

SNOW-MELTING TECHNOLOGIES IN SAPPORO UTILIZING WASTE ENERGY

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Abstract

For Sapporo, the capital of Hokkaido Prefecture and a city of 1.8 million people, securing effective road width in winter has been an important political issue, because annual snowfall here can reach 5 m. Snow removed from the street and piled at the roadside narrows roads and obstructs pedestrian visibility, thereby disturbing traffic flow and safety. The City of Sapporo hauls roadside snow at regular intervals to snow disposal sites in the suburbs and flood plains along a river.

The volume of snow disposed by the City, snow-removal businesses, and others in an average year is 13 million m³. It was 27 million m³ in 1995, a year of record snowfall. Nevertheless, some snow disposal sites have been taken out of use in order to avoid pollution by soil, sand, and garbage in the snow; because of urbanization; in order to avoid the noise and vibration pollution generated by snow disposal machinery in residential neighborhoods. It also is getting more difficult each year to find replacement sites.

Therefore, the City of Sapporo in 1991 determined it would promote snow treatment at facilities (e.g., snow-melting tanks). These are expected to handle the increasing amount of snow requiring treatment that has resulted from residents' requests for higher snow-removal levels of service and to compensate for the scarcity of snow disposal sites.

We will introduce urban snow-melting technologies developed by the City of Sapporo

Introduction

1. Prospect for snow-melting tanks

The snow-melting tank utilizes waste energy including that of processed sewage and the waste heat of garbage incineration plants, to efficiently maintain urban functions and a comfortable environment in winter, and to use energy effectively. At present (the year 2001), six snow-melting tanks are in operation, treating about 1.3 million m³ of snow.

The snow-melting tanks treat snow hauled by snow-removal trucks as effectively as do snow-disposal sites. Their advantages follow.

- 1) They can remove soil, sand, and garbage in snow.
- 2) Large amounts of snow can be treated at a facility of relatively small area during the night in the downtown district and in industrial areas, where the nighttime population is much lower than in daytime.
- 3) The snow-hauling distance is shortened.
- 4) They can be used as multipurpose facilities for rainwater storage or as fire-prevention water tanks in snow-free seasons.

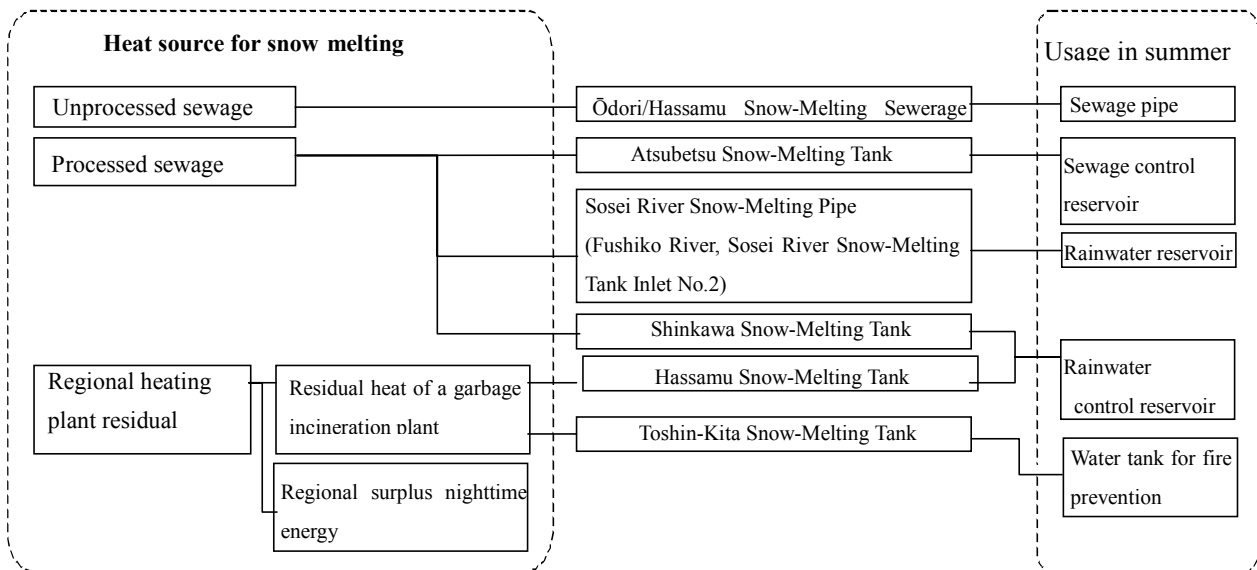
The City of Sapporo will further develop the snow-melting facilities, taking into consideration their vital role as an effective and efficient snow countermeasure.

