

# Current issues of environmental engineering

# Algal bloom

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- Excessive growth of algae
- Green/red
- Occurs when:
  - **N** & **P** concentrations are high
  - other algal growth conditions are optimal (temp., light intensity, etc.)
  - water is stagnant

**폐수종말처리시설의 방류수 수질기준**(제26조 관련)

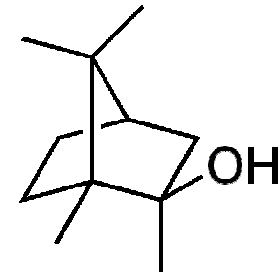
1. 방류수 수질기준

구 분	적용기간 및 수질기준									
	2010.12.31 까지	2011.1.1 부터 2011.12.31. 까지	2012.1.1.부터 2012.12.31.까지				2013.1.1. 이후			
			I 지역	II 지역	III 지역	IV 지역	I 지역	II 지역	III 지역	IV 지역
생물화학적 산소요구량 (BOD) (mg/L)	20(30) 이하	20(30) 이하	20(30) 이하	20(30) 이하	20(30) 이하	20(30) 이하	10(10) 이하	10(10) 이하	10(10) 이하	10(10) 이하
화학적 산소요구량 (COD) (mg/L)	40(40) 이하	40(40) 이하	40(40) 이하	40(40) 이하	40(40) 이하	40(40) 이하	20(40) 이하	20(40) 이하	40(40) 이하	40(40) 이하
부유물질 (SS) (mg/L)	20(30) 이하	20(30) 이하	20(30) 이하	20(30) 이하	20(30) 이하	20(30) 이하	10(10) 이하	10(10) 이하	10(10) 이하	10(10) 이하
총질소 (T-N) (mg/L)	40(60) 이하	40(60) 이하	40(60) 이하	40(60) 이하	40(60) 이하	40(60) 이하	20(20) 이하	20(20) 이하	20(20) 이하	20(20) 이하
총인 (T-P) (mg/L)	4(8) 이하	4(8) 이하	0.2(0.2) 이하	0.3(0.3) 이하	0.5(0.5) 이하	4(8) 이하	0.2(0.2) 이하	0.3(0.3) 이하	0.5(0.5) 이하	2(2) 이하
총대장균 균 수 (개/mL)	3,000	3,000	3,000	3,000	3,000	3,000	3,000 (3,000)	3,000 (3,000)	3,000 (3,000)	3,000 (3,000)
생태독성 (TU)	-	1(1) 이하	1(1) 이하	1(1) 이하	1(1) 이하	1(1) 이하	1(1) 이하	1(1) 이하	1(1) 이하	1(1) 이하

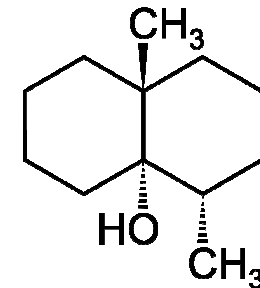
# Algal bloom – water quality issues

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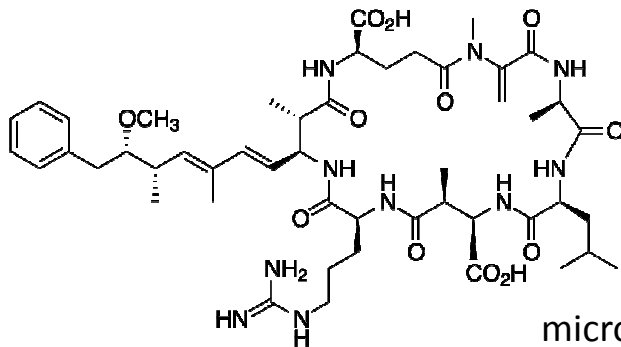
- Impact to aquatic ecosystem
- High turbidity
  - clog filters in water treatment plants
- Taste & odor generating compounds
  - 2-MIB, geosmin
- Toxic compounds
  - Cyanotoxin
  - Generated by green-blue algae (cyanobacteria)



