New Opportunities in Distributed, Non-Potable Water Use

Presentation to 2016 SW Onsite Wastewater Conference

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North Carolina State University

Direct or Indirect Re-Use?

Outline

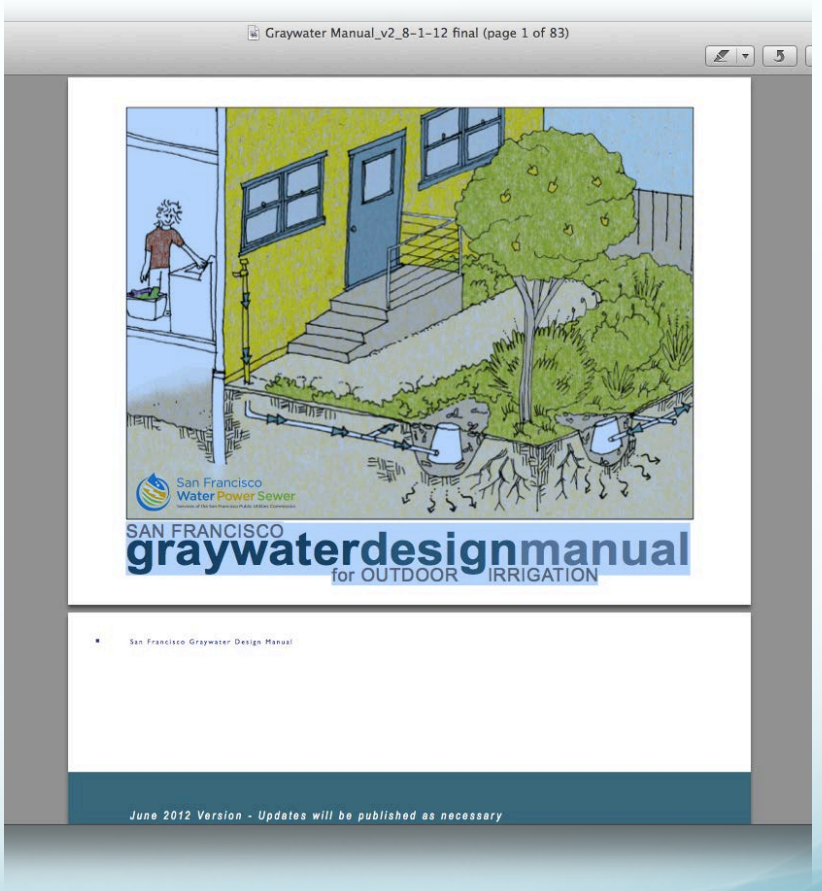
- Opportunities and challenges
- Technology performance
- Management requirements

Wastewater/Graywater

- Three systems certified to 350, others in process
- Wastewater and graywater
- NSF criteria generally accepted in state or province health and building codes
- ICC Green Code

Graywater

- Laundry, bath, hand wash sink, but NOT kitchen sink (dishwasher ok if rinse cycle only)
- Thermotolerant coliform (not fecal or total)



Next step - SW/HRW

- Stormwater and harvested rainwater
  - CSA Draft HR standard
  - ARCSA standard for small system
- Significant differences in quality
- Volume is climate dependent
- SW significant NPS
  - 303 d
  - 305b

350 Calls

- Discussions indicate confusion, but standard proposed for NON-POTABLE use
- Several calls, still some confusion
- Some manufacturers strongly supportive of a standard
- Product to be tested against standard using challenge

Rainwater and stormwater

- May not be as clean as you think
- Reactive
- Impact on metal pipe?
- Impact on plumbing fixtures
  - Appearance
  - Aesthetic

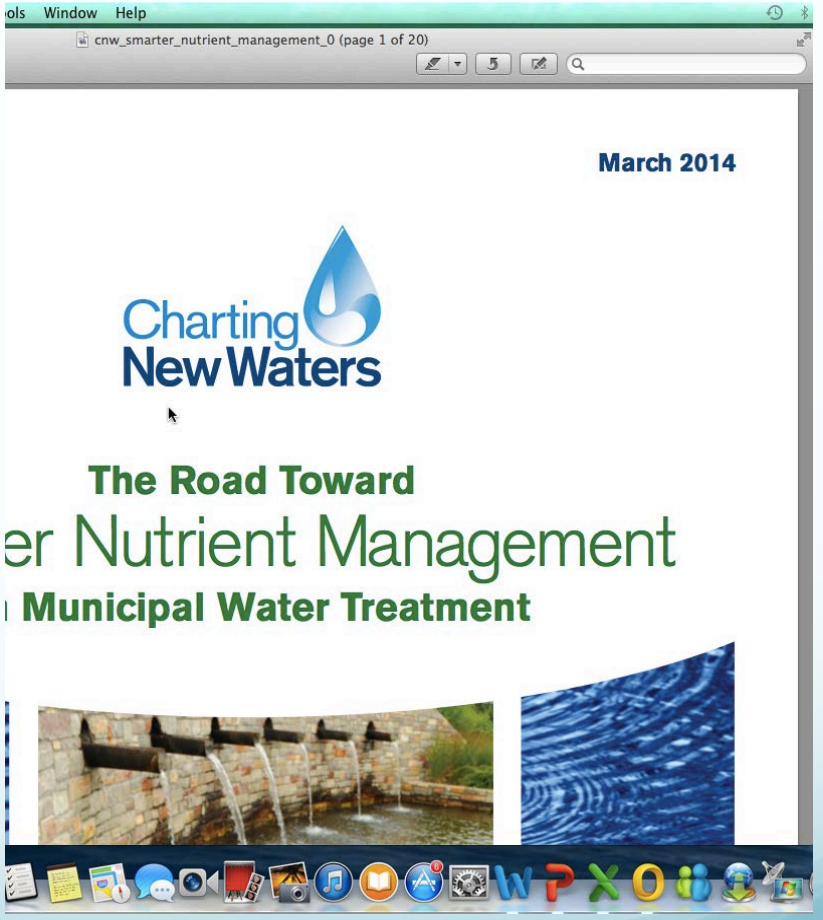
Table 1, Typical Residential, Commercial and Industrial Harvested Rainwater and Paved Lot Stormwater Quality

	Residential rainwater1	Commercial rainwater[1]	Industrial rainwater[1]	Paved Lot Stormwater[2]
TSS (mg/l)	27	15	41	56
Coliform C/100ml)	290	1117	144	41976
Zn (mg/l)	149	330	1155	1.2

1. Bannerman, 1993; 2. Pitt, 2004

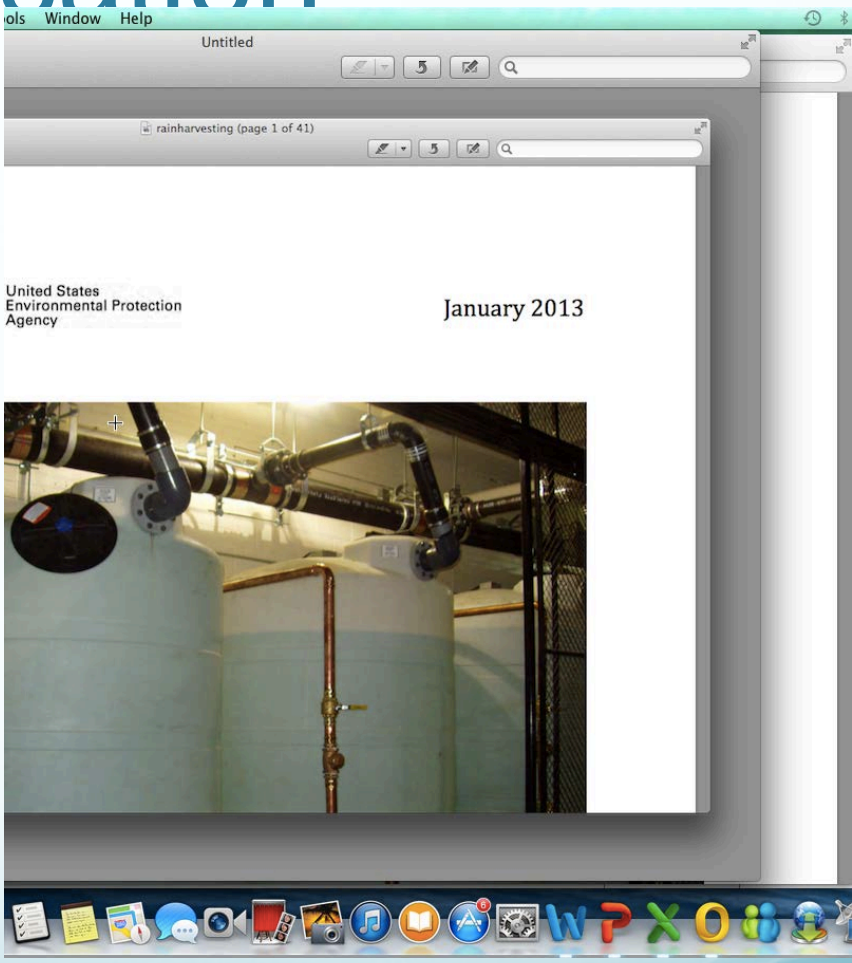
Rainwater Harvest

- Emerging interest
- Criteria and standards lacking
- NSF 350 listed as option



EPA Publication

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



Regulatory Issues and Reuse

- USEPA
  - Consistent with PL 92-500
  - Guidelines for Land Application and Reuse
- State
  - Inconsistent policy between states
  - Regulation for Wastewater Reclamation and Reuse
  - Recommendations and requirements in strategy
  - ENFORCEMENT

