Resource Management in a Resource Challenged World

Presentation to SW Onsite Conference

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Critical Resources and Waste Management Activities

- Air
- Water
- Food
- Energy

- Energy production air impact, Diminishing AQ impacts populations worldwide
- Diminishing water quality major source of disease,
  - High quality water reduces potential health impacts,
  - reduce pollutant discharge improve quality of life. Reclaimed water and residuals can be used in food production
  - Wastewater and nutrients harvested can be used for food or energy production, solids digestion can produce energy

Five Pillars

- Scientifically sound, efficient technology
- Competent personnel
- Sustainable management entities
- Rules, regulations, and ordinances that encourage beneficial reuse
- Publics that demand reliable infrastructure and communities that demand sustainable service

The Sewer regulations in 1848 unlocked the potential of sewer technology

Edwin Chadwick 1800 – 1890, The pioneer of the plumbing regulations

Sir Edwin Chadwick KCB was an English social reformer who is noted for his work to reform the Poor Laws and to improve sanitary conditions and public health.

Timeline

In 1823, he enrolled in law school at The Temple in London.

1830: On 26 November 1830 he was called to the bar, becoming a barrister, also known as a court lawyer.

- **In 1832, Chadwick began on his path to make improvements with sanitary and health conditions.**
- **In 1834, he was appointed secretary to the Poor Law commissioners.**
- **In 1842, wrote, "*The Sanitary Condition of the labouring Population*"**
- **1848 – his work contributed to the passing of the Public Health Act**
- **In 1852, Chadwick conversed with Swansea MP, Lewis Llewelyn Dillwyn, in relation to the construction of a sewerage system in Swansea.**

Source: Wikipedia, Sept. 2016

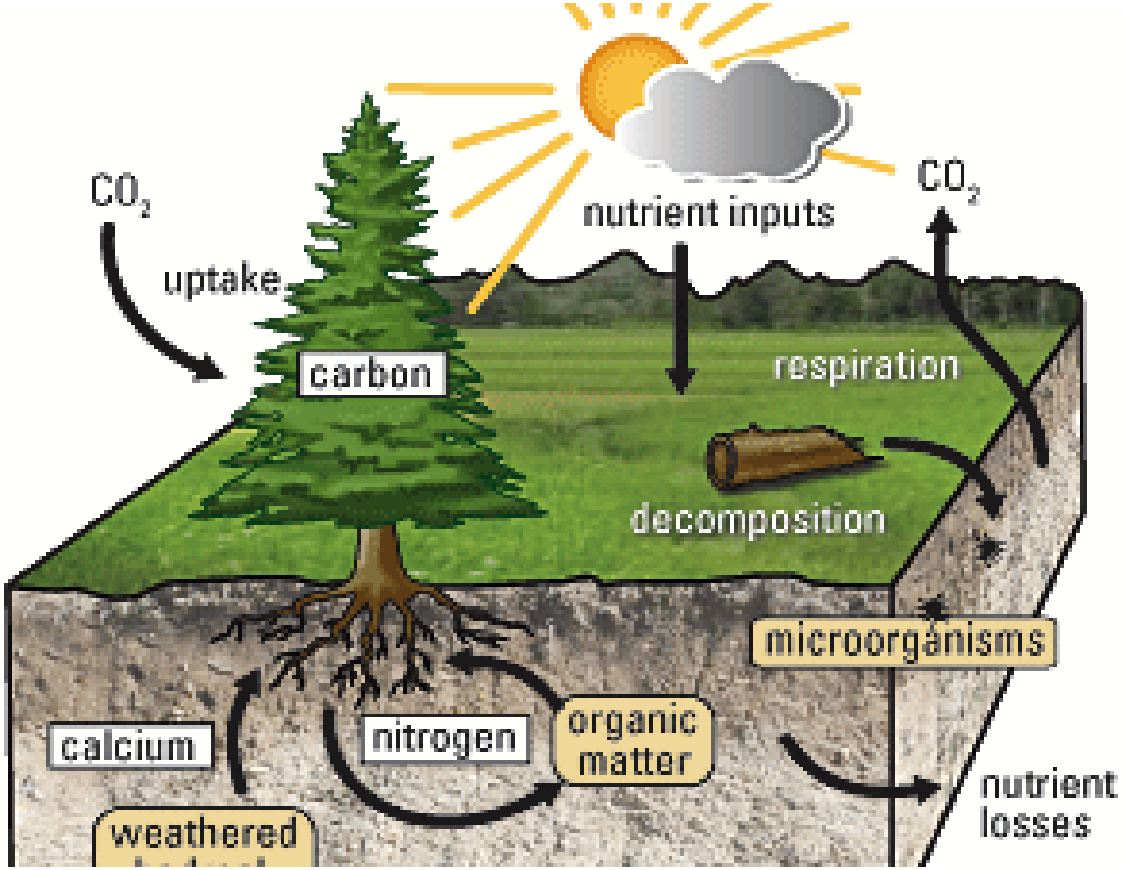
Public Health Issue

- Sanitation, which started the public health revolution in Europe and America during the 19th century, remains a key neighbourhood challenge in slums.