Snow-Melting Facilities in Sapporo (the end of 2000)

Name of Facility		Treatment capacity (m ³ /day)	Heat source (source water)	Start-up
In operation	Atsubetsu Snow-Melting Tank	10,000	Processed sewage	Jan. 1993
	Hassamu Snow-Melting Tank	2,200	Waste heat of an incineration plant	Feb. 1995
	Sosei River Snow-Melting Pipe	2,100	Processed sewage	Jan. 1997
	Ōdori Snow-Melting Sewerage Tank	1,400	Unprocessed sewage	Feb. 1997
	Toshin-Kita Snow-Melting Tank	4,000	Regional heating plant	Feb. 1998
	Hassamu Snow-Melting Sewerage Tank	2,100	Unprocessed sewage	Jan. 2000
	Total	21,800	about 1,300,000 m ³ /year (at 60 day full-operation/year)	
Under planning	Hakken Snow-Melting Tank by Using Sewerage	3,500	Unprocessed sewage	2002
	Shinkawa Snow-Melting Tank	9,000	Processed sewage	2003
	Fushiko River Snow-Melting Pipe	4,000	Processed sewage	2003
	Sosei River Snow-Melting Pipe's Second Snow Inlet	2,500	Processed Sewage	2004
	Total	19,000	about 1,140,000 m ³ /year (at 60 day full-operation/year)	
Total		40,800	about 2,450,000 m ³ /year (at 60 day full-operation/year)	

2. Snow-Melting Tanks in operation

1 Existing snow-melting tanks and those under planning are classified roughly into three types by energy source.



The six snow-melting facilities in use are outlined below.

(1) Atsubetsu Snow-Melting Tank

-1 Outline

Location: 1073 Yamamoto, Atsubetsu-cho, Atsubetsu-ku, Sapporo

Start-up: January 1993

Heat source: processed sewage of Atsubetsu Sewage Treatment Plant

Water supply: 70,000 m³/day

Snow-melting improvement measure: agitation system by diffuser

Size of a reservoir: 5 m (width) × 42 m (length), 6.5 m (depth),
(3 lines of 2 reservoirs each)

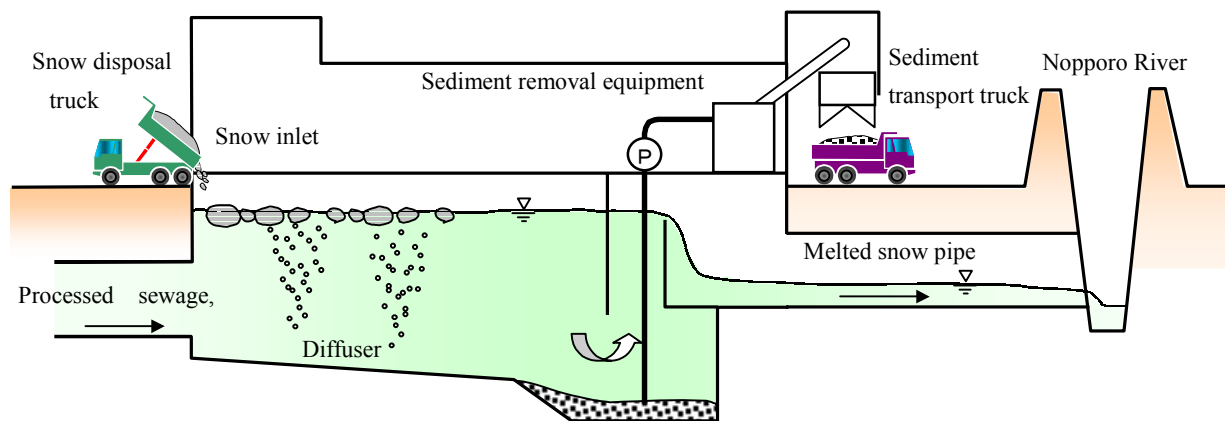
Effective capacity: 8,000 m³ (4,000 m³ × 2 ponds)

Snow dumping method: dumping snow directly by dump truck (6 snow inlets)

Volume of treated snow: V = 10,000 m³/day

Expected annual treatment volume: 10,000 m³/day × 60 days = 600,000 m³

-2 System chart



(2) Hassamu Snow-Melting Tank

-1 Outline

Location: 14-14 Hassamu, Nishi-ku, Sapporo (Hassamu Industrial Park)