State Policies

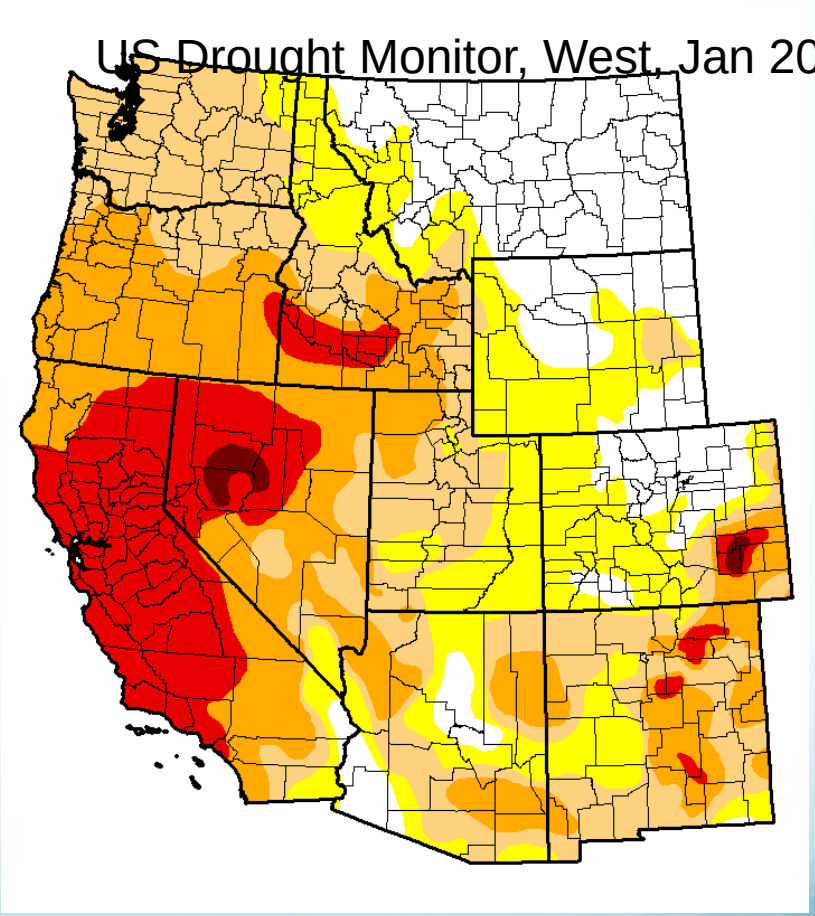
- North Carolina – Aggressive reuse policy allows some potable reuse
  - Reuse rules for irrigation, etc
  - SB 163 “reclaimed water as source water”
- Virginia, Aggressive Code
- New York, Building Code Efforts
- Arizona- Aggressive policies to address shortages
- California – Governor signaled aggressive efforts to facilitate reuse
  - San Francisco reuse efforts and manual
  - Others…

Reuse Guidelines

- Guidelines because NO mandate
- Variety of end uses
- Recent interest in direct and indirect potable use
- This document is available via the internet:
- http://www.waterreuseguidelines.org

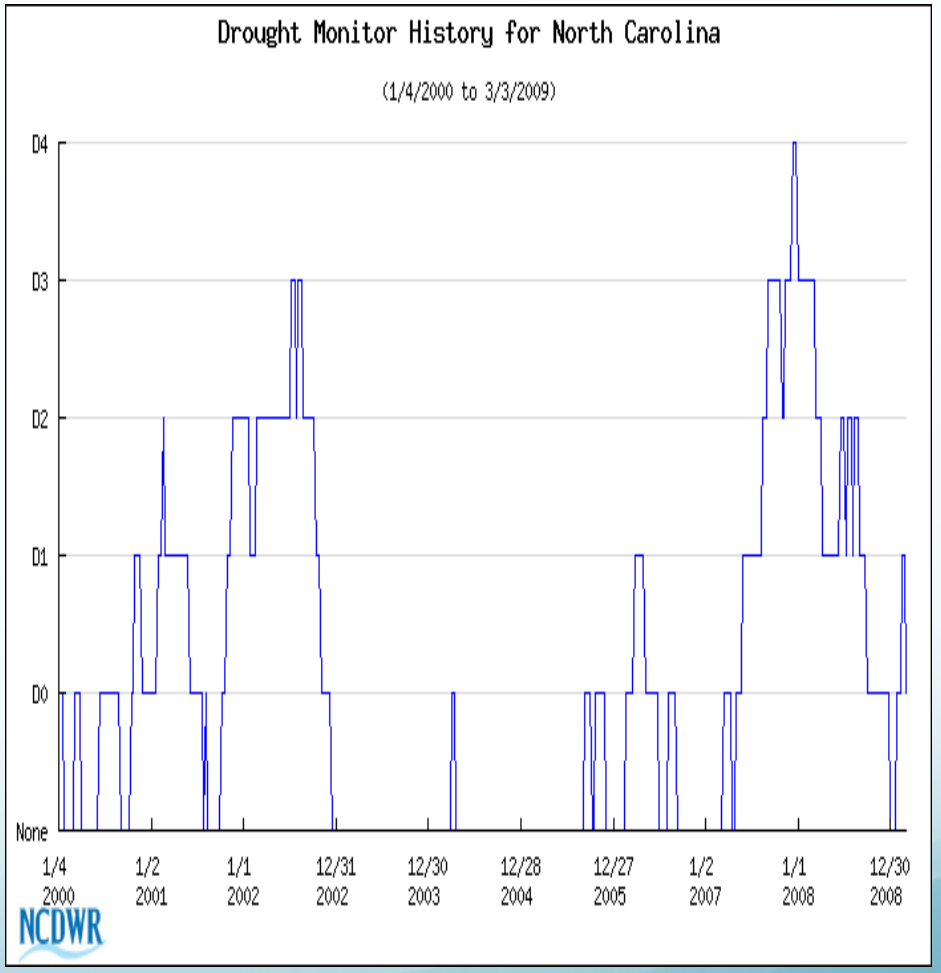
Water Scarcity – One Driver

- National drought data
- Frequent updates
- Forecast
- Water management tool

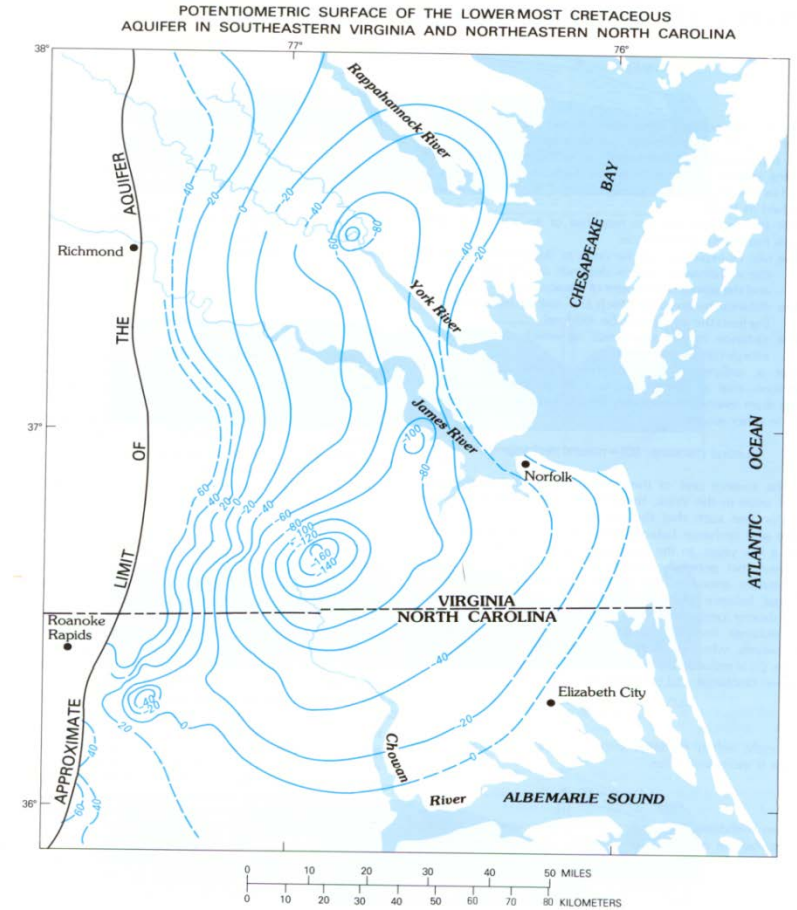


Drought History

- Significant stress on water systems through decade
- Increasing population pressures expected



Groundwater Potentiometric Surface Data – Dwindling Supplies



Reuse and Non-Potable Use Implications

- Environmental and Public Health Consequences
  - Discharge elimination
  - Reliable supply of high quality water-potable demand management
  - LEED
  - Important tool, provided health concerns addressed
- Resource Allocation Consequences
  - Extends water supplies
  - Reduces energy demands on potable system
  - Saves Dollars
  - Important tool to optimize resource management provided sustainability addressed

Health Concerns

- Public Health Concerns drive reuse efforts
- Microorganism levels reduced to detection
- Advanced treatment and Multi-barrier disinfection processes where exposure high
  - Chemical (chlorine, ultraviolet light, Peracetic acid)
  - Barriers (microfiltration)

Incidence of problems

- Primary effluent – irrigated lands in Mexico and Israel health issued documented
- Secondary effluent – no documented incidence of disease
- Advanced Treatment – No documented incidence of disease