- Lilford, et al. 2016, The Lancet

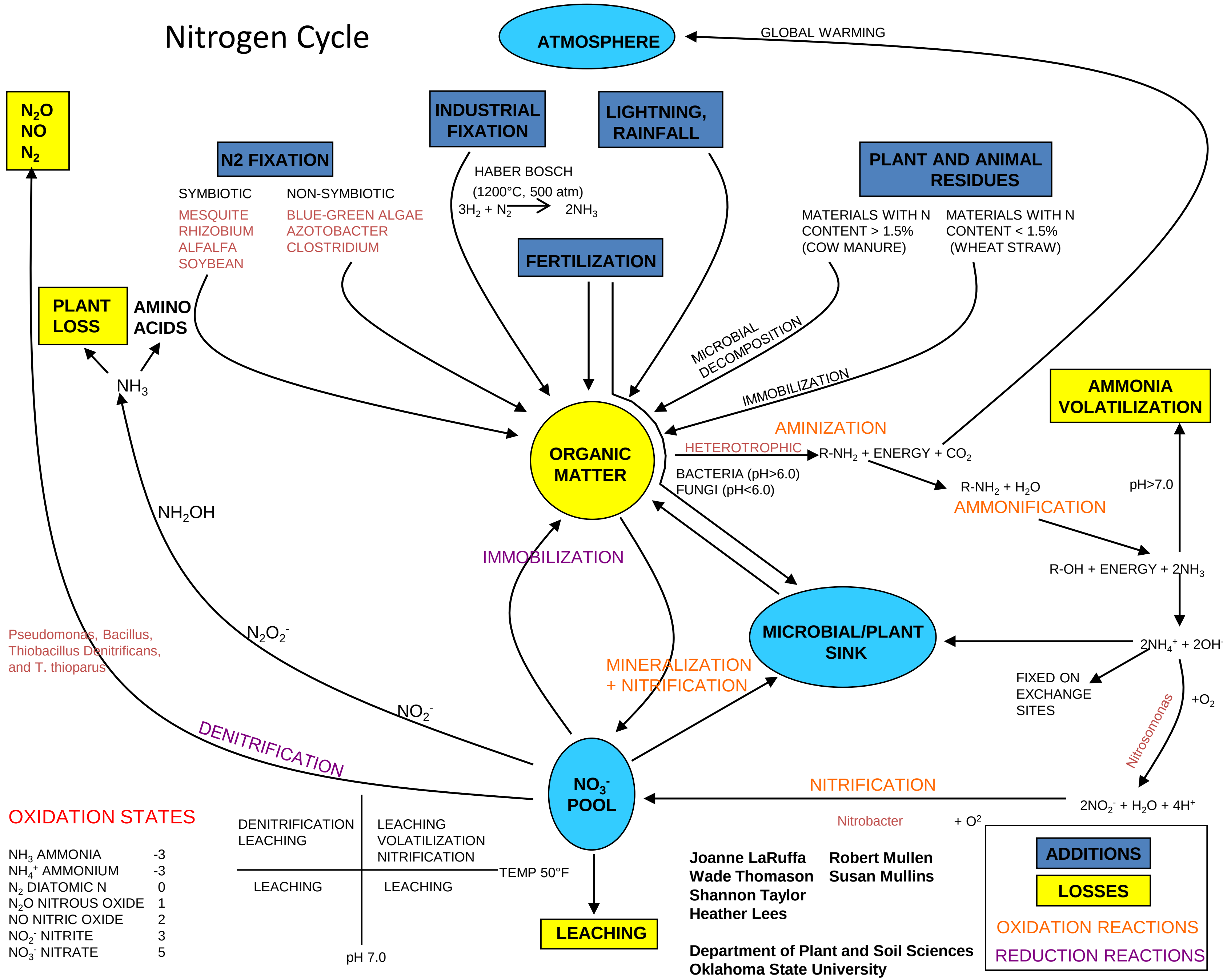
No New Resources –
Just more people creating demand

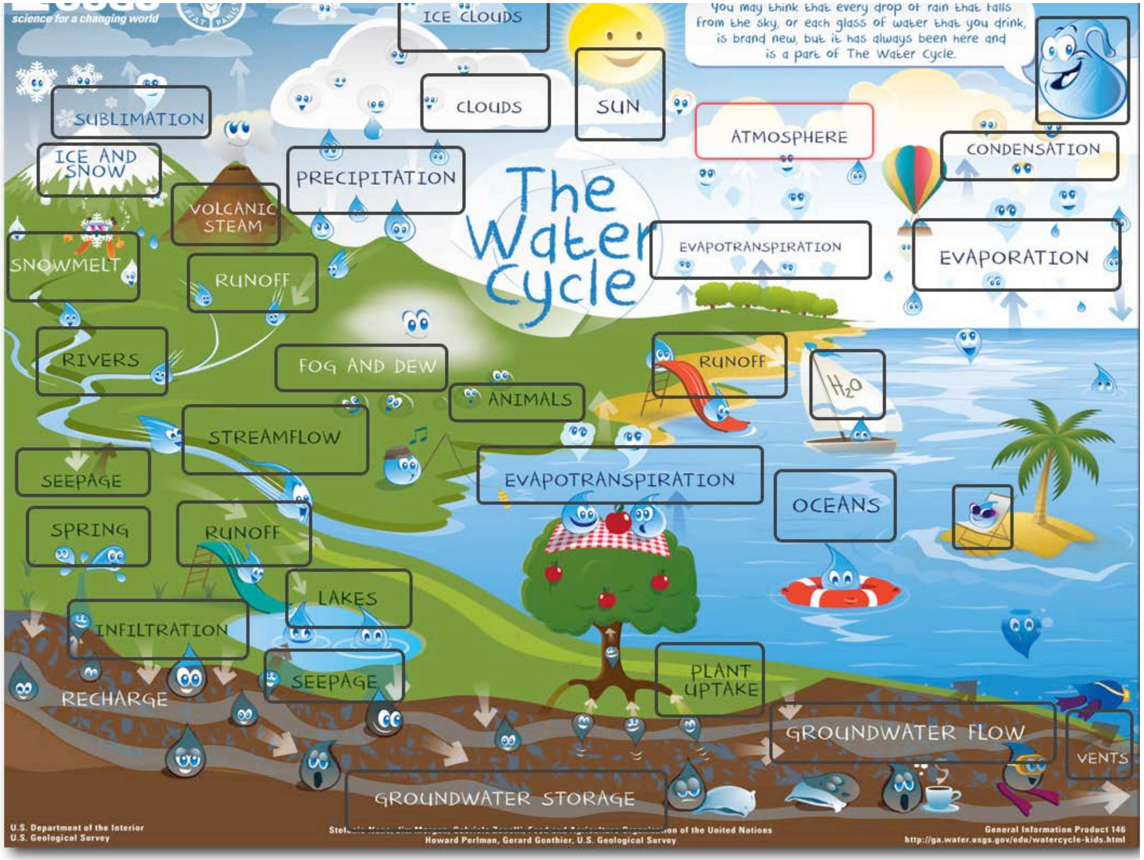
- Carbon/energy cycle
- Nutrient cycle
- Water cycle