2-methylisoborneol (2-MIB)



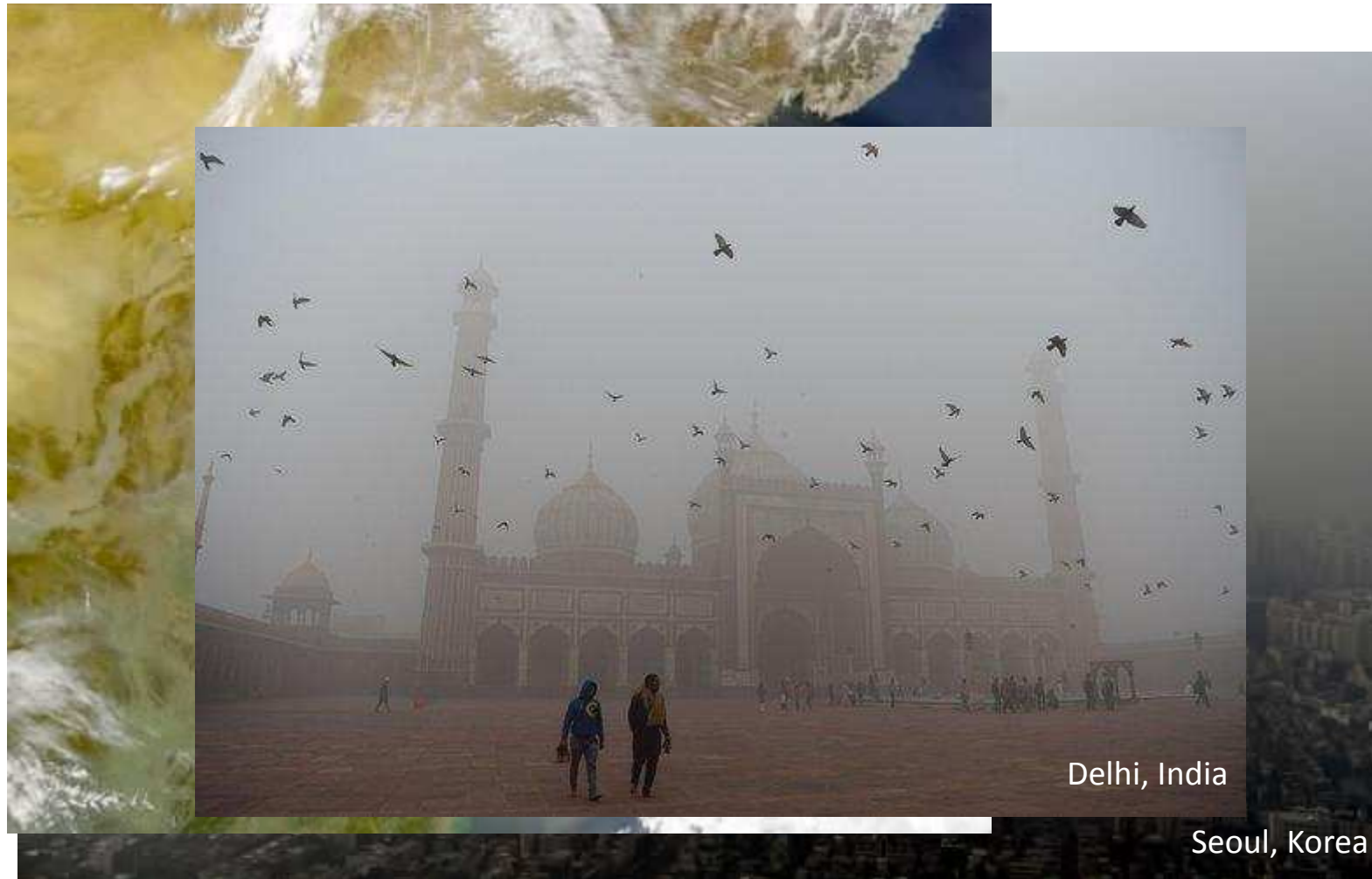
geosmin



microcystin (a type of cyanotoxin)