Sources of Non-Potable Water

- Wastewater and graywater
- Harvested rainwater
- Stormwater
- Drainage water
- Water plant backwash
- Dry weather runoff (irrigation)

Rainwater and stormwater

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- Impact on plumbing fixtures
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No U.S. Standard

- CSA/ICC B 805 201X (May, 2015)
- Tiers for use
  - C1 – irrigation
  - C2.1 and 2.2 limited indoor use
  - C3 indoor use
  - C4 culinary/potable uses (DW Standards apply)

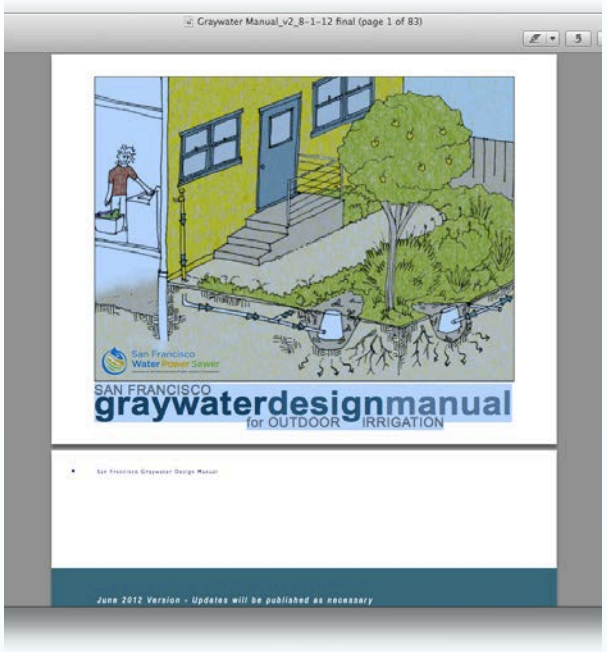
CSA

- Standard applied at end use
- Irrigation water requires 100 micron filtration

Tier	Turbidity	HPC	Cl
TC		350	
C2.1	<2	<5	0.05
C2.2	<2	<5	0.05
C3	<2	<5	0.05
C4	DW	DW (ND)	DW

Graywater

- Bath, laundry, NO KITCHEN sink
- Indoor and outdoor use
- Addressed in NSF 350-1



Optimizing Current Reuse Practices

First Steps to Evaluate / Implement Reuse

I. **Reclaimed Water Demand Projections** – Initial Planning Period (Planning Horizon of 25 Years)
   a. Irrigation Demands (Landscape, Lawns, Common Areas, etc…)
   b. Industrial Demands (Chiller / Cooling Water Makeup, Boiler Feed, Washdown, etc…)
   c. Indoor Demands (Toilet Flushing, Courtyards, Dual Plumbing, etc…)
   d. Fire Protection
   e. Other Uses (Aesthetics, Fountains, Ponds, etc.)
   f. Continuous vs. Seasonal Operations
      - Average Daily Flows & Pressures
      - Peak Daily Flows & Pressures
      - Daily Demand Curves
      - Demand Projection Curves

First Steps to Evaluate / Implement Reuse

II. **Treatment Standards imposed by End Use**

III. **Capital Improvement Program - Sustainability**

a. Preliminary Project Cost Estimates

i. Treatment Alternatives

ii. Distribution System Alternatives

iii. Storage

b. Reclaimed User Systems

c. Five Year Capital Improvement Program

III. **Public Education / Outreach Needs**

a. Work Sessions with Community Leaders

b. General Public (Staff / Students) Education / Outreach

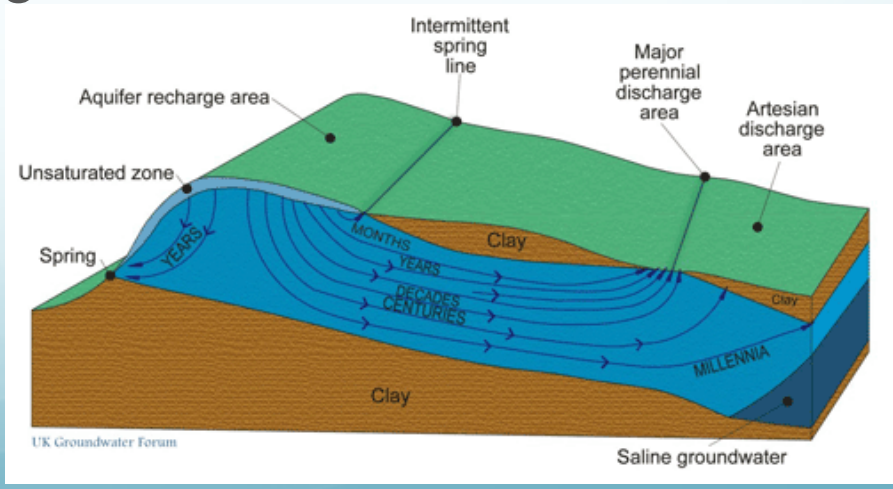
c. End-User Training and Education

Planned Direct and Indirect Potable Reuse

(through surface supply and groundwater)

Few National Examples (Clayton Co, GA; Water Factory 21, OCWD, CA), AZ

- Generally, no more than 25% indirect feed for direct reuse (treatment plant through wetland to water treatment plant)
- Indirect – natural buffers – surface or groundwater
  - Twelve month travel time between infiltration / withdrawal
  - Minimum 2,000 foot between infiltration / withdrawal



Water Quality Concerns

- Intended Use of reclaimed or harvested water drives issue
- Risk Based Management
- Treatment Requirements
  - Constituents of concern (BOD, N, P, Na, coliform, virus)
  - Treatment and Disinfection
    - Microbiological
    - Organic
    - Nutrients and salts
    - turbidity

Some Water Quality Rules/Standards

- 15 A NCAC 0 2U (reclaimed water)
- 18 Arizona Administrative Code 11 A3 (B)
  - Classes A+, A, B+, B, C
  - Type 1, 2 or 3 permit
- California Title 22 (reclaimed water from municipal sources)
- NSF 350 and 350-1 (Non-Potable water use)
- NO EPA STANDARDS for Non-Potable use
  - No congressional mandate
  - Guidelines only

Selected Standards

Jurisdiction	Turbidity	BOD	TSS	Coliform	C. perfringens	Coliphage
CA	2	NS (adv oxidation)	NS (adv filtration)	2.2		
FL		20	5	ND		
NC	5	10	5	14	-3 log	-4 log
VA	5	10	5	14		
NYC	2	10	10	2.2		
AZ	2 (Cl A)	2nd Tmt/disin/ Filt	NS	23		

NSF/ANSI 350

- American National Standard
- Residential and commercial treatment systems
- Sources; graywater and combined wastewater
  - Graywater: laundry and bathing, excluding toilet and kitchen.
  - Combined: blackwater and graywater.
- Non-potable effluent uses
  - Indoor; toilet and urinal flushing.
  - Outdoor; surface and subsurface irrigation.

NSF/ANSI 350

- Residential wastewater; Up to 1500 gpd
  - Laboratory testing with actual wastewater.
- Graywater; Up to 1500 gpd
  - Laboratory testing with synthetic wastewater; bathing, laundry, or both
  - Exception; commercial laundry water
- Systems exceeding 1500 gpd, and commercial laundry
  - Field evaluation using actual building wastewater.

350 and 350-1 Standards

350

- Domestic wastewater and graywater used indoors
  - Chemical
  - Biological
  - Physical
  - Indoor uses and unrestricted outdoor use

350-1

- Graywater
  - BOD and TSS
  - Outdoor use only
  - Buried/subsurface drip

NSF/ANSI 350 Effluent Criteria

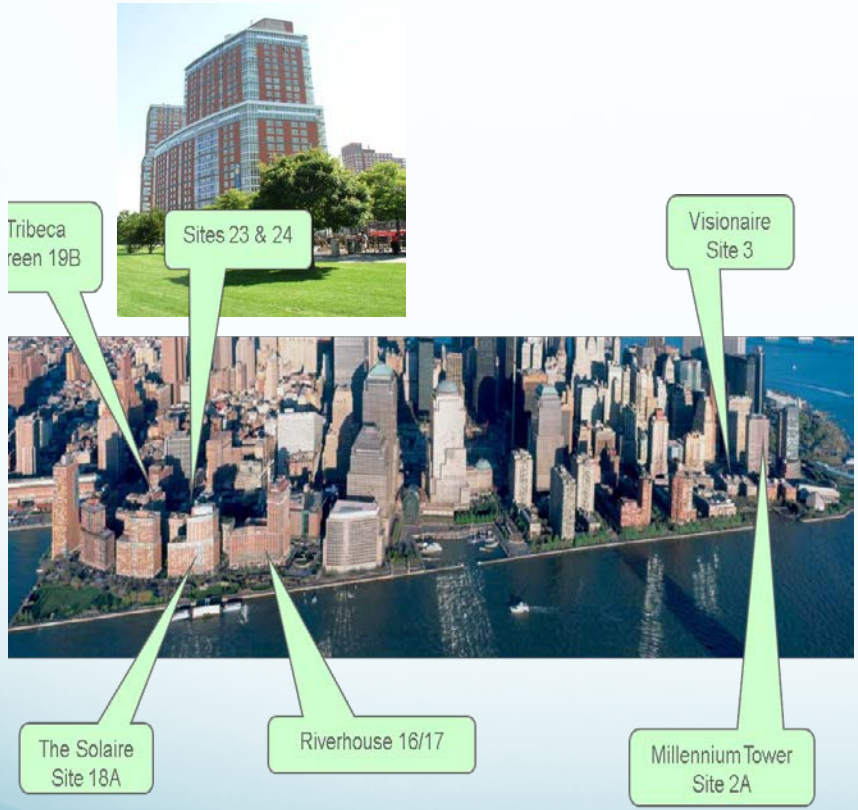
Standards

Parameter	Class R	Class C
$CBOD_5$	10 mg/L (25)	10 mg/L (25)
TSS	10 mg/L (30)	10 mg/L (30)
Turbidity	5 NTU (10)	2 NTU (5)
E. coli	14 MPN/100 mL (240)	2.2 MPN/100 mL (200)
pH	6.0 – 9.0	6.0 – 9.0
Chlorine	0.5 - 2.5 mg/L	0.5 - 2.5 mg/L