Carbon Cycle

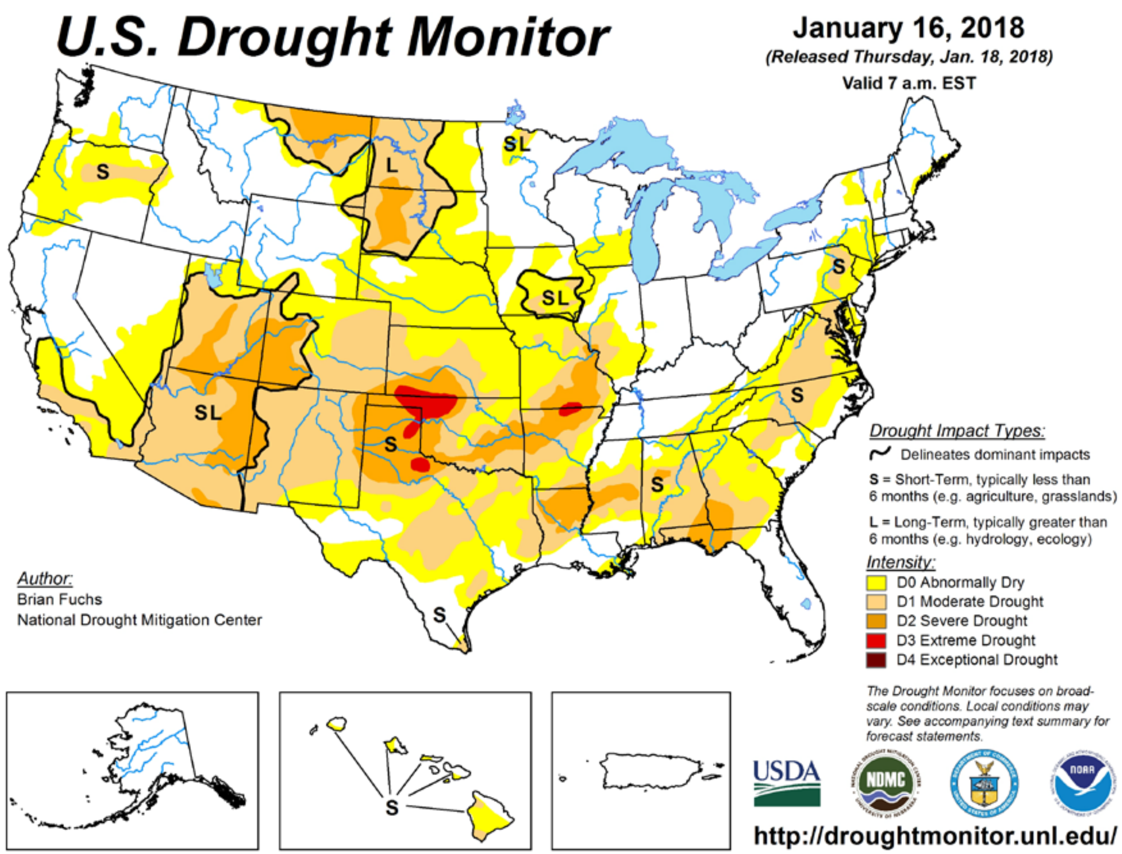
Nitrogen Cycle





Water Cycle

URL: http://water.usgs.gov/edu/watercycle-kids-adv.html



Drought Map, January 2018

Moderate drought common through much of U.S.

Enjoy water? You’re drinking dinosaur pee
Postmedia Network
Published:
May 29, 2015
Updated:
May 29, 2015 1:51 PM EST
Filed Under: Toronto SUN

That glass of water in your hand is dinosaur pee, apparently.
Not like it’s unfiltered, but a science YouTube video posted this week raises the interesting tidbit that, since dinosaurs were around for 186 million years and water molecules are everlasting, it’s a foregone conclusion that every drop of water on the planet passed through the prehistoric species once upon a time.
"While most of the water molecules in your 8 ounce glass have never been drunk by another human, almost every single molecule has been drunk by a dinosaur,”
"So drink up and enjoy your dinosaur pee.”

Every bottle of Evian you drink from is Tyrannosaurus Rex pee.
"All the water on earth has been here for 4.5 billion years. It’s all toilet-to-tap at some level."

Sanitation

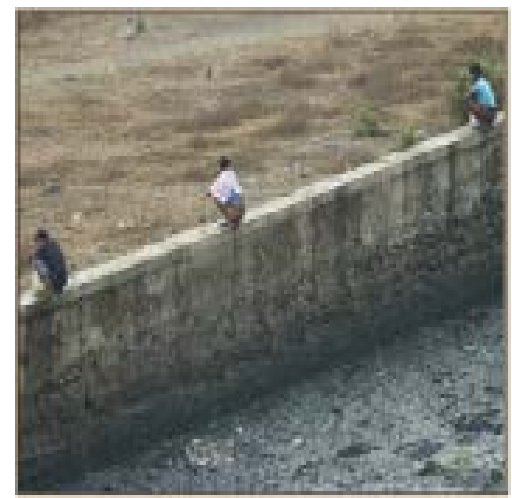
- Basic principal of public health
- Continuing improvements necessary
- And yes, there are shithole/shithouse countries that still rely on open defecation

Challenge

- ~**2.4 billion** people around the world do not have access to "improved" sanitation.
- ~**1 billion** people still defecate in the open
- Diarrheal disease is the second largest killer of children under the age of 5,
  where >500,000 die every year.

$$$

$$$?



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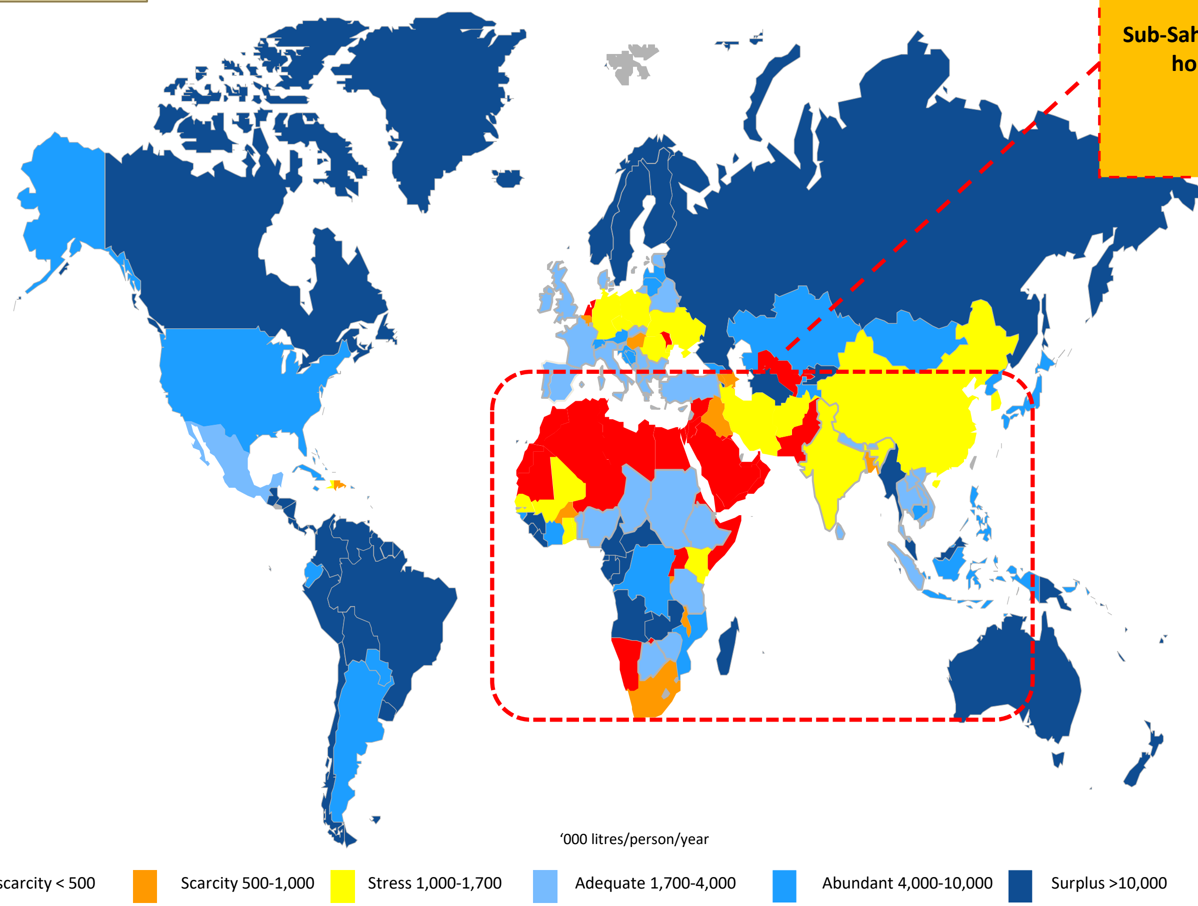
WATER SCARCITY WILL MAKE FECAL SLUDGE MANAGEMENT EVEN MORE IMPORTANT