Start-up: February 1995

Heat source: Residual heat from Hassamu Incineration Plant

Snow-melting water: 20.93 GJ/hour (5 Gcal/hour)

Snow-melting improvement measure: agitation system by diffuser

Size of a reservoir: 14 m (width) × 17 m (length), 8 m (depth), (1 reservoir)

Effective capacity: 1,900 m³

Snow dumping method: dumping snow directly by dump truck (3 snow inlets)

Volume of treated snow: $V = \mu Q / [\rho (J + |t| - c)] \doteq 2,200 \text{ m}^3/\text{day}$

μ : snow-melting efficiency (0.75)

Q : heat capacity (20,930,000 kJ/kg)(5,000,000 kcal/h)

ρ : snow density (0.5 t/ m³=500 kg/ m³)

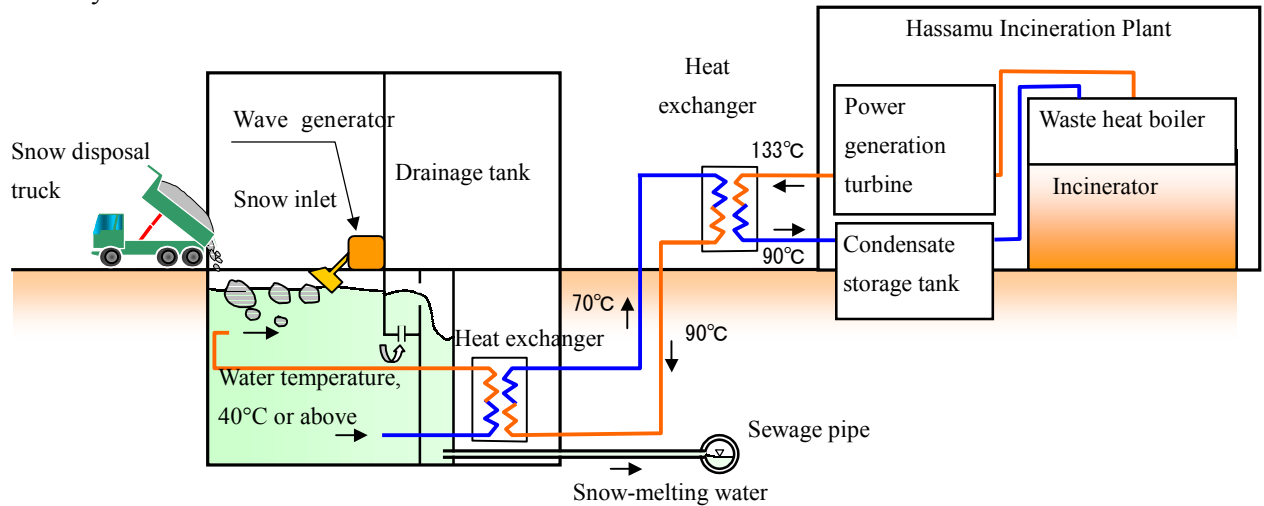
J : latent fusion heat (334.88 kJ/t) (80 kcal/kg)

t : snow temperature (− 4°C)

c : specific heat capacity of snow(2.093 kJ/t°C)(0.5 kcal/t°C)

Expected annual treatment volume: 2,200 m³ × 60 days = 132,000 m³

-2 System chart

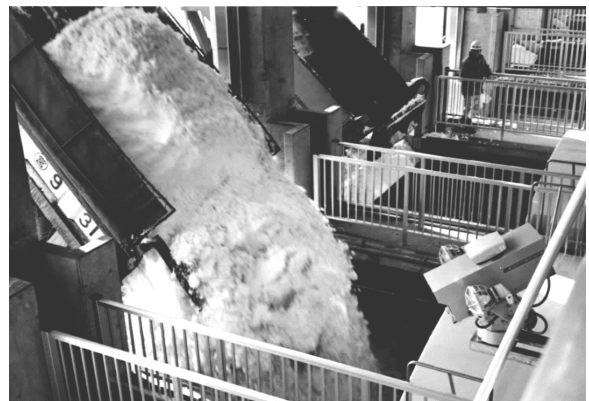


-3 Snow dumping

Hassamu Snow-Melting Tank



Atsubetsu Snow-Melting Tank



(3) Sosei River Snow-Melting Pipe

-1 Outline of facility

Location: North 28 East 1, Higashi-ku, Sapporo

Start-up: January 1997

Heat source: Processed sewage of Sosei River Treatment Plant (processed sewage temperature: 12 to 13°C)