Use

- Indoor
  - Toilet flush
  - Laundry (?)
- Outdoor
  - Unrestricted irrigation
  - Pressure washing
  - De Minimis discharge

NYC

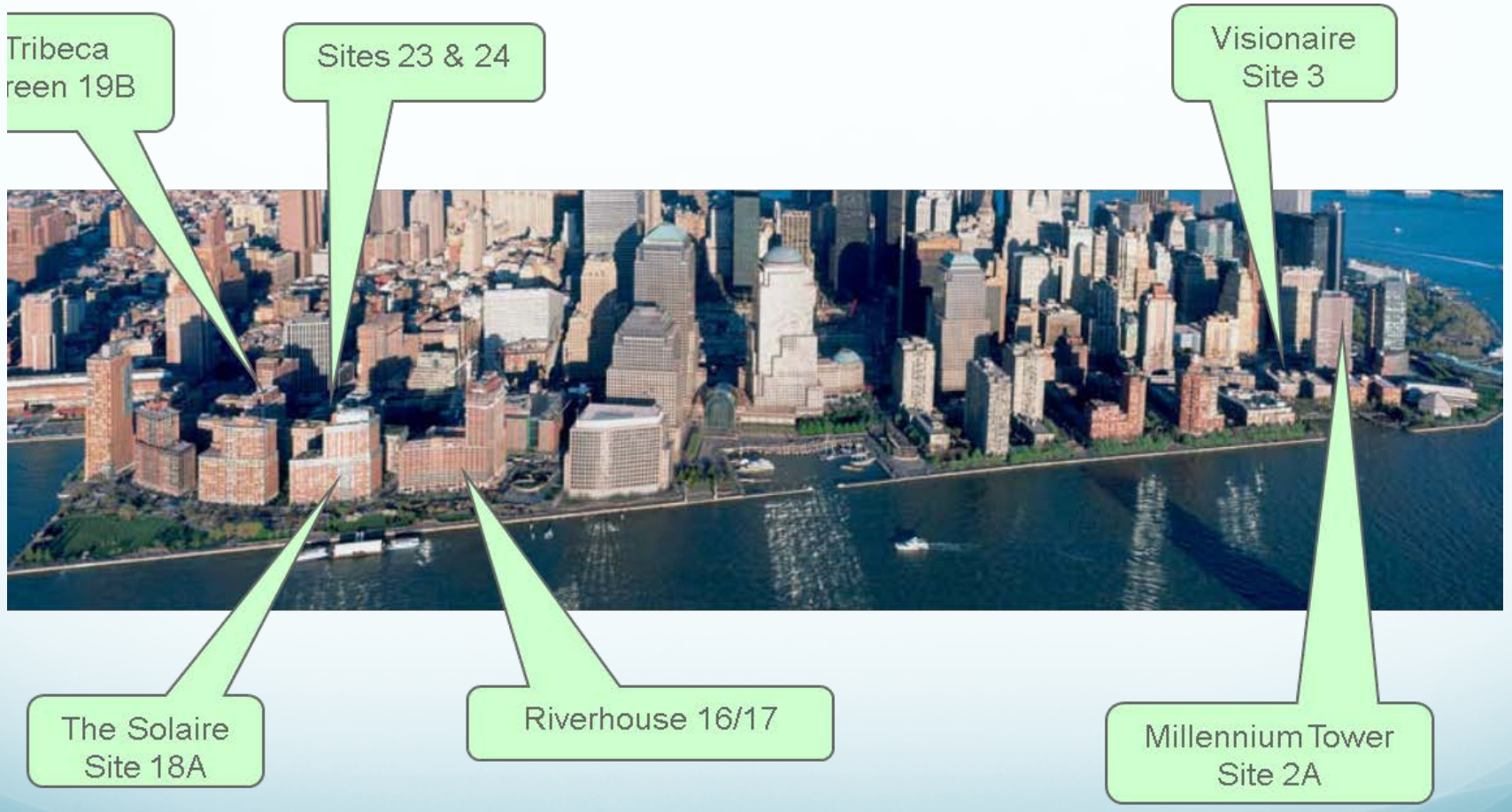


- Decentralized reuse in highly urbanized area
- LEED Platinum
- Green roof filters and captures stormwater
- Wastewater and stormwater treated for reuse
  - Toilet flushing
  - Cooling tower supply
  - Irrigation of park
- Over 50% reduction in potable water consumption
- Almost 60% reduction in wastewater discharge to city

Reference – Battery Park City Authority, Manhattan Borough, NYC, The Solaire – Alliance Environmental, LLC

GovEnergy
www.govenergy.gov

Water reuse influencing the NYC skyline



Wastewater/ Graywater

- Onsite reuse
- Challenge: adjacent to water supply
- The solution: onsite reuse system,
  - High quality treatment
  - Reduced nutrient discharge to GW
  -

Design Parameters

- Minimal land space available/required
- Lack of rules for reuse
  - Used NSF, DWQ or USEPA as a guide
- Modified design for small system
- SCADA

Required Effluent Quality

	Monthly Average	Daily Max	Results
BOD5	10 mg/L	15 mg/L	<5
TSS	5 mg/L	10 mg/L	<5
NH3	4 mg/L	6 mg/L	<2
E-COLI	3/100 mg/L	25/100 mg/L	ND
TURBID	n/a	10 NTU	<1 (15 sec frq)

Benefits of the System

- Honor Donor's legacy and vision
- Reduce nutrient loading to Falls Lake watershed
- Reduce amount of water withdrawn from aquifer
- Provides educational opportunity
- Cost?

Park

Indoor reuse and SAS

Building Code approval

MBR treatment/Pressure manifold/Chamber

NO FIELD REDUCTION

HQW achieved

Award winner

On-line turbidity monitor

ICC and USGBC

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

LEED Certification

Leadership in Energy and Environmental Design

LEED for New Construction and Major Renovation 2009
Project Scorecard

Yes	?	No			
			Water Efficiency		**10 Points**
			Prereq 1	**Water Use Reduction**, 20% Reduction	Required
			Credit 1.1	**Water Efficient Landscaping,** Reduce by 50%	2
			Credit 1.2	**Water Efficient Landscaping,** No Potable Use or No Irrigation	2
			Credit 2	**Innovative Wastewater Technologies**	2
			Credit 3.1	**Water Use Reduction,** 30% Reduction	2
			Credit 3.2	**Water Use Reduction**, 40% Reduction	2
			Project Totals (Certification Estimates)		**110 Points**

Not Certified **Certified:** 40-49 points **Silver:** 50-59 points **Gold:** 60-79 points **Platinum:** 80+ points




IgCC – Ch 3: Jurisdiction

- Water Use Provisions
- Local Jurisdiction determines applicability for Municipal Reuse Systems (Table 302.1)
- Ref: ASHRE/USGBC/IES Standard 189.1 design of High Performance of Green Buildings

Ch 7: Water Resource Conservation, Quality and Efficiency

- 702 – fixtures
  - 702.7: municipal reclaimed water; where available and required in 302.1 reclaimed water shall be supplied to:
    - Water closets
    - Water supplied urinals
    - Water supplied trap primers, and
    - Applicable industrial uses (NCDENR 0.2U defines these)
    - Accessible if less than 150% of distance to potable line

Section 704: Treatment Devices

- 704.3: Onsite reclaimed water system applicable to graywater and wastewater
- Water use in toilet and urinals or irrigation AND SIMILAR APPLICATIONS
- NSF 350

Ch 7, section 706: Non-Potable Water Requirements

- 706.1: Scope – Use and application comply w/local laws, rules and ordinances
- 706.2: Signage – “Non-Potable water is used for… DO NOT DRINK”
- 706.3: Quality – Rules and regs in local jurisdiction or NSF 350

Section 707 – Rainwater Collection and Distribution

- 707.11.5: Filtration – intended use
- 707.11.6: Disinfection – intended use
- 707.11.7.2: Materials NSF 61 if potable use

Section 708 – Gray Water Systems

- 708.2: Permits – Local jurisdiction
- 708.3: Potable connection - backflow protection
- 708.5.1 – Gray water irrigation –
  - Surface and subsurface irrigation
  - 24 Hr retention time

Section 709: Reclaimed Water Systems

- 709.2: Permits – Required!!!
- 709.3: Potable Connections – Protected
- 709.5: Applications – used IAW section 706 and local codes
- 709.1: Tests and Inspections
  - 709.10.1: testing make up piping and reclaimed system
  - 709.10.2: inspection and testing of backflow prevention assemblies IAW 312.10 IPC