Future: 2030

Sub-Saharan Africa & Asia will be home to 74% of world's population



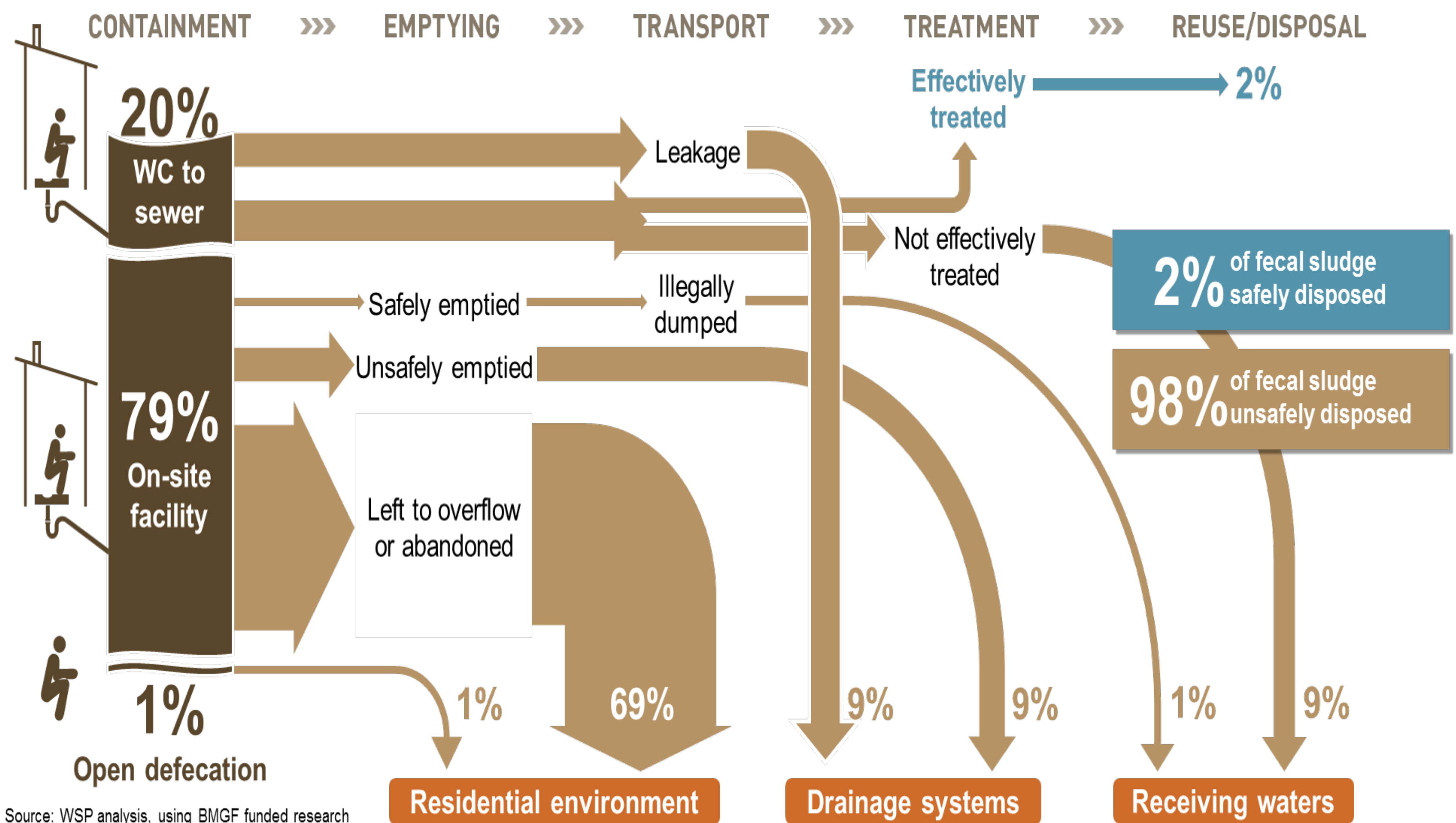
1. United Nations environment programme
Source: 'Global Water Initiative' (June 2005), GEF International Waters Conference, The Coca-Cola Company, Grail Research, BCG Analysis

FSM is part of the solution even in large cities

(i.e. Map of Dakar sanitation network, Source ONAS)

Example of Poor Fecal Sludge management (FSM):

Institutional open defecation - Sludge direct to the environment: no service chain

