Some Thoughts On The Future Of Wastewater Treatment

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Basis for Presentation

WASTEWATER AND FOOD WASTES ARE RENEWABLE RECOVERABLE SOURCES OF ENERGY, RESOURCES, AND WATER

A Question and Answer About Wastewater Treatment in the Future

QUESTION

How can we enhance wastewater treatment, reduce energy usage, and recover additional energy and resources?

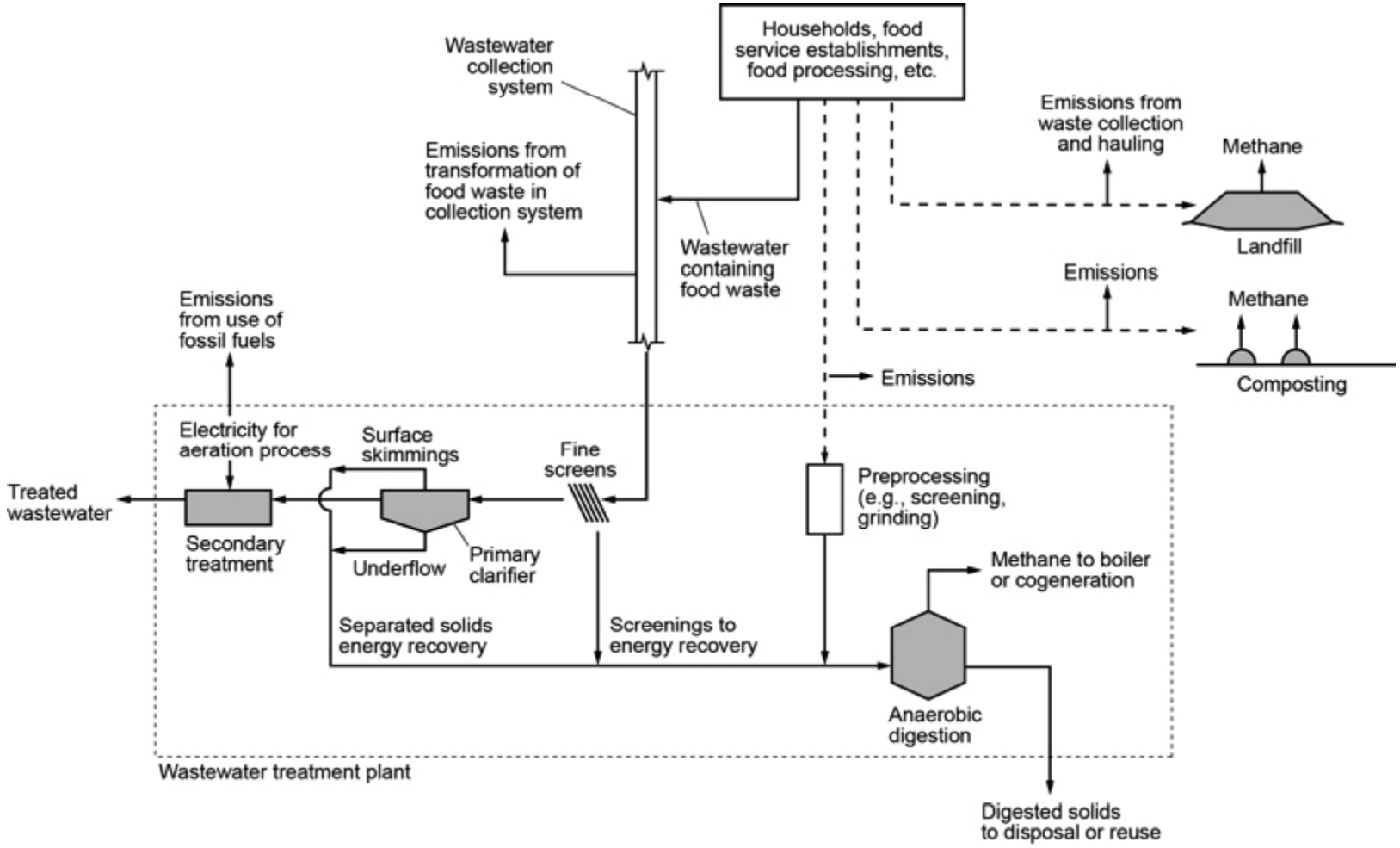
ANSWER

To accomplish these objectives it will be necessary to modify the characteristics of the waste to be treated

Overview of Presentation

- What to do with Food Waste
- Wastewater Constituents and Characteristics
- Energy Content of Wastewater Versus Energy Needed For Treatment
- Modification of Wastewater Characteristics – Near-Term Interventions
- Modification of Wastewater Characteristics – Long-Term Interventions
- A Final Thought and Sustainability Challenge

Food Waste Management Options



Wastewater Characteristics

Conventional

- Organic constituents
- Inorganic constituents

Additional

- Heat energy
- Chemical energy

Constituents in Wastewater

Constituent	Unit	Value (typical)
Solids, total (TS)	mg/L	390 -1230 (720)
Dissolved, total (TDS)	mgIL	270 – 860 (500)
Suspended solids, total (TSS)	mg/L	120 – 400 (210)
Biochemical oxygen demand (BOD) 5-d, 20°C	mg/L	110 – 350 (190)
Total organic carbon (TOC)	mg/L	80 – 260 (140)
Chemical oxygen demand (COD)	mg/L	250 – 800 (430)
Oil and grease	mg/L	30 – 90 (60)
Flowrate	gal/capita•d	200 – 60 (120)

Energy Content of Wastewater

Heat energy

Specific heat of water = 4.1816 J/g •°C at 20°C

Chemical oxygen demand (COD)

$C_5H_7NO_2 + 5O_2 = 5CO_2 + NH_3 + 2H_2O$
(113) 5(32)

Chemical energy (Channiwala,1992)

HHV (MJ/kg) = 34.91 C + 117.83 H - 10.34 O
- 1.51 N + 10.05 S - 2.11A

Energy Content of Wastewater

Constituent	Unit	Value
Wastewater, heat basis	MJ/10°C•10^3 m^3	41,900
Wastewater, COD basis	MJ/kg COD	12 - 15
Primary sludge, dry	MJ/kg TSS	15 - 15.9
Secondary biosolids, dry	MJ/kg TSS	12.4 - 13.5

Required and Available Energy for Wastewater Treatment, Exclusive of Heat Energy

- Energy required for secondary wastewater treatment

  1,200 to 2,400 MJ/1000 m^3

- Energy available in wastewater for treatment, using previous data

  Q = [430 kg COD/1000 m^3) (1000 m^3) (13 MJ/ kg COD)