Section 710: Alternative Onsite Nonpotable Water Sources

- 710.1: including but not limited to stormwater, RO reject water, foundation drain water, pool backwash shall be permitted if properly treated for intended use and IAW local jurisdiction requirements

Ch 9: Commissioning, O and M

- 901.1: Scope - Pre and Post occupancy issues
- 903.1: Commissioning –
  - Registered design professional requirements
  - Commissioning plan
  - 904.3: Building O and M
    - Record documents
    - O and M manual shall be provided to owner

Selected Standards

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NYC	2	10	10	2.2		

Additional Information and NC/CDC/NEHA Research Report

- Water Environment Research Foundation (WERF) funded research project ***When to Consider Distributed Systems in Urban and Suburban Areas***
- Products
  - Detailed case study summaries, white papers
  - MCDA-based decision-support tool
  - Database of case studies
  - Other targeted communications products (journal articles, presentations, etc.)
- Public access at www.werf.org and www.ndwrcdp.org

Pradahn: Decentralized Reuse,

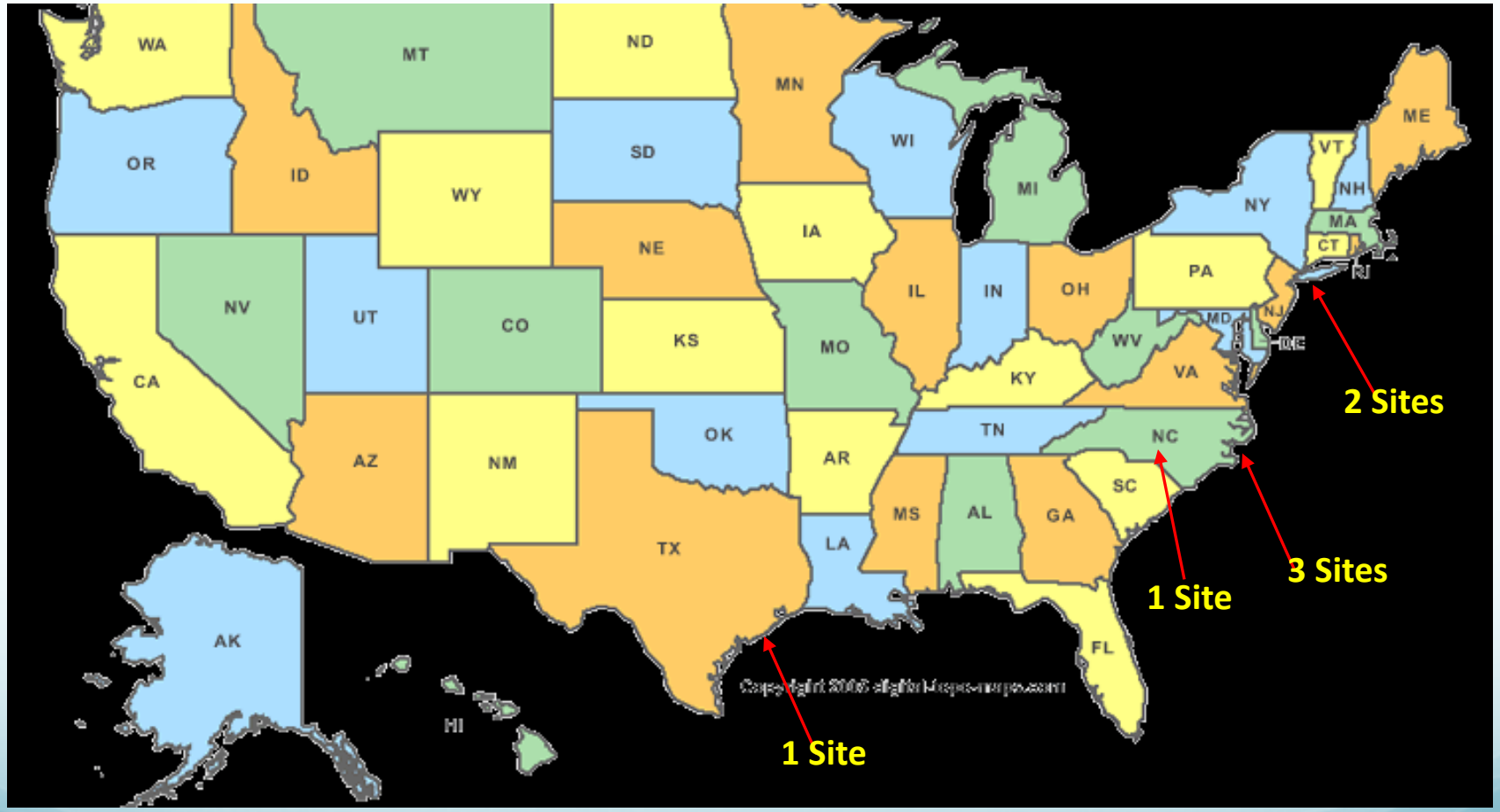
Objectives:

1. Feasibility of using reclaimed water from decentralized systems as non-potable waters for rural and urban communities
2. Implications for public health and environmental quality

Materials and Methods

- Functioning decentralized WW treatment systems across the United States
- One year assessment of decentralized WW reuse system performance
- Routine influent and reclaimed water quality monitoring

Study sites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2 Sites
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3 Sites
1 Site

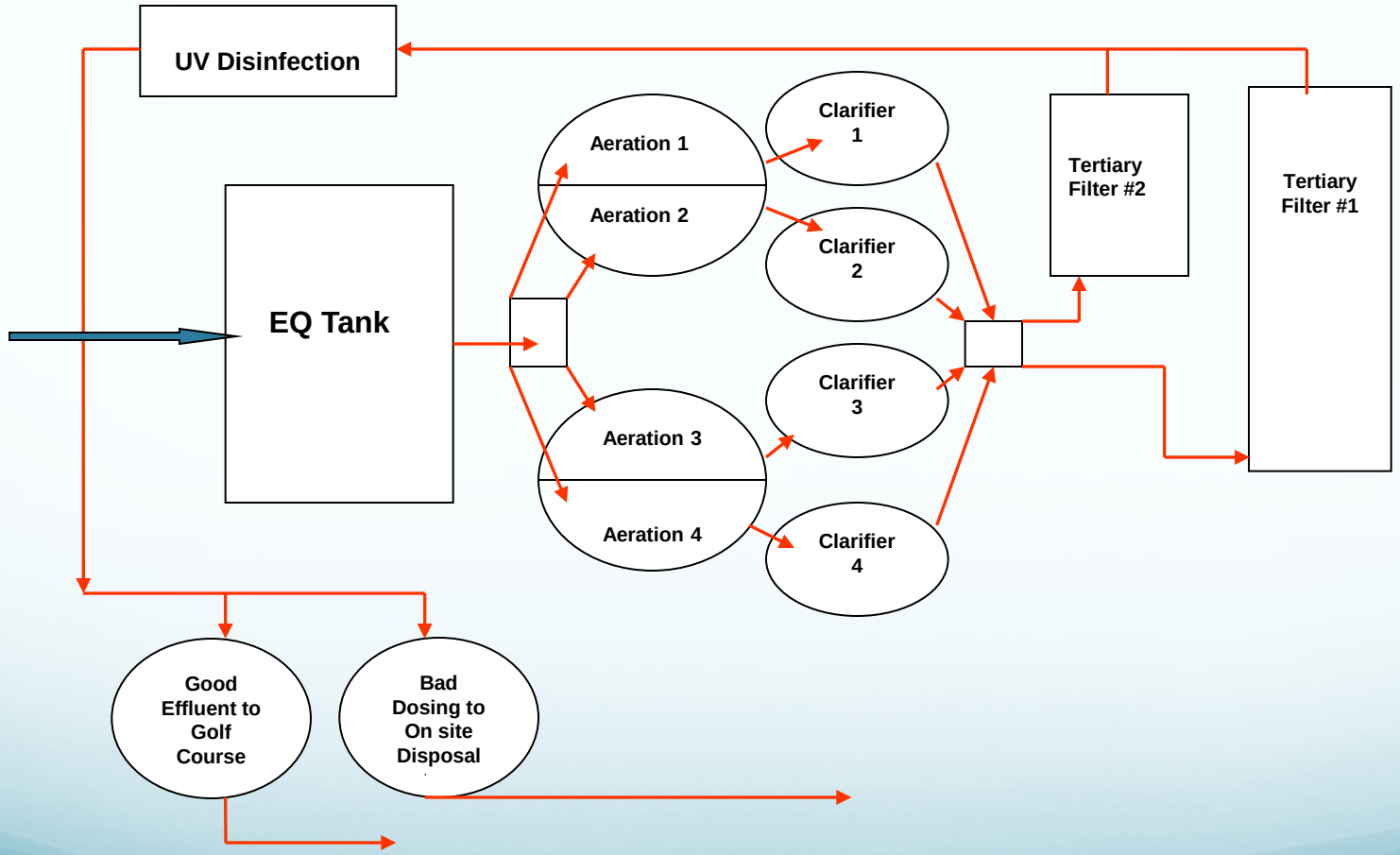
Study sites

Site ID	Facility Type	Type of Reuse	Treatment Systems	Scale of reuse
A PINC	Resort; golf course community with two hotels and small commercial; 900 customers	Surface irrigation of golf course & common grounds; water features	Activated sludge and tertiary filtration w/UV	**Large-scale** multi-subdivision development; cluster
B KDNC	Resort; residential and commercial resort community; 475 customers	Surface irrigation of common grounds; water features	Extended aeration and tertiary filtration w/UV	**Large-scale** subdivision & commercial district; cluster
C GWNC	Resort; retirement community; small; "residential" condo	Surface irrigation at individual homesites & common areas	WWTP w/Cl.	**Small-scale** condominium complex; cluster
D GSNC	Seasonal; school complex; high school and middle school	Subsurface drip irrigation of ball fields (football, soccer, baseball)	Constructed wetland and tidal wetland w/Cl and UV	**Small-scale**, on-site; "wastewater mining"; advanced on-site backup system
E KETX	Very small cluster system	Surface irrigation system with pop-up sprayers	Suspended growth ATU w/Cl	**Very small-scale** cluster system; on-site
F VNYC	High-rise family residential bldg; "residential"	Toilet flushing in high-rise, chiller makeup waters and irrigation	MBR w/ UV and Ozonation	**Medium-scale** on-site; "sewer mining"; sewer backup
G SNYC	High-rise family residential ,with commercial aspects	Toilet flushing in high-rise, chiller makeup waters and irrigation	MBR w/ UV and Ozonation	**Medium-scale** on-site; "sewer mining"; sewer backup