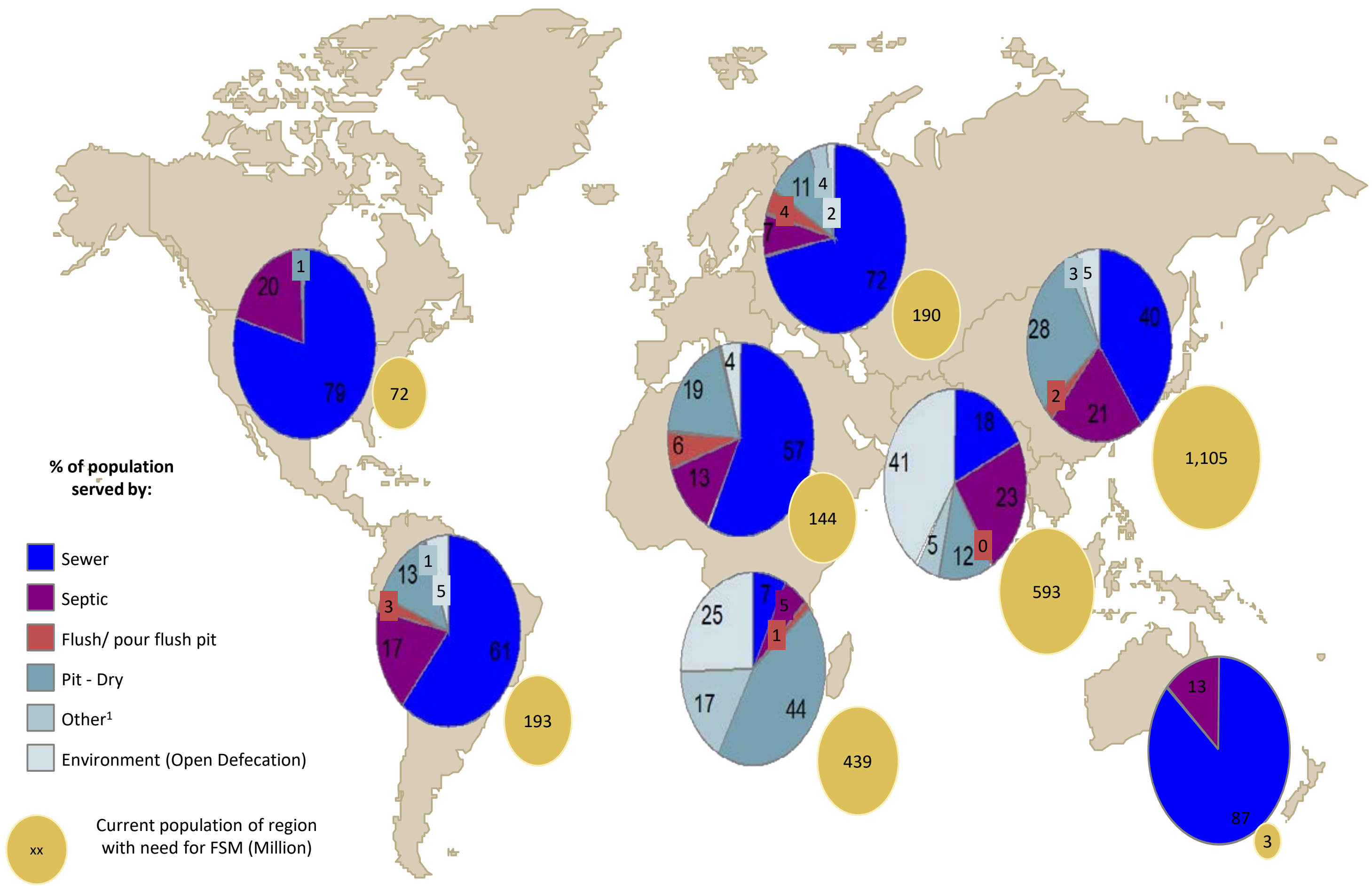


What happens when pits are full?

Manual emptying (service provider or family member)

Mechanic emptying (Private or public service providers

~2.7 BILLION PEOPLE WORLDWIDE NEED FECAL SLUDGE MANAGEMENT TODAY



1. Open pits, pits without slabs and composting toilets included in "Other" as these do not need FSM (open pits/ pits without slabs covered up when full)
Source: UN JMP sanitation data, BCG analysis

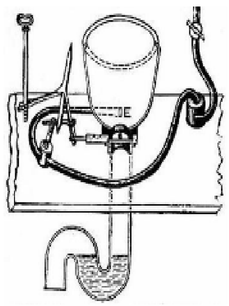
US (not U.S) not them

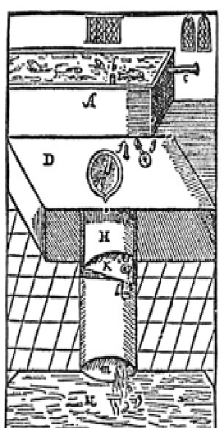
- Good access to sanitation in “developed countries”
- Pollution source that still must be managed
- CWA 1972, Eliminate direct discharge of pollutants to waters of the United states.
- Similar mandates in E.U. countries and NZ/ AU

A Rough History of the Modern Toilet

1596

- Flush toilet invented and built for Queen Elizabeth I



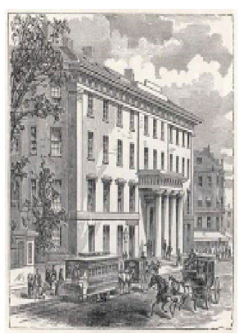


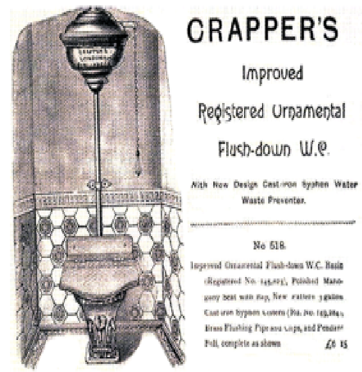
1775

- Alexander Cummings awarded 1st patent for the flush toilet

1829

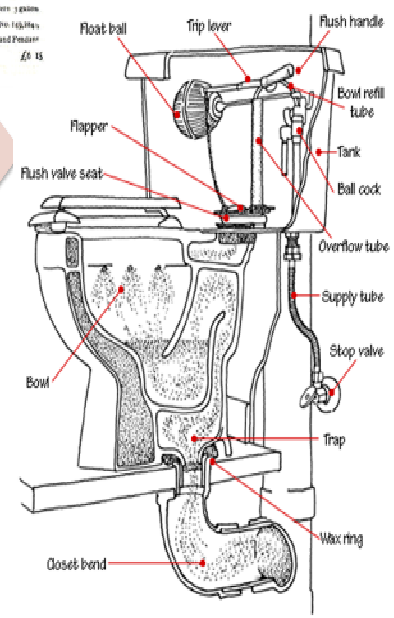
- Tremont Hotel, Boston – 1st hotel to have indoor plumbing with 8 toilets





1836 – 1910

- Thomas Crapper, London plumber popularized the flush toilet

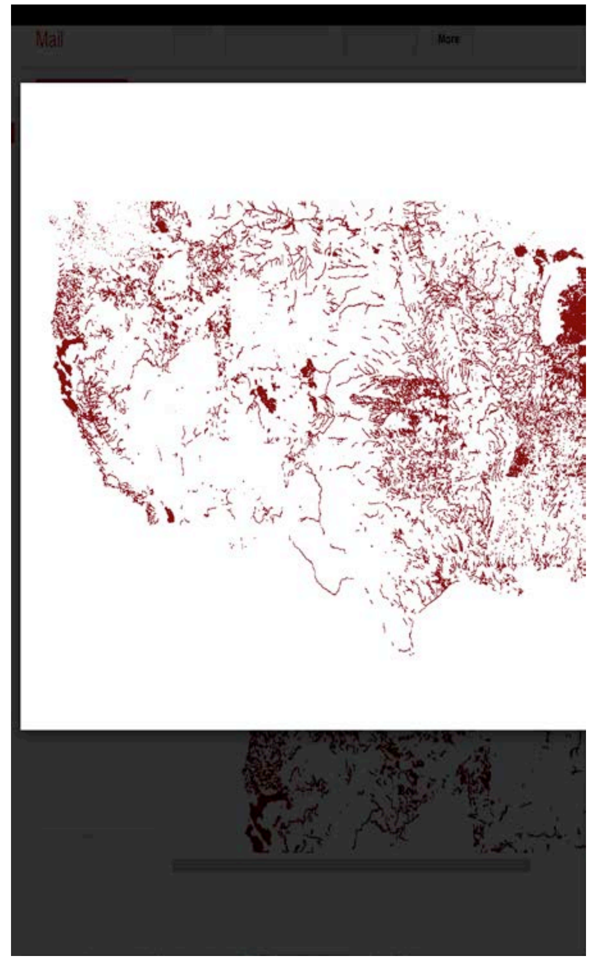


In 2007, the British Medical Journal poll of 11,300 members. What has contributed the most to global health since 1840

<u>No.1 The flush toilet</u> - above antibiotics, anesthesia, vaccinations

Impaired Waters Western U.S.

