out think the box

Vermi-composting | Worms in Sanitation

Oakland, CA, USA

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introduction

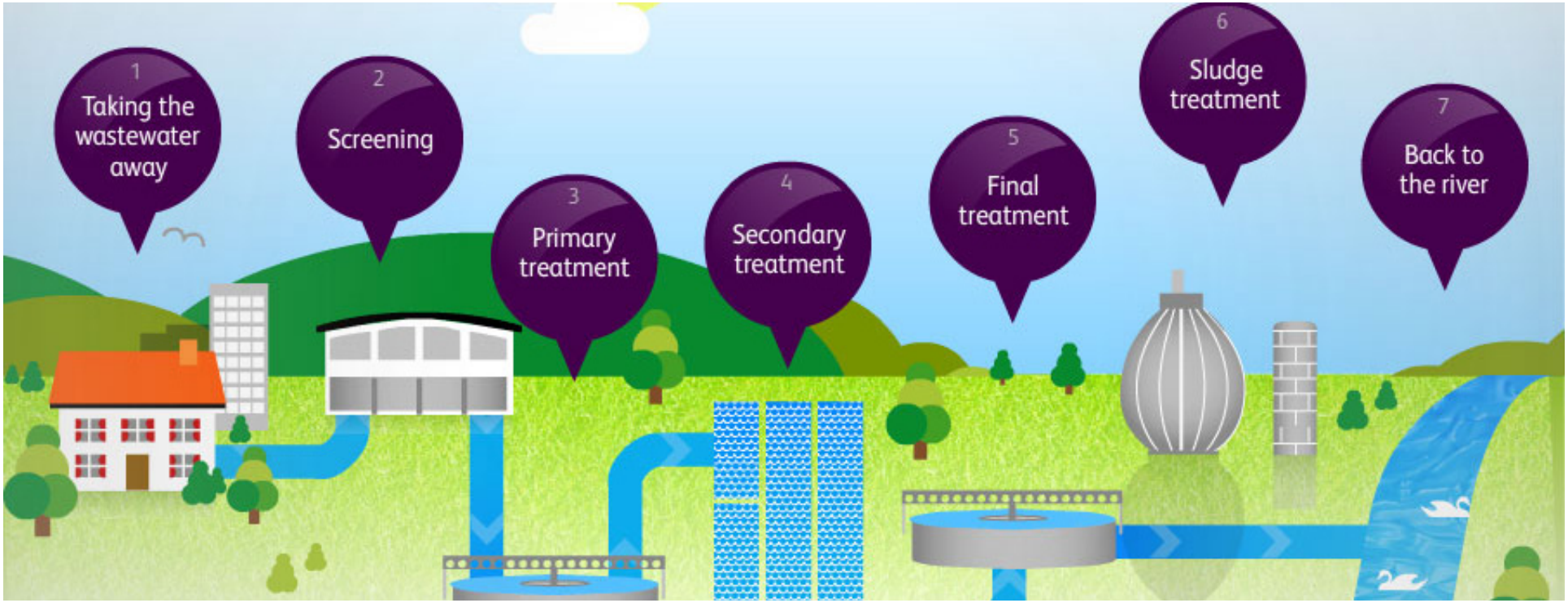
The problems:

- Resource scarcity:
  - Potable water
  - Drinkable water
- Ready water access during disaster relief scenarios
- Sanitation management 72 hours post-disaster event

flush toilet system

Let's talk about the flush toilet

Excreta from land dwellers (humans included) is not naturally designed to be decomposed in flushed water.



flush toilet system (cont'd) 5

Let's talk about the flush toilet:

- Centrally processed sewage treatment
- Costly environmentally
- Pollutes enormous amounts of clean water
- Lengthy and energy intensive process
- Smelly, slow anaerobic process that encourages pathogen growth
- Requires residual treatment
- Removes beneficial organisms

septic tanks

Let's talk about septic tanks (anaerobic decomposition)

- Requires pumping out
- Solids accumulation rate exceeds anaerobic digestion rate
- Pass thru water (untreated)
- Leach fields/soak pits

- Dissolved pollutants & pathogens (sludge) => NO_{3-} & bacterial pollution

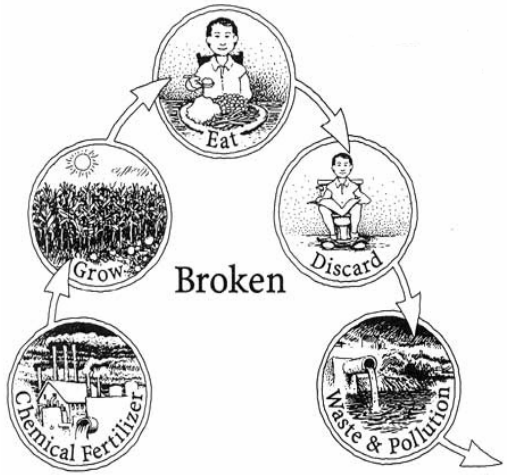


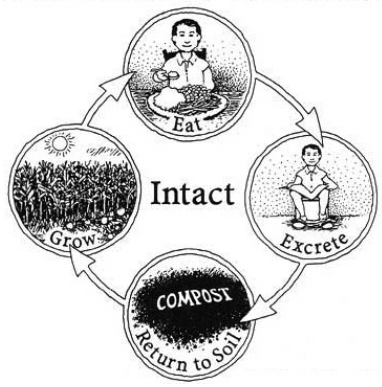
Image Citation: Jenkins, J., 1998. The Humanure Handbook, 2nd Edition, http://weblife.org/humanure/chapter2_1.html

ecosan & vermi-composting

Let's talk about aerobic decomposition

- Fast
- Odor- & Pathogen-free
- No discharge
- Pollutants & sewage septage are:
  - Completely consumed
  - Converted into rich fertile soil (humus)

- Inorganic & organic pollutants:
  - Ingested by worms (locked up)
  - Broken down (by micro-flora & fauna)



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vermi-composting

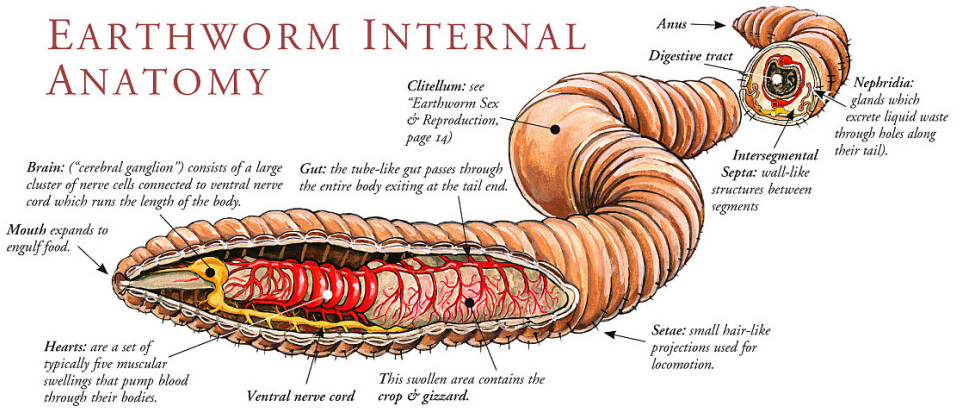
Use of worms to convert organic material into worm/vermi-compost. 'Vermi' - Latin for worm.

Worms at work | 20 days time lapse of vermicomposting by Gregor Skoberne

vermi-composting

Why worms?

- 600 million years of adaptation
- Bodies act as bio-filters
- Plant & animal excreta turned into soil
- Organic undesirables ingested & degraded
- Digestates turn into nutrient-dense, microbial-rich soil
- Heavy metals & organic pollutants (locked up)
- Increase soil hydraulic conductivity & aeration



vermi-composting

Why worms?

- Lifespan ~3-7 years
- Stimulate microbial activity in system
- Degrade pollutants/ waste water organics
- Gut harbors millions of nitrogen-fixing & decomposter microbes
- Enormously adaptable and tolerant e.g. salty soils, soils w/high heavy metal concentration & toxic, organic pollutants

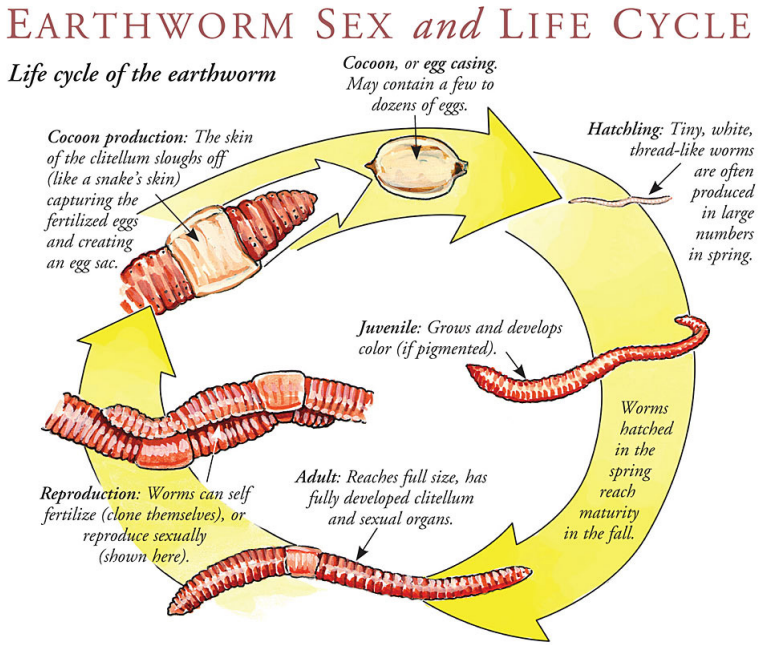


Image © Rick Kollath

vermi-composting

Why worms?

- Easy to establish & self-regulate population
- Numbers double ~60-70 days e.g. ~256 worms generated every 6 months from a single, bisexual individual
- Temperature:
  - Range | 41-84°F (5-29°C)
  - Ideal | 55-77°F (13-25°C)
- Moisture:
  - 60-70% (ideal)
- pH 6.5

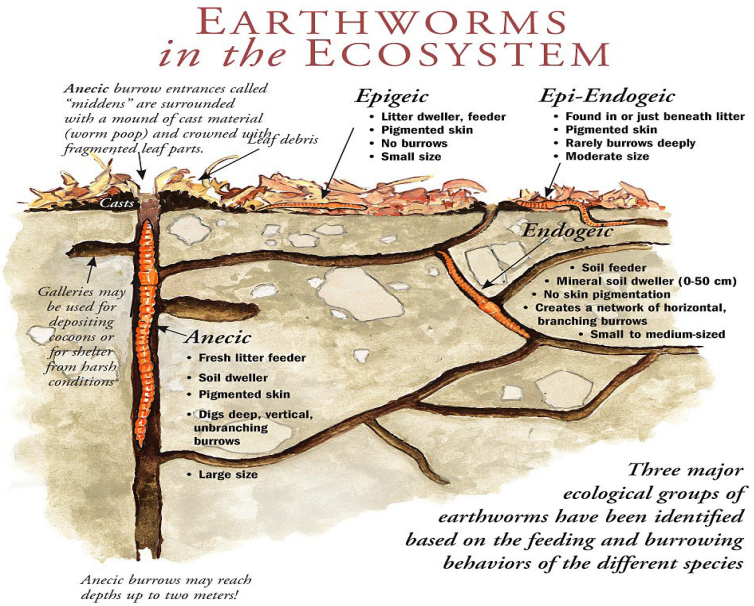


Image © Rick Kollath

vermi-composting

Worms in sanitation

- Simple, low-tech
- Inexpensive
- Preferred species

Eisenia foetida e.g.

  - Tiger Worm
  - Red Wiggler Worm

- Excluded activity in waste mgt. in CA
- Types of systems
  - Vast worm beds
  - Sewerage works

- Also practiced in:
  - India
  - So America (Chile, Bolivia)
  - New Zealand
  - Portugal

Huasi is vermi-composting faeces with subsequent solar drying in the same compartment in El Alto, Bolivia (Photo: H. Hoffmann, 2012).

vermi-composting

Example | For every two persons using the system:

- Processor system size (volume): 1 m^3
- Initial load:
  - 0.5 kg worms/m^2 (~1 lb/yd^3)
  - => ~ 1,000 worms
- Intake food feedstock rate:
  - 0.40-0.45 kg feed/1 kg worms/day
  - ~1 lb feed/1 lb worms/day

vermi-composting vs conventional waste treatment (cwt)

Vermi-composting

- Inexpensive/Low cost
- Very little water required
- Generates vermi-cast/ casings (worm compost)
- Safe & sanitary
- Low risk

CWT

- Expensive
- Requires large water inputs
- Generates sludge
- Encourages pathogens

solution-based approach

Reuse of Vermi-composted Faecal Matter

- Resource-recycling
- Innovation in adaptive, integrated container-based sanitation collection opportunity
- De-couple sanitation & water
  - Use Eco-sanitation (resource recovery)
  - Reduces water scarcity
- Mother Nature does not make waste

performance aims

Meet/Exceed NSF/ANSI 41 Non-liquid systems & USEPA Class A Biosolids high quality soil amendment properties following IAPMO WE•Stand*:

- Stable Volatile Solids (VS)
- Mature end product
- Balanced pH
- Free of foreign objects
- Free of heavy metals
- Goal | <1000 fecal coliform units (cfu)/g) for vermi-compost safety

* *http://www.iapmo.org/we-stand/*

performance aims (cont'd)

Vermi-compost parameters to measure ensuring worms destroy pathogens:

- Total Solids, TS (%)
- Volatile Solids, VS (%)
- Neutral pH
- Low, total ammonia (NH_3)
- Nitrate (NO_{3-})
- E. coli
- Goals <1000 fecal coliform units (cfu)/g) for vermi-compost safety

Citation: Vermicomposting toilets, an alternative to latrine style microbial composting toilets, prove far superior in mass reduction, pathogen destruction, compost quality, and operational cost Geoffrey Hill, Susan Baldwin (2011)

proposition*

For urban encampments and tiny houses:

- Stop defecating in water & compost instead
- Disaster preparedness
- Homeless encampment inhabitants trained to manage, maintain & gain transferrable skills
- Eco-sanitation & vermi-compost management

*First proposed to City of Oakland on 23 May 2016

benefits

- ↑ Resource recovery
- ↑ Soil quality
- ↑ Plant vigor
- ↑ Grow better food
- ↑ Resilience
- ↑ Job opportunities
- ↓ Stress on municipal H_2O infrastructure
- ↓ Pathogens
- ↓ Weed seeds
- ↓ Carbon emissions
- ↓ Need for pesticides

parting thoughts

Out think the box.
Prepare. Respond. Adapt.

Worms are the intestines of the Earth - Aristotle

Image © Nature Commode