# Air quality issues

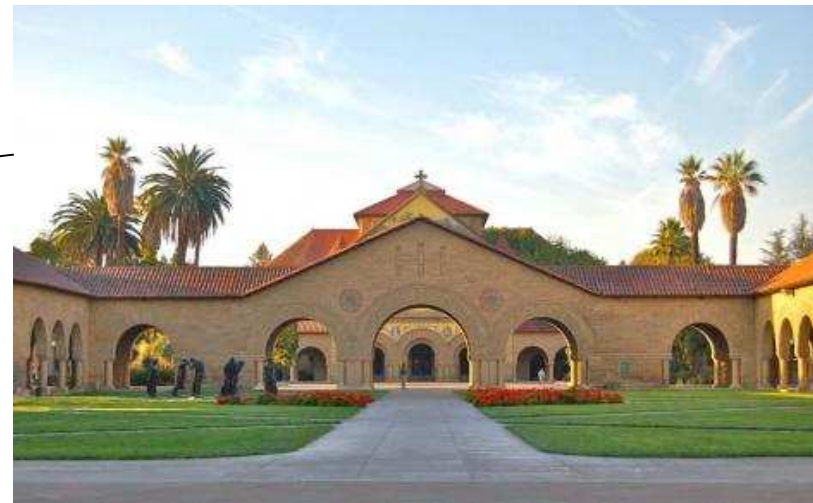
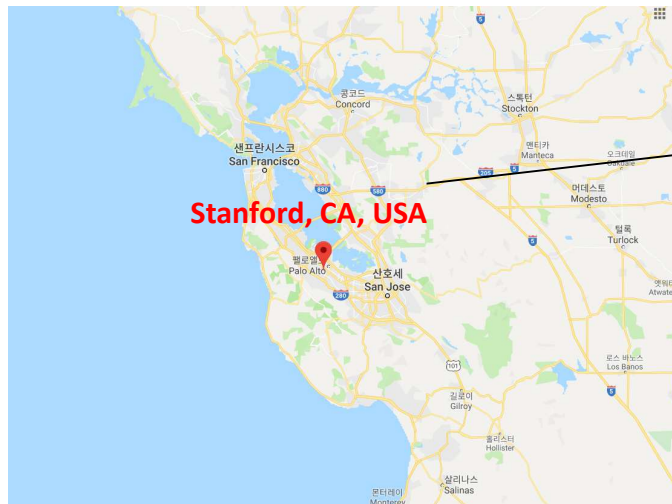
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# Air quality issues

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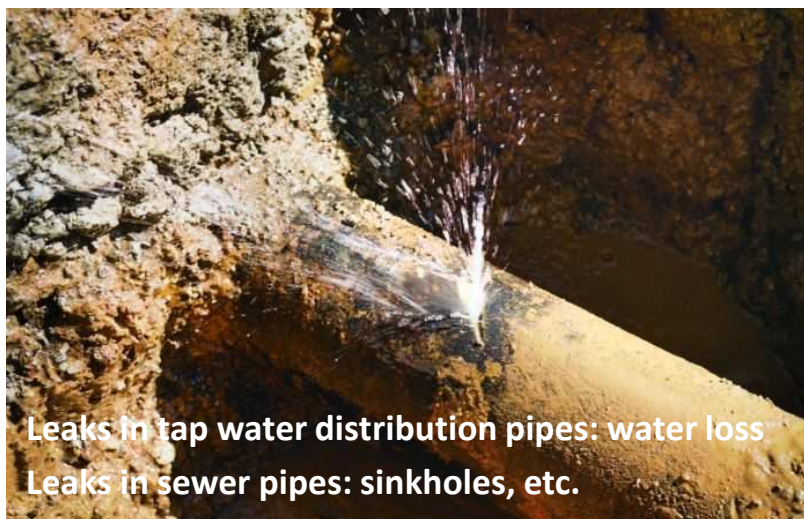
- Complicated issue
  - Multiple source, complicated mechanisms of atmospheric physics & chemistry involved
  - Impact may occur far away from the source
- Once air pollutants are released, they can seldom be treated by engineering approaches
  - Political/social issues are involved