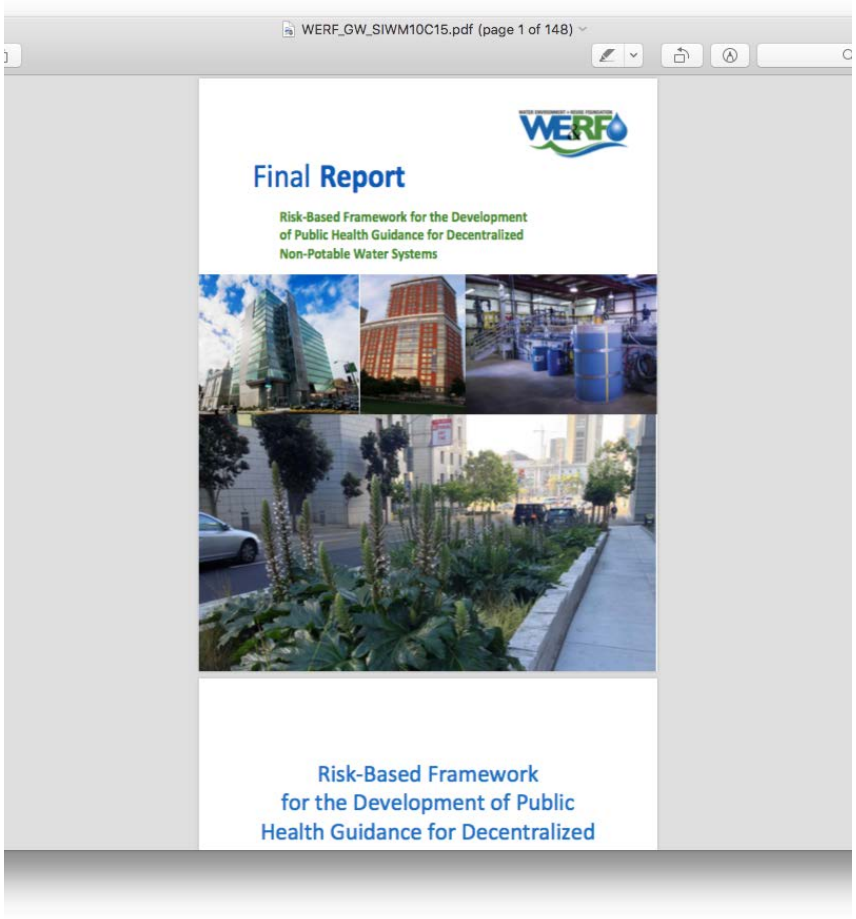
- 303 d listed waters
- Non-specific impairment
- USEPA continues to update listing



Improve water management

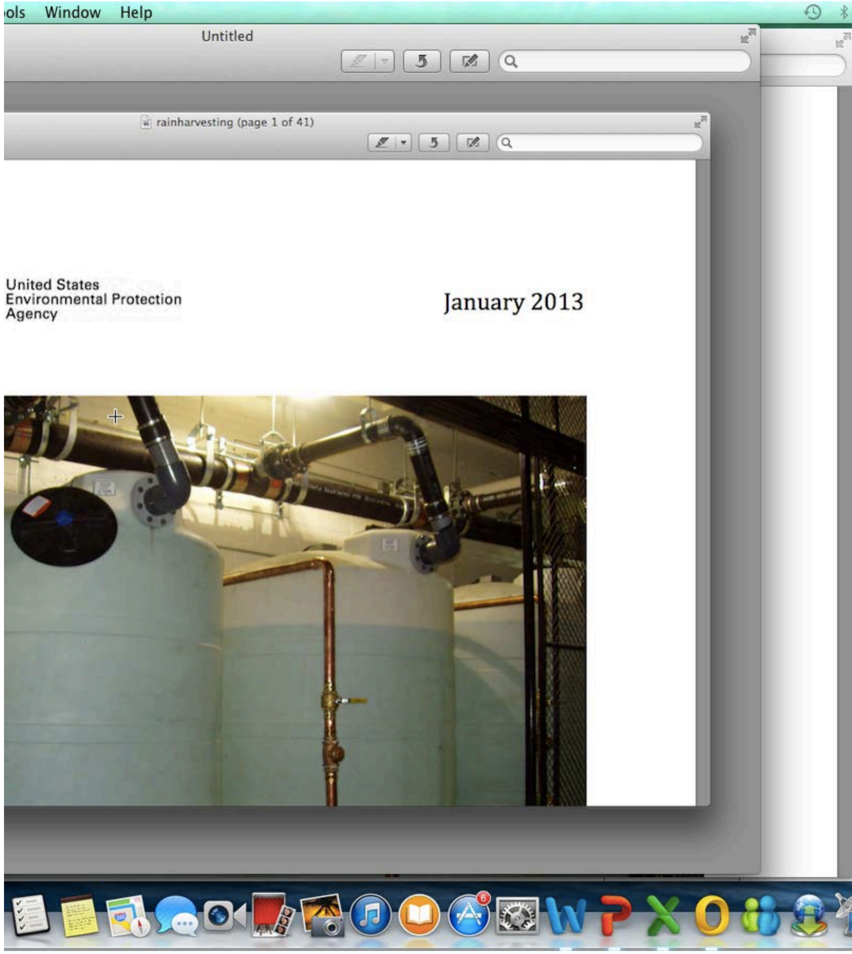
- Wastewater – Highest risk
- Harvested rainwater
- Stormwater
- Alternative water sources