Water supply: 24,000 m³/day

Additional equipment: rotary snow shooter

Size: inner diameter-5,000 mm, total length-2,495 m

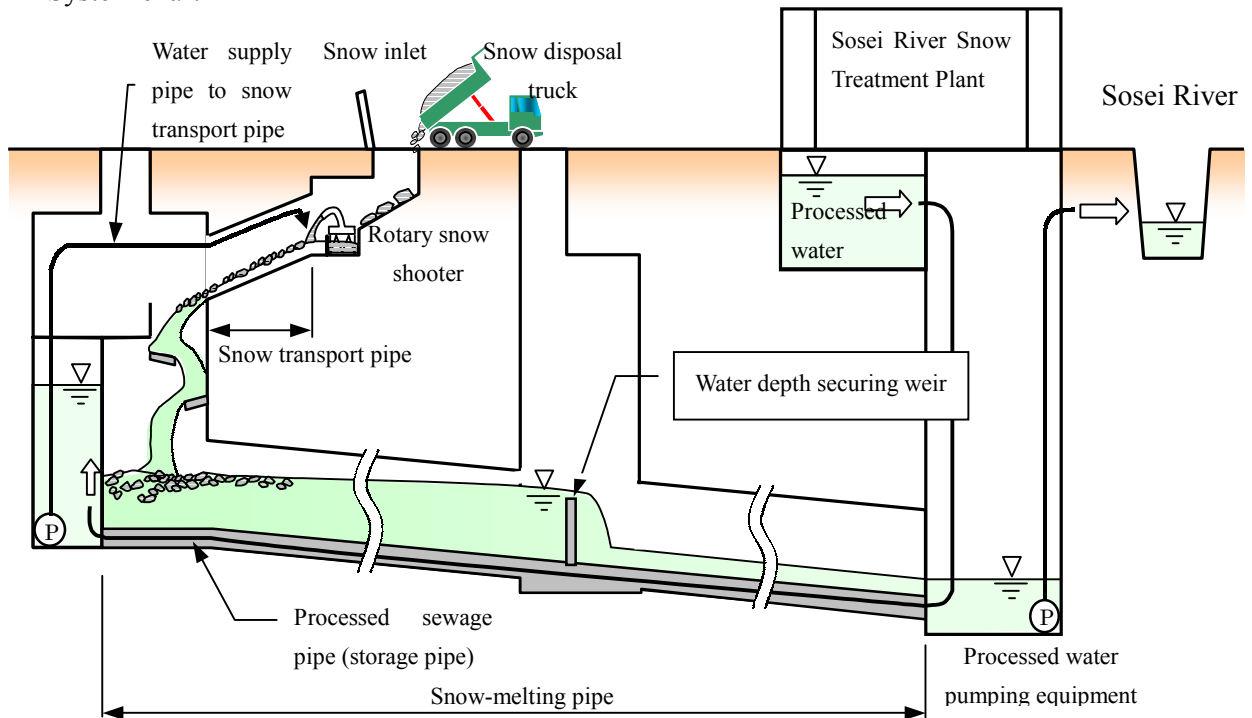
Capacity: 46,400 m³

Snow dumping method: dumping snow directly by dump truck (1 snow inlet)

Treatment capacity: V= 2,100 m³/day

Expected annual treatment volume: 2,100 m³/ day × 60 days = 126,000m³

-2 System chart



(4) Ōdori Snow-Melting Sewerage Tank

-1 Outline

Location: Odori West 13, Chuo-ku , Sapporo

Start-up: March 1997

Heat source: unprocessed sewage of Shinkawa district (water temperature around 15°C)

Size (combined sewerage): 3.1m (width) x 3.1m (length)