# Aged water infrastructure, failures

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- 50-100 yr old pipes & treatment facilities in developed countries
  - Need renovation that serves for the next ~50 yrs – how should it be changed??
- Failure to predict capacity
  - Earlier design period – too much idle capacity / later design period – exceeded capacity
- \$\$\$ not enough to provide infrastructure that supports growing population in developing countries





# Global warming & climate change

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- Water quantity issues
  - More frequent, severe flood & drought
- Water quantity issues
  - Increased runoff: more significant non-point pollution issues
  - Increased water temperature: reduced dissolved oxygen (DO)

시간당 110.5mm는 100년만에 내린 폭우...동부간선로 전구간 · 올림픽대로-강변북로 일부 통제

발행일 : 2011.07.27



[AD] 코어i7 맥북에어 스크래치에디션 43%할인





# Paradigm shift

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- Industrial revolution — 20<sup>th</sup> century
  - Economic growth
  - Economies of scale, mass production & consumption
  - Focus on the efficiency of main function
  - Robust infrastructure
  - Specialization



# Paradigm shift

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- 21<sup>st</sup> century
  - Sustainable society
  - Multi-function
  - Multi-criteria
    - “Triple bottom line”: accounting for social, environmental and economic aspects
  - Adaptive, resilient infrastructure
  - Integrated assessment & control



# SUSTAINABLE DEVELOPMENT GOALS



# More natural processes

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- Use ecological services to deal with environmental problems
  - Phytoremediation
  - Wetland treatment
  - Low impact development, green roofs
  - ....
- And get other benefits
  - Increased amenity
  - Flood control
  - Rainwater harvesting
  - Climate control
  - Social service



Enhanced Stormwater Treatment Wetland  
McIntosh Park  
Project # 60921 022  
Date 09.27.06





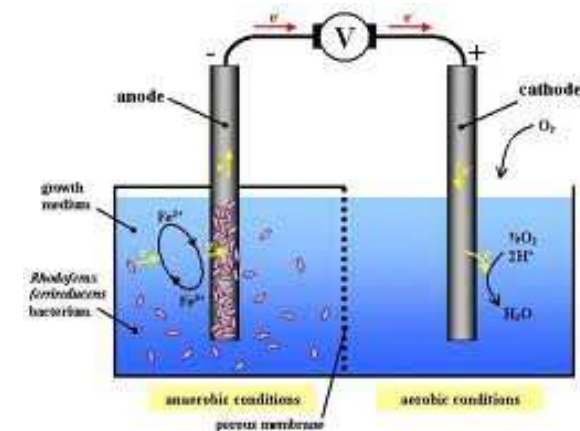
# Resource/energy recovery from wastewater

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- Wastewater = water + nutrients + carbon (=energy)
- Energy in wastewater > energy needed to treat wastewater
- Recovering energy from wastewater
  - Use anaerobic instead of aerobic process for wastewater treatment:  $\text{CH}_4$  can be generated!
  - Electricity generation (ex: microbial fuel cells)
- Recovering nutrients from wastewater
  - N & P recovery for use as fertilizers



<http://www.biocycle.net>



<http://www.sflorg.com>



# Reclamation of treated wastewater

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- Apply advanced treatment, e.g., reverse osmosis, UV disinfection, to obtain treated water with high quality
- Non-potable & potable reuse
- Advantages
  - Reliable water resource
  - Cheaper option than seawater desalination
  - Better water cycle, sustainable
- Limitations
  - Drinking water price is still very low!
  - Potential failure of the treatment process
  - Public acceptance