- Jay Garland Later



EPA Publication

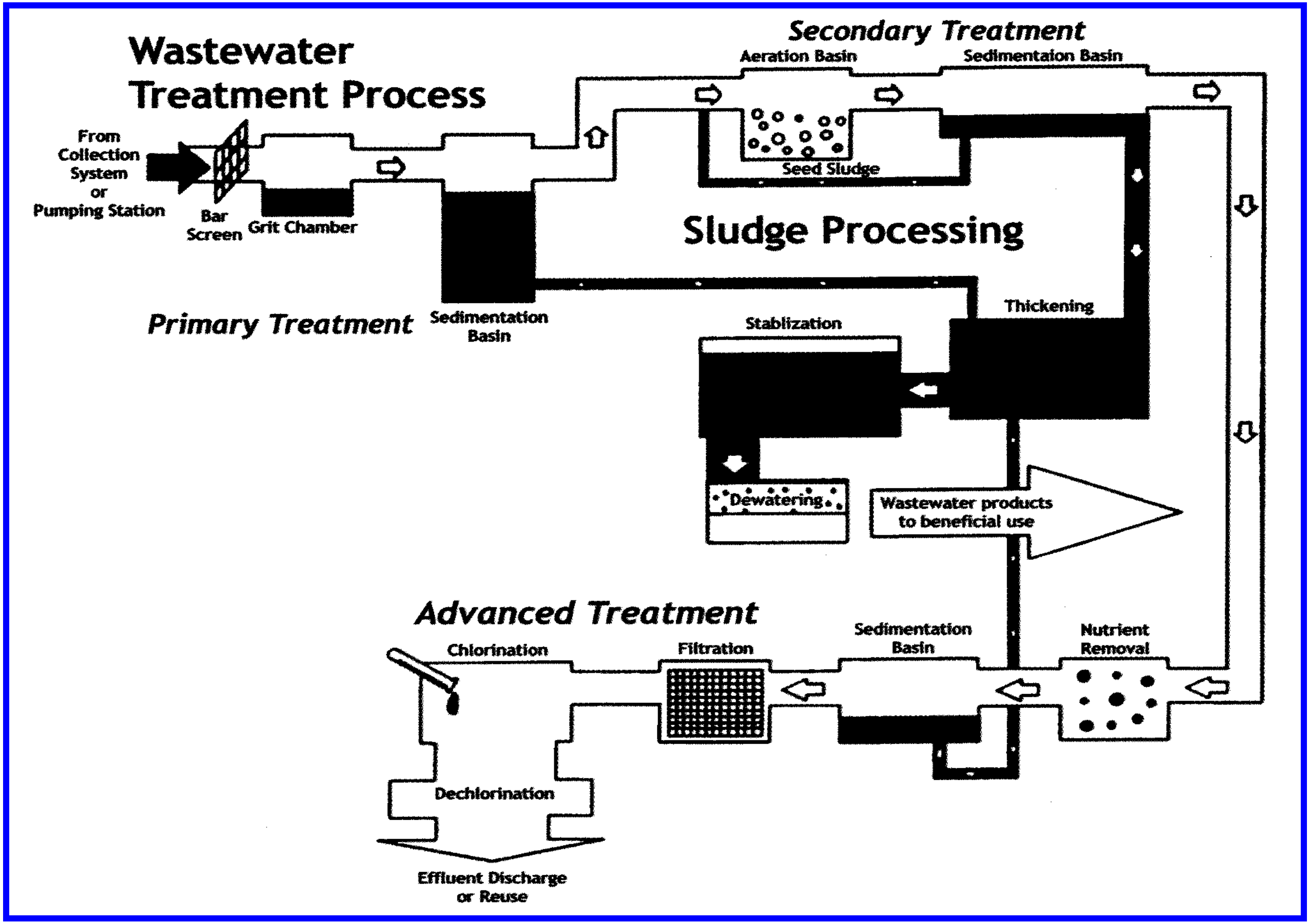
- EPA-841-R-13_002
- NO NATIONAL STANDARDS
- Rainwater harvest described as SW pollutant reduction
- NSF 350 described on pg. 16



What is in "Waste"

- Plant and animal matter from food and other organics
  - Nutrients
  - Organic matter
- Water
- CNY Wastewater Plant, 0.5 BGD capacity
  - Treated wastewater
  - Biogas for use
  - Treated biosolid
  - Distributed reuse in NYC!

Diagram of wastewater treatment facility



What can be recovered onsite (at or NEAR source)

- Water for use/reuse
- Nutrients
- Energy
- Food grown on site using reclaimed water

Advanced Wastewater Treatment

Processes

- Process capabilities (BOD, TSS, Nutrients, Biologicals)
  - NSF
  - State Rules

Pretreatment

Fixed Media

Suspended media
Onsite MBR

Parameter	BOD	TSS	Coliform	N
TS1	15	15	10000	10 NH4
TS2	10	10	1000	19 TN
Reuse	5-10	5 -10	14 (LRT Based)	<19 TN

Wilkerson Park, Wake Co

- Indoor reuse and SAS
- Building Code approval
- MBR treatment/Pressure manifold/Chamber

  NO REDUCTION

  HQW achieved
- Award winner
- On-line turbidity monitor
- Monthly Monitoring by private operator $500/month plus quarterly sampling)

	BOD	TS	TN	coli	Turbidity (5 min/5 yr)
Av	ND	ND	12	ND	.05
Max	7	ND	51	ND	.07

Multi family

- 10000 GPD ATU/Drip multi family
- Inspection
  - NC rule requires 1/wk ($20,800/yr)
- Annual Monitoring ($2500/yr)
- Maintenance and repair ($1000.0
- $24,300 yr retained in local economy and user bill is approximately $60/mo

Wastewater Quality Multi-Family Site (as mg/l, SU, or count)

Constituent	Influent	Effluent (average)
BOD5	280	<2
TSS	158	2.8
TN	81	16
Turbidity	190	1.4
E. Coli	10E+8	<2 (7+ log reduction)
Enterococcus	10E+5	<2 (4+log reduction)
Regrowth	NA	<2

Example Water Budget for Irrigation TOTAL IRRIGATED 6.5 MG over 4 Ac

Limiting Soil Ksat =	0.250	inch/hour	
Drainage Coefficient =	0.050		
Kv = Ksat * (Drainage Coeff.) =		0.3	inch/day

	# of Days in Month (days)	ET (in/mo)	Vertical Drainage (in/mo)	Monthly Precipitation (in/mo)	Maximum Allowable Irrigation (in/mo)	Maximum Allowable Irrigation (gallons/day)	Maximum Allowable Irrigation (gallons/month)
January	31	0.90	9.30	5.90	4.30	3,767	116,771
February	28	1.40	8.40	5.20	4.60	4,461	124,918
March	31	2.20	9.30	7.90	3.60	3,154	97,762
April	30	3.30	9.00	5.40	6.90	6,246	187,377
May	31	4.30	9.30	6.10	7.50	6,570	203,670
June	30	4.80	9.00	6.50	7.30	6,608	198,239
July	31	4.70	9.30	8.30	5.70	4,993	154,789
August	31	4.00	9.30	9.00	4.30	3,767	116,771
September	30	3.30	9.00	10.50	1.80	1,629	48,881
October	31	1.90	9.30	5.90	5.30	4,643	143,927
November	30	1.20	9.00	6.00	4.20	3,802	114,055
December	31	0.70	9.30	5.90	4.10	3,592	111,340
TOTAL =	365	32.70	109.50	82.60	59.60		1,618,499

ICC and USGBC Specify Reuse as Option

- IgCC (Green Code, 2012)
  - Water efficiency provisions
  - Ch's 3, 7, and 9
- ICC (2015 Code)
- LEED Building
- LEED ND

Resource Recovery-Urine Separation

- High N and P
- Sterile
- Storage for 6 months then land applied typical

- Eight million gallons of water had to be drained from a reservoir in Oregon after a man urinated in it.

- L.A. Times, 19 Jun 2011
- Sometimes people panic

Urine Separation/Diversion

- Excellent source of readily available nutrients
- Service contract???

Wastewater Solids are Resources

- Class B Solids can be land applied
- Composted and marketed
  - Tip fee
  - compost@$25/C.U.
- Lime stabilized
  - Sold or given away as lime

The Part 503 Rule

❖Standards for the Use or Disposal of Sewage Sludge (Title 40 of the Code of Federal Regulations [CFR], Part 503.