Site A WWTP

- A privately held Public Utility
  - 900 customers
- Design flow = 600,000 gpd
- Avg. daily flow = 350,000 gpd
- Non Compliant effluent – less than 1% of time
- Activated sludge followed by tertiary treatment
- UV disinfection

Site A - process flow diagram

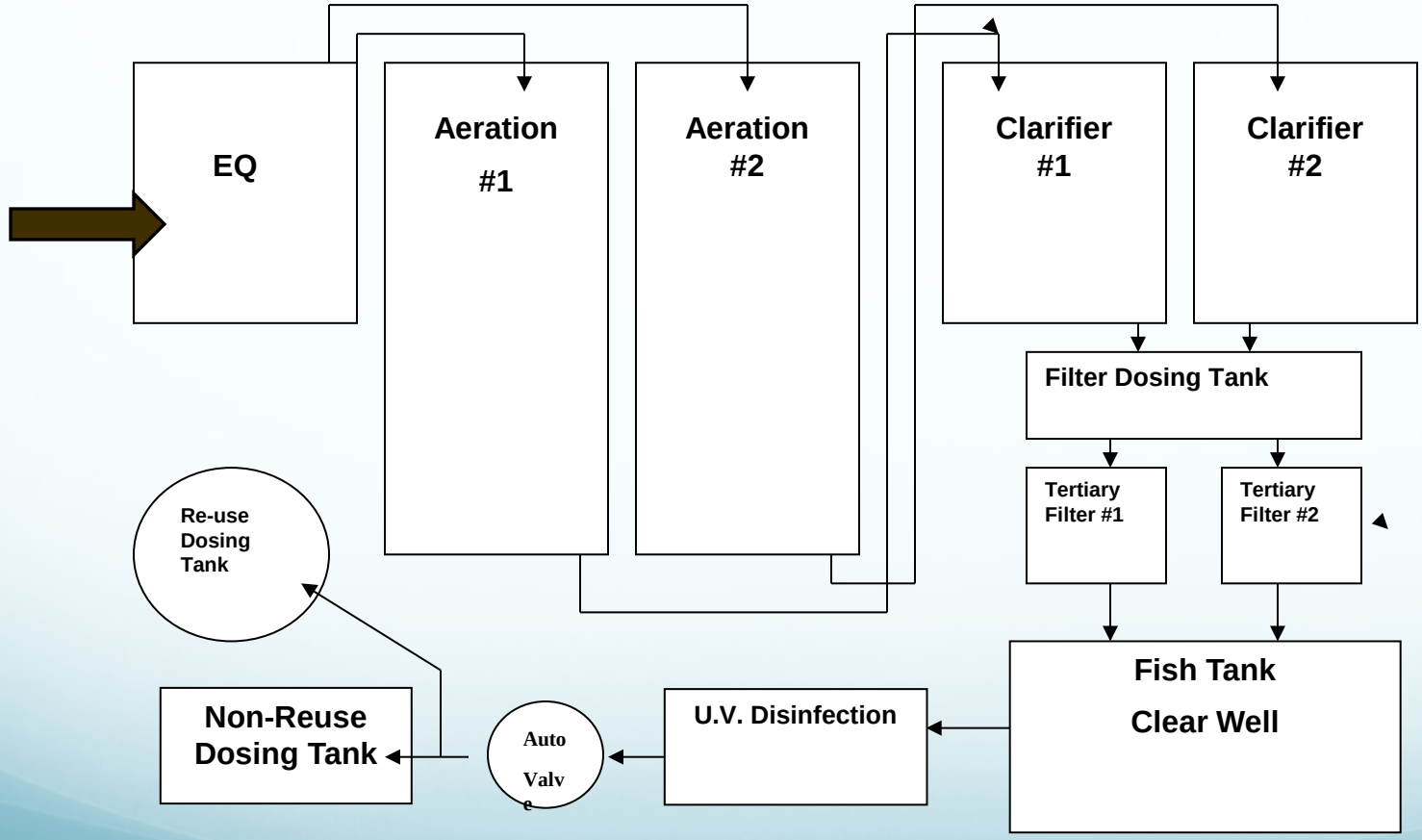


Site B WWTP

- Serves about 475 customers
- Design flow:500,000 gpd
- Actual flow:

  20,000 to 25,000 gpd
- Extended Aeration process
- UV disinfection

Process diagram for site B WWTP plant



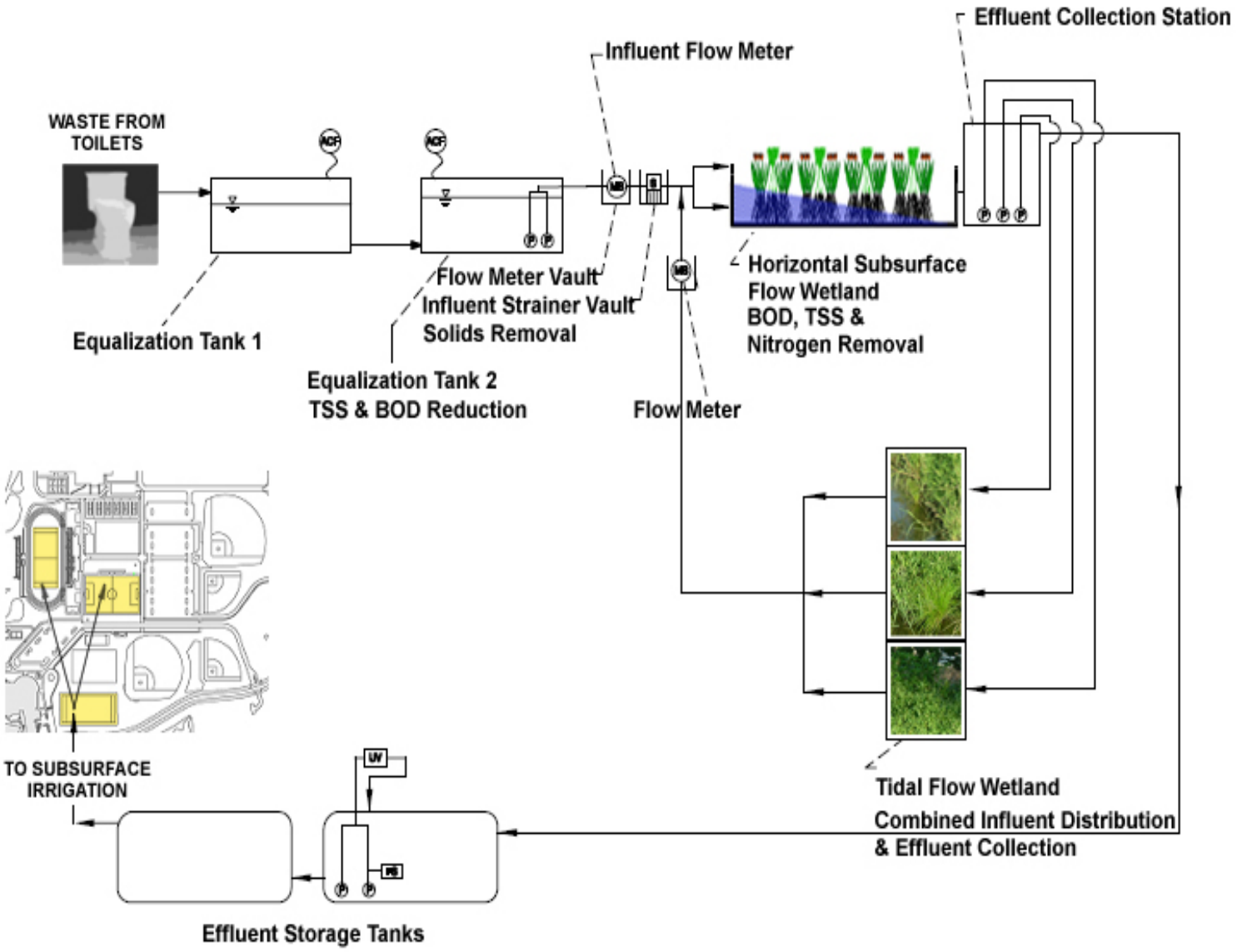
Site C

- A privately held Public Utility serves about 41 patio houses
- Total design flow = 36,000 gpd
- Activated sludge followed by clarifier and then sand filter with chlorine disinfection
- Chlorine dosing = 0.5ppm

Site D

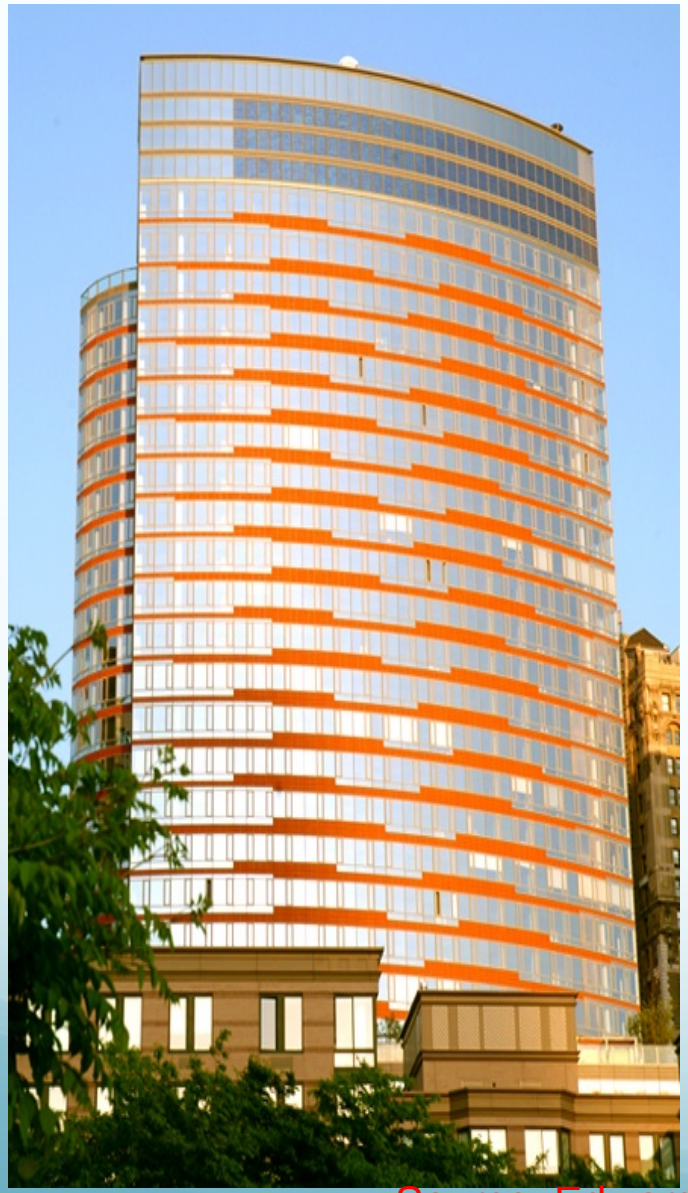
- Wastewater flow – 25,000 gpd
- Horizontal flow wetland nitrification basin with gravel media and aquatic plants
- Three tidal marsh upflow wetland denitrification biofilters with medium and coarse sand media and aquatic plants
- Storage, disinfection, and pumping to drip irrigate athletic fields
  - Stadium football field
  - Football field
  - soccer field

Site D - Process flow diagram



Site E

- Design flow = 770 gpd
- Actual flow = 600 gpd
- Suspended growth ATU with chlorine disinfection
- All of the reclaimed water is used in the spray field

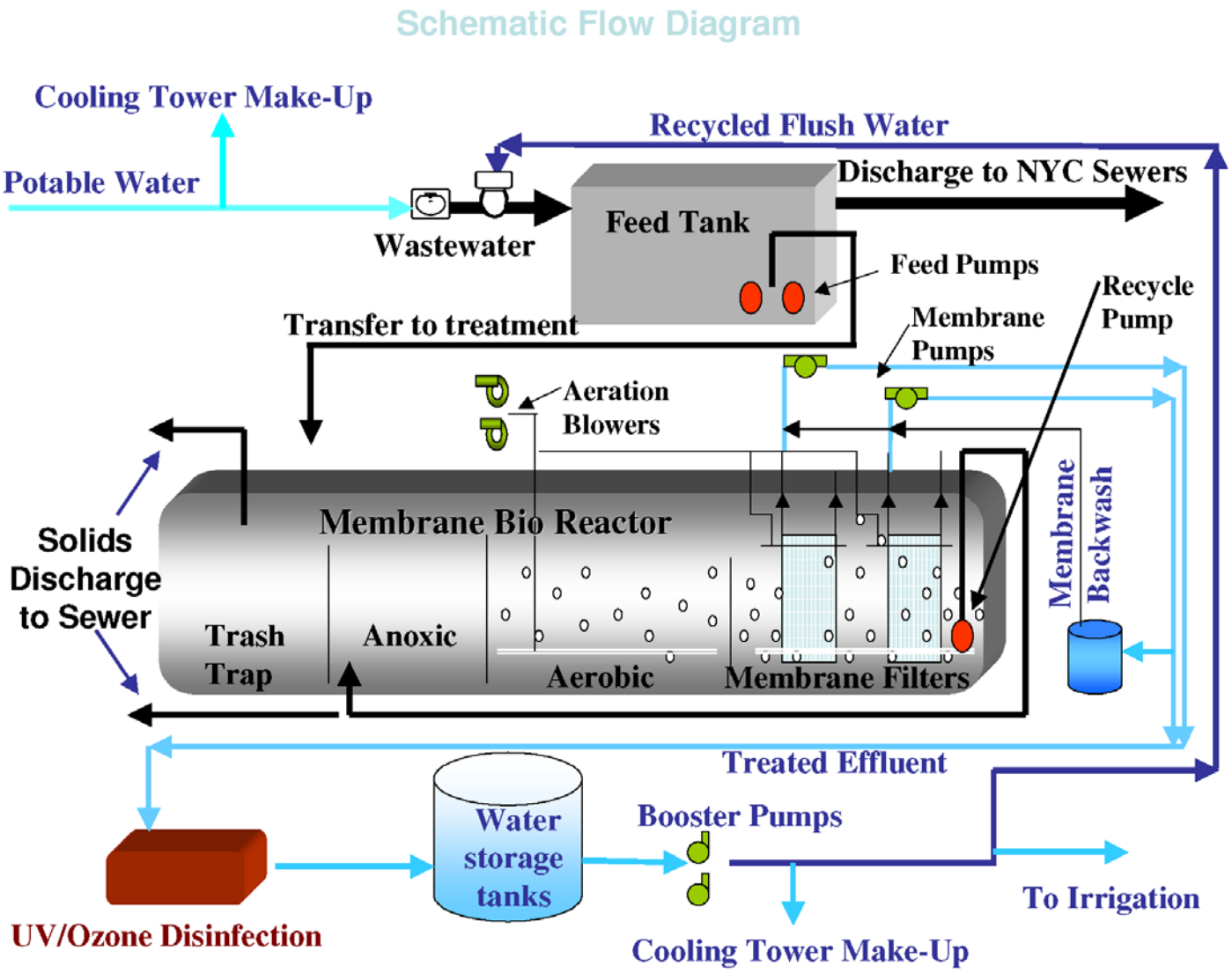


Site F

- 251 Condominiums (35 stories)
- 30,000 gpd WW treatment plant
- Platinum Certification LEED™
- 48% reduction in water use
- > 50% reduction in wastewater discharge
- MBRs – Ultra-filter
- UV and Ozone