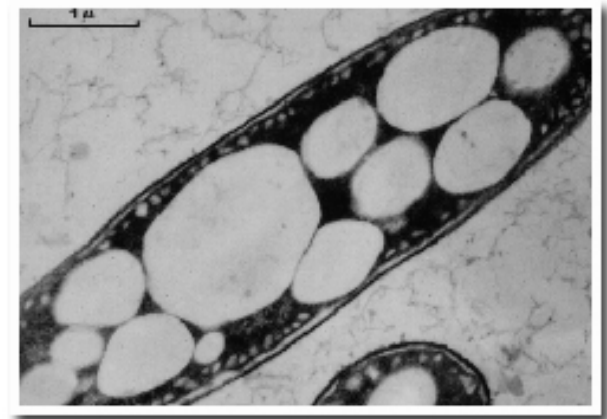




# Waste to energy, waste to products

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- CH<sub>4</sub> generation from organic wastes (anaerobic processes)
- Composting
  - Convert biodegradable organic wastes into stable form
  - Agricultural use
- Bio-oil production from biomass
  - Pyrolysis of organic wastes (straw, nut shells, sewage sludge, etc.) or algae to produce bio-oil
- Bioplastic production from wastes
  - Some microorganisms accumulate polymer material called “polyhydroxyalkanoate” in their cells under certain conditions
  - Biodegradable and biocompatible plastic



<http://www.nrc-cnrc.gc.ca>





# Decentralized systems

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- Works to be done
  - Develop a new paradigm and techniques for water & wastewater treatment and management
  - Needs better operation & maintenance strategy
  - Develop design methodology to construct a complicated network of facilities at various scale