- Commonly known as the Part 503 Rule.
- Developed by U.S. EPA, as required by the Clean Water Act Amendments of 1987.
- The Part 503 Rule establishes minimum requirements when biosolids are applied to land to condition the soil or fertilize crops or other vegetation grown in the soil.
- Determination of biosolids quality is based on trace element (pollutant) concentrations and pathogen and vector attraction reduction.
- Federal regulations require that state regulations be at least as stringent as the Part 503 rule.
- Pathogen reduction Required, Pollutant concentration limits and

  VAR required

Properties and constituents of Wastewater Solids

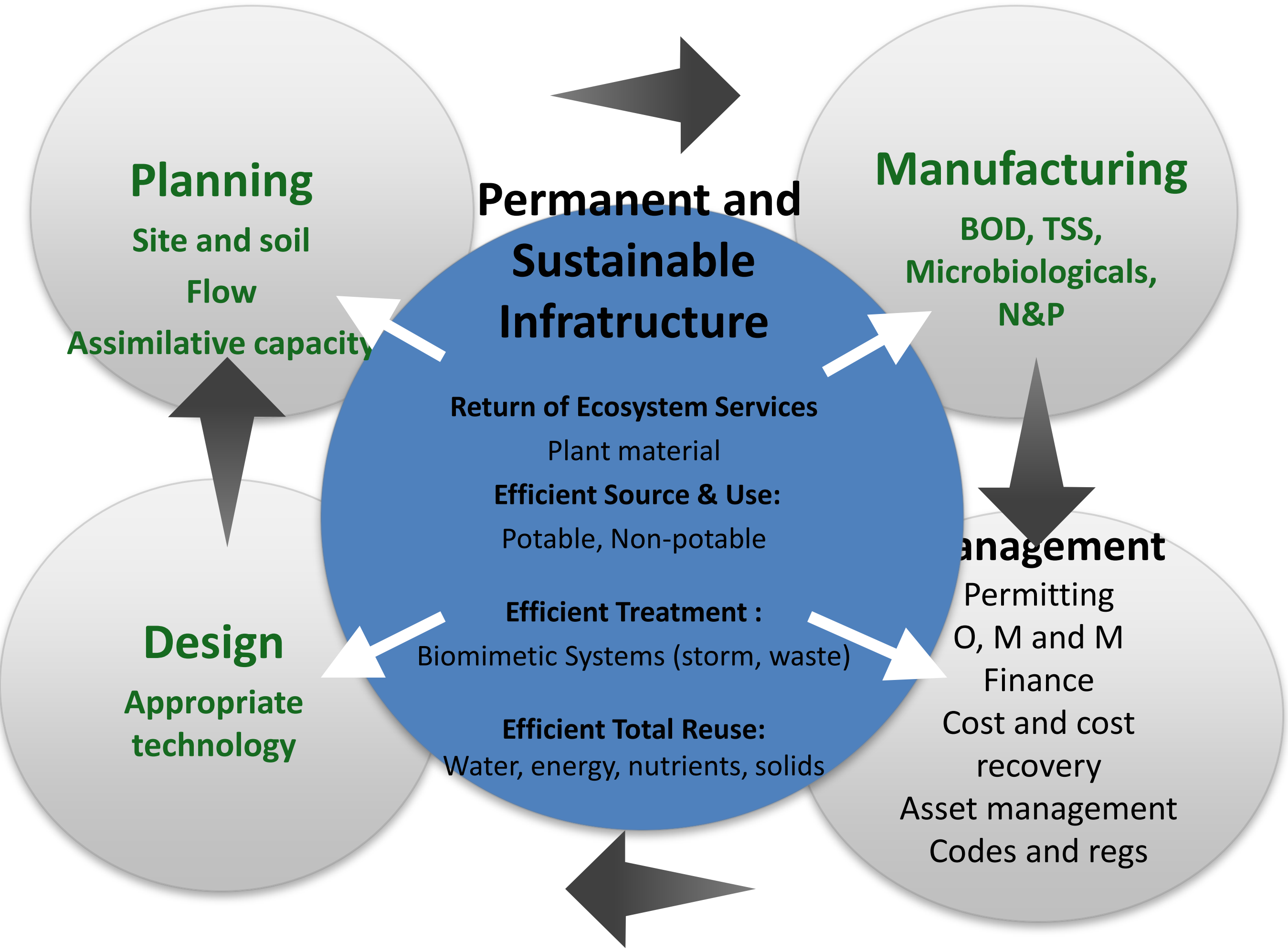
- Nutrients:
  - Elements required for plant growth that provide biosolids with most of their economic value.
  - Include nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), sulfur (S), boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn).

Means and variability of nutrient concentrations[a] in biosolids collected and analyzed in Pennsylvania between 1993 and 1997 From Stehouwer, R.C., A.M. Wolf, and W.T. Doty. 2000. Chemical monitoring of sewage sludge in Pennsylvania: Variability and application uncertainty. J. Environ. Qual. 29:1686-1695.

Nutrient	Total N[b]	NH_4 N	Organic N	Total P	Total K
	%				
Mean	4.74	0.57	4.13	2.27	0.31
Variability[c]	1.08	0.30	1.03	0.89	0.27

[a] Concentrations are on a dried solids basis.
[b] Determined as total Kjeldahl nitrogen.
[c] Standard deviation of the mean.

Resource Centered, Integrated Decentralized Infrastructure in Communities Of The Future:



SUSTAINABLE PRODUCTS/SERVICES

WATER:

POU treatment and use

Reduces demand on POTW

ENERGY:

Renewable: Biogas from FOG, Septage, biosolids

NUTRIENTS:

Nitrogen

Phosphorus

Potassium

Soil Addatives

ECOSYSTEM SERVICES:

Inedible, Edible

Carbon Sequestration

Biomass

Stream flow

JOBS:

Not readily exported

Sustainability

- Laws and rules that enable
- People and organization
  - Operators and managers
  - Business
  - Limits to outsourcing- can’t ship this local oversight overseas

NC Rule Benefits Onsite Infrastructure

- Depending on system classification monitoring may be required
- Type IV, V, and VI require monitoring and reporting
- Example: type IV (b) system over 1500 GPD
  - Quarterly site visit (yr 1 and 2) then 2/yr
    - Typical $150-200/visit
  - Wastewater testing
    - BOD, TSS, TN typical cost $60-80/event
    - Estimated annual cost: $960/yr (may drop to $560/yr)

In Process

- Arizona Department of Environmental Quality
- **Workgroup Charter: Recycled Water from Onsite Systems**

Generate taxable real property

- Tax base increases
  - Benefits to local government
  - Local tax base/business tax supports local community

Ask Yourself

- Do we Plan
  - Growth = tax base
  - Incentive to grow is common
  - Alternatives analysis/codes – water
- Does technology help?
  - Advanced onsite treatment
  - Comprehensive solids management
  - Do we manage technology as though it was infrastructure – remember for those using the system it is!

Resource Management/Resource Challenge

- Wide variety of water sources benefit from managed approach
- Solids generated in the system must be managed properly
- Trained, competent personnel required at all levels
  - Regulatory agency
  - Installer
  - Operator/service provider

Thank You

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