

improvement approach for maintenance (sign boards and numbering)



No scaffolding for maintenance  
No heat retention measures



Inadequate screen equipment





## 5.2 Installation example of Johkasou at temporary housing



Pic 1

Iwate Prefecture  
(underground : 35 PE)



Pic 2

Fukushima Prefecture  
(Semi-underground installation + embankment:  
45 EP × 2 units)



Pic 3

Iwate Prefecture  
(Semi-underground installation,  
heat retention measures : 42 PE)



Pic 4

Iwate Prefecture  
(Ground installation, No heat retention measures:  
90 PE × 6 units + 30 PE)



## 6. Status of Johkasou installed in evacuation shelters

(Source: (2016) Damage situation survey on Johkasou by Kumamoto earthquake, Association of Johkasou, kumamoto.)

### In Minamiaso village (Kumamoto earthquake: 14<sup>th</sup> April, 2016)

#### ① Kukino General Welfare Center

The total number of evacuees were 3,370 peoples until 18<sup>th</sup> May. There were several days when the **maximum number of evacuees exceeded the PE of Johkasou (287 PE)**, however, there were no problems with the treatment function of the Johkasou, **and the treated water quality was stable.**

treatment process	PE	item	11, Apr	18, Apr	22, Apr	20, May	27, May	
contact aeration system	287	Number of evacuees		670	1,471	3,370	※	
		Water quality item	pH	7.1		7.8	7.3	7.7
			DO	3.8		4.2	3.3	7.7
			Transparency	100		100	100	100
			Residual chlorine	0.2		0.2	0.2	0.2
			Chlorine amount	1,000	1,000	1,000	1,000	1,000

※all evacuees moved out by May 18

#### ② Minamiaso Junior High School Gymnasium

The total number of evacuees were 13,072 peoples until 24<sup>th</sup> May. On 14<sup>th</sup> April, a power outage of the discharge pump and damage (displacement) on the inflow pipes were monitored, however, by 19<sup>th</sup> April restoration works such as emergency generator installation has taken. **There were 800 evacuees at maximum in the term, and it greatly exceeded the PE of Johkasou (66 PE), however, there were no problems with the treatment function and the treated water quality was stable.**

treatment process	PE	item	14, Apr	18, Apr	25, Apr	18, May	17, Jun	13, Jul	
moving bed aeration system with flow control tank	66	Number of evacuees		2,000	5,522	12,292	13,072	※	
		Water quality item	pH	8.3		8.0	8.1	7.7	7.6
			DO	4.2		4.8	4.4	4.0	4.5
			Transparency	30		30	30	30	30
			Residual chlorine	0.2		0.2	0.2	0.2	0.2
			Chlorine amount	-	-	-	-	-	-

※ all evacuees moved out by 24th May



## 7. 2011.3.11 “Records and experiences of the Great East Japan Earthquake”

2011.3.11

東日本大震災の記録・体験記

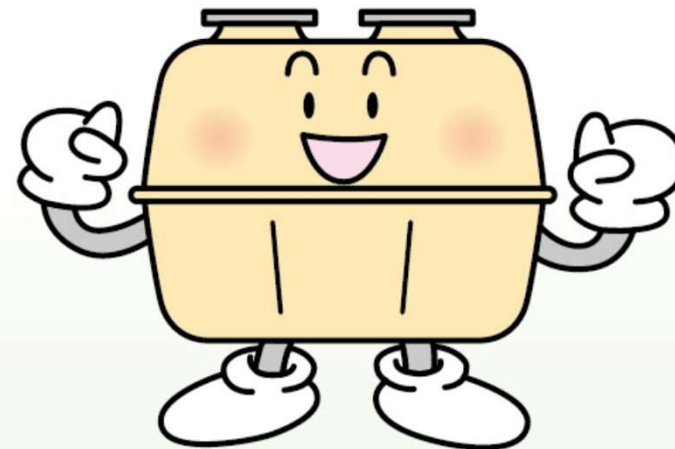


平成25年3月

公益社団法人 宮城県生活環境事業協会

You can download “Records and experiences of the Great East Japan Earthquake” from the URL below.

<http://www.m-seikatsukankyo.or.jp/other/report311/>



Thank you for your attention.