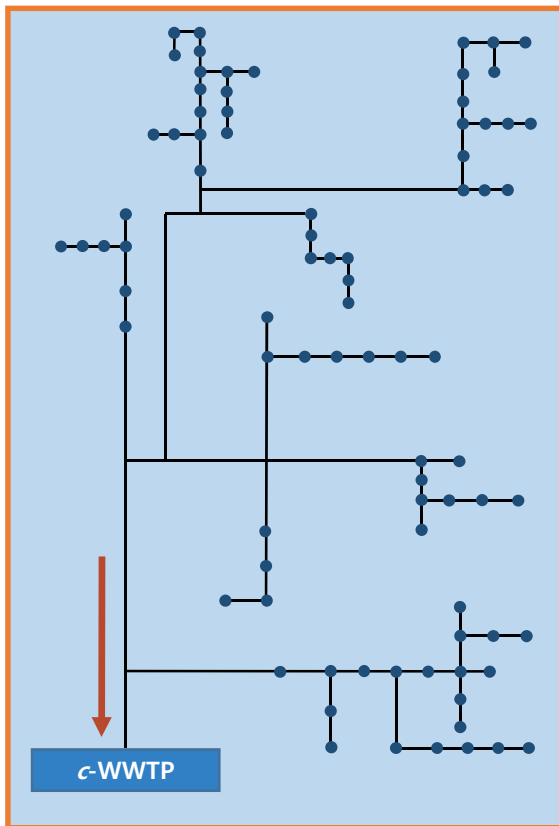


VS

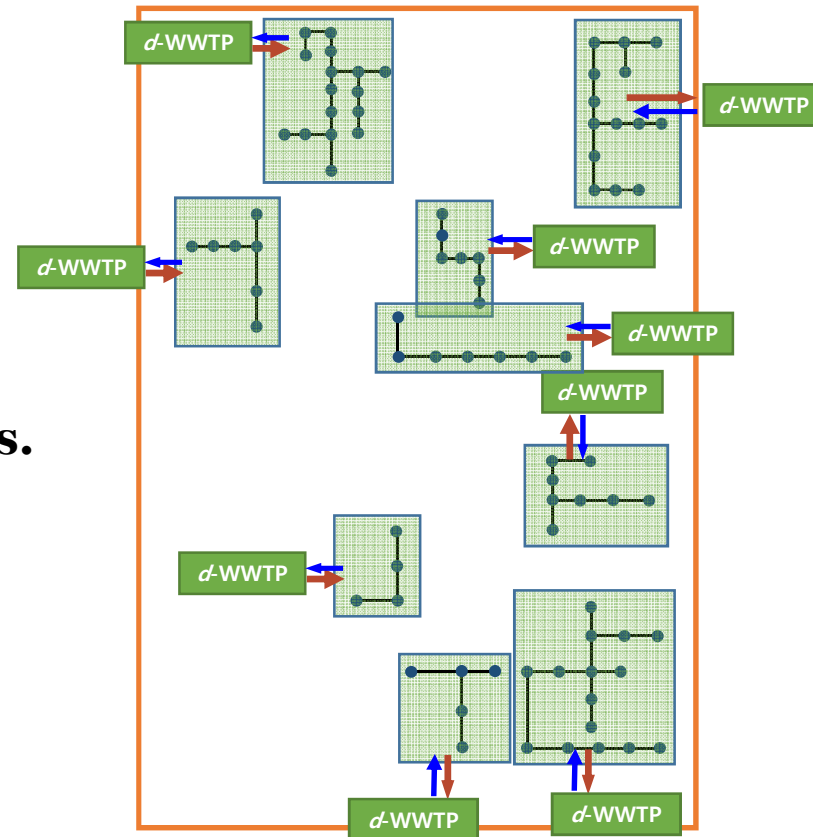


# Potential water network configurations

**Fully centralized**



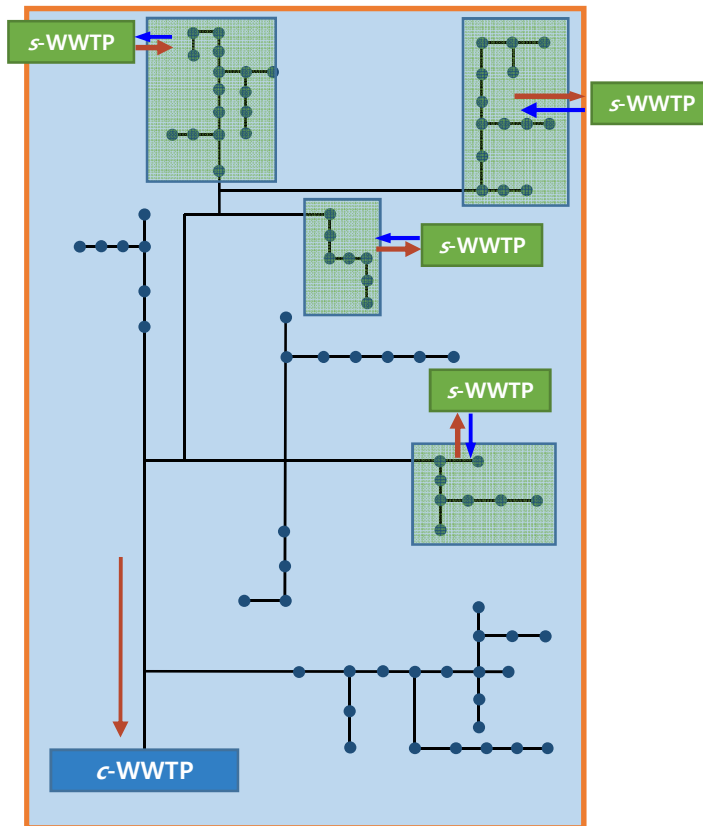
**Fully decentralized**



**VS.**

# Potential water network configurations

**Hybrid**  
(cent.+satellite)



**Clustered**  
(clustering for control, recovery, etc.)