  5,590 MJ/1000 m^3

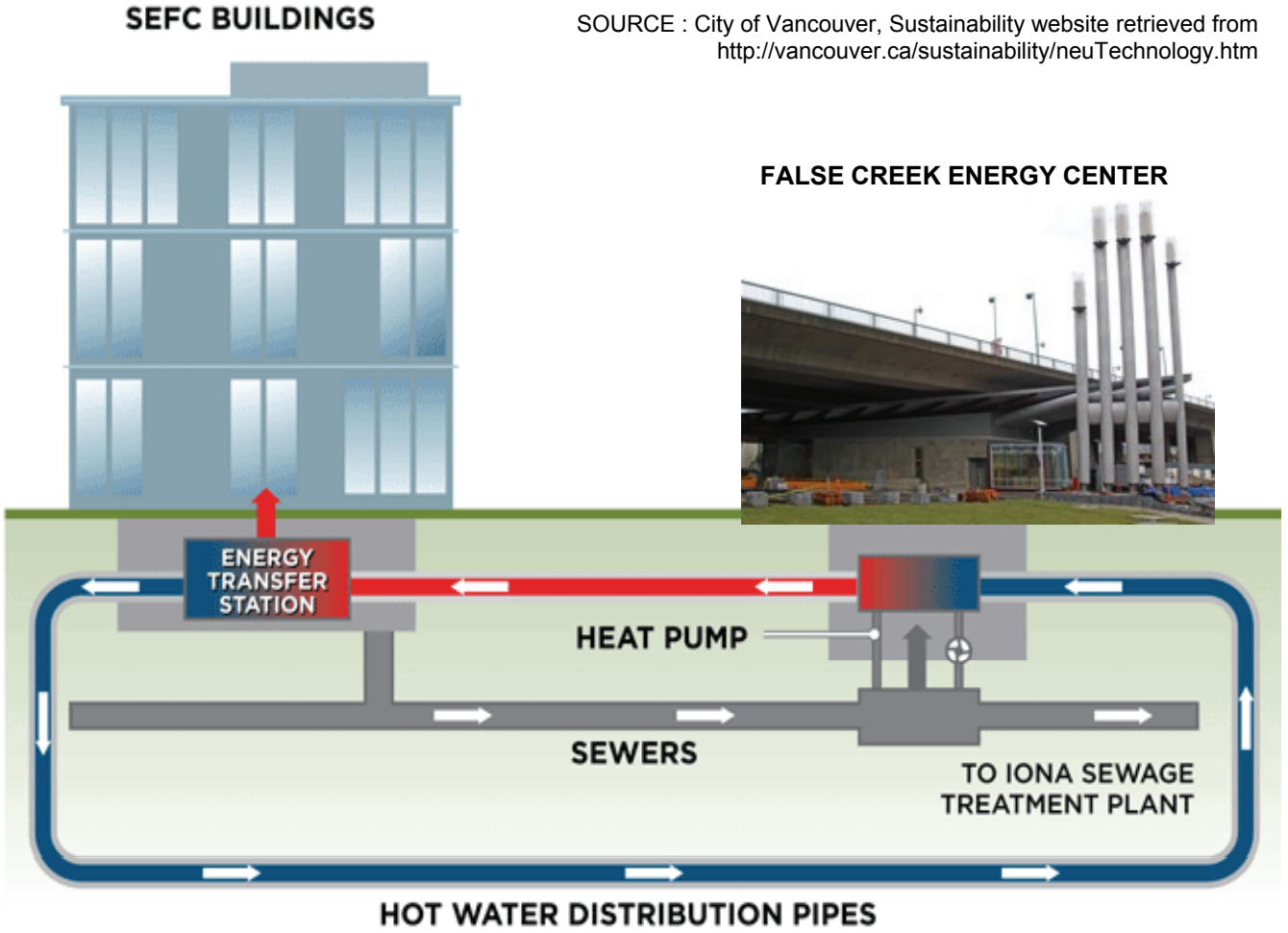
- Energy available in wastewater is 2 to 4 times the amount required for treatment

What is the Key Question – How to Recover and Use Energy ?

- Anaerobic digestion and power generation
- Ambient temperature anaerobic treatment and power generation
- Complete treatment without biological processing with heat drying and power generation
- Upstream recovery of heat and chemical energy

Heat Recovery from Wastewater

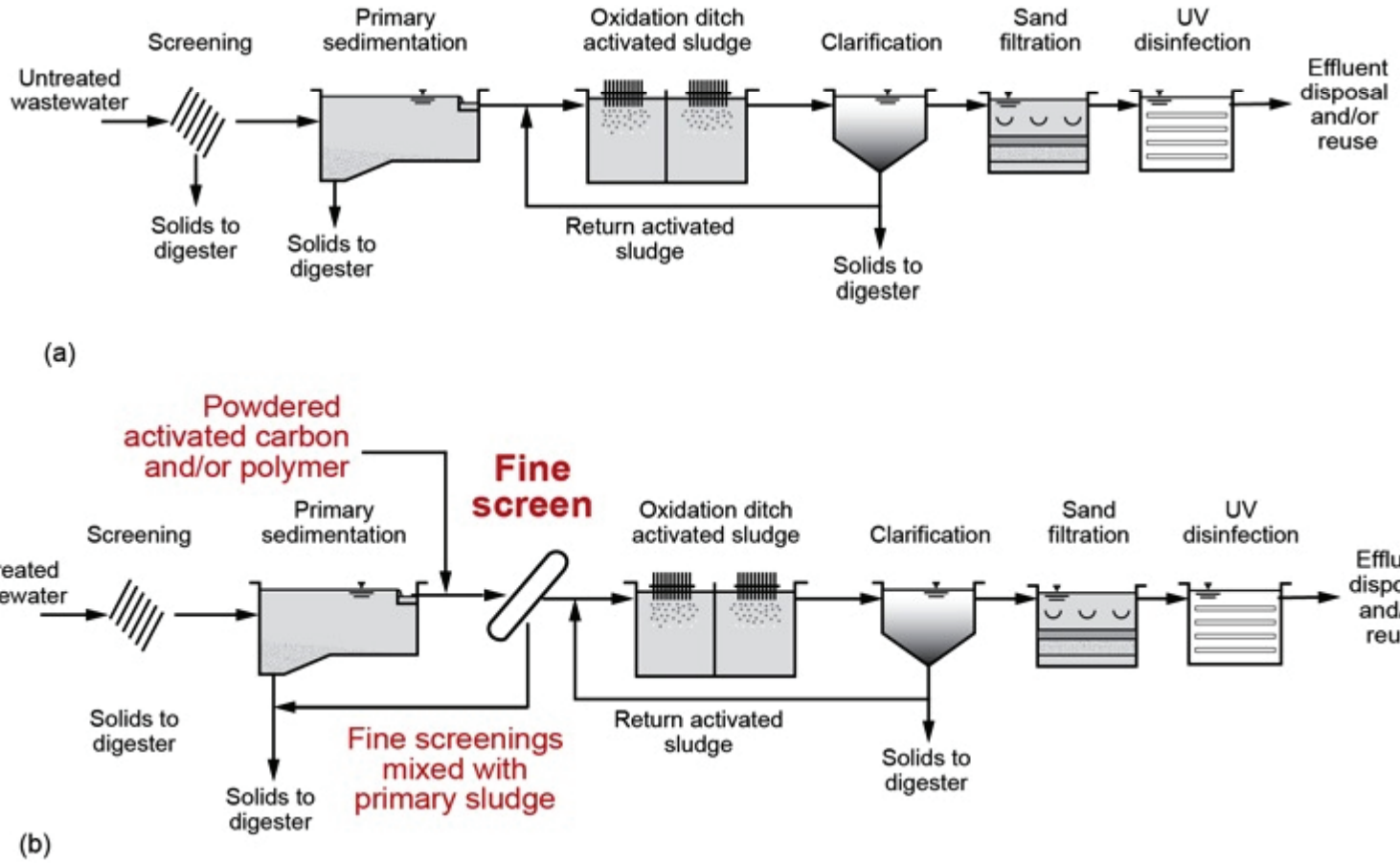
SOURCE : City of Vancouver, Sustainability website retrieved from http://vancouver.ca/sustainability/neuTechnology.htm



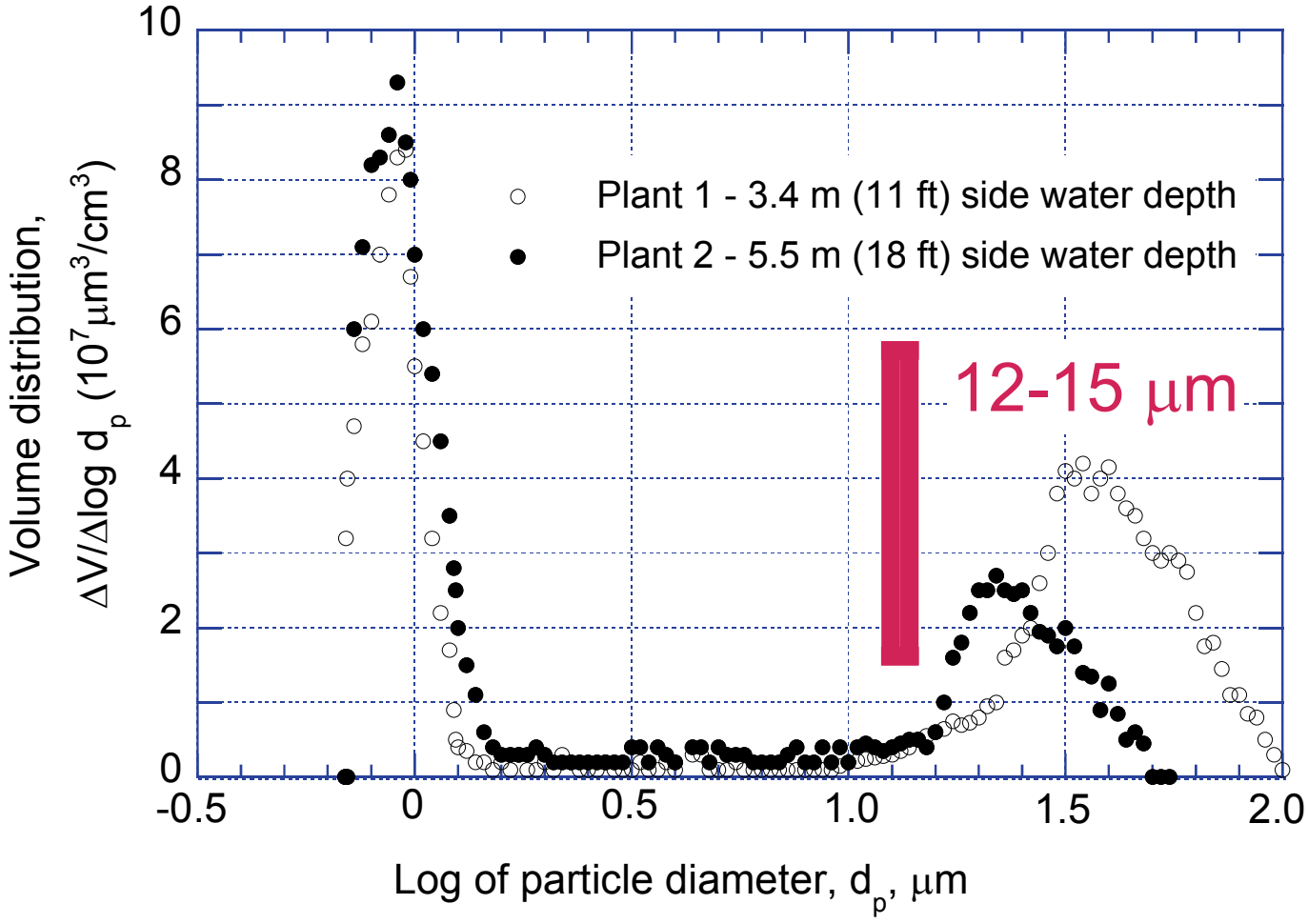
Modification of Wastewater Characteristics – Near-Term Interventions

1. Reduce energy usage through reduced organic loading
2. Modify particle size to enhance treatment
3. Additional energy recovery through anaerobic digestion
4. Separate treatment for return flows
5. Conversion of food waste and fats, oils, and grease

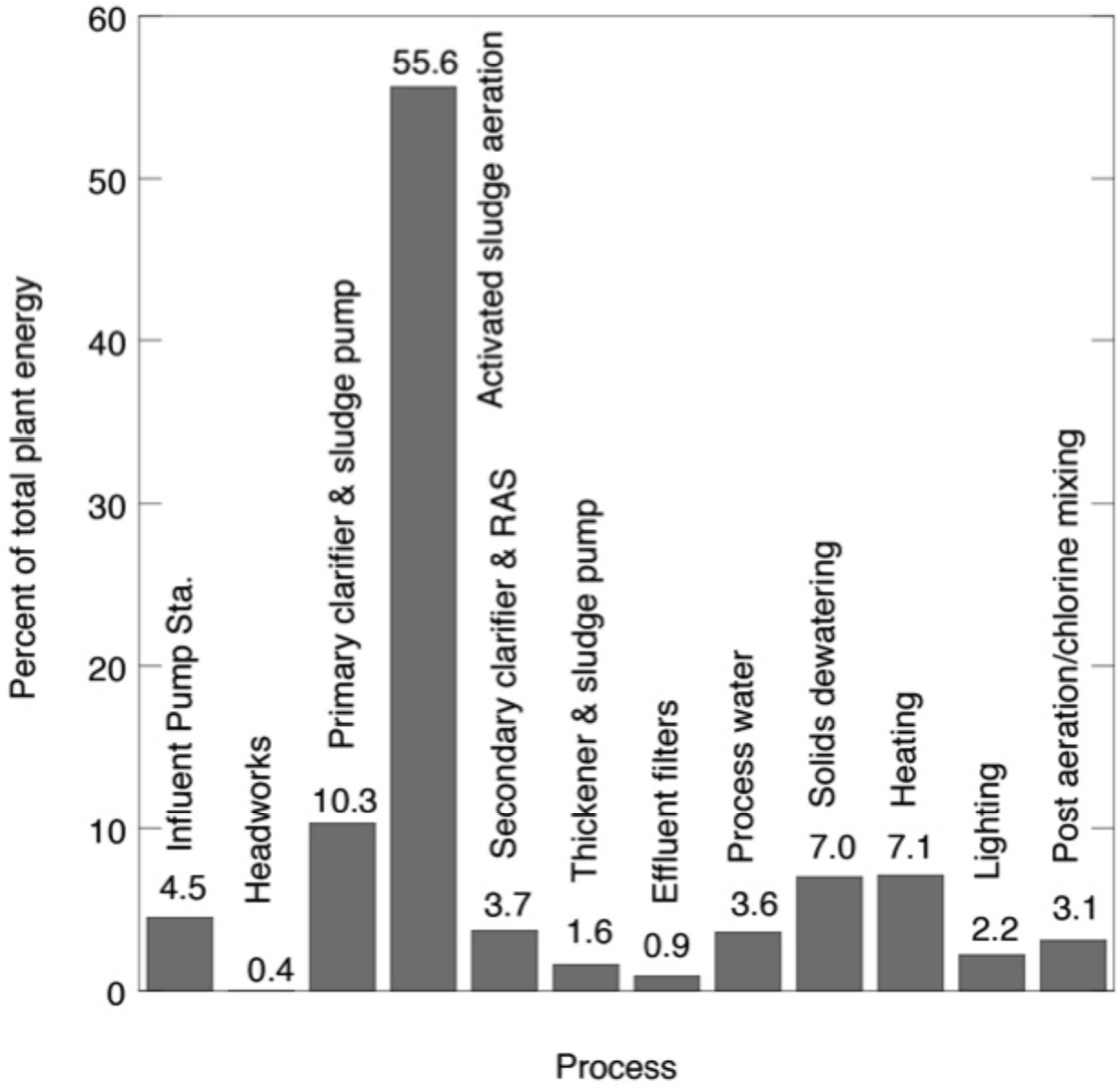
Wastewater Treatment Process Flow Diagrams With Conventional and New Technologies



Particle Size Modification With Primary Effluent Filtration

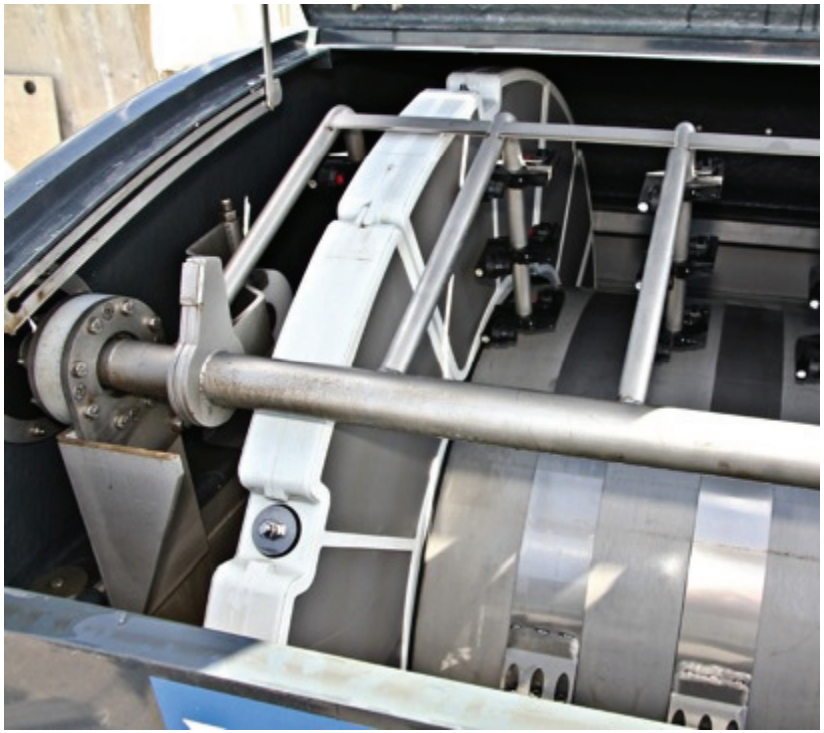


Energy Usage in Activated Sludge Treatment



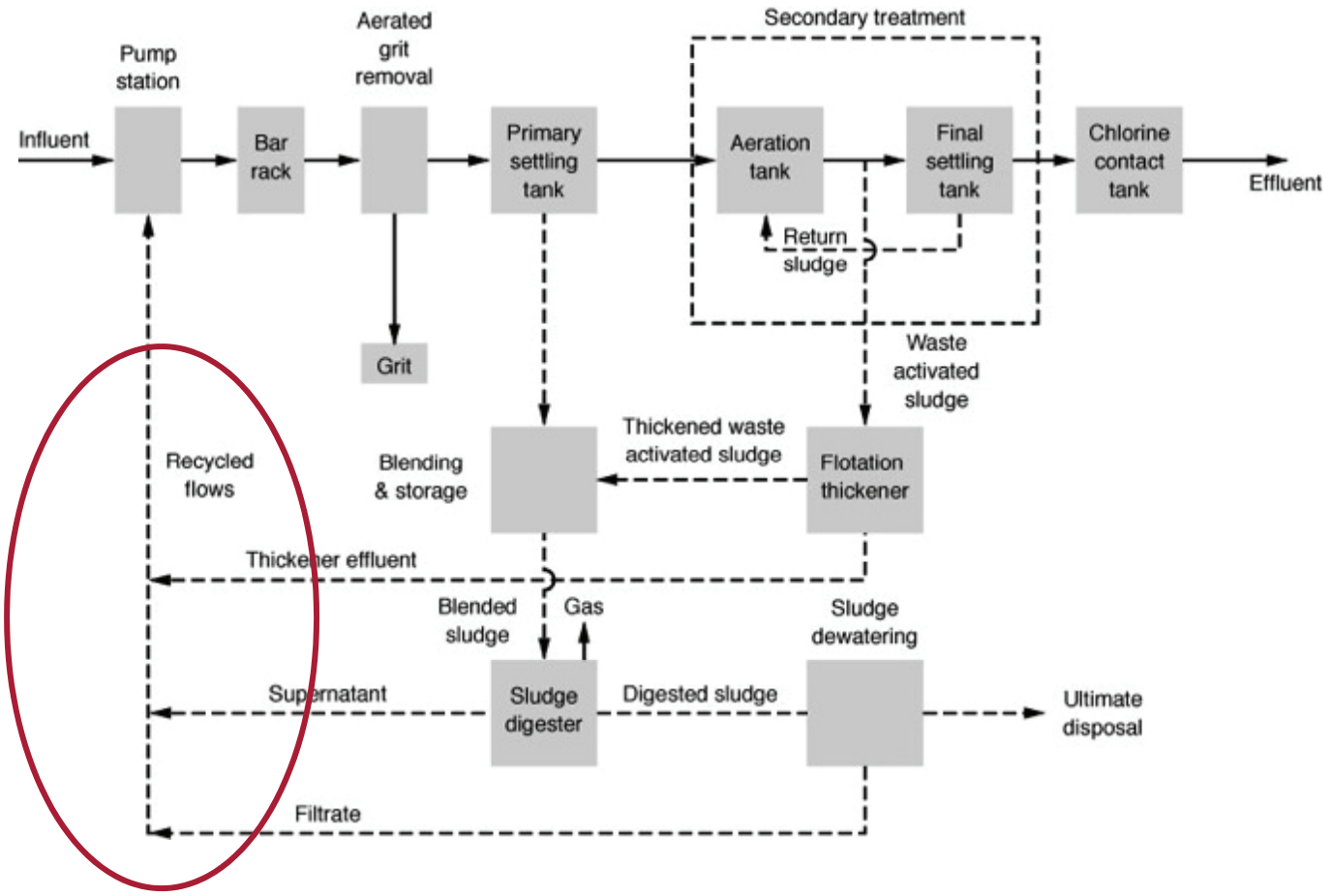
Primary Effluent Filtration with Fuzzy Filter

Primary Effluent Filtration with WesTech Disk Filter

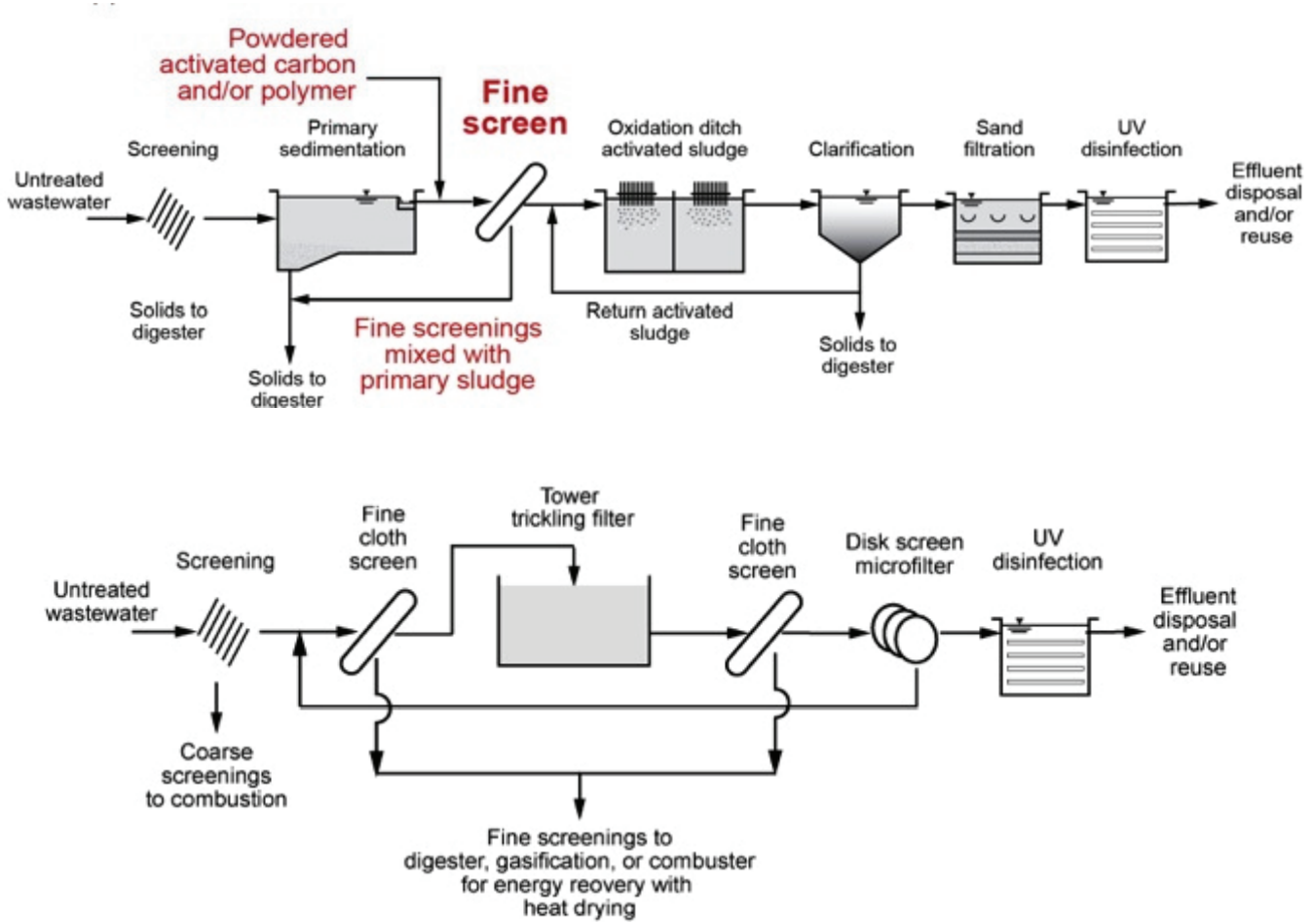


Impact of Recycle Flows on Nitrogen Removal

Return flows contain nitrogen

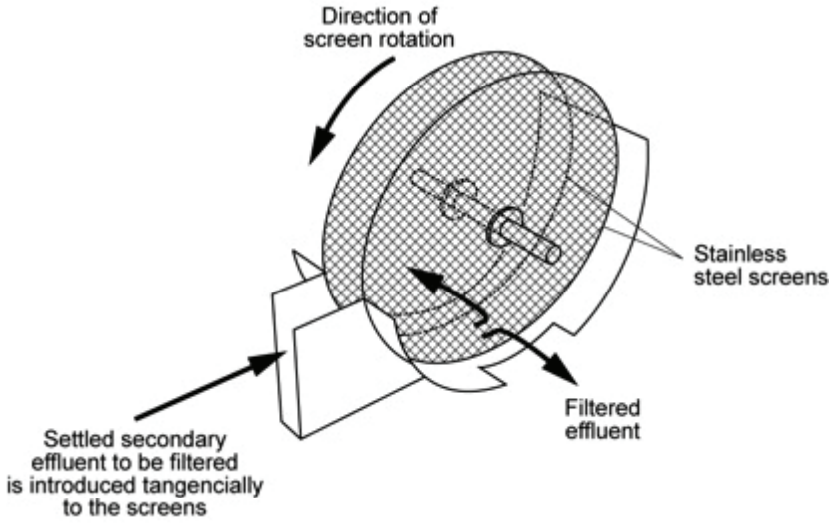


Wastewater Treatment Process Flow Diagrams With Conventional and New Technologies



Fine Screen for Solids Removal

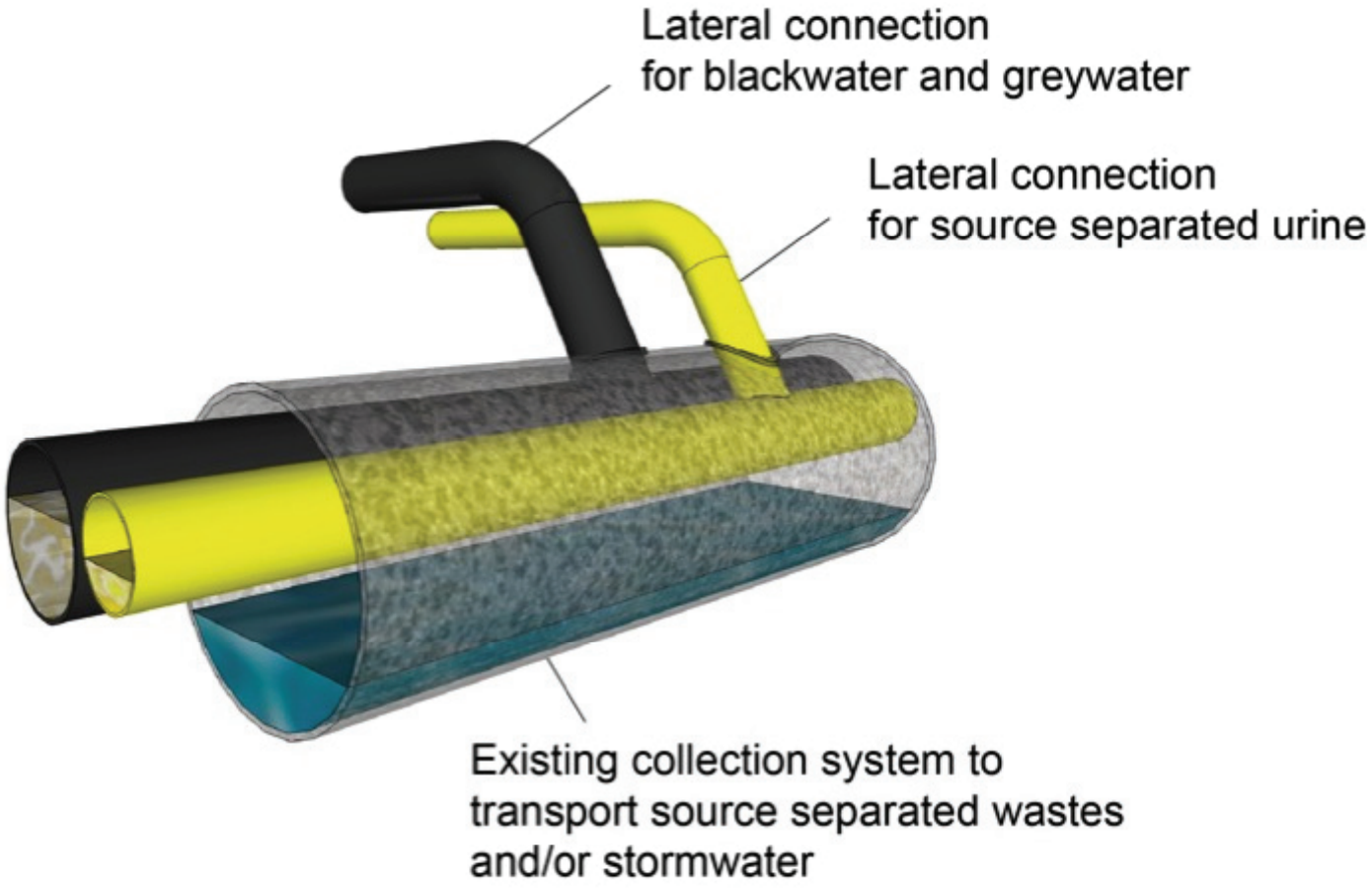
Stainless Steel Cloth Filter (10 μm) for Filtration of Secondary Effluent



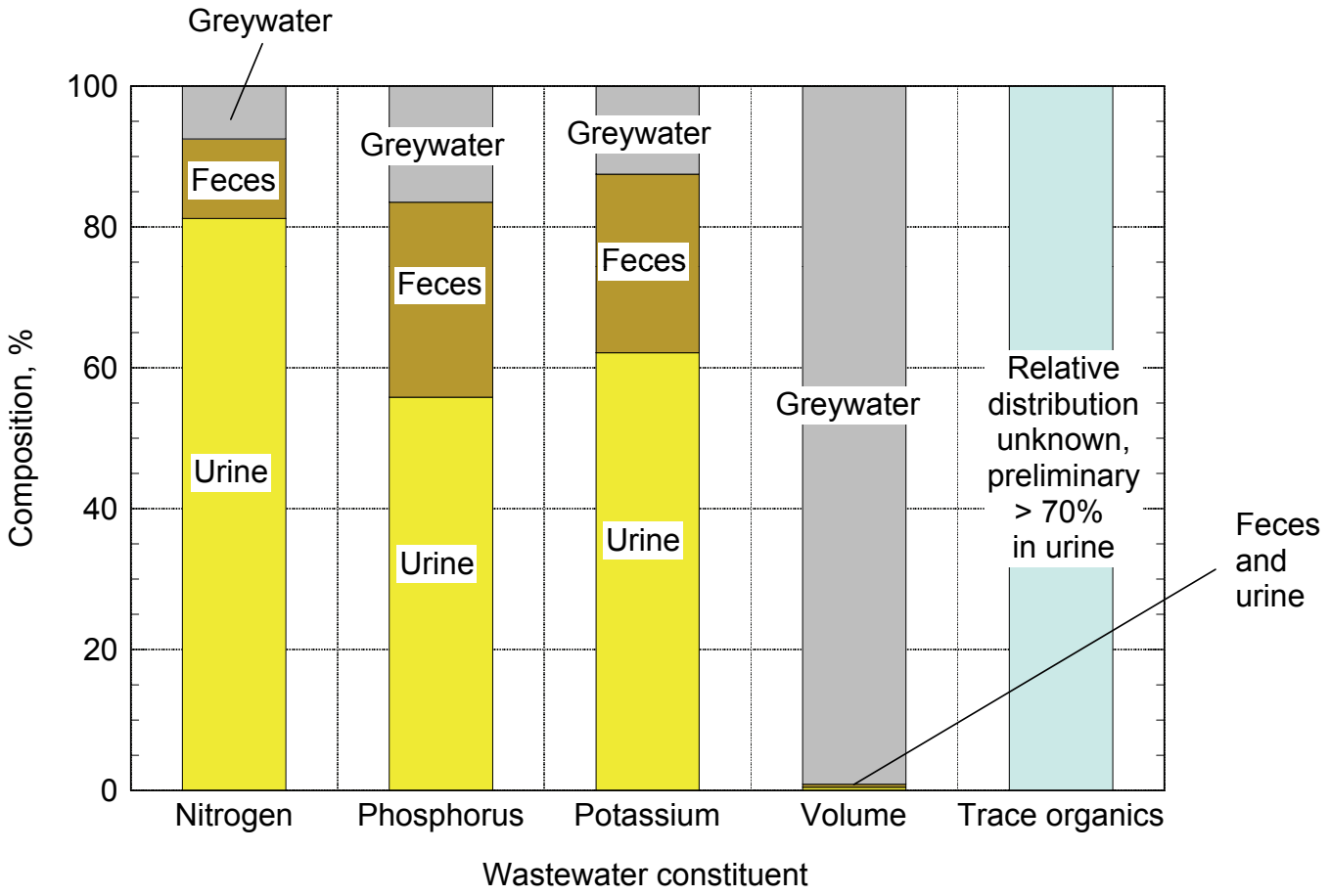
Modification of Wastewater Characteristics – Long-Term Interventions

1. Separation of waste constituents at the source into urine and black water
2. Reduce phosphate content of consumer products
3. Alternative treatment processes and configurations
4. Recover wastewater solids upstream in satellite stations

Use of Existing Collection System For Source Separated Resource Streams



Nutrients and Trace Organics in Domestic Wastewater: A Case for Urine Separation



Source: Jönsson et al.(2000) Recycling Source Separated Human Urine.

Examples of Urine Separation Fixtures

Urine Utilization in Indoor Wetland System

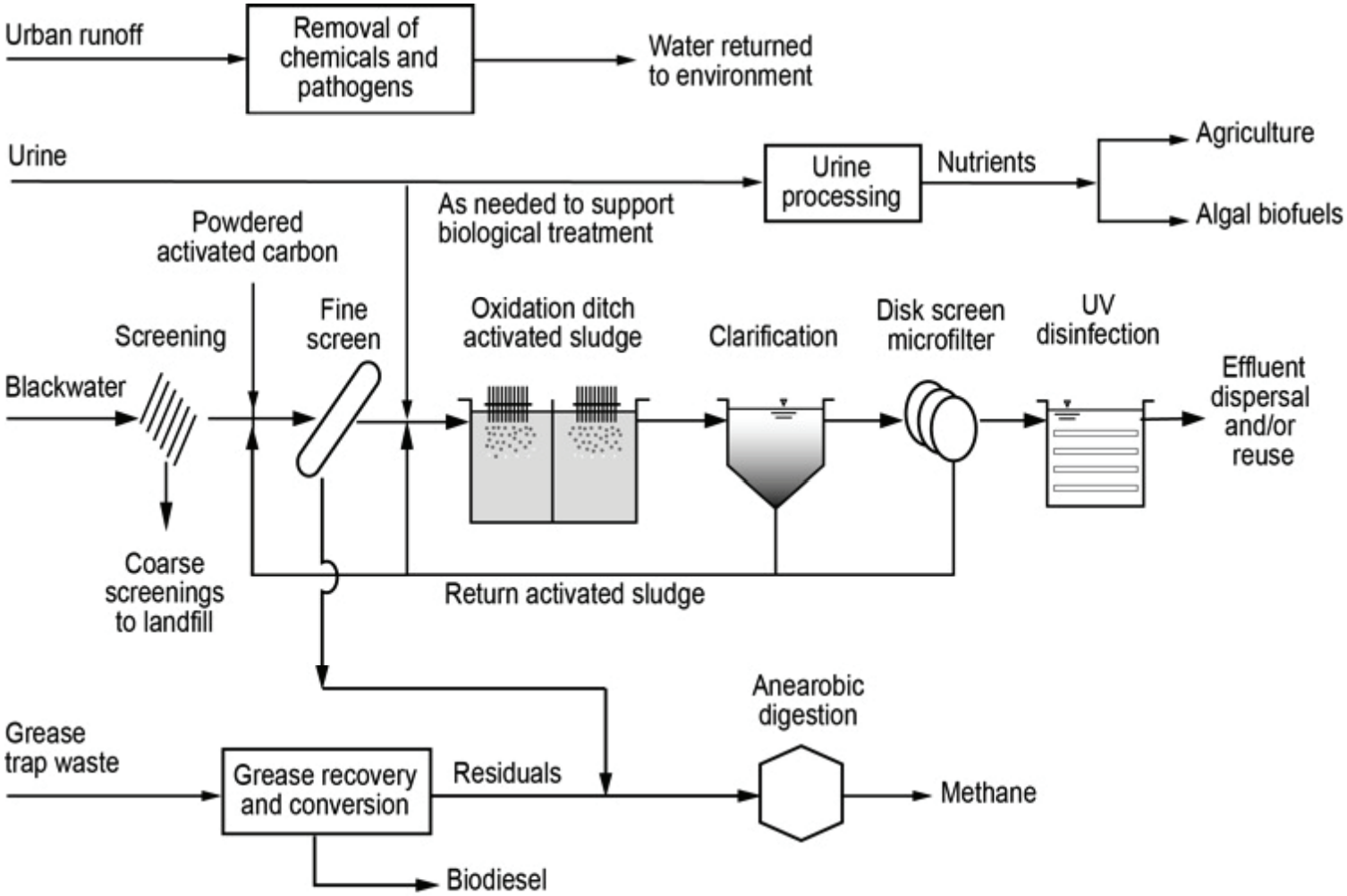
Potential Impacts of Urine Separation Based on 190 L/capita-d (50 gal/capita-d)

Constituent	Typical, g/capita-d	Typical, mg/L	With US, g/capita-d	With US, mg/L
BOD_5	85	450	85	~450
COD	200	1050	200	~1050
TSS	95	500	95	~500
NH_4-N	7.8	42	0.6	3
Organic N	5.5	30	2.4	13
TKN	13.3	72	3.0	16
P (biogenic)	1.4	7.4	0.6	3.3
P (other)	1.0	5	0.5	2.6

Potential Impacts of Urine Separation On Biological Wastewater Treatment

Constituent	With US, mg/L	After primary, mg/L	Cell yield, mg/L
BOD_5	~450	292	190
COD	~1050	525	-
TSS	~500	150	-
NH_4-N	3	~3	Req. N for cell growth 23.5
Organic N	13	~9	
TKN	16	~12	
P (biogenic)	3.3	2.3	Req. P 4.7
P (other)	2.6	1.8	

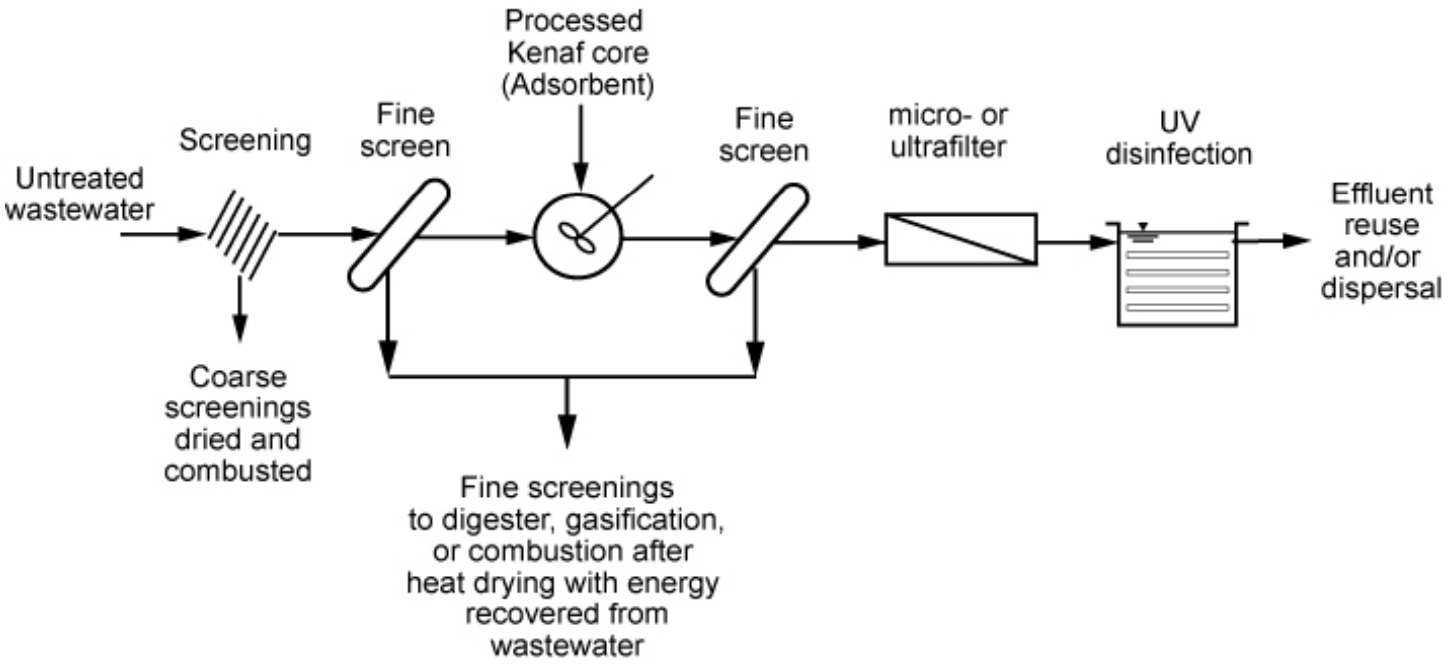
Future Wastewater Management



New Concept for the Treatment and Recovery of Energy from Wastewater

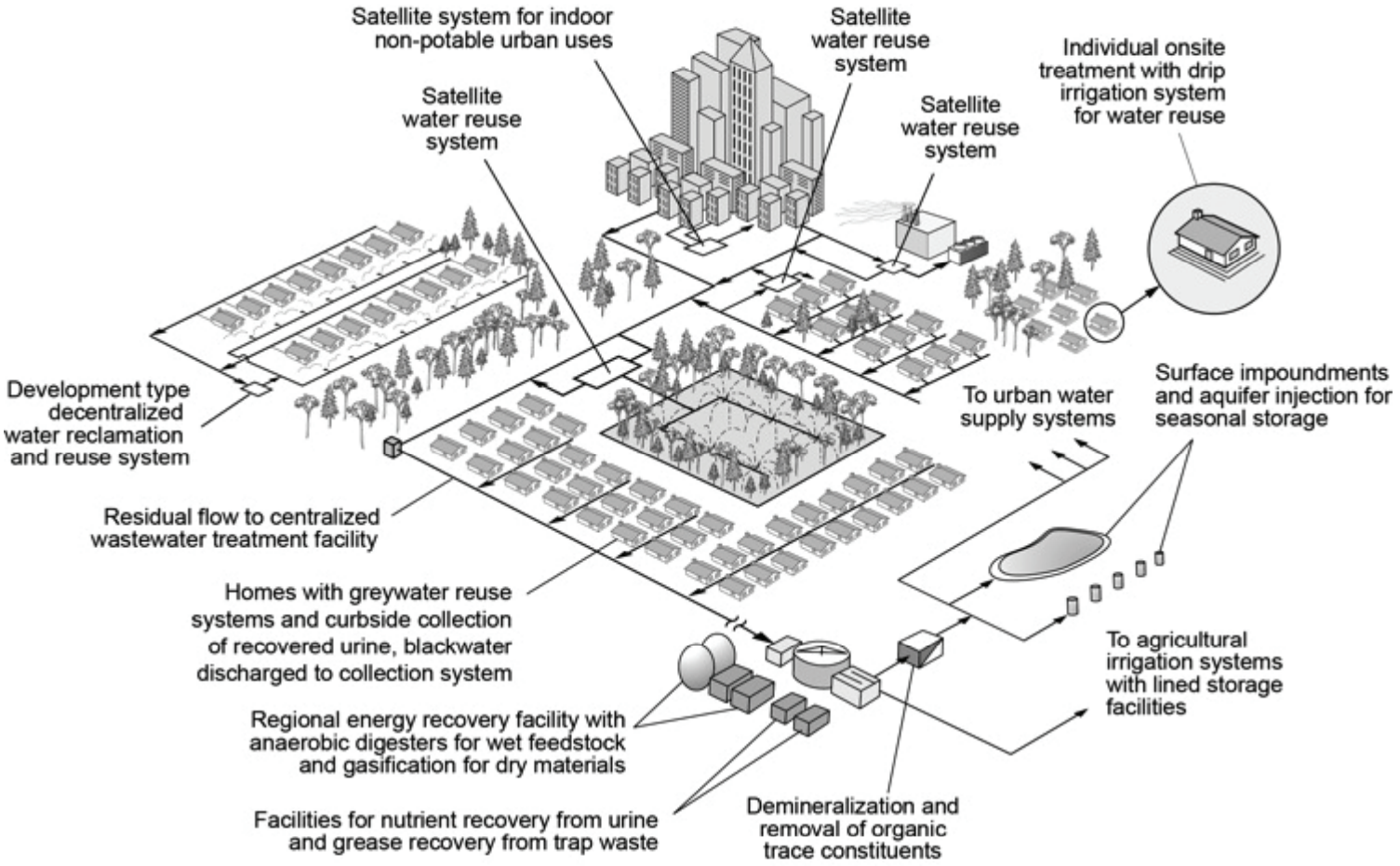
- Replace primary and secondary sedimentation tanks with cloth screens
- Use ***"plant adsorbent (e.g., Kenaf)"*** to adsorb organics and ammonia
- Recover heat energy for drying solids
- Generate energy from dried solids

Wastewater Treatment Process Flow Diagram Without Biological Treatment

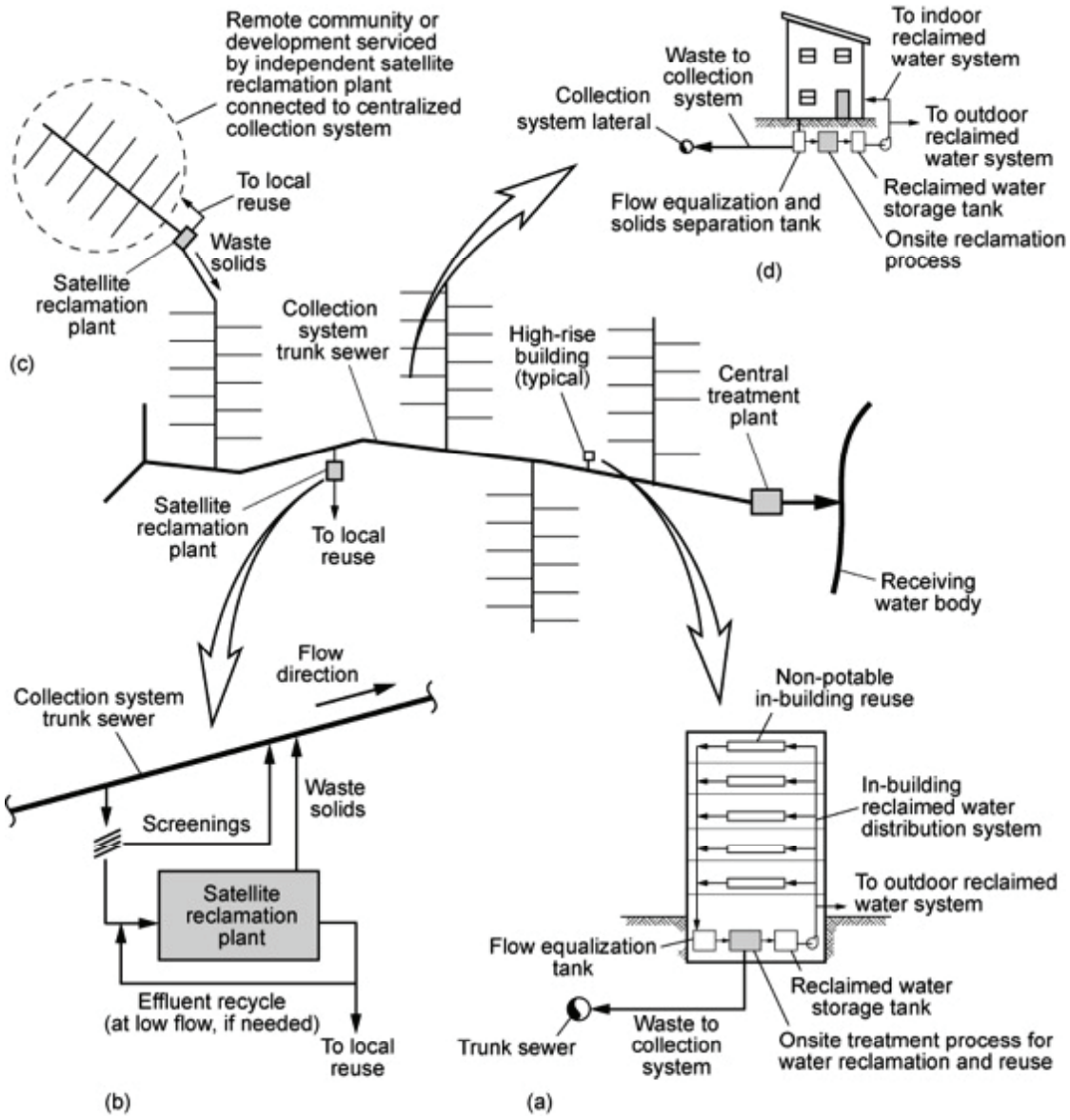


Membrane Filtration of Screened Effluent

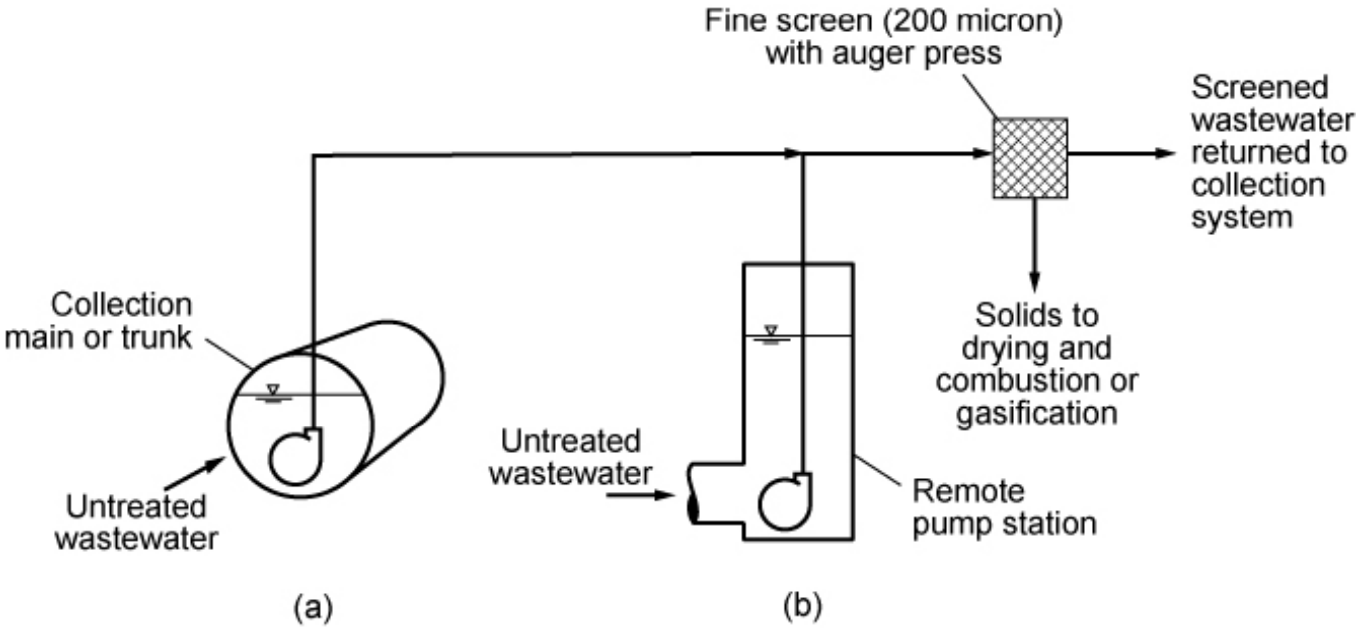
Integrated Wastewater Management With Decentralized, Satellite, Centralized Facilities



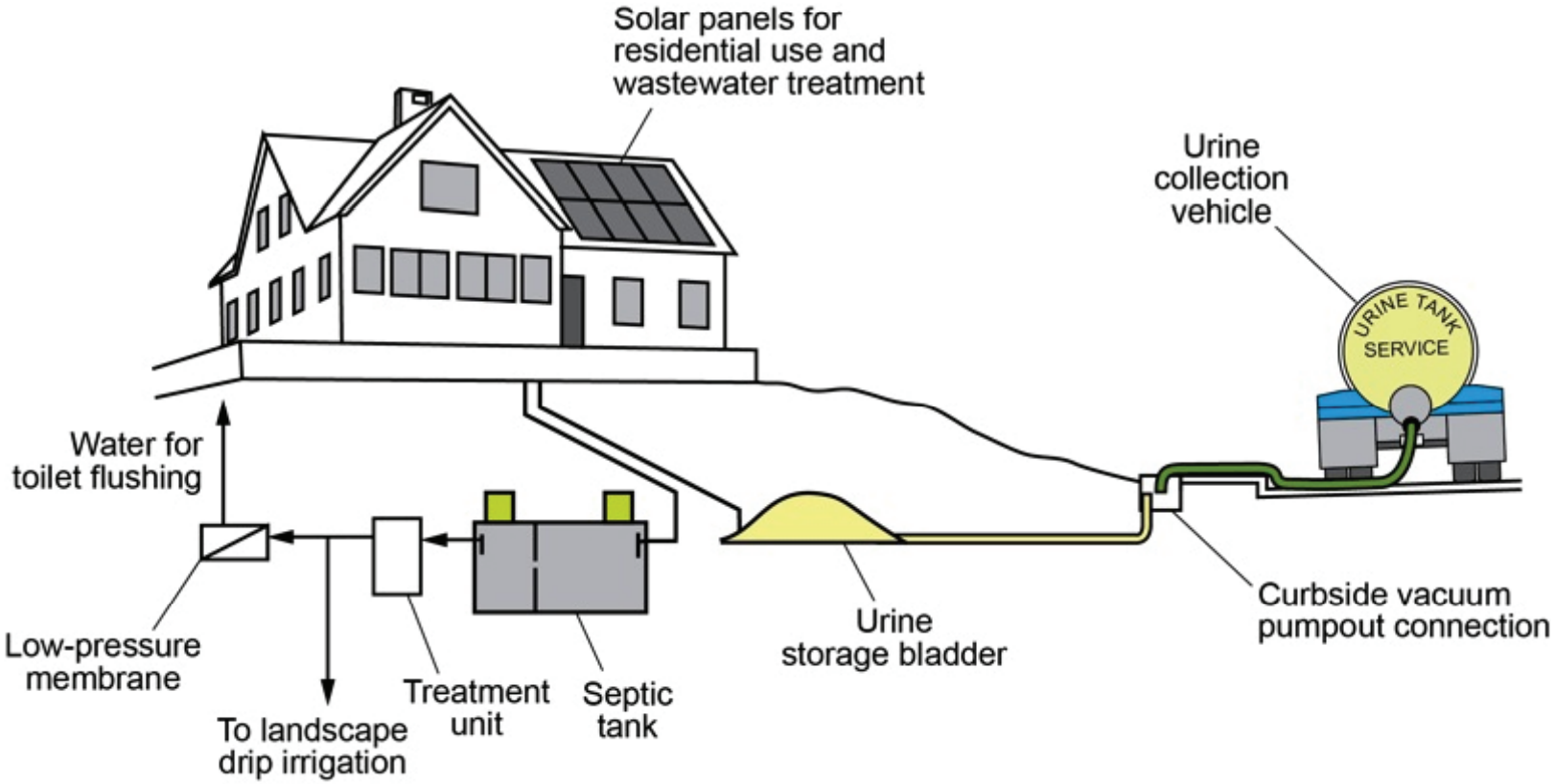
Satellite Systems for Reclamation and Reuse



Recovery of Constituents from Wastewater Collection System



Nutrient Separation, Storage, and Recovery From Individual Residence



Take Away Message

In closing, we must all continue to seek new concepts and technologies to change the status-quo with respect to how the energy and resources in wastewater and food waste are recovered to develop a more sustainable future – a challenge worthy of the attendees at this Education Seminar

THANK YOU
FOR LISTENING