Source: Edward A. Clerico, P.E., President Alliance Environmental LLC

Site F - Process flow diagram

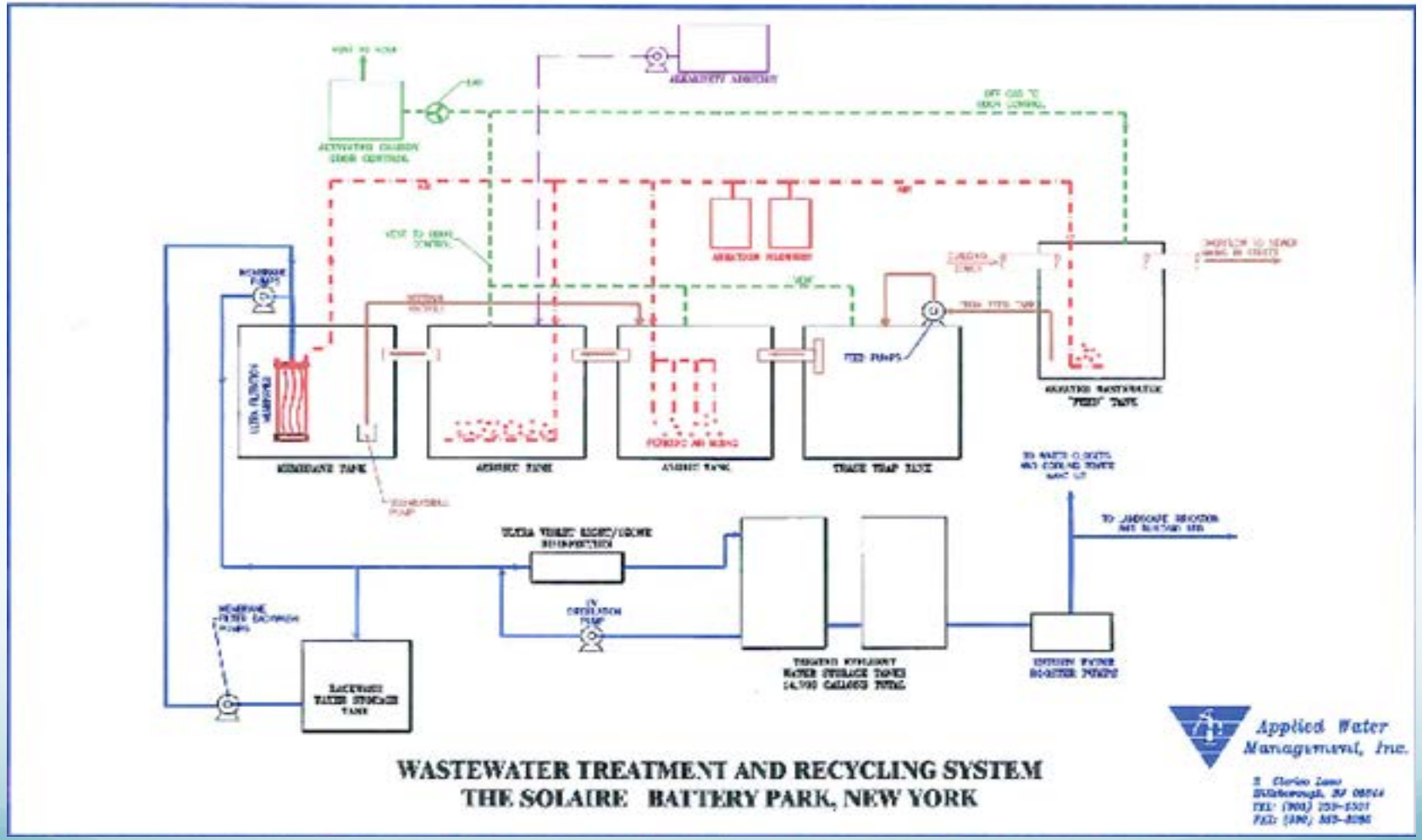


Site G

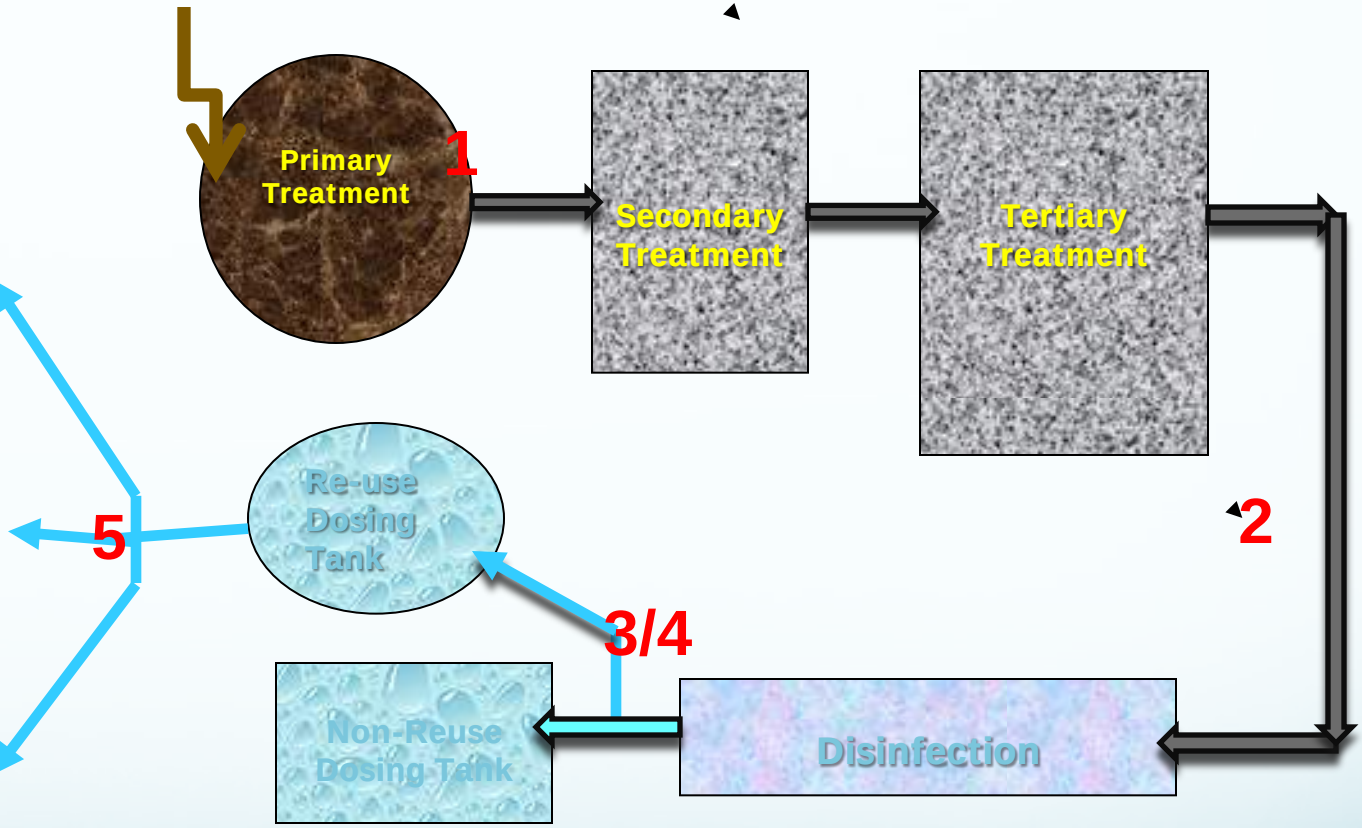
- 293 units
- 25,000 GPD WW treatment plant
- LEED™ Gold Certification
- 48% reduction in water use
- 56% reduction in wastewater discharge

Source: Edward A. Clerico, P.E., President Alliance Environmental LLC

Site G - Process flow diagram



Sampling ports



1 = Influent, 2 = Effluent pre-disinfection
3 = Effluent post disinfection, 4 = Ultra filtration and 5 = End point distribution

Results and discussions

BOD-

Study Sites	Influent BOD_5			Effluent BOD_5			% Reduction	ANOVA (95% CI)
	Avg.	Min	Max	Avg.	Min	Max		
A	160	85	290	1	<2	<2	99.4	A
B	340	161	460	3	<2	8	99.1	A
C	624	280	901	4	<2	10	99.4	A
D	81	25	186	13	15	21	83.4	B
E	114	65	133	9	4	15	91.8	A
F	219	192	234	3	<6	<6	98.6	A
G	175	153	193	3	<6	<6	96.3	A

EPA Guideline = 10 or less; NC rules = Monthly avg. 10 or less, daily max 15, site E home

TSS

Study Sites	Influent TSS			Effluent TSS			% Reduction	ANOVA (95% CI)
	Avg	Min	Max	Avg	Min	Max		
A	129	53	232	1.3	<1	2.3	99.0	AB
B	201	158	257	1.4	<1	4	99.3	AB
C	583	71	1136	2.8	<1	6.7	99.5	A
D	26	19	35	2.3	<1	3.5	91.0	B
E	50	44	56	8.0	5	12	84.0	C
F	296	262	320	0.8	<1	1	99.7	A
G	237	208	260	0.5	<1	<1	99.8	A

EPA Guideline = N/A; NC rules = Monthly avg. 5 or less, daily max 15

Total Nitrogen

Study Sites	Influent TN			Effluent TN			% Reduction	ANOVA (95% CI)
	Avg	Min	Max	Avg	Min	Max		
A	51	25	103	21	6	38	58	B
B	52	29	73	13	5	24	76	AB
C	71	61	84	16	5	37	77	AB
D	160	130	199	24	16	32	85	A
E	59	6	68	15	9.6	18	75	AB
F	63	61	65	29	20	36	54	AB
G	56	48	65	31	24	38	45	B

Turbidity

Study Sites	Influent			Effluent			% Reduction
	Avg	Min	Max	Avg	Min	Max	
A	71	65	80	0.9	0.3	2	98.7
B	117	77	160	0.8	0.2	1.7	99.3
C	194	88	390	1.4	0.2	2.7	99.3
D	16	12	22	0.4	0.2	0.5	97.7
E	50	34	88	4.1	2.3	6.9	91.9
F	65	49	77	0.3	0.1	0.4	99.6
G	50	4	83	0.2	0.0	0.2	99.7

EPA Guideline = (Weekly avg. 2 or less, should not exceed 5 any time); NC rules = Turbidity (10 or less)

Microbial Indictors

Study sites	Geo mean (CFU/100 ml)/Log Reduction			
	E. coli	C. perfringens	Total coliform	Enterococci
A	<10/>6	16/3	176/<5	5/5
B	57/5	58/3	>1945/<4	23/4
C	<1/>8	100/3	169/<6	<2/6
D	2/5	<3/3	101/4	<2/4
E	<41/>4	31/1	<185/<4	<24/<3
F	<1/>6	<1/>4	<1/>7	<1/>6
G	<1/>7	<1/>5	<1/>7	<1/>6

NC rules (2U)= E. coli: 3 or less, daily max 25 (Class A-indoor), 14 or less, daily max 25 (Class B)

Microbial re-growth reoccurrence

Study Sites	*E. Coli (port 3)*	*E. Coli (port 5)*
	CFU/100ml	CFU/100ml
A	<10	<12
B	57	35
C	<1	1
D	2	1
E	<41	228
F	<1	<1
G	<1	<1

Conclusions

Use of reclaimed effluent from DWR systems can reduce demands on potable water supplies by providing local water supplies for meeting non-potable needs in homes and communities.

These options are supported by regulatory agencies, water supply agencies, manufacturers, and the public

This approach provides great potential for cost reduction and energy saving in wastewater transport and process, reduces usage of high value, high dollar, energy intensive drinking water and enhance environmental protection opportunities.