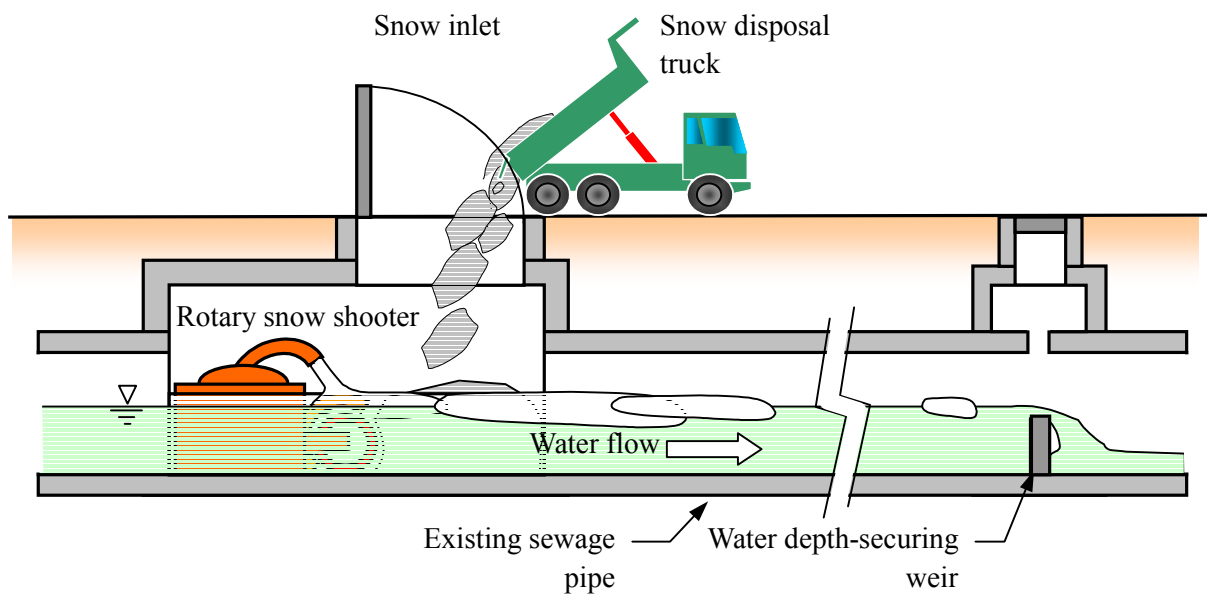
Additional equipment: rotary snow shooter

Snow dumping method: dumping snow directly by dump truck (1 snow inlets)

Treatment Capacity: $V=1,400 \text{ m}^3/\text{day}$

Expected annual treatment volume: $1,400 \text{ m}^3 \times 60 \text{ days} = 84,000 \text{ m}^3$

-1 System chart



(5) Toshin-Kita Snow-Melting Tank

-1 Outline

Location: North 7 West 3, Chuo-ku, Sapporo

Start-up: February 1995

Heat source: regional energy-supply plant

Heat capacity: 36.00 GJ /h (avg. 8.6 Gcal/h, max. 10.5 Gcal/h)

Size of a Reservoir: 23m (width) × 33m (length) × 5.8m (depth), 1 reservoir

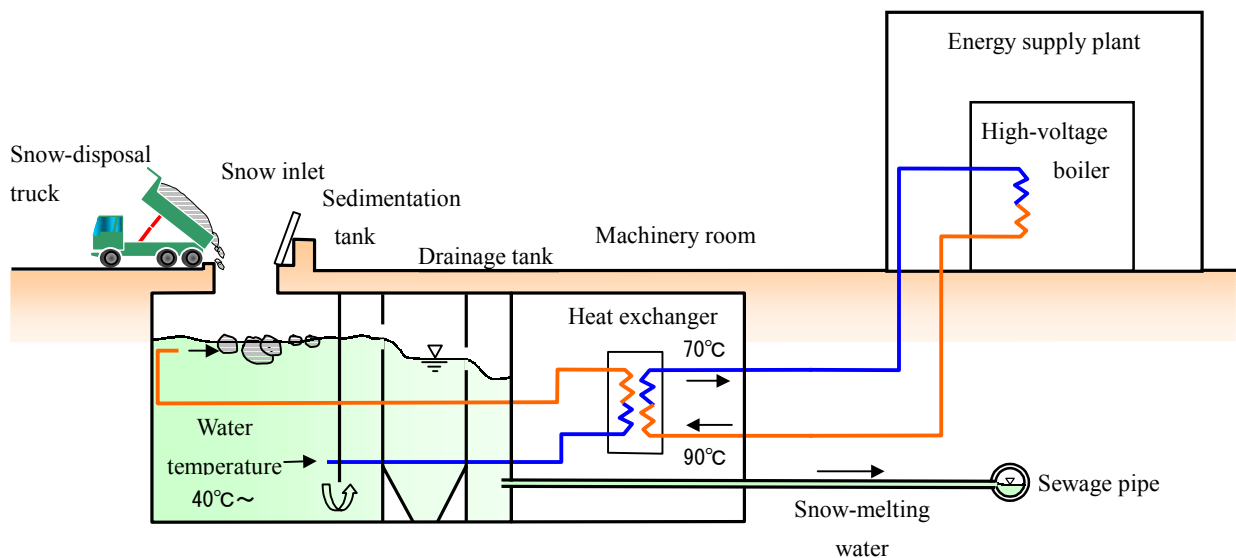
Active capacity: 4,000 m³

Snow dumping method: dumping snow directly by a dump truck (4 snow inlets)

Volume of treated snow: $V = \mu Q / [\rho (J + |t| - c)] \doteq 4,000 \text{ m}^3/\text{day}$

Expected annual treatment volume: 4,000 m³ × 60 days = 240,000 m³

-2 System chart



(6) Hassamu Snow-Melting Sewerage Tank

-1 Outline

Location: 14-4 Hassamu, Nishi-ku, Sapporo

Start-up: March 2000

Heat source: unprocessed sewage of Teine district,
(water temperature around 15°C)

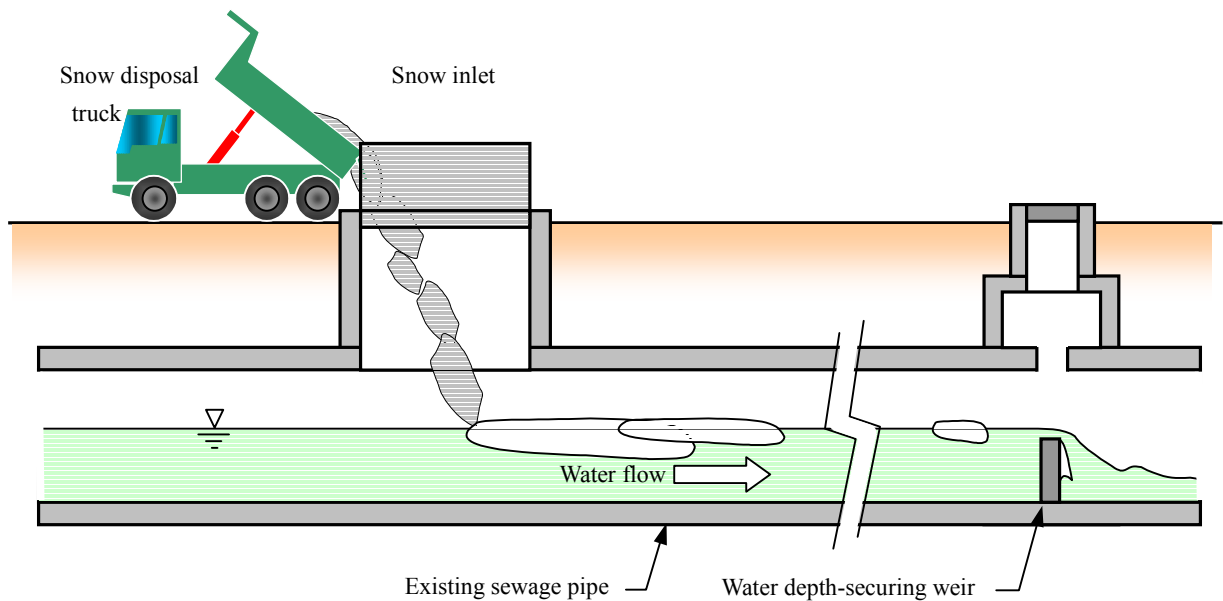
Size (combined sewerage): 4.0 m (width) × 4.0 m (length)

Snow dumping method: dumping snow directly by dump truck (1 snow inlet)

Treatment capacity: $V = 2,100 \text{ m}^3/\text{day}$

Expected annual treatment volume: 2,100 m³ × 60 days = 126,000 m³

-1 System chart



4. Conclusion

The sewerage pervasion rate in Sapporo City (at the end of 2000) is 99.2 % of total population (flush toilet pervasion rate: 98.6 %). The rate is almost 100 %. Nine sewage treatment facilities (one in a suburb of Sapporo) discharge about 990,000 m³ of sewage per day (total treated water volume: 1,110,000 m³/day.) Of this, only 180,000 m³ (18.2 %) is used for snow treatment facilities including that for snow-melting tanks (125,000 m³/day, 12.6 %). Accordingly, further effective utilization of heat energy of processed/unprocessed sewage is considered important for stable and environmentally friendly snow treatment. The City of Sapporo will continue to actively seek snow-melting